White, L., & Mády, K. (2008). The long and the short and the final: Phonological vowel length and prosodic timing in Hungarian. In P.A. Barbosa, S. Madureira & C. Reis (Eds.), *Proceedings of the 4th Conference on Speech Prosody, 2008* (pp. 363-366).

The long and the short and the final: Phonological vowel length and prosodic timing in Hungarian

Laurence White[1] *and Katalin Mády*[2]

[1] Department of Experimental Psychology, University of Bristol
[2] Institute of Phonetics and Speech Processing, University of Munich

laurence.white@bristol.ac.uk mady@phonetik.uni-muenchen.de

Abstract

The phonological vowel and consonant length distinctions in languages such as Hungarian may provide a constraint on the degree to which prosodic structure can influence speech segment duration. Here we show that, like many other languages, Hungarian does mark prosodic structure with durational variation, in particular, utterance-final lengthening. There is an influence of phonological vowel length on the locus of utterance-final lengthening: long and short vowels are lengthened in absolute-final syllables; long vowels are also lengthened in penultimate syllables. Lengthening within pitch-accented words, observed in languages such as English, appears absent, however. Furthermore, we do not find support for the inverse relationship between word length and stressed vowel duration suggested by previous studies.

1. Introduction

Prosodic structure is known to influence speech timing. In English, it is well established that constituents of pitch-accented words are lengthened [15] and that syllables are longer utterance-finally than utterance-medially [17]. It has been asserted that there is an inverse relationship between stressed vowel duration and word length [4], but this polysyllabic shortening effect has been shown to arise largely from the attenuation of the accentual lengthening of the stressed syllable in longer words [16].

In English, there are no phonemic distinctions cued by vowel duration alone and thus no phonological constraint on the degree of prosodic variation in vowel duration. Many languages do, however, have a phonemic distinction between long and short vowels and consonants cued wholly or largely by duration. This suggests a constraint on prosodic timing effects: short vowels may not be lengthened, or long vowels shortened, so much as to cause perceptual ambiguity at the segmental level.

Finnish and Hungarian are both Finno-Ugric languages with a quantity distinction for vowels and consonants. They also share a fixed word-initial stress pattern, but differ in the suprasegmental correlates of stress. Finnish indicates stress by lengthening of the first two morae, whether these are both in the word-initial stressed syllable or not [13]. Additional lengthening is observed within these morae when the word carries contrastive pitch accent, but not when the accent is thematic [10]. Thus, both long and short vowels show degrees of lengthening due to prominence, but the relationship between such durational variation and word structure is systematic and may serve – together with the alignment of the F0 contour with the segmental string – to facilitate distinction of long and short vowels in ambiguous cases [9]. There is no evidence of polysyllabic shortening in Finnish: compensatory timing relationships appear to operate largely within a locus defined with respect to the first two morae of the word [10]. Utterance-final lengthening is observed in both absolute-final syllables and in penultimate syllables: the magnitude of lengthening in penultimate position is much greater for long vowels, but this appears to be a proportional scaling effect [7].

Thus, despite the segmental quantity distinctions, suprasegmental durational variation is also observed in Finnish, although the interactions are complex, perhaps as a result of the need to maintain a perceptual phonemic contrast.

It has been claimed that Hungarian does not use vowel lengthening to indicate lexical stress, in order to maintain the quantity distinction between long and short vowels; further, that lexical stress is marked by higher intensity and an optional change in pitch [2]. Temporal effects of prosodic structure have been demonstrated, however, though previous studies are not always clear about the prosodic domains under investigation. An early study of 350 short utterances produced by five different speakers found that both short and long vowels were shortest in initial position, intermediate in medial position and longest in final position [5], although the materials confounded the effects of syllable structure, word position and utterance position. A single-speaker study comparing whole-word durations in utterance-initial, medial and final positions showed considerable final lengthening for monosyllables [8]. The amount of lengthening was attenuated according to word length, but still significant for pentasyllables. Data are lacking on the distribution of final lengthening within the word, and regarding durational effects in utterance-penultimate syllables in particular, although it has been reported that a consonant preceding an utterance-final vowel can also be lengthened in Hungarian [2, 3].

