

<https://doi.org/10.3176/hum.soc.sci.1961.2.03>

ON QUALITATIVE FEATURES OF ESTONIAN STRESSED MONOPHTHONGS OF THREE PHONOLOGICAL DEGREES OF LENGTH *

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The *ä*-sounds

Over-long *â*. The *â* of the third phonological degree of length is the most open front vowel. A comparison of the formation of *â* with that of *ê* (Fig. 37) shows the following changes in the position of the organs of speech. The whole configuration of the tongue indicates an articulation which is very considerably lower (the shift from *ê* to *â* appears to be greater than that from *î* to *ê*, cf. Fig. 14). The *mediodorsum* rises towards the back part of the *mediopalatum*, the *corona* is raised in the direction of the *alveoli*. The pharynx is strikingly narrower. The larynx is in a slightly lower position. The air passage is generally very wide, being narrower between the *corona* and the *alveoli* and only a shade wider between the root of the tongue and the posterior wall of the pharynx. In the case of *ê*, however, the narrowest stricture within the vocal tract is between the *mediodorsum* and the *mediopalatum*. The *velic* stricture for *â* is not so complete. The angle between the jaws and the lip aperture are very considerably greater.

Owing to the width of the air passage, the dorsum barely touches the palate at the edges of the *postpalatum* (Fig. 38). Cf. this with the linguo-palatal contact area in the case of *ê* (Fig. 15).

Next let us compare the formation of *â* and *â* by the same person (Fig. 39). The tip of the tongue rests against the rear of the front lower teeth in pronouncing *â*, but against the lower *alveoli* in the case of *â*. In the articulation of *â* the tip of the tongue is lower in relation to the palate, but higher with regard to the lower jaw. The configuration of the tongue indicates a generally higher and more palatal position. At the same time the pharynx widens. The very characteristic narrowest stricture of the air passage for *â* (in contrast to that for *â*) is between the root of the tongue and the posterior wall of the pharynx. The tip of the epiglottis in the case of *â* is slightly farther away from the root of the tongue, while its distance from the posterior pharyngeal wall is markedly greater. The *valleculae* are wider. The position of the larynx on the vertical axis is approximately the same. The position of the velum is very conspicuously higher and, consequently, the *velic* stricture is also notably narrower. The jaws are drawn even farther away from each other. There is an appreciably bigger lip aperture.

It should be pointed out that the opening between the jaws varies for different persons. The variation of the angle between the jaws can be illustrated, for example, by comparing *â* and *â* as pronounced by Subject II (Fig. 40). One can see here a lesser angle between the jaws and a smaller lip aperture. At the same time the air

* The beginning in No. 1 of the present publication for 1961.

Fig. 37. Subject VI. Röntgenogram of Estonian over-long \hat{e} and over-long \hat{a} .

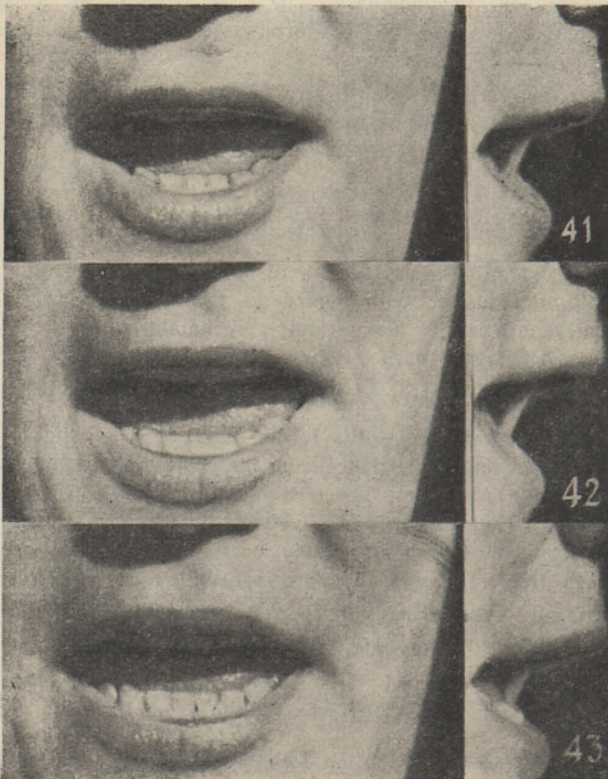
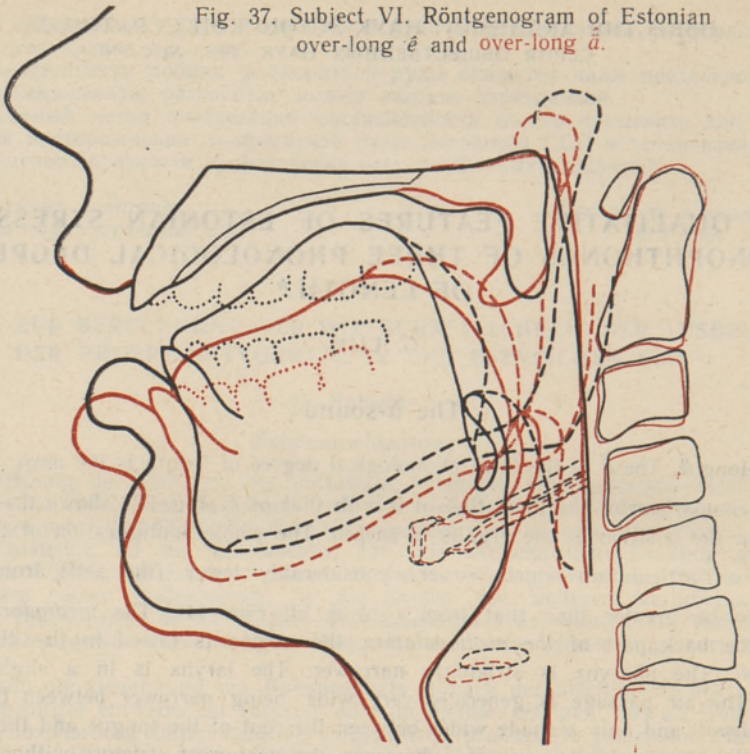


Fig. 38. Subject B.

Palatogram of Estonian over-long \hat{a} , long \bar{a} and short \bar{a} .

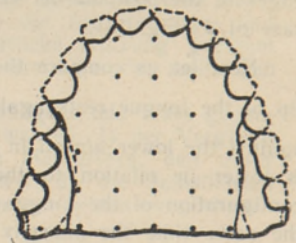


Fig. 41. Lip-position of Estonian over-long \hat{a} .

Fig. 42. Lip-position of Estonian long \bar{a} .

Fig. 43. Lip-position of Estonian short \bar{a} .

Fig. 39. Subject VI. Röntgenogram of Estonian
over-long \hat{a} and over-long \hat{a} .

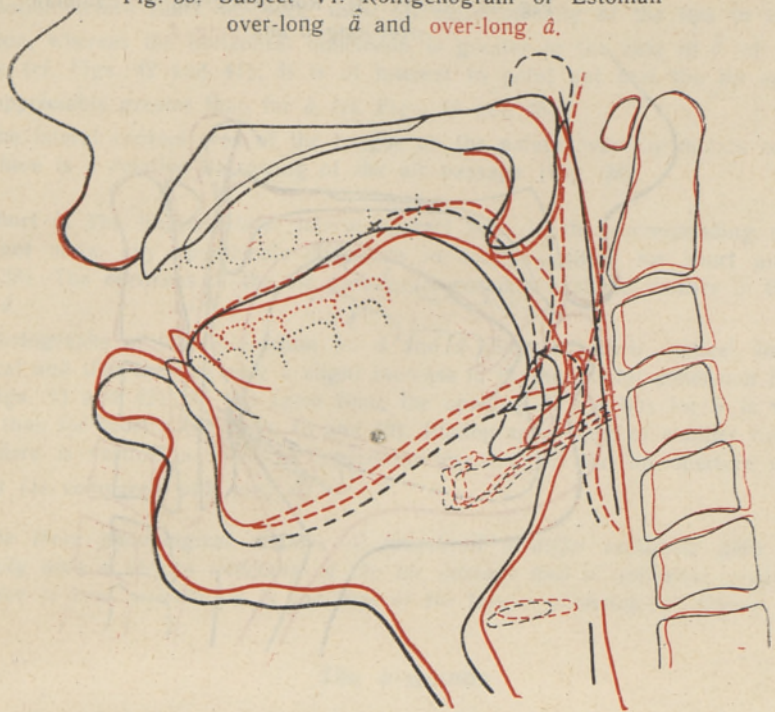


Fig. 40. Subject II. Röntgenogram of Estonian
over-long \hat{a} and over-long \hat{a} .

