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PROS AND COS ABOUT HUNGARIAN [a:]

INTRODUCTION

To pay respect to Kempelen, the outstanding phonetician and speech technologist and to commemorate the 200th anniversary of his death, in this paper we will review different descriptions of the Hungarian [a:] sound, starting with Kempelen's original insights, which represent a milestone in the study of both general and Hungarian phonetics. Kempelen was the first to describe the Hungarian [a:] in a two-dimensional general phonetic framework. The various descriptions of this vowel, proposed by 20th century researchers, seem to be quite contradictory and we will give an overview of the previous articulatory and acoustic investigations. Finally, the paper will report on a small-scale study by the author, which explores the spectral characteristics of the lower third of the Hungarian vowel system, including the sound [a:].

KEMPELEN'S VIEWS ON A-TYPE SOUNDS

In Kempelen's book entitled *Mechanismus der menschlichen Sprache nebst Beschreibung einer sprechenden Maschine*, Kempelen's objective is to give a general phonetic description. He tries to grasp the similarities and differences in the pronunciation of the "basic sound or letters" in European languages. In such a formulation of the problem we can still clearly witness the influence of the Greco-Roman tradition, represented by the three basic aspects of the phonetic segment: "nomen-figura-potesta". For Kempelen the Latin alphabet is a natural basis for a phonetic classification. He does not seem to hesitate at all to choose the five vowel qualities of the Latin language (A, E, I, O, U) as the basic main "reference" types of vowels. Nevertheless Kempelen's classification is an important milestone in terms of establishing a general phonetic classification of vowels.

According to Kempelen, the only difference between any two vowels is that the voice is modified in diverse ways by a wider or narrower passage formed by either the tongue or the lips or both, so he characterizes vowels along the two corresponding dimensions: labial aperture (see *Figure 1* on Tableau X.) and length/aperture of the channel formed by the tongue (see *Figure 2* on Tableau X.). As can be seen, the distance between the lips and the round/spread opposition are not represented separately, as a result of which the labial vowel O is more closed than the vowel I. At the same time, it is an important feature of his vowel classification that the lip opening and front/back dimension – to use modern terminology – are separated from pitch as an individual sound symbolic quality (see *Figure 3–4* on Tableau X).

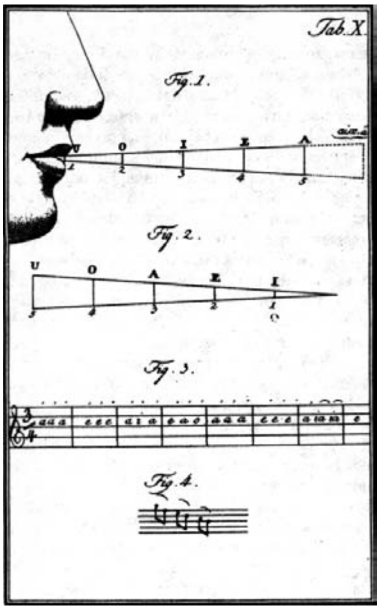


Figure 1: Kempelen's Tableau X.

In Kempelen's description, vowel A emerges as the simplest sound, which could be perfectly articulated even by somebody without a tongue, teeth or lips. It is the simplest, the easiest sound because while pronouncing it all the speech organs are in their most natural position. Kempelen identifies the sound in the beginning of the Latin word *Arma* as the basic type of A.

In Kempelen's categorization the prototypical sound A has the biggest labial aperture among the vowels. On the other hand, the length of the vocal tract is in between two extreme positions yielded by I and U. A-type sounds can be both closer and more backward positioned in different languages. The main difference across the languages is caused by the length of the vocal tract and so all the different A-type sounds in this respect are between A and O. Kempelen claims that there are three different A-type sounds: the basic one mentioned earlier and two variants (see *Table 1*). It should be mentioned that it is somewhat confusing and controversial that in Kempelen's work in §122 when summarizing his views on vowels the order of vowels based on the front/back dimension is reversed and it seems that the short vowel [ɔ] is pronounced closer to the front of the mouth cavity. *Table 1* below shows a summary of Kempelen's classification based on §112.

According to Kempelen, in Hungarian there are two kinds of A. The first one is long, with a similar quality as in Latin (e. g. *száz, ház*). The other one is more backward positioned (in Kempelen's word "deeper") and it is short (e. g. *hamar az*).

