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Observations on the Prosodic Marking of Narrow Focus in Lithuanian

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Abstract. This paper explores prosodic marking of narrow focus in Lithuanian. The research material consists of almost 50 records of sentences with narrow focus in different locations. These sentences were read by four native male speakers. For each of the focused and non-focused tokens fundamental frequency, intensity parameters, duration, the first and the second formants were measured. The results show that focally prominent syllables are pronounced with higher pitch and intensity, expanded pitch range, and longer duration. Some of such syllables are pronounced with tenser vowel articulation.

Keywords: Lithuanian, narrow focus, pitch, intensity, duration, the first formant, the second formant.

1. Introduction

Information structure in discourse influences phonetic features of a speech. One of the examples of this influence is the emphasis on information which is important from a speaker's point of view. This information is at the centre (or 'focus') of speaker's communicative interest (Crystal, 2004). A speaker can bring all phrase into focus because the whole phrase conveys new information. The answer to a question "What happened?" could be an example of a broad focus; when a speaker focuses on one word, as in the answer to a question "Who broke the window?", the focus is narrow. In the first case, the phonetic properties of the phrase are usually quite neutral. In narrow focus, the emphasized (focused) elements (words) tend to be realized with an increase in articulatory effort such as increased duration, amplitude, and pitch excursion size (Sluijter, 1995; Heldner, 2003; Xu and Xu, 2005; Jeon and Nolan, 2017; Wang and Féry, 2018; Destruel and Féry, 2020, among others). Additionally, crosslinguistic studies show that variations in F0 peak shape, scaling and alignment (Avesani and Vayra, 2003; Ambrazaitis and Frid, 2014), phrasing (Jun, 1996), pitch accent type (Campbell, 1995; Ambrazaitis and Frid, 2014), spectral information (Baumann et al., 2007) may be used as alternative or additional strategies to mark prominence or focus.

The research on the acoustic features of focus of the Lithuanian language is very limited. Pukelis (1974) compared stressed, pre-stressed and post-stressed syllables and concluded that pitch, intensity, and duration are variable and cannot indicate narrow

focus. He hypothesized that the quality of a stressed syllable may be an important indicator of narrow focus.

Other studies are not intended for the analysis of focus, but for the realization of stress and syllable accent. Very valuable observations on the features of focused words have been provided by Pakerys (1982). The research by Pakerys shows that in many positions the pitch of stressed vowels and diphthongs is higher than the pitch of unstressed ones. However, in the post-phrase-accented position, the pitch of stressed and unstressed syllables is lower than in the phrase-accented (focus) position. Pakerys revealed that almost always the average of the pitch of a circumflex syllable is higher. The pitch curve's slope of acute and circumflex is steeper in the post-phrase-accented position than in the pre-phrase-accented one.

Some observations are presented in episodic studies on F0 and focus (Kazlauskaitė, 2015; Kazlauskienė and Sabonytė, 2018). The most recent experiments on a similar topic were conducted by Sabonytė and Goldshtein (2021). The results of their research show that F0 and duration could be markers of a focused word.

The Lithuanian language has a lexical stress; therefore, it is likely that the domain of narrow focus could be a stressed syllable and the acoustic features of focus may appear in syllables which have a lexical stress. For this reason, we started our research of narrow focus from analysis and comparison of the features of stressed syllables in focused and non-focused words.

2. Aim, Material and Methods

This study investigates how narrow focus is phonetically realized in a statement in the Lithuanian language. This is the initial stage of the study of narrow focus in Lithuanian. Therefore, a controlled-read speech was chosen for the analysis. In order to carry out the experiment, four native male speakers actors read sentences with narrow focus in different locations of a phrase 3-5 times[1]:

a) [²ˈʃʲɛnʲˑdʲiɛn [¹ˈdʲɪrboːmʲɛ]$_{FOC}$ ²ˈkʲæːtʊrʲɛs ²ˈvɑːlʲendʲɐs ‖ [vɐ²ˈdoːvɐ(s)]$_{FOC}$ ²ˈsɑːkʲeː (|) kɐ(d)‿dɐ²ˈbɐrˑ jɛʊ‿²ˈgɑːlʲɪmʲɛ [²ˈɛɪˑtʲɪ]$_{FOC}$ nɐ²ˈmoː (|) oː‿rʲiː²ˈtoːɪ̯ susʲɪ²ˈrʲɪŋˑksʲɪmʲɛ [tuɔ‿pɐʧʲʊ̯]$_{FOC}$ mʲɛˈtʊ ‖]

