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ARTICULATION OF THE ESTONIAN SONORANT CONSONANTS. III PALATALIZED [n] AND [l]

0.1. The phenomenon of palatalization in modern Standard Estonian has not been quite levelled as yet (cf. Hint, 1968; Erelt, Kull, 1970). The cause for instability is first to be looked for in the dialect background of the speakers of the literary language since the occurrence of palatalization in Estonian dialects is rather many-featured (Laugaste, 1956; Keem, 1959, 1970). Conducive to unevenness is also the fact that palatalization is not marked in spelling.

0.2. As palatalizable consonants the dental-alveolars /t, n, l, s/ are known. However, after front vowels also palatalized velars can clearly be heard, cf. e.g. [säŋ́ki] — [saŋga].

The palatalization of Estonian consonants is generally regarded as a result of the assimilation of [i] (also in case of the former [i] apocope) or [j]. In Standard Estonian this generally seems to be so. However, purely physiologically palatalization cannot be defined as only a phenomenon of automatic coarticulation. Here the dialects in Hiiumaa and on the North-Estonian coast should be borne in mind, where a perceptible palatalization is absent altogether, or the Mulgi dialect where palatalization occurs only in case of the loss of [i] but is absent when it is preserved (Tanning, 1961). Though in the pronunciation of Standard Estonian the palatalization of consonants before [i] can be observed in most cases there are instances where the assumable palatalization here is missing. For the most part these are loan- and foreign words (*boss* : *bossi*, *blond* : *blondi*, *konsonant* : *konsonandi*) or when in the consonant clusters preceding [i] there is a consonant which it is difficult to palatalize, e.g. [r] (*mandri*, *kaatri*, *Kadri*). Still probably there is a certain so-called real coarticulatory automaticity as the transition between the final part of a consonant or the last component of a consonant cluster and the following [i] also in all the enumerated cases of non-palatalization, but it is not sufficiently intensive and permanent to create palatalization perceivable to a speaker of the literary language. The initial part of a consonant or the first components of a consonant cluster are in those cases non-palatalized when judging by perception. By the way, in the literature on Estonian phonetics (Ariste, 1953, 1968; Laugaste, 1956) only just the initial part of a consonant or the first component of a consonant cluster or a geminate are regarded as palatalized, while in the perception of palatalization a considerable role is played by the *i*-like transition preceding the palatalized consonant (Liiv, 1965*a*, *b*). (Mainly in diminutive words) where palatalization is not caused by the neighbourhood of [i], it actually seems to be the first component of a consonant cluster or a geminate that is palatalized, e.g. *kutsu*, *kussu*. The weakening of palatalization towards the end of a geminate or a consonant cluster can be perceived also in the partitive plural of *i*-stem words (e. g. *kaste*, *palle*; in Western dialect *kasta*, *palla*, respectively). One has doubts as to how sound this standpoint is in a position preceding [i] (cf. Lehiste, 1965; Vihman, 1967).

Thus, keeping in mind the location of palatalization we could hypothetically come to two cases of occurrence: (1) when a consonant or a consonant cluster precedes [i] (including the apocopated nominative singular of *i*-stem words; excluding the above-

mentioned cases of non-palatalization) the whole consonant or consonant cluster is palatalized; (2) in the preceding position of some other vowel the initial part of a consonant or the first component of a consonant cluster is palatalized. In other words, in all the cases of palatalization it is necessarily the initial part of a consonant or the first component of a consonant cluster which is palatalized. The palatalization/non-palatalization of the final part of a consonant or the following component(s) of a consonant cluster is a purely coarticulatory phenomenon and entirely depends upon the vowel of the following syllable.

0.3. The present article pays attention to three problems. First, it is considered in what the palatalized sonorants differ from non-palatalized ones, i. e. what articulatory features determine palatalization. Secondly, it is observed whether the same characteristic articulatory features which were regarded as essential in distinguishing non-palatalized equivalents are relevant in distinguishing palatalized sonorants between themselves. In the third place, all these cases are analysed keeping in view the three degrees of quantity.

1. Methods and material*

1.1. The experimental material for the description of the articulation dynamics of [ń] and [l′] was obtained by the complex techniques of lateral cinefluorography and the filming of lip articulations, both synchronized with sound spectrography (and oscillography). The same language material was used in both filming procedures: *Pa|n|i ka paja tulele* 'P u t also the pot on the fire'. *Pa|nn|i peal juba säriseski pekk* 'The fat was sizzling on the p a n already'. *Pa|nn|i polnudki pliidil* 'The p a n was not on the kitchen range at all'. *Pa|l|i paigutati uude pesuköögi* 'The w a s h - t u b was placed in the new laundry room'. *Pa|ll|i põrkest tuligi värav* 'The b a l l rebounded and the result was a goal'. *Pa|ll|i põrgatada ta ei jõudnudki* 'He did not manage to dribble the b a l l at all'.

The sonorants under study occur in the initial word of a sentence in the context [a]—[i]. In this case only when the vowel of the following syllable happens to be [i], we can find examples of palatalized sonorants in the three phonemic degrees of quantity.

As a rule, one sample of each unit to be analysed was obtained from every informant. The total experimental material amounts to 375 cinefluorograms and 205 cineframes of lip movements. Taking into consideration the fact that the peculiarities of the articulation dynamics may play quite an essential part in distinguishing the Estonian phonemic degrees of quantity, the whole word containing a palatalized sonorant was drawn and measured frame by frame.

1.2. The same language material was further utilized to prepare 32 X-ray shots vizualizing the so-called culmination phases of [ń] and [l′] by the technique of static roentgenography synchronized with oscillography, and 13 X-ray shots of sonorants pronounced in isolation.

1.3. In order to measure the contact between the tongue and the hard palate, the traditional palatographic procedure was used employing artificial palates (including the inner surfaces of teeth) and in addition also the method of direct palatography. The experimental material here consisted of single nonsense words containing a sonorant in the three degrees of quantity embedded in the vowel [a]; in addition palatograms were made of words containing a palatalized sonorant in a word-final position: /ańa/, /ań : a/, /pań : : a/, /pań : :/ '(frying-)pan'; /al′a/, /al′ : a/, /pal′ : : a/, /pal′ : :/ 'ball'.

Each of the informants used for traditional palatography pronounced every word 8 times (256 palatograms in all) and for direct palatography 4 times (32 palatograms in all).

1.4. Two informants were used for cinefluorography: Õ. P. (female), R. T. (male); one informant (Õ. P.) was used for the filming of lip articulation. Static X-ray shots

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* A detailed description of the methods used and technical data have been presented elsewhere: Лийв, Ээк, 1968; Eek, 1969, 1970*a*.

were made of 6 informants: K. K., H. P., T. K. (female), R. T., A. S., A. E. (male). Four informants were used for traditional palatography (R. T., A. S., A. E., K. K.), one for direct palatography (A. E.).

2. Articulation dynamics in words containing palatalized sonorants

The preceding studies on the articulation of Estonian sonorants (Eek, 1970*a, b*) clearly show that the characteristic features determining the degree of quantity of intervocalic sonorants have a certain organizing influence on the production of the entire word. This influence is not reflected only in the change of durational relations of separate segments but also in the qualitative differences between the same segments. Taking into consideration these circumstances it is not right to confine oneself to only the description of the occlusion phase of sonorants. This is why the articulation of the whole word is analysed by segments.

2.1. In order to measure roentgenograms a coordinate system has been prepared, the description of which can be found elsewhere (Eek, Remmel, 1969). Here is an abridged list of coordinates used in this work (more comprehensive definitions are to be found in: Eek, 1970*a*, 2.1.7; see Fig. 1): L_h — the height of the lip aperture; I_d — the distance between the tips of the anterior upper and lower incisors; *2′*, *3′* — the distance of the

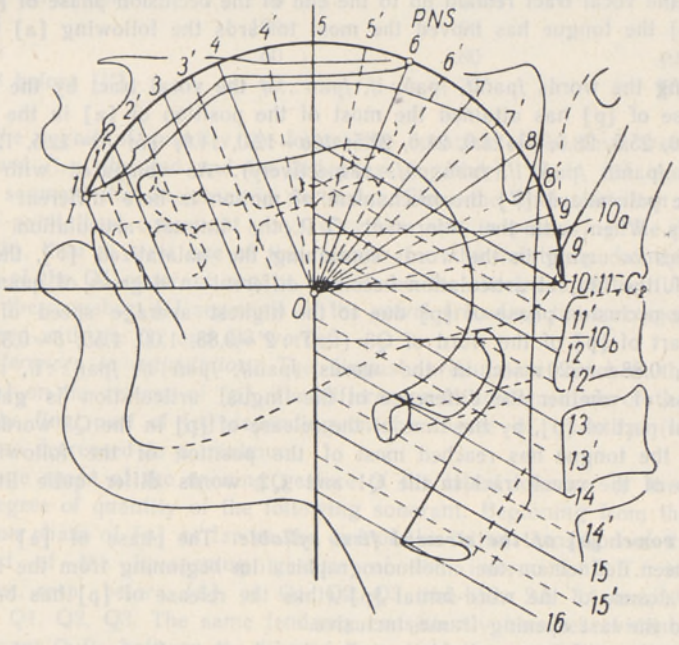

Fig. 1. Reference coordinate system for measuring roentgenograms.

predorsum from the alveoli or the prepalate; *4*, *4′*, *5*, *6* — the distance of the mediodorsum from the medio-and postpalate; 6_o, $6_o'$, 7_o, 8_o — the distance of the postdorsum from the origin of the coordinate system (describes the movement of the tongue dorsum in the velar and uvular region); *10a, 10, 10b* — the distance of the root of the tongue from the rear wall of the pharynx; *12, 13, 13′* — the distance of the epiglottis from the rear wall of the pharynx; U_h — the height of the uvula; U_w — the distance between the back wall of the uvula and the rear wall of the pharynx; H_f, Lar_f — describe the

forward-and-back movement of the hyoid bone and the larynx, respectively; H_u, Lar_u — describe the up-and-down movement of the hyoid bone and the larynx, respectively.