There has been some investigation of polysyllabic shortening in Hungarian. An early experiment found stressed vowels to be shorter in disyllables than monosyllables, although the experimental design was highly unbalanced (~ 650 monosyllables vs 20 disyllables) [6]. Two studies have compared stressed and unstressed syllables in sequences of words from one to five syllables in length, and found shortening of the initial (stressed) syllable, as well as evidence of word-final lengthening [6, 14]. The targets were uttered as isolated words, however, allowing the possibility that observed polysyllabic shortening could be due to the attenuation of final lengthening in the longer words.

The durational effects of pitch accent (phrasal stress) have not been investigated directly, although the durational difference between short and long vowels has been reported to be smaller in unaccented syllables than in accented syllables, due to lengthening of short vowels in unaccented words [3]. This surprising finding contradicts what has been

found for languages such as English (lengthening in accented words [15]) and Finnish (no effect of thematic accent, lengthening in contrastively accented words [10]).

As this summary of the available literature indicates, the influence of prosodic structure on speech segment duration in Hungarian is not clearly established. We would like to determine the distribution of the durational effects of pitch accent and utterance-finality, and examine the interaction of these effects with phonological vowel length and with word length. In this initial study, we consider just the effect of prosodic structure on stressed (i.e. word-initial syllable) vowels. The experimental questions are:

- Are stressed vowels longer in utterance-final words than in utterance-medial words?
- Are stressed vowels longer in pitch-accented words?
- Is there an inverse relationship between word length and stressed vowel duration (polysyllabic shortening)?
- Do prosodic influences on speech segment duration affect phonologically long and short vowels equally?

2. Method

2.1. Materials

The materials were constructed around a pair of vowels contrasting in phonemic vowel length: /o/ and /o:/. Each vowel was placed in a fixed syllable frame within three lexical contexts: monosyllabic, disyllabic and trisyllabic. The short vowel target words were *sok*, *sokat*, *sokaság*, and the long vowel targets were *sók*, *sókat*, *sókanal*. Each word was placed in four sentence contexts: utterance-medial focused, utterance-medial non-focused, utterance-final focused, utterance-final non-focused. We allowed the sentence context to guide speakers, and found that, for the most part, accent was placed according to the focus structure of the sentence.

There were 24 experimental sentences in total: 2 vowel length conditions x 3 word length conditions x 2 accent conditions x 2 utterance position conditions.

2.2. Recordings

All participants read all sentences in four random orders, with order of block presentation varied between speakers, hence there were 96 experimental utterances for each speaker. Speakers were instructed to read the sentences in a normal conversational voice and at a comfortable, natural rate, pausing between sentences, but not pausing within sentences.

2.3. Participants

We recorded ten native Hungarian speakers from Budapest. None reported any speech or hearing problems.

2.4. Vowel duration measurement

The second author, a native Hungarian speaker, listened to all the recordings to assess their production. Utterances were excluded where the focused target word had not received an accent or where the unfocused target word had been accented. Up to three prosodically-acceptable utterances per sentence context were chosen for each target word for each speaker. There were eight data cells out of 240 for which there were no usable utterances, a missing data rate of 3.3%.

For each of the prosodically-acceptable utterances, target vowel onset and offset were labelled by the first author, by inspection of the waveform and spectrogram in Praat (http://www.fon.hum.uva.nl/praat/). Vowel onset and offset were primarily determined according to the appearance and disappearance of the second formant, with reference also made to the shape of successive pitch periods in ambiguous cases. Vowel durations were then extracted using a Praat script and the means for each speaker calculated from the three or fewer prosodically-acceptable realisations for each condition.

3. Results

3.1. Overall results

Table 1 shows the mean vowel durations for all experimental conditions. The first trend to note is the lack of any consistent effect of pitch accent on stressed vowel duration. A By-Subjects repeated-measures ANOVA including Pitch Accent, Vowel Length, Word Length and Utterance Position as factors confirmed that there was no main effect of Pitch Accent [$F(1,4) = 1.93$, $p > .1$]. There were main effects of all the other factors and a number of interactions, including between Vowel Length and Utterance Position [$F(1,4) = 36.12$, $p < .005$]. To explore these effects and interactions further, we pooled the data for accented and unaccented words, and performed separate ANOVAs for short vowels and long vowels. This pooling also had the effect of reducing the missing data rate to zero.

