Broken tone in Leivu and Livonian

Pire Teras[1], *Tuuli Tuisk*[123]

[1]University of Tartu, Estonia
[2]University of Copenhagen, Denmark
[3]University of Latvia, Latvia
pire.teras@ut.ee, tuuli.tuisk@ut.ee

Abstract

This paper focuses on the phonetic realisation of the broken tone in the highly endangered Finnic languages – Leivu and Livonian. An investigation of the temporal and tonal characteristics of words with the plain tone and broken tone consisting of a long first syllable and a short second syllable in spontaneous speech was carried out. The changes in pitch alignment, durations, and duration ratios of the syllables in disyllabic words were analysed and the role of intensity was studied. The analysis revealed a difference in the observed acoustic characteristics in words with either plain tone or broken tone. Also, differences between Leivu and Livonian were observed. With respect to tonal characteristics, two distinct patterns are evident. In words with broken tone, the pitch peak in the primary-stressed syllable is earlier, while in words with plain tone the peak is late. In Livonian, the duration of the syllable nucleus is slightly shorter in broken tone words than in plain tone words, in Leivu it can be longer.

Index Terms: broken tone, plain tone, fundamental frequency, duration, intensity, Leivu, Livonian, Finnic languages

1. Introduction

The languages around the Baltic Sea form an interesting linguistic area where the Indo-European and Finno-Ugric languages meet. Among these languages, Livonian, some South Estonian dialects, Latvian, Lithuanian, and Danish share a similar feature in their pronunciation, which is described using different terms and has different origins depending on the particular language.

The Danish term "stød" is central in Danish phonology (e.g., [1]) and has also been used to describe the similar features found in Livonian [2] and the South Estonian Leivu and Lutsi dialects historically spoken in Latvia [3], [4], where it is also referred to as the broken tone and marked with an apostrophe (e.g., Livonian *kuo'ig* 'ship').

In Danish, stød has traditionally been characterised as a kind of creaky voice, i.e., non-modal voice with aperiodic and irregular amplitude, often accompanied by a fundamental frequency (F0) perturbation, and an abrupt and brief dip in F0 (e.g., [5]). Danish stød has also been explained by phonation type as a brief dynamic voice quality movement in the direction of more compressed voice and back to modal voice, rather than involving a specific voice quality such as creak [6].

Similar phenomena have been described in the contact language of Leivu and Livonian – Latvian, a Baltic language – where syllable tones are an important part of the prosodic system. Standard Latvian is described as having three syllable tones or intonations in long syllables – level or drawling, falling, and broken (e.g., [7], [8], [9], [10]). There is a great variation in Latvian dialects with a tendency towards replacing the broken tone with falling tone and to combine the falling and the drawling tones into a single level tone. The other living Baltic language, Lithuanian, is described as having two contrastive tones (e.g., [11], [12]). There is a distinction between (1) a sharp acute tone and (2) a circumflex tone. The distinction between tones is clearest in the western part of Lithuania, especially in the Northern Žemaitian dialects, where the main acute tone is realised as a broken tone.

Both the South Estonian Leivu dialect and Livonian were spoken in Latvia (see Figure 1 [13]).

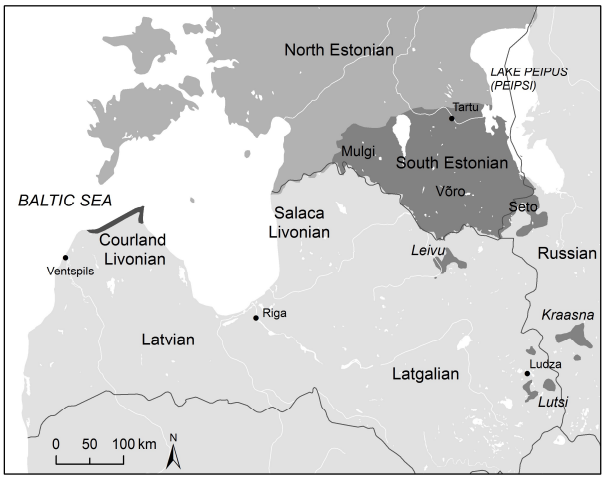

Figure 1: *Leivu and Livonian areas in Latvia* (map: Timo Rantanen [13])