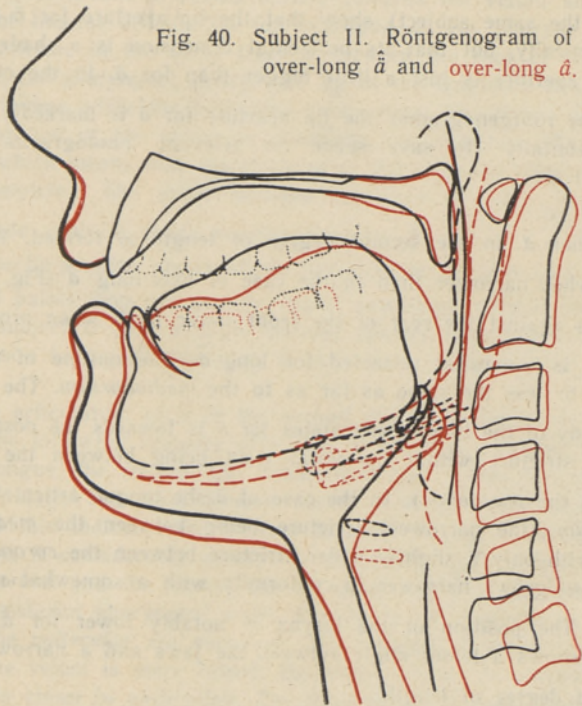
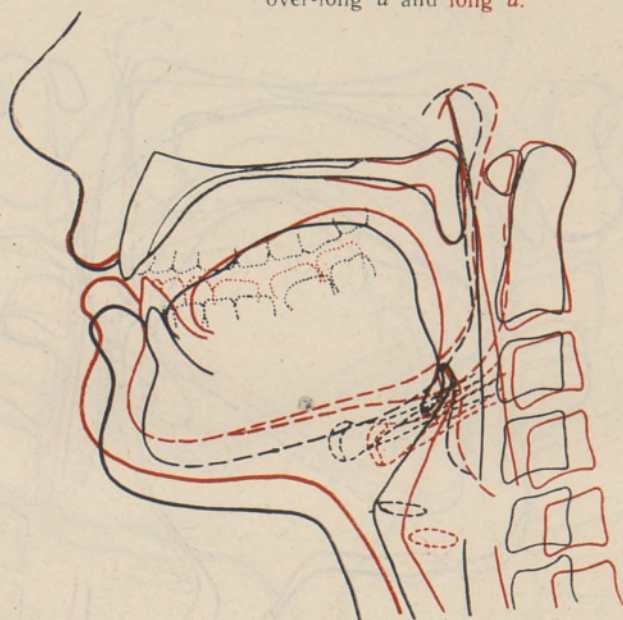


Fig. 44. Subject II. Röntgenogram of Estonian
over-long \hat{a} and long \bar{a} .



passage is narrower between the *mediodorsum* and the boundary region of the *mediopalatum* and the *postpalatum*. In the case of \hat{a} the position of the larynx is higher.

In conformity with what has been said above, Figs. 41 and 47 (which give the lip-positions of the same subject) show that the lip aperture for \hat{a} is slightly smaller if measured vertically, but that its horizontal dimension is a shade bigger, and that the size of the aperture is just a little bigger than for \hat{a} . In the other person filmed (Subject I in the röntgenograms) the lip aperture for \hat{a} is markedly larger both vertically and horizontally (to save space the relevant photographs have not been reproduced here).

Long \bar{a} . When \bar{a} in the second degree of length is formed, the air passage is generally somewhat narrower than in the case of over-long \hat{a} (Fig. 44). If the tip of the tongue rests against the rear of the front lower teeth when pronouncing \hat{a} of the third degree, it is somewhat retracted for long \bar{a} . The outline of the surface of the tongue is more or less the same as far as to the *mediodorsum*. The principal direction in which the body of the tongue articulates for \bar{a} is towards the *postpalatum-praevelum* (the narrowest stricture within the vocal tract being between the front part of the *postdorsum* and the *praevelum*). In the case of \hat{a} the tongue articulates mainly towards the *mediopalatum* (the narrowest stricture being between the *mediodorsum* and the *mediopalatum* with only a slightly wider stricture between the *corona* and the *alveoli*). The pharynx also grows narrower in conformity with a somewhat more velar position of the tongue. The position of the larynx is notably lower for \bar{a} . A comparison of röntgenograms shows a lesser angle between the jaws and a narrower lip aperture for \bar{a} of the second degree of length.

Motion-picture films, however, show an equal opening of the lips in the vertical direction, whereas the horizontal dimension is greater in the case of \bar{a} of the second degree (cf. Figs. 42 and 41). It is of interest to point out that the lip aperture for \bar{a} is appreciably greater than for \bar{a} (cf. Figs. 42 and 48).

The lateral contact area of the tongue on the palate near the molars corroborates that there is a relative narrowing of the air passage (Fig. 38).

Short \bar{a} . The linguo-palatal lateral contact area in the corresponding palatogram does not show any appreciable difference in tongue-position for short and long \bar{a} (Fig. 38). The openness of the air passage is possibly a shade smaller in the case of short \bar{a} .

Photographs of the lip-position for \bar{a} and \bar{a} show that their vertical dimension is identical and that there is only a slight increase in the horizontal dimension for short \bar{a} (cf. Figs. 43 and 42). At the same time, the opening of the lips for \bar{a} is very much wider than for short a (cf. Figs. 43 and 49). Photographs taken of another subject show that there is vertical as well as horizontal lessening of the lip aperture when \bar{a} is formed (as compared with long \bar{a}).

The three phonological degrees of length of \bar{a} differ relatively little. One can generally note a certain widening of the air passage and a somewhat greater palatal character of oral articulation in the case of the longer phonological degrees of length.

The a -sounds

Over-long \hat{a} . In the formation of over-long \hat{a} (Fig. 45) the tip of the tongue is pressed against the lower *alveoli*. The position of the tip of the tongue and the *corona* in the oral cavity is very low. A fairly deep depression appears in the region of the *praedorsum*. This would seem to indicate a laxness of the corresponding muscles of the tongue. The *postdorsum* is raised tensely towards the velum and this marks the main direction of lingual articulation for over-long \hat{a} . The pharynx is fairly narrow. The narrowest stricture in the vocal tract is between the root of the tongue and the posterior wall of the pharyngeal cavity. The tip of the epiglottis rests actively against the root of the tongue while the *valleculae* grow wider. The larynx is in a high, tense position. The position of the velum is relatively low and lax. The *velic* stricture is relatively wide, which means that the blocking of the oral and nasal cavities cannot be regarded as complete. The angle between the jaws is big. The lip aperture is conspicuously wide (only a shade smaller than for \hat{a}).

A film of the lip-position shows slight labialization for over-long \hat{a} (Fig. 47).

The artificial palate does not usually record any linguo-palatal contact. It was only in the case of Subject D that a slight palatal contact was recorded (Fig. 46).

There is reason to regard over-long \hat{a} as a back vowel.

Long \bar{a} . The articulation of \bar{a} of the second degree of length differs from that of over-long \hat{a} in the following respects (Fig. 45). When \bar{a} is pronounced, the position of the tip of the tongue, the *corona*, the *praedorsum* and the *mediodorsum* is higher in relation to the palate. The *mediodorsum* curves towards the *mediopalatum* and the *postpalatum*, and this indicates the general direction of the movement of the lingual body. The pharynx is considerably wider. The narrowest stricture within the vocal tract is between the *corona* and the *alveoli* (in the case of \hat{a} it is between the root of the tongue and the posterior pharyngeal wall). The tip of the epiglottis is close to the root of the tongue, the *valleculae* are narrower. The position of the larynx on the vertical axis is lower. The velum is more raised; the *velic* stricture is narrower. The jaws are drawn appreciably closer to each other. The lip aperture is considerably narrower.

Fig. 45. Subject II. Röntgenogram of Estonian over-long \hat{a} and long \bar{a} .

