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F_0 in Lithuanian: The Indicator of Stress, Syllable Accent, or Intonation?

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Abstract. This study is focused on analysing whether changes of F_0 in the Lithuanian language are influenced by: 1) stress and the type of a syllable accent (acute, circumflex); 2) the type of a sentence (declarative, exclamatory, interrogative); 3) phrase accent (focused word). The research material consists of the recordings of three female Standard Lithuanian speakers. Each of the samples was read 5 times. The analysis of the relation of F_0 in a stressed and an unstressed syllable, in an acute and a circumflex, in a focal and non-focal position, in declarative, exclamatory, interrogative sentences allows us to assume that the pitch is an indicator of intonation rather than of a lexical stress and a syllable accent.

Keywords. Lithuanian language, fundamental frequency, stress, syllable accent, intonation

1. Introduction

The term *prosody* covers several phonetic parameters – pitch (F_0), duration, and amplitude. On the other hand, the notion of prosody includes such phonological phenomena as stress, rhythm, timing, phrasing, and intonation. These two levels overlap due to ternary uses of F_0 in languages: 1) lexical (the expression of stress and tone at the word level), 2) post-lexical (the expression of intonation at the utterance level), 3) paralinguistic (showing speaker's emotions). In order to determine the importance of F_0 for each of these levels, they should be analysed carefully.

Concerning the research on Lithuanian prosody, some authors of previous works mention that stressed syllables are pronounced higher in Lithuanian [1], [2]. However, there is also the opposite opinion that F_0 is not a very important attribute of stressed syllables [3]. The research by Pakerys [4] shows that in many positions pitch of stressed vowels and diphthongs is higher than of unstressed ones. However, in the post-phrase-accented position, the pitch of stressed and unstressed syllables is lower than in the phrase-accented position.

The tonal description of Lithuanian syllable accents started with F. Kurschat's works [5]. Later some authors (e.g. [1], [2]) supported this position; however, some reservations also existed [3]. Girdenis and Pupkis [6] conclude that on equal conditions acute and circumflex have a falling (in case of statements) or rising (in case of questions) pitch; a rising and falling pitch indicates different intonational types of utterances rather than syllable accents. Pakerys [4] revealed that almost always the

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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. In case of questions, pitch curves of acute and circumflex are very similar.

The intonation of Lithuanian has not been analysed in detail so far. The first studies on this topic (e.g. [7], [8], [9]) were related to different types of sentences and syntactic structure. Bikulčienė ([10], [11]) found that the contours of F_0 are usually falling in declarative sentences. The intonation of imperatives is characterized by the rising-falling pitch.

Probably the most detailed analysis of Lithuanian intonation was conducted by Kundrotas. He compared the models of Lithuanian and Russian intonational systems (e.g. [12], [13]), developed and described 7 intonational contours of Lithuanian intonation (e.g. [14], [15]). Most of his studies deal with the analysis of the position of a phrase accent in a phrase. However, the patterns that he described are based only on psychoacoustics.

We can see from the description given above that most of the aforementioned studies are not relatively new and were conducted using the technological means available at that time. Moreover, they lack a complex analysis of F_0 taking into consideration different phonological phenomena like it has been done analysing other languages (e.g. European Portuguese [16], Catalan [17], Tamil [18], Mongolian [19] etc.). One of the newest studies on this topic concerning the Lithuanian language was done by Hualde and Riad [20]. They examined the realization of word accent contrasts across intonational contexts in East Aukštaitian Lithuanian and Standard Latvian.

In order to start a detailed analysis of Lithuanian intonation, we have to investigate the relation between pitch and stress, syllable accent. This is important because pitch can be an indicator of the mentioned linguistics phenomena as well as intonation. Therefore, this pilot study is focused on analysing the changes in F_0 influenced by: 1) stress and the type of a syllable accent (acute, circumflex); 2) the type of a sentence (declarative, exclamatory, interrogative); 3) phrase accent (focused word).

2. Material and Methods

The material of the research consists of the recordings of 3 female Standard Lithuanian speakers (who are linguists, aged 54, 38, and 23). Each of the samples (12) was read and recorded 5 times. The samples were segmented, and pitch data was extracted using PRAAT.