The South Estonian Leivu dialect represents one of three South Estonian language islands – Leivu, Lutsi, Kraasna (Figure 1). These are historically South Estonian-speaking regions located beyond the borders of Estonia [14]. They were geographically separated from the main body of South Estonian speakers for at least several centuries. Two of these communities – Leivu and Lutsi – were located in present-day Latvia. The third community – Kraasna – was located just a short distance across the present-day border in Russia. Both Leivu and Lutsi existed in relatively diverse linguistic environments. Leivu was spoken in northeastern Latvia. The Leivus lived in contact with speakers of the local Latvian subdialects and also show traces of possible contact with Livonian – an ancient Finnic language indigenous to Latvia, which was historically spoken across vast territories in Latvia around the Gulf of Rīga. After becoming gradually Latvian-speaking, and following wars and pandemics, only two small

10.21437/TAI.2021-6

Livonian-speaking areas remained in Latvia. One of these – Vidzeme or Salaca Livonian – was located on the eastern shore of the Gulf of Rīga. The other – Kurzeme or Courland Livonian – was spoken on the Livonian Coast in northwestern Latvia.

Broken tone or stød is one of the innovations that the Leivu and Lutsi South Estonian dialects share with Livonian [3], [15]. The question of the phonological and phonetic nature of the broken tone is related to the question of its origin. In case of both Leivu and Livonian, it has been suggested that broken tone, for example, arose as a reflex of lost intervocalic /h/ (e.g., [3], [15], [16], [17]), e.g., Livonian *raha* > *rǭ'* [rɔːˀ] 'money', Leivu *raha* > *ra'a* [rɑːːˀ] 'money'. The influence of Latvian broken tone has also been noted [18].

According to Viitso [15, p. 278], in Leivu, /h/ was "substituted with stød mostly in illative forms of monosyllabic vocalic stems and in stems where ***h*** occurred between identical vowels". Broken tone in Leivu has been described as a prosodic change in progress [19]: in most of cases, /h/ has been lost; however, in some cases no loss of /h/ occurs and /h/ is pronounced as voiced. It appears that such a loss can result in minimal pairs, e.g., *maa* [mɑːː] (plain tone, Q3[1]) 'land' vs. *maha* > *ma'a* [mɑːːˀ][2] (broken tone, Q3) 'land, sg.ill; down'. The acoustic phonetic analysis of Leivu CV'V-words has shown that compared to CVV-words, broken tone words are characterised by (1) a more consistent early F0 turning point (TP), (2) a somewhat longer duration of syllable nucleus, (3) in almost all cases a short (slight fall and rise) or sharp drop in intensity, and in some cases (4) by laryngealisation of the final part of the syllable nucleus [19].

In Livonian word prosody, stød is also referred to as the broken tone and is described as contrasting with the plain tone. Livonian broken tone is a phonological unit, which on the suprasegmental level has specific characteristics. The most typical aspects are (1) an early location of the F0 TP and intensity turning point within the primary-stressed syllable of the word [20], (2) a characteristic rising-falling shape of the pitch contour [21], [22], (3) a decrease in primary-stressed syllable duration [20], (4) laryngealisation [16], [20], and (5) an irregular intensity contour [23]. It has also been proposed that Livonian broken tone is the phonetic manifestation of a HL tonal pattern compressed within one syllable [24]. It has been suggested that not only the syllable carrying broken tone but also the following syllable might cue the difference between words with broken and plain tone. A significant decrease of the S2 duration has been observed in the case of Livonian spontaneous speech [23].

2. Aims, materials, and methods

While Livonian broken tone is rather well studied, there is insufficient research on Leivu broken tone. There also has been no previous experimental phonetic comparative research on the broken tone in Livonian and Leivu. The current paper focuses on the acoustic analysis of CV'VCV- and CVVCV-words in the South Estonian Leivu dialect and Courland Livonian, e.g., Leivu *ra'aga* [rɑːːˀkɑ] 'money, sg.com', *poiga* [poiːkɑ] 'son, sg.prt', Liv *rǭ'dõ* [rɔːˀdə] 'money, sg.prt', *mǭdõ* [mɔːdə] 'land, sg.prt' (the number of analysed words is given in Table 1).