No. of syllables in word	Accent condition	
	Unaccented	Accented
Short vowels: utterance medial		
1	60 (2.5)	54 (1.8)
2	47 (1.6)	45 (1.9)
3	47 (1.8)	46 (0.7)
Short vowels: utterance-final		
1	75 (5.1)	80 (5.1)
2	44 (2.9)	49 (1.5)
3	38 (2.1)	47 (1.8)
Long vowels: utterance-medial		
1	88 (4.4)	94 (6.7)
2	89 (4.6)	86 (5.0)
3	86 (4.6)	88 (3.8)
Long vowels: utterance-final		
1	127 (7.6)	135 (8.2)
2	105 (6.7)	108 (4.8)
3	92 (5.5)	95 (4.3)

Table 1: Mean vowel durations in ms (standard errors in parentheses) for all experimental conditions.

3.2. Durational patterns for short vowels

Figure 1 shows mean vowel duration for short stressed vowels, pooled across accent conditions. A two-way By-Subjects repeated-measures ANOVA showed effects of Word Length [$F(2,18) = 71.52$, $p < .001$] and Utterance Position [$F(1,9) = 6.65$, $p < .05$], and an interaction between these factors [$F(2,18) = 25.48$, $p < .001$]. Tukey HSD post-hoc

comparisons showed that the vowel was longer in monosyllables than in either disyllables or trisyllables in both positions: utterance-medial, $p < .05$; utterance-final, $p < .01$. The nature of interaction was shown in a posthoc comparison: vowels were longer in utterance-final monosyllables than in medial monosyllables ($p < .01$). Thus, the degree of "monosyllabic lengthening" was greater in utterance-final position.

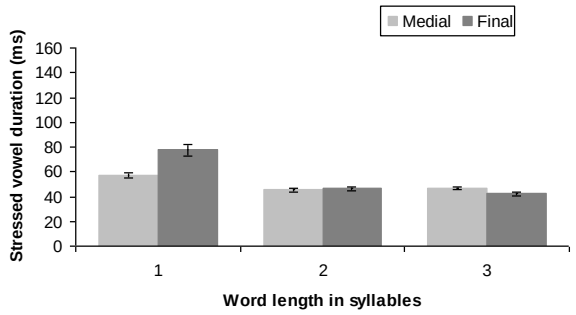

Figure 1: *Mean durations for short stressed vowels according to word length and utterance position (error bars indicate ± one standard error).*

The results clearly do not support the polysyllabic shortening hypothesis, which predicts vowel duration differences between disyllables and trisyllables as well as between monosyllables and disyllables. The interaction suggests that two processes are at work, accounting for the different magnitude of the monosyllabic lengthening effect in utterance-medial and utterance-final words.

Utterance-final lengthening is the obvious interpretation in that position. Short vowels are longest in absolute-utterance-final syllables, and there is no evidence of lengthening of the vowel in utterance-penultimate or antepenultimate syllables.

What underpins the finding of a monosyllabic lengthening effect in utterance-medial position? Examination of the materials indicates that, whenever the stressed vowel was in monosyllabic position utterance-medially, it was followed by another stressed (i.e. word-initial) syllable, as, for example, in: "Nálunk meg sok vizsgálatot végeznek a kutatók" (target underlined). In polysyllables, however, the stressed vowel was always followed by an unstressed (i.e. non-word-initial) syllable. There is evidence in English of stress-adjacent lengthening, whereby the first of two successive stresses is lengthened relative to when it is followed by an unstressed syllable [1], although it is unclear whether this actually applies only in the case of adjacent pitch accents. An analogous effect of either type could account for this observation in the Hungarian materials, although a comparison with monosyllables followed by unstressed function words would be needed to confirm this.

3.3. Durational patterns for long vowels

Figure 2 shows mean vowel duration for long stressed vowels, pooled across accent conditions. Once again, a two-way By-Subjects repeated-measures ANOVA showed effects of Word Length [$F(2,18) = 28.12$, $p < .001$] and Utterance Position [$F(1,9) = 45.58$, $p < .001$], and an interaction between these factors [$F(2,18) = 22.53$, $p < .001$]. Tukey HSD post-hoc comparisons indicated that the difference in vowel duration between utterance-medial monosyllables and polysyllables (mean 8 ms) did not attain significance (the critical difference at $\alpha = .05$ was 11 ms).

