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Analogy by frequency and functional load: possible reasons for the vowel length neutralisation process in Hungarian?

KATALIN MÁDY
Research Institute for Linguistics
Hungarian Academy of Sciences
mady.katalin@nytud.mta.hu

UWE D. REICHEL
Research Institute for Linguistics
Hungarian Academy of Sciences
uwe.reichel@nytud.mta.hu

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ABSTRACT

Vowel quantity is phonologically distinctive in Hungarian. Over years, the quantity opposition has become rather unstable in high vowels, especially in unstressed positions. This paper investigates the role of analogy by frequency and that of functional load. Due to the overall higher frequency of short vowels in all vowel classes including low vowels, results provide no evidence for the impact of frequency-based neutralisation. Differences show high functional load for low vowels, but low functional load for high and mid vowels. The potential communicative loss connected to the opposition in low vowels could explain the stability of their opposition.

1. The Hungarian vowel system

Hungarian has traditionally been described as a language with a phonological quantity distinction for both vowels and consonants. While the relevance of this feature for consonants has been questioned by Siptár (1995) based on the small number of minimal pairs and their restricted distribution, the quantity distinction for vowels is unquestionably a relevant feature according to both phonetic and phonological descriptions. The vowels *i–í, ü–ű, u–ú, o–ó, ö–ő*, where the accent sign marks long quantity, not stress, correspond to the vowel qualities /i–iː/, /y–yː/, /u–uː/, /o–oː/, /ø–øː/ and are accounted for as five pairs distinguished primarily by length.

The remaining vowels, *a–á* and *e–é*, are classified in a different manner in form-oriented (phonetic) and function-oriented (phonological) frameworks. Phonetic descriptions take into account that these vowels do not only differ by quantity, but also by quality, the latter being the primary cue. According to traditional descriptions, short *a* is a back, mid-low, rounded vowel /ɔ/, while long *á* corresponds to a central, low, and unrounded /aː/. In Mády (2008) it was argued that vowel height is not necessarily distinctive between *a* and *á*, since the somewhat smaller jaw opening of *a* can be explained by the fact that the vowel is rounded: Hungarian /y/ was also produced with a smaller jaw opening than its unrounded equivalent /i/ in this articulography study. Nevertheless, the *a* vowels /ɒ/ and /aː/ are obviously distinguished by at least one quality feature next to quantity. The same is true for *e* and *é*, of which the short vowel corresponds to a somewhat lowered open-mid front unrounded /ɛ/, and the long one to close-mid front unrounded /eː/. The vowel system of Standard Hungarian does not contain any other vowels such as reduced ones or diphthongs.

Phonologists, on the other hand, encounter phonological processes in which /ɒ/ alternates with /aː/ and /ɛ/ with /eː/ in exactly the same way as short and long mid and high vowels do. One such rule is *Final Stem Vowel Shortening*: in certain stems, a long vowel is replaced by its short counterpart if a given suffix is added to the stem, e.g., *k**ú**t* /kuːt/ 'well'–*k**u**tak* /kutɒk/ 'wells', *k**é**z* /keːz/ 'hand'–*k**e**zel* /kɛzɛl/ 'handle', *s**á**r* /ʃaːr/ 'mud'–*s**a**rat* /ʃɒrɒt/ 'mud-ACC'. Another example is *Internal Stem Vowel Shortening* that is triggered by certain suffixes such as *-ál*, *-ikus* etc., e.g., *akt**í**v* /ɒktiːv/ 'active'–*akt**i**vál* /ɒktivaːl/ 'activate', *kult**ú**ra* /kultuːrɒ/ 'culture'–*kult**u**rális* /kulturaːliʃ/ 'cultural'. (See Siptár & Törkenczy 2000, 58–62 for a detailed description.) In this paper we will accept the assumption that the vowels /ɒ/–/aː/ and /ɛ/–/eː/ are vowel pairs with quantity as a distinctive feature, regardless of their different qualities, for reasons to be explained below.