2.2. *Word-initial* [*p*]. The phase of [p] on the cinefluorographic film has been determined from the first frame of the labial closure up to the last closure frame included. Since the production of labial closure leaves the tongue relatively movable, it is of interest to what extent the lingual articulation reaches the position of the following vowel [a] already in the occlusion phase of [p].

Let us first consider the words /pal'i/, /pal' : i/, /pal' : : i/. When the implosion frame of [p] of these words has no considerable differences at all in the measurements of the oral and pharyngeal cavities (e. g. R. T. : *2'*=17.0, 17.5, 18.0; *3'*=18.5, 20.0, 19.5; *4*=19.0, 20.5, 20.5; *5*=15.5, 16.5, 17.5; *10a*=18.5, 19.5, 19.5 mm in the words /pal'i/, /pal' : i/, /pal' : : i/, respectively), then already in the medial temporal phase of respective bilabial stops (i. e., on the fifth frame before the release of [p]) in the word of the third degree of quantity the oral cavity is always the largest and the pharyngeal cavity the narrowest (R. T.: *2'*=22.5, 22.5, 27.0; *3'*=24.5, 24.0, 27.5; *4*=24.5, 24.5, 27.5; *5*=19.5, 19.0, 20.5; *10a*=14.5, 15.5, 13.5 mm in the words /pal'i/, /'pal' : i/, /pal' : : i/, respectively). At this in the initial part of the occlusion phase of [p] the average speed of articulators is the highest in the word of the third degree of quantity and the lowest in that of the first degree of quantity[1] (R. T. : *2'*=0.73, 1.42, 2.57; *3'*=0.80, 1.14, 2.28; *5*=0.53, 0.71, 0.85; *10a*=0.53, 1.14, 1.71 mm/20 msec, in the words /pal'i/, /pal' : i/, /pal' : : i/, respectively). Though the average speeds of articulators in the final part of the occlusion phase of [p] are lower and the differences between the speeds also somewhat decrease, the above-mentioned differences of the vocal tract remain up to the end of the occlusion phase of [p]. Thus by the end of [p] the tongue has moved the most towards the following [a] in the word of Q3.

Also among the words /pańi/, /pań : i/, /pań : : i/ the vocal tract by the end of the occlusion phase of [p] has attained the most of the position of [a] in the word of Q3 (R. T. : *2'*=27.0, 25.5, 28.5; *5*=21.0, 21.0, 22.5; *10a*=12.0, 11.0, 9.5; *10*=12.5, 12.5, 10.5 mm, in the words /pańi/, /pań : i/, /pań : : i/, respectively). As compared with the words containing the palatalized [l'] the mechanism of motion is here different with different informants. When with the informant Õ. P. the lingual articulation follows the same tendencies occurring in the words containing the palatalized [l'], then with the informant R. T. the lingual articulation becomes different in degrees of quantity only at the end of the occlusion phase of [p] due to the highest average speed of articulators in the final part of [p] of the word of Q3 (R. T. : *2'*=0.88, 1.00, 1.55; *5*=0.33, 0.33, 0.55; *10*=0.66, 0.66, 0.88 mm/20 msec, in the words /pańi/, /pań : i/, /pań : : i/, respectively).

Regardless of whether the difference in the lingual articulation is gained in the medial or final part of [p], by the time of the release of [p] in the Q3 words containing [ń] and [l'], the tongue has reached most of the position of the following [a]. The configurations of the vocal tract in the Q1 and Q2 words differ quite little between themselves.

2.3. *The vowel* [*a*] *of the stressed first syllable.* The phase of [a] of the first syllable has been defined on the cinefluorographic film beginning from the first opening frame of the closure of the word-initial [p] (thus the release of [p] has been included, as well) up to the last opening frame, inclusive.

2.3.1. *Durations.* In two-syllable words the degree of quantity of inter-vocalic non-palatalized sonorants does not influence the duration of the vowel of the primary stressed syllable but only its quality (Eek, 1970*a*, *b*). But the greater the degree of quantity of the inter-vocalic palatalized sonorant, the more lasting is the vowel of the first syllable (the average absolute durations of [a] of two informants, measured from the dynamic spectrograms by a comparative analysis of cinefluorograms and spectrograms: 160, 190, 202 msec, resp. before [ń] of Q1, Q2, Q3 and 175, 200, 212 msec, resp.

[1] The 1st, 2nd, 3rd degree of quantity will be henceforth presented in an abbreviated form, Q1, Q2, Q3, respectively.

before [l'] of Q1, Q2, Q3). At the same time the duration of the vowel preceding the palatalized sonorant is longer than that of the vowel preceding the non-palatalized sonorant (cf. also Liiv, 1965*a*, *b*). In the present case it is difficult to determine the durations of the initial transition, the culmination phase and the final transition of [a]. If we take into account the changes on the cinefluorographic film in the speed of articulators, we have conventionally three articulation phases in pronouncing [a] (see Fig. 2). In the present article the onset of the 1st phase or the traditional initial transition is defined by the first frame of labial release and the end by the frame reflecting the attainment of the maximum labial opening. In the following 2nd phase there takes place a rapid movement of the tongue towards the palatalized sonorant. The boundary between the 1st and the 2nd phase could conventionally be regarded as the culmination of the vowel. The 3rd phase is made up by an overshort [i] segment immediately before the palatalized sonorant, during which the speed of the tongue as compared with the preceding phase is considerably reduced (cf. Kettunen, 1913; Saaberk, 1920; Sovijärvi, 1959; Liiv, 1965*a*, *b*; Itkonen, 1969). The 2nd and 3rd phases correspond to the traditional final transition. The durations of these phases in milliseconds (with a certain conventionality) for the informant R. T.:

	1st phase	2nd phase	3rd phase
Q1	90	80	10
Q2	90	80	30
Q3 before [ń]	90	70	65
Q1	100	90	—
Q2	80	80	40
Q3 before [l']	80	70	75

The greater the degree of quantity the longer the duration of the final transition of the preceding vowel (i. e. the 2nd and the 3rd phase together). It is the duration of the overshort [i] segment that increases in particular. Since the final transition of the vowel preceding the palatalized consonant plays a certain role in perceiving the palatalization (Liiv, 1965*a*, *b*), then at least one of the reasons for the relatively faintly perceivable palatalization of the Q1 sonorant can be considered the shortness of the final transition (in particular the overshort [i] segment) of the vowel preceding the corresponding sonorant as compared with the Q2 and Q3 words.

2.3.2. *Differences in articulation.* The lingual articulation reaches the maximum position of [a] on the release of [p]. The differences in configuration of the vocal tract observed in the final part of [p] depending on the degree of quantity (see 2.2) have with the release decreased to a minimum.

The average speed of the opening gesture of the labial closure is the higher, the greater the degree of quantity of the following sonorant. Beginning from the last frame of the occlusion phase of [p] as far as the end of the initial transition of the vowel the average speed of the lip-opening gesture of the informant R. T. is: 2.0, 2.2, 3.3 mm/20 msec, resp. before [ń] of Q1, Q2, Q3 and 2.2, 2.5, 3.1 mm/20 msec, resp. before [l'] of Q1, Q2, Q3. The same tendency consistently becomes evident also in the case of informant Ö. P., both on the film of lip articulations and the cinefluorographic film. The speed of the lip-opening gesture in Q3 is much higher than in Q1 and Q2. According to this the lip aperture is the widest in the culmination phase of [a] of the Q3 words (e. g. R. T.: $L_h = 11.5$, 12.0, 15.0 mm; $I_d = 14.5$, 15.0, 17.0 mm, before [ń] of Q1, Q2, Q3, resp.; $L_h = 11.5$, 12.0, 14.5 mm; $I_d = 15.0$, 15.5, 17.5 mm, resp. before [l'] of Q1, Q2, Q3). Taking into account the size of the lip aperture while pronouncing palatalized sonorants (see below 2.4.4.1), from the standpoint of coarticulation the opposite tendency could be expected. Instead of moving by the most economic way towards the following consonant, the articulators in case of identical context still reach most of the target position of the corresponding vowel in the culmination phase of the vowel preceding the Q3 consonant (in comparison with the Q1 and Q2 words) (Eek, 1970*a*, *b*). Therefore it

seems to be correct to state that in the Q3 words the coarticulatory link between the vowel of the first syllable and the following Q3 consonant is the weakest (cf. Liiv, 1970). Probably the feature of tenseness culminating on the first component of the Q3 geminate consonant (Eek, Remmel, 1969) is realized so that each sound of the corresponding syllable is articulated most tensely. In the Q3 words, instead of the "normal" coarticulatory link there occurs the so-called tenseness link. As a result in the present case, [a] preceding the Q3 sonorants is pronounced with the widest lip aperture.

Let us now examine more closely what changes in the tongue position take place while moving from the vowel to the palatalized sonorant. Since the mediodorsum starts rising towards the palate immediately from the beginning of [a] (this is possible only due to the word-initial [p]) and the movement is consistently unidirectional as far as the end of the vowel, then we shall first compare the speeds of the tongue contours in an interval from the first frame of the vowel till the so-called overshort quasi-stationary [i] segment (i. e. during the whole of the 1st and 2nd phases defined under 2.3.1). [a] of the Q3 word is pronounced with the quickest rise of the mediodorsum towards the palate and the withdrawal of the root of the tongue from the rear wall of the pharynx. The average speeds of the corresponding *i*-directional transition with the informant R. T, are: *4*=2.4, 2.4, 2.7; *5*=2.0, 1.9, 2.1; *10*=1.4, 2.2, 2.4 mm/20 msec, resp. before [ń] of Q1, Q2, Q3, and *4*=2.4, 2.5, 2.5; *5*=2.0, 2.2, 2.3; *10*=1.7, 2.1, 2.4 mm/20 msec, resp. before [l′] of Q1, Q2, Q3. On the other hand, the speed of the tongue tip and the predorsum to the alveolar closure is highest in the Q1 words. This is to be expected for bearing in mind the relatively long segment of the overshort [i], the alveolar contact in the Q2 and Q3 words would in the opposite case take place too early (e. g. R. T.: the average speed *2′*=3.2, 2.8, 2.9 mm/20 msec, resp. before [ń] of Q1, Q2, Q3, and 3.4, 3.1, 3.0 mm/20 msec, resp. before [l′] of Q1, Q2, Q3).

