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THE ROLE OF DURATION RATIOS AND FUNDAMENTAL FREQUENCY IN SPONTANEOUS LIVONIAN

Abstract. The article focuses on the study of Livonian word prosody. The paper deals with duration ratios and fundamental frequency contours in Livonian. An acoustic-phonetic analysis of the recordings of spontaneous speech by 8 speakers was carried out. The measurements were subjected to statistical treatment, and the results were analysed from the point of view of their role in the Livonian prosodic structure. The paper deals primarily with the role of quantity and tone and their phonetic realisation. Words with a long first syllable (consisting of voiced sounds) containing a half-long or a short vowel in the second syllable were analysed. On the basis of the duration ratios one group of speakers differentiated the two types of words similarly to Estonian Q2 and Q3 words, while the other group did not. Words where stød was expected were differentiated from words where stød was not expected primarily by an earlier F0 peak.

Keywords: word prosody, quantity, fundamental frequency, Livonian.

1. Introduction

Livonian is the southernmost Finnic language spoken in Latvia. Livonian is a highly endangered language. Only a few people still speak Livonian as their mother tongue. As a result of a revitalisation movement, more ethnic Livonians speak it as a second or third language. There are 12 historically Livonian villages on the Livonian Coast. The current article focuses on the speech from the villages in the eastern part of the Livonian Coast.

There are several acoustic-phonetic studies on Livonian word prosody: Vihman 1971 (1 speaker); Pajupuu, Viitso 1986 (1 speaker); Lehiste, Teras, Pajusalu, Tuisk 2007 (10 speakers); Lehiste, Teras, Ernštreits, Lippus, Pajusalu, Tuisk, Viitso 2008 (8 speakers); Teras, Tuisk 2009 (2 speakers). All these studies were made on the basis of read speech. Problems of Livonian phonology are dealt with by Tiit-Rein Viitso (1981; 2008) and Kalevi Wiik (1989).

The prosodic features of Livonian are as follows: 1) primary stress is fixed, falling on the first syllable of a word; 2) there is a phonological opposition of short and long primary stressed syllables; the vowel in the second syllable in words with a short first syllable is half-long, and with a long first syllable half-long or short (the syllable ratios are 0.5–0.7, 1.0–1.8,

and 2.4–3.2 respectively) (Lehiste, Teras, Ernštreits, Lippus, Pajusalu, Tuisk, Viitso 2008); 3) there is a tone opposition in the primary stressed long syllables (words with *stød* (or broken tone) and words without *stød*).

In primary stressed syllables, Livonian can have short and long monophthongs (short *kadūb* 'it disappears', long *kīraz* 'ax', *sōdō* 'to get'), diphthongs (short *piezā* 'nest', long *lūomōz* 'animal', *aigō* 'time (PSg)') and triphthongs (short *kuoigīd* 'ship (NPl)', long *lūoima* 'warp'). There are also short consonants (*sadāb* 'it rains') and short and long geminate consonants (*katād* 'you (Sg) cover', *kattō* 'to cover') and consonant clusters (*katļā* 'cauldron', *katļō* 'cauldron (PSg)') in Livonian. Livonian orthography marks long vowels by placing a macron above the vowel (e.g. *pīla* 'cloud'). The half-long vowels in the second syllable are indicated as long, also with a macron, but they are not contrastively long.

The quantity system of Livonian has similarities with that of Estonian (Lehiste 1960; 1997). In Estonian, there are three different quantity degrees: short (Q1), long (Q2), and overlong (Q3). The characteristic ratios between the first and second syllable within a disyllabic foot are 2:3 for Q1, 3:2 for Q2, and 2:1 for Q3 (Lehiste 1960; Liiv 1961). Similar duration ratios have been found in Livonian disyllabic words (see above). The respective examples are for instance: Estonian *kada* (Q1) 'slingshot', *kata* (Q2) 'cover (Imp2Sg)', *katta* (Q3) 'to cover', *metsa* (Q2) 'forest (GSg)', *metsa* (Q3) 'forest (PSg)', Livonian *kadāg* 'juniper', *katāb* 'he/she covers', *kattō* 'to cover', *mōtsā* 'forest', *mōtsō* 'forest (PSg)'.¹ The first short syllable is followed by a half-long vowel in the second syllable, and a long syllable is followed by a half-long or short vowel in the second syllable.

The tonal system of Livonian has similarities with that of Latvian. Like Latvian, Livonian uses *stød* (broken tone) as one of its prosodic features (cf. Markusa 1991). The domain of the possible occurrence of *stød* is a long stressed syllable, where the syllable nucleus is a long vowel (diphthong or triphthong) or a short vowel (diphthong or triphthong) plus a voiced coda consonant (Lehiste, Teras, Ernštreits, Lippus, Pajusalu, Tuisk, Viitso 2008), e.g. *rō'dō* 'money (PSg)', *tō'tō* 'you (Pl) want', *jo'ugō* 'into river', *kuo'ig* 'ship', *ka'llō* 'fish (PSg)', *vie'ddō* 'to pull'. *Stød* in Livonian is phonologically contrastive, cf. *tī'edō* 'to do' vs *tīedō* 'work (PSg)', *pa'llō* 'to burn' vs *pallō* 'to ask, to beg'. In Livonian transcription, *stød* is marked with an apostrophe (*pū'dōz* 'clean').

