

ACOUSTIC AND ARTICULATORY PROPERTIES OF LITHUANIAN SONORANTS IN VARIOUS POSITIONS

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Abstract. *The paper analyzes the sonorants of the Lithuanian language: lateral (/l/, /lʲ/), nasal (/m/, /mʲ/, /n/, /nʲ/), trill (/r/, /rʲ/), as well as [ɲ], [ɲʲ], and the velar allophone of /n/. The goal of this article is to compare the acoustic and articulatory properties of the Lithuanian sonorants pronounced in various positions (prevocalic [R]VR, intervocalic V[R]V and postvocalic RV[R]). Four acoustic properties of Lithuanian sonorants have been analyzed: 1) structure of the F1–F4 formants; 2) the first nasal formant (N1); 3) the bandwidth of the first nasal formant (B1); 4) the frequency range of the antiformant (Z1). This study has shown that there is no single absolute acoustic feature that could be used to distinguish between all the sonorants in the Lithuanian language – sonorants must be studied in a comprehensive manner by evaluating various parameters, the manner of articulation, secondary palatalization and other relevant aspects.*

Key words: *Lithuanian language, sonorant, lateral, nasal, trill, acoustic property, articulatory property.*

The goals, objects and method of investigation. In 2021–2022, the Institute of the Lithuanian Language launched the project *The Sound System in the Contemporary Baltic Languages at the Beginning of the 21st Century: Comparative Acoustic and Perceptive Research of Sonorants* (BaltSon, this project was supported by the Research Council of Lithuania). The aim of the project was to carry out the instrumental comparative study of the Baltic sonorants pronounced in various positions. The **goal** of this article is to compare the sonorants of the standard Lithuanian language pronounced in prevocalic ([R]VR), intervocalic (V[R]V) and postvocalic (RV[R]) positions, highlight their acoustic and articulatory properties and reveal the variations of the sonorant system in the Lithuanian language.

Sonorant sounds are produced with a relatively free airflow, its opposite is non-sonorant (or obstruent) (Crystal, 2008, p. 442). All Lithuanian sonorants are classed as voiced consonants with no voiceless counterparts. The pronunciation of sonorants is dominated by the elements of tone (which is a feature of a vowel), the bands of their formants are visible relatively well, and the whisper, noise, or hum (which are the features of a consonant) are typically (yet inconsistently) clearer for some sonorants, such as [v], [vʲ] only (Ambrazevičius, 2011, p. 43). The

classification of Lithuanian sonorants by the place and manner of articulation is systemized in Table 1.

Table 1

Classification of Lithuanian sonorants

(LG 2006, p.46–47; Pakerys 2003, p. 84; Kazlauskienė 2018, p. 58; Urbanavičienė, Indričāne, Jaroslavienė & Grigorjevs 2019, p. 25)

Manner of articulation		Place of articulation					
		bilabial	labio-dental	dental	alveolar	palatal	velar
sonorant	approximant		/v/ /vʲ/			/j/	
	nasal	/m/ /mʲ/		/n/ /nʲ/			[ŋ] ¹ [ŋʲ]
	lateral			/l/	/lʲ/		
	trill				/r/ /rʲ/		

The empirical material was read by 12 Lithuanian informants – 6 males and 6 females – who were native speakers (aged 21 to 42); their pronunciation meets the norms of standard Lithuanian. Every segment ([R]V[R], V[R]V clusters) covered by the research was repeated up to 3–5 times. The records were made with a portable high-resolution recorder *Tascam DR-100MK II* and a headset *AKG C 520*. The study was conducted using Praat, Microsoft Excel and SPSS software.

The article analyzes the main acoustic features of sonorants: the structure of the F1–F4 formants; the frequency range of the anti-formant (Z1); the nasal formant (N1); the nasal formant band width (B1) (more about the methodology: Urbanavičienė, Indričāne, Jaroslavienė, Grigorjevs 2019, p. 61–66; Urbanavičienė, Taperte 2022, p. 97–98; Urbanavičienė, Taperte 2022a, p. 213–214).

The laterals of the Lithuanian language. Based on the structure of the F1–F4 formants, Lithuanian lateral consonants – the dental [l] and the palatalized dental [lʲ] – have been found to differ significantly taking account of the different (prevocalic, intervocalic, and postvocalic) positions of the RVR combination, the place of articulation of laterals, and the phonetical context of the adjacent vowels.

¹ The velar allophone of /n/ which occurs before [–k/–g] in the Lithuanian language.

The results of the research allow classifying the palatalized [lʲ] as alveolar and the non-palatalized [l] as dental consonants in terms of the place of articulation.