Vowel length in Hungarian is encoded by orthography: long vowels are marked by an accent aigu sign, short vowels by the absence of it (e.g., *ó-o*, *ő-ö* for /o/ and /ø/, the umlaut marking front rounded vowels). This has two consequences: first, native Hungarian speakers are consciously aware of vowel quantity, second, the pronunciation norm is conserved by orthography to some extent.

Given this, it might appear surprising that quantity is not consistently realised in the way orthography would suggest. For example, the compound word *k**ó**rház* 'hospital' is often produced as /k**o**rhaːz/, i.e., with a short /o/, in Educated Colloquial Hungarian (a variety widely accepted all over the country), although the lexemes *kór* 'disease' and *ház* 'house' are both pronounced with long vowels. This discrepancy between orthography and the usual pronunciation of a word does not involve mid vowels very often, but it is frequent for the high vowels *u*, *y*, and *i*. While there are some examples where an orthographically short vowel is produced as a long one in colloquial speech (such as *dicsér* 'praise' that is pronounced as /diːʧeːr/ by many speakers), the vast majority of the discrepancies involves cases in which long graphemes are produced as short vowels (e.g., *címke* /t͡simkɛ/ 'label'). The shortening tendency is even more advanced in unstressed syllables. Siptár and Törkenczy (2000) claim that the quantity distinction for high vowels is missing completely in word-final position, at least in Educated Colloquial Hungarian.

In this paper, the relevance of the distribution of short and long vowels is investigated, with a special focus on syllables carrying higher or lower prominence. Hungarian has fixed word-level stress that is always word-initial. Syllables with lexical stress are potential carriers of sentence-level pitch accents. Thus, the distribution of short and long vowels in these syllables might have a different impact on the preservation of the vowel quantity distinction.

The structure of this paper is as follows: in section 2, a short diachronic overview of quantity variation in dialects is given. In section 3, the frequency of short and long vowels in a type and a token word list is analysed. In section 4, the potential interplay between the functional load of a quantity opposition and its preservation is investigated.

2. Dialectal variation

There is considerable variation in the distribution of high short and long vowels across the regional varieties of Hungarian. In large parts of Western Hungary, the vowel system does not contain long high vowels at all (Kálmán 1989). On the other hand, a prevalence of long high vowels can be observed in the Eastern Hungarian dialects, in which many short vowels of the standard variety are lengthened, especially in stressed (i.e., word-initial) syllables. According to Benkő (1957), short vowel lengthening in the Eastern dialects took place from the 16th century on, and the opposite tendency to shorten long vowels in the Western regions is at least this old. Benkő explains the instability of these vowels by the process of the Final Stem Vowel Shortening (see above): while in the Eastern dialects the shortening rule often failed to apply to suffixed stems and resulted in a higher number of long vowels, the Western region shortened vowels in unsuffixed stems analogously to their suffixed forms as opposed to Central Hungarian dialects on which today's standard is based. (E.g., Eastern ***út*** 'road', ***ú**tazik* 'travel', as opposed to Central ***út***, ***u**tazik*, and Western *v**i**z* 'water', *v**i**zes* 'wet' as opposed to Central *v**í**z*, *v**i**zes*.)

Another change in vowel quantity was the shortening of word-final long /uː/ and /yː/ that included large regions both in West and East (in the West it also applied to /iː/). Since word-final vowels in polysyllabic words are always unstressed in Hungarian, Benkő (1957) suggests that the shortening process is due to the missing prominence in these syllables. Although the same process did not take place in Central Hungary, it is remarkable that vowel shortening in unstressed syllables has become part of today's Colloquial Educated Hungarian that is also spoken in the capital Budapest in Central Hungary.

According to Benkő, the quantity change in stressed syllables was triggered by the coexistence of stems with long and short word-final vowels in their unsuffixed and suffixed forms. However, as described above, this rule is not restricted to high vowels, on the contrary, it mostly applies to stems with low vowels (for an exhaustive list, see Siptár 2003, 311). The few stems that include word-final mid vowels are special: in course of the shortening process, a /v/ is inserted after the vowel, e.g., *l**ó*** 'horse' vs. *l**o**vak* 'horses'. Thus, the systematic shortening of stem vowels alone cannot account for the variable quantity of high vowels.