Stød is often referred to as a period of laryngealization. However, younger speakers nowadays do not produce it (Lehiste, Teras, Ernštreits, Lippus, Pajusalu, Tuisk, Viitso 2008). Studies of Livonian prosody have also pointed to differences in fundamental frequency (F0) contours in words where *stød* is expected or is not expected. Lauri Posti (1937) differentiated rising tone on the first syllable (in words without *stød*) and broken tone (in words with *stød*), where F0 rises until the onset of *stød*, and then drops abruptly. Analysing Livonian polyphthongs, Hille Pajupuu and Tiit-Rein Viitso (1986) also found that the F0 peak occurs later in polyphthongs without *stød* and earlier in polyphthongs with *stød*, still remaining close to the beginning of

¹ These triplets are in a sense simplification. In Estonian short unvoiced and in Livonian short voiced plosives are spelt with letters *g*, *b*, *d*. Both in Estonian and Livonian *k*, *p*, *t* are short geminate plosives. In addition Livonian has voiced long geminate plosives (e.g. *sa'ddō* 'to rain').

the *stød* period. Lauri Kettunen (1937) has also mentioned that words where *stød* is not expected can be pronounced with falling tone. In words with a long first syllable (where *stød* is not expected), there is a late F0 peak when the second syllable vowel is half-long and an early F0 peak when the second syllable vowel is short (Lehiste, Teras, Ernštreits, Lippus, Pajusalu, Tuisk, Viitso 2008). In words where *stød* is expected, the location of the F0 peak varies, being late in words in phrase-final position and early in words in sentence-final position. Most recent findings on *stød* (Teras, Tuisk 2009) show that when speakers have to pronounce words in minimal pairs then the words where *stød* is expected are differentiated from words where *stød* is not expected first and foremost by laryngealization (it occurred in 87% of the words with *stød*) and by an early F0 peak (occurring in the first third of the syllable) followed by a fall in F0 (in words without *stød*, the turning point was late, being in the end of the first syllable).

The current article seeks answers to the following questions which concern the role of quantity and fundamental frequency in spontaneous Livonian:

- 1) What are the duration ratios in words with a long first syllable (consisting of voiced sounds) in spontaneous speech?
- 2) Is there any difference in pitch contours associated with differences in syllabic ratios?
- 3) Do pitch contours of words pronounced with and without *stød* differ with respect to the position of the F0 peak?

2. Material and method

The spontaneous speech of 5 female (born in 1880–1918) and 3 male speakers (born 1904–1921) was analysed. The speakers were recorded in 1972–1997. In the recordings they talk about their everyday life, work and family. The speakers are from 4 villages in the eastern part of the Livonian Coast: Kūolka, Vaid, Sīkrōg, Kuoštrōg. The five female speakers are PK (born in 1918, Vaid), KK (born in 1889, Kuoštrōg), PŠ (born in 1880, Kuoštrōg, born in Sīkrōg), EM (born in 1918, Vaid) and EŽ (born in 1914, Sīkrōg). The three male speakers are PD (born in 1909, Sīkrōg), JZ (born in 1904, Vaid) and VB (born in 1921, Kūolka).

An acoustic-phonetic analysis of the words extracted from spontaneous speech was carried out. The analysed material consisted of words selected on the basis of their sound structure and number of syllables. Disyllabic words with a long first syllable containing a half-long and short vowel in the second syllable were analysed (when the long syllable had a coda consonant, it was voiced). As these types are similar to the Estonian Q2 and Q3 words, and therefore we will refer to them as Q2 and Q3 words. Words with *stød* were also analysed (most of them were in Q3). The analysed material consisted altogether of 358 words. All words were in stressed sentence-initial and sentence-medial position. Some examples of the analysed words: *jālga* 'foot' : *jalgõ* 'foot (PSg)', *lēba* 'bread' : *leibõ* 'bread (PSg)', *nōļa* 'joke' : *naļļõ* 'joke (PSg)', *vī'mõ* 'rain (PSg)', *mie'rrõ* 'sea (IIIsg)'.

The recordings were analysed using the Praat software for speech analysis (Boersma, Weenink 2008–2009). The duration of all segments was measured. The duration of foot from the beginning of the first syllable nucleus to the

end of the second syllable nucleus was also measured. Syllable durations and duration ratios were calculated. When the first syllable (S1) is open, the syllable duration equals that of the syllable nucleus. When the syllable is closed, the duration of the coda consonant is added to the duration of the syllable nucleus. The second syllable (S2) duration equals the duration of the vowel in the second syllable. Fundamental frequency measurements were taken at the beginning and end of each syllable, and at the peak or turning point of the F0 curve within the first syllable. The location of the F0 peak relative to the beginning of the first syllable was also established and will be given in percentages.

