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Tatiana Mamonova, George Moroz

VOT FEATURES OF CONSONANTS IN ABAZA

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Tatiana Mamonova[1], George Moroz[2]

VOT FEATURES OF CONSONANTS IN ABAZA[3]

Voice onset time (VOT) is a parameter which distinguishes the way consonants are articulated . This parameter is widely used in acoustic phonetics. In particular, there are many studies of it in the languages of the world. This paper presents an analysis of VOT in the Abaza language (Northwest Caucasian). We measured the VOT of plain consonants and ejectives, extracted annotated values and performed mixed effects regression showing the influence of the place of articulation and phonation type on VOT values.

JEL Classification: Z.

Keywords: plosives, VOT, acoustic phonetics, Northwest Caucasian languages, Abaza.

[1] HSE University, School of Linguistics, t_mamonovaa@outlook.com
[2] Linguistic Convergence Laboratory, HSE University, Junior Research Fellow, agricolamz@gmail.com
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1.Introduction

1.1 Closure duration and voice onset time

Consonants cross-linguistically differ by a number of features. For example, CD (closure duration) and VOT (voice onset time) measurements show the distinction of consonants by place and manner of articulation in all languages. In particular , these features show variance between voiced, voiceless and ejective consonants. This contrast is explained by different types of phonation: ejectives involve both oral and glottal closure, with a so-called glottalic initiation (cf. Catford, 1977), i.e. an upward movement of the larynx providing the necessary pressure difference for the stop release. Voiced consonants tend to have negative VOT because voicing time starts before the burst (cf. Cho and Ladefoged, 1999).

There is much research about VOT. Cross-linguistic diversity of VOT values is shown in Cho and Ladefoged's paper (1999). They present VOT measures in 18 languages around the world and demonstrate that there is no general trend for the VOT parameter which distinguishes ejectives and plain consonants. Furthermore , they prove that a boundary between voiceless aspirated and voiceless unaspirated consonants must be defined for each language separately (Abramson & Whalen, 2017). Moreover, it is known that VOT depends on many features such as the place of articulation (the further the back the closure, the longer the VOT is), prosodic position and speaking rate (Fischer, Jorgensen, 1954; Peterson & Lehiste, 1960; Wysocki, 2004; Vicenik, 2010; Grawunder/Simpson/Khalilov 2010).

Features of VOT in Caucasian languages have been studied in detail, too. Catford (1992) measured VOT duration in a number of Caucasian languages which belong to different language families: East, North and South Caucasian. He found that there is a tendency for "the VOT of aspirated stops to be longer in languages where these are contrasted with unaspirated stops" and there is a significant variety between VOT values. Gravunder (2017) used a sample of eleven Caucasian languages. He found that there are alternations between the VOT difference of ejective and non-ejective consonants. In some languages the VOT for ejectives was longer than the VOT for voiceless consonants,while in others the VOT values of ejectives were shorter. Gordon and Appelbaum (2006) in an article on the phonetic structures in Kabardian, a Northwest Caucasian language, also investigated VOT features. They found that in the intervocalic position aspirated stops have bigger values than ejectives.

Most previous descriptions of Abaza consonants (Genko 1955, Tabulova 1976, O'Herin 1992, and others) do not provide any phonetic evidence, so this is the first acoustic analysis of Abaza. The aim of this paper is to present the results of comparison of the VOT measurements made for plain consonants and ejectives in the Abaza language (one of the first acoustic research papers on this language) and describe the impact of place of articulation on VOT.

This article consists of following sections. In the rest of the Introduction Abaza language and its phonology (1.2), where a brief description of the Abaza phonetic system is given. Materials and methods are discussed in Section 2. Section 3 is about the results of our research. In the last section, we provide a discussion of our study.

1.2 Abaza and its phonology

Abaza is a language of the Abkhaz-Abaza group of Northwest Caucasian languages. It is spoken in Russia (mostly in the Karachay-Cherkess Republic) and in Turkey. According to the 2010 Russian census, there are slightly less than 38 thousand speakers of Abaza in Russia. The exact number of speakers in other countries, mainly in Turkey (Chirikba 2012), is unknown.

Abaza has a complex system of consonants (Table 1). It consists of 65 segments. There is a distinction between voiced, voiceless and ejective. Consonants in the brackets are rare, allophonic or loaned from Circassian. The sounds /dẑ/, /tŝ'/, /tŝ/, /ẑ/, /ŝ/ are specific sounds of Northwest-Caucasian languages which are known as hissing-hushing fricatives (Chirikba 1983), dental-alveleolar fricatives (Kumakhov 1981, Chirikba 1983), lamino-alveo-palatal fricatives (Colarusso 1988), or post-alveolar sibilants (Ladefoged, Maddieson 1996).

