

## On neutral vowels in Hungarian

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### ABSTRACT

Neutral vowels are vowels that may intervene between the trigger and target of a harmony pattern even when they bear the opposite value for the harmonizing feature. Despite the significant body of work on and the crucial role of vowel harmony in phonological theory, surprisingly little attention has been devoted to the low-level phonetic properties of neutral vowels. We examine a prototypical example of neutrality from Hungarian vowel harmony by comparing tongue dorsum location for the phonemically invariant neutral vowels like [ɨ] in different harmonic contexts -- a back context where the neutral vowel appears between two back vowels, and a front context where the neutral vowel appears between two front vowels. Observed differences in tongue dorsum location are linked to independent results on the quantal relation between articulation and sound and may provide a phonetic basis for the phenomenon of neutrality in vowel harmony.

### 1. INTRODUCTION

Since Öhman's seminal investigation of coarticulation in VCV sequences [1], it is known that vowels exert influences on other vowels across intervening consonants. Such V-to-V coarticulation effects are generally assumed to provide a natural phonetic basis for vowel harmony ([2], [3]), the phenomenon found in many languages by which vowels in some morphophonological domain must agree in terms of certain phonetic properties. For example, in Hungarian, vowels in a word must agree in terms of the feature [ $\pm$ back]. The phonological consequences of this systematicity are most readily observed in suffix vowel alternations, as in város-nak 'city.dative' vs. öröm-nek 'joy.dative', where the backness of the suffix vowel is dictated by the backness of the preceding stem vowel (the acute accent denotes length, the umlaut denotes front round vowels; [4], [5], [6], [7]). In many languages with vowel harmony, however, one also finds a set of so-called *neutral* vowels whose presence seems to have no effect on the harmonic pattern of the morpheme they are part of. In Hungarian, the neutral vowels are [i, i, é, e] and some representative examples of words containing these vowels are papír-nak 'paper.dative', gumi-nak 'rubber.dative', kávé-nak 'coffee.dative', and hárem-nak 'harem.dative'. As seen in these examples, the first ([+back]) stem vowel dictates the backness value for the suffix vowel across the intervening neutral vowel which is specified for the opposite value of backness. Effectively, then, vowels may

establish harmony relations across not only consonants but also neutral vowels. Consequently, neutral vowels present a challenge to the proposal that vowel harmony has its basis in V-to-V coarticulation effects between consecutive vowels.

### 2. TWO HYPOTHESES ON NEUTRALITY

In seeking to rationalize the apparently paradoxical behavior of neutral vowels, we may turn to the low-level phonetic properties of such vowels. In one hypothesis, Ohala traces the phonetic basis for the neutrality of [i e] in the coarticulatory properties of these vowels. Given the extreme values of F2 for [i e], Ohala proposes that these vowels exert a strong coarticulatory effect on their adjacent vowels such that "listeners would be most aware of such a phonetically mechanical effect and thus be able to parse it out of the signal" ([3], p. 493). This observation may help explain why neutral vowels do not trigger harmony. However, the other equally important trait of neutral vowels is that they allow their surrounding vowels to harmonize. Thus, in zafir-ban 'sapphire.ellative' the suffix vowel agrees with the first stem vowel in being back. It is not clear how the backness of the suffix vowel can be ascribed to (a phonologization of) V-to-V coarticulation from the first stem vowel, given that the two vowels are not adjacent, and given that the intervening [i] would block such an effect from propagating to the suffix.

An alternative hypothesis is that transparency is grounded in the quantal nature of the relation between articulation and sound ([8]). Independent work by Stevens, using simple tubes, and Wood, using natural human vocal tract profiles, has shown that the acoustic outputs for non-low front vowels—exactly the transparent vowels of languages like Hungarian and Finnish—are insensitive to a limited amount of variation in the articulatory parameter of constriction location ([9], p. 12, [10], p. 41).

We hypothesize that the [i:] in zafir-ban 'sapphire.ellative' is somewhat retracted articulatorily as compared to the [i:] in zefir-ben 'zephyr.ellative', but that this retraction of the vowel's constriction location falls within that limited region of variation that does not result in any significant acoustic consequences. If this hypothesis is correct it provides a principled understanding of the co-occurrence of two properties of the phenomenon, the nature of the harmonizing parameter (tongue dorsum retraction) and the set of transparent vowels in Hungarian ([i, e, í, é]). The hypothesis is also consistent with the selection of a back

suffix in words like *zafir-ban*, because the neutral vowel does participate articulatorily in the harmony (albeit with non-distinctive retraction), and it is thus able to induce backness on the suffix vowel.