3. Results and discussion

3.1. Duration in disyllabic words where stød was not expected

Average syllable durations, duration ratios of syllables and foot durations in disyllabic words where stød was not expected are given in Table 1. Q2 words (e.g. *rānda* 'shore', *võrõz* 'stranger') and Q3 words (e.g. *randõ* 'shore (PSg)', *võrõd* 'strangers (NPl)') were analysed separately.

Table 1

Average syllable durations (ms), duration ratios and foot durations (ms) in Q2 and Q3 words without stød (N — number of measurements, s.d. — standard deviation)

| Q2, without stød | | | | | | Q3, without stød | | | | | |
|------------------|------------|------------|-----------|-------------|------------|------------------|------------|------------|-----------|-------------|------------|
| Speaker | N | S1 | S2 | S1/S2 | foot | Speaker | N | S1 | S2 | S1/S2 | foot |
| PK | 9 | 218 | 101 | 2.29 | 381 | PK | 12 | 234 | 84 | 2.91 | 405 |
| s.d. | | 56 | 26 | 0.47 | 67 | s.d. | | 69 | 27 | 0.73 | 102 |
| KK | 9 | 250 | 90 | 2.89 | 340 | KK | 10 | 181 | 61 | 2.96 | 242 |
| s.d. | | 27 | 17 | 0.68 | 24 | s.d. | | 39 | 10 | 0.37 | 48 |
| PŠ | 15 | 205 | 76 | 2.67 | 331 | PŠ | 13 | 174 | 67 | 2.67 | 29 |
| s.d. | | 68 | 18 | 0.40 | 98 | s.d. | | 36 | 16 | 0.57 | 52 |
| EM | 9 | 203 | 117 | 1.91 | 373 | EM | 11 | 192 | 84 | 2.43 | 333 |
| s.d. | | 56 | 40 | 0.75 | 72 | s.d. | | 37 | 21 | 0.79 | 53 |
| EŽ | 22 | 191 | 83 | 2.36 | 325 | EŽ | 18 | 209 | 69 | 3.12 | 331 |
| s.d. | | 37 | 14 | 0.58 | 40 | s.d. | | 39 | 14 | 0.63 | 51 |
| PD | 12 | 259 | 99 | 2.62 | 419 | PD | 14 | 260 | 89 | 2.91 | 423 |
| s.d. | | 57 | 25 | 0.40 | 79 | s.d. | | 63 | 15 | 0.59 | 78 |
| JZ | 10 | 197 | 86 | 2.36 | 299 | JZ | 23 | 219 | 72 | 3.04 | 324 |
| s.d. | | 51 | 24 | 0.51 | 64 | s.d. | | 53 | 15 | 0.78 | 70 |
| VB | 24 | 205 | 96 | 2.19 | 361 | VB | 15 | 201 | 76 | 2.69 | 328 |
| s.d. | | 55 | 21 | 0.65 | 58 | s.d. | | 45 | 13 | 0.65 | 49 |
| Average | 110 | 216 | 94 | 2.41 | 354 | Average | 116 | 209 | 75 | 2.84 | 336 |
| | | 51 | 23 | 0.52 | 65 | | | 48 | 16 | 0.64 | 63 |

The duration ratio of the first and second syllable is 1.91–2.89 in Q2 words and 2.43–3.12 in Q3 words. Average duration ratio in Q2 words is 2.41 and in Q3 words 2.84. There is a considerable overlap of duration ratios of these two types of words.

Average syllable durations in Q2 words are 216 ms (S1) and 94 ms (S2) and average duration ratio is 2.41. In Q3 words average syllable durations

are 209 ms (S1) and 75 ms (S2), the average duration ratio is 2.84. The duration of the first syllable is almost identical in Q2 and Q3 words, but Q2 words have a longer S2 duration than Q3 words. The same tendency was shown by Lehiste, Teras, Ernštreits, Lippus, Pajusalu, Tuisk, Viitso 2008.

While analysing the speakers' pronunciation we noticed that in the speech of only four speakers there was a significant difference between the duration ratios of Q2 and Q3 words. An ANOVA shows that the difference is statistically significant at the $p = 0.05$ level (speaker PK), $p < 0.05$ (speakers JZ, VB), $p < 0.001$ (speaker EŽ). For 5 speakers there is also a significant difference between the duration of the second syllable vowel of Q2 and Q3 words ($p = 0.05$ (speaker JZ), $p < 0.05$ (speakers EM, VB, EŽ), $p < 0.001$ (speaker KK)). There is no significant difference between the duration of the first syllable of Q2 and Q3 words for any speaker (except the speaker KK who had a significantly longer S1 duration in Q2 words than in Q3 words).

