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## ARTICULATION OF THE ESTONIAN SONORANT CONSONANTS. V. [ŋ]

### 0. Introductory remarks

In Standard Estonian the velar-palatal nasal [ŋ] never occurs independently, but only in combinations before the homorganic stop consonant /k/, e. g. in the words *pang* [paŋg] 'pail', *pank* [paŋk] 'bank'. Only in the dialects of the Estonian islands the geminate [ŋŋ] exists independently as the weak grade of [ŋç].<sup>1</sup> [ŋ] occurs neither word-initially nor word-finally.

Diachronically [n, ñ, ŋ] are considered to be of the same origin.<sup>2</sup> It is interesting to point out here that as soon as [n] in the original word stem occurs before /k/ in some case of the word, it generally undergoes assimilation, e. g. *panema* 'to put': *pange* [paŋçè] 'put', Imperative; *minema* 'to go': *minge* [miŋçè] 'go', Imperative. There are, however, words where the rule of assimilation is not valid, e. g. *veenma* 'to persuade': *veenge* [vêŋç] 'persuade', Imperative; *möönma* 'to admit': *mööŋge* [mõŋç] 'admit', Imperative; in the diminutive forms of Russian names (*Vanka* [vaŋkkà]). There is only one comparatively large group of words where [ŋ] preceding /k/ is in opposition with [n] or [ñ]: *kangi* [kaŋgi] 'bar', Partitive — *kanngi* [kaŋgi] 'even a jug' — *kanngi* [kaŋgi] 'even a toy'; *kongi* [koŋgi] 'cell', Partitive — *konngi* [koŋgi] 'even a frog' — *konngi* [koŋgi] 'even a bit of snot'; *istungi* [iŋŋgi] 'sitting', Genitive — *istungi* [iŋŋgi] 'I am even sitting', etc. In these cases of contrast [n] or [ñ] are always followed by the particles *-gi*, *-ki*.

In determining the phonemic status of [ŋ] there exist two contradictory points of view. (1) On the basis of these pairs and triplets of contrast [ŋ] is considered to be an independent phoneme.<sup>3</sup> (2) [ŋ] is

<sup>1</sup> P. Ariste, *Hiiu murrete häälikud*. — Acta et Commentationes Universitatis Tartuensis B 47 I, Tartu 1939; *idem*, *Eesti keele foneetika*, Tallinn 1953; *idem*, *Eesti keele foneetika*. Opik Ajaloo-Keeleteaduskonna keeleosakondade üliõpilastele, Tartu 1968.

<sup>2</sup> T.-R. Viitso, *Kas ŋ on eesti keeles foneem?* — KK 1962 4, pp. 229–230.

<sup>3</sup> P. Ariste, *Eesti keele foneetika*; *idem*, *Eesti keele foneetika*. Opik Ajaloo-Keeleteaduskonna keeleosakondade üliõpilastele; R. T. Harms, *Estonian Grammar*, Bloomington 1960; T.-R. Viitso, *Kas ŋ on eesti keeles foneem?*, pp. 229–230; V. Hallap, *Ostarbekohasuse printsiip fonoloogias*. Sissejuhatus ühte fonoloogilisse käsitusse. — KK 1962 12, pp. 734–739.

regarded as a combinatory variant of /n/ depending on the context of /k/. Applying morphemic analysis, it becomes evident that in cases when [n] or [ń] occur before /-ki/, the morpheme boundary is between [n] and /-ki/; in case of [ŋ], however, the morpheme boundary between [ŋ] and /ki/ is absent. If we regard the particles *-gi*, *-ki* as an enclitic word, no /n/ — /ŋ/ oppositions can be found, because in such a case [nŋ] is phonologically /n+k/ (+ denotes word juncture) and is not in the same phonological context as [ŋŋ]. As a result of such analysis, the sounds [ŋ] and [n] are considered to be allophones of /n/.<sup>4</sup>

## 1. Material

1.1. As [ŋ] does not occur in Standard Estonian independently (Q1 is absent as a result), only Q2 — Q3 opposition is possible in the cluster [ŋŋ].<sup>5</sup>

The following test material was used in roentgenographic experiments and the filming of lip articulation<sup>6</sup>: *Saŋg|a pikkust saab ju muuta* 'It is possible to change the length of the handle'. *Saŋg|a tol pangel pol-nudki* 'That pail had no handle'.

The cluster [ŋŋ] occurs in the initial word of a sentence and is surrounded by the vowels [a]. One sample of each unit to be analyzed was obtained from every informant. The total experimental material amounts to 138 cinefluorograms, 12 static X-ray shots and 80 cineframes of lip movements. In addition, 7 X-ray shots were made of [ŋ] pronounced in isolation.

1.2. The experimental material for palatography consisted of single words containing a [ŋŋ] cluster in the context of the vowel [a] and word-finally: *panga* 'bank', Genitive; *panga* (nonsense word); *pang* 'pail'.