The speeds of articulators are not equal during the whole vowel. During the initial transition of [a] (1st phase), when the opening gesture of the labial closure is accompanied by the relatively slow movement of the tongue towards the palatalized sonorant, there dominate the rise of the mediodorsum to the palate and the withdrawal of the root of the tongue from the rear wall of the pharynx. The speeds grow with an increase in the degree of quantity of the following sonorant. At the same time the rise of the predorsum to the alveoli is the slowest, as a rule, and the differences in the degrees of quantity are not so essential (average speeds with R. T.: *2′*=1.0, 0.4, 1.0; *4*=1.0, 1.2, 1.8; *5*=1.1, 1.4, 1.4; *10*=0.3, 0.7, 1.1 mm/20 msec, resp. before [ń] of Q1, Q2, Q3; *2′*=0.8, 0.6, 1.0; *4*=1.1, 1.8, 1.8; *5*=1.2, 1.6, 1.7; *10*=1.2, 1.0, 1.7 mm/20 msec, resp. before [l′] of Q1, Q2, Q3). According to the spectrograms prepared from tape recording synchronized with cinefluorography, the values of the second formant during the 1st phase increase most rapidly in the Q3 word and most slowly in the Q1 word (e. g. the average speeds of changes in the F2 values with the informant R. T.: 55, 77, 94 Hz/20 msec, resp. before [ń] of Q1, Q2, Q3 and 85, 93, 121 Hz/20 msec, resp. before [l′] of Q1, Q2, Q3.[2]

In all the degrees of quantity the speeds of articulators are highest in the 2nd phase of [a]. The most consistent difference according to degrees of quantity appears here in the widening of the pharyngeal cavity. The higher the degree of quantity of the following sonorant, the higher the speed of withdrawal of the root of the tongue from the rear wall of the pharynx (average speed R. T.: *10*=2.2, 3.2, 3.5 mm/20 msec, resp. before [ń] of Q1, Q2, Q3 and 1.8, 2.4, 2.6 mm/20 msec, resp. before [l′] of Q1, Q2, Q3). The rise of the predorsum to the alveoli, as a rule, is quickest in Q1 words. Also the rising speed of the F2 frequency in all degrees of quantity is highest during the 2nd phase of [a]. At the same time the speed is highest before the Q3 and lowest before the Q1, Q2 sonorant (e. g. average speeds of changing F2 values with informant R. T.: 175, 175, 200 Hz/20 msec, resp. before [ń] of Q1, Q2, Q3, and 133, 135, 142 Hz/20 msec, resp. before [l′] of Q1, Q2, Q3.

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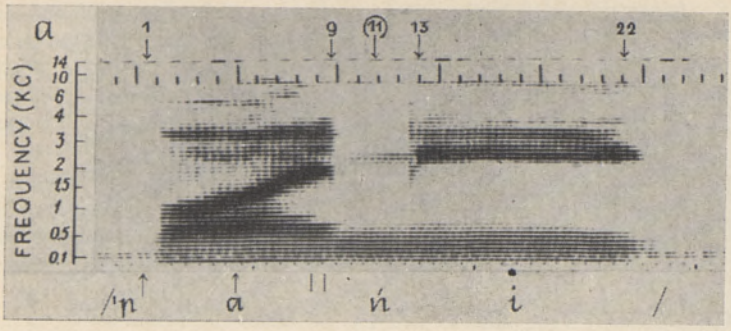
[2] The author is very much indebted to L. Veskis for the measurements of spectrograms.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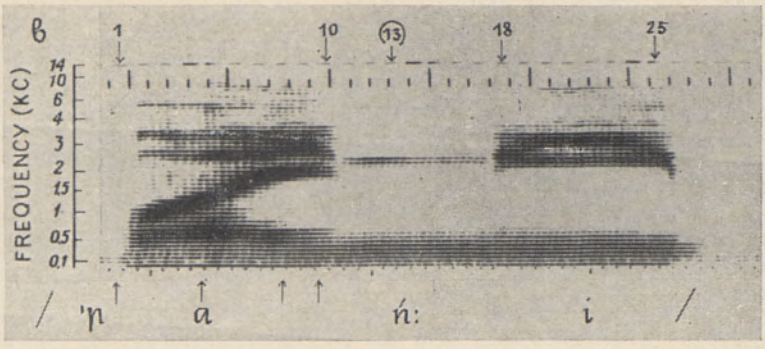
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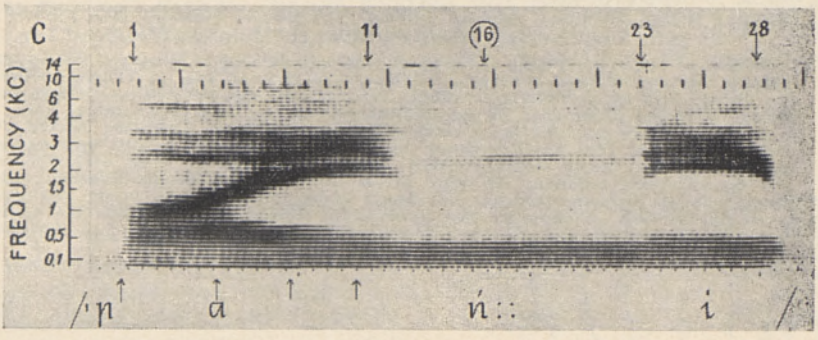
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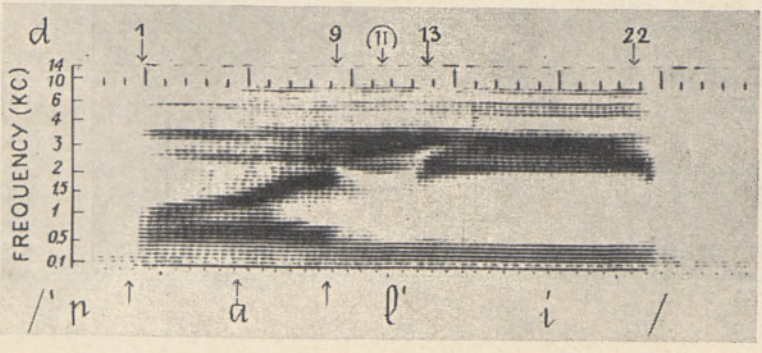
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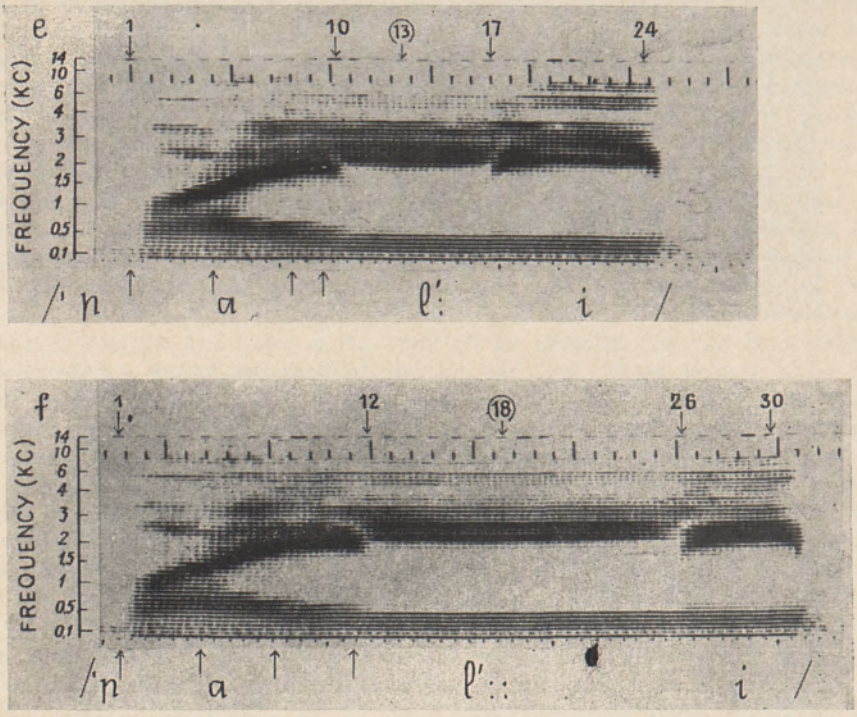

Fig. 2. Dynamic spectrograms, synchronized with cinefluorograms, of the Estonian words *pani (a); panni,* Genitive *(b); panni,* Partitive *(c); pali (d); palli,* Genitive *(e); palli,* Partitive *(f).* Informant R. T.

Vertical lines in the upper part of the spectrograms indicate time intervals, the distance between two shorter lines represents an interval of 20 msec and the distance between two longer lines an interval of 100 msec. X-ray frame exposures (10 msec) have been registered on the upper edge of the spectrograms in the form of horizontal lines; as a facility for frame counting every tenth and every first frame have been marked with darker lines. The first vertical arrow in the uppermost edge of the spectrograms indicates the first frame of the stressed vowel [a]; the second arrow designates the first frame of the sonorant; the third arrow (encircled) marks the so-called quasi culmination phase of the sonorant; the fourth is for the first frame of the unstressed vowel [i]; the fifth indicates the last frame of [i]. The distances between the vertical arrows in the bottom of the spectrograms indicate respectively the 1st, 2nd, 3rd phase of [a].

During the overshort [i] segment (in the 3rd phase) the *i*-directional movement continues, but the speeds of the articulators have considerably decreased.