We divided the speakers into two groups. One group consists of 5 speakers (PK, EŽ, EM, JZ and VB) who differentiated between Q2 and Q3 words, and the other group contains the three remaining speakers (KK, PŠ, PD) who did not differentiate between Q2 and Q3 words. In the first group, four speakers out of five (PK, EM, JZ, VB) were from adjacent villages in the easternmost part of the Livonian Coast. These speakers were also more or less related to one another. They all lived on the famous Livonian Zūonkõ farm in the beginning of the 20th century, where before the farm was sold in the 1930s, even four families could live together in the same household. One speaker (EŽ) came from the western part of the eastern Livonian Coast, but the fact that she differentiated Q2 and Q3 words can be explained with her background. Her mother was Estonian and the speaker is probably influenced by her mother's language. On the other hand three speakers (KK, PŠ, PD) in the second group were from the western part of the eastern Livonian Coast. Thus the geographical background of the speakers can explain the differences in the pronunciation of these two groups.

Because of the differences between the speakers we decided to separate the data and recalculate average durations and duration ratios for both groups of speakers. The results are presented in Table 2 and 3.

As can be seen from Table 2 the duration ratios are 2.22 (Q2 words) and 2.84 (Q3 words) for the first group (the difference is significant at the $p < 0.0001$ level). Thus, in Q3 words the duration ratio of syllables is considerably bigger (3:1) than in Q2 words (2:1) for the group that differentiates between Q2 and Q3 words. Average syllable durations are 203 ms and 97 ms in Q2 words and 211 ms and 77 ms in Q3 words. The duration of S1 in Q3 words is somewhat but not significantly longer than in Q2 words. However, the duration of S2 in Q3 words is significantly shorter ($p < 0.0001$) than in Q2 words.

For the second group the duration ratios are 2.73 (Q2 words) and 2.85 (Q3 words) (see Table 3). Average syllable durations are 238 ms and 88 ms in Q2 words and 205 ms and 72 ms in Q3 words. In the pronunciation of this group, Q3 words have on average even shorter duration than Q2 words; S2 duration is also shorter in Q3 than in Q2 words. However, there is no significant difference between the syllable durations and duration ratios of Q2 and Q3 words (except S2 duration).

Table 2

**Average syllable durations (ms), duration ratios
and foot durations (ms) in Q2 and Q3 words without stød, recalculated
(N — number of measurements, s.d. — standard deviation)**

| Q2, without stød | | | | | | Q3, without stød | | | | | |
|------------------|-----------|------------|-----------|-------------|------------|------------------|-----------|------------|-----------|-------------|------------|
| Speaker | N | S1 | S2 | S1/S2 | foot | Speaker | N | S1 | S2 | S1/S2 | foot |
| PK | 9 | 218 | 101 | 2.29 | 381 | PK | 12 | 234 | 84 | 2.91 | 405 |
| s.d. | | 56 | 26 | 0.47 | 67 | s.d. | | 69 | 27 | 0.73 | 102 |
| EŽ | 22 | 191 | 83 | 2.36 | 325 | EŽ | 18 | 209 | 69 | 3.12 | 331 |
| s.d. | | 37 | 14 | 0.58 | 40 | s.d. | | 39 | 14 | 0.63 | 51 |
| EM | 9 | 203 | 117 | 1.91 | 373 | EM | 11 | 192 | 84 | 2.43 | 333 |
| s.d. | | 56 | 40 | 0.75 | 72 | s.d. | | 37 | 21 | 0.79 | 53 |
| JZ | 10 | 197 | 86 | 2.36 | 299 | JZ | 23 | 219 | 72 | 3.04 | 324 |
| s.d. | | 51 | 24 | 0.51 | 64 | s.d. | | 53 | 15 | 0.78 | 70 |
| VB | 24 | 205 | 96 | 2.19 | 361 | VB | 15 | 201 | 76 | 2.69 | 328 |
| s.d. | | 55 | 21 | 0.65 | 58 | s.d. | | 45 | 13 | 0.65 | 49 |
| Average | 74 | 203 | 97 | 2.22 | 348 | Average | 79 | 211 | 77 | 2.84 | 344 |
| | | 51 | 25 | 0.59 | 60 | | | 49 | 18 | 0.72 | 65 |

Table 3

**Average syllable durations (ms), duration ratios
and foot durations (ms) in Q2 and Q3 words without stød, recalculated
(N — number of measurements, s.d. — standard deviation)**