The aim is to determine the acoustic phonetic characteristics of both word types. The research questions are as follows:

(1) what are the most dominant characteristics of broken tone in both languages,

(2) how does broken tone differ between the two languages.

The data from the spontaneous speech of 3 male speakers of Leivu (born in 1867, 1901, and 1906) and 3 male speakers of Livonian (born in 1905, 1909, and 1921) was analysed. Nowadays, Livonian is not actively spoken anymore and Leivu is not spoken at all. For that reason, old tape recordings made between the 1950s and 1980s were used; the recordings are found in two Estonian archives: the University of Tartu Archives of Estonian Dialects and Kindred Languages[3] and the Archive of Estonian Dialects and Finno-Ugric Languages at the Institute of the Estonian Language[4].

There are some limitations due to the materials. In the case of Leivu, disyllabic broken tone words originally were trisyllabic Q1 words with an intervocalic short voiced /h/, e.g., *rahaga* [rɑ.ḫɑˑkɑ] (Q1) 'money, sg.com'. The loss of /h/ has resulted in disyllabic broken tone words (Q3), e.g., *ra'aga* [rɑːːˀkɑ] 'money, sg.com'. It is known from Estonian spontaneous speech, that mono- and disyllabic words are most common (85%) and that 10% of all words are trisyllabic (see Figure 4.10 in [25]). The smaller percentage of trisyllabic words in spontaneous speech could explain why there were only five examples of originally trisyllabic CV'VCV words available in the analysed recordings of Leivu speakers.

Table 1: *The number of analysed words.*

Words	**Leivu**	**Livonian**
Plain tone	44	79
Broken tone	5	57
Total	**49**	**136**

The words were acoustically analysed using Praat [26]. The duration of all segments and fundamental frequency from the beginning and end of the first and second syllable vowel and from the turning point where F0 starts to fall were measured and statistically analysed. The location of the F0 turning point was calculated as the percent of the V1 duration. Observations about intensity contours and laryngealisation were also made. No average was taken for Leivu broken tone tokens.

3. Results and discussion

3.1. Duration

Previous research has shown that in Livonian, long primary-stressed syllables are generally shorter in duration in broken tone words than in plain tone words (e.g., [27]). In Leivu, the opposite has been shown [19]. The current results reveal the similar difference between these two languages (see Figure 2).

[1] Like Estonian, Leivu is also characterised by three quantities (referred to as Q1, Q2, and Q3) [4]. Q3 is marked with (additional) [ː].

[2] Teras [19] has used [ˀ] in between vowels to mark broken tone (e.g., *ra'a* [rɑˑˀɑ]), but in this paper transcription used for Livonian is followed and the broken tone mark [ˀ] is put after the length mark.

[3] https://murdearhiiv.ut.ee/

[4] http://emsuka.eki.ee/

While in Livonian, the duration of the first syllable nucleus is slightly shorter in broken tone words than in plain tone words (223 ms vs. 208 ms), in Leivu, it can be longer (170–248 ms in broken tone words vs. 223 ms in plain tone words).

A one-way ANOVA showed that the difference between the duration of V1 in Livonian broken tone and plain tone words is not statistically significant (F (df=1, 134) = 1.98, p = 0.16). There was also no statistically significant difference for each speaker individually (F (df=1, 27) = 0.36, p = 0.55; F (df=1, 51) = 2.49, p = 0.12; F (df=1, 52) = 3.32, p = 0.08).

In Livonian, a durational difference was also detected for V2: it is shorter in broken tone words than in plain tone words (64 ms vs. 80 ms). There is no such tendency in Leivu. The ANOVA showed that the difference between the duration of V2 in Livonian broken tone and plain tone words is statistically significant (F (df=1, 134) = 26.65, p < 0.0001). However, analysing the speakers separately, it appears that the difference is significant for two speakers (F (df=1, 51) = 21.21, p < 0.0001; F (df=1, 52) = 10.14, p < 0.05), but not for one speaker (F (df=1, 27) = 1.01, p = 0.32).