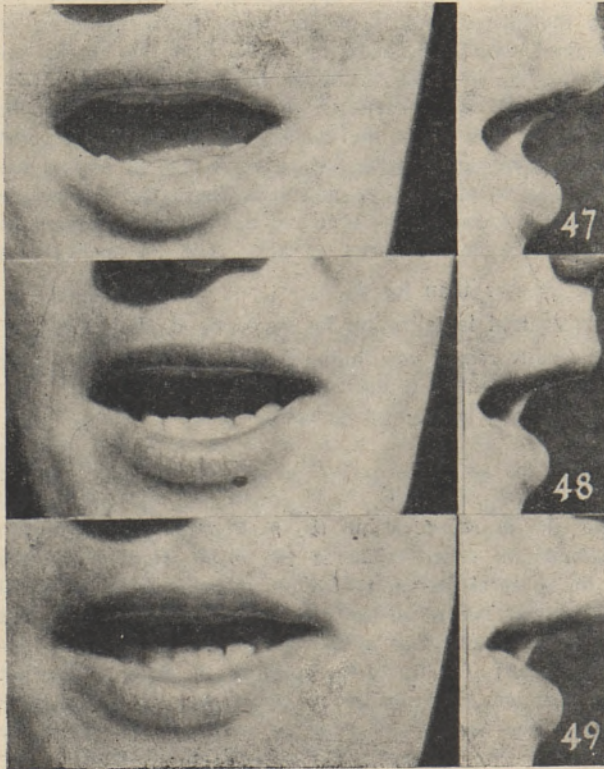
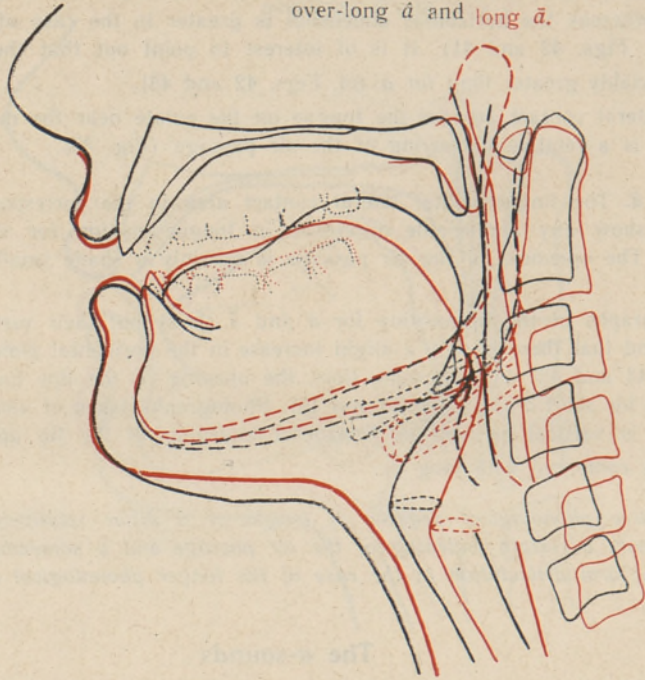


Fig. 46. Subject D.

Palatogram of Estonian over-long \hat{a} and long \bar{a} .

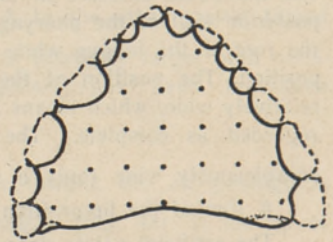


Fig. 47. Lip-position of Estonian over-long \hat{a} .

Fig. 48. Lip-position of Estonian long \bar{a} .

Fig. 49. Lip-position of Estonian short a .

The marked decrease in the vertical dimension of the lip aperture can also be seen in the photographs (cf. Figs. 48 and 47). One can likewise see here that the slight labialization characteristic of the Estonian over-long \hat{a} is somewhat reduced in the case of \bar{a} .

All that has been said above permits us to refer to \bar{a} in the second phonological degree of length as a central or even a front vowel rather than a back vowel as has been done hitherto.

Short a . Fig. 49 shows that the angle between the jaws is appreciably smaller when short a is pronounced. The vertical dimension of the lip aperture decreases considerably. There also is a notable retraction of the sides of the mouth and a certain reduction of the slight lip-rounding that has been referred to.

On the basis of our observations we are inclined to assume an even more marked palatal articulation for short a .

The material presented above makes it possible to speak of a considerable difference in the articulation of over-long, long and short a . This difference finds expression, above all, in the different horizontal position of the lingual body and in the tongue height. In the case of over-long \hat{a} the body of the tongue (postdorsum) articulates towards the velum; for \bar{a} the body of the tongue (mediodorsum) curves towards the mediopalatum; in the case of short a there may even be some characteristic palatal articulation. There is a striking difference in the angle between the jaws and in the opening of the lips. The articulation of over-long \hat{a} appears to be characterized by a greater muscular tenseness of the organs of speech.

The u -sounds

Over-long \hat{u} . The \hat{u} of the third degree of length is the closest tense back vowel (Fig. 50). In forming \hat{u} , the tip of the tongue is notably retracted. The whole lingual body curves very tensely towards the velum, the characteristic general direction of its movement being backwards and upwards. The relative laxness of the muscles of the tongue in the region of the *praedorsum* is probably indicated by the depression that is formed here. The column of air between the back part of the tongue and the posterior pharyngeal wall is relatively narrow, especially in the upper two thirds of the pharynx. The narrowest stricture of the vocal tract is between the *postdorsum* and the *praevelum*. This stricture may be as extremely narrow as the one between the *praedorsum* and the *praepalatum* in the case of over-long \hat{i} . The tip of the epiglottis rests actively against the root of the tongue. The position of the larynx on the vertical axis is low. The velum is actively raised. The angle between the jaws is small. The lip aperture is narrow. X-ray profile sketches also show active protrusion of the lips.

A motion-picture film (Fig. 54) of the lip-positions of the same person shows that the maximum labialization occurs in the case of over-long \hat{u} ; there is very active vertical as well as horizontal tenseness of the labial muscles accompanied by conspicuous protrusion of the lips.

Palatograms of \hat{u} obtained from different persons (Figs. 51, 52, 53) show a slightly greater or lesser postpalatal contact between the dorsum and the palate. This variation depends on the shape of the palate in different persons and likewise on natural variation in the degree of closeness of articulation and in the place of the narrowest stricture on the horizontal axis.

Long \bar{u} . The articulation of \bar{u} of the second degree of length differs very markedly from that of over-long \hat{u} (Fig. 50). The whole configuration of the vocal tract shows that there is considerable laxness of the organs of speech. One might hence call this sound a lax, back vowel. In pronouncing \bar{u} the tip of the tongue is a shade more

Fig. 50. Subject II. Röntgenogram of Estonian
over-long \hat{u} and long \bar{u} .

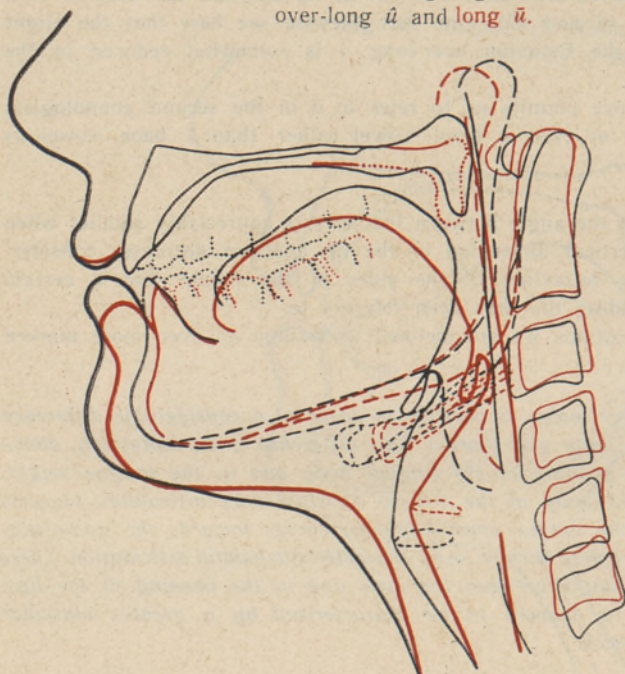


Fig. 51. Subject B.

Palatogram of Estonian
over-long \hat{u} , long \bar{u} and
short u .

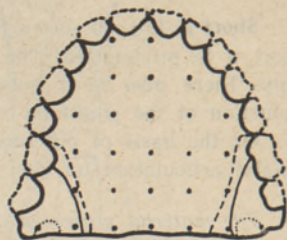


Fig. 52. Subject C.

Palatogram of Estonian
over-long \hat{u} , long \bar{u} and
short u .

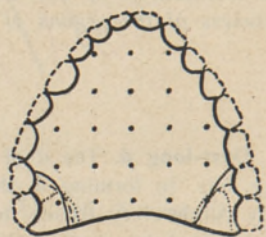


Fig. 53. Subject D.

Palatogram of Estonian
over-long \hat{u} , long \bar{u} and
short u .

