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## ON VOCALITY OF /I/ AND /U/ IN LITHUANIAN DIPHTHONGS

The problem of vocalicity of diphthongal components has been both of interest and ambiguity to many phoneticians during the recent years<sup>1</sup>. The main point is whether the second component of the diphthongs /au/, /ai/, /ei/ etc. should be considered as a vowel or a semi-vowel. No satisfactory solution of it was found as yet. It should be noted that the determination of vocalicity of the second component in diphthongs is of great importance in considering the problem of syllable structure. If, on the one hand, the second components of the falling diphthongs /ai/ and /au/ were considered as vowels we should acknowledge these syllables to be open (at least in most cases), and, on the other hand, if these diphthongs contain semi-vowels, as their second components, the syllables should be defined as closed ones.

It is natural to think the both components of a pure diphthong to be vocalic. It is by this feature that one distinguishes between a pure diphthong and a semi-diphthong. The question arises, however, on what ground the definition of the second component of a diphthong, as a non-vocalic sound, is given by some authors. Taking into account the articulatory mechanism of a diphthong the reasoning might be as follows: in pronouncing the diphthongs /ai/, /au/, /ei/ the vocal tract is being gradually narrowed. A similar process of narrowing observed in many vowel+semi-vowel (VS) sequences, such as /aw/, /aj/ etc. Thus, diphthongs and VS sequences should be characterized by a certain similarity of articulation. Furthermore, the second components /i/ and /u/ of falling diphthongs, like semi-vowels /j/ and /w/, never serve syllabic elements, thus being functionally of the same type.

Are the above common rough articulatory features sufficient for the second component of a pure diphthong to be taken as a semi-vowel? It is only a detailed phonetic analysis that would enable us to arrive at a satisfactory solution of the problem.

<sup>1</sup> P. Delattre, Change as a correlate of the vowel-consonant distinction, — *Studia linguistica* XVI (1964) 12–25; C. M. Wise, Acoustic structure of English diphthongs and semi-vowels vis-à-vis their phonemic symbolization, — *Proceedings of the Fifth International Congress of Phonetic Sciences*, Basel-New York, 1965, 589–593.

The solution of the given problem without any confirmation by exact acoustic features, limiting vowels and semi-vowels, is next to impossible. The above features have been found due to the recent experiments both with natural and synthetic speech<sup>2</sup>. It has been shown that the extent of the first 2 formant transitions enable listeners to distinguish speech sounds within each of the three classes: consonants, semi-vowels and vowels. The syllables /bɛ/ and /gɛ/ were transformed into /wɛ/ and /jɛ/, respectively, when the duration of the first- and second formant transitions was gradually slowed down. Further increases in the duration of the transitions caused /wɛ/ and /jɛ/ become /uɛ/ and /iɛ/, respectively.

The formant structure of the retention stage is another characteristic feature which contributes to distinguishing vowels, semi-vowels and consonants. So /u/ is characterized by higher formant frequencies of F<sub>1</sub> and F<sub>2</sub> than it is the case with the semi-vowel /w/. The locus of F<sub>1</sub> and F<sub>2</sub> for the consonant /b/ is still lower than for the semi-vowel /w/. The loci of F<sub>1</sub> and F<sub>2</sub> for /g/ are found to be more separated than for the semi-vowel /j/. When comparing /j/ and /i/ one finds the former to be more diffuse than the latter.<sup>3</sup>

The above acoustic features of vowels, semi-vowels and consonants are known to have articulatory correspondents. The consonants /b/ and /g/ are characterized by a complete closure at the beginning of their articulation. In pronouncing /w/ and /j/ there is a considerable narrowing for the air to pass while in articulating /u/ and /i/ a more-or-less free passage is found. Thus different formant structure of the above sounds depends upon the degree of closure along the vocal tract. It should be noted that the tempo of changes in the formant structure depends upon the abruptness in the opening of the vocal tract.

Thus, for the second component of a diphthong to be defined as a vowel or a semi-vowel one is to investigate: (a) transition processes of the diphthong and (b) the formant structure of the steady part of its components.

Our considerations below are based upon the data of spectral analysis of the Lithuanian diphthongs /au/, /ai/ and /ei/ (both falling and rising).<sup>4</sup>

**Transitions.** Two kinds of transitions should be considered: (a) transitions between two components of a diphthong and (b) those after the diphthong.