Depending both upon the longest duration of the final transition of the vowel of the first syllable and the highest speed of the articulators in the Q3 word, the last frame of the vowel preceding the Q3 sonorant has been pronounced with the narrowest oral cavity and the widest pharyngeal cavity (R. T.: *3′*=9.0, 6.0, 5.5; *4*=11.0, 8.0, 6.5; *5*=6.5, 5.5, 4.5; *10*=23.5, 28.5, 31.5 mm, resp. before [ń] of Q1, Q2, Q3 and *3′*=8.5, 6.5, 5.5; *4*=10.5, 8.0, 7.5; *5*=6.0, 4.5, 3.0; *10*=24.0, 29.5, 31.0 mm, resp. before [l′] of Q1, Q2, Q3). That the *i*-likeness of the final transition increases with degrees of quantity is apparent also from the spectrograms where it is correlated with the lowering of the F1 frequencies and the rising of F2, for instance in informant R. T.:

	F1	F2	F3	F4
Q1	525	1850	2550	3300
Q2	375	2100	2700	3300
Q3 before [ń]	225	2175	2850	3150
Q1	525	1850	2475	3300
Q2	375	1950	2475	3300
Q3 before [l′]	300	2100	?	3150

Thus, alongside the longer duration of the final transition of the vowel (from this, in particular, the overshort [i] segment), the stronger palatalization of the following Q2 and Q3 sonorant as compared with the Q1 sonorant is determined also by the greater *i*-likeness of the final transition of the preceding vowel.

2.4. ***The occlusion phase of the palatalized sonorants.*** The occlusion phase of sonorants on the cinefluorographic film has been determined by an interval beginning from the first frame of the alveolar closure up to the last frame of the closure, inclusive.

2.4.1. *Durations.* Here the average durations have been presented of the occlusion phase of the sonorants in the three degrees of quantity measured from spectrograms prepared on the basis of synchronous tape recordings made during the cinefluorographic procedure with 2 informants: 65, 150, 235 msec, resp. Q1, Q2, Q3 [ń] (Q1 : Q2 : Q3 = = 1 : 2.3 : 3.6; Q2 : Q3 = 1 : 1.5) and 80, 160, 250 msec, resp. Q1, Q2, Q3 [l′] (Q1 : Q2 : Q3 = = 1 : 2.0 : 3.1; Q2 : Q3 = 1 : 1.5).

2.4.2. *Linguopalatal contact*

2.4.2.1. The data about the location and size of the linguopalatal contact have been drawn from the palatograms.[3] For measurements the coordinates given in Fig. 3 are used. The distance of the anterior and the posterior edge of the dental-alveolar contact from the upper edge of the incisors were measured along the median line of the palate *a*—*a*: the segments *AB* and *AC*, resp. The right- and the left-hand lateral contact is summarily described by the segment *DE* on the straight line *b*—*b* passing between the first and second molars on either side (the smaller the lateral contact, the longer the segment *DE*, and *vice versa*).

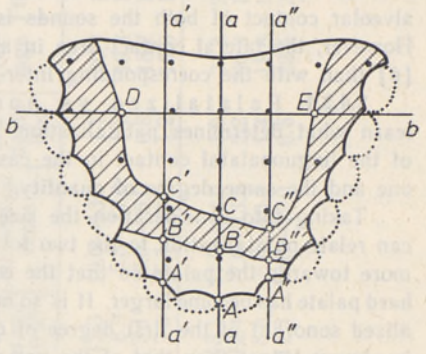

Fig. 3. Coordinate system for measuring palatograms.

2.4.2.2. The linguopalatal contact area can be indirectly estimated by the length of the alveolar contact (measure *BC*) and the width of the lateral contact (measure *DE*).

[3] The corresponding statistical computations have been performed by M. Remmel.

An increase in the degree of quantity is accompanied by an increase both of the length of the alveolar contact and the width of the lateral contact of [ń] and [l′], for instance, with informant R. T.: the average *BC*=5.7, 9.5, 10.7 mm ([ń]); 8.0, 8.0, 10.3 mm ([l′]); *DE*=37.8, 30.5, 26.0 mm ([ń]); 39.6, 38.5, 34.0 mm ([l′]), resp. Q1, Q2, Q3 (cf. also Ariste, 1943).

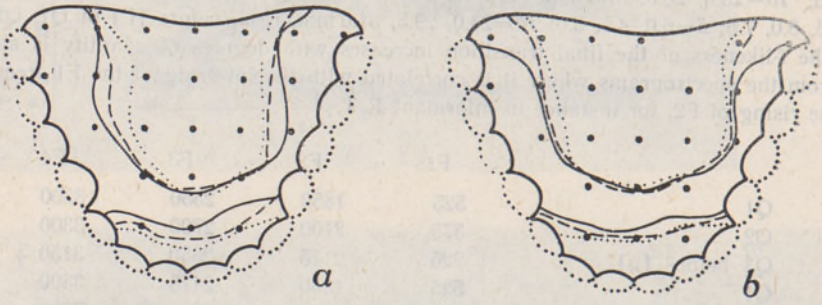

Fig. 4. Superimposed palatograms of Estonian palatalized sonorants of three degrees of quantity. Informant R. T.
a — [ń]; *b* — [l′].
Q1 ——; Q2 — — —; Q3 . . . .

The anterior edge of the alveolar contact moves forward with the degrees of quantity. This tendency is stronger with the palatalized nasals than with the laterals of the same degree of quantity, e. g. A. S.: the average *AB*=11.5, 7.6, 4.5 mm ([ń]); 12.3, 10.8, 7.8 mm ([l′]), resp. Q1, Q2, Q3 (see Table 1, Fig. 4). As to the location of the posterior edge of the alveolar contact, there are no essential differences; with the growth of the degree of quantity the posterior edge may to some extent move either forward or backward. Thus the area of the alveolar contact increases chiefly on account of the forward movement of the anterior edge of the contact.

2.4.2.3. While pronouncing the word-final [l′] the alveolar contact, as a rule, is more backward than in a palatalized inter-vocalic lateral in whatever degree of quantity. In case of the word-final [ń] the tendency is not so conspicuous (for instance, pronounced by R. T., the alveolar contact is even more forward than Q3). The length of the alveolar contact of both the sounds is either the longest or a little shorter than Q3. However, the lateral contact area in all the cases is bigger with the word-final [l′] and [ń] than with the corresponding inter-vocalic sounds.

2.4.2.4. Palatalized vs non-palatalized sonorant. In order to learn what determines palatalization, let us compare the results of the measurements of the linguopalatal contact in the case of palatalized and non-palatalized sonorants of one and the same degree of quantity.

Taking into consideration the size and the location of the linguopalatal contact, we can relate palatalization to the two following features. (1) The tongue dorsum has moved more towards the palate so that the contact area of the side edges of the tongue on the hard palate has become larger. It is so marked that even the lateral contact area of the palatalized sonorant of the first degree of quantity (i. e. the cases of the least lateral contact) is always larger than that of the non-palatalized sonorant of the third degree of quantity (i. e. the cases of the largest contact). (2) With the palatalized sonorants the place of articulation has shifted a bit forward. As to the size of the alveolar contact there are no considerable differences. There are a lot of cases (in particular, with [l′]) where the alveolar contact area of the palatalized sonorant is even smaller than that of the non-palatalized sonorant (cf. Ariste, 1939, 255). Thus, the linguopalatal contact area of the palatalized sonorants has increased mainly on account of the lateral contact (cf. Vihman, 1967). The fact that there are no considerable differences in the size of the alveolar contact can probably be explained by the circumstance that the pressure of the tongue tip and

Table 1

Data from the measurement of palatograms, mm (Informant A. S.)

Word	Alveolar contact										Lateral contact: *DE*			
	Distance of the anterior edge, *AB*				Distance of the posterior edge, *AC*				The length of the alveolar contact, *BC*					
	average	confidence borders of the average at p=0.95	limits of individual cases	standard deviation	average	confidence borders of the average at p=0.95	limits of individual cases	standard deviation	average	limits of individual cases	average	confidence borders of the average at p=0.95	limits of individual cases	standard deviation
aṅa	11.5	10.7—12.3	10.0—13.0	1.1	20.7	19.8—21.6	19.5—23.0	1.2	9.1	8.0—10.0	48.4	47.1—49.7	45.5—50.5	1.9
aṅ : a	7.6	6.3— 8.9	5.5—11.0	1.8	19.3	18.4—20.2	17.0—21.0	1.2	11.6	9.5—14.0	35.2	34.0—36.4	33.0—38.5	1.7
paṅ : : a	4.5	3.9— 5.1	3.0— 6.0	0.8	18.2	17.6—18.8	17.5—20.0	0.8	13.6	12.5—15.5	32.1	31.3—32.8	30.5—34.0	1.0
paṅ : :	7.0	6.1— 7.9	5.5—10.0	1.2	18.0	17.2—18.7	17.0—20.0	1.0	10.9	10.0—12.5	30.2	28.9—31.5	27.0—33.5	1.8
al′a	12.3	11.6—13.1	11.0—14.0	1.0	21.3	20.5—22.0	19.0—23.0	1.0	8.9	5.0—10.0	55.9	51.5—60.3	50.0—70.0	6.2
al′ : a	10.8	9.2—12.4	7.0—13.5	2.2	20.3	18.6—22.1	17.0—24.0	2.5	9.5	7.0—12.0	43.0	42.2—43.7	42.0—44.5	1.0
pal′ : : a	7.8	6.8— 8.8	6.0—10.0	1.4	18.6	17.5—19.8	17.0—21.0	1.5	10.8	10.0—11.5	40.8	39.9—41.6	38.5—42.5	1.1
pal′ : :	10.9	10.5—11.3	10.0—12.0	0.5	22.5	21.8—23.1	21.0—24.0	0.9	11.5	11.0—13.5	35.9	34.6—37.2	33.0—38.5	1.8

the predorsum on the alveoli is presumably more or less equal both in palatalized and non-palatalized sonorants.