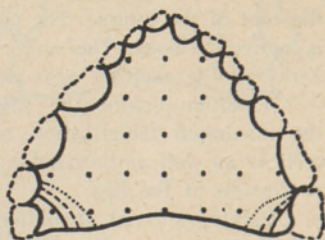


Fig. 54. Lip-position of
Estonian over-long \hat{u} .

Fig. 55. Lip-position of
Estonian long \bar{u} .

Fig. 56. Lip-position of
Estonian short u .

advanced and lower. On the whole, the articulation of \bar{u} is characterized by a lower and more advanced position of the tongue. The upper two thirds of the pharynx are considerably wider, the lower third being correspondingly narrower. The narrowest stricture of the vocal tract is between the root of the tongue and the back wall of the pharyngeal cavity. The position of the epiglottis indicates relative muscular laxness in this region as well. The volume of the pharynx is decreased by the considerably higher position of the vocal cords. The velum is in a notably lower position. The jaws are somewhat separated from each other. Profile sketches show an obvious widening of the opening between the lips.

The difference in lip-positions as seen in the corresponding motion-picture films is relatively small (cf. Figs. 55 and 54), although here, too, it is possible to observe a somewhat lesser activity of the muscles of the lips and a certain widening of the lip aperture.

Palatograms obtained from Subjects B and C (Figs. 51, 52) probably illustrate, above all, the somewhat more advanced character of the formation of long \bar{u} as compared with that of over-long \hat{u} , whereas the palatogram of Subject D (Fig. 53) appears to show that a lesser degree of closeness prevails in the articulation of this person.

Short u . The articulation of u in the first degree of length is probably characterized by a tongue-position that is even lower and more advanced on the horizontal axis as well as by weaker labialization. Thus, for instance, the reduction of linguo-palatal contact in the corresponding palatograms from Subjects B and D (Figs. 51, 53) illustrates first and foremost the more open articulation of short u , while the corresponding palatogram obtained from Subject C (Fig. 52) would seem to indicate a relatively dominant, more advanced articulation in the case of this person.

The photograph of the lip-position for short u (Fig. 56) shows relatively weaker labialization. The vertical as well as horizontal tenseness of the muscles of the lips is not so great: the opening formed by the lips is bigger and there is less protrusion.

The formation of short, long and over-long u differs markedly: the longer the phonological degree of length, the higher the tongue-position, the more velar is the position of the tongue on the horizontal axis and the greater the tenseness of the muscles. This is accompanied by more active labialization and a lower position of the larynx on the vertical axis. The gradation of the labialization of u according to degrees of phonological length is not so marked as in the case of the different degrees of \hat{u} .

The o -sounds

Over-long \hat{o} . In pronouncing \hat{o} of the third degree of length the tip of the tongue is slightly more advanced and its position in the oral cavity is lower than for over-long \hat{u} (Fig. 57). The configuration of the tongue indicates a markedly more open articulation which varies with persons to a certain extent, but which might be called mid-low or mid (see Fig. 62). The lingual body is drawn more into the pharynx (in pronouncing \hat{u} it articulates tensely towards the velum). This leads to a marked decrease in the volume of the pharynx. The narrowest stricture of the vocal tract is between the root of the tongue and the posterior pharyngeal wall and is located in the middle part of the pharynx. The position of the larynx on the vertical axis is approximately the same. The velum is not raised so high. The angle between the jaws is generally greater. There is more open labialization, the lip aperture is more oval in shape (cf. also Figs. 59 and 54). There is notably less protrusion of the lips.

The post-palatal contact area of the tongue and the palate is smaller (the dorsum just touches the most posterior molars on either side), this being added evidence of a more open articulation (cf. Figs. 58 and 51).

Fig. 57. Subject V. Röntgenogram of Estonian over-long *û* and over-long *ô*.

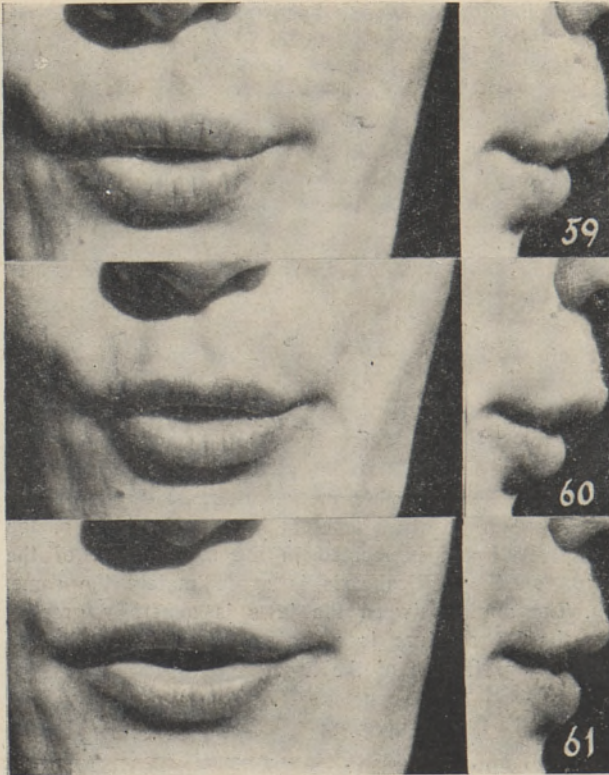
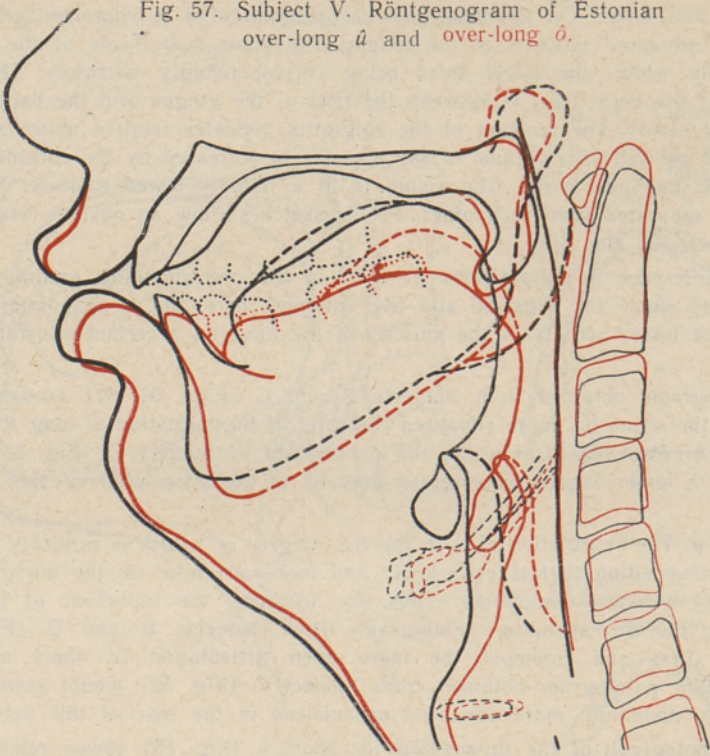


Fig. 58. Subject B.

Palatogram of Estonian over-long *ô*, long *õ* and short *o*.

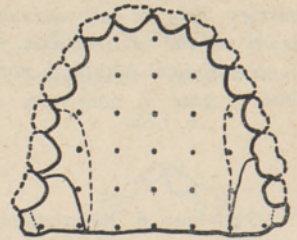
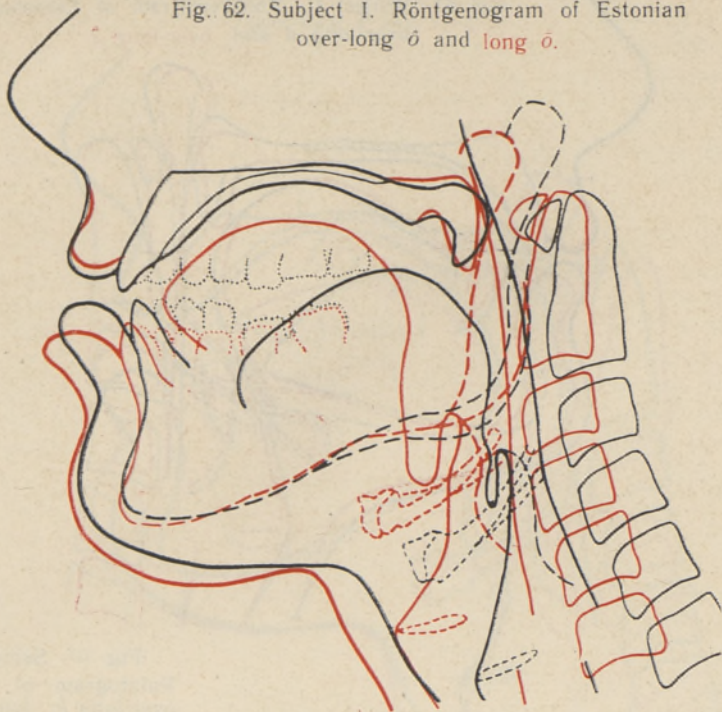


Fig. 59. Lip-position of Estonian over-long *ô*.

