

# The Temporal Structure of Penta- and Hexasyllabic Words in Estonian

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## Abstract

This article concentrates on five- and six-syllable Estonian words consisting of two or more metric feet of the first quantity degree (Q1), comparing the temporal structures of the feet. After an introductory discussion of the problems related to secondary stressed feet, the article first of all deals with half-length of unstressed syllables in Q1 feet. This is followed by an analysis of durations and duration ratios of primary and secondary stressed Q1 feet of five- and six-syllable words. It appears that in these long words the temporal structure of Q1 feet is not similar. It differs from the structure of Q1 feet of shorter (di- to tetrasyllabic) words where there is a significant lengthening of the unstressed vowel (V2). The results show that in Estonian the whole structure of prosodic word determines the temporal structure of feet.

## 1. Introduction

The length of Estonian word stems is one to nine syllables, but most frequently, Estonian words consist of one to six syllables [7].

In an Estonian non-compound word, rhythmic division into feet generally follows a trochaic pattern, and the first syllable is normally primary stressed ([*pa.ra.ne.sin*] ‘I recovered’, [*e.la.si.me*] ‘we lived’). Some exclamatory words are not subject to this general pattern (e.g. [*ait.täh:*] ‘thanks’, [*en'näe:*] ‘behold’), and the same applies to a number of foreign words ([*i.te:*] ‘idea’) where stress does not fall on the first syllable. Trisyllabic simple words in contemporary Estonian typically consist of one foot in which the stressed syllable is followed by two unstressed syllables (e.g. [*ho.pu.ne*] ‘horse’). In some cases, a trisyllabic word may exhibit a secondary stressed second or third syllable (e.g. [*tõ.li.si*] ‘labourers’, [*pu.na.sei:t*] ‘red ones’). Tetrasyllabic and longer Estonian words always have at least two feet. Foot isochrony has been perceived as one of the main characteristics of Estonian prosody [8].

If a prosodic word consists of an odd number of five or more syllables, then the last stressed syllable is followed by two unstressed syllables ([*pa.ra.ne.si.me*] ‘we recovered’, [*te.ke.le.va.ma.le.gi*] ‘to the more active as well’). Some derivational affixes may begin with a secondary stressed syllable ([*pa.ra.ne.mi.se*] ‘of the recovering’, [*ka.na.ta.la.se*] ‘of the Canadian’) if the latter comes after two unstressed syllables. Hence, the division of stems into feet in longer words is not immediately predictable [2].

The Estonian primary stressed foot may be in one of the first, second or third quantity degrees (referred to as Q1, Q2 and Q3). Also secondary stressed feet are traditionally said to be in one of these quantity degrees [1], [8]. This claim primarily applies in case of morphological secondary stress,

whereas feet carrying rhythmic secondary stress are usually in the first or second quantity degree.

## 2. Vowel lengthening in the unstressed syllable of Q1 feet

In words consisting of Q1 feet, the primary or secondary stressed first syllable is short and open, while the following unstressed syllable may be either open or closed. In open unstressed syllables, the presence of vowel lengthening has been established [10], [11]. The controversial issue has been whether the unstressed syllable or weak branch of the Q1 foot is phonologically short (monomoraic) or long (bimoraic).

In case of Q1 feet, previous studies have most often described the (vowel) duration ratios of disyllabic words. Lehiste has drawn attention to the fact that the so-called half-long vowel in the second syllable is a significant characteristic of the Q1 foot. The duration ratio of vowels (V2/V1) in such CVCV words is approximately 1.5 [3], [5]. Such lengthening of the unstressed syllable has been explained by means of foot isochrony [8].

Previous studies have shown that the duration ratio of V2 and V1 may be dependent upon the dialectal background of the speaker. The most striking examples of half-length can be found in South-East Estonia as well as on the West Estonian islands (V2/V1 > 1.5) and it is least noticeable in the North-East coastal dialect (V2/V1 < 1.25) [9]. Mid-Estonian pronunciation is located between these two extremes (V2/V1 = 1.25–1.40), being closest to the pronunciation of Standard Estonian [9].