For the analysis of F_0 in stressed and unstressed syllables, the following examples were selected: *Neliko pãmato prie kelio.* (‘There is no foundation left near the road.’) and *Mergaitę pamãto prie kelio.* (‘He/She sees the girl near the road.’). Stressed and unstressed syllables were analysed in the words *pãmato* [$^{2\prime}$pɑːmɐtoː] and *pamãto* [pɐ$^{2\prime}$mɑːtoː][2]. For the analysis, the mean values of F_0 were extracted from both (stressed and unstressed) syllables having [ɑː] and [ɐ] sounds as the syllable nuclear.

To find out if F_0 is an indicator of different syllable accents, the sentences with minimal pair (*Šitaip áusiu tinklą*. ‘I'll weave a net like this’. *Šitaip aũsiu batą*. ‘I'll put on a shoe like this’; acute *áusiu* [$^{1\prime}$ɑˑʊsʲu̯] ‘I will weave’, circumflex *aũsiu* [$^{2\prime}$ɐuˑsʲu̯] ‘I will put on’) and near-minimal pair (*Šitaip dróžė medį*. ‘He/She carved a tree like this’.

[2] Symbol $^{2\prime}$ means circumflex, symbol $^{1\prime}$ means acute.

Šitaip rõžė žydi. 'The rose blooms like this'; acute *dróžė* [^{1}ˈdroːʒʲeː] 'he/she carved', circumflex *rõžė* [^{2}ˈroːʒʲeː] 'a rose') were chosen. The minimum and maximum F_0 values of acute and circumflex were extracted, and the difference was calculated.

For the analysis of the relation between the type of a sentence and the changes in F_0, these sentences were recorded: *Namas neturi pãmato.* ('The house does not have a foundation.'), *Namas neturi pãmato?* ('The house does not have a foundation?'), and *Namas neturi pãmato!* ('The house does not have a foundation!'). The mean values of F_0 were extracted from stressed and unstressed syllables in the target word *pãmato* [^{2}ˈpɑːmɐtoː].

To examine the relation between F_0 and a phrase accent, the following sentences were chosen (the focused word is in bold): ***Pãmato*** *neliko prie kelio.* ('There is no foundation left near the road.'), *Neliko* ***pãmato*** *prie kelio.* ('There is no foundation left near the road.'), and *Prie kelio neliko* ***pãmato***. ('There is no foundation left near the road.'). These sentences were read and recorded after the interlocutor asked the speaker *Ko neliko prie kelio?* ('What is not left near the road?'), and then the speaker answered, every time focusing on a different word. For the analysis, a mean of F_0 was extracted from stressed and unstressed syllables in target word *pãmato*.

The statistical data were analysed, and graphs were produced using Excel, while pitch contours were drawn using PRAAT [12].

3. Experiments and Discussion

3.1. The Relation between Stress, Syllable Accent and F_0

The analysis of stressed and unstressed syllables shows that in the word *pãmato* the pitch of the vowel *a* in the stressed syllable is undoubtedly higher than in the unstressed syllable (*pãmato ã* – $\bar{x}$=208±18, Med=212; *a* – $\bar{x}$=172±15, Med=173)[3]. This cannot be said about *pamãto* where the difference is not so obvious (*a* – $\bar{x}$=212±35, Med=194, *ã* – $\bar{x}$=212±47, Med=212). In this case, a very high variance of data can be seen (see also Figure 1). This raises a question about the ambiguity of such results. The more detailed analysis of the data showed that some tendencies related to the age and possibly to the experience of public speaking of the speakers may exist. In the samples recorded by the elder speaker, *pamãto* and *pãmato* have a very similar difference of the pitch between stressed and unstressed syllables. In the samples of younger speakers, such difference does not exist, and often even the syllable in the pre-stressed position of *pamãto* has a higher pitch. There is no reason to think that younger speakers shift the stress to the first syllable because it is clearly perceived in the recordings that the second syllable is stressed. However, in the samples of younger speakers, the pitch started to fall quite early (starting with the stressed syllable of the first word). We cannot see any influence of other factors here because the phonetic environment of the target words is similar.

After the comparison of the pitch of the vowel *a*, it can be seen that F_0 values in the syllables *pã* and *pa* are very similar. However, the pitch of the vowel *a* in the syllables *ma* and *mã* is undoubtedly higher in the case of the stressed syllable.

[3] $\bar{x}$ - a mean, Med - a median.