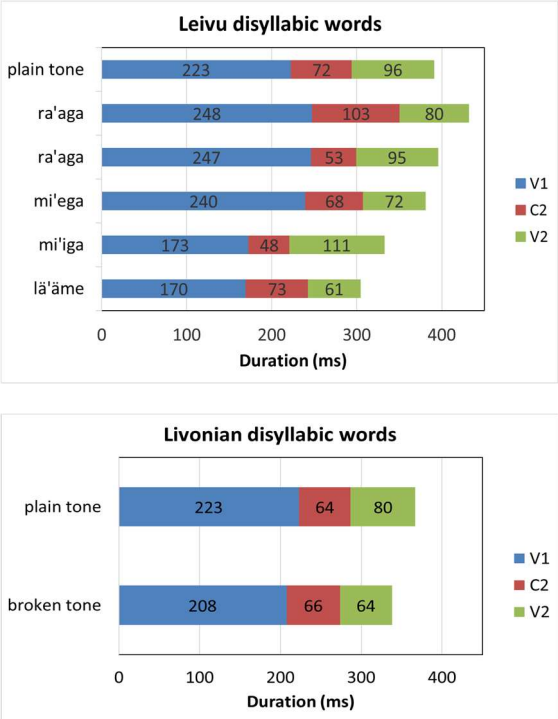

Figure 2: *Duration (in ms) in Leivu (above) and Livonian (below) plain tone words and broken tone words.*

3.2. Fundamental frequency

The results reveal that in Leivu and Livonian the most dominant and stable characteristic of broken tone is an early F0 turning point (TP) in the primary-stressed syllable (see Figure 3). In Leivu broken tone words, there was an early F0 TP occurring at 12–35% of the duration of V1. In plain tone words, there was also almost always an early TP occurring at 27%. However, in 18% of analysed tokens there was a late F0 TP occurring at 68% of the V1 duration.

The F0 TP in Livonian broken tone words was at 49% and in the plain tone words at 83% of the V1 duration. In Livonian plain tone words, the turning point was occasionally in the consonant between the S1 and S2 vowel or at the beginning of the S2 rhyme. Two contrastive overall F0 movements occur more consistently in the case of Livonian.

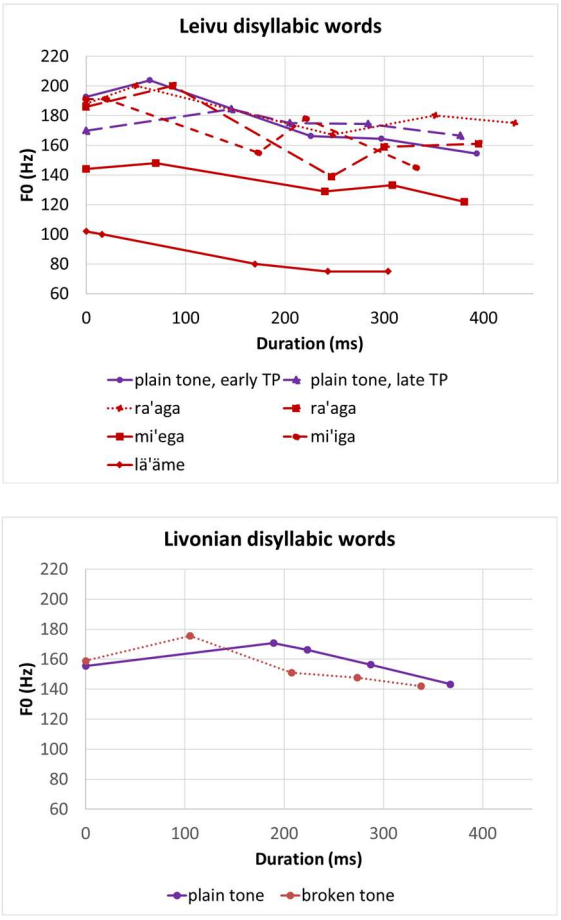

Figure 3: *F0 (in Hz) in Leivu and Livonian plain tone words (solid line) and broken tone words (dotted line).*

Table 2: *Average F0 values and standard deviations (in Hz) at the beginning and end of the V1 and V2 (V1b, V1e, V2b, V2e), and at the turning point (TP), and the location of the turning point (%).*