As vowel lengthening is usually observed in the second syllable of disyllabic Q1 words, the connection between the lengthening of the unstressed vowel and the word-final lengthening remains unexplained. However, Lehiste [4], [6] has shown that the lengthening of the unstressed second syllable is also present in tri- and tetrasyllabic words (V2/V1 in disyllabic words 1.21, in trisyllabic words 1.28, and in tetrasyllabic words 1.33). A similar lengthening also occurred in the secondary stressed foot of tetrasyllabic words (V4/V3 = 1.63). On the basis of her results, Lehiste claims that Estonian tetrasyllabic words are divided into two disyllabic units similar to disyllabic words [4]. Hence, there is no difference between primary and secondary stressed feet and foot isochrony is active in secondary stressed feet as well. Such vowel lengthening in the unstressed syllable of the secondary stressed foot of tetrasyllabic words has also been indicated by Sepp [9]. Sepp’s analysis of six-syllable words demonstrated that if a word is divided into disyllabic feet vowel lengthening may be absent in the unstressed syllable of the secondary stressed foot, but always present in the primary stressed foot.

A recent study [7] dealing with four- to six-syllable words with Q1 feet in the two outermost peripheries of the Estonian language area – Võru in the South-East and

Saaremaa in the West – indicated that the lengthening of the vowel of the unstressed syllable is not a constant characteristic. This lengthening was absent in the pronunciation of Võru informants, or occurred minimally at the end of words, which might partly be influenced by word-final lengthening. The only exception were the six-syllable words divided into three disyllabic feet, where the primary stressed foot was characterized by vowel lengthening in the unstressed syllable in both areas.

### 3. Q1 feet in five- to six-syllable words

Previous studies have already raised the question about the presence or absence of lengthening of the vowel in the unstressed syllable in Q1 feet. The aim of this study is to examine this topic in further detail by analyzing a larger set of data.

#### 3.1. Research material and methods

In order to carry out this study, six informants were recorded: three men and three women (born in 1981–1985). All informants are students at the University of Tartu, and come from different parts of Estonia.

Each informant recorded 40 short sentences. 20 of these sentences contained five-syllable test words and the other 20 six-syllable test words with open syllables placed in the middle of the carrier sentences between one-foot units (e.g. [*te.ki 'mu.ri. la.se.le 'pai:*] ‘patted the little child’).

The recordings were made using a Sony TCD-D 100 DAT recorder and an AKG D40S microphone. The analysis was carried out with PRAAT. Duration of all segments was measured. Recorded words where the informants’ pronunciation slipped were not analyzed.

#### 3.2. Five-syllable words

Table 1 presents the durations of vowels in five-syllable words with a secondary stressed third syllable. Table 2 presents data of the words with a secondary stressed fourth syllable. Figure 1 comparatively presents average durations of the words of both classifications.

Table 1: *Vowel durations, standard deviations (ms) and duration ratios in five-syllable Q1 words with a secondary stressed third syllable.*

Speaker	N	V1	V2	V2/V1	V3	V4	V5	V4/V3
MR	10	64	62	0.96	58	45	46	0.79
		14	15		15	12	8	
MK	10	88	102	1.16	83	89	62	1.07
		22	21		15	17	20	
NS	10	80	86	1.07	71	73	70	1.02
		16	16		14	21	17	
MM	10	73	80	1.09	69	60	59	0.86
		21	11		20	19	11	
MT	10	64	70	1.09	63	59	68	0.95
		21	24		13	26	19	
MJ	10	70	83	1.18	74	76	60	1.03
		10	14		17	21	11	
<b>Average</b>	<b>60</b>	<b>73</b>	<b>81</b>	<b>1.09</b>	<b>70</b>	<b>67</b>	<b>61</b>	<b>0.95</b>
		<b>17</b>	<b>17</b>		<b>16</b>	<b>19</b>	<b>14</b>	