3. Distribution of short and long vowels

3.1. Frequency in types

Another potential reason for the shortening of long high vowels is their lower frequency in the language. According to Gósy (2004), long vowels are far less frequent in Hungarian than short ones. The proportion of long vowels is given with 21% among all vowels, long /yː/ being the most unfrequent one (*ibid.*, 85ff).

A further question is whether the distribution of long and short vowels is identical across word-initial (= stressed and potentially accented) and non-initial (always non-prominent) syllables. A lower occurrence of long vowels in non-initial syllables could explain the shortening tendency in an analogy-based framework.

Type analysis was performed on a word list consisting of 29,245 lemmas based on the lexical entries in *Magyar értelmező kéziszótár* (Pusztai 2003). The list contained word stems (such as *asztal* 'table') and derived forms (such as *asztalos* 'carpenter'), but not words with inflectional suffixes such as plural forms, since the latter are not separate lexicon entries.

Frequency counts for vowels are given in Table 1. Since there is no general agreement on the corresponding IPA symbols in the literature, orthographic symbols are used.

Table 1: Frequency of vowels in lexicon entries in *Magyar értelmező Kéziszótár*

Vowel	Word-initial syllable	Non-initial syllable	Sum
a	5804	10130	15934
á	2121	6387	8508
e	6016	9990	16006
é	1823	3554	5377
i	3926	8420	12346
í	532	1188	1720
o	3673	6766	10439
ó	686	2938	3624
ö	1295	1143	2438
ő	339	1382	1721
u	1749	2742	4491
ú	417	484	901
ü	610	512	1122
ű	221	350	571

Figures 1 and 2 (overleaf) show the frequency of short and long vowels in the dataset, consisting of 85 198 vowels altogether, 29 212 of which occurred in the first syllable of the word (34%). The amount of short vowels was 62 776 (74%).

Given that the proportion of non-initial syllable positions was substantially higher, the ratios reported in the figures were calculated based on the overall count of vowels in word-initial vs. non-initial syllables, e.g., the absolute frequency of short /o/ in the word-initial syllable was divided by the number of all vowels in the same position.

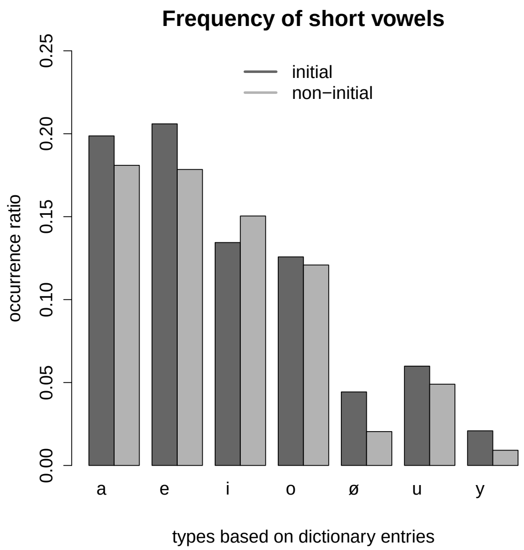

Figure 1: Frequency of short vowels in lemmata. Dark grey: vowels in word-initial syllables, light grey: vowels in non-initial syllables.

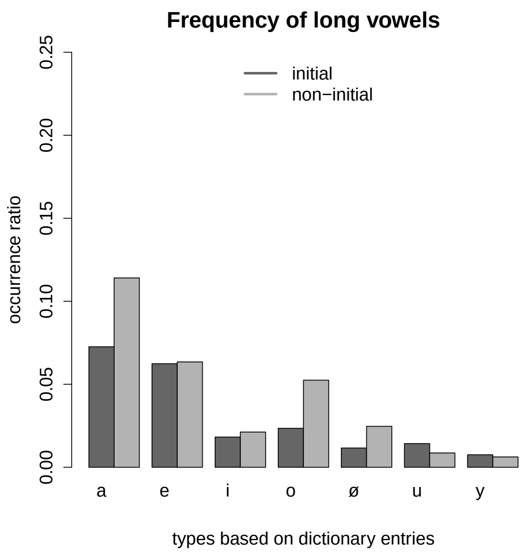

Figure 2: Frequency of long vowels in lemmata. Dark grey: vowels in word-initial syllables, light grey: vowels in non-initial syllables.