Each of the informants used for traditional palatography pronounced every word 8 times (96 palatograms in all) and 12 palatograms with direct palatography.

1.3. Two informants were used for cinefluorography: Õ. P. (female), R. T. (male). Static X-ray shots were made of six informants: R. T., A. S., A. E. (male), K. K., H. P., T. K. (female). One informant was used for the filming of lip articulation: Õ. P. Four informants were used for traditional palatography (R. T., A. S., A. E., K. K.) and one for direct palatography (A. E.).

## 2. Articulation dynamics in words containing [ŋ]

2.1. *Word-initial [s]*. The frame of the cinefluorographic film corresponding to the onset of the noise spectrum on the spectrogram is regarded as the beginning of [s]. The end of [s] is defined by the

<sup>4</sup> I. Lehiste, Segmental and Syllabic Quantity in Estonian. — American Studies in Uralic Linguistics (= Indiana University Publications, Uralic and Altaic Series, Vol. 1). Bloomington 1960; T.-R. Viitso, Üks lingvistiline ahelprobleem. — Nonaginta (= Emakeele Seltsi Toimetised 6), Tallinn 1963, pp. 276—283; cf. the discussion about the phonematic analysis of the German [ŋ]: T. Vennemann, The German Velar Nasal. A Case for Abstract Phonology. — *Phonetica* 22 1970 2, pp. 65—81.

<sup>5</sup> Q1, Q2, Q3 — the first, second and third degrees of quantity respectively.

<sup>6</sup> A detailed description of the methods used has been presented in earlier papers: Г. Лийв, А. Ээк, О проблемах экспериментального изучения динамики речеобразования: комплексная методика синхронизированного кинофлуорографирования и спектрографирования речи. — Eesti NSV Teaduste Akadeemia Toimetised, Biologia 17 1968 1, pp. 78—102; A. Eek, Uusi meetodeid artikulaatoorses foneetikas. — KK 1969 8, pp. 475—489.



frame before an abrupt downward shift of the tongue tip and the mandible for [a].

The following movements characterize the articulation of [s] preceding [a]: during the whole [s] phase the mediodorsum is lowered and the root of the tongue approaches the rear wall of the pharynx, so that the oral cavity widens and the pharyngeal cavity narrows. The same movement continues during the initial transition of the following [a]. The tongue body moves backwards until the medial temporal phase of [s], so that the postdorsum approaches the velum and uvula, at the same time the hyoid bone rises. In the final part of [s], there is an opposite tendency in the movement of the postdorsum and the hyoid bone due to the coarticulation of [a].

As regards the degrees of quantity, the differences in the configuration of the vocal tract are minimal. However, the articulatory link registered between the final part of [s] and the following [a] in the Q3 word is somewhat stronger than in the word of Q2, particularly if we take into consideration the earlier beginning of the lip-opening gesture and the greater amount of this gesture in the Q3 word. Also the root of the tongue moves nearer to the rear wall of the pharynx and the hyoid bone is pulled more downward during the final transition of [s].

## 2.2. The vowel [a] of the stressed first syllable

**2.2.1. Durations.** The average absolute durations of [a] of two informants, measured from the dynamic spectrograms by a comparative analysis of cinefluorograms and spectrograms, are 185 msec before [ŋŋ] in Q2 as well as in Q3.

**2.2.2. Differences in articulation.** The following movements of articulators take place in the [a]-phase. Until the medial temporal phase the lower lip, the mandible, the pre- and mediodorsum move downward, whereas the movement of the postdorsum is minimal. When after the medial temporal phase of [a], the postdorsum begins its rise toward the velum for the articulation place of [ŋ], the anterior part of the oral cavity may proceed to widen by the continuing downward movement of the predorsum. The downward movement of the front part of the tongue before velar sounds (followed by a slight rise) is rather consistent.

The speed of the opening gesture of the alveolar constriction during the initial transition is highest in the Q3 word (e. g. the average speeds of the articulators within the interval from the last frame of [s] up to the quasi-culmination phase<sup>7</sup> of [a] with Informant R. T.:  $L_h = 1.7, 2.4$ ;  $I_d = 2.0, 2.6$ ;  $2' = 3.3, 4.2$ ;  $3 = 2.3, 3.3$ ;  $4 = 0.7, 1.0$  mm/20 msec before [ŋ] of Q2, Q3 respectively; O. P.:  $L_h = 0.7, 0.8$ ;  $I_d = 1.1, 1.4$ ;  $2' = 2.6, 3.3$ ;  $3' = 1.3, 1.7$ ;  $4 = 0.9, 1.2$  mm/20 msec before [ŋ] of Q2, Q3 respectively).<sup>8</sup> In the final part of the word-initial [s] as well as in the initial transition of [a], the [a]-directional movement continues to be more prominent in the Q3 word than in that of Q2.