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<sup>2</sup> A. M. Liberman, P. Delattre, L. Gerstman and F. S. Cooper, Tempo of frequency change as a cue for distinguishing classes of speech sounds, — *Journal of Experimental Psychology* LII (1956) 127–138; J. D. O'Connor, L. Gerstman, A. M. Liberman, P. Delattre and F. S. Cooper, Acoustic cues for the perception of initial /w, j, r, l/ in English. — *Word* XIII (1957) 24–44.

<sup>3</sup> P. Delattre, Ref. 1, 16; C. M. Wise, Ref. 1, 592.

<sup>4</sup> Falling diphthongs are traditionally marked by /'/, i.e. /áu/, /ái/, /éi/, while rising ones are distinguished by /~/, i.e. /aũ/, aĩ/, /eĩ/.

The first question arises whether the transitions from a more open sound to a less open one in diphthongs are capable to convert the second component into a semi-vowel.

By removing transition portions some researchers have tried to prove the transitions within diphthongs to be not essential for the hearer's interpretation of the diphthong.<sup>5</sup> We find this method to be insufficient as the removal of the transition does not eliminate the rise of a semi-vowel. After eliminating the natural transition and moving the initial and final components together, even a more sudden transition is to be expected which would contribute to the rise of a semi-vowel. In our opinion the opposite way seems to be more reasonable, i.e. slowing down the transition. If this slowing did not affect the diphthong itself, we could assert the tempo of transitions to be not essential. Thus in such a slowed diphthong no semi-vowel could be found since the latter is characterized by rapid transitions.

From our standpoint, not only the importance of sonority of the second component but also the presence or absence of a semi-vowel in a diphthong could be

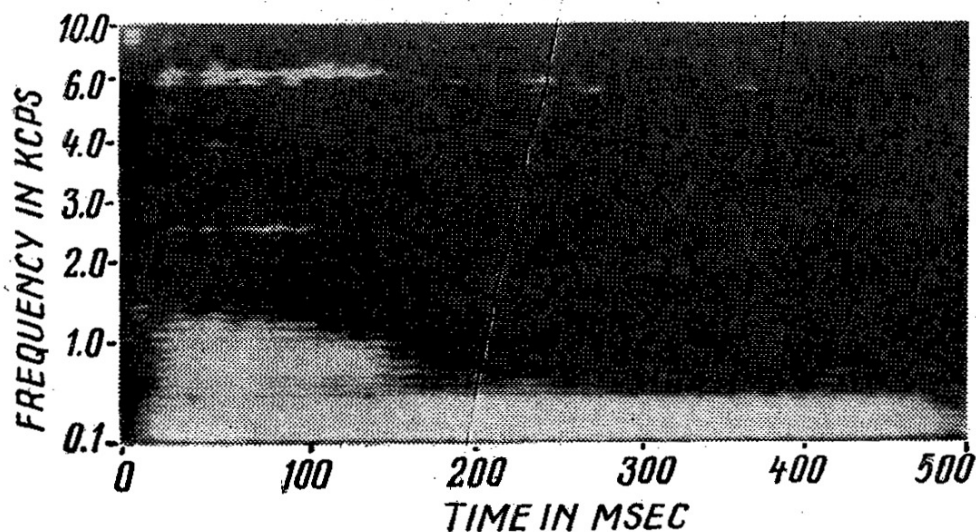


Fig. 1. The vowel sequence /aũ:/ in *paũkti* „to buzz“

proved in natural speech analysis. For this sake, the comparison of the formant transitions between two pure vowel sequences /a+u/ and /a+i/ and the formant transitions of the corresponding diphthongs /au/ and /ai/ is effective. Spectrograms show that formant transitions in diphthongs are still slower than in vowel sequences (Fig. Fig. 1–4). Hence, if the tempo of formant transitions in a sequence of two vowels does not give rise to a semi-vowel, a slower formant transition in diphthongs, consequently, cannot give a rise to it either.