2.4.2.5. [ń] vs [l′]. As was discovered on describing [n] and [l] (Eek, 1970*a*, 2.2.3), the place of articulation of the palatalized nasal is also somewhat more advanced than that of the palatalized lateral (Fig. 4*a, b*). When [ń] is a dental-alveolar nasal (the dental cases chiefly occur in Q3), then [l′] is an alveolar lateral. In one and the same degree of quantity the lateral contact area of [ń] is larger than that of [l′] (informant K. K. excluded). A consistent difference in the size of the alveolar contact as appeared while comparing [n] and [l], does not occur here. So the palatalization has somewhat levelled the differences in the linguopalatal contact of the two types of sounds.

2.4.3. *The movements of articulators.* The movements of articulators in the occlusion phase of the palatalized sonorants is in some respects different as compared with the non-palatalized equivalents. When the mediodorsum in the occlusion phase of [n] and [l] up to the so-called quasi-culmination (context *-aCa*) approaches the palate and the root of the tongue moves off from the rear wall of the pharynx, and later on at the end of the occlusion phase the movement in the opposite direction takes place; then in case of [ń] and [l′] (context *-aCi*), due to the following [i], the movement of the corresponding articulators (narrowing of the oral cavity, enlargement of the pharyngeal cavity) during the whole occlusion phase is u n i d i r e c t i o n a l. Since a certain *i*-likeness was achieved by the end of the final transition of the vowel preceding the sonorant already, the [i]-directional movement in the occlusion phase of the palatalized sonorant is much weaker than the [a]-directional movement in the final part of the closure phase of [n] and [l]. Probably for the reason that the lowest degree of *i*-likeness was reached by the end of the final transition of the vowel preceding the Q1 sonorant, the *i*-directional movement in the closure phase of Q1 [ń] and [l′] is most prominent.[4] Here the pharyngeal cavity widens more than the oral cavity narrows. Only immediately before the release of Q2 and Q3 [ń], [l′], probably as a result of the relaxation of alveolar contact, the predorsum shifts down a little.

Such a tendency to a continual unidirectional *i*-like movement through the whole occlusion phase provides no reason for stating that the palatalized sonorant preceding [i] should be depalatalized towards the end of the occlusion phase. The palatalization lasts (or even increases) through the entire single or geminate sonorant. This is confirmed also by comparisons between the measurements of the initial and final frames of the occlusion phase (R. T.: *4*=8.5, 7.0; *5*=3.5, 3.0; *10*=25.5, 29.5 mm, resp. the beginning and the end of the occlusion phase of Q1 [ń]; the corresponding data for Q2 [ń]: *4*=7.5, 6.0; *5*=3.5, 2.5; *10*=29.5, 33.0 mm and for Q3 [ń]: *4*=5.5, 5.5; *5*=3.5, 3.5; *10*=32.5, 34.0 mm). I. Lehiste's results in the study of the acoustic structure of the Estonian palatalized sonorants also seem to suggest the same fact. No considerable changes in the formant structure during the occlusion phase of the palatalized sonorants have been observed (Lehiste, 1965).

It is obvious that the Estonian palatalized sonorants, as regards their articulatory quality and production mechanism, are entirely different sounds in comparison with the non-palatalized equivalents (see 2.3.1, 2.3.2, 2.4.2, 2.4.4). The production mechanism of palatalization in modern Estonian most likely does not differ depending on whether the

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[4] Due to the continual unidirectionality of such a movement it is impossible to determine the culmination phase of the Q1 sonorant. The quasi-culmination phase of the Q1 [ń] and [l′] is therefore called the penultimate frame of the occlusion phase (with the duration of 3 to 4 frames). Since the [i]-directional movement in the Q2 and Q3 [ń] and [l′] is minimal (depending upon the coordinate 0—2 mm), then from the viewpoint of the movements of the mediodorsum and the root of the tongue the whole occlusion phase can be regarded as stationary. But when taking into account the postdorsal articulation considered essential in distinguishing between [n] and [l] (Eek, 1970*a*, 2.2.6), it becomes evident that also in case of the palatalized equivalents the difference of the postdorsal articulation is achieved more or less in the middle of the occlusion phase. This is the moment which in the present case is called the quasi-culmination phase of the Q2 and Q3 sonorants.

palatalized consonant is followed by [i] or some other vowel or the palatalized consonant is word-final. On the other hand, the depalatalization of the final part of the palatalized consonant probably depends upon the context only and thus is a merely coarticulatory phenomenon. When on pronouncing the consonant preceding [i] we could observe the retention of palatalization during the whole occlusion phase, as could also be expected, then before some other vowel (e. g. *Polla)* the gradual depalatalization of the final component of the geminate on passing over to the articulation of the following vowel is equally to be expected.

2.4.4. *The configurations of the vocal tract in the so-called quasi-culmination phase of* [ń] *and* [l′]

2.4.4.1. In the following let us draw comparisons between the configurations of the vocal tract of [ń] and [l′] in the three degrees of quantity occurring in the so-called quasi-culmination phase defined in Footnote 4 (Fig. 5, 6, Table 2).

Table 2

Selection of data from the measurement of the quasi-culmination phase of [ń] and [l′], mm

	L_h	I_d	$3'$	4	5	6_o	$6_o'$	7_o	8_o	$10a$	10	H_u	Lar_u
R. T.													
pańi	8.5	8.0	6.0	8.0	3.0	—	30.0	27.5	23.5	27.5	28.5	30.0	—
pań : i	8.0	7.5	4.5	6.0	2.5	—	28.5	25.5	20.5	30.5	31.5	29.5	—
pań : : i	7.5	6.5	4.0	5.5	2.5	—	27.0	23.0	18.0	31.5	33.5	29.5	—
Ö. P.													
pańi	13.0	5.0	5.0	5.0	3.5	28.0	—	23.5	19.5	22.5	21.5	30.0	47.0
pań : i	11.5	5.5	4.0	4.5	3.5	28.0	—	22.5	18.5	23.5	23.0	30.0	46.5
pań : : i	10.5	5.0	3.0	3.5	3.0	27.0	—	21.5	17.0	24.5	24.5	30.0	46.0
R. T.													
pal′i	10.0	10.5	5.0	6.5	3.0	—	36.5	33.0	26.0	26.0	28.0	29.5	—
pal′ : i	10.0	10.0	5.0	6.5	3.0	—	37.5	33.0	24.0	28.5	31.0	30.5	—
pal′ : : i	8.5	9.5	4.5	6.5	2.0	—	39.0	34.0	25.0	29.0	32.5	30.5	—
Ö. P.													
pal′i	15.5	7.5	6.5	7.5	4.5	32.0	—	29.5	25.5	19.5	19.5	26.5	45.0
pal′ : : i	11.5	7.5	4.0	5.5	4.0	32.5	—	30.5	25.5	21.0	22.5	29.5	45.5

The lip aperture regularly narrows with an increase in the degree of quantity (R. T. : L_h=8.5, 8.0, 7.5; I_d=8.0, 7.5, 6.5 mm, resp. [ń] of Q1, Q2, Q3, and L_h=10.0, 10.0, 8.5; I_d=10.5, 10.0, 9.5 mm, resp. [l′] of Q1, Q2, Q3). In a Q3 sonorant the mouth corners are the most retracted (e. g. the distance between the Indian ink spots marking the corners of the mouth as measured from the film of the lip articulation of the informant Ö. P. : 52.5, 52.0, 53.0 mm, resp. [ń] of Q1, Q2, Q3, and 52.0, 52.0, 55.0 mm, resp. [l′] of Q1, Q2, Q3). In one and the same degree of quantity [l′] always has a wider lip aperture than [ń], but evidently due to the palatalization the differences in the labial aperture of the two types of sounds have diminished in comparison with their non-palatalized equivalents (cf. Eek, 1970*a*, Table 2).

On the increase of the degree of quantity the anterior part of the oral cavity has become narrower, which is in accord with the measurements of the lateral contact on the palatograms (R. T. : $3'$=6.0, 4.5, 4.0; 4=8.0, 6.0, 5.5; 5=3.0, 2.5, 2.5 mm, resp. [ń] of Q1, Q2, Q3, and $3'$=5.0, 5.0, 4.5; 4=6.5, 6.5, 6.5; 5=3.0, 3.0, 2.0 mm, resp. [l′] of Q1, Q2, Q3). From the lateral roentgenograms it is impossible to find on the basis of tongue contours such a difference in the distance between the mediodorsum and the palate (measure 5) that would serve to distinguish [ń] from [l′] in the pronunciation of all the informants. As a quite slight tendency it can be observed that particularly [ń] of

Q2 and Q3 has been pronounced with a somewhat higher position of the predorsum (measure *3′* and *4*) than that of [l′].