As a result of these circumstances, in the quasi-culmination phase of the first syllable [a], the vocal tract has achieved most of the target

<sup>7</sup> The quasi-culmination phase of a vowel is described by the data from the last frame of its culmination, the next frame displaying already a measurable transition toward the articulation place of the following consonant.

<sup>8</sup> For the measurement of roentgenograms a coordinate system was designed: A. Eek, M. Remmel, Some Remarks Concerning Speech Production. — CΦΥ V 1969 2, pp. 141–145; A. Eek, Articulation of the Estonian Sonorant Consonants. I. [ŋ] and [l]. — ETATU 19 1970 1, 2.1.7.; see Fig. 1.

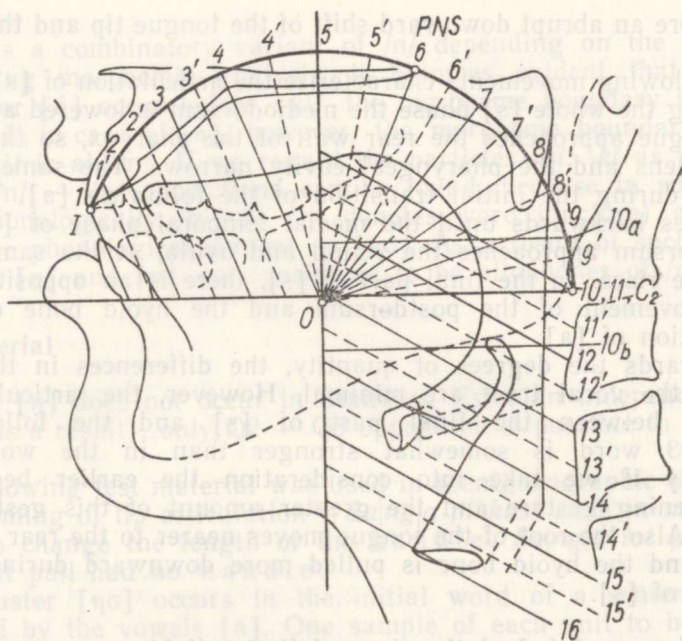


Fig. 1. X-ray tracing with landmarks and reference coordinate system.

position of the respective vowel in the Q3 word (the widest lip aperture and the front part of the oral cavity, the narrowest pharyngeal cavity). To confirm this we present the measurement data of the quasi-culmination phase of [a], and in brackets these figures will be supplemented by maximum measurements in the region of the anterior part of the oral cavity which have been fixed for a given coordinate in some later frame due to the continuing lowering of the pre- and mediodorsum in [a] as described above (R. T.:  $L_h = 14.0, 17.0$ ;  $I_d = 13.0, 14.5$ ;  $2' = 21.0 [24.0]$ ,  $22.0 [26.5]$ ;  $3 = 20.0 [21.0]$ ,  $21.0 [23.5]$ ;  $4 = 21.0, 22.5 [23.0]$ ;  $5 = 15.0, 16.5$ ;  $10 a = 14.5, 12.5$ ;  $10 = 15.5, 13.0$  mm before [η] of Q2, Q3 respectively).

In the final part of [a] the main movement is the rising of the postdorsum to the velar closure, accompanied presumably by the narrowing of the lip aperture and the anterior part of the oral cavity. During the motion picture projection of the cinefluorographic film, it becomes evident that the postdorsum does not bulge directly towards the velum and uvula, but the whole tongue body moves counterclockwise in a curved path to the formation of the velar contact. The same phenomenon can be observed during the *i*-like transition before palatalized sonorants. Articulation by the large mass of the tongue body (as it is apparent in the case of the given examples) is probably more efficiently controlled by operation of its larger and slower positioning musculature in a continuous rather than oscillating fashion. Articulation of alveolar consonants by the small mass of the tongue tip could be controlled in a back and forth manner by the smaller, faster muscles which control tongue-tip motion.<sup>9</sup>

<sup>9</sup> Cf. J. S. Perkell, *Physiology of Speech Production: Results and Implications of a Quantitative Cineradiographic Study*. Research Monograph No. 53. The M. I. T. Press, Cambridge, Massachusetts, and London, England, 1969, § 3.6.



In the final transition of [a] before [ŋ] of Q3 the average speed of the movement of the postdorsum towards the velar closure is higher than in the Q2 word (R. T.:  $T_0 = 1.6, 1.8$  mm/20 msec; Ö. P.:  $T_0 = 1.3, 2.0$  mm/20 msec before [ŋ] of Q2, Q3 respectively).

The final part of the pre-nasal vowel is nasalized. The velopharyngeal passage usually opens before the medial temporal phase of the pre-nasal vowel. Incidentally, almost the whole vowel-phase following the nasal (except after a [ŋG] cluster) is nasalized. The velopharyngeal passage closes immediately before the initial stop of the next word.<sup>10</sup>

### 2.3. The occlusion phase of the homorganic nasal-stop [ŋG] cluster

As [ŋ] does not exist as an independent sound in Estonian, but occurs only in clusters with the homorganic stop consonant, the cluster [ŋG] is studied below as an entity.