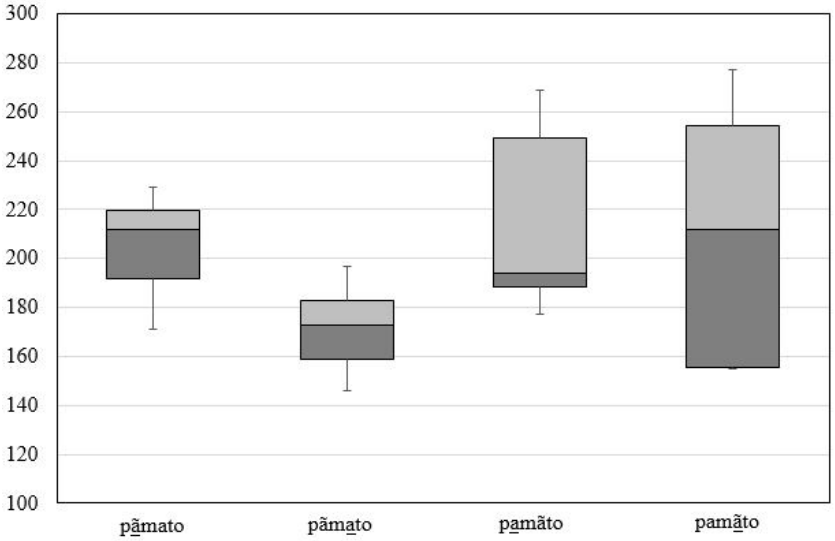

Figure 1. The scores of F_0 mean within stressed and unstressed syllables (the analysed vowel is underlined).

The analysis of pitch peculiarities of syllable accents revealed that the difference between the minimum and maximum of F_0 is smaller in case of acute vowel, rather than in circumflex vowel of the same structure (see Figure 2). Moreover, the difference between the maximum and minimum F_0 of circumflex syllables tends to vary more. However, such results are controversial: a detailed analysis of the empirical data showed that, again, this great and irregular variety in differences is related to the age of the speakers. In the samples produced by the younger speakers, acute and circumflex of long vowels are indistinctive.

If the syllable nuclear is a diphthong, the difference between the maximum and minimum F_0 tends to vary more and is greater in case of acute than in circumflex.

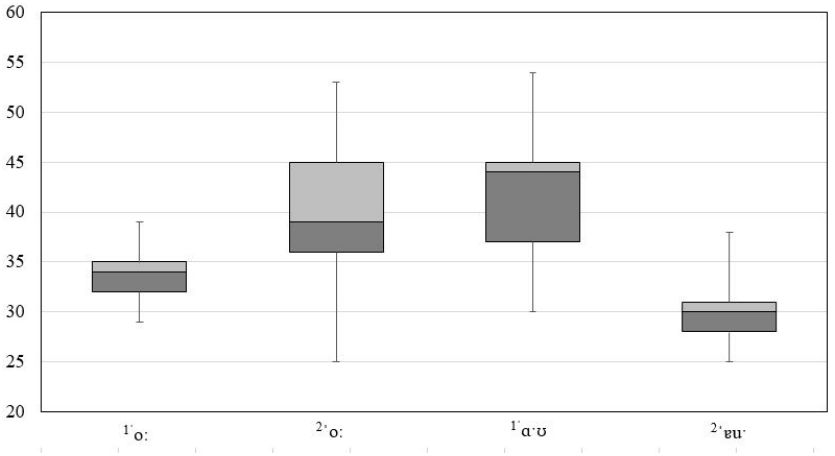

Figure 2. The scores of the difference in F_0 within acute and circumflex.

It is important to mention that the results of the analysis of diphthongs and long vowels in the samples produced by the elder speaker confirm the results of previous

studies on Lithuanian syllable accent (e.g. Pakerys [4]). According to this speaker, acute in Lithuanian is characterized by a sharper slope of F_0, whereas the contour of circumflex is falling as well; however, the slope is not that steep (see typical samples of syllable accents represented by elder speakers Figure 3).