The amount of short vowels in word-initial syllable position was higher than in non-initial syllables, except for /i/. At the same time, long vowels occurred more often in non-initial syllables in most vowel pairs. A possible reason for this could be that certain derivational suffixes with high frequency contain long vowels, such as *-ás/-és*, *-ság/-ség*.

Interestingly, vowel frequency did pattern with the three categories high, mid and low. Short /ɛ/ was the most frequent vowel closely followed by short /ɒ/, and also their long equivalents were more frequent than the other five vowels. The low frequency of the other high vowels /u/, /y/ is in line with the analogy hypothesis. On the other hand, the frequency of long /iː/ was almost identical with that of long /øː/, while /i/ alone is involved in the shortening process described in the literature. Thus, the tendency observed in the type-based word list does not support the analogy by frequency hypothesis.

3.2. Frequency in tokens

Type frequency by itself is not necessarily informative about the actual occurrence of long vowels in spoken language for various reasons. First, token frequency is not taken into account. Second, inflexional suffixes that do not occur in the list of lexical entries discussed above contain more often short than long vowels in Hungarian. Third, the frequency of certain types in colloquial speech can substantially differ from the word list discussed in the previous section.

For this reason, spoken language data from a maptask corpus was used to analyse the distribution of short and long vowels in spontaneous speech. The corpus contains data from 27 speakers between 18 and 63 years, including 13 female and 14 male speakers. Dialectal background and social status of speakers differed (see Mády 2010a for more detail).

The database was created for the acoustic analysis of short and long vowels in identical consonantal environments. On one of the maps, a path along various objects was marked. The speaker with this map was supposed to guide the second speaker along this path by verbally explaining the route. As can bee seen in Figure 3, the two maps were not completely identical, resulting in vivid discussions during the recording session. The maps used for the task are shown in Figure 3 (overleaf).

The overall length of the speech material was 115 minutes. Recordings were transcribed into their orthographic form, i.e., according to the grapheme system of Hungarian using the canonical form of words. The material was segmented into word forms. Unfinished forms due to interruption