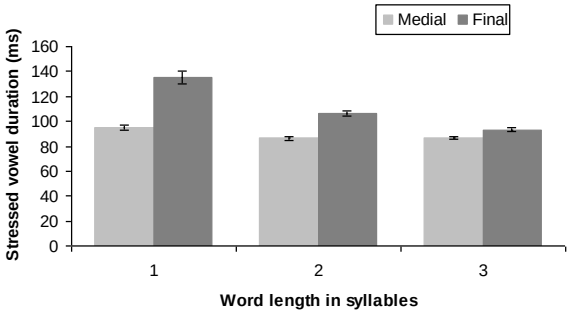

Figure 2: *Mean durations for long stressed vowels according to word length and utterance position (error bars indicate ± one standard error).*

For utterance-final words, however, there was clear evidence of a gradient lengthening effect, diminishing with distance from the boundary: vowels in monosyllables were longer than in disyllables ($p < .01$) and vowels in disyllables were longer than in trisyllables ($p < .05$). A comparison between medial and final words indicated that the degree of final lengthening was significant for both monosyllables ($p < .01$) and disyllables ($p < .01$).

The contrast in utterance-final durational patterns for long and short disyllables indicates the nature of the interaction between Vowel Length and Utterance Position found in the initial omnibus ANOVA. The magnitude of lengthening is greater for long vowels: for monosyllables, long vowels show 40 ms (42%) utterance-final lengthening, whereas short vowels show 21 ms (37%). As the percentage figures indicate, however, the proportion of lengthening, relative to utterance-medial duration, is comparable for long and short vowels. This to some extent echoes the findings for Finnish [7]; however, for Hungarian, the distribution of lengthening differs for long and short vowels. Short vowels are only lengthened in absolute utterance-final syllables, whereas long vowels are also lengthened by 19 ms (23%), relative to utterance-medial position, in utterance-penultimate syllables. There is no evidence of a lesser but proportional degree of utterance-penultimate lengthening in short vowels, as found for Finnish.

The interpretation of utterance-medial monosyllabic lengthening as a stress-adjacency effect is not supported for long vowels. There is, however, a numerical difference which might prove robust with greater experimental power. The difference might also relate to contrasts in syntactic function and structure: the "sók" stimuli were the first elements in noun-noun phrases, while "sok" is an adjective ("many"), followed by a noun which is likely to be closely prosodically bound to the preceding target word and to be pitch accented, both of which could magnify any stress-adjacency effect. Further studies with a range of materials would be needed to confirm this finding.

4. Discussion

4.1. Are stressed vowels longer in utterance-final words than in utterance-medial words?

The results clearly demonstrate the operation of utterance-final lengthening in Hungarian, despite the apparent importance of duration as a cue to phonological vowel length. It may be noted that the shortest utterance-medial long vowels (about 87 ms in disyllables and trisyllables) are not greatly longer than short vowels in absolute utterance-final syllables (78 ms). This raises the question of whether vowel lengthening serves as an explicit cue to utterance boundaries for listeners, as it seems unlikely that it could simultaneously cue vowel identity and prosodic structure. Perceptual studies would be necessary to determine whether it is in fact the overall distribution of lengthening within the utterance-final word that gives rise to the percept of a boundary. Further work is also required to ascertain if lengthening is manifest at utterance-medial prosodic boundaries in Hungarian.

4.2. Are stressed vowels longer in pitch-accented words?

Here we find no evidence of a consistent lengthening effect of pitch accent on stressed vowel duration in Hungarian. This is in line with the observation that there is no durational marking of lexical stress in Hungarian. There is indirect evidence here that a clash between stressed or pitch-accented syllables may have durational consequences, with lengthening of the first stress. More work is necessary to establish the validity of this mechanism. We have not tested whether *contrastive* focus causes lengthening, as in Finnish [12].

4.3. Is there an inverse relationship between word length and stressed vowel duration?

Previous studies that have reported polysyllabic shortening in Hungarian may have confounded word-level and utterance-level effects. Here we find no evidence of polysyllabic shortening. The distribution of accentual lengthening has been hypothesised to underpin the observation of polysyllabic shortening in English [16]; according to this interpretation, the lack of a polysyllabic shortening effect is unsurprising, given the absence of accentual lengthening in Hungarian.