Table 1. Abaza consonant system. (vo - voiced, ej - ejectives, pl - plain)

	plosives			affricates			fricatives			sonorants	
	vo	ej	pl	vo	ej	pl	vo	ej	pl		
labial	b	p’	p				(v)	(f’)	(f)	m	w
dental	d	t’	t	dz	ts’	ts	z		s	n	
alveolar											r
post-alveolar				dẑ	tŝ’	tŝ	ẑ		ŝ		

retroflex				dʐ	tʂ’	tʂ	ʐ		ʂ		
alveolo-palatal				dʑ	tɕ’	tɕ	ʑ		ɕ		
palatal									(ç)		j
lateral							(ɮ)	(ɬ̣)	(ɬ)		l
velar	g	k’	k								
	g^{j}	k’^{j}	k^{j}								
	g^{w}	k’^{w}	k^{w}								
uvular		q’	q				ʁ		χ		
		q’^{j}					ʁ^{j}		χ^{j}		
		q’^{w}	q^{w}				ʁ^{w}		χ^{w}		
laryngeal			ʔ				ʕ		ħ		
							ʕ^{w}		ħ^{w}		

There are two basic vowel phonemes in Abaza: /a/ and /ə/. In addition, there are four additional vowel segments found mainly in loanwords or which arise when vowel + glide sequences contract: [u] (< /əw/ and /wə/), [o] (< /aw/), /i/ (< /əj/ and /jə/), [e] (< /aj/). Unlike other Northwest Caucasian languages /ə/ is not realised as [a] after /ħ/ or /ħ^{w}/. Stress is distinctive in Abaza. The stressed syllable is longer and more intensive than the non-stressed. In this paper the stressed vowel is marked with the acute, e. g. /sará/.

2. Materials and methods

2.1 Materials

The data analysed in this study were recorded in July 2018 during a field trip to the village of Inzhich-Chukun in the Karachay-Cherkess Republic in Russia. Six female native speakers of Abaza (aged 19 to 59) were recorded in a separate classroom at the local school with the windows shut. The speakers produced three repetitions of a set of 100 stimuli containing the target plosive in two-syllable words with the vowel /a/ and a stop consonant in the intervocalic position (the stimuli list is available in Appendix 1). All stimuli were presented in two languages at the same time: Russian and Abaza. The words were embedded in a carrier phrase: /sará aẑá X χən isħ^{w}át'/ ‘I said (word) three times’. Speakers were recorded using a Tascam DR-40 recorder. The recording settings were set to .wav, 44.1 kHz, 16-bit, stereo. The stimuli were automatically gathered from a dictionary (Tugov 1967): if a word had two syllables, all of its vowels were /a/, and it was not loaned, our Python script appended it into the list of stimuli . There were no appropriate words with a plain velar, but one of the speakers pronounced the uvular written as <хъ> in the traditional orthography like a plain velar consonant. The distribution of consonants in our dataset is presented in Figure 1.