Fig. 60. Lip-position of Estonian long *õ*.

Fig. 61. Lip-position of Estonian short *o*.

Fig. 62. Subject I. Röntgenogram of Estonian over-long \hat{o} and long \bar{o} .



Long \bar{o} . The articulation of \bar{o} of the second degree of length differs most markedly from that of over-long \hat{o} (Fig. 62; see also the corresponding X-ray photographs in Plate I*). It is surprising to note that the direction in which the main body of the tongue moves as well as its position are entirely the contrary. In pronouncing long \bar{o} the lingual body articulates towards the *alveoli* and the *praepalatum*, whereas it is directed towards the pharynx and the velum for over-long \hat{o} . Consequently the pharynx is much wider in the case of \bar{o} . The narrowest stricture of the vocal tract is between the *corona* and the *alveoli* for \bar{o} , but between the root of the tongue and the posterior wall of the pharynx for \hat{o} . In accordance with this the epiglottis is also notably farther away from the root of the tongue in the case of \bar{o} , and the *valleculae* are conspicuously wider. The position of the larynx on the vertical axis, and, consequently, that of the vocal cords, is very considerably higher (the body of the hyoid bone being 15.5 mm, the vocal cords — 17.5 mm higher). The velum is more actively raised. The jaws are drawn apart from each other. There is half-open labialization (the lower jaw is notably protruded). As regards its place of articulation, long \bar{o} corresponds to the front vowels; its degree of closeness is even greater than that of long \bar{u} (cf. Figs. 62 and 50). The pronunciation of \bar{o} in the second degree of length is almost entirely identical in the case of all five informants.

The lip-position in the motion-picture film (cf. Figs. 60 and 59) also shows a reduction of labialization for long \bar{o} , but the labialization of \hat{o} is narrower here and the difference as compared with over-long \hat{o} is smaller than in the case of the corresponding röntgenograms.

The astonishing difference in oral articulation for long and over-long o is also shown by the relevant palatogram (Fig. 58).

* The photos presented do not belong to the best from the technical point of view, but they are chosen in order to give an idea of unexpected articulations.

Fig. 63. Subject II. Röntgenogram of Estonian over-long \hat{a} and over-long \hat{e} .

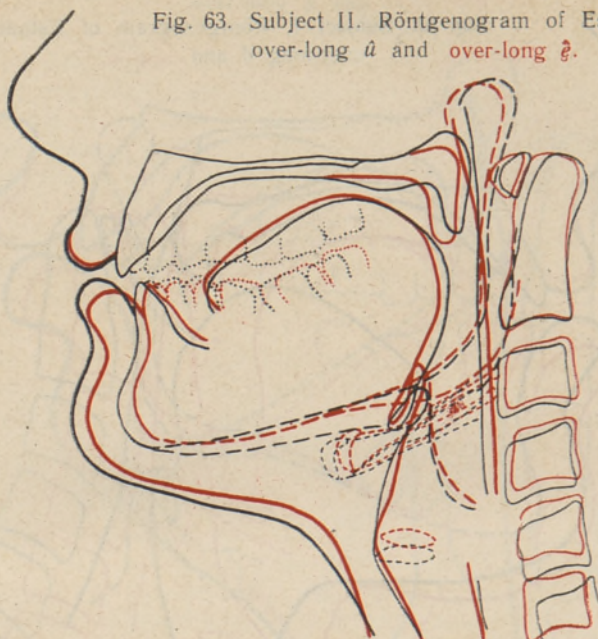


Fig. 67. Subject A. Palatogram of Estonian over-long \hat{e} , long \bar{e} and short e .

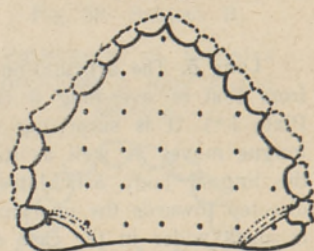


Fig. 68. Subject B. Palatogram of Estonian over-long \hat{e} , long \bar{e} and short e .

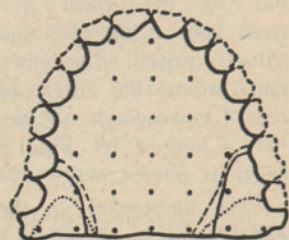


Fig. 64. Lip-position of Estonian over-long \hat{e} .

Fig. 65. Lip-position of Estonian long \bar{e} .

Fig. 66. Lip-position of Estonian short e .

Fig. 69. Subject I. Röntgenogram of Estonian
over-long \hat{e} and long \bar{e} .

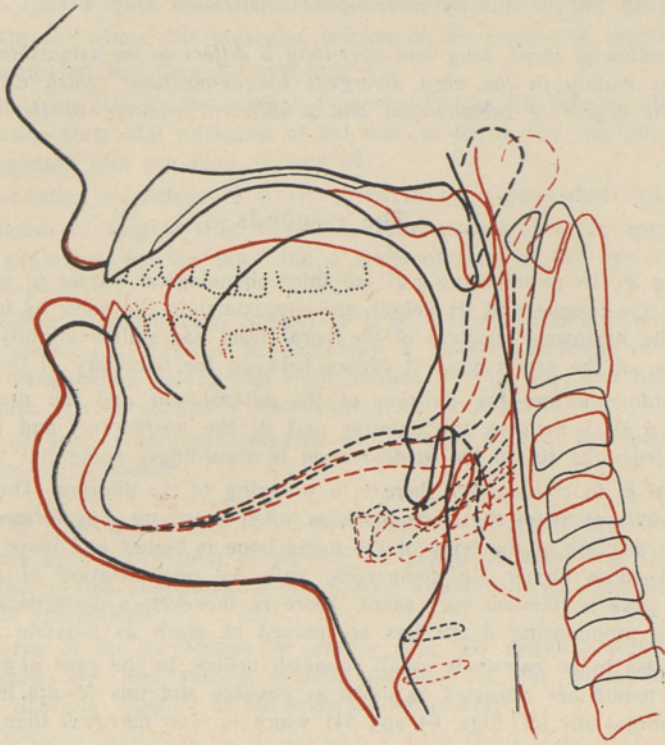
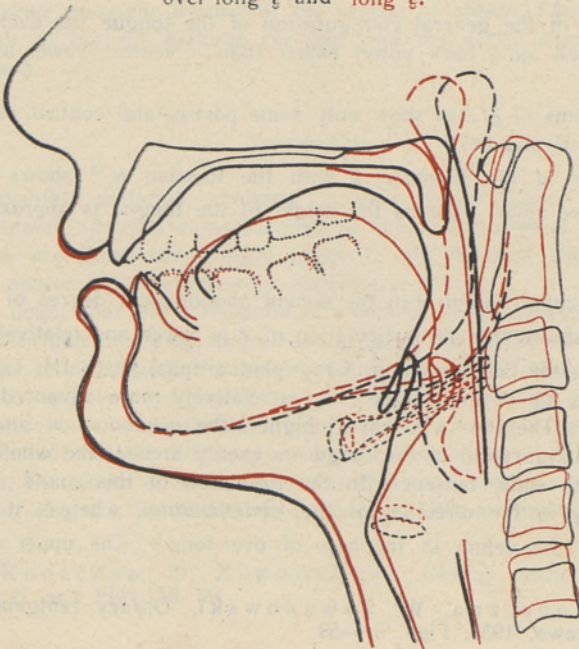


Fig. 70. Subject II. Röntgenogram of Estonian
over-long \hat{e} and long \bar{e} .



Short o. The short *o* is distinguished from the corresponding long sound by a lower articulation — this is shown by the reduction of the linguo-palatal contact area on the palatogram (Fig. 58) — and by more open labialization (Fig. 61).

The formation of short, long and over-long o differs to an astonishing extent. This difference lies mainly in the very divergent tongue-positions which are accompanied by a different degree of labialization and a different position of the larynx on the vertical axis.