Labial aperture

1		ü										**U**
2					oe					**O**		
3	**I**		é									
4				**E**								
5											o	
6								a				
7									å			
8							**A**					
9						ae						
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*

Aperture of the channel formed by the tongue

Notes on symbols:
A: Latin e. g. *Arma* a: German e.g. *Gabe* å: Hungarian e. g. *hamar*; English e. g. *Talk*
E: Latin e. g. *ecce* é: French e.g. *varieté;* Hungarian *é* ae: German *ä*; French
I: same in all the languages **O**: German e. g. *Wohl,* French *o* o: Latin e. g. *hoc*
oe: German *ö*; French *eu* **U**: German *u*; French *ou*, English *oo* ü: German *ü*; French *u*

Table 1. The 12 vowel qualities, distinguished by Kempelen, represented in a two-dimensional way

Kempelen's views coincide with those of Antal Simon, the author of the first book published on phonetics in Hungarian (cf. Vértes O. 1959). Simon is assumed to have been familiar with Kempelen's works. Simon suggested that in order to pronounce "á" [a:] the mouth should be opened wide, the tongue on the other hand should be left in its normal position. To pronounce "a" [ɔ], the tongue should be pulled back a bit and should be held tight at its root (Simon 1808).

How does Kempelen's classification fit in with the history of describing and classifying Hungarian A-type sounds?

THE BEGINNINGS

As in other European vernaculars the first descriptions and classifications of Hungarian sounds were also made according to Latin or Hebrew traditions (Szathmári 1968; Vértes O. 1980). Different kinds and rather fragmentary articulatory descriptions of Hungarian vowels can be found in the first Hungarian grammars, but the distinction between the two types of Hungarian A was noticed by all the 16th–17th century grammarians. In János Sylvester's *Grammatica Hungarolatina* (1539) and Mátyás Dévai Bíró's *Orthographia Ungarica* (1538/1549) it is mentioned that the long A should be pronounced with a more widely opened mouth. In the works by Albert Szenczi Molnár (*Novae Grammaticae Ungaricae*, 1610) and György Komáromi Csipkés (*Hungaria Illustrata*, 1655) these sounds are put in *clarum-obscurum* contrast. According to Szenczi Molnár, not only the two types of A but all the long Hungarian vowels are "clearer, brighter", than the short ones. This *clarum-obscurum* distinction might somewhat remind us of the certain aspects of modern *tense-lax* opposition. A different aspect of classification was introduced by Pál Pereszlényi (*Grammatica Lingvae Ungaricae*, 1682). He was the first one who described vowel harmony and vowel assimilation as distinguishing features of the Hungarian sound system. He introduced two new categories of Hungarian vowels: high- and low-pitched, which correspond to the front/back dimension. According to this classification the sound "á" [a:] undoubtedly belongs to the same category as velar vowels, unlike in Kempelen's articulatory classification.

Modern Hungarian Phonetics

At the turn of the 19th and 20th century experimental phonetics was established in Hungary and new classificatory systems based on phonological considerations were proposed. In the description of the vowel system the phonological approach meant (see Balassa 1904; Horger 1929; Papp 1966) that the vowel space was defined by horizontal and vertical tongue positions according to 3x2 categories, which resulted in classifying [a:] as a low vowel of the same height as [ɛ] and [ɔ]. The mere phonetic description, however, acknowledges four vertical tongue positions: Hungarian [a:] is an open vowel, the only open vowel in the system. Both phonological and phonetic classifications on the other hand, are binary in relation to the horizontal position of the tongue, i.e. there is no central position acknowledged as a category in its own right. According to the majority of researchers, the Hungarian [a:] is a velar sound from the point of view of both its phonological and phonetic features. The former descriptions and classifications of the sound [a:] as central can only be partially found in works, such Gombocz's (1925/1940), who proposed a 4-unit division for both the velar and palatal quality. He places the [a:] sound in the velar category closest to the palatal categories. The non-velar or rather medio-velar phonetic quality of the [a:] sound is emphasized later by Bolla (1982, 1995) in the related literature.

The question arises whether it is possible to find mere phonetic justifications and empirical data to support the classification of the [a:] as a velar sound.

The empirical findings from articulatory investigations seem to support the phonetic velar classification of the [a:] to some extent. In order to study Hungarian vowels, Bárczi (1928) made the first experimental analysis based on X-ray examination. With respect to [a:], Bárczi suggests that the tongue has almost the same position as during quiet breathing, i. e. in contrast to observations made earlier, the X-ray shows that the dorsum rises above the line defined by the position of the tongue during quiet breathing, which can be taken as a tentative justification in support of the velar quality of [a:].