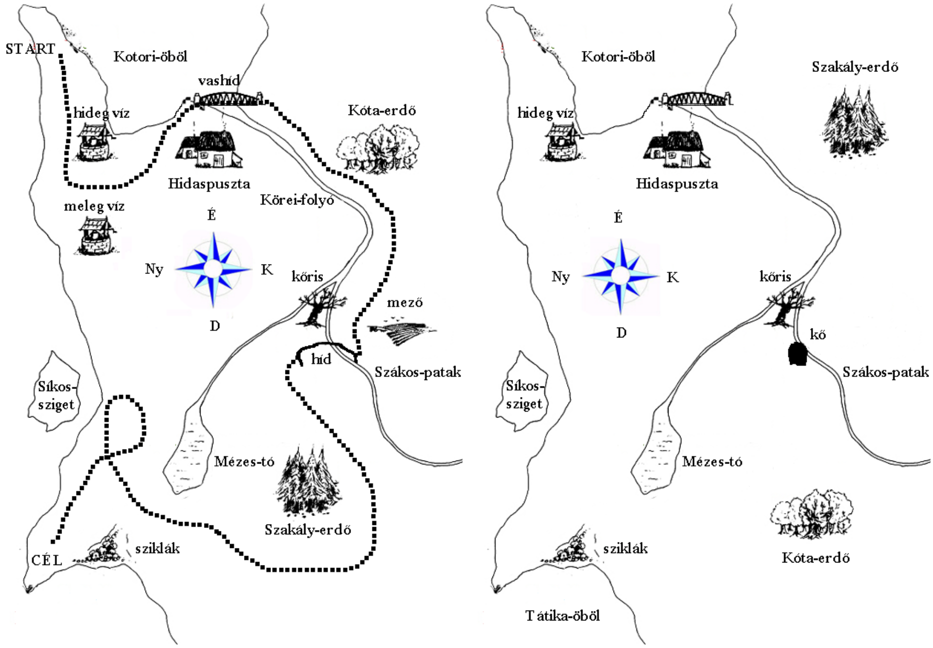

Figure 3: Maps used for the task. Left: first speaker's map, right: second speaker's map.

were removed from the list. Since target words were partly invented geographical names such as *Szákos-patak* referring to a stream that are not part of everyday language usage, proper names were not taken into account for further analysis.

One of our research questions is whether the frequency of short and long vowels located in potentially prominent (i.e., pitch-accented) syllables is identical. However, not every word can carry a pitch accent. Therefore, definite and indefinite articles such as *a* 'the', non-accentable conjunctions such as *és* 'and', *ha* 'if' and modal particles such as *hát* 'well' were excluded from the analysis. Admittedly, this procedure is blind for the presence of pitch accents on these words. For example, the indefinite article *egy* 'a' is homophonous with the numeral *egy* 'one', and the latter usually carries a pitch accent. Since manual checking of the accent patterns was not possible in this case, all tokens of this type were disregarded. Other words that can function both as a content or a function word, e.g., *fog* 'grab' or a future auxiliary, were regarded as potential prominence carrier units and were included in the analysis.

The final dataset contained 17,916 vowels, 9024 of which were located in word-initial syllables (50%), and 13,475 were short ones (75%). The high proportion of vowels in word-initial syllables was due to the overall high occurrence of monosyllabic words such as verbal prefixes.

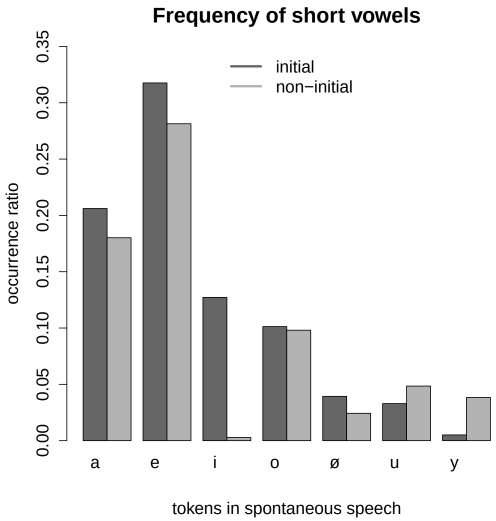

Figure 4: Frequency of short vowels in spontaneous speech. Dark grey: vowels in word-initial syllables, light grey: vowels in non-initial syllables.

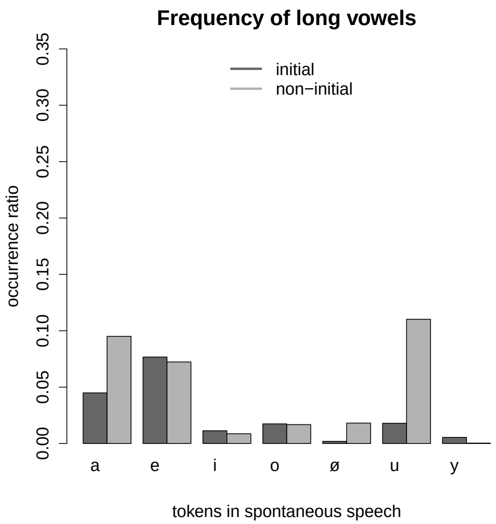

Figure 5: Frequency of long vowels in spontaneous speech. Dark grey: vowels in word-initial syllables, light grey: vowels in non-initial syllables.