The occlusion phase of a [ŋG] cluster on the cinefluorographic film has been determined by an interval beginning from the first frame of the velar closure up to the last frame of the closure, inclusive.

**2.3.1. Durations.** The average durations of the occlusion phase of the [ŋG] cluster in the case of 2 informants are 170, 260 msec in the words of Q2, Q3 respectively (Q2 : Q3 = 1 : 1.5). It is interesting to mention that the relation of the average durations of [ŋG] clusters between Q2 and Q3 is identical with the relation of the average durations of the intervocalic geminate sonorants between Q2 and Q3.

**2.3.2. Linguopalatal contact.** On the artificial palate (covering the hard palate) in each individual case a linguopalatal contact was registered only in the upper corners of the hard palate. There are no essential differences in the size of the contact area (only in word-final [ŋG] clusters the contact area has increased). As in the case of a back vowel context, the contact of a [ŋG] cluster is mainly on the velum (see below the data of roentgenography), an artificial palate covering only the hard palate is not suitable for studying the linguopalatal contact of velar consonants. The artificial palate may also disturb the articulation so that the contact may be more retracted than that of the normal position. This may explain why there were no significant differences in the size of the contact area of a [ŋG] cluster in Q2 and Q3 words.

With the method of direct palatography it is possible to study the anterior part of the velum as well (the anterior edge of the linguopalatal contact can thus be registered).<sup>11</sup> The data obtained by this method show that the anterior edge of the contact of a [ŋG] cluster in Q3 is more advanced than in Q2; the contact of the word-final [ŋG] cluster is the foremost, e. g. A. E.: average  $AB = 46.8, 44.8, 43.6$  mm for [ŋG] of Q2, Q3 and of word-final position (see Fig. 3).

**2.3.3. The movement of articulators.** At the beginning of the [ŋ] phase, in connection with the intensifying of the postdorsal-velar contact (the contact becomes longer both in forward and backward directions), the mouth orifice and the oral cavity narrow. After the quasi-culmination phase<sup>12</sup>, the main movement is the rise of the velum to close the velopharyngeal passage. At the same time some widening of the pharyngeal

<sup>10</sup> Cf. P. Ariste, Nasalisatsioonist eesti keeles. — EK 1938 3/5, pp. 138—145.

<sup>11</sup> For the measurement of palatograms a coordinate system was designed: A. Eek, Articulation of the Estonian Sonorant Consonants. I, 2.1.2; see Fig. 2.

<sup>12</sup> The quasi-culmination phase is the frame of the cinefluorographic film on the next frame of which the rise of the velum to close the velopharyngeal passage can be registered.



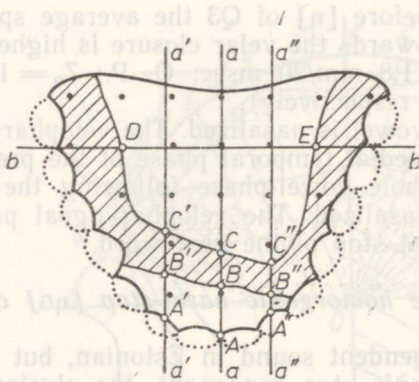


Fig. 2. Coordinate system for measuring palatograms.

cavity and the rising of the hyoid bone can be registered. The position of the larynx is not changed in the course of the whole [ŋG] cluster.

During the rise of the velum, the uvula moves away from the postdorsum, as a result of which the posterior edge of the linguovelar contact continuously advances and the length of the contact lessens (see Fig. 4). Consequently we can confirm P. Ariste's statement (based on palatographical data)<sup>13</sup> that the area of the linguovelar contact of [ŋ] is greater than that of the homorganic stop. The anterior edge remains mainly in the same position or minimally advances in the transition to the articulation of [G]; see Fig. 4. Thus the length of the contact lessens at the expense of shifting forward the posterior edge of the contact. The stop consonant [G] can be said to be more advanced than [ŋ] only because the linguovelar contact of [G] does not reach as far back as in pronouncing [ŋ].<sup>14</sup>

The rise of the velum for [G] may start at different moments in the case of different informants (Informant R. T. — after the medial temporal phase of a [ŋG] cluster; Informant Ö. P. — noticeably before the medial temporal phase).