A similar conclusion can be drawn based on Bolla's X-ray tracings (1993) *Figure 2a & b* show X-ray tracings of the vowel [a:] in the word *rág* (see *2a*) and in *rag*, *rág* (see *2b*)**.** In *Figure 2a*, the diagram showing quiet breathing is superimposed on the tracings of [a:] in *rág*. The comparison suggests that the dorsum does not go much lower than the position it normally occupies during quiet breathing. In *Figure 2b*, it can be seen that on pronouncing á, the dorsum is slightly raised in the direction of the soft palate, although this change in the position of the dorsum is much smaller than in the case of [ɔ].

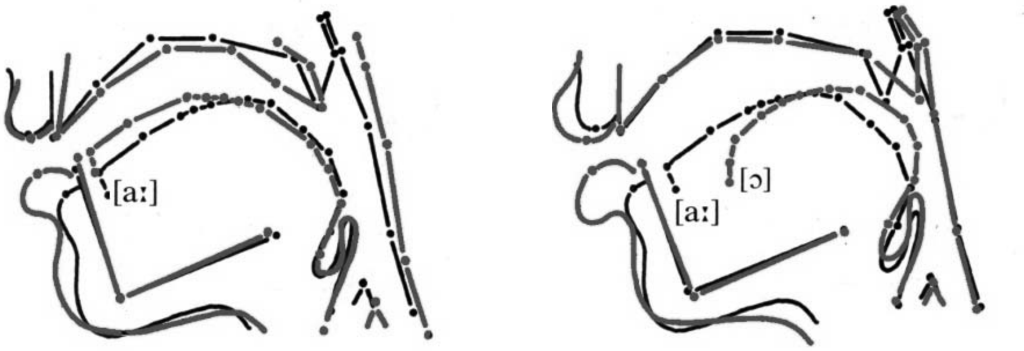


Figure 2a & b: Bolla's X-ray tracings (1993)

On examining the quality of the vowel [a:] from an acoustic perspective, i. e. in terms of the F1-F2 vowel space, the question arises whether the debate surrounding the classification of [a:] is the result of the greater articulatory-acoustic variability of this sound as compared to other vowels. According to Gombocz (1925/1940), it is exactly the [a:] and the [ø] that show the greatest regional and individual variation among the Hungarian vowels. Actually, it is not surprising that there is such phonetic variability in the case of [a:]. The realizations of the phoneme /a:/ are typical examples of quantal speech segments in languages. It is supposed to be robust for variations of the positions of many articulators, and maintaining the a-like perceptual quality does not require articulatory precision (Stevens 1989).

The aim of this study is to revisit some of the proposals that have been put forward as a result of acoustic experiments focusing on spectral characteristics of the Hungarian vowels (see Tarnóczy 1941, 1965; Magdics 1965; Molnár 1969; Szende 1976; Vértes O. 1982; Olaszy 1985; Gósy 1983, 2002; Bolla 1995; Szalay 1995). These studies markedly differ in the documentation of the number of subjects and the experimental design, and the way they analyze and present the measurement data. Furthermore, until recently there has been less attention paid to phonetic variability. The present investigation has been designed to reinvestigate the phonetic variability of [ɔ], [ɛ], [a:], the lower third of the Hungarian vowel system by exploring their formant structure.

METHOD

In the experiment all the three vowels − [ɔ], [ɛ], [aː] − were recorded in word stressed position in seven different consonantal contexts (e. g. *t**á**kolmány* [taːkolmaːɲ], *t**á**nyéron,* [taːɲeːron], *v**á**sárol* [vaːʃaːrol], *m**á**moros* [maːmoroʃ] etc.). The subjects had to read out three- or four-syllable words embedded in sentences. The subjects were eleven females, aged between 21 and 30 (five of them were born in Debrecen, six were from Budapest).

The speech samples were digitalized and analysed with the help of Praat (Boersma/ Weenink 1993–2004). The values of the first three formants and the fundamental frequency were measured. The formant values were computed at the middle of the vowels.

The statistical evaluation of the data was carried out in SPSS for Windows 11.0 software package.