| Q2, without stød | | | | | | Q3, without stød | | | | | |
|------------------|-----------|------------|-----------|-------------|------------|------------------|-----------|------------|-----------|-------------|------------|
| Speaker | N | S1 | S2 | S1/S2 | foot | Speaker | N | S1 | S2 | S1/S2 | foot |
| KK | 9 | 250 | 90 | 2.89 | 340 | KK | 10 | 181 | 61 | 2.96 | 242 |
| s.d. | | 27 | 17 | 0.68 | 24 | s.d. | | 39 | 10 | 0.37 | 48 |
| PŠ | 15 | 205 | 76 | 2.67 | 331 | PŠ | 13 | 174 | 67 | 2.67 | 299 |
| s.d. | | 68 | 18 | 0.40 | 98 | s.d. | | 36 | 16 | 0.57 | 52 |
| PD | 12 | 259 | 99 | 2.62 | 419 | PD | 14 | 260 | 89 | 2.91 | 423 |
| s.d. | | 57 | 25 | 0.40 | 79 | s.d. | | 63 | 15 | 0.59 | 78 |
| Average | 36 | 238 | 88 | 2.73 | 363 | Average | 37 | 205 | 72 | 2.85 | 322 |
| | | 51 | 20 | 0.49 | 67 | | | 46 | 14 | 0.51 | 59 |

There is a tendency towards foot isochrony in Livonian. This is an important aspect which is similar to Estonian. Like in Estonian, a longer first syllable is followed by a shorter second syllable, and vice versa, resulting in approximately equal durations of S1 + S2 and S3 + S4 sequences (Ross, Lehiste 2001). Figure 1 illustrates the relationships between the two syllables of disyllabic words.

Q2 and Q3 words have almost the same foot durations. The pronunciation of the speakers PK, EŽ and JZ shows a clear trend according to which when the first syllable duration increases the second syllable duration decreases. In the pronunciation of the speakers EM and VB, Q2 and Q3 words have an almost equal duration of S1, but the duration of S2 is considerably longer in Q2 than in Q3 words. In the pronunciation of the second

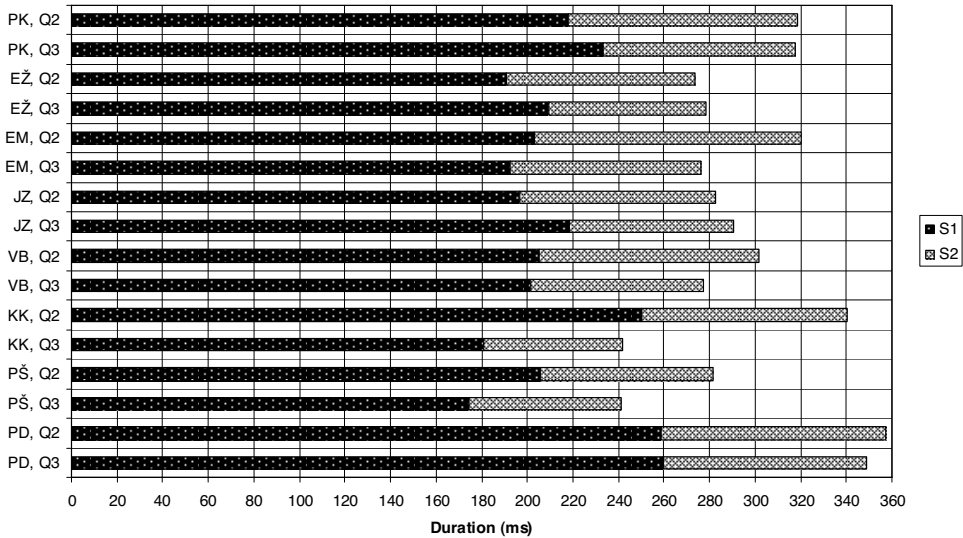


Figure 1. Foot isochrony. Average S1 and S2 durations in Q2 and Q3 words of all the speakers.

group the duration of S1 in Q2 words can be even longer than in Q3 words (speakers KK and PŠ).

3.2. Duration in disyllabic words where stød was expected

We also tried to find Q2 and Q3 words where stød is expected. Unfortunately only a few words in Q2 could be found in the data (which is due to using spontaneous speech). However, previous analysis of read speech has shown that stød-words also have a smaller duration ratio in Q2 than in Q3 (Lehiste, Teras, Ernštreits, Lippus, Pajusalu, Tuisk, Viitso 2008).

Average syllable durations, duration ratios of syllables and foot durations in disyllabic words where stød was expected are given in Table 4. Some examples of analysed words: *mō'zō* 'land (Ill.Sg.)', *nā'dō* 'to see', *si'ņņi* 'blue'.

Compared to words where stød is not expected, words where stød is expected have a shorter first syllable (186 ms compared to 211 and 205 ms, see Table 2 and 3). Previous studies have also shown similar results (cf. Lehiste, Teras, Ernštreits, Lippus, Pajusalu, Tuisk, Viitso 2008; Teras, Tuisk 2009). The duration ratio is also somewhat smaller in Q3 words where stød was expected (2.60) than in Q3 words where stød was not expected (2.84 and 2.85). The average duration of the laryngealization period varied between 28–67 ms. Laryngealization occurred only in 36% of words where stød was expected (speakers KK and PD did not produce stød). Compared to our earlier study (Teras, Tuisk 2009) on stød this is much less than in a speech situation where speakers have to pronounce minimal pairs where stød differentiates the meaning of the word. In this situation laryngealization occurred in 87% of the analysed words (one of the speakers (PK) was same in both research). In the spontaneous speech, it is the context