4.4. Do prosodic influences on segment duration affect phonologically long and short vowels equally?

Vowel quantity appears important for determining the locus of final lengthening: short vowels are not lengthened further from the boundary than the absolute utterance-final syllable, whereas long vowels are lengthened by 23% in utterance-penultimate syllables. It may be that the pause immediately following the final syllable allows the lengthening of the short vowel to be interpreted unambiguously in that case.

5. Conclusions

Although the segmental and suprasegmental uses of duration are different in English, Finnish and Hungarian, in all three languages lengthening effects are observed at important points within the utterance. The domain-and-locus model [16] of English speech timing suggests that, outside these loci of lengthening, prosodic structure does not directly influence speech timing. The absence of polysyllabic shortening noted here for Hungarian is in line with the predictions of the model, which has also been applied to account for the distribution of durational effects in Finnish [11]. As in many languages, the utterance-final boundary is a locus of lengthening in Hungarian; however, the nature of the locus appears here to be influenced by the phonological length of the final stressed vowel.

6. Acknowledgements

Thanks are due to Anna Babarczy and Eva Deliaga for invaluable assistance with recruitment and recording. Work supported by a British Academy grant to the first author.

7. References

[1] Bolinger, D. 1965. *Forms of English: Accent, Morpheme, Order*. Cambridge, Mass.: Harvard University Press.

[2] Fónagy, I. 1958. A hangsúlyról [On stress]. *Nyelvtudományi Értekezések* 18.

[3] Kassai, I. 1979. *Időtartam és Kvantitás a Magyar Nyelvben*. [*Duration and Quantity in Hungarian*.] Budapest: Akadémiai Kiadó.

[4] Lehiste, I. 1972. The timing of utterances and linguistic boundaries. *Journal of the Acoustical Society of America* 51, 2018-2024.

[5] Magdics, K. 1966. A magyar beszédhangok időtartama [Duration of Hungarian speech sounds]. *Nyelvtudományi Közlemények* 68, 125-139.

[6] Meyer, E.A. & Gombocz, Z. 1909. *Zur Phonetik der Ungarischen Sprache* [*On the Phonetics of Hungarian*]. Upsala : Berlings Buchdruckerei.

[7] Nakai, S., Kunnari, S., Turk, A., Suomi, K. & Ylitalo, R. (Under revision). Utterance-final lengthening and quantity in Northern Finnish.

[8] Olaszy, G. 2006. *Hangidőtartamok és Időszerkezeti Elemek a Magyar Beszédben* [*Sound Durations and Temporal Structure in Hungarian Speech*]. Budapest: Akadémiai Kiadó.

[9] Suomi, K. 2005. Suomen kielen prominenssien foneettisesta toteutumisesta [Phonetic realisation of prominence in Finnish]. Virittäjä 109, 221-243.

[10] Suomi, K. 2007. On the tonal and temporal domains of accent in Finnish. *Journal of Phonetics* 35, 40-55.

[11] Suomi, K. (Under revision). Durational elasticity for accentual purposes.

[12] Suomi, K., Toivanen, J. & Ylitalo, R. 2003. Durational and tonal correlates of accent in Finnish. *Journal of Phonetics* 31, 113-138.

[13] Suomi, K. & Ylitalo, R. 2004. On durational correlates of word stress in Finnish. *Journal of Phonetics* 32, 35-63.

[14] Tarnóczy, T. 1965. Can the problem of automatic speech recognition be solved by analysis alone? Rapport du 5. Congrès International d'Acoustique, Vol. 2. Confèrances générales Liège: D.E. Commins 371─387.

[15] Turk, A.E. & White, L.S. 1999. Structural influences on accentual lengthening in English. *Journal of Phonetics* 27, 171-206.

[16] White, L. 2002. *English Speech Timing: A Domain and Locus Approach.* Unpublished University of Edinburgh PhD dissertation.

[17] Wightman, C.W., Shattuck-Hufnagel, S., Ostendorf, M. & Price, P.J. 1992. Segmental durations in the vicinity of prosodic phrase boundaries. *Journal of the Acoustical Society of America*, 91, 1707–1717.