Now we shall deal with the determination of the boundary between [ŋ] and [G]. If we take into consideration that in pronouncing a stop consonant the velopharyngeal passage must be completely closed, the duration of the [G] segment in Q2 as well as in Q3 words will be in case of Informant R. T. 20 msec (i. e. the last frame of [ŋG] cluster) and 40 msec in case of Informant Ö. P. (i. e. 2 last frames of [ŋG] cluster). The [G] segment, determined in such a way, is a voiceless velar stop (only Informant R. T. has a voiced initial part of [G]). The release of [G] is voiceless as well, but this segment of a consonant belongs (as we have defined in the present study) to the following vowel, as the transition. During the rise of the velum (i. e. during the transition from [ŋ] to [G]) together with the constant narrowing of the velopharyngeal passage the higher components of the [ŋ] spectrum weaken until complete damping in the phase of [G].

<sup>13</sup> P. Ariste, *Hiiu murrete häälikud*, pp. 191—192.

<sup>14</sup> Cf. P. Ariste, *Eesti keele foneetika*, p. 34; *idem*, *Eesti keele foneetika. Öpik Ajaloo-Keeleteaduskonna keeleosakondade üliõpilastele*, p. 63.

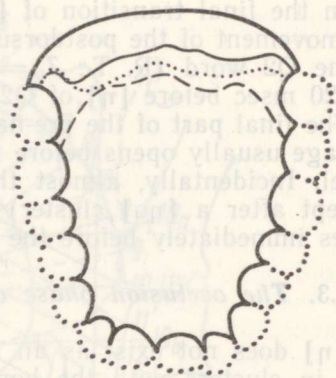


Fig. 3. Superimposed palatograms achieved by the method of direct palatography of Q2, Q3 and word-final [ŋG] clusters. Informant A. E.

Q2 —————; Q3 .....; word-final variant - - - -



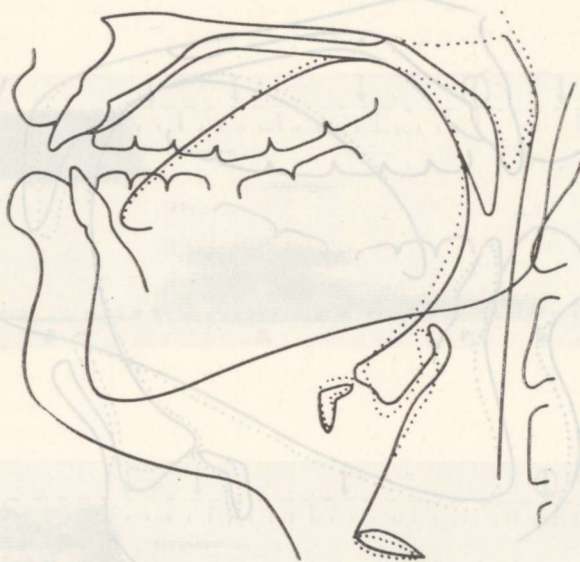


Fig. 4. Superimposed cinefluorograms of Estonian [ŋ] and [ŋ]. Informant O. P. The quasi-culmination phase of [ŋ] in the Q3 word *sanga* (Partitive) ———; the last frame of [ŋ] in the Q3 word *sanga* (Partitive) . . . . . The median line of the dorsum has been drawn; projections of the side edges of the tongue have been omitted for the sake of clarity.

Thus in a [ŋŋ] cluster the main durational component is the nasal, whereas the homorganic stop comprises in a Q2 word only 19% and in a Q3 word about 10% of the total duration of the cluster.<sup>15</sup>

2.3.4. *The configuration of the vocal tract in the quasi-culmination phase of [ŋ]*

2.3.4.1. In the following let us draw comparisons between the configurations of the vocal tract of [ŋ] in Q2 and Q3 occurring in the quasi-culmination phase defined in Footnote 12 (Figs. 5, 6).

There are no consistent differences in the size of the mouth orifice according to the degrees of quantity. In [ŋ] of Q3 the mandible may be in a slightly lower position (O. P.:  $L_h = 7.5, 7.5$ ;  $I_d = 4.5, 4.5$  mm; R. T.:  $L_h = 10.5, 11.0$ ;  $I_d = 11.0, 12.5$  mm for [ŋ] of Q2, Q3 respectively).

As the anterior edge of the velar contact of [ŋ] in Q3 is more advanced than in Q2, the oral cavity is narrower in [ŋ] of Q3 (R. T.: 4 = 14.0, 13.5; 4' = 10.0, 9.0; 5 = 6.0, 4.0; O. P.: 4 = 12.5, 10.5; 4' = 9.5, 7.5; 5 = 6.5, 3.5 mm for [ŋ] of Q2, Q3 respectively).

The basic articulatory difference between Q2 and Q3 can be the greater intensity of the formation of the velar closure in [ŋ] of Q3. This is proved by the constantly greater length of the velar contact (e. g. R. T.: measured from roentgenograms  $BC = 12.5, 20.0$  mm for [ŋ] of Q2, Q3

<sup>15</sup> There is some basis to interpret the [ŋŋ] cluster (especially in Q3) as a velar nasal with an occlusive release [ŋ<sup>o</sup>] or a velar geminate nasal with an occlusive release [ŋŋ<sup>o</sup>], if the transitional segment of [ŋ] with the rising of the velum is considered as the second component of the geminate.