Table 4

**Average syllable durations (ms), duration ratios
and foot durations (ms) in Q3 words with stød**
(N — number of measurements, s.d. — standard deviation)

| Speaker | N | S1 | S2 | S1/S2 | foot |
|----------------|------------|------------|-----------|-------------|------------|
| PK | 10 | 182 | 76 | 2.47 | 327 |
| s.d. | | 23 | 16 | 0.44 | 30 |
| KK | 8 | 148 | 57 | 2.70 | 205 |
| s.d. | | 25 | 12 | 0.71 | 32 |
| PŠ | 18 | 166 | 67 | 2.46 | 287 |
| s.d. | | 34 | 21 | 0.68 | 50 |
| EM | 12 | 175 | 76 | 2.48 | 291 |
| s.d. | | 43 | 20 | 0.93 | 51 |
| EŽ | 32 | 185 | 73 | 2.65 | 309 |
| s.d. | | 45 | 17 | 0.74 | 60 |
| PD | 13 | 231 | 96 | 2.53 | 382 |
| s.d. | | 49 | 25 | 0.71 | 63 |
| JZ | 16 | 208 | 73 | 2.85 | 295 |
| s.d. | | 56 | 18 | 0.36 | 88 |
| VB | 23 | 190 | 73 | 2.66 | 315 |
| s.d. | | 22 | 13 | 0.56 | 30 |
| Average | 132 | 186 | 74 | 2.60 | 301 |
| | | 37 | 18 | 0.64 | 51 |

that aids the understanding of the meaning of the word and the speaker needs not to produce all phonetic features characteristic of the words with stød. Similarly, in words with stød pronounced in frame sentences, laryngealization is not produced in all words and not by all speakers (Lehiste, Teras, Ernštreits, Lippus, Pajusalu, Tuisk, Viitso 2008).

3.3. Fundamental frequency of disyllabic words

We will next look at the fundamental frequency contours of disyllabic words. Average F0 values in the beginning and end of the first and second syllable and F0 turning point (peak) in the first syllable and its location relative to the duration of the first syllable (in %) are given in Table 5 (Q2 words) and in Table 6 (Q3 words).

Table 5

Fundamental frequency (in Hz) in disyllabic Q2 words without stød

| Speaker | N | S1 | | | | S2 | |
|---------------|-----------|--------------|------------|-----------|------------|--------------|------------|
| | | F0 beginning | F0 peak | % | F0 end | F0 beginning | F0 end |
| Female | 64 | 206 | 256 | 82 | 242 | 234 | 201 |
| s.d. | | 32 | 48 | 13 | 47 | 47 | 40 |
| Male | 46 | 148 | 168 | 70 | 163 | 155 | 140 |
| s.d. | | 24 | 27 | 14 | 27 | 22 | 21 |

Table 6

Fundamental frequency (in Hz) in disyllabic Q3 words without stød

| Q3 without stød, late peak | | | | | | | |
|-----------------------------|-----------|--------------|------------|-----------|------------|--------------|------------|
| Speaker | N | S1 | | | | S2 | |
| | | F0 beginning | F0 peak | % | F0 end | F0 beginning | F0 end |
| Female | 42 | 225 | 265 | 77 | 249 | 238 | 205 |
| s.d. | | 33 | 38 | 13 | 33 | 40 | 41 |
| Male | 29 | 142 | 173 | 79 | 165 | 161 | 147 |
| s.d. | | 22 | 19 | 17 | 18 | 20 | 20 |
| Q3 without stød, early peak | | | | | | | |
| Speaker | N | S1 | | | | S2 | |
| | | F0 beginning | F0 peak | % | F0 end | F0 beginning | F0 end |
| Female | 22 | 224 | 229 | 23 | 200 | 191 | 176 |
| s.d. | | 32 | 40 | 17 | 33 | 34 | 29 |
| Male | 23 | 160 | 170 | 27 | 152 | 141 | 127 |
| s.d. | | 26 | 30 | 16 | 32 | 26 | 23 |

Q2 words where stød was not expected have a late F0 peak occurring on average at 70–82% of the total duration of the first syllable (see Table 4). The analysis of such words revealed that the actual F0 peak can occur during the onset of the second syllable or even in the beginning of the second syllable vowel.

Q3 words had two kinds of peak locations (see Table 6). According to the F0 results two different groups of words emerged. In 61% of the analysed Q3 words there was a late F0 peak (at 77–79%) as in Q2 words. However, in 39% of the analysed Q3 words the F0 peak was early occurring in the first third of the first syllable (at 23–27%). The same tendency was noticed by Lehiste, Teras, Ernštreits, Lippus, Pajusalu, Tuisk, Viitso 2008. The location of the F0 peak varied both in phrase-final and sentence-final position.

Average F0 values and the location of F0 turning point in the words where stød was expected are given in Table 7.