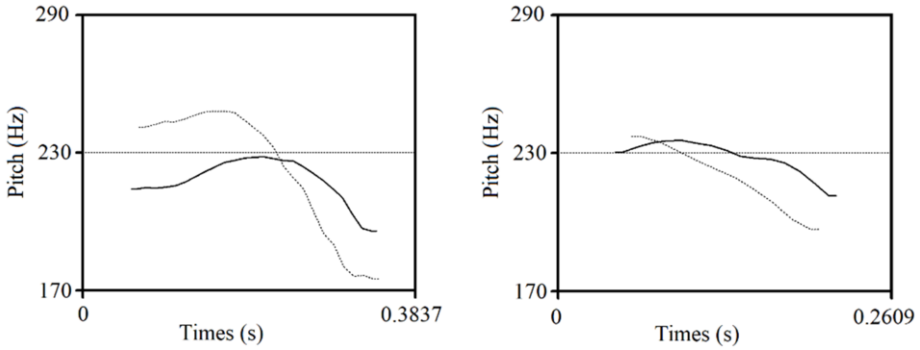

Figure 3. The samples of acute (a dotted line) and circumflex (a solid line): [ˈˈɑ·ʊ] and [ˈˈʁu·] on the left, [ˈˈo:] and [ˈˈo:] on the right.

3.2. The Influence of Different Sentence Types and Focus on F_0

As the results show, the pitch of stressed and unstressed syllables in different positions of the focused word has a clear tendency to differ: the pitch is always higher in the case of stressed syllables, and this fact does not depend on the position of a word in a sentence (see Table 1 and Figure 4).

After the comparison of the pitch of focused and non-focused words (already discussed in Section 3.1.), it can be seen that the pitch of the stressed syllable of the focused word is much higher than of the non-focused one (see Table 1). The pitch of the unstressed syllable is similar in both – focused and non-focused – positions. Consequently, it can be noted that F_0 is the indicator of both: of a lexical stress and a phrase accent.

Table 1. F_0 of stressed and unstressed syllables in focal and non-focal position (symbol I means initial position, M – middle position, F – final position in the sentence)

Vowel	*pãmato*	*pãmato I*	*pãmato M*	*pamãto F*
ã	$\bar{x}$=208±18	$\bar{x}$=276±25	$\bar{x}$=269±14	$\bar{x}$=268±20
	Med=212	Med=275	Med=273	Med=268
a	$\bar{x}$=172±15	$\bar{x}$=174±14	$\bar{x}$=170±14	$\bar{x}$=171±22
	Med=173	Med=171	Med=166	Med=164

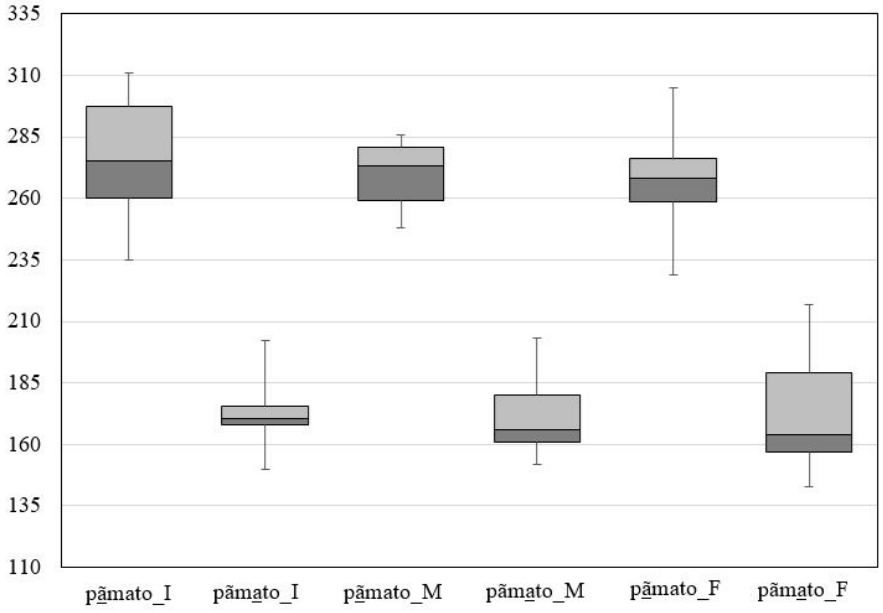

Figure 4. The scores of F_0 means within acute and circumflex.

The analysis of the word *pãmato* used in different types of sentences shows the F_0 dependence on the type of a sentence. In addition, it is necessary to pay attention to the fact that the values of the pitch of the stressed syllables are more dispersed in all sentences (see Figure 5).