b) [[²ˈʃʲɛnʲˑdʲiɛn]$_{FOC}$ ¹ˈdʲɪrboːmʲɛ ²ˈkʲæːtʊrʲɛs ²ˈvɑːlʲendʲɐs ‖ vɐ²ˈdoːvɐ(s) [²ˈsɑːkʲeː]$_{FOC}$ (|) kɐ(d)‿dɐ²ˈbɐrˑ [jɛʊ‿²ˈgɑːlʲɪmʲɛ]$_{FOC}$ ²ˈɛɪˑtʲɪ nɐ²ˈmoː (|) [oː‿rʲiː²ˈtoːɪ̯]$_{FOC}$ susʲɪ²ˈrʲɪŋˑksʲɪmʲɛ tuɔ‿pɐʧʲʊ̯ mʲɛˈtʊ ‖]

c) [²ˈʃʲɛnʲˑdʲiɛn ¹ˈdʲɪrboːmʲɛ [²ˈkʲæːtʊrʲɛs]$_{FOC}$ ²ˈvɑːlʲendʲɐs ‖ vɐ²ˈdoːvɐ(s) ²ˈsɑːkʲeː (|) [kɐ(d)‿dɐ²ˈbɐrˑ]$_{FOC}$ jɛʊ‿²ˈgɑːlʲɪmʲɛ ²ˈɛɪˑtʲɪ nɐ²ˈmoː (|) oː‿rʲiː²ˈtoːɪ̯ [susʲɪ²ˈrʲɪŋˑksʲɪmʲɛ]$_{FOC}$ tuɔ‿pɐʧʲʊ̯ mʲɛˈtʊ ‖]

EN. *We worked four hours today. The manager said we could go home now and will meet at the same time tomorrow*.

LT. *Šiandien dirbome keturias valandas. Vadovas sakė, kad dabar jau galime eiti namo, o rytoj susirinksime tuo pačiu metu*.

The hypothesis of this stage of the research is that the most important features of narrow focus concentrate on syllables with a lexical stress. For this reason, only the centres of stressed syllables were analysed. The acoustics data of the investigated segments were measured using Praat (Boersma and Weenink, 2018). 4 fundamental

[1] The focused words are written in square brackets with the symbol FOC. Semantically and grammatically predicted boundary of an intermediate phrase are marked by (|) but they varied in the records. The diacritic ¹ˈ marks an acute, ²ˈ - a circumflex. Acoustic analysis was conducted on all readings.

frequency and intensity parameters (mean, minimum, maximum, range), the duration, the first (F1) and the second (F2) formants of the stressed syllable nucleus of focused and non-focused words were measured. The segmentation of the analysed units was done manually and was based on hearing and signal representation in Praat. Whereas the centre of a syllable may consist of mixed diphthongs, in their case only vowel formants were measured, except the diphthong [ˀɛɪ̯], where the formants of the whole segment were measured. The beginning and the end of the vowels have adjacent sound features due to coarticulation. Therefore, the formants of the middle part of the vowels were measured.

3. Results and Discussion

3.1. Perception test

Before the acoustic analysis, a perception test was conducted, where 13 native speakers, students of the Lithuanian Philology and Publishing programme were asked to highlight more emphasized words in order to validate if they match with the controlled focused words of the production experiment. 12 records from our empirical material were selected for testing (3 sentences with different narrow focus locations read by 4 speakers) and presented randomly to the participants.

As can be seen in Table 1, the respondents recognized focused words well (on average 88%). Narrow focus is less recognizable in words [vɐˀdoːvɐs], [sʊsʲɪˀrʲɪŋˑksʲɪmʲɛ], and [tuɔ‿pɐˈʧʲʊ̯] (respectively En. 'manager', 'will meet', 'at the same'). Their lexical meaning may have led to such results because they are rarely emphasized in natural speech in a similar context.