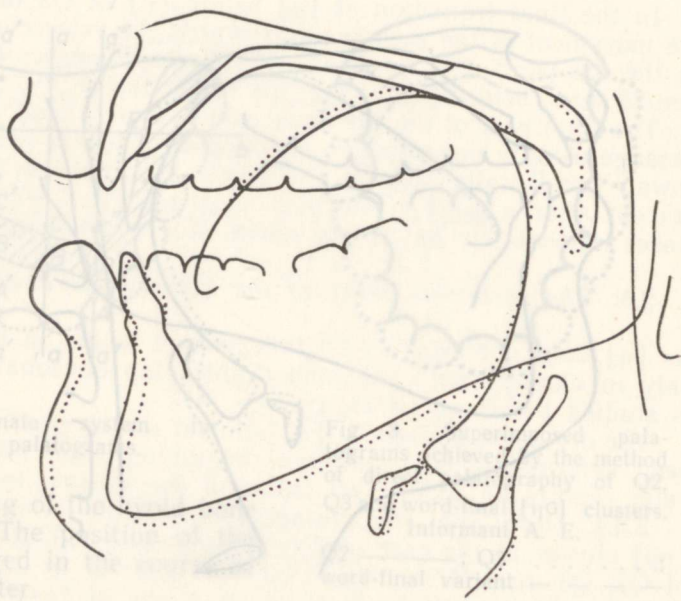


Fig. 5. Superimposed cinefluorograms of Estonian [ŋ] in the quasi-culmination phase. Informant R. T. Q2 (in the word *sanga*, Genitive) —; Q3 (*sanga*, Partitive) . . . . .

The median line of the dorsum has been drawn. The exposures of the frames traced for this Figure are indicated on the spectrograms *a, b* in Fig. 6 by an encircled arrow.

respectively). The greater length of the linguovelar contact of [ŋ] in Q3 has been achieved mainly because the velum and uvula have fallen lower against the postdorsum than in Q2 (e. g. the distance of the back wall of the velum from the origin of the coordinate system in case of Informant R. T.: 55.5, 52.5 mm for [ŋ] of Q2, Q3 respectively).

As the velum has fallen lower (the velopharyngeal passage is wider), [ŋ] in Q3 has a greater degree of nasality than [ŋ] in Q2.

No differences in the measurements of the pharyngeal cavity valid for all the informants can be observed.

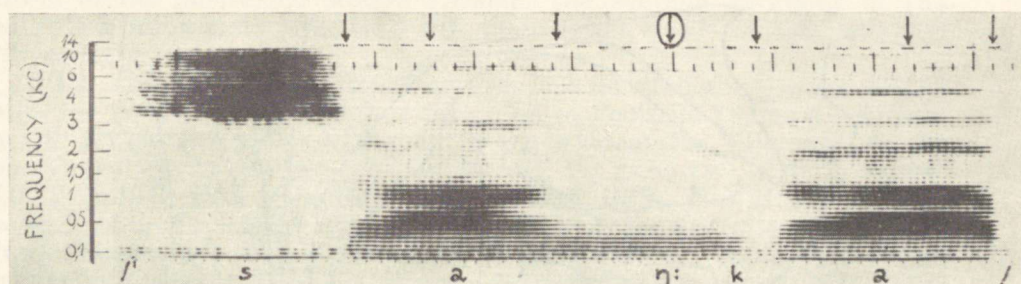
**2.3.4.2. [ŋ] pronounced in isolation.** When [ŋ] is pronounced in isolation the following can be observed: (1) the place of articulation is considerably retracted (medio-postvelar contact); (2) the velum is pulled lower, so that the uvula also forms a contact with the postdorsum; (3) the length of the linguovelar contact is greater than in [ŋg] cluster (see Fig. 7).

Due to the more retracted linguovelar contact, the oral cavity is wider in the isolated [ŋ] than in the [ŋg] cluster (H. P.: 4 = 18.0, 17.5, 22.5; 4' = 16.5, 15.5, 19.0; 5 = 13.5, 11.5, 15.0 mm for [ŋ] of Q2, Q3 and in isolation respectively). Due to the lower position of the larynx the pharyngeal cavity of the isolated [ŋ] is the longest (H. P.:  $Lar_u$  = 40.0, 48.0 mm for [ŋ] of Q3 and in isolation respectively).