Leivu	**N**	**V1b**	**TP**	**%**	**V1e**	**V2b**	**V2e**
Plain tone	36	193	204	27	166	165	154
		34	44	13	46	45	43
Broken tone	5	162	168	21	134	145	136
		39	44	11	34	43	39
Livonian							
Plain tone	79	156	171	83	166	156	143
		32	36	17	41	34	36
Broken tone	57	159	176	49	151	148	142
		33	40	21	34	33	35

Studies on Danish stød have shown that the only constant and ever-present acoustic property of stød is a higher F0 at the onset of the syllable (e.g., [28]). As for Livonian, a similar

property has been found in read speech (e.g., [17]). Such tendency is not observed in the current average results of Livonian (Table 2). The average onset F0 values in plain tone words and broken tone words are similar (156 Hz and 159 Hz) and there is no statistically significant difference (F (df=1, 134) = 0.40, p = 0.5). However, there is a variation between the Livonian speakers. F0 at the onset of the primary-stressed syllable in broken tone words was slightly lower in the pronunciation of one Livonian speaker. The tendency for F0 to be higher at the beginning of V1 in broken tone words than in plain tone words has also been found in Leivu monosyllabic words [19], but in disyllabic words there is no such tendency (plain tone words with an early F0 TP 193 Hz, broken tone words 162 Hz, see Table 2).

3.3. Intensity and laryngealisation

The role of intensity is emphasised in studies focusing on the broken tone in Leivu and Livonian. Broken tone words are characterised by an irregular intensity contour within the S1 rhyme, while in words with plain tone the intensity alignment is more stable. As regards the current study, the overall intensity contour is irregular mostly in Livonian.

Figure 4 shows examples from Leivu and Livonian: Leivu *rahaga > ra'aga* [rɑːˀɑkɑ] 'with money' and Livonian *mǭ'zõ* [mɔːˀzə] 'down'. A short drop in intensity during the V1 can be observed both in Leivu and Livonian.

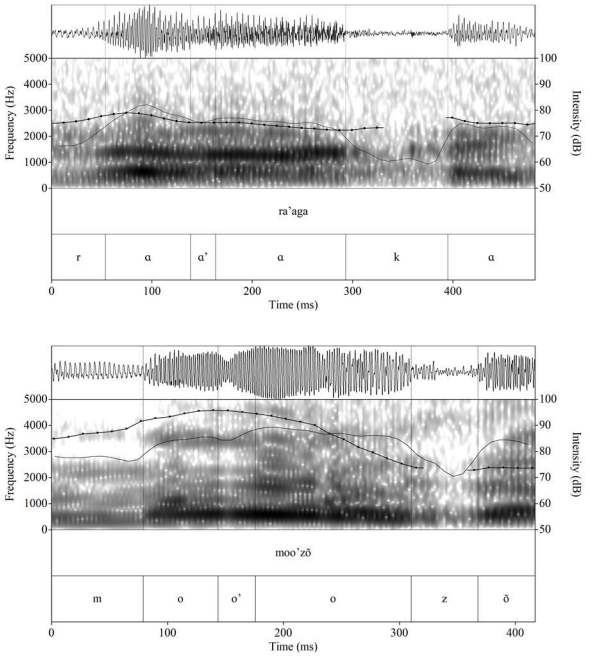

Figure 4: *Leivu* ra'aga [rɑːˀɑkɑ] *'money, sg.com' pronounced with broken tone by speaker PM (above). Livonian* mǭ'zõ [mɔːˀzə] *'down' pronounced with broken tone by Speaker JZ (below). F0 – dotted line (scale 60–300 Hz), intensity – solid line.*

Laryngealisation or creaky voice is considered to be the main characteristic of Danish stød (e.g., [29]). It has also been given as one of the characteristics of Latvian and Lithuanian broken tone [9], [12]. As for Livonian, laryngealisation occurs more in read speech than in spontaneous speech [2]. The current analysis shows that laryngealisation was present in less than a half of the Livonian broken tone words. Out of three Livonian speakers, laryngealisation was detected less in the pronunciation of one speaker. The duration of laryngealisation varied between 19–137 ms, with an average duration of 58 ms. In Leivu broken tone words, a short drop and rise or sudden drop in intensity during the stressed syllable nucleus occurred. Laryngealisation was present in four accented words occurring mainly in the final part of V1 (duration 73–130 ms, average duration 108 ms), while in one word the whole V1 was laryngealised.