Table 1. Perception test results[2]

Words in focus	Accuracy (%)	Words in focus	Accuracy (%)
[ˀˈʃʲɛnʲˑdʲiɛn]	94	[(jɛʊ‿)ˀˈgɑːlʲɪmʲɛ]	94
[ˈˈdʲɪrboːmʲɛ]	90	[ˀˈɛɪˑtʲɪ]	86
[ˀˈkʲæːtʊrʲɛs]	98	[oːˍ‿rʲiːˈˈtoːɪ̯]	98
[vɐˀˈdoːvɐs]	75	[sʊsʲɪˀˈrʲɪŋˑksʲɪmʲɛ]	71
[ˀˈsɑːkʲeː]	90	[tuɔ‿pɐˈʧʲʊ̯]	79
[kɐ‿dɐˀˈbɐrˑ(‿jɛʊ)]	94		

3.2. F0 of the Nucleus of Stressed Syllables

The results show that the F0 mean of stressed syllables is higher in focused words (see Table 2). On average these syllables are produced with 1.2 times higher pitch. This difference is statistically significant[3]. In stressed syllables with nucleus vowels [æː], [ɑː] (in the word [ˀˈgɑːlʲɪmʲɛ]) and mixed diphthongs [ɐrˑ], [ɪŋˑ] the F0 mean was slightly higher but statistically insignificant.

Measurements of the F0 minimum show that the bottom pitch is rather similar in focused and non-focused stressed syllables; it is slightly higher in their focused

[2] The percentage shows how often the focused words were recognized as focused ones.
[3] Statistical significance was tested using *t-test* (significance level 0.05).

counterparts, except the mixed diphthongs [ɐr˙], [ɪŋ˙], and vowels [æː] and [ʊ̣]. Apart from [ɐr˙], there was no statistically significant increase observed.

Table 2. F0 of nucleus of stressed syllables[4]

Researched words	Mean (Hz)	Min (Hz)	Max (Hz)	Range (Hz)
[²ˈʃʲɛnʲ˙dʲiɛn]$_{N}$	137 (±27)	126 (±22)	142 (±28)	16
[²ˈʃʲɛnʲ˙dʲiɛn]$_{FOC}$	171 (±50)	134 (±42)	189 (±54)	55
[¹ˈdʲɪrboːmʲɛ] $_{N}$	117 (±29)	103 (±22)	123 (±34)	20
[¹ˈdʲɪrboːmʲɛ]$_{FOC}$	157 (±39)	110 (±30)	177 (±50)	67
[²ˈkʲæːtʊrʲɛs]$_{N}$	122 (±26)	117 (±24)	126 (±26)	9
[²ˈkʲæːtʊrʲɛs]$_{FOC}$	124 (±36)	116 (±33)	132 (±38)	16
[ʊɐ²ˈdoːʊɐs]$_{N}$	131 (±21)	121 (±20)	136 (±23)	15
[ʊɐ²ˈdoːʊɐs]$_{FOC}$	164 (±42)	135 (±39)	178 (±44)	43
[²ˈsɑːkʲeː]$_{N}$	114 (±26)	108 (±25)	120 (±27)	12
[²ˈsɑːkʲeː]$_{FOC}$	151 (±46)	123 (±31)	167 (±52)	44
[kɐ‿dɐ²ˈbɐr˙(‿jɛʊ)]$_{N}$	125 (±29)	105 (±21)	137 (±33)	32
[kɐ‿dɐ²ˈbɐr˙(‿jɛʊ)]$_{FOC}$	142 (±38)	94 (±13)	178 (±46)	84
[(jɛʊ‿)²ˈgɑːlʲɪmʲɛ]$_{N}$	115 (±29)	108 (±29)	121 (±30)	13
[(jɛʊ‿)²ˈgɑːlʲɪmʲɛ]$_{FOC}$	128 (±22)	113 (±23)	138 (±20)	25
[²ˈɛɪ˙tʲɪ]$_{N}$	104 (±15)	100 (±13)	115 (±26)	15
[²ˈɛɪ˙tʲɪ]$_{FOC}$	126 (±41)	109 (±26)	133 (±46)	24
[oː‿rʲiː¹ˈtoːɪ̯]$_{N}$	153 (±42)	105 (±20)	173 (±50)	68
[oː‿rʲiː¹ˈtoːɪ̯]$_{FOC}$	179 (±46)	116 (±29)	204 (±42)	88
[sʊsʲɪ²ˈrʲɪŋ˙ksʲɪmʲɛ]$_{N}$	118 (±26)	110 (±29)	132 (±32)	22
[sʊsʲɪ²ˈrʲɪŋ˙ksʲɪmʲɛ]$_{FOC}$	131 (±27)	103 (±11)	137 (±25)	34
[tuɔ‿pɐˈɣʲʊ̣]$_{N}$	120 (±17)	118 (±17)	124 (±16)	6
[tuɔ‿pɐˈɣʲʊ̣]$_{FOC}$	132 (±19)	113 (±16)	146 (±28)	33

The F0 maximum is always higher in stressed syllables of focused tokens. Except syllables [ɛɪ˙], [ɪŋ˙], [æː], statistically the F0 maximum of other focally prominent syllables differed (on average 1.3 times) significantly.