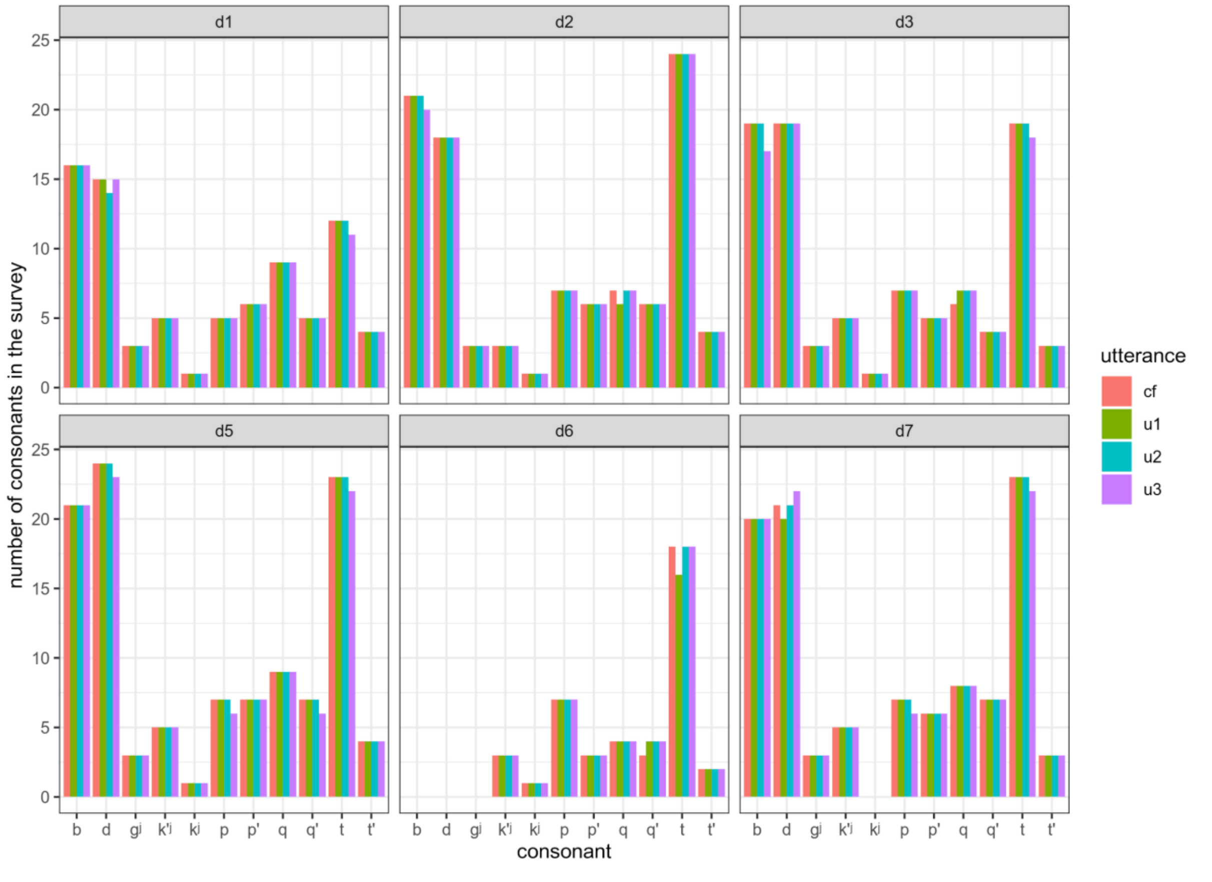

Figure 1. Number of analyzed consonants coloured by utterance

2.2 Methods

We measured CD and VOT durations and the duration of the preceding and following vowels. The Praat (Boersma, Weenink 2018) annotation consists of 4 labels: CD and VOT, consonant, word, and utterance. Figure 2 shows the example of annotation. After that, annotation data were extracted with Praat script and analyzed in R (R Core Team 2019). All data and annotations are available online: https://github.com/agricolamz/abaza_vot_with_mamonova.

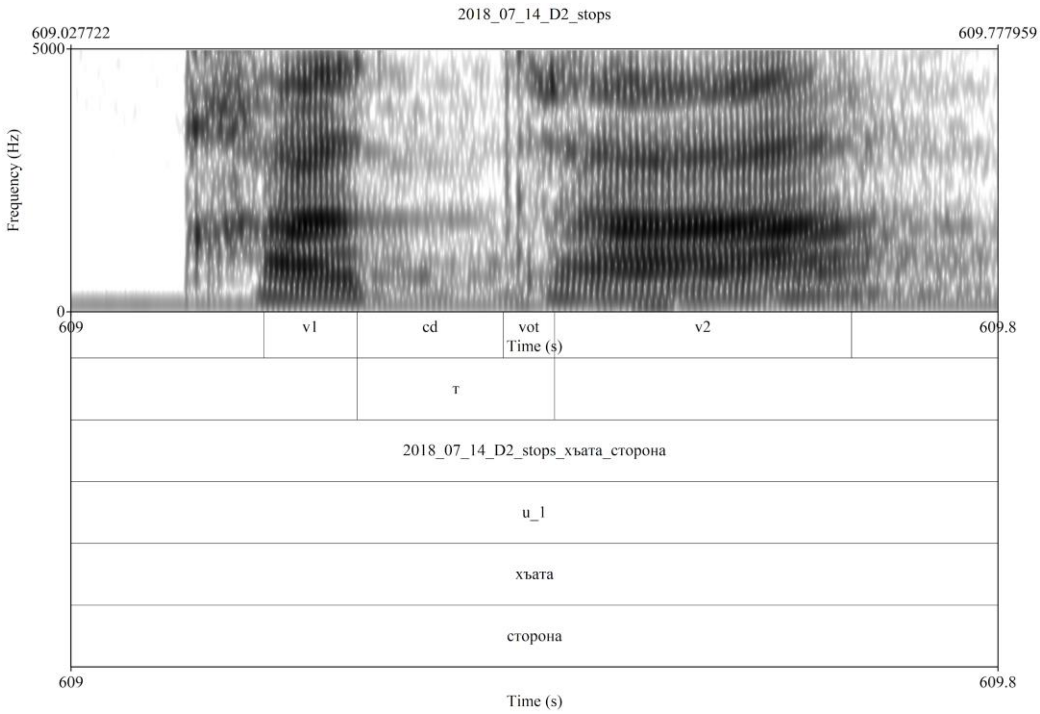

Figure 2.The example of annotation in Praat. The tiers include annotation, sound, filename, utterance, stimulus, and its translation.