Table 7

Fundamental frequency (in Hz) in disyllabic Q3 words with stød

| Q3 stød, late peak | | | | | | | |
|---------------------|-----------|--------------|------------|-----------|------------|--------------|------------|
| Speaker | N | S1 | | | | S2 | |
| | | F0 beginning | F0 peak | % | F0 end | F0 beginning | F0 end |
| Female | 23 | 207 | 263 | 66 | 235 | 229 | 207 |
| s.d. | | 33 | 66 | 10 | 52 | 48 | 35 |
| Male | 12 | 158 | 184 | 61 | 166 | 165 | 159 |
| s.d. | | 21 | 23 | 7 | 21 | 23 | 26 |
| Q3 stød, early peak | | | | | | | |
| Speaker | N | S1 | | | | S2 | |
| | | F0 beginning | F0 peak | % | F0 end | F0 beginning | F0 end |
| Female | 57 | 232 | 244 | 27 | 195 | 207 | 194 |
| s.d. | | 34 | 49 | 14 | 36 | 33 | 38 |
| Male | 40 | 155 | 166 | 34 | 139 | 140 | 134 |
| s.d. | | 24 | 27 | 14 | 25 | 19 | 17 |

Similar to Q3 words where *stød* was not expected also words where *stød* was expected could have a peak in the second half or in the first half of the first syllable. However, even when the peak was late (in 27% of the analysed words), it tended to occur earlier (at 61–66%) than in Q3 words where *stød* was not expected (at 77–79%). In most of cases (in 73% of the analysed words) Q3 words with *stød* had an early peak occurring at 27–34% of the total duration of the first syllable. 74% of the words with *stød* where laryngealization period was not produced still had an early F0 peak. Among the speakers who did not produce laryngealization, the speaker PD had an early F0 peak in all and the speaker KK in most of the *stød* words.

According to the results of (Lehiste, Teras, Ernštreits, Lippus, Pajusalu, Tuisk, Viitso 2008), again, a similar trend appeared also in words with *stød*. Words with a long open first syllable and a short second syllable vowel had a late F0 peak in phrase-final position (both in words where *stød* was realised and where it was not realised). In sentence-final position, these words were pronounced with an early F0 peak. Unlike the words where *stød* was not expected, there were no productions with a late F0 peak in sentence-final position.

As already said before, in our material there were no Q2 words where *stød* was expected. Still, Q2 words without *stød* always had a late peak. It is difficult to explain the variation of the F0 peak location in Q3 words (both with and without *stød*). This could be explained either by a large variation in spontaneous speech or the influence of utterance-level intonation. When we look at the Q3 words with an early F0 peak it is expected for the words with *stød* to have an early F0 peak in most cases.

Figure 2 illustrates F0 movement in Q3 words with a late peak. It can be seen that the F0 peak is considerably earlier in words pronounced with *stød* (66 and 61% vs. 77 and 79%). This figure shows that even under the influence of utterance-level intonation the words pronounced with *stød* still have a different F0 peak location than words without *stød*. This finding confirms the stability and importance of the Livonian broken tone in Livonian prosody. In the case of Q3 words with an early peak, words where *stød* was expected were in majority.

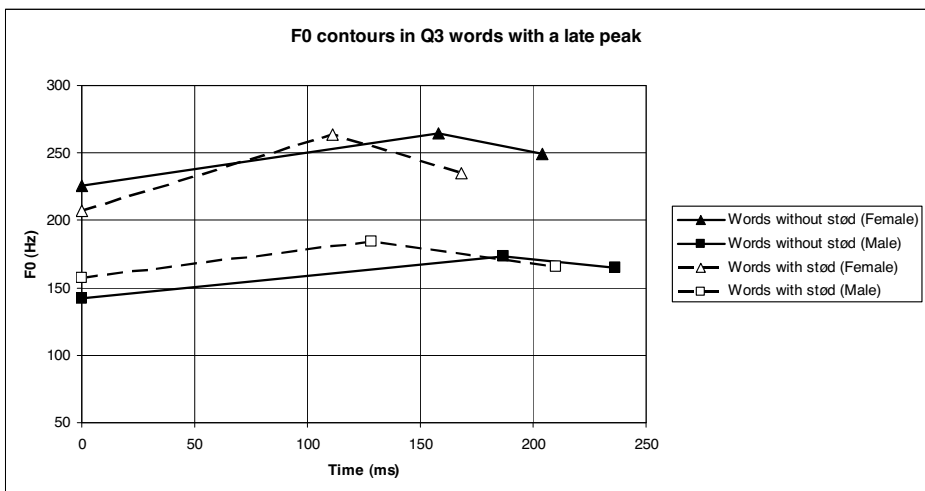


Figure 2. F0 contours in Q3 words with and without *stød*.