Syllables in focused words are always marked by a wider F0 range compared with their unfocused counterparts. Sometimes the range is wider three-four times, for example, in syllables with mixed diphthongs [ɛnʲ˙], [ɪr], [ɐr˙], vowels [oː], [ɑː] (in the words [ʊɐ²ˈdoːʊɐs], [²ˈsɑːkʲeː]) or it may be expanded even six times, for example, in the focally stressed short vowel [ʊ̣]). As the data shows, the wider F0 range in focused syllables may be reached by increasing the F0 maximum: the F0 maximum rises significantly, whereas the F0 minimum remains relatively unchanged.

We can presume that stressed syllables of focused words are characterized by higher F0 mean, maximum, and range (see typical examples in Figure 1).

[4] [ ]$_{N}$ - a non-focused word, [ ]$_{FOC}$ - a focused word, Range - the difference between F0 maximum and F0 minimum.

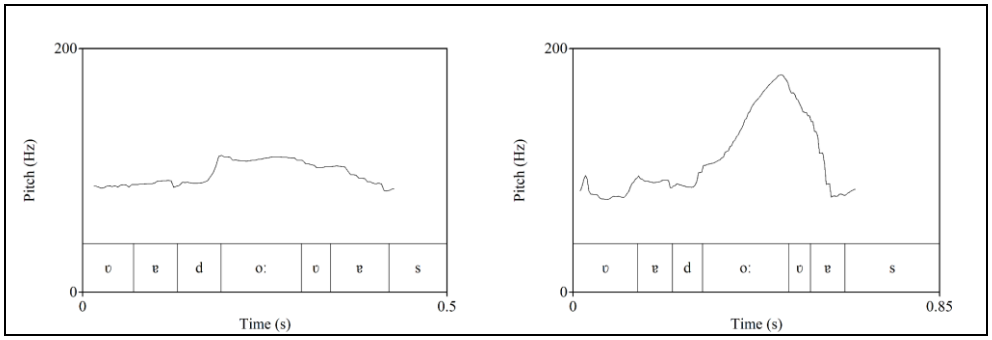

Figure 1. The samples of F0 in the non-focused words (on the left) and the focused words (on the right)

3.3. Intensity of the Nucleus of Stressed Syllables

The intensity results revealed that the mean intensity is a significant indicator for marking narrow focus. On average the syllables of focused words are 1.1 times more intensive than their non-focused counterparts (see Table 3). This difference is statistically significant.

Table 3. The intensity of the nucleus of the stressed syllables

Researched words	Mean (dB)	Min (dB)	Max (dB)	Range (dB)
[²ˈʃʲɛnʲˑdʲiɛn]$_{N}$	68 (±4)	66 (±4)	70 (±4)	4
[²ˈʃʲɛnʲˑdʲiɛn]$_{FOC}$	72 (±3)	67 (±2)	75 (±3)	8
[¹ˈdʲɪrboːmʲɛ] $_{N}$	65 (±4)	62 (±4)	67 (±4)	5
[¹ˈdʲɪrboːmʲɛ]$_{FOC}$	71 (±3)	67 (±3)	73 (±4)	6
[²ˈkʲæːtʊrʲɛs]$_{N}$	66 (±3)	64 (±3)	68 (±4)	4
[²ˈkʲæːtʊrʲɛs]$_{FOC}$	71 (±4)	66 (±3)	73 (±4)	7
[ʊɐ²ˈdoːʊɐs]$_{N}$	69 (±4)	66 (±4)	70 (±4)	4
[ʊɐ²ˈdoːʊɐs]$_{FOC}$	73 (±2)	69 (±2)	75 (±2)	6
[²ˈsɑːkʲeː]$_{N}$	65 (±4)	61 (±4)	67 (±4)	6
[²ˈsɑːkʲeː]$_{FOC}$	71 (±2)	65 (±3)	73 (±3)	8
[kɐ‿dɐ²ˈbɐrˑ(‿jɛʊ)]$_{N}$	67 (±4)	64 (±4)	68 (±5)	4
[kɐ‿dɐ²ˈbɐrˑ(‿jɛʊ)]$_{FOC}$	71 (±3)	60 (±7)	74 (±4)	14
[(jɛʊ‿)²ˈgɑːlʲɪmʲɛ]$_{N}$	67 (±5)	64 (±5)	68 (±5)	4
[(jɛʊ‿)²ˈgɑːlʲɪmʲɛ]$_{FOC}$	72 (±2)	67 (±3)	73 (±2)	6
[²ˈɛɪˑtʲɪ]$_{N}$	62 (±4)	57 (±5)	64 (±4)	7
[²ˈɛɪˑtʲɪ]$_{FOC}$	68 (±3)	61 (±5)	71 (±3)	10
[oː‿rʲiː¹ˈtoːɪ̯]$_{N}$	65 (±4)	61 (±4)	67 (±4)	6
[oː‿rʲiː¹ˈtoːɪ̯]$_{FOC}$	70 (±3)	60 (±5)	72 (±3)	12
[sʊsʲɪ²ˈrʲɪŋˑksʲɪmʲɛ]$_{N}$	63 (±4)	61 (±4)	64 (±4)	3
[sʊsʲɪ²ˈrʲɪŋˑksʲɪmʲɛ]$_{FOC}$	68 (±3)	65 (±3)	69 (±3)	4
[tuɔ‿pɐˈʧʲʊ̯]$_{N}$	60 (±4)	58 (±4)	61 (±4)	3
[tuɔ‿pɐˈʧʲʊ̯]$_{FOC}$	66 (±2)	61 (±4)	68 (±3)	7