While pronouncing [ń] the postdorsum withdraws increasingly from the velum and uvula (R. T.: $6_o'$=30.0, 28.5, 27.0; 7_o=27.5, 25.5, 23.0 mm, resp. Q1, Q2, Q3). The same tendency is revealed also in the case of [l′], but in the pronunciation of some inform-

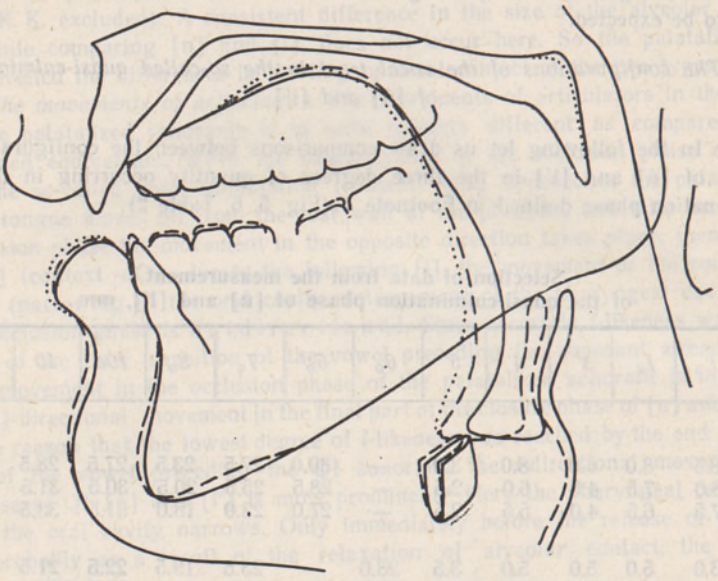

Fig. 5. Superimposed X-ray tracings of Estonian [ń] in the quasi-culmination phase. Informant R. T.
Q1 (in the word *pani*) ——; Q2 (*panni*, Genitive) — — —; Q3 (*panni*, Partitive) . . . .
Only the median line of the dorsum has been drawn; projections of the side edges of the tongue have been omitted for the sake of clarity. The exposures of the frames traced for this Figure are indicated on the spectrograms *a*, *b*, *c* in Fig. 2 by an encircled arrow.

ants one can observe even the contrary, i. e. increasing velarization according to degrees of quantity (R. T.: $6_o'$=36.5, 37.5, 39.0; 7_o=33.0, 33.0, 34.0 mm, resp. Q1, Q2, Q3). The feature of laterality distinguishing [l] from [n] (during [l] the tongue dorsum in a cross-sectional view is convex and the tongue sides are pressed down to provide a free egress for the air flow, while during [n] at least the median part of the postdorsum is concave and the air flow from the mouth is completely obstructed both by the median part and the sides of the predorsum) is quite valid also with the palatalized equivalents. The feature of laterality can be estimated indirectly even from the roentgenograms. When during the *i*-like transition of the vowel preceding [l′] the shadows of the tongue sides increase both on the postdorsum and on the root of the tongue, then before the implosion of [l′] the shadow of the tongue sides on the postdorsum decreases so that in the occlusion phase of [l′] it can be registered on the root of the tongue only. On the postdorsum it appears again only during the following [i]. On the other hand, during [ń] the shadow of the tongue sides remains on the postdorsum which refers to the concavity of its median part. As the result of this with all the informants during [ń] the barium-marked median part of the postdorsum has more moved off from the velum and uvula than during [l′] of the same degree of quantity.

The pharyngeal cavity widens with the withdrawal of the root of the tongue and the epiglottis from the rear wall of the pharynx (R. T.: *10a*=27.5, 30.5, 31.5; *10*=28.5, 31.5,

33.5; *12*=20.0, 25.0, 26.0 mm, resp. [ń] of Q1, Q2, Q3, and *10a*=26.0, 28.5, 29.0; *10*= =28.0, 31.0, 32.5; *12*=20.0, 28.0, 30.5 mm, resp. [l′] of Q1, Q2, Q3). As a rule, the oral pharynx in [l′] is narrower than in [ń] of the same degree of quantity.

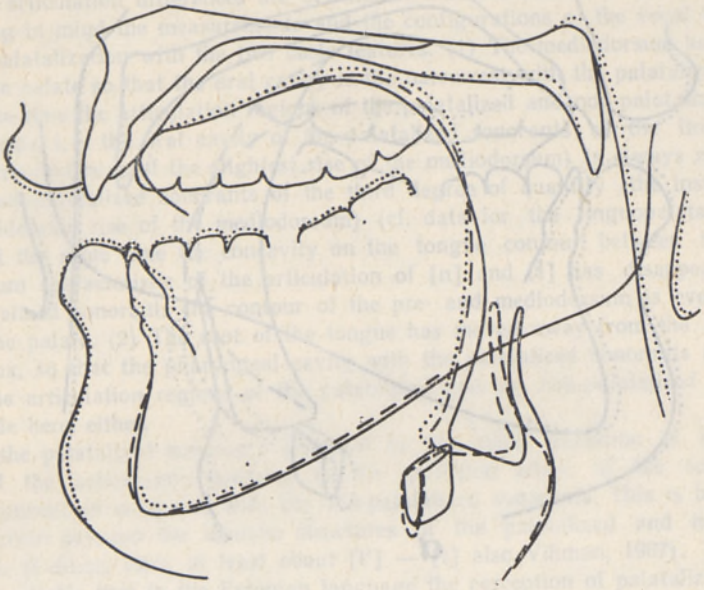

Fig. 6. Superimposed roentgenograms of Estonian [l′] in the quasi-culmination phase. Informant R. T.
Q1 (in the word *pali*) ——; Q2 (*palli*, Genitive) — — —; Q3 (*palli*, Partitive) . . . .
Only the median line of the dorsum has been drawn. The exposures of the frames traced for this Figure are indicated on the spectrograms *d*, *e*, *f* in Fig. 2 by an encircled arrow.

[ń] is articulated with an open velopharyngeal passage. With the increase of the degree of quantity the widening of the velopharyngeal passage can be observed. [l′] is articulated with a closed velopharyngeal passage.

The qualitative differences in the vocal tract configurations of the palatalized sonorants of different degrees of quantity are rather small. Regardless of this while collating the measurement data a consistent tendency could be registered to articulate the Q3 palatalized sonorant with the narrowest lip aperture and oral cavity, with the widest pharyngeal cavity and the largest linguopalatal contact area. It seems as if Q3 [ń] and [l′] were the most tensely articulated ones among the palatalized sonorants.

2.4.4.2. [ń] and [l′] pronounced in isolation. While making comparisons between the types of the palatalized sonorants pronounced in isolation and the corresponding inter-vocalic sonorants we can observe a number of articulatory differences which probably have been caused by the lacking of the vowel context. Thus the degree of nasality of [ń] pronounced in isolation is consistently higher than that of the inter-vocalic [ń] (T. K.: U_w=9.5, 12.5 mm, resp. [ń] of Q3 and in isolation). Due to the lower position of the larynx the pharyngeal cavity of the isolated [ń] and [l′] is the longest (T. K.: Lar_u=34.0, 42.0 mm, resp. [ń] of Q3 and in isolation; the corresponding measurements for [l′] are 34.0, 40.0 mm). In connexion with this also the lowest position of the hyoid bone should be mentioned (T. K.: H_u=26.0, 36.5 mm, resp. [ń] of Q3 and in isolation, the corresponding measurements for [l′] are 30.0, 37.5 mm). During the isolated [ń] (informant A. S. excluded) and [l′] (informant A. E. excluded) the mediodorsum does not rise so high towards the palate as it does with the palatalized sonorants

preceding [i] (H. P.: *4*=4,5, 6.5; *5*=3.0, 6.5 mm, resp. [ń] of Q3 and in isolation; *4*=7.0, 8.0; *5*=7.0, 8.0 mm, resp. [l′] of Q3 and in isolation).

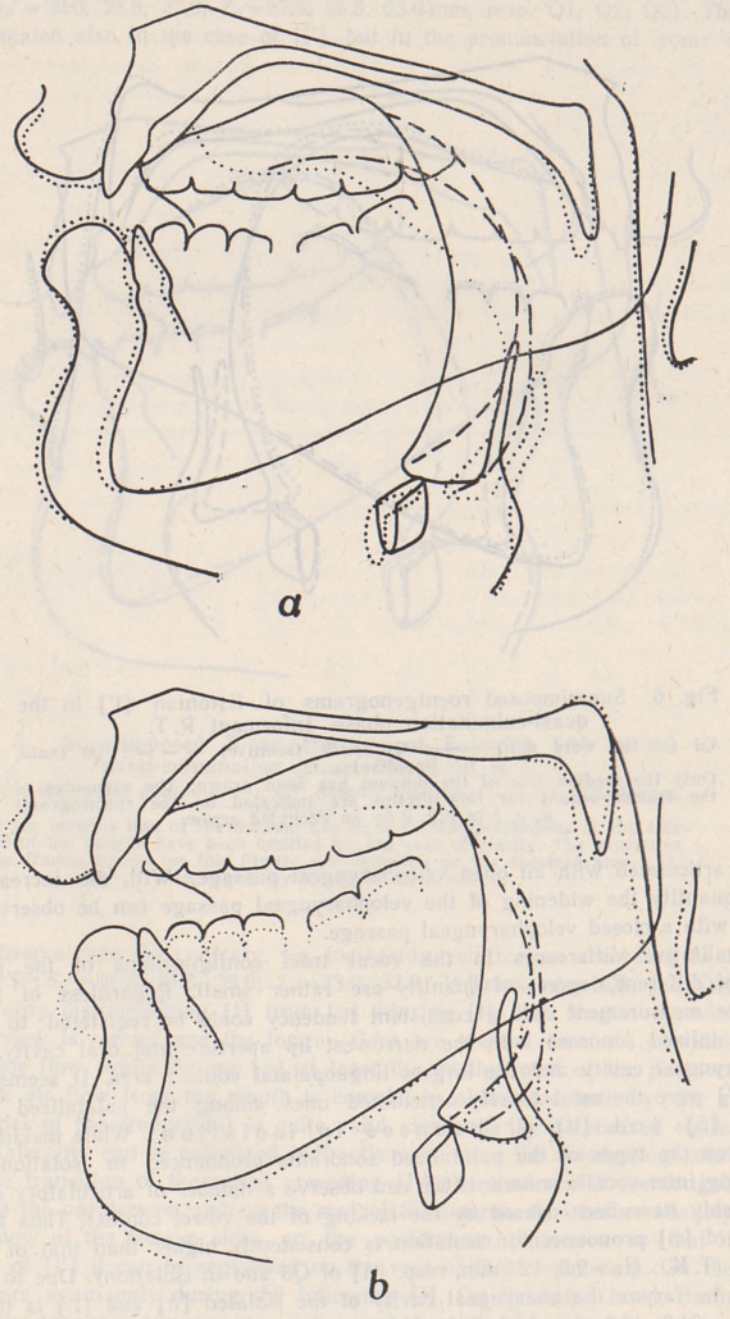

Fig. 7. Roentgenograms of the opposition of Estonian [ń] — [n] and [l′] — [l] of the third degree of quantity in the quasi-culmination phase. Informant R. T.

a – [ń] ——, [n] . . . . ; *b* – [l′] ——, [l] . . . . — — — marks the projection of the side edges of the tongue while articulating [ń] and [l′]; —.—.—. indicates the projection of the side edges of the tongue while articulating [n] and [l].