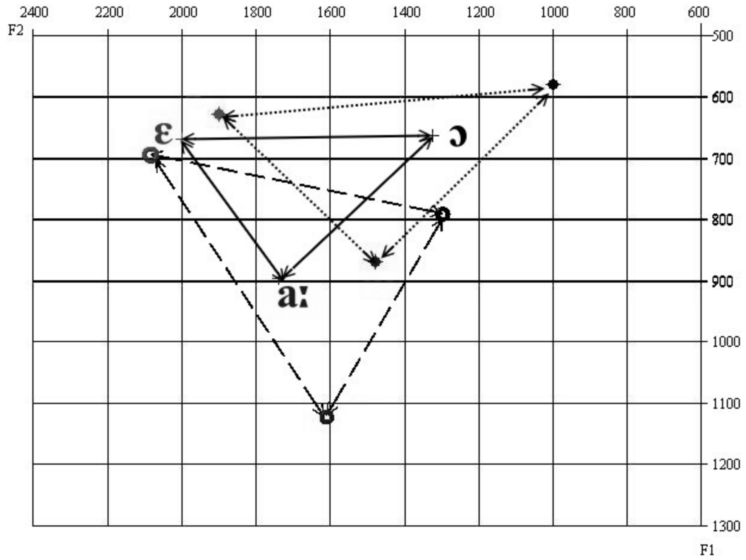
RESULTS

Table 2 below gives a summary of the descriptive statistics for the vowels under investigation. As can be seen in the Table, the results differ most markedly in the case of the second formant of the sound [aː] from the values found in the literature. The mean value of 1740 Hz is considerably high for the given vowel.

		[aː]	[ɔ]	[ɛ]
F1	Mean	896	662	668
	Standard deviation	108,79	97,56	74,53
	Relative SD	12,1	14,7	11,2
F2	Mean	**1740**	1326	1999
	Standard deviation	166,96	237,94	172,85
	Relative SD	9,6	17,9	8,6
F3	Mean	2694	2671	2851
	Standard deviation	272,50	280,19	201,58
	Relative SD	10,1	10,5	7,1

Table 2. A summary of the descriptive statistics for the vowels [ɔ], [ɛ], [aː]

Figure 3 presents a comparison between two earlier studies (Tarnóczy 1965; Magdics 1965) and the findings from the present investigation. As can been seen, the results differ not only in absolute values, but also in the relative positions of the [aː]. In the present investigation, the vowel space is reduced and it seems to be more forward-positioned.



Notes: Tarnóczy: ……….. Magdics: _ _ _ _ _ _ Present study: ________

Figure 3: A comparison of the mean formant frequencies of the vowels [ɔ], [ɛ], [aː], *based on Tarnóczy (1965), Magdics (1965) and the present study.*

Figure 4 below shows the dispersion ellipses for all the subjects. This figure is intended to highlight the spread of F1-F2 values, which can also be seen in *Table 2* above, where the relative standard deviation values are also given (relative SD = SD/mean) in order to provide a more reliable comparison of the data.

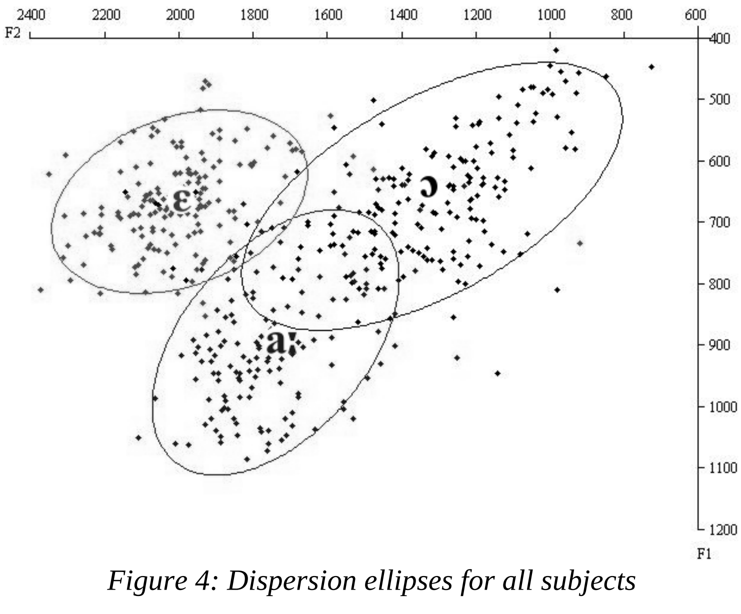
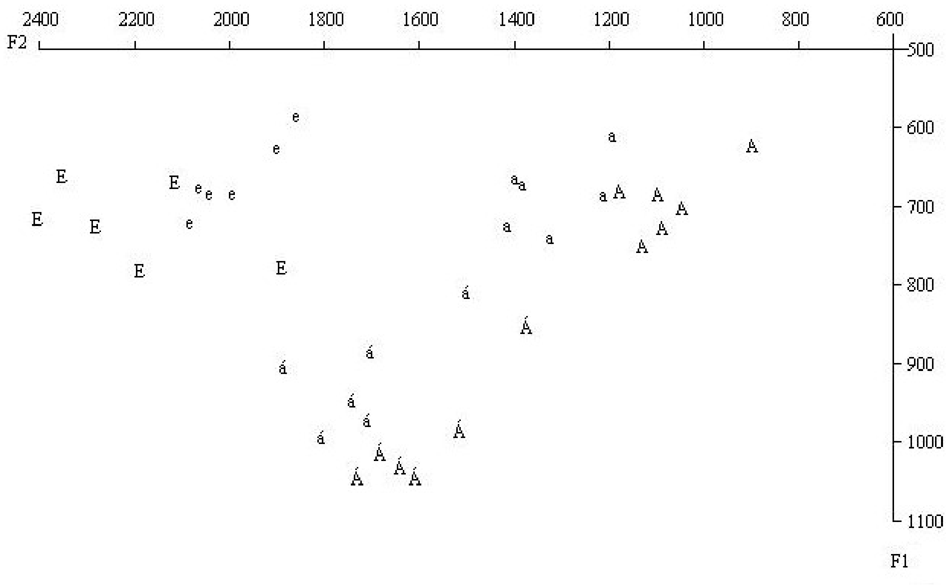