Measurements of minimum and maximum intensity show the same tendency to produce a nucleus with higher minimum (except [ɐr˙], [o:] in [o:‿rʲi:¹ˈto:ɪ̯]) and maximum intensity in focused words. The differences are relatively small (on average 1.1 times), although always statistically significant in cases with intensity maximum. In the case of minimum intensity, only half of the examples significantly differentiate focally prominent syllables from non-focal ones.

The results of the range of intensity show the same regularity: the intensity range in focally stressed syllables is always wider, sometimes twice ([²ˈʃɛnʲ˙dʲiɛn], [o:‿rʲi:¹ˈto:ɪ̯]), [tuɔ‿pɐˈɣʲʊ̯]) or even three times ([kɐ‿dɐ²ˈbɐr˙(‿jɛʊ)]). Like the maximum intensity, the overall intensity, the intensity range is also an effective way to mark the prominence.

As in the case of F0, higher intensity mean, maximum, and range may indicate narrow focus (see typical examples in the Figure 2).

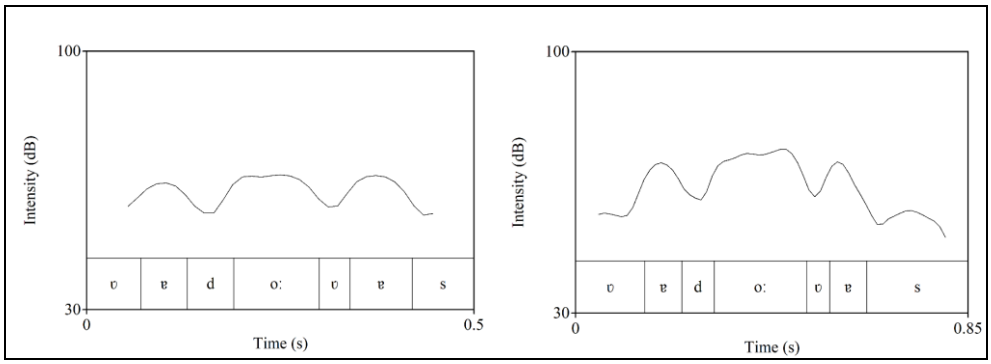

Figure 2. The samples of intensity in the non-focused words (on the left) and the focused words (on the right)

3.4. Duration of the Nucleus of Stressed Syllables

The nucleus of the stressed syllables of focused words are on average 1.5 times longer than those without narrow focus (see Table 4). This difference is statistically significant. We have not observed regularities related to the constituent sounds of syllable nuclei because the lengthening of vowels and diphthongs is varied. Long vowels may be lengthened 1.4-1.7 times. These results negate Pukelis's (1974) data and confirm Pakerys's (1982) findings. The lengthening interval of diphthongs is quite similar: from 1.3 to 1.9 times. The short vowel [ʊ̯] is the most lengthened; however, conclusions cannot be drawn for all short vowels because the data are scarce. On the other hand, words [tuɔ‿pɐˈɣʲʊ̯]$_{FOC}$ and [kɐ‿dɐ²ˈbɐr˙(‿jɛʊ)]$_{FOC}$ are heard as more prominent. Moreover, their semantics (respectively En. ‘at the same’, ‘now’) presuppose the possibility of being more focused.