**2.4. The vowel [a] of the unstressed second syllable.** The second syllable [a] has been determined from the cinefluorographic film with an interval from the first opening frame of the velar closure of the preceding stop consonant (thus the unvoiced release of [g] has been comprised, as well) up to the last open frame, inclusive (see Fig. 6).



a



b

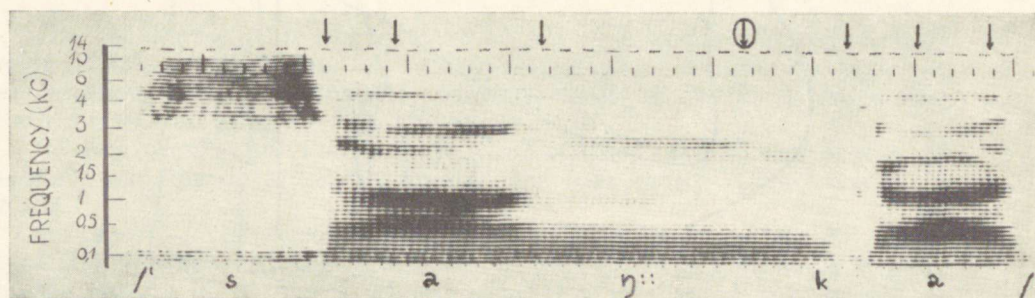


Fig. 6. Dynamic spectrograms, synchronized with cinefluorograms, of the Estonian words *sanga*, Genitive (a); *sanga*, Partitive (b). Informant R. T.

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. The first vertical arrow in the uppermost edge of the spectrogram indicates the first frame of [a]; the second arrow designates the quasi-culmination phase of the stressed vowel; the third arrow marks the first closure frame of [η]; the fourth arrow (encircled) — the quasi-culmination phase of [η]; the fifth arrow — the first frame of the unstressed vowel [a]; the sixth — the quasi-culmination phase of [a]; the seventh — the last frame of [a].

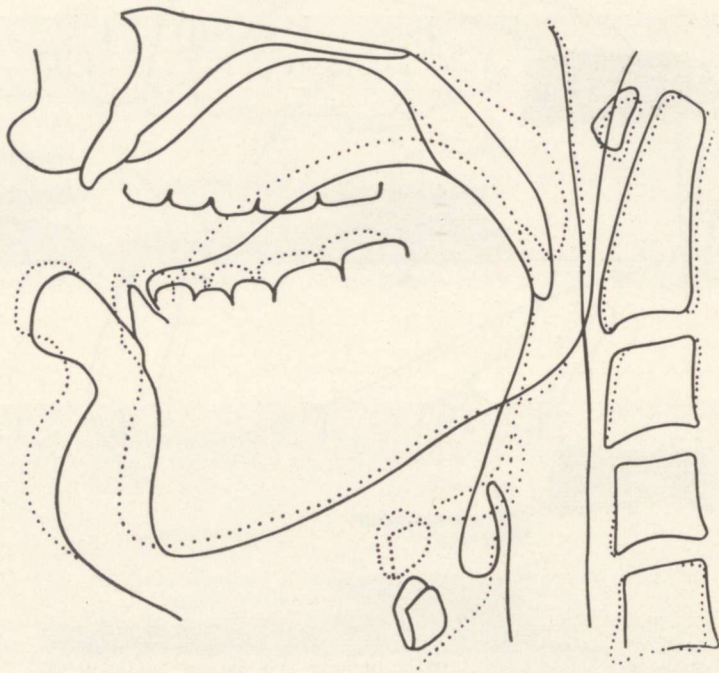


Fig. 7. Static roentgenograms of [ŋ] pronounced in isolation and of [ŋ] in Q3. Informant A. S.  
 [ŋ] pronounced in isolation ———; [ŋ] in Q3 of the word *sanga* (Partitive) . . . . .



**2.4.1. Durations.** The increase of the degree of quantity of the inter-vocalic [ŋG] cluster is attended by the shortening of the duration of the vowel of the unstressed second syllable. The average durations of [a] with two informants are 215, 147 msec after [ŋG] of Q2 and Q3 respectively.

**2.4.2. Differences in articulation.** The quasi-culmination phase of [a] after the [ŋG] cluster in Q3 (see definition in Footnote 7) has a narrower mouth orifice and oral cavity than in Q2, whereas the differences in the pharyngeal cavity are not considerable (Ö. P.:  $L_h = 13.0, 12.0$ ;  $I_d = 10.0, 7.0$ ;  $2' = 19.5, 16.0$ ;  $3' = 23.0, 18.0$ ;  $4 = 23.5, 18.5$ ;  $4' = 21.5, 17.0$ ;  $5 = 18.5, 14.5$ ;  $10a = 10.0, 10.5$ ;  $10 = 8.0, 9.5$  mm for [a] after Q2 and Q3 [ŋG] respectively). These differences in the vocal tract could be expected taking into consideration the reductive influence of the tense [ŋG] cluster on the duration and articulation of the following vowel.<sup>16</sup>

### 3. Summary interpretation

The Estonian [ŋ] in the context of [a] is a postdorsal postpalatal-velar (in isolation — medio-postvelar). It occurs only in combination with a homorganic stop consonant. In the [ŋG] cluster the main durational component is the nasal.