In five-syllable words with Q1 feet, where secondary stress falls on the third syllable, some degree of lengthening occurs

in the vowel of the unstressed syllable (V2) of the primary stressed foot, but this could not be construed as half-length ( $V2/V1 = 1.09$ ; see Table 1). In the secondary stressed foot, the vowel of the unstressed syllable (V4) following the stressed syllable is not lengthened at all ( $V4/V3 = 0.95$ ). In the primary stressed foot, a slightly more noticeable lengthening of the vowel of the unstressed syllable occurs in the speech of the informant MJ ( $V2/V1 = 1.18$ , ANOVA indicates that V2 is different from V1 with a probability of  $p = 0.03$ ). In the speech of the other informants, however, the unstressed V2 is not significantly longer (or is even shorter) than the stressed V1 (according to ANOVA  $p = 0.2$ ).

Table 2: *Vowel durations, standard deviations (ms) and duration ratios in five-syllable Q1 words with secondary stressed fourth syllable.*

Speaker	N	V1	V2	V2/V1	V3	V4	V5	V5/V4
MR	9	65	65	1.00	43	44	54	1.23
		12	10		14	18	8	
MK	10	89	101	1.13	79	76	72	0.94
		13	13		12	16	15	
NS	10	93	100	1.07	67	63	79	1.24
		13	13		16	19	13	
MM	9	77	89	1.16	57	59	75	1.28
		8	14		10	19	15	
MT	9	61	70	1.15	44	44	64	1.48
		13	13		9	12	18	
MJ	10	63	82	1.30	60	58	70	1.20
		13	17		8	12	12	
<b>Average</b>	<b>57</b>	<b>75</b>	<b>84</b>	<b>1.14</b>	<b>58</b>	<b>57</b>	<b>69</b>	<b>1.23</b>
		<b>12</b>	<b>13</b>		<b>11</b>	<b>16</b>	<b>13</b>	

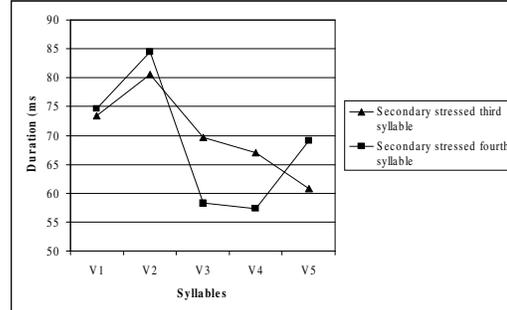


Figure 1: *Vowel durations (ms) in five-syllable Q1 words with a secondary stressed third or fourth syllable.*

In those words where secondary stress falls on the fourth syllable, some degree of lengthening of the vowel in the unstressed syllable in primary stressed feet also occurs ( $V2/V1 = 1.14$ ), which should still not be construed as half-length. However, half-long V2 is present in the pronunciation of the informant MJ ( $V2/V1 = 1.30$ ). In secondary stressed feet, a more noticeable lengthening of the unstressed syllable vowel is present ( $V5/V4 = 1.23$ , according to ANOVA  $p < 0.001$ ) and this may be a case of half-long vowel. But it could not be said to what extent word-final lengthening may influence such lengthening.

A comparison of words of both foot divisions shows that in words with a secondary stressed third syllable, V3 is significantly longer than the V3 of unstressed syllable of words with a secondary stressed fourth syllable (70 ms and

58 ms respectively,  $p < 0.001$ ). The unstressed, word-final vowel (V5) is slightly, though not significantly, shorter in words with a secondary stressed third syllable ( $p=0.09$ ), but half-length of the word-final vowel already became evident in case of secondary stressed V4.

Total durations and durations per foot of five-syllable words are presented in Table 3.

Table 3: Average durations and standard deviations (ms) of five-syllable words.