The standard deviation of the focused words is higher than that of the non-focused words. The standard deviation is twice as high in some examples. This signals that the duration of these segments varies much more, and this suggests that the lengthening of a nucleus in stressed syllables in focused words is not a consistent and stable indicator of narrow focus.

It should be noted that further analysis is needed to determine whether such a difference in duration is not related to the different rate of focused words. Perhaps

focused words are pronounced more slowly and, as a result, this increases not only the duration of the stressed syllable nucleus, but other sounds, too. It would be beneficial to analyse the duration of consonants as well. This lengthening may also be due to pre- or post-focus pauses, which are quite common.

Table 4. Duration of the nucleus of the stressed syllables[5]

Researched words	Median (ms)	AVR (ms)	CI (ms)	Ratio (N:FOC)
[ˀˈʃɛnʲːdʲiɛn]$_{N}$	141	143 (±26)	135÷151	1.4
[ˀˈʃɛnʲːdʲiɛn]$_{FOC}$	201	198 (±43)	179÷218	
[ˈˈdʲɪrboːmʲɛ] $_{N}$	118	118 (±15)	113÷122	1.3
[ˈˈdʲɪrboːmʲɛ]$_{FOC}$	153	158 (±29)	145÷172	
[ˀˈkʲæːtʊrʲɛs]$_{N}$	97	105 (±23)	98÷112	1.6
[ˀˈkʲæːtʊrʲɛs]$_{FOC}$	153	163 (±30)	149÷176	
[ʊɐˀˈdoːʊɐs]$_{N}$	91	97 (±29)	88÷106	1.7
[ʊɐˀˈdoːʊɐs]$_{FOC}$	150	159 (±48)	137÷181	
[ˀˈsɑːkʲeː]$_{N}$	94	103 (±30)	93÷123	1.4
[ˀˈsɑːkʲeː]$_{FOC}$	119	145 (±55)	121÷170	
[kɐ‿dɐˀˈbɐrˑ(‿jɛʊ)]$_{N}$	89	89 (±13)	85÷93	1.9
[kɐ‿dɐˀˈbɐrˑ(‿jɛʊ)]$_{FOC}$	185	167 (±36)	152÷185	
[(jɛʊ‿)ˀˈgɑːlʲɪmʲɛ]$_{N}$	117	117 (±14)	113÷122	1.5
[(jɛʊ‿)ˀˈgɑːlʲɪmʲɛ]$_{FOC}$	167	173 (±28)	160÷186	
[ˀˈɛɪˑtʲɪ]$_{N}$	129	129 (±25)	121÷137	1.3
[ˀˈɛɪˑtʲɪ]$_{FOC}$	173	168 (±31)	154÷182	
[oː‿rʲiːˈˈtoːɪ̯]$_{N}$	78	80 (±18)	74÷85	1.4
[oː‿rʲiːˈˈtoːɪ̯]$_{FOC}$	109	109 (±23)	98÷120	
[sʊsʲɪˀˈrʲɪŋˑksʲɪmʲɛ]$_{N}$	99	100 (±18)	95÷106	1.5
[sʊsʲɪˀˈrʲɪŋˑksʲɪmʲɛ]$_{FOC}$	154	154 (±23)	143÷164	
[tuɔ‿pɐˈɣʲʊ̯]$_{N}$	44	45 (±11)	42÷48	1.8
[tuɔ‿pɐˈɣʲʊ̯]$_{FOC}$	73	82 (±35)	66÷98	

3.5. Quality of the Vowels of the Nucleus in Stressed Syllables

The results of qualitative features of vowels revealed two tendencies. First, if the nucleus of a syllable consists of a vowel, this vowel is more tense in focused words rather than in non-focused (see Table 5). Open vowels have the largest difference in tension. They are on average 1.8 times more tense in stressed syllables of focused words.

It should be noted that [ʊ̯] is highly reduced in this data, and its formants are very close [ə]. Nevertheless, the vowel [ʊ̯] is tenser in the focus position. As can be seen from the duration results, this vowel is very lengthened in focused words, and this lengthening affects the inherent qualitative characteristics.