2.4.4.3. Palatalized vs non-palatalized sonorant. In order to determine the articulatory features of palatalization let us draw comparisons between the vocal tract configurations of the inter-vocalic palatalized and non-palatalized sonorants in the quasi-culmination phase (see Fig. 7). As the features of palatalization only these articulation differences are of interest that are valid for all the informants.

Keeping in mind the measurements and the configurations of the vocal tract, we can associate palatalization with the two basic features. (1) The mediodorsum has risen more towards the palate so that the oral cavity is the narrowest with the palatalized sonorants. At the same time the articulation regions of the palatalized and non-palatalized sonorants never coincide, i. e. the oral cavity of the palatalized sonorants of the first degree of quantity (the instances of the slightest rise of the mediodorsum) is always narrower than with the non-palatalized sonorants of the third degree of quantity (the instances of the most considerable rise of the mediodorsum) (cf. data for the linguopalatal contact in 2.4.2.4). At the same time the concavity on the tongue contour between the pre- and mediodorsum characteristic of the articulation of [n] and [l] has disappeared, so that with palatalized sonorants the contour of the pre- and mediodorsum is evenly convexed towards the palate. (2) The root of the tongue has moved away from the rear wall of the pharynx, so that the pharyngeal cavity with the palatalized sonorants is always the widest. The articulation regions of the palatalized and the non-palatalized sonorants do not coincide here, either.

Thus the palatalized sonorants are, both by the final transition of the preceding vowel and the articulatory features of the occlusion phase of the sonorant, quite different sounds, as compared with the non-palatalized sonorants. This is borne out also by comparison between the acoustic structures of the palatalized and non-palatalized consonants (Lehiste, 1965; at least about [l′] — [l] also Vihman, 1967). Though there are data available that in the Estonian language the perception of palatalization depends upon the character of the final transition of the vowel preceding the sonorant (Liiv, 1965*a*, *b*), it is not known whether and to what extent the perception of palatalization depends also upon the differences in the occlusion phases of the corresponding sonorants.[5]

2.5. ***The vowel [i] of the unstressed second syllable.*** The second syllable [i] has been determined from the cinefluorographic film with an interval from the first opening frame of the alveolar closure of the preceding palatalized sonorant (thus the release of [ń] and [l′] has been comprised, as well) up to the last opening frame, inclusive (see Fig. 2).

2.5.1. *Durations.* The increase of the degree of quantity of the inter-vocalic palatalized sonorant is attended by the shortening of the duration of the vowel of the unstressed second syllable. The average durations of [i] with two informants are 190, 145, 110 msec, resp. after [ń] of Q1, Q2, Q3, and 190, 160, 115 msec, resp. after [l′] of Q1, Q2, Q3. It is interesting to note that in the words containing palatalized sonorants the correlations

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[5] When judging by the data for the Russian language, only the acoustic differences in the occlusion phases of consonants seem to be sufficiently distinctive to distinguish between the palatalized and non-palatalized consonants (Shupljakov, Fant, de Serpa-Leitão, 1969). This has been confirmed also by some perception tests (Зиндер, Бондарко, Вербицкая, 1964; Щупляков, 1968). Nevertheless it should be mentioned that we have no ground to identify palatalization in Estonian and Russian. First, Estonian palatalization is regarded as weaker (Matthews, 1953; Ariste, 1959). Secondly, when the palatalization of the Estonian consonants has been marked by the *i*-likeness of the final transition of the preceding vowel and the initial part of the occlusion phase of the consonant (the palatalization of the final part of the consonant or that of the final component of the geminate appears only with the influence of the following [i], which, particularly on the release of the Q3 consonant, may become even weaker), then in Russian the situation seems to be contrary (Любимова, 1966; Derkach, Fant, de Serpa-Leitão, 1970). Namely, besides the occlusion phase of the consonant the palatalization here is determined just by the strongly aspirated release of the consonant (Зиндер, Бондарко, Вербицкая 1964; cf. also Вийтсо, 1963; Vihman, 1967).

of duration between the vowels of the stressed and the unstressed syllable have changed a little in comparison with the words containing non-palatalized sonorants. Namely, the "longerness" of the vowel of the second syllable following Q1 [ń] and [l′] as compared with the vowel of the first syllable is much smaller than that of the vowel following [n] and [l]. On the other hand, the "shorterness" of the vowel of the second syllable following Q3 [ń] and [l′] as compared with the vowel of the first syllable is much greater than that of the vowel following Q3 [n] and [l].

2.5.2. *Differences in articulation.* In order to avoid (while interpreting the obtained data) the difficulties that may arise from the coarticulatory influence of the next word in the sentence, let us confine ourselves only to the presentation of the articulation data of the vowel of the second syllable of the [l′] words. In the present case the word-final [i] is always followed by [p]: /pal′i+pa-/, /pal′ : i+pō-/, /pal′ : : i+pō-/. The comparisons between the vocal tract configurations are made in the so-called quasi-culmination phase of [i]. The quasi-culmination phase of a vowel is described by the data from the last frame of its culmination phase, the next frame displaying already a measurable transition toward the articulation place of the following consonant.

The oral cavity of [i] following Q3 [l′] is widest and pharyngeal cavity narrowest (R. T.: *3′*=6.0, 6.0, 8.5; *4*=5.5; 6.5, 9.0; *5*=3.0, 3.0, 4.0; *10a*=33.5, 32.5, 32.5, *10*=34.5, 34.5, 33.5 mm, resp. after [l′] of Q1, Q2, Q3). We can suppose that the greatest reduction of [i] of the unstressed final syllable of the Q3 word, both by its duration and its articulatory quality, is due to the tense articulation of the preceding Q3 sonorant.

3. Summary interpretation

The qualitative differences in the vocal tract configurations of the palatalized (as well as the non-palatalized) sonorants of different degrees of quantity are quite small. Despite this a consistent tendency can be registered to articulate the Q3 palatalized sonorant with the narrowest lip aperture and oral cavity, the largest pharyngeal cavity and the widest linguopalatal contact area. It seems as if Q3 [ń] and [l′] were the most tensely articulated ones among the inter-vocalic palatalized sonorants.

When the difference between the Q1 and Q2 sonorants may chiefly be based on the opposition between the short and long sound (or single sound and geminate), then the difference between the Q2 and Q3 sonorants is not caused so much by the longer duration of Q3 as by the greater tenseness of articulation. By the way, this can be demonstrated by anybody even by a simple pronunciation exercise. It is quite possible (however, in any case only when articulated relatively slackly and "evenly") to prolong the duration of the inter-vocalic Q2 sonorant over the duration of the Q3 of normal speech, but still the Q2 sonorant can be heard. But if we articulate the first syllable together with the syllable-final first component of the geminate only a little more tensely, the Q3 sonorant can be heard already. The feature of tenseness distinguishing the Q3 sonorants is usually realized in speech as follows: (1) every sound of the first syllable (the syllable-final first component of the geminate sonorant included) gains most of the target value of the corresponding sounds, as a result of which (2) the coarticulatory link between the sonorant and the preceding vowel is the weakest; (3) the speed of the articulators during the pronunciation of the vowel preceding the sonorant (in the present case that of the *i*-like transition) is the highest; (4) the occlusion phase of the sonorant is, as a rule, of the longest duration; (5) the vowel of the final syllable is the shortest and usually also shorter than the vowel of the first syllable. There is no data available as yet as to what extent one or another of the enumerated representations of the tenseness is essential from the point of view of quantity perception.

Palatalization may be associated with the following articulatory distinctions: (1) the *i*-likeness of the final transition of the vowel preceding the sonorant; (2) in the occlusion phase of the palatalized sonorant the oral cavity is always the narrowest (thus the linguopalatal contact area is the largest) and the pharyngeal cavity the widest. The mentioned articulation regions of the palatalized and non-palatalized sonorant never

coincide. Thus we can regard the palatalized sonorants as sounds quite different from their non-palatalized equivalents.

Taking into consideration what has been said about the articulation of [ń] and [l′], we can treat the degrees of quantity of the palatalized sonorants as follows: the 1st degree of quantity as /ń, l′/, the 2nd degree of quantity as geminate /ńń, l′l′/ beginning wiht a lax syllable-final component, and the 3rd degree of quantity as geminate /ˈńń, ˈl′l′/ beginning with a tense syllable-final component.

LITERATURE

Ariste P., 1939. Hiiu murrete häälikud. Acta et Commentationes Universitatis Tartuensis B **47** (1). Tartu.

Ariste P., 1943. Eesti ühiskeele palatalisatsioonist. In: Katselisfoneetilisi tähelepanekuid. Acta Universitatis Tartuensis B **50** (2): 3—35. Tartu.

Ariste P., 1953. Eesti keele foneetika. Tallinn.

Ariste P., 1959. Liivi keele palatalisatsiooni olemusest. Emakeele Seltsi Aastaraamat **4** 1958: 256—262. Tallinn.

Ariste P., 1968. Eesti keele foneetika. Õpik Ajaloo-Keeleteaduskonna keeleosakondade üliõpilastele. Tartu.

Derkach M., Fant G., de Serpa-Leitão A., 1970. Phoneme Coarticulation in Russian Hard and Soft VCV-Utterances with Voiceless Fricatives. Royal Institute of Technology (Stockholm), Speech Transmission Laboratory Quarterly Progress and Status Report 1970 (2—3): 1—7.

Eek A., 1969. Uusi meetodeid artikulatoorses foneetikas. Keel ja Kirjandus (8): 475—489.

Eek A., 1970*a*. Articulation of the Estonian Sonorant Consonants. I. [n] and [l]. Eesti NSV Teaduste Akadeemia Toimetised — Ühiskonnateadused **19** (1): 103—121.