Secondary stressed third syllable			Secondary stressed fourth syllable		
Word	Foot 1	Foot 2	Word	Foot 1	Foot 2
665	293	372	632	395	237
60	40	32	51	32	33

By examining the total durations of words and feet, it can be maintained that the words with a secondary stressed third syllable are on average pronounced slower than words with a secondary stressed fourth syllable. The duration of a disyllabic primary stressed foot is longer than that of a disyllabic secondary stressed foot (293 and 237 ms). Also the trisyllabic primary stressed foot has a longer duration than the trisyllabic secondary stressed foot (395 and 372 ms respectively). Not taking into consideration the duration of the third syllable of the primary and secondary stressed foot, the following average durations of disyllabic feet were established: 274 ms and 256 ms. The first of these durations is close to the duration of the primary stressed disyllabic foot and the second to the duration of the disyllabic secondary stressed foot.

### 3.3. Six-syllable words

Table 4 presents durations of the six-syllable Q1 words with two secondary stressed feet. Table 5 presents words with one secondary stressed foot. Figure 2 compares the vowel durations of words of both classifications.

Table 4: Vowel durations, standard deviations (ms) and duration ratios in six-syllable Q1 words with secondary stressed third and fifth syllable.

Sp.	N	V1	V2	V2/V1	V3	V4	V4/V3	V5	V6	V6/V5
MR	9	66	69	1.04	64	55	0.85	61	62	1.01
		16	10		12	13		15	18	
MK	10	85	103	1.22	73	77	1.05	71	74	1.05
		15	13		11	14		13	13	
NS	10	95	104	1.09	77	87	1.12	82	100	1.21
		9	14		14	17		19	36	
MM	10	76	85	1.11	66	71	1.07	62	75	1.20
		7	10		19	14		13	6	
MT	10	57	65	1.14	43	51	1.18	54	61	1.14
		11	11		11	16		17	11	
MJ	9	66	79	1.21	58	70	1.19	67	60	0.89
		8	8		8	9		10	12	
Av.	58	74	84	1.14	64	68	1.08	66	72	1.08
		11	11		13	14		14	16	

In six-syllable words that were divided into disyllabic feet, the vowels of unstressed syllables are slightly lengthened in comparison to those of the stressed ones (more so in primary stressed than in secondary stress feet) but not half-long. In the

primary stressed foot, a more noticeable lengthening of V2 as compared to V1 occurs in the speech of informants MK and MJ (V2/V1 respectively 1.22 and 1.21, significant difference in duration between V2 and V1 with a probability of  $p = 0.01$ ,  $p = 0.003$ ). As for the other informants, the durational differences between these vowels are not significant ( $p = 0.09$ ).

Table 5: Vowel durations, standard deviations (ms) and duration ratios in six-syllable Q1 words with secondary stressed fourth syllable (total number of words 59).

Sp.	N	V1	V2	V2/V1	V3	V4	V5	V6	V5/V4
MR	10	62	70	1.13	48	56	58	56	1.04
		16	19		15	16	11	13	
MK	10	83	106	1.27	73	79	76	72	0.97
		14	23		13	17	19	14	
NS	10	90	96	1.07	61	66	81	72	1.23
		11	13		13	22	9	16	
MM	10	79	89	1.13	66	70	69	68	0.99
		11	13		12	17	11	21	
MT	9	65	71	1.09	44	41	46	63	1.14
		16	16		15	10	11	9	
MJ	10	67	77	1.16	65	58	60	60	1.04
		14	10		10	14	12	10	
Av.	59	74	85	1.14	59	61	65	65	1.07
		14	16		13	16	12	14	

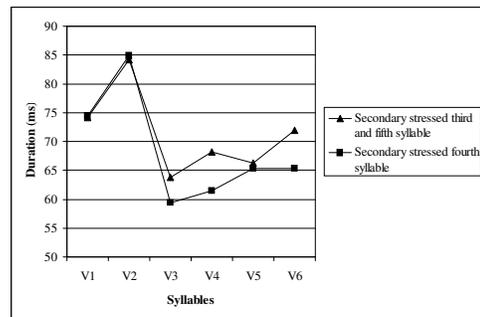


Figure 2: Vowel durations (ms) in six-syllable Q1 words with secondary stressed third and fifth syllable.

