Varvara Petrova

Lomonosov Moscow State University

petrovavarvara2004@gmail.com

Spectral features of Ossetic sibilants as acoustic cues for their place of articulation and airstream mechanism

Sibilant fricatives and affricates in Ossetic are subject to significant dialectal variation. There are 8 phonologically distinct sibilant fricatives and affricates in Iron Ossetic (/s/, /ʃ/, /z/, /ʒ/, /t͡ʃ/, /d͡ʒ/, /t͡s’/, /t͡ʃ’/) and 5 – in Digor Ossetic (/s/, /z/, /t͡s/, /d͡z/, /t͡s’/), many of which have multiple allophones. The sets of allophones for some of the phonemes vary not only across the dialects, but also within both of the dialects: there are differences between Standard Iron and Kudaro-Dzau Iron, Digora Digor and Chikola Digor. To this day, the only qualitative instrumental research has been done for Standard Iron; centre of gravity (CoG), which has been established as a reliable cue for place of articulation of sibilants and could enable a cross-linguistic comparison, has never been measured for sibilants of any variety of Ossetic.

For this study, CoG was used as a measure of the nature of frication. Its high correlation with the place of articulation of sibilants was determined for a variety of languages, see e. g. [Jongman et al. 2000], [Padgett & Zygis 2007]. The interaction of CoG and airstream mechanism is a less known phenomenon. It was postulated to be higher for Mehri ejective fricatives than for their pulmonic counterparts in [Ridouane et al. 2016]. The same tendency could be assumed true for the affricates of Chajul Ixil based on data visualization in [Adell 2016], however, only the difference between CoG of consonants within each airstream mechanism group was investigated statistically in the paper.

Data for this research were collected in Vladikavkaz in July 2024. The consultants were asked to translate the words from Ossetic to Russian, then pronounce each word they were familiar with in a natural manner and repeat it twice with a pause after each utterance. The procedure was repeated for the same words in a pre-determined carrier phrase, which contained the stimulus in the intervocalic environment and was the same for all of the stimuli obtained from one speaker. The utterances were recorded on Zoom H5 recorder using a WH20XLR microphone. The questionnaires were made separately for Iron and Digor. For each dialect, they consisted of the stimuli containing every sibilant consonant present in its system before every vowel 1) word-initially and 2) word-medially in the intervocalic position (Ossetic vowel systems consists of /i/, /e/, /u/, /o/, /ɜ/, and /a/ in both dialects and, additionally, /ə/ in Iron, see e. g. [Sokolova 1953]); the vowels following the sibilant consonants were stressed.

Consonant	Vowel	Stimuli (word-initial sibilant)	Stimuli (intervocalic sibilant)
/s/	/a/	/sag/ ‘deer’	/basast/ ‘defeat’
/z/	/a/	/zard/ ‘song’	/wazal/ ‘frost’
/t͡s/	/a/	/t͡savd/ ‘hit’	/wat͡sar/ ‘captivity’
/t͡s/	/i/	/ t͡sirt/ ‘grave’	/kɜt͡si/ ‘which’
/t͡s’/	/i/	/ t͡s’ink/ ‘stab’	/χilit͡s’i/ ‘rubble’
/d͡z/	/a/	/d͡zabur/ ‘shoe’	/id͡zag/ ‘full’

Table 1. Selected stimuli from the questionnaire for the speakers of Digor Ossetic.

The segmentation was carried out manually in Praat [Boersma & Weenink 2024]. The difference in realization of /s/ by the speakers of Standard Iron ([s]) and Kudaro-Dzau Iron ([ʃ]) is shown in Picture 1: lower COG corresponds to the posterior place of articulation.

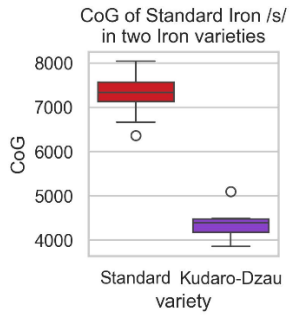
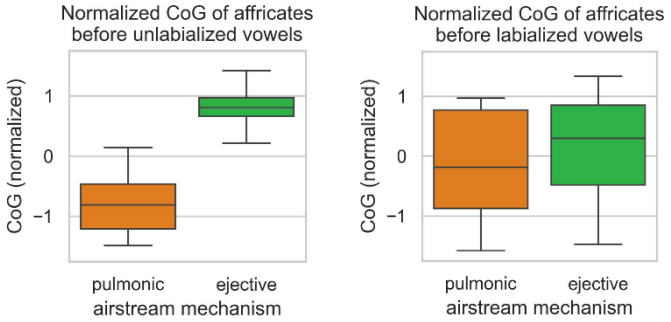


Figure 1. CoG of realizations of /s/ by the speakers of Standard Iron and Kudaro-Dzau Iron.

Data investigated for the influence of airstream mechanism on COG were normalized as follows: $\frac{(xi-xmean)}{\sigma}$, where x_{mean} is a mean value for all of the fricative phases of pulmonic and ejective affricates of the same speaker before the same vowel, σ is a standard deviation. The UMW test shows there to be a significant correlation between higher CoG and ejective quality in the environment before unlabialized vowels, which allows us to postulate CoG as a cue for the type of airstream mechanism in affricates. A cross-linguistic parallel for neutralization in pre-labialized environment can be found in [Heegård Petersen 2024], where pre-labialized position of Argentine Danish alveolar affricate was associated with lowered CoG.

The connection of sibilant spectral properties to their place of articulation, voicing, and airstream mechanism in all of the aforementioned varieties of Ossetic as well as the influence of the position in a word on physical properties of sibilants will be discussed in detail in the talk.



Figures 2a-b. Normalized CoG of Digor affricates before a) unlabialized and b) labialized vowels.

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