The process and materials of the current study show that it is somewhat difficult to provide any definite conclusions on the phonological status of the broken tone in Leivu. The lack of sufficient amount of test words makes it impossible to claim that broken tone has the same role in Leivu as in Livonian. Nevertheless, the assumption that this is an example of a prosodic change in progress [16] seems to be the appropriate description for the situation of the broken tone in Leivu.

4. Conclusions

Together with Latvian, Lithuanian, and Danish, the South Estonian Leivu dialect and Livonian belong to a group of languages around the Baltic Sea, which form an interesting linguistic region where the Indo-European and Finno-Ugric languages interact. These languages share a similar feature in their pronunciation – broken tone or stød. This particular characteristic is described using different terms, having various properties and different origins depending on the particular language. Nevertheless, there are some overlapping acoustic characteristics of this phenomenon.

According to the results of the current study, the following conclusions can be made for Leivu and Livonian:

- The most dominant shared characteristic of broken tone in Leivu and Livonian is an early F0 turning point in the primary-stressed syllable.
- In Livonian, the characteristic F0 movement and irregular intensity contour occur more consistently than in Leivu.
- While in Livonian the duration of the first syllable nucleus is slightly shorter in broken tone words than in plain tone words, in Leivu it can be longer.
- In Livonian, the V2 is shorter in duration in broken tone words. There is no such tendency in Leivu.
- In Livonian, laryngealisation occurred in less than half of cases, in Leivu it occurred in four accented words, but not in one deaccented word.

This study leaves several options open for the future research. While in Livonian the role of the broken tone is better described, additional research material is needed in order to make any final conclusions about the role of broken tone in Leivu.

5. Acknowledgements

This research has been supported by the Estonian Ministry of Education and Research project (grant SHVEE21397 "Livonian pronunciation features"), by the Estonian Research Council (grant GHVEE22112J "Stød in the languages around the Baltic Sea"), and by the University of Tartu (grant PHVEE19903).

6. References

[1] N. Grønnum, M. Vazquez-Larruscaín and H. Basbøll, "Danish Stød: Laryngealization or Tone," *Phonetica* 70, pp. 66–92, 2013.

[2] T. Tuisk, *Livonian word prosody*. Doctoral Thesis, University of Tartu. University of Tartu Press, 2015.

[3] U. Balodis, K. Pajusalu and P. Teras, "Broken tone in South Estonian dialects in Latvia," *Linguistica Lettica*, 24, pp. 98–114, 2016.

[4] P. Teras, "Quantity in Leivu," *Linguistica Uralica* XLVI, 1. pp. 1–16, 2010.

[5] E. Fischer-Jørgensen, *A Phonetic Study of the Stød in Standard Danish*. University of Turku, Phonetics. Turku, 1989.

[6] G. F. Hansen, *Stød og stemmekvalitet*. En akustik-fonetisk undersøgelse af ændringer i stemmekvaliteten i forbindelse med stød. Ph.d.-afhandling. Det Humanistiske Fakultet, Københavns Universitet. 2015.

[7] *Latviešu valodas dialektu atlants. Fonētika*. Apraksts, kartes un to komentāri. Rīga: LU Latviešu valodas institūts, 2013.

[8] *Latviešu valodas gramatika*. Rīga: LU Latviešu valodas institūts, 2013.

[9] A. K. Kariņš, *The Prosodic Structure of Latvian*. PhD dissertation. University of Pennsylvania, 1996.

[10] A. K. Kariņš, "Lexical tone and stress in Latvian," *Berkeley Linguistic Society* 23, pp. 186–197, 1997.

[11] G. Dogil. "Baltic languages," *Word prosodic systems in the languages of Europe*. Berlin, New York: Mouton de Gruyter, pp. 877–896, 1999.

[12] L. Balode and A. Holvoet, "The Lithuanian language and its dialects," *Circum-Baltic Languages. Volume I: Past and Present*, pp. 41–79, 2001.