Eek A., 1970*b*. Articulation of the Estonian Sonorant Consonants. II. [r]. Eesti NSV Teaduste Akadeemia Toimetised — Ühiskonnateadused **19** (3): 296—310.

Eek A., Remmel M., 1969. Some Remarks Concerning Speech Production. Soviet Fenno-Ugric Studies **5** (2): 141—145.

Erelt T., Kull R., 1970. Quo vadit eesti õigekeelsussõnaraamat. Sõnavalik, õigehääldus, õigekiri. Keel ja Kirjandus (3) : 147—160.

Hint M., 1968. Ortoeepia normeerimise probleeme. Keel ja struktuur (2). Töid strukturaalse ja matemaatilise lingvistika alalt. Tartu.

Itkonen T., 1969. Zur Synchronie und Diachronie der ostfinnischen Palatalisation. Opuscula Instituti Linguae Fennicae (3): 1—31. Universitas Helsingiensis.

Keem H., 1959. Epenteetilisest palatalisatsioonist tartu murdes. Emakeele Seltsi Aastaraamat **4** 1958: 145—151. Tallinn.

Keem H., 1970. Tartu murde tekstid. Eesti murded (3). Tallinn.

Kettunen L., 1913. Lautgeschichtliche Untersuchung über den Kodaferschen Dialekt. Suomalais-ugrilaisen Seuran Toimituksia **33**. Helsinki.

Laugaste G., 1956. Konsonantide palatalisatsioon eesti keeles. Tartu Riikliku Ülikooli Toimetised (43): 74—88. Tallinn.

Lehiste I., 1965. Palatalization in Estonian: Some Acoustic Observations. Estonian Poetry and Language: 136—162. Stockholm.

Liiv G., 1965*a*. Some Experiments on the Effect of Vowel-Consonant Transitions upon the Perception of Palatalization in Estonian. Soviet Fenno-Ugric Studies **1** (1): 33—36.

Liiv G., 1965*b*. Preliminary Remarks on the Acoustic Cues for Palatalization in Estonian. Phonetica **13** (1—2): 59—64.

Liiv G., 1970. Some Remarks on the Acoustic Structure Dynamics of Coarticulation and Distinctive Quantity (with Special Reference to Estonian Syllable Nuclei). Paper presented to Congressus Tertius Internationalis Fenno-Ugristarum. Tallinn, 17.—23. VIII 1970. (In print).

Matthews W. K., 1953. palətəlaizeiʃn in estouniən. Le Maître Phonétique, Troisième Série (100): 29—32.

Saaberk A., 1920. Tegeliku eesti foneetika alged. Tallinn.

Shupljakov V., Fant G., de Serpa-Leitão A., 1969. Acoustical Features of Hard and Soft Russian Consonants in Connected Speech: a Spectrographic Study. Royal Institute of Technology (Stockholm), Speech Transmission Laboratory Quarterly Progress and Status Report 1968 (4): 1—6.

Sovijärvi A., 1959. Sonagrammitutkimuksia Kuhmoisten murteen liudennuksesta. In: Verba docent. Suomalaisen Kirjallisuuden Seuran Toimituksia (263): 423—441. Helsinki.

Tanning S., 1961. Mulgi murdetekstid. Eesti murded (1). Tallinn.

Vihman M. M., 1967. Palatalization in Russian and Estonian. Phonology Laboratory, Department of Linguistics, University of California, Berkeley. Project on Linguistic Analysis. Reports. Second Series (1): VI—V32.
Вийтсо Т.-Р., 1963. Об одной возможности описания фонологии русского языка. Tartu Riikliku Ülikooli Toimetised (139). Труды по русской и славянской филологии (6): 405—409. Tartu.
Зиндер Л. Р., Бондарко Л. В., Вербицкая Л. А., 1964. Акустическая характеристика различия твердых и мягких согласных в русском языке. Ученые записки Ленинградского университета (325). Серия филологических наук **69**: 28—36.
Лийв Г., Ээк А., 1968. О проблемах экспериментального изучения динамики речеобразования: комплексная методика синхронизированного кинофлуорографирования и спектрографирования речи. Eesti NSV Teaduste Akadeemia Toimetised — Bioloogia **17** (1): 78—102.
Любимова Н. А., 1966. Акустические характеристики русских сонантов (групповые и индивидуальные признаки). Автореферат, Ленинград.
Щупляков В. С., 1968. Акустический признак восприятия мягкости стационарных шумных согласных [s] и [š]. Paper 3 III 10 in: Труды VI Всесоюзной акустической конференции. Москва.

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EESTI KEELE SONOORSETE KONSONANTIDE ARTIKULEERIMINE. III PALATALISEERITUD [n] ja [l]

Resümee

[ń] on denti-alveolaarne nasaal, [l′] — alveolaarne lateraal. Erinevais kvantiteediastmeis olevate palataliseeritud sonorantide (nagu mittepalataliseeritutegi) kõnetrakti konfiguratsioonide kvalitatiivsed erinevused on üsna väikesed. Sellele vaatamata on registreeritav järjekindel tendents hääldada III kvantiteediastme sonoranti ahtaima suuava ning suuõõne, kõige laiema neeluõõne ja suurima lingvopalataalse kontakti pindalaga. Näib, et intervokaalsetest palataliseeritud sonorantidest on pingsaimalt artikuleeritud III kvantiteediastme [ń] ja [l′].

Kui I ja II kvantiteediastme sonorantide erinevus võib baseeruda põhiliselt lühikese ja pika hääliku (ehk lihthääliku ja geminaadi) vastandatusel, siis II ja III kvantiteediastme sonorantide erinevust ei tekita mitte niivõrd III kvantiteediastme suurem kestus, kuivõrd suurem artikuleerimispingsus. III kvantiteediastet eristav pingsustunnus realiseerub kõnevoolus olemasoleva katsematerjali põhjal tavaliselt järgmiselt: (1) esimese silbi iga häälik (kaasa arvatud silpi lõpetava geminaatsonorandi esikomponent) saavutab kõige enam vastavate häälikute sihtväärtusest, (2) mistõttu sonorandi ja eelneva vokaali koartikulatoorne seos on nõrgim; (3) sonorandile eelneva vokaali *i*-lise siirde kiirus on suurim; (4) sonorandi oklusioonifaas on harilikult suurima kestusega; (5) järgsilbi vokaal on lühim ja tavaliselt ka lühem esimese silbi vokaalist.

Palataliseeritust saab seostada järgmiste tunnustega: (1) sonorandile eelneva vokaali järelsiirde *i*-lisus; (2) palataliseeritud sonorandi oklusioonifaasis on suuõõs alati ahtaim (ka lingvopalataalne kontakt suurim) ja neeluõõs avaraim. Seejuures ei kattu palataliseeritud ja mittepalataliseeritud sonorantide mainitud artikulatsioonipiirkonnad kunagi. Seega võime palataliseeritud sonorante pidada mittepalataliseeritud vastetest täiesti erinevaiks häälikuiks.

Neid asjaolusid arvestades võime [ń] ja [l′] kvantiteediastmeid käsitada järgmiselt: I kvantiteediaste kui /ń, l′/, II kvantiteediaste kui geminaat /ńń, l′l′/ silpi lõpetava *lax*-komponendiga ja III kvantiteediaste kui geminaat /ˈńń, ˈl′l′/ silpi lõpetava *tense*-komponendiga.

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АРТИКУЛЯЦИЯ ЭСТОНСКИХ СОНОРНЫХ СОГЛАСНЫХ. III ПАЛАТАЛИЗОВАННЫЕ [n] и [l]

Резюме

[ń] — денто-альвеолярный носовой согласный, [l′] — альвеолярный боковой согласный. Различия конфигураций речевого тракта при произнесении палатализованных сонорных согласных (как и непалатализованных) в разных степенях долготы весьма невелики. Несмотря на это, отмечается последовательная тенденция произносить сонорный согласный в третьей степени долготы при более узких губном отверстии и полости рта, самой широкой полости глотки и наибольшей площади соприкосновения языка с нёбом. Очевидно, что из интервокальных палатализованных сонорных согласных наиболее напряженную артикуляцию имеют [ń] и [l′] в третьей степени долготы.

Если разница между сонорными согласными в первой и второй степени долготы базируется в основном на противопоставлении краткого и долгого звука (или простого согласного и геминаты), то разница между сонорными согласными во второй и третьей степени долготы возникает не столько вследствие большей длительности согласного третьей степени долготы, сколько в результате большей напряженности артикуляции. Признак напряженности, отличающий третью степень долготы, в потоке речи реализуется, как показывают экспериментальные данные, следующим образом: (1) каждый звук первого слога (включая первый компонент геминаты сонорных согласных, заканчивающий слог) достигает положения, наиболее близкого к *target*-позиции соответствующих звуков, вследствие чего (2) коартикуляторная связь сонорного согласного с предшествующим гласным наиболее слабая; (3) скорость *i*-подобного переходного сегмента гласного, предшествующего сонорному согласному, наибольшая; (4) окклюзионная фаза сонорного согласного обычно имеет наибольшую длительность; (5) гласный второго слога наикратчайший, обычно он короче также гласного первого слога.

Палатализованность можно связать со следующими признаками: (1) *i*-подобный конечный переходный сегмент гласного, предшествующего сонорному согласному; (2) в окклюзионной фазе палатализованного сонорного согласного полость рта всегда самая узкая (и больше площади соприкосновения языка с нёбом), а полость глотки самая широкая. При этом описанные области артикуляции палатализованных и непалатализованных сонорных согласных никогда не совпадают. Следовательно, палатализованные сонорные согласные можно считать звуками, совершенно отличными от их непалатализованных соответствий.

Учитывая изложенные обстоятельства, степени долготы сонорных согласных [ń] и [l′] мы можем рассматривать следующим образом: первую степень как /ń, l′/, вторую — как геминату /ńń, l′l′/ с заканчивающим слог ненапряженным компонентом и третью — как геминату /ˈńń, ˈl′l′/ с заканчивающим слог напряженным компонентом.

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