The distribution of short vowels was partly different from the frequency counts in the word list. Here, /ɛ/ was by large the most frequent vowel. This is in line with the wide-spread assumption that this sound is the most frequent one in Hungarian, but it differs from frequency data based on the lexicon entries where /ɒ/ was only slightly less frequent than /ɛ/. It is interesting that /i/ was extremely unfrequent in unstressed syllables.

The relative frequencies of long vowels show a similar pattern to type frequencies, with the exception of /uː/.

The distributional data do not favour the hypothesis that the small number of long high vowels could be responsible for the preference for short high vowels. First, /iː/ is not less frequent than /øː/. Second, not only high, but all long vowels are less frequent both in stressed and unstressed positions than short ones.

4. Functional load of quantity oppositions

Next to the vowel frequency analyses we investigated whether the functional load of a quantity opposition could account for its preservation. We hypothesise that oppositions with a high functional load are more stable than oppositions for which the functional load is low. The importance of the opposition is quantified by two measures described in the following.

4.1. Functional load

The functional load (FL) of a phonological opposition of the phonemes a and b is related to the number of contrasts this opposition is responsible for in a language L. The information-theoretic definition adopted here was first introduced in Hockett (1967):

$$\mathrm{FL}(a,b) \quad = \quad \frac{H(L) - H(L_{a=b})}{H(L)}$$

$H(L)$ is the entropy of a language L. $L_{a=b}$ denotes a language lacking an opposition of a and b. $\mathrm{FL}(a,b)$ thus stands for the relative amount of information loss resulting from such a merging, reflecting the increase of homophones.

L and $L_{a=b}$ are the sets of word types w of *Magyar értelmező kéziszótár* before and after vowel merging, respectively. Merging or neutralisation means that in the second lexicon, long vowels were replaced by their short counterpart in all stems. From the word type frequencies contained in this dictionary, maximum likelihood probabilities were calculated in order to derive the entropies for L and $L_{a=b}$ as follows:

$$\begin{aligned} H(L) &= -\sum_{w \in L} p(w) \log_2 p(w) \\ H(L_{a=b}) &= \sum_{w \in L_{a=b}} p(w) \log_2 p(w) \end{aligned}$$

The frequencies for merged types in $L_{a=b}$ were simply obtained by summing up the frequencies of all types of L undergoing this merging after the neutralisation of the opposition of a and b.

4.2. Type number ratio

Since the FL is calculated over the entire lexicon, it does not normalise for vowel-related frequencies, that in turn determine the number of resulting homophones after quantity merging. FL is positively correlated with vowel frequency, since the merging of frequent vowels results in more homophones so that their quantity opposition receives a high functional load.

In order to reduce this frequency bias, we additionally calculated the ratio of those types only, that are affected by a vowel quantity merging. As an example, for the merging of /uː/ we considered only those words that contain the letter *u* and/or *ú*. For these types we derived the ratio N_a/N_b, where N_b denotes the number of types before merging and N_a denotes the number of types after merging.

4.3. Word stress

In order to test the impact of word stress on quantity merging, we applied the two measures for three different vowel merging scenarios: (1) in all syllables, (2) in the word-stressed (initial) syllable only, and (3) in all non-stressed (non-initial) syllables only.

4.4. Results

The functional loads and type number ratios for each vowel pairing are shown in Figures 6 and 7, respectively. Important oppositions are indicated by a high functional load and a low type number ratio.