Figure 4: Dispersion ellipses for all subjects

Based on *Table 2* and *Figure 4*, we may claim that there is not enough evidence to support the assumption that the sound [a:] can be characterized by exceptional variability. The results of from the present study suggest the position of [a:] in the vowel space is less variable than that of the [ɔ]. In fact, it is the [ɔ] sound that has the greatest variability.

The present study has also tried to explore the impact of coarticulation on the formant structure of [a:]. The investigation focused on two main questions:

1. How does the quality of the vowel pronounced in isolation differ from its quality when pronounced in context?
2. Is it possible to identify the nature of impact of the surrounding consonants?



Notes:
E, Á, A: [ε], [a:], [ɔ] pronounced in isolation
e, á, a: [ε], [a:], [ɔ] pronounced in context

Figure 5: Comparison of vowel qualities when pronounced in isolation vs. in context

Figure 5 shows the mean values of the three vowels pronounced in isolation and in context by 6 subjects from Budapest. As can be seen, the vowels pronounced in isolation are more peripheral, i. e. they are positioned further away from the centre of the vowel space. *Table 3* below gives the gains and losses in percentages of the position change of the vowels pronounced in isolation and in context. If we assign 100 % to the F1 value of [a:] in context, the F1 value of the isolated [a:] will be marked as 109 %. This means that there is a 9 % gain along the F1 dimension.

Vowel		F1 gains/losses in %	F2 gains/losses in %
[ɔ]	Mean	103,80	81,30
	Std. Dev.	4,38	5,63
[a:]	Mean	108,60	92,30
	Std. Dev.	5,60	3,73
[ɛ]	Mean	109,60	110,70
	Std. Dev,	10,28	6,03

Table 3: F1-F2 gains and losses of the position change of the vowels (isolated vs. in context)

Based on the figures in *Table 3* and *Figure 5* above, we may conclude that the [ɛ] and the [a:] sounds are shifted to a similar extent and in the same direction towards the centre of the vowel space. The position change for the [ɔ] sound is largest, there is an almost 19 % difference in the case of F2. This phenomenon is well known in the literature: the embedding of speech sounds in continuous speech causes articulatory and acoustic undershoot. The formants may already change in CVC pronounced in isolation as compared to pronouncing the vowels in isolation, and may not necessarily reach the canonical target that characterizes the steady state of the isolated vowels (Recasens 1999). What seems to be an interesting observation about the quality of the [a:] is that position change is not restricted to the F2 dimension only.

In response to our second question formulated above, we examined whether the place of articulation of the neighboring consonants has a variable impact on the formant frequencies of [a:]. In the case of the [a:], there was no statistically significant difference (ANOVA) between the F1, F2 and F3 formant frequencies with respect to the place of articulation of either the preceding or the following consonants. In contrast to the earlier claims found in the literature (Magdics 1965), there was no difference observed in terms of labial, labiodental vs. dorsal consonant surroundings in the case of any of the formants. It seems that the impact of the surrounding consonants even out in cases where the neighboring consonants are of different places of articulation.

CONCLUSION

Based on the results of the acoustic analysis, we may claim that in continuous speech the Hungarian [a:] has high F2 values, which are higher than the values reported in the literature earlier. Although no one-to-one correspondence is assumed between acoustic data and articulatory movements, it is widely accepted that moving the tongue forward increases the low pharyngeal constriction and raises F2 (see Wood 1979). It may be the case that the high F2 values are due to the relaxed articulation of the subjects, which is so typical nowadays. The analysis of the impact of the neighboring consonants has revealed that continuous speech can be characterized by an articulatory-acoustic feature that is independent of the consonant surrounding. Based on all that, we propose that the sound [a:] should be regarded as palatomedial from a phonetic point of view.

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