The *e*-sounds

Over-long ê. In pronouncing ê of the third phonological degree of length the configuration of the tongue and its height are approximately the same as for over-long *û* (Fig. 63). The narrowest stricture of the vocal tract has shifted slightly closer to the central region of the oral cavity. It occurs between the boundary of the *mediodorsum* and the *postdorsum* and the junction of the *postpalatum* and the *praevelum* for ê, whereas for *û* it is between the anterior part of the *postdorsum* and the *praevelum*. The tongue from the tip to the *mediodorsum* is accordingly somewhat more advanced in the case of ê. In consequence there is a widening of the pharynx. The highest point of the dorsum is at about the same place as when over-long *û* is formed (cf. Figs. 63 and 45). The position of the body of the hyoid bone is higher and more retracted, that of the vocal cords higher (in comparison with the pronunciation of *û*). The angle between the jaws is likewise very small. There is, however, a diametrical difference in lip action: in pronouncing *û* the lips are pursed as much as possible and protruded, thus giving rise to an extremely small roundish orifice; in the case of ê, however, the sides of the mouth are retracted as much as possible and this results in an extremely narrow horizontal slit (cf. Figs. 64 and 54) which is even narrower than that for over-long *î* (cf. Figs. 64 and 3). There is very great muscular tension in the case of both ê and *û*.

The pronunciation of over-long ê by Subject I is even closer and more velar (Fig. 69).

On the basis of the general configuration of the tongue the over-long Estonian ê should be classified as a back vowel rather than a central vowel as has been done hitherto.

The palatograms of ê also show only some post-palatal contact of the tongue and the velum (Figs. 67 and 68).

A comparison of the Estonian ê with the Russian *ы*⁵² shows clearly that the Estonian ê is more velar, whereas the height of the tongue is approximately the same or even higher.

Long ē. A comparison of ē in the second phonological degree of length with ê in the third degree shows that the articulation of ē is lower and relatively more advanced (Fig. 70; see also the corresponding X-ray photographs, Plate II). Long ē is a typical central vowel. The tip of the tongue is in a relatively more advanced part of the oral cavity, and lower. The *corona* is raised higher, the *mediodorsum* and the *postdorsum* are lower. The configuration of the tongue is evenly arched; the whole dorsum appears to participate with equal tenseness in the formation of this sound. The lingual body articulates mainly in the direction of the *mediopalatum*, whereas it is raised mainly upwards towards the velum in the case of over-long ê. The upper two thirds of the

⁵² See H. Koneczna, W. Zawadowski, *Obrazy rentgenograficzne głosek rosyjskich*. Warszawa, 1956, Figs. 51—59.

pharynx are notably wider, the lower third — narrower. The position of the body of the hyoid bone is slightly higher and more retracted, that of the vocal cords somewhat higher. The angle between the jaws is approximately equally small in the relevant röntgenograms (just a little wider, as could be expected, for \bar{e}), the lip aperture is a shade wider. On the whole, the muscular tension of the organs of speech for long \bar{e} seems to be somewhat less than for over-long \bar{e} .

A very slight increase in the vertical dimension of the slit between the lips and a slightly less active horizontal retraction of the sides of the mouth may also be observed in the motion-picture film (cf. Figs. 65 and 64).

The pronunciation of Subject I is characterized by a somewhat closer and more palatal articulation of long \bar{e} (Fig. 69). This difference is probably compensated for by a greater angle between the jaws and a wider opening of the lips as well as by a lower larynx position.

The palatogram obtained from Subject B (Fig. 68), who has a relatively low and wide palate, shows (as was to be expected) a notable increase in mediopalatal contact. The corresponding palatogram from Subject A (Fig. 67), who has a relatively very high palate, merely records a somewhat more open articulation.

The Estonian long \bar{e} may be compared with another type of the Russian *е* which has a flatter tongue-position.⁵³

Short e . The palatograms of e in the first degree of length (Figs. 67 and 68) show a probably more open articulation of short e (as compared with long \bar{e}). A relatively greater reduction of the post-palatal contact area would seem to indicate a somewhat more advanced articulation.

A photograph of the lip-position for short e (Fig. 66) shows a slight widening of the slit between the lips and a certain decrease in the horizontal dimension (i. e. a slight drawing together of the sides of the mouth).

There are considerable differences in the articulation of the three phonological degrees of length of e . The different quality of the e -sounds is probably determined first and foremost by the different tongue-position within the oral cavity: a longer degree of length is accompanied accordingly by a closer and more velar articulation as well as by a greater muscular tension of the organs of speech. This leads to an even further narrowing of the slit between the lips and the active drawing apart of the sides of the mouth.

Summary

The experimental material analysed reveals considerable qualitative differences in the Estonian stressed monophthongs of three phonological degrees of length. These differences are quite surprisingly great in the different phonological degrees of *i* and *o*, but appear to be smallest in the case of \bar{a} .

There is no doubt that the corresponding acoustic effects depend on the system of resonance chambers determined by the whole configuration of the vocal tract. Nevertheless, it is possible to distinguish the greater functional load of some organs of speech in determining the quality of different sounds and their variants. The more essential articulatory features of the tamber differences that are characteristic of the vowels *i* and *e* include notable differences in tongue-position: the longer the phonological degree of length, the closer (i. e. the narrower the air passage) and the more palatal is the articulation (Figs. 1, 2; 15, 20). It is probable that an important part is played

⁵³ See H. Koneczna, W. Zawadowski, *Obrazy rentgenograficzne głosek rosyjskich*, p. 29 ff. and Figs. 58, 59.

in the formation of certain distinctive features by the different laryngeal articulation whose details are unfortunately still unknown to us. The more important articulatory features of the qualitative variants of the labial vowels \ddot{u} and \ddot{o} in different phonological degrees of length appear to be their different degrees of labialization and the different positions of the larynx on the vertical axis: the longer the duration of the vowel, the more active and closer is its labialization and the lower the position of the larynx (the differences of tongue-position being relatively small, insignificant and inconsistent) (Figs. 7—10, 12, 13; 30—36). The movement of the larynx along the vertical axis is characterized by a noteworthy autonomy: a comparison of the same degrees of length of \ddot{u} and \ddot{o} clearly shows a different degree of labialization (the tongue-position is also markedly different), but an approximately identical position of the larynx (Figs. 27, 28).

The tongue-position seems to play an essential role in the formation of the variants of a , u , e with their timbre differences: the longer the vowel, the closer is its articulation (the narrowness of the air passage) and the greater its velarity. The different lip-positions are also of significance here (Figs. 45—49; 50—56; 64—70, Plate II). The labial articulations of u and e illustrate two diametrically different tendencies in lip action. The articulatory differences of o are peculiar: over-long \ddot{o} is characterized by a more open articulation and velarity; long, and probably short o likewise, however, are characterized by greater closeness and even a palatal nature (Figs. 58, 62, Plate I). The more active labialization and lowering of the larynx that occur in the longer degrees of u and o are not so marked as for the corresponding degrees of \ddot{u} and \ddot{o} (cf. Figs. 50, 54—56; 59—62 and 8—10, 12; 30—32, 35, 36). In the longer phonological degrees of \ddot{a} there is a widening of the air passage and a somewhat greater palatal character of oral articulation (Figs. 38, 44).

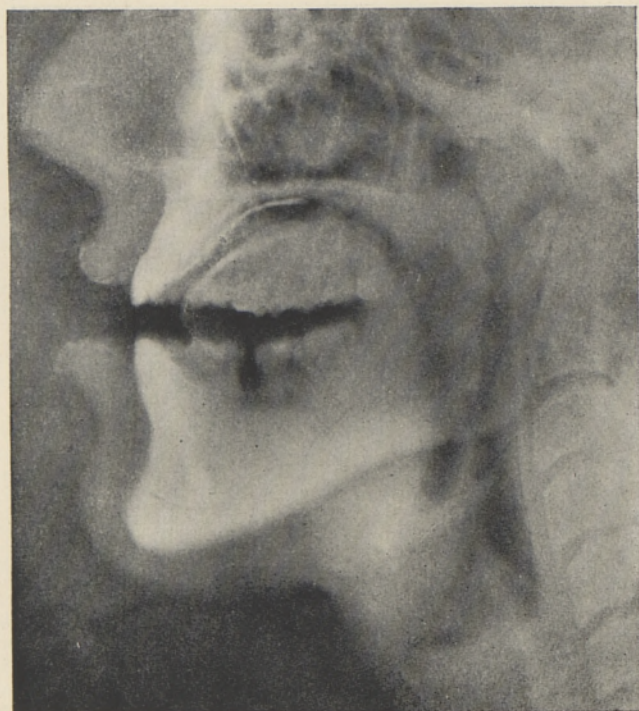
The pharyngeal cavity also changes in consequence of the different positions of the tongue and the larynx: its width increases as the tongue advances and its length increases with a lowering of the larynx. The direction in which the tongue moves also usually determines the position of the epiglottis and the width or narrowness of the *valleculae*: as the tongue advances, the epiglottis draws away from the root of the tongue, and the *valleculae* widen; the muscular tension of this region is likewise relevant. The position of the velum and the completeness of the *velic* stricture usually correspond to the degree of closeness of articulation. The angle between the jaws varies very greatly. Generally speaking, it seems to be the greatest for \ddot{a} and the smallest for e . Both vertical and horizontal labialization accompanied by some protrusion of the lips increase in the formation of \ddot{o} , o , \ddot{u} and u respectively (cf. Figs. 30—32; 59—61; 8—10; 54—56). A contrary tendency as regards lip action, i. e. a narrowing of the horizontal slit between the lips accompanied by retraction of the sides of the mouth, is increasingly noticeable in the formation of e , i , and e respectively (cf. Figs. 16—18; 3—5; 64—66). There is a noteworthy three-degree gradation of lip action corresponding to the three phonological lengths of each type of sound referred to. In the case of a and \ddot{a} the lip aperture increases with an increase in the degrees of length (Figs. 47—49; 41—43).