In [ŋ] of Q3 the area of the linguovelar contact, the degree of nasality and the duration are greater, the oral cavity is narrower than in Q2.

For words of the second and the third degree of quantity (of otherwise identical context) the differences in the vocal tract probably depend on the feature of tenseness which culminates in the occlusion phase of the third degree of quantity and has a power of coordinating the movements of articulators (a strong articulatory link between the word-initial consonant and the following vowel; the higher speeds of the transitions of the first syllable vowel; the reduction of the vowel of the unstressed syllable).

Taking these facts into consideration, we may treat the degrees of quantity of [ŋ] as follows: Q2 as a /ŋk/ cluster beginning with a lax syllable-final component and Q3 as a /ŋk/ cluster beginning with a tense syllable-final component.

<sup>16</sup> Cf. A. Eek, Some Coarticulation Effects in Estonian. — СФУ VI 1970 2, pp. 81—85.

АРВО ЭЭК (Таллин)

### Артикуляция эстонских сонорных согласных. V. [ŋ]

В эстонском литературном языке веларно-палатальный носовой согласный [ŋ] выступает не как самостоятельный звук, а только комбинаторно в положении перед гоморганическим смычным [k], в силу чего в сочетании [ŋG] возможна лишь оппозиция между второй и третьей степенями долготы.

Основным артикуляционным различием между [ŋ] во второй степени долготы и [ŋ] в третьей следует считать максимальную интенсивность образования веларной смычки у [ŋ] третьей степени долготы. Это последовательно подтверждается максимальной длиной веларного контакта в словах третьей степени долготы. Вместе с тем передний край контакта у [ŋ] в третьей степени долготы продвигается вперед по сравнению со второй степенью долготы. В результате большего опущения нёбной занавески (VELO-Фарингальный проход шире) [ŋ] в третьей степени долготы характери-

зается более высокой степенью назальности, чем [ŋ] во второй. В связи с тем, что передний край веллярного контакта у [ŋ] в третьей степени долготы по сравнению со второй степенью долготы продвигается вперед, полость рта при его артикуляции уже. В размерах полости глотки не обнаруживаются зависящих от степени долготы различий, которые наблюдались бы у всех информантов.

Так как при произношении смычного вело-фарингальный проход должен быть полностью закрыт, длительность сегмента [G] в слове как второй, так и третьей степеней долготы составляет 20—40 мсек. Таким образом, в сочетании [ŋG] основным по длительности компонентом является носовой согласный.

Если принять во внимание особенности образования лингво-веллярной смычки, то представляется, что [ŋ] в третьей степени долготы артикулируется с большим напряжением, чем [ŋ] во второй. При этом признак напряженности, кульминирующий в фазе [ŋ], оказывает координирующее влияние на весь первый слог. Например, в слове *sanga* третьей степени долготы между конечной частью начального [s] и последующим [a] отмечается несколько более сильная артикуляторная связь, чем в слове второй степени долготы, особенно если принять во внимание, что в слове третьей степени долготы губная щель начинает расширяться раньше и имеет больший объем. В слове третьей степени долготы в конечной части [s] корень языка передвигается в сторону задней стенки глотки, а подъязычная кость опускается больше, чем в слове второй степени долготы. В начальном переходе гласного, предшествующего сонорному согласному третьей степени долготы, скорость раскрытия альвеолярной щели [s] значительно выше, чем в слове второй степени долготы. Таким образом, большая по сравнению со словом второй степени долготы интенсивность движения в сторону [a] в конечной части начального [s], отмечаемая в слове третьей степени долготы, сохраняется и в начальном переходе [a]. В результате всего этого речевой тракт в кульминационной фазе [a] первого слога больше всего приближается к целевой позиции соответствующего гласного в слове третьей степени долготы. Учитывая особенности произношения следующего носового согласного, с точки зрения коартикуляции следовало бы ожидать противоположной тенденции. В силу этого представляется, что в словах третьей степени долготы коартикуляторная связь между гласным первого слога и следующим сонорным согласным третьей степени долготы слабая. Признак напряженности, кульминирующий, по-видимому, на первом компоненте сочетания [ŋG] в третьей степени долготы, реализуется таким образом, что каждый звук соответствующего слога артикулируется с максимальным напряжением. В словах третьей степени долготы обычная коартикуляторная связь заменяется связью по напряженности. Вместе с тем скорость движения артикуляторов в конечном переходе гласного, предшествующего носовым согласным, оказывается максимальной.

Факты, связанные с координацией описанного здесь признака напряженности, относятся ко всем интервокальным сонорным согласным третьей степени долготы.

Учитывая их, степени долготы [ŋ] можно трактовать следующим образом: вторую степень как сочетание /ŋk/ с ненапряженным компонентом, оканчивающим слог, и третью степень как сочетание /ŋk/ с напряженным компонентом, оканчивающим слог.