### 3. HUNGARIAN NEUTRAL VOWELS

In this first articulatory study of neutral vowels in vowel harmony, we focused narrowly on whether neutral vowels are produced differently in a back harmony context as compared to a front harmony context. In short, we examined whether there are any differences in the location of the tongue dorsum between [i:] in *zafir-ban* ‘sapphire.ellative’ and [i:] in *zefir-ben* ‘zephyr.ellative’. See [11], [12] for previous acoustic studies of Hungarian and Finnish neutral vowels, respectively.

Electromagnetic midsagittal articulometry (Emma, [13]) was employed to record the trajectories of receivers placed on the tongue (tip, body, dorsum) in the mid-sagittal plane during neutral vowels. Three Hungarian subjects, all speakers of the Budapest variety, read a randomized list of 116 stimuli words embedded in the sentence ‘Azt mondom, hogy \_\_\_ és elismétlem azt, hogy \_\_\_ még egyszer’ (‘I say \_ and I say \_ once again’). There were two repetitions of this sentence per word. Stimuli words contained neutral vowels in front/back contexts, and the contexts were matched for consonantal environment as closely as possible. A sample of pairs from the stimuli words used is given in Table 1. There were a total of 58 such pairs. A representative fragment of the Emma data showing tongue tip, body and dorsum kinematics for the word *acél-nak* ‘steel.dative’ is shown in Figure 1. The labels ‘max’ show target locations for the receivers, where target is taken as the location of the receiver at the time point when it reaches extreme horizontal advancement during the vowel.

BACK	FRONT	SUFFIX
kábít-om ‘daze’ [ka:bi:tom]	répít-em ‘send’ [re:pi:tɛm]	1 <sup>st</sup> pers. sg. poss.
buli-val ‘party’ [bulival]	bili-vel ‘pot’ [bilivɛl]	Instrumental
bódé-től ‘hut’ [bo:de:to:l]	bidé-től ‘bidet’ [bide:tø:l]	Ablative
hárem-ba ‘harem’ [ha:rembɔ]	érem-be ‘medal’ [e:rɛmbɛ]	Illative

Table 1: Representative stimuli.

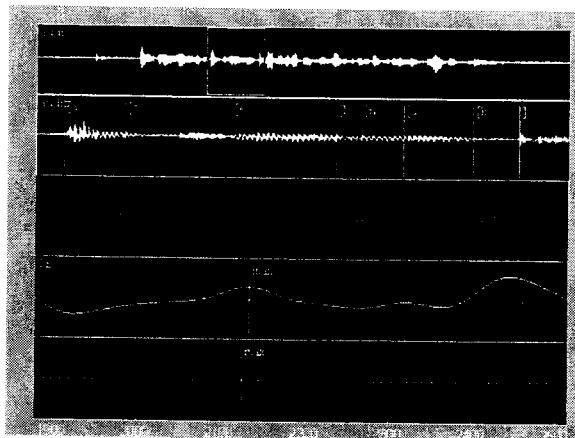


Figure 1: Emma TT, TB and TD kinematics for *acél-nak*.

Because Emma allows only partial access to the tongue dorsum, Ultrasound ([14]) was also employed to image the entire surface of the tongue during the production of neutral vowels. Two [i:] tongue shapes from opposite harmonic contexts are shown in Figure 2, where the tongue tip is to the right. The heavy line is from *zafir-ban* ‘sapphire.ellative’ and the light from *zefir-ben* ‘zephyr.ellative’. As is evident, the neutral vowel is retracted in the back context. The vertical line shows the approximate position of the tongue dorsum receiver in the Emma experiment.

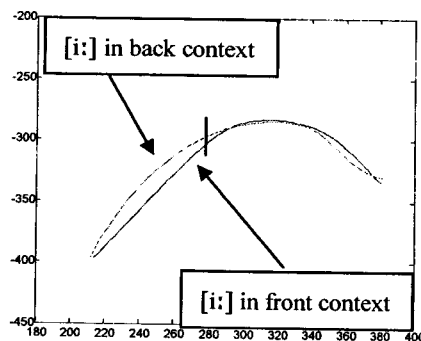


Figure 2: Ultrasound tongue shapes for [i:].