Second, if the nucleus of a syllable consists of a mixed diphthong, the qualitative characteristics of a vowel are almost unchanged. The same goes for [ɛɪˑ]. However, [ɐrˑ] is the exception in this group. This diphthong is 2 times more tense in focused words than in non-focused ones. In this case, the lengthening may affect the qualitative characteristics, because [ɐrˑ] is very lengthened in focused words.

[5] AVR - an average, CI - a confidence interval.

Table 5. Qualitative features and tension of vowels of the nucleus[6]

Researched words	F1 (Hz)	F2 (Hz)	T	Ratio of T (N:FOC)
[ˀˈʃɛnʲːdʲiɛn]$_{N}$	441 (±91)	1856 (±125)	415	1:1
[ˀˈʃɛnʲːdʲiɛn]$_{FOC}$	565 (±59)	1859 (±125)	424	
[ˈˈdʲɪrboːmʲɛ]$_{N}$	363 (±82)	1831 (±148)	468	1.1:1
[ˈˈdʲɪrboːmʲɛ]$_{FOC}$	321 (±54)	1936 (±182)	436	
[ˀˈkʲæːtʊrʲɛs]$_{N}$	661 (±75)	1534 (±67)	195	1:1.7
[ˀˈkʲæːtʊrʲɛs]$_{FOC}$	812 (±93)	1518 (±111)	330	
[vɐˀˈdoːvɐs]$_{N}$	591 (±97)	1044 (±134)	547	1:1.2
[vɐˀˈdoːvɐs]$_{FOC}$	601 (±115)	945 (±147)	656	
[ˀˈsɑːkʲeː]$_{N}$	692 (±64)	1427 (±79)	265	1:1.6
[ˀˈsɑːkʲeː]$_{FOC}$	824 (±72)	1410 (±72)	414	
[kɐ‿dɐˀˈbɐrˑ(‿jɛʊ)]$_{N}$	513 (±74)	1318 (±100)	195	1:2
[kɐ‿dɐˀˈbɐrˑ(‿jɛʊ)]$_{FOC}$	639 (±73)	1259 (±169)	380	
[(jɛʊ‿)ˀˈgɑːlʲɪmʲɛ]$_{N}$	672 (±61)	1477 (±53)	195	1:1.9
[(jɛʊ‿)ˀˈgɑːlʲɪmʲɛ]$_{FOC}$	800 (±69)	1427 (±81)	373	
[ˀˈɛɪˑtʲɪ]$_{N}$	345 (±56)	2075 (±111)	730	1.1:1
[ˀˈɛɪˑtʲɪ]$_{FOC}$	421 (±99)	2109 (±164)	688	
[oː‿rʲiːˈˈtoːɪ̯]$_{N}$	575 (±139)	1177 (±344)	398	1:1.2
[oː‿rʲiːˈˈtoːɪ̯]$_{FOC}$	590 (±106)	1109 (±216)	481	
[sʊsʲɪˀˈrʲɪŋˑksʲɪmʲɛ]$_{N}$	358 (±79)	2094 (±175)	736	1:1
[sʊsʲɪˀˈrʲɪŋˑksʲɪmʲɛ]$_{FOC}$	354 (±65)	2107 (±141)	753	
[tuɔ‿pɐˈɣʲʊ̯]$_{N}$	482 (±171)	1488 (±216)	30	1:6
[tuɔ‿pɐˈɣʲʊ̯]$_{FOC}$	397 (±49)	1422 (±206)	181	

4. Conclusions

The research leads to the following conclusions:

1. F0 mean, maximum, and range are good correlates for marking narrow focus. Narrow focus is realized by raising pitch and expanding the pitch range of stressed syllables.
2. The intensity mean, maximum and range help to indicate words in focus, whereas the intensity minimum (as well as the F0 minimum) is not a reliable cue of focus.
3. The duration of nuclei in stressed syllables is an indicator of narrow focus.
4. Vowels of focused syllables may be more tense than in non-focused ones; however, the same cannot be said of diphthongs. Admittedly, these assumptions should be verified with a larger database.

In summary, focally prominent syllables are pronounced with higher pitch, higher intensity, expanded pitch and intensity range, longer duration, and with tenser vowel articulation. Not all speakers use the same strategies for focus marking, and not all mentioned strategies need to be employed simultaneously.