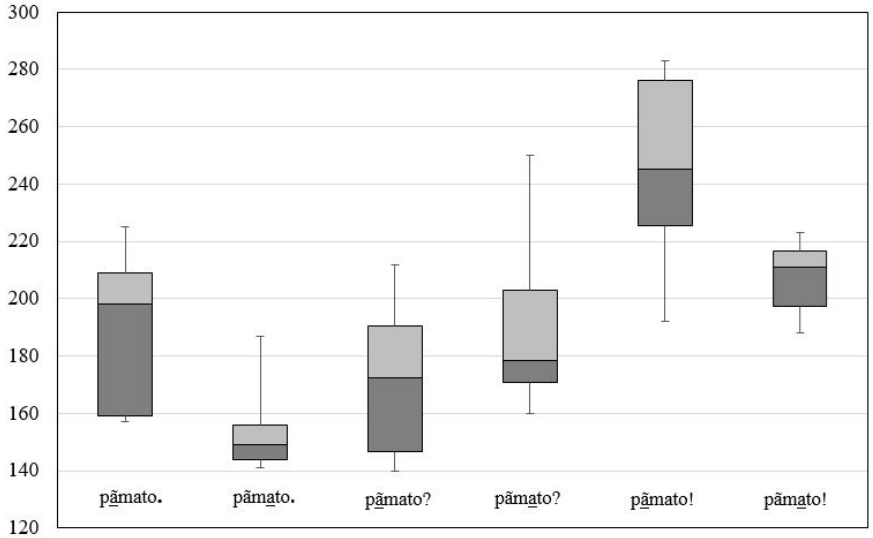

Figure 5. The scores of F_0 means within the stressed and unstressed syllables in different types of sentences.

In the case of declarative sentences, the stressed syllable has higher pitch than the unstressed one (see Table 2).

Table 2. F_0 of stressed and unstressed syllables in declarative (.), interrogative (?), exclamatory (!) sentences.

Vowel	*pãmato.*	*pãmato?*	*pamãto!*
ã	$\bar{x}$=189±25	$\bar{x}$=170±24	$\bar{x}$=245±31
	Med=198	Med=173	Med=245
a	$\bar{x}$=155±17	$\bar{x}$=191±30	$\bar{x}$=207±12
	Med=149	Med=179	Med=211

In questions, the pitch of the stressed syllable is lower or very similar to the following unstressed one and this is influenced by the late pitch rise at the end of the utterance (see samples of typical utterances represented by elder speakers in Figure 6).

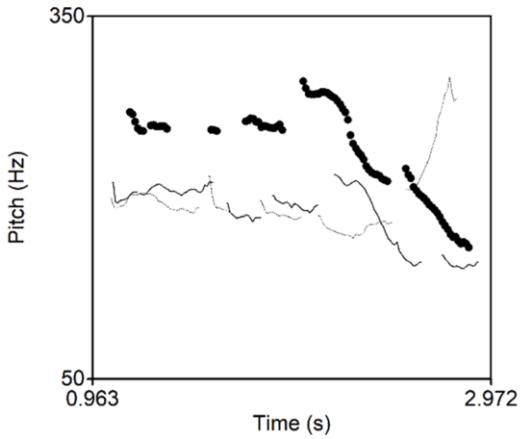

Figure 6. The samples of declarative (a solid line), interrogative (a dotted line) and exclamatory (a speckled line) sentences.

In exclamatory sentence, the stressed syllable has a higher pitch than the following unstressed syllable. However, the pitch of both – stressed and unstressed – syllables in exclamatory sentence is much higher than in declarative sentences. Moreover, not only is the target word uttered higher but the whole phrase as well, although the shape of F_0 curve is similar in both cases (see Figure 6).

4. Conclusions

The analysis of the relation of F_0 in a stressed and an unstressed syllable, in an acute and a circumflex, in the focal and non-focal position, in declarative, exclamatory, interrogative sentences allows us to assume that the pitch is an indicator of intonation rather than of a lexical stress and a syllable accent. Of course, we cannot deny that the pitch is one of the features of a lexical stress and syllable accent but the changes of F_0 in these linguistic phenomena are not so significant than in case of the focus position and the type of a sentence. Therefore, it is possible to analyse and describe the intonation of Lithuanian based on F_0 changes.

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