This finding is also confirmed by a reverse recording of /au/ and /ai/. The reverse rising diphthong /aũ/ was estimated by the hearers as a triphthong /uoɑ/,

<sup>5</sup> C. M. Wise, Ref. 1, 589–590

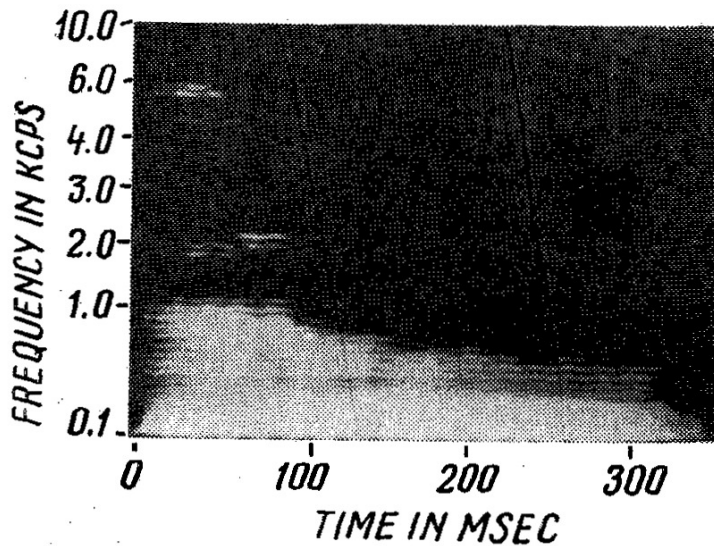


Fig. 2. The diphthong /aũ./ in *paũkši* „bird“ (Sing. Voc.)

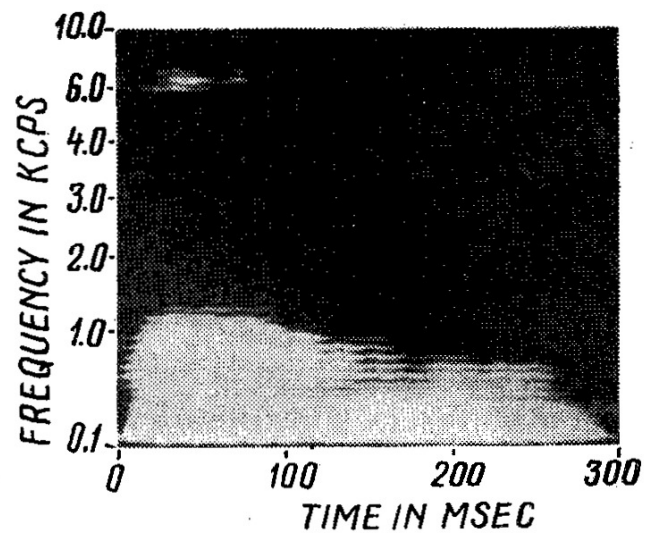


Fig. 3. The diphthong /aũ./ in *kaũkè* „howled“

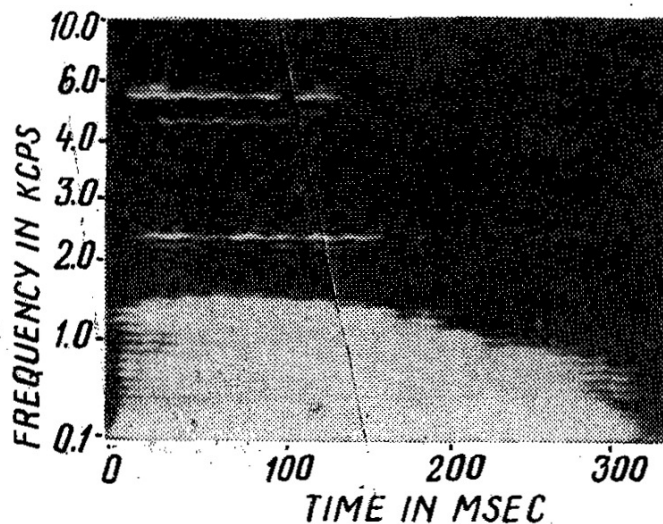


Fig. 4. The diphthong /á.u/ in *káukè* „mask“

the first component of it being a slightly delabialized /u/. The falling diphthong /áu/, when played reversely, was taken for a triphthong /uoá./ where /u/ was found to be less labialized and the last component /á./ prolonged.

Thus, even in acoustically favourable conditions for a sonorant /w/ to appear (i.e. when the transition from a more close to a more open sound is heard) neither a sonorant /w/ nor a considerably labialized /u/ is perceived.