The statistical analysis and visualisation were made with the following packages for R (R Core Team 2019): ggplot2 (Wickham 2006), ggbeeswarm (Clarke, Sherrill-Mix 2017) lme4 (Bates, Maechler, Bolker, Walker 2015), lmerTest (Kuznetsova, Brockhoff, Christensen 2017), effects (Fox, Weisberg 2019).

3. Results

The resulting CD and VOT values are presented in Figure 3. Each point on the plot corresponds to one observation, which quasi randomly offsets the type of phonation variable from each value. Each row corresponds to the number of an utterance (1, 2, 3, and cf -- carrier phrase). From the graph we see that the VOT of voiced plosives is negative (which is obvious), but the VOT values of voiced consonants tend to be greater than values of ejectives among all pronunciations and places of articulation.

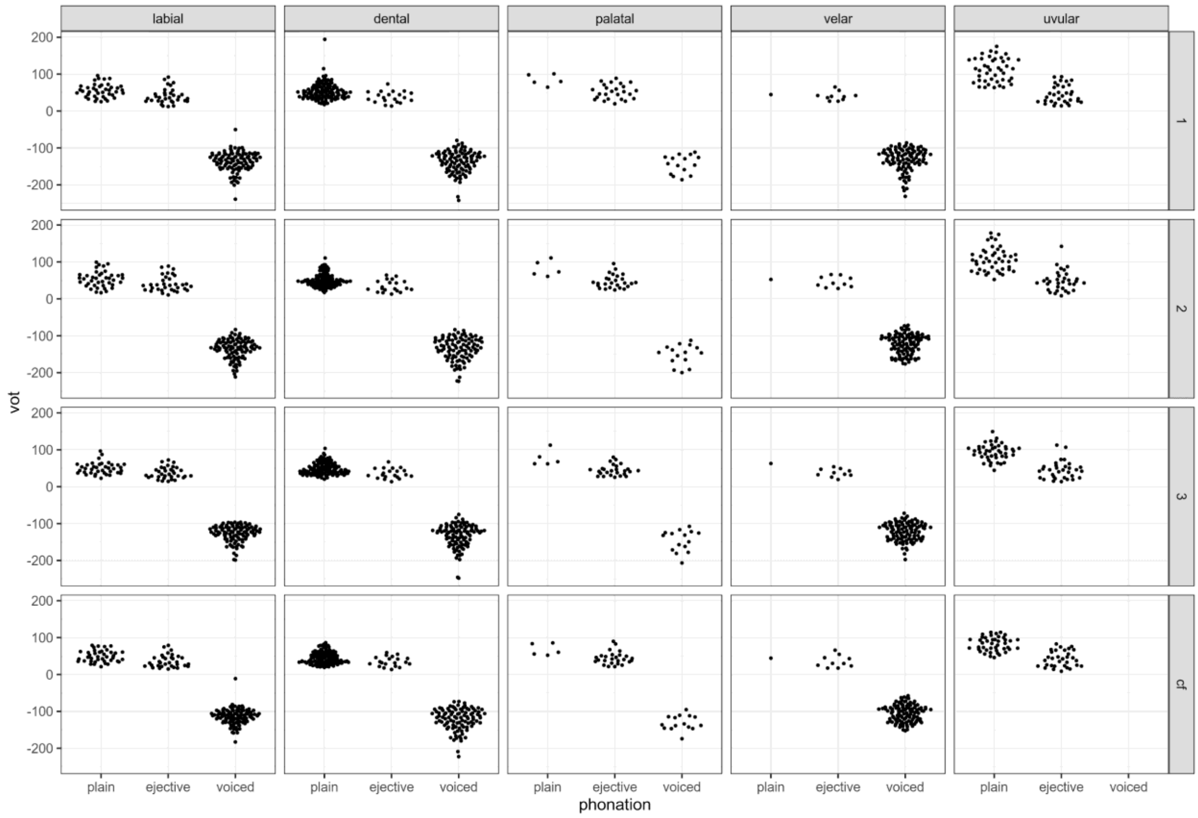

Figure 3. Distribution of VOT values by the type of phonation and number of utterance

In order to check our observations, we decided to evaluate a mixed effects regression model, computing differences between all kind of places of articulation and types of phonation. In Table 2 we present the fixed effect results of the linear regression model which predicts the VOT duration using the place of articulation and the type of phonation. Speaker, utterance and word were used as a random effect. The *lme4* (Bates, Maechler, Bolker, Walker 2015) formula used for this model is the following:

VOT~POA+phonation+(1|speaker)+(1|utterance)+(1|word)

As is seen in Table 2, VOT values in plain labial sounds were used as a reference level, so estimated values show the difference between the reference level and