The articulation of over-long vowels is generally characterized by greater muscular tension of the organs of speech. This is especially apparent in the case of close vowels.

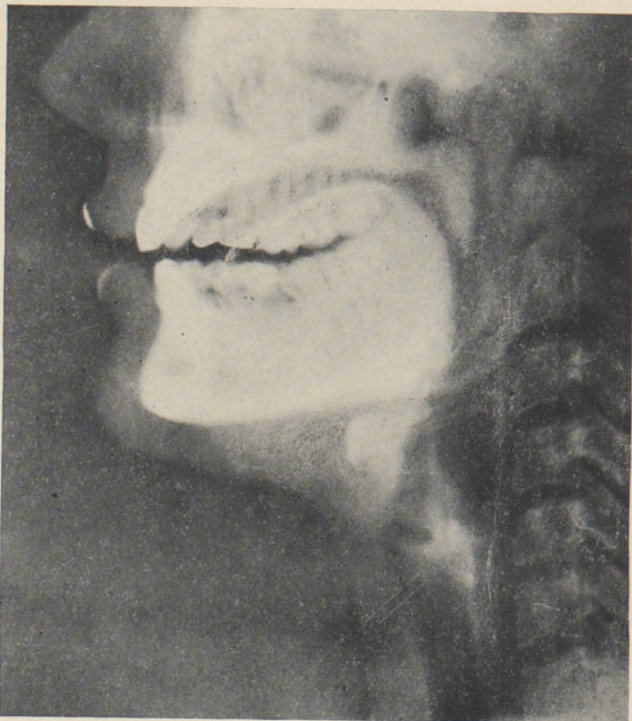
The röntgenographic material presented shows that the traditional articulatory classification of the vowels as front (palatal) and back (velar) is very relative and is, on the whole, often based on the auditive impression and not on the real position of the organs of speech. It would be expedient to classify the vowels according to the place of their highest degree of supra-laryngeal narrowing (narrowest stricture of the vocal tract). For instance, the marked pharyngeal narrowing seems to be a very characteristic feature of some so-called velar and even palatal vowels.



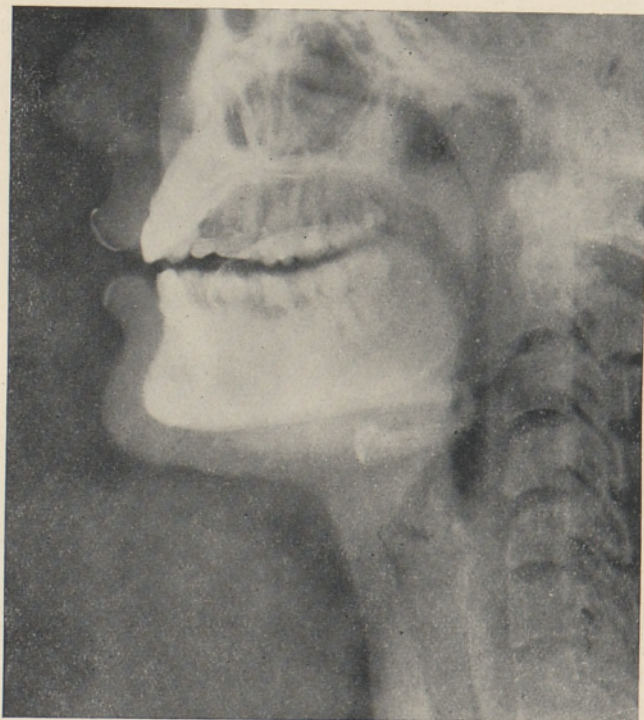
Subject I. X-ray photograph of Estonian over-long \bar{o} .



Subject I. X-ray photograph of Estonian long \bar{o} .



Subject II. X-ray photograph of Estonian over-long ē.



Subject II. X-ray photograph of Estonian long ē.

So-called compensatory articulation involves a number of interesting articulatory facts and features, but their more detailed study does not come within the scope of the present paper.

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Received
Nov. 3rd, 1960

EESTI KEELE PEARÖHULISE SILBI KOLMES FONOLOOGILISES VÄLTUSASTMES ESINEVATE MONOFTONGIDE KVALITATIIVSED TUNNUSJOONED

G. Liiv

Resümee

Kvantiteedi ja kvaliteedi korrelatsioonid eesti keele foneetilises struktuuris on eksperimentaalsete meetodite abil süstemaatiliselt veel uurimata. Üldiselt valitseb arvamus, et kolmes fonoloogilises vältusastmes esinevad vokaalid on kvaliteedilt identsed või erinevad õige vähe.

Eksperimentaalse materjali analüüsist aga selgub, et kolmes fonoloogilises pikkusastmes hääldataval pearöhulise silbi monoftongidel on tunduvalt kvalitatiivseid erinevusi. Need erinevused on otse üllatavalt suured *i* ja *o* eri vältusastmetes, kõige väiksemad näivad nad olevat *ä* artikuleerimisel.

On vaieldamatu, et vastava akustilise efekti loob kogu kõnetrakti konfiguratsiooniga määratavate resonantsruumide süsteem. Ometi võib märgata, et eri häälikute ja nende variantide kvaliteedi kujundamisel on teatavad hääldamisorganid funktsionaalselt rohkem koormatud. Vokaalide *i* ja *e* eri vältusastmete vahel esinevate selgete kvalitatiivsete erinevuste olulisemate artikulatsiooniliste tunnusoontena võiks märkida tähelepandavaid erinevusi keele asendis: mida pikem vältusaste, seda suurem on artikulatsiooni kõrgusaste (seda kitsam õhukanali ahtus) ja palataalsus (joon. 1, 2; 15, 20). Teatavate distinktsioonide kujundamisel etendab siin arvatavasti olulist osa erinev larüngaalne artikulatsioon, mille üksikasjad on meile siiani kahjaks teadmata. Labiaalsete vokaalide *ü* ja *ö* pikkusastmeti esinevate erikvaliteediliste variantide olulisemate artikulatsiooniliste tunnusoontena näivad olevat erinevad labialisatsiooniastmed ja kõri (*larynx*) erinev asend vertikaalteljel: mida pikem on vokaali kestus, seda aktiivsem ja kitsam on labialisatsioon, seda madalam on kõri asend; erinevused keele asendis on suhteliselt väikesed ja ebaolulised ning ebajärjekindlad (joon. 7—10, 12, 13; 30—36). Kõri liikumisel piki vertikaaltelge on märkimisväärne autonoomsus: *ü* ja *ö* samade vältusastmete artikulatsiooni võrdlus näitab selgelt erinevat labialisatsiooniastet (tunduvalt erinev on ka keele asend), kuid umbes samast kõri asendit (joon. 27, 28).

Olulist osa näib etendavat erinev keele asend *a*, *u* ja *ɛ* eritämbriiliste variantide foneerimisel: mida suurem on vokaali pikkusaste, seda suurem on artikulatsiooni kõrgusaste (seda kitsam on õhukanali ahtus) ja velaaratus. Märkimisväärset osa etendab siin ka huulte erinev asend (joon. 45—49; 50—56; 64—70, tahvel II). *u* ja *ɛ* labiaalne artikulatsioon illustreerib seejuures huulte tegevuse kaht diametraalselt vastupidist tendentsi. *o* artikulatsioonilised erinevused on omapärased: ülipikka *ô*-d iseloomustab artikulatsiooni madalam kõrgusaste ja velaaratus, pikka ja vististi lühikestki *o*-d aga kõrgem artikulatsiooniaste ja palataalsuski (joon. 58, 62, tahvel I). *u* ja *o* pikemates vältusastmetes esinev aktiivsem labialisatsioon ja kõri madaldumine pole sedavõrd ilmekas kui *ü* ja *ö* vastavate pikkusastmete foneerimisel (vrd. joon. 50, 54—56; 59—62 ja 8—10, 12; 30—32, 35, 36). *ä* pikemates vältusastmetes võib märkida õhukanali avardamist ja oraalse artikulatsiooni mõningaselt suuremat palataalsust (joon. 38, 44).