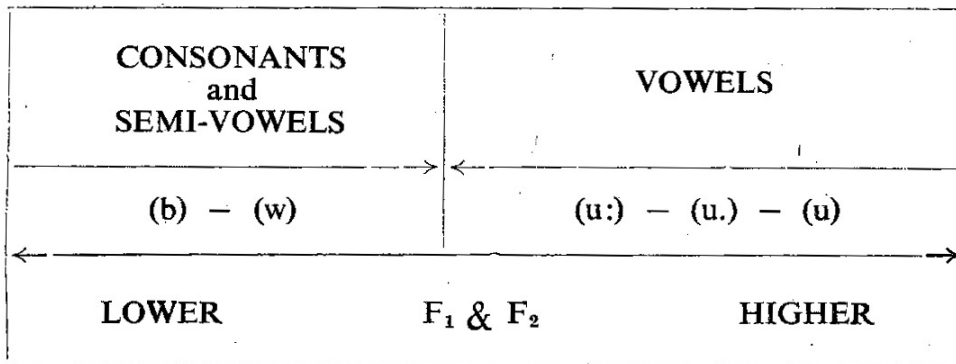
The diphthongs /ái/ and /aĩ/, when played reversely, are heard as /ieá./ and /ieá./, respectively. In both cases no /j/ is perceived. Consequently, the above findings show that the formant transitions in diphthongs from one component to the other are too slow to serve a basis for the semi-vowels /j/ and /w/.

Moreover, no considerable formant shift is observed in the transition from a diphthong to a next sound. If, however, there appears a slight move of formants

in this transition it should be explained by the coarticulation of the given sound sequences.<sup>6</sup> Thus, there is no ground of considering the formant shift at the end of the diphthong to be an indicator of sonority of its second component since such slight formant shifts are found in transitions from vowels to consonants (cf. Fig. 1 and Fig. 2).

The spectral analysis of the steady parts of the diphthongs confirms the assumption that the second component can't be considered as a semi-vowel. The data obtained by other researchers show the locus of  $F_1$  and  $F_2$  of the consonant /b/ to be lower than in /w/ and, at the same time,  $F_1$  and  $F_2$  of both (i.e. /b/ and /w/) being lower than in /u:/<sup>7</sup>.

On the basis of our experiments,  $F_1$  and  $F_2$  were found to be lower in the pure /u:/ than in /u./ (i.e. the second component of the rising diphthong /aũ/) and much lower than in /u/ (i.e. the second component of the falling diphthong /áu/; cf. Fig. Fig. 1–4). The above results may be illustrated by the following:



This sequence of sounds well proves the second components of the diphthongs /áu/ and /aũ/ to be vowels, not consonants, as  $F_1$  and  $F_2$  in their spectra are found higher than those of /u:/ which is characterized by a higher  $F_1$ ,  $F_2$  than /w/.

The second components of /ái/ and /aĩ/ are found to be less diffuse than for the vowel /i:/. Insofar as /j/ is characterized by a more diffuse spectrum, consequently, the second components of these diphthongs (i. e. /i/ and /i./) cannot be considered as /j/ by their spectra.

Thus the spectral analysis of the above diphthongs shows that in „narrowing” diphthongs it is vowels, not consonants that constitute their second elements.

The second elements of falling diphthongs are not likely to be considered as consonants for the only reason of their inability to serve syllabic elements. Neither do the first components of rising diphthongs serve as syllabic elements, but there can be no doubt, however, in defining them as vocalic.

<sup>6</sup> G. E. G. Öhman, Coarticulation in VCV utterances: spectrographic measurements, — The Journal of the Acoustical Society of America XXXIX (1966) 151–168.

<sup>7</sup> P. Delattre, Ref. 1; C. M. Wise, Ref. 1.

## APIE LIETUVIŲ KALBOS DIFTONGINIŲ /I/ IR /U/ VOKALIŠKUMĄ

### *Reziumė*

Lietuvių literatūrinės kalbos dvibalsių /au/, /ai/, /ei/ antrieji sandai yra balsiai, o ne pusbalsiai. Ši išvada daroma, remiantis spektrinės analizės duomenimis, kurie rodo, jog: a) pereinamieji procesai dvibalsiuose yra per lėti, kad galėtų susiformuoti sonantai /j/ ir /w/, b) vidinė diftonginių /i/, /u/ struktūra yra aiškiai vokališkos prigimties.