To quantify the tongue dorsum differences apparent in Figure 2, we examined the effect of harmonic context ([±back]) on the location of the tongue dorsum receiver in the Emma data. The reported results are from the first subject only. Analysis of the other subjects is currently in progress. It was found that the horizontal position of the tongue dorsum receiver varies as a function of the harmonic context: the neutral vowels are more retracted in the back context than in the front context. The average difference between front and back contexts is 0.67mm. Pooling across vowels, the tongue dorsum receiver

locations show a significant difference (paired t-test,  $p=0.006$ ,  $n=232$  pairs). Per vowel differences were ‘i’ [i:], -0.503, ‘í’ [i] -0.056, ‘é’ [e:] -1.4285, ‘e’ [ɛ] -0.7245 mm. Due to the relatively advanced placement of the tongue dorsum receiver, the differences between front and back versions of neutral vowels may be found to be larger, if measured at a more posterior position on the tongue’s surface.

Can the observed differences in tongue dorsum retraction be due to coarticulation? The ‘i’ is found between back vowels in *zafir-ban*, but between front vowels in *zefir-ben*. This contextual difference or by hypothesis its coarticulatory effect may be responsible for the differences in ‘i’ production in the two contexts. To address this question, retraction effects must be compared between a vowel harmony context and a context where only coarticulation is in effect. In a language with fully productive vowel harmony, however, it is not possible to construct a reliable test of this sort without introducing extra differences. For example, vowel harmony is blocked across word boundaries, so we may compare words with phrases, e.g. [i] in *kabin-bol* ‘cubicle.ellative’ vs. [i] in the phrase *Jóska m[j]it mond?* ‘what is Jóska saying?’ However, prosodic differences between the phrasal context and the word context make this a non-trivial comparison. A pilot study using this comparison (with 22 tokens) did not reveal any significant differences. Vowel harmony is also blocked across the two morphemes of a compound. This presents another potential comparison context, e.g. between *vas\$villa* ‘iron\$fork pitchfork’ and a matched *CaCCi-CCa* word. However, the morphological environments are different, stem\$stem versus stem-suffix. Moreover, the neutral vowel in one part of the compound (e.g. *villa*) is necessarily part of word and therefore it is potentially subject to low-level harmony effects instantiated as phonetic coarticulation. We are led to the conclusion that in a language with fully productive vowel harmony it is not possible to separate the effect of V-to-V coarticulation from vowel harmony. The phonological pattern of vowel harmony and the phonetic phenomenon of coarticulation are intertwined in the phonetics of neutral vowels.

A potentially informative comparison involves the so-called *abstract* stems, a class of Hungarian stems with neutral vowels selecting back suffixes. When monosyllabic stems with neutral vowels are combined with suffixes, they usually select the front versions of these suffixes: *víz* ‘water(.nominative), *víz-nek* ‘water.dative’, *kéz* ‘hand(.nominative), *kéz-nél* ‘hand.addessive’. A limited number (about fifty) of these stems, however, select the back versions, as in *hid* ‘bridge(.nominative), *hid-nak* ‘bridge.dative’. Our stimuli included twelve pairs of neutral vowels in monosyllabic stems, with the two words in each pair matched for consonantal environment as with the rest of the stimuli. We examined the position of the tongue dorsum receiver for neutral vowels in such stems, as they occur in their isolation forms (no overt suffix). Data show a tendency for the neutral vowels selecting back suffixes to be more retracted than neutral vowels selecting front

suffixes. This relationship obtains in nine out of twelve pairs, and the total number of pairs was small. For example, tongue dorsum location differences for ‘i’ in the pair *sip-cím* were -1.7665 and -1.1856 (in two instances of the same comparison).

BACK	FRONT	
vív [vi:v] ‘fence’	ív [i:v]	‘bow’
síp [ji:p] ‘whistle’	cím [t̪si:m]	‘address’
cél [t̪se:l] ‘aim’	szél [se:l]	‘wind’
hég [he:j] ‘crust’	ég [e:j]	‘night’

Table 2: Sample monosyllabic stimuli.

In the isolation forms of these monosyllabic stems, there is no back vowel to which we may attribute the retraction observed in the stem vowel. Moreover, retraction correlates with the suffix form; the retracted (/advanced) neutral vowel tends to select a back (/front) suffix. This is suggestive but not conclusive evidence that the low-level phonetic differences observed on transparent vowels are phonologically relevant. Clearly, a more careful investigation of this domain of Hungarian harmony is called for.

#### 4. CONCLUSIONS

We conclude that neutral vowels are articulated differently as a function of their harmonic context. This is consistent with the hypothesis that the phonetic basis of neutrality is to be found in the quantal relation between constriction location retraction and acoustics. Further work is necessary to establish this conclusion firmly and to sharpen our related hypothesis about the phonetic basis of neutrality.

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