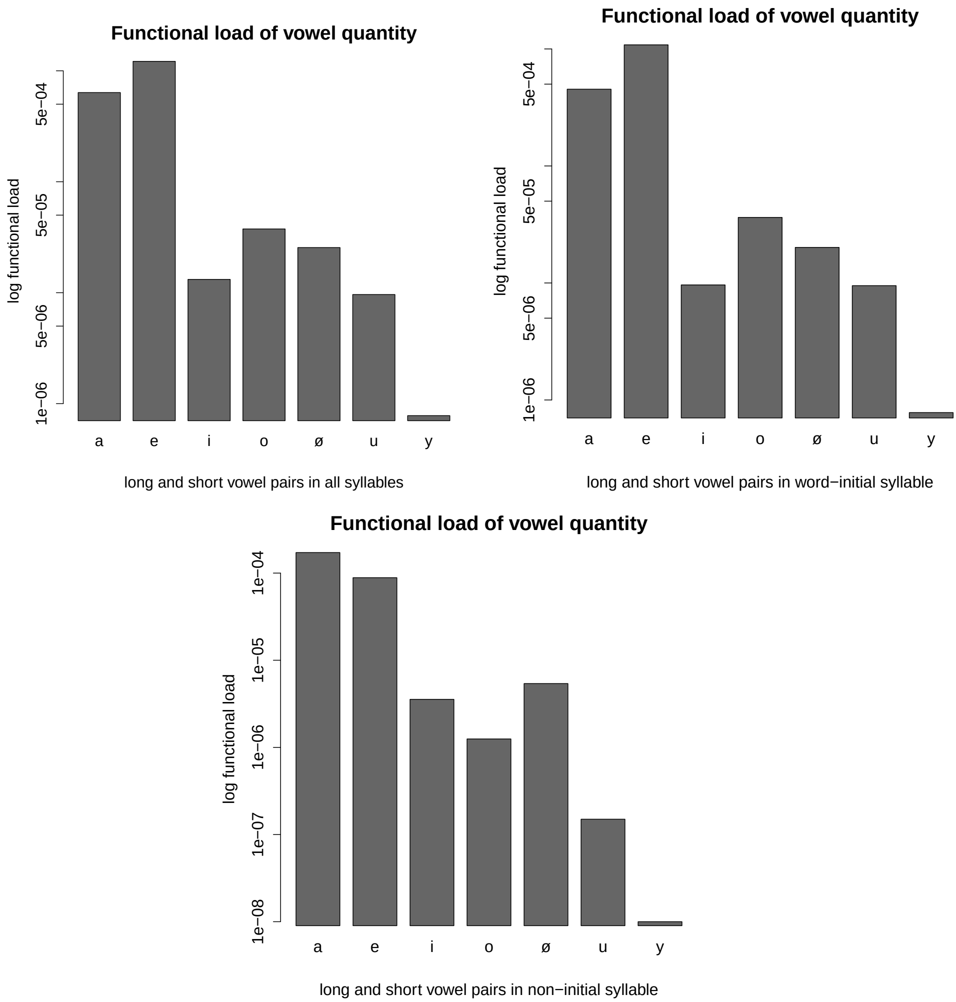

Figure 6: Functional loads of vowel quantity oppositions over the entire word (top-left), in word-initial stressed position (top-right), and in non-initial unstressed position (bottom)