[13] M. Norvik, U. Balodis, V. Ernštreits, G. Kļava, H. Metslang, K. Pajusalu and E. Saar, "The South Estonian language islands in the context of the Central Baltic area," *Journal of Estonian and Finno-Ugric Linguistics* 12 (2), pp. 33–72, 2021, https://doi.org/10.12697/jeful.2021.12.2.02.

[14] U. Balodis and K. Pajusalu, "Introductory survey of the South Estonian language islands", *Journal of Estonian and Finno-Ugric Linguistics* 12 (2), pp. 7–31, 2021, doi: https://doi.org/10.12697/jeful.2021.12.2.01.

[15] T.-R. Viitso, "Livonian and Leivu: Shared innovations and problems," *Linguistica Uralica*, XLV, 4, pp. 269–282, 2009, doi:10.3176/lu.2009.4.03.

[16] M. M. Vihman, *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, 1971, [MS].

[17] P. Kallio, "Historical phonology from Proto-Finnic to Proto-Livonian," *Journal of Estonian and Finno-Ugric Linguistics* 7 (1), pp. 39–65, 2016, https://doi.org/10.12697/jeful.2016.7.1.02.

[18] E. Winkler "Zum Stoßton im Ostseefinnischen," In *Aspekte baltischer Forschung.* (Schriften des Institutes für Baltistik der Ernst-Moritz-Arndt-Universität Greifswald, Band 1.) Essen, 344–363, 2000.

[19] P. Teras, "Broken tone in Leivu CV'V-words," *Journal of Estonian and Finno-Ugric Linguistics* 12 (2), pp. 169–190, 2021, https://doi.org/10.12697/jeful.2021.12.2.07.

[20] P. Teras and T. Tuisk, "The characteristics of stød in Livonian," *Nordic Prosody. Proceedings of the Xth Conference*, Helsinki 2008. Frankfurt: Peter Lang Verlag, pp. 217–226, 2009.

[21] H. Pajupuu and T.-R. Viitso, "Livonian polyphthongs," In Arvo Eek (Ed.), *Estonian Papers in Phonetics 1984–1985*. Tallinn, pp. 96–130, 1986.

[22] A. Penttilä and L. Posti, "Über die steigende und sog. Stossintonation im Livischen," *Finnisch-Ugrische Forschungen,* XXVII. Helsinki, pp. 235–272, 1941.

[23] T. Tuisk, "Acoustics of stød in Livonian," *Proceedings of the 18th International Congress of Phonetic Sciences*. Paper number 356. Glasgow, UK: the University of Glasgow, 1–5, 2015, https://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS2015/Papers/ICPHS0356.pdf.

[24] P. Kiparsky, "Livonian stød," *Segmental Structure and Tone*. W. Kehrein, B. Köhnlein, P. Boersma, M. van Oostendorp (eds.). Berlin/Boston: Walter De Gruyter, pp. 195–210, 2017.

[25] E. L. Asu, P. Lippus, K. Pajusalu, P. Teras, *Eesti keele hääldus*. Tartu, University of Tartu Press, 2016.

[26] P. Boersma and D. Weenink 2021. Praat: doing phonetics by computer. [Computer program.] Version 6.1. http://www.praat.org/.

[27] S. Suhonen, "Über die Quantität der livischen Vokale," In Antti Iivonen, Seppo Suhonen, Pertti Virtaranta (Eds.), *Voces amicorum Sovijärvi. In Honorem Antti Sovijärvi septuagesimum annum agentis die XXII mensis aprilis anno MCMLXXXII.* (Mémoires de la Société Finno-Ougrienne 181). Helsinki, 295-306, 1982.

[28] N. Grønnum, "F0, voice quality, and Danish stød revisited," *Proceedings of the 18th International Congress of Phonetic Sciences* (ICPhS XVIII). Paper number 0423. Glasgow: University of Glasgow, 2015, https://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS2015/Papers/ICPHS0423.pdf.

[29] N. Grønnum, "Laryngealization or Pitch Accent – the Case of Danish Stød," *Speech Prosody 7 – Proceedings of the 7th international conference on Speech Prosody: Social and Linguistic Speech Prosody*. Dublin, 2014. pp. 804–808, 2014, https://www.isca-speech.org/archive/pdfs/speechprosody_2014/grnnum14_speechprosody.pdf