4. Conclusions

The main aim of this paper was to give an overview of the role of duration ratios and fundamental frequency in spontaneous Livonian. The results of the analysis described in the present paper indicate that the prosodic structure of disyllabic Livonian words with a long first syllable (consisting of voiced sounds) resembles in some respect that of Estonian disyllabic Q2 and Q3 words. However, some differences in realising these two quantities could also be found.

The speakers could be divided into two groups according to syllable duration ratios. One group of speakers (KK, PŠ, PD) did not differentiate Q2 and Q3 words: Q2 – 2.73, Q3 – 2.85. The other group (PK, EM, EŽ, JZ, VB) did differentiate these two types of words. Duration ratio was 2.22 in Q2 words (longer S2 duration), and 2.84 in Q3 words (shorter S2 duration). The duration of the first syllable did not differ significantly in these two quantities. Like Estonian Livonian is also characterised by foot isochrony.

Words where *stød* is not expected have a late F0 peak in Q2 (at 70–82%). In most of the cases the peak is also late in Q3 words (at 77–79%). However, in these words the peak can also occur earlier (at 23–27%). Q3 words where *stød* is expected are characterised above all by an early F0 peak occurring in the first third of the first syllable. Even when the peak occurs later, it is still earlier (at 61–66%) than the late peak in the Q3 words where *stød* is not expected. In spontaneous speech, laryngealization is rare in *stød* words (it occurred in 36% of the words). However, *stød* words without laryngealization also tend to have an early F0 peak.

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REFERENCES

- Boersma, P., Weenink D. 2008–2009, Praat 4.4–5.1 [Computer program].
<http://www.praat.org/>.
- Kettunen, L. 1937, *Vielä liivin kielen intonaatioista*. – *Vir.*, 313–317.
- Lehiste, I. 1960, Segmental and Syllabic Quantity in Estonian. – *American Studies in Uralic Linguistics*, Bloomington (UAS 1), 21–82.
- Lehiste, I. 1997, Search for Phonetic Correlates in Estonian Prosody. – *Estonian Prosody: Papers from a Symposium*, Tallinn, 11–35.
- Lehiste, I., Teras, P., Pajusalu, K., Tuisk, T. 2007, Quantity in Livonian: Preliminary Results. – *LU XLIII*, 29–44.

- Lehiste, I., Teras, P., Ernštreits, V., Lippus, P., Pajusalu, K., Tuisk, T., Viitsõ, T.-R. 2008, *Livonian Prosody*, Helsinki (MSFOu 255).
- Liiv, G. 1961, Eesti keele kolme vältusastme vokaalide kestus ja meloodiatüübid. — *KK*, 412–424, 480–490.
- Markusa, D. 1991, Syllable Tonemes in Latvian. — *Proceedings of the XIIth International Congress of Phonetic Sciences, August 19–24, 1991, Aix-en-Provence, France, Volume 2/5*, 242–245.
- Pajupu, H., Viitsõ, T.-R. 1986, *Livonian Polyphthongs*. — *Estonian Papers in Phonetics 1984–1985*, Tallinn, 96–130.
- Posti, L. 1937, *Lisää liivin intonaatioista*. — *Vir.*, 189–200, 263.
- Ross, J., Lehiste, I. 2001, *The Temporal Structure of Estonian Runic Songs*, Berlin–New York.
- Teras, P., Tuisk, T. 2009, *The Characteristics of Stød in Livonian*. — *Nordic Prosody. Proceedings of the Xth Conference, Helsinki 2008, Frankfurt am Main–Berlin–Bern–Bruxelles–New York–Oxford–Wien*, 217–226
- Vihman, M. M. 1971, *Livonian Phonology, with an Appendix on Stød in Danish and Livonian*. Dissertation Submitted in Partial Satisfaction of the Requirements for the Degree of Doctor of Philosophy in Linguistics in the Graduate Division of the University of California, Berkeley (MS).
- Viitsõ, T.-R. 1981, *Läänemeresoome fonoloogia küsimusi*, Tallinn.
- 2008, *Liivi keel ja läänemeresoome keelemaastikud*, Tartu–Tallinn.
- Wiik, K. 1989, *Liivin katko*, Turku.

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ДЛИТЕЛЬНОСТЬ И ОСНОВНОЙ ТОН В СПОНТАННОЙ ЛИВСКОЙ РЕЧИ

Статья посвящена изучению просодии слова в ливском языке, в ней представлен обзор соотношения длительностей и основного тона. В основу акустико-фонетического анализа положены записи спонтанной речи 8 информантов. Результаты измерений рассматривались соответственно их роли в просодической структуре ливского языка. Прежде всего обращается внимание на количество и тон, а также на фонетическую реализацию. Анализировались слова с долгим первым слогом (в нем были звонкие звуки), во втором слоге которых встречался полудолгий или краткий гласный. На основе соотношения длительностей выделены две группы информантов — одни различали слова, похожие на эстонские слова со второй и третьей степенями долготы, другие их не различали. Слова с прерывистым тоном отличались от слов с постоянным тоном прежде всего пиком основного тона.