Sõltuvalt keele ja kõri erinevast asendist muutub ka neeluõõne (*cavum pharyngis*) ruumala: keele ettepoole liikudes suureneb ta laius, kõri laskudes aga ta pikkus. Kõripealise (*epiglottis*) asendi ja keele-kõripealise orukeste (*valleculae glossoepiglotticae*) avaruse või ahtuse määrab tavaliselt samuti keele liikumissuund: keele ettepoole liikudes eemaldub kõripealis keelepärast (*radix linguae*) ja valleekulid avarduvad; teatavat osa etendab siin ka selle piirkonna lihaste pingus. Veelumi asend ja velaarfarüngaalse ahendi tõhusus vastab tavaliselt keele kõrgusastmele. Lõualuudevaheline nurk varieerub

õige tublisti: üldiselt näib ta olevat kõige suurem *ä* ja kõige väiksem *ɛ* hääldamisel. Nii vertikaal- kui horisontaalsuunaline labialisatsioon koos huulte teatava ettepoole lükumiseга kasvab vastavalt *õ, o, ü* ja *u* hääldamisel (vrd. joon. 30—32; 59—61; 8—10; 54—56). Huulte tegevuse vastupidine tendents, nimelt horisontaalsuunalise pilu ahenemine koos suunurkade teineteisest eemaldumisega tõhustub vastavalt *e, i*, ja *ɛ* hääldamisei (vrd. joon. 16—18; 3—5; 64—66). Seejuures on märkimisväärne huulte tegevuse vastav kolmeastmeline gradatsioon iga häälikutüübi kolme vältusastme artikuleerimisel. *a* ja *ä* hääldamisel suureneb hääliku vältusastme pikenedes huulte ava (joon. 47—49; 41—43).

Üldiselt iseloomustab ülipikkade vokaalide artikulatsiooni hääldamisorganite lihaste suurem pingsus. See ilmneb eriti selgesti kõrgete vokaalide hääldamisel.

Röntgenograafiline materjal näitab, et kehtiv vokaalide artikulatsiooniline klassifikatsioon palataalseiks ehk eesvokaalideks ning velaarseiks ehk tagavokaalideks on vägagi tinglik ja põhineb sageli arvatavasti eelkõige kuuldelisel muljel, mitte aga hääldamisorganite tegelikul asendil. Näib, et otstarbekohane oleks vokaale rühmitada kõnetrakti kitsaima supra-larüngaalse ahutuse asukoha järgi. Näiteks on teatavaile nn. velaar-seile ja isegi palataalseile vokaalidele väga iseloomulik märgatav farüngaalne ahend, mis moodustub keelepära ja neeluõõne tagaseina vahel.

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Saabus toimetusse
3. XI 1960

КАЧЕСТВЕННАЯ ХАРАКТЕРИСТИКА ЭСТОНСКИХ ПОДУДАРНЫХ МОНОФОНГОВ ТРЕХ ФОНОЛОГИЧЕСКИХ СТЕПЕНЕЙ ДОЛГОТЫ

Г. Лийв

Резюме

Соотношения количественной и качественной сторон в фонетической структуре эстонского языка с точки зрения экспериментальных данных до сих пор систематически не изучены. В общем распространено мнение, что гласные в трех фонологических степенях долготы по качеству идентичны или же различаются ничтожно мало.

Анализ экспериментального материала показывает значительные качественные различия подударных монофонов в зависимости от фонологической степени долготы. Наиболее разительны эти различия между разными степенями долготы *i* и *o*; наименее значительны они при артикуляции *ä*.

Бесспорно, что соответствующий акустический эффект создается системой резонаторов, определяемой общей конфигурацией всего речевого тракта, но тем не менее можно указать на большую функциональную нагрузку определенных органов произношения при образовании различных гласных и их вариантов. Наиболее существенными артикуляционными признаками качественных различий разных степеней долготы гласных *i* и *e* можно считать заметные различия в положении языка: чем больше степень долготы, тем выше ступень его подъема (сужение воздушного столба) и палатальность артикуляции (рис. 1, 2; 15, 20). Важную роль при образовании определенных различий играет, очевидно, и специфическая для каждого случая ларингальная артикуляция, детали которой, к сожалению, доньше неизвестны.

Существенными артикуляционными признаками вариантов разного качества лабиализованных гласных *ü* и *õ* разных степеней долготы являются, по-видимому, разные степени лабиализации и различное положение гортани (*larynx*) по вертикальной оси: чем больше длительность гласного, тем больше степень лабиализации и тем ниже положение гортани; различия в положении языка сравнительно незначительны и непоследовательны (рис. 7—10, 12, 13; 30—36). Движение гортани по вертикальной оси имеет значительную автономность: сравнение артикуляции одинаковых степеней долготы *ü* и *õ* показывает явно различную степень лабиализации (а также и различные положения языка), но примерно одинаковую позицию гортани (рис. 27, 28).

Существенную роль в образовании разных тембров при различных степенях долготы гласных *a*, *u* и *ɛ* играет положение языка: чем больше степень долготы гласного, тем выше положение языка (сужение воздушного столба) и тем больше веларность. Следует отметить, что определенную роль при этом играет и различное положение губ. Лабиальная артикуляция при *u* и *ɛ* иллюстрирует две диаметрально противоположные

тенденции действия губ (рис. 45—49; 50—56; 64—70, таблица II). Свообразны артикуляционные различия *o*. Сверхдлгое *õ* характеризуется меньшей степенью подъема языка и велярностью артикуляции, тогда как долгое *o*, по всей вероятности, короткое *o* артикулируются при более высоком положении языка и даже с некоторой палатальностью (рис. 58, 62, таблица I). Существующая при более долгих степенях *u* и *o* более активная лабиализация и опускание гортани не настолько значительны, как при соответствующей фонации *ü* и *õ* (ср. рис. 50, 54—56; 59—62 и 8—10, 12; 30—32, 35, 36). При более долгих степенях *ä* можно отметить расширение воздушного столба и несколько большую палатальность ротовой артикуляции (рис. 38, 44).

В зависимости от различного положения языка и гортани изменяется и объем полости глотки (*cavum pharyngis*): при продвижении языка вперед глотка расширяется, при опускании гортани она удлиняется. Положение надгортанника (*epiglottis*) и расширение и сужение валлекул (*valleculae glossoepiglotticae*) зависит обычно также от направления движения языка: при продвижении языка вперед надгортанник отодвигается от корня языка (*radix linguae*) и валлекулы расширяются; некоторую роль здесь играет также напряженность мускулов этой области. Положение мягкого нёба (*palatum molle*) и полнота велярно-фарингальной смычки обычно соответствуют степени подъема языка. Челюстной угол варьирует довольно значительно в разных произнесениях; создается впечатление, что он самый большой при произнесении *ä* и самый маленький — при *e*. Как вертикальная, так и горизонтальная лабиализация вместе с некоторым выпячиванием губ возрастает соответственно при произнесении *õ*, *o*, *ü* и *u* (ср. рис. 30—32; 59—61; 8—10; 54—56). Противоположная тенденция действия губ, а именно сужение горизонтальной щели и оттягивание назад углов рта, усиливается соответственно при произнесении *e*, *i*, *e* (ср. рис. 16—18; 3—5; 64—66). При этом нужно отметить трехступенчатую градацию соответствующего действия губ при артикуляции трех степеней долготы звуков. При артикуляции *a* и *ä* более долгих степеней долготы отверстие между губами увеличивается (рис. 47—49; 41—43).

В целом, артикуляция сверхдлгих гласных характеризуется бльшей напряженностью произносительных органов, что особенно заметно при произнесении гласных высокого подъема.

Рентгенографический материал показывает, что традиционная артикуляционная классификация гласных на гласные переднего ряда (палатальные) и заднего ряда (велярные) весьма условна и часто основывается, вероятно, главным образом на слуховом впечатлении, а не на действительном положении органов произношения. Можно полагать, что было бы целесообразно группировать гласные по признаку месторасположения наибольшего сужения речевого тракта в надгортанных полостях. Например, для некоторых так называемых велярных и даже палатальных гласных, по-видимому, весьма характерно заметное фарингальное сужение, образующееся между корнем языка и задней стенкой глотки.

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Поступила в редакцию
3. XI 1960