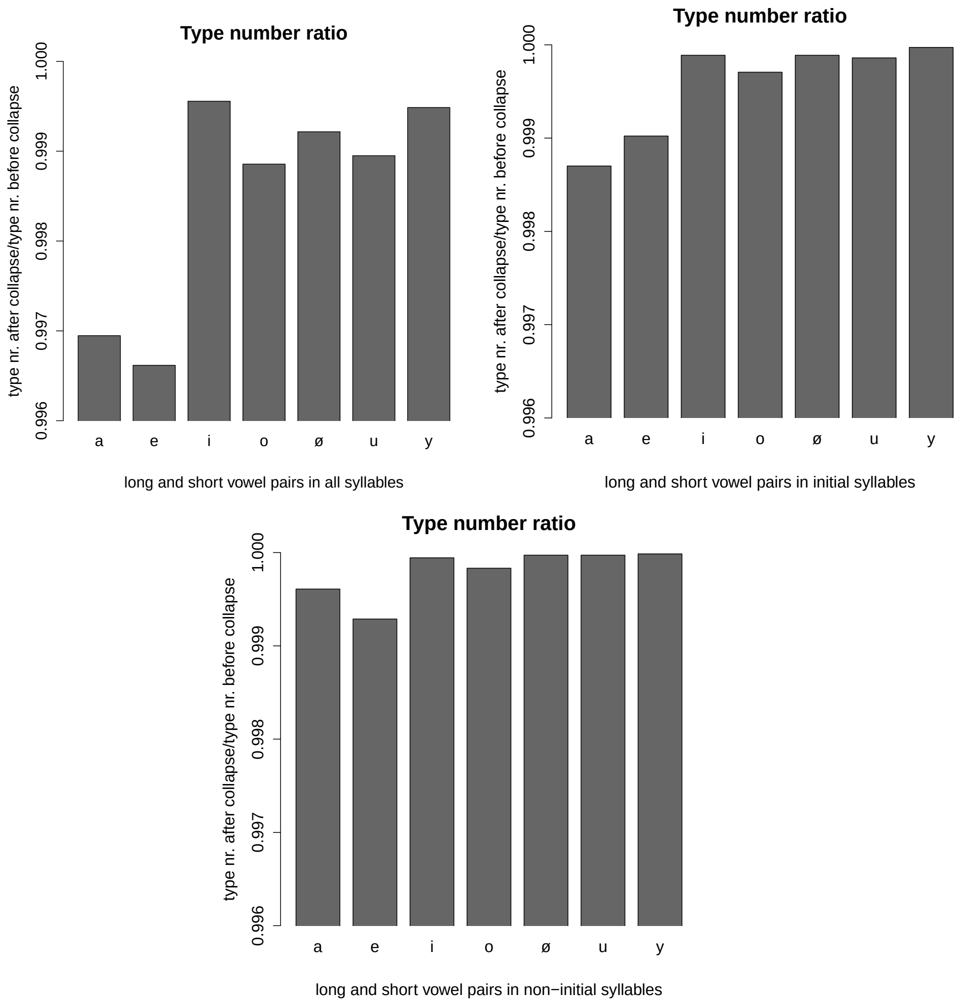

Figure 7: Type number ratios of vowel quantity oppositions over the entire word (top-left), in word-initial stressed position (top-right), and in non-initial unstressed position (bottom)

Based on Figure 6 for the impact of functional load on quantity preservation, the following conclusions can be drawn:

- The quantity oppositions for /e, a/ have the highest functional loads, which – in line with our hypothesis – prevents them to undergo quantity merging. This merging would result in a significant decrease in lexical contrasts and therefore an increase in ambiguity.
- Over the entire word, /i, u, y/ quantity oppositions have the lowest functional loads. Thus it is not crucial to maintain these oppositions, and indeed, these vowels are least stable in preserving them.
- Also word-initially the functional loads of /i, u, y/ quantity oppositions are the lowest, so that the absence of these oppositions e.g., in Western Hungarian does not lead to a communicative loss.
- However, in non-initial syllables also the quantity opposition for /ø/ has a low functional load, but against the expectation for this vowel the quantity opposition is maintained.

For the type number ratios shown in Figure 7 we obtained the same tendencies.

- For /a, e/ the lowest ratios were measured, again well explaining the stability of their quantity contrasts in order not to drastically increase the number of homophones.
- /i, u, y/ show high ratios, especially in non-initial syllables, indicating only a negligible increase of ambiguity in case of quantity merging.
- However, high ratios are given also for /o, ø/.

5. Discussion and conclusions

Vowel statistics, i.e., analogy by frequency did not turn out to play a crucial role in explaining varying degrees of the stability of quantity oppositions. The functional load of an opposition, however, was found to have an impact on maintaining quantity contrasts. A high functional load is a sufficient motivation to maintain such contrasts. The reverse case, i.e., when a low functional load leads to quantity merging, holds for high vowels.

The quantity opposition in mid vowels might be subject to an ongoing sound change process. Perception experiments in Mády (2010b) and Mády (2012) show that the perceptual boundary between long and short /o/ in word-final position is shifted towards the short vowel in young speakers, but not in the older group. Young participants categorised both shorter and more centralised /o/ segments as long vowels, whereas a segment had to be longer and more centralised to be identified as a long /oː/ by listeners above 50 years. Thus, the quantity distinction might become less stable also for mid vowels within a certain time range. This development would again be well explainable by the low functional load of mid-vowel quantity oppositions.

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