In contrast to the comparable non-palatal F1–F4, the formants of the palatalized [lʲ] are more stable and less dependent on the adjacent vowels than the non-palatalized [l].

The phonetic context of the vowels affects the intensity of palatalization: the pronunciation of the palatalized [lʲ] next to the front vowels [ɪ], [i:], and [e:] becomes ‘softer’ compared to the way it is pronounced next to the fronted back vowels [ɔ], [ɔ:], [ʊ], and [ʊ:].

The nasals of the Lithuanian language. The research has found the acoustic qualities of the nasal sonorants of the Lithuanian language, such as the nasal formant (N1), the width of the nasal formant frequency band (B1), and the anti-formant (Z1), to have varying differential weights. Based on the increase/decrease of their acoustic quality, Lithuanian nasals can be arranged in certain sequences (see Table 2).

Table 2

Comparative analysis of the acoustic features of Lithuanian nasals
 (the symbol “<<” means statistical significance using SPSS software)

Acoustic feature	Lithuanian nasals
Nasal formant (N1)	dental [n, nʲ] < labial [m, mʲ] << velar [ŋ, ŋʲ]
Nasal formant band width (B1)	palatalized labial [mʲ] < palatalized dental [nʲ] < dental [n] < palatalized velar [ŋʲ] << labial [m] < velar [ŋ]
Anti-formant (Z1)	labial [m, mʲ] < dental [n, nʲ] << velar [ŋ, ŋʲ]

The data of the frequency of the nasal formant (N1) and its band width (B1) set the velar allophones [ŋ, ŋʲ] far apart from the non-velar nasal sonorants: labial [m, mʲ] and dental [n, nʲ]. The differences between the respective acoustic properties of the labial and dental nasals are small (see Table 2).

According to the frequencies of antiformants (Z1), it is possible to distinguish between Lithuanian velar and non-velar nasals – Z1 values of velar nasals are usually higher: [m, mʲ, n, nʲ] < [ŋ, ŋʲ]. The Z1 values of Lithuanian palatalized nasals [mʲ], [nʲ] are higher than those of the corresponding non-palatalized nasals, but no clear divergence has been observed.

The trills of the Lithuanian language. The Lithuanian trills [r] and [rʲ] have been analysed in terms of several acoustic features: by determining the dynamics of the formants F1, F2, F3, and F4 in a prevocalic, intervocalic, and postvocalic position; by comparing the values of the trill formants in the context of different vowels; and by examining the statistical significance of the differences in formants.

Table 3

The F1–F4 formants of Lithuanian trills

Formant	Lith. [r]	Lith. [rʲ]
Formant values (average of all realisations, Hz)		
F1	450	360
F2	1280	1810
F3	2370	2690
F4	3530	3750
Direction of formant shift in the context of different vowels		
F1	↘ with high vowels, ↗ with low vowels	
F2–F4	↗ with V ⁱ , ↘ with V ^u	↗ with V ⁱ , ↘ with fronted V ^u

A comparison of the summarized values of the formants has revealed that the highest value of the F1 formant is typically found in Lith. [r] and has to do with velarization, while the lowest value of the F1 formant is present in Lith. [rʲ], which typically does not involve any velarization. The highest value of the F2 formant has been estimated for Lith. [rʲ] and can be accounted for by the secondary palatalization, while the lowest F2 value is typically present in the non-palatalized Lith. [r].

The position within the syllable affects the structure of the Lithuanian trill formants. This position has a very high impact on the first formant, the second formant being the most indifferent one.

The context of the adjacent vowels has a similar effect on the dynamics of the trill formants in the Lithuanian language: the first formant has to do with the rise of the adjacent vowel (with F1 dropping before high vowels and rising before low vowels), and the second formant and the subsequent formants depend on whether the adjacent vowel is front, central, or back (with back vowels making the F2 formant drop, and front vowels go up). This correlation has failed to work out with the data for the F4 formant of Lith. [r] only. The research has shown that fronted back vowels tend to cause the F2 formant of Lith. [rʲ] to go up to a lesser extent, compared to the adjacent front vowels. The syllable position affects the formants of Lithuanian trills equally: when comparing the <R>VR – V<R>V –

RV<R> positions, the formant frequencies of Lith. [r] and [r̥] ascend (except F1, see Table 3).

Conclusion. The study has shown that there is no single distinctive acoustic feature that would distinguish between all the Lithuanian sonorants. Sonorants must be studied in a comprehensive manner by evaluating various parameters: syllable or phrasal position, stress, speaking style and other aspects. Parallel study of perception would be beneficial to link acoustic and articulatory data with auditory processes.

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