[6] T - a tension. The tension is calculated according to the formula: T=|F1-500|+|F2-1500|, where F1 is the value of the first formant and F2 is the value of the second formant (Girdenis, 2014: 238). The values of neutral sound [ə] (F1=500, F2=1500) are subtracted from the calculated formants values.

The object of this study was the properties of a stressed syllable in focused words. The acoustic properties of pre- and post-stressed syllables should be investigated in the future.

Additionally, the data have shown that speakers may use alternative and/or additional means to signal focus, such as changing the rate of speech and adding pauses. Adding pauses before or/and after focused words is speaker dependent. These phenomena should be studied in more detail.

In the next stage of the study, the results need to be verified on a larger and more diverse dataset. Analysing a larger data requires normalization of the speech rate and a complex statistical analysis. Based on these results, the speech corpus which is used for speech technologies will be expanded.

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References

Ambrazaitis, G., Frid, J. (2014). F0 peak timing, height, and shape as independent features, *Proceedings of 4th International Symposium on Tonal Aspects of Languages* (TAL 2014), 138-142.

Avesani, C., Vayra, M. (2003). Broad, narrow and contrastive focus in Florentine Italian, *Proceedings of the 15th ICPhS*, 1803-1806.

Baumann, S., Becker, J., Grice, M., Mücke, D. (2007). Tonal and articulatory marking of focus in German, *Proceedings of the 16th ICPhS*, 1029-1032.

Boersma, P., Weenink, D. (2018). Praat: doing phonetics by computer, version 6.035. www.praat.org [computer program].

Campbell, N. (1995). Loudness, spectral tilt, and perceived prominence in dialogues, *Proceedings ICPhS 95*, 676-679.

Crystal, D. (2004). *A dictionary of finguistics & phonetics*, 5th ed., Blackwell Publishing.

Destruel, E., Féry, C. (2020). Prominence in French dual focus, *Language and Speech*, **64**, 319-345.

Girdenis, A. (2014). *Theoretical foundations of Lithuanian phonology*, Vilnius: Eugrimas.

Heldner, M. (2003). On the reliability of overall intensity and spectral emphasis as acoustic correlates of focal accents in Swedish, *Journal of Phonetics*, **31** (1), 39-62.

Jeon, H-S., Nolan, F. (2017). Prosodic marking of narrow focus in Seoul Korean, *Laboratory Phonology: Journal of the Association for Laboratory Phonology*, **8** (1), 1-30, DOI: https://doi.org/10.5334/labphon.48.

Jun, S.-A. (1996). *The phonetics and phonology of Korean prosody*, New York: Garland Publishing.

Kazlauskaitė, R. (2015). Loginis ir frazės kirtis informaciniuose tekstuose, *Žmogus ir žodis*, **17**(1), 37-50.

Kazlauskienė, A., Sabonytė, R. (2018). F0 in Lithuanian: the indicator of stress, syllable accent, or intonation?, *Human language technologies – the Baltic perspective, 8th international conference Baltic HLT 2018*, September 27-29, Tartu, Estonia: proceedings / eds. K. Muischnek and K. Müürisep. Amsterdam: IOS press, 55-62.

Pakerys, A. (1982). *Lietuvių bendrinės kalbos prozodija*, Vilnius: Mokslas.

Pukelis, V. (1974). Frazės kirčiu pabrėžto žodžio ir jo kirčiuoto skiemens akustiniai požymiai lietuvių kalbos patikrinamuosiuose klausimuose, *Eksperimentinė ir praktinė fonetika. Eksperimentinės fonetikos ir kalbos psichologijos kolokviumo medžiaga*, **6**, 199-217.

Sabonytė, R., Goldshtein, Y. (2021). F0 and duration changes in unstressed *vs* stressed syllables connected to postlexical stress and sentence type in Standard Lithuanian, Youssef, I., Vázquez-Larruscaín, M. (eds.). *Nordlyd 45.1, selected papers from the fifth Fonologi i Norden Meeting*, 119-128.

Sluijter, A. M. C. (1995). *Phonetic correlates of stress and accent*, Hague: Holland Academic Graphics.

Wang, B., Féry, C. (2018). Prosody of dual-focus in German: interaction between focus and phrasing, *Language and Speech*, **61** (2), 303-333. DOI: https://doi.org/10.1177/0023830917721942.

Xu, Y., Xu, C. X. (2005). Phonetic realization of focus in English declarative intonation, *Journal of Phonetics*, **33** (2), 159-197.

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