In six-syllable Q1 words with a secondary stressed fourth syllable, the vowel of the unstressed syllable following the stressed syllable is slightly lengthened (more so in primary stressed than in secondary stressed feet), but not half-long (see Table 5). However, a half-long vowel is present in the primary stressed foot as pronounced by informant MK ( $V2/V1 = 1.27$ ). In the secondary stressed foot, the unstressed vowel of the fifth syllable is half-long compared to the vowel of the secondary stressed fourth syllable in the pronunciation of informant NS ( $V5/V4 = 1.23$ , V5 is significantly longer than V4:  $p = 0.05$ ).

Table 6 presents total durations and durations per foot of six-syllable words. In six-syllable words with a secondary stressed third and fifth syllable the primary stressed foot is pronounced longer than the other feet, and the word-final secondary stressed foot is longer than the word-internal secondary stressed foot. When a six-syllable word consists of two feet the primary stressed foot is also much longer than the secondary stressed one.

Table 6: Average durations and standard deviations (ms) of six-syllable words.

Secondary stressed third and fifth syllable				Secondary stressed fourth syllable		
Word	Foot 1	Foot 2	Foot 3	Word	Foot 1	Foot 2
783	288	240	255	773	404	369
59	33	23	31	61	35	38

Not taking into consideration the duration of the third syllable of the trisyllabic primary and secondary stressed foot, the average durations of the disyllabic feet are as follows: 288 ms and 252 ms. As the resulting durations are similar to those of the disyllabic feet of the six-syllable word, it is quite clear that the stressed syllable and the following unstressed syllable constitute a core of the so called trisyllabic foot.

#### 4. Discussion

Previous studies have stated that half-long vowels occur in the unstressed syllables of both primary and secondary stressed Q1 feet in Estonian words. It has also been established that the occurrence of such half-length is not regular and may depend on the dialectal background of the speaker.

This study showed that in the speech of young Estonian speakers, a modest lengthening of the vowel of the unstressed syllable of the Q1 foot occurs in the pronunciation of five- and six-syllable Q1 words, but in secondary stressed feet the lengthening is minimal or not present at all. These results raise the question about the phonological status of the lengthening of the vowel in unstressed syllables. The possibility exists that this might above all be a phonological contrast expressed through the word root. On the other hand, our data may support the idea that the lengthening of the vowel of the unstressed syllable in Estonian is a phonetic marker indicating the foot or prosodic word boundary.

The results presented indicate that the location of secondary stress within the word may influence the temporal structure of Estonian words, as appeared to be the case in five-syllable words, but this influence depends on the general prosodic structure of the word. Analysis of six-syllable Q1 words shows that different location of secondary stress does not significantly change duration ratios within the word. Comparison of the foot durations indicates that primary stressed feet are slightly longer than secondary stressed feet, and there is a high degree of consistency within each type of foot. It may still be assumed that foot isochrony is among the main characteristics of Estonian prosodic structure.

#### 5. Conclusions

This article analyzed vowel durations and duration ratios in Estonian five- and six-syllable words consisting of Q1 feet. The duration ratios of the vowels indicate that such long words do not exhibit lengthening of the vowel of the unstressed syllable to an extent which is characteristic of two- to four-syllable words. A minimal lengthening of the vowel of the unstressed syllable occurs in primary stressed feet and even less in secondary stressed feet; this occurs first and foremost in positions where final lengthening may be expected.

Pronunciation of the five- to six-syllable words showed different secondary stress and temporal patterns. In five-syllable words with a secondary stressed third syllable, the durations of V2 and V3 are similar, but where the fourth syllable has secondary stress, V3 is significantly shorter than

V2. Such a relation could not be established in six-syllable words. The duration ratios of primary stressed and secondary stressed feet are similar in six-syllable words with different locations of the secondary stress. This gives reason to assume that, for instance, fundamental frequency may play a part in the recognition of secondary stressed syllables which, however, was not analyzed in this study. Comparison of both duration ratios and total durations of the feet indicates that the temporal structures of primary stressed feet and secondary stressed feet in Estonian are different. The durational realization of the feet is determined by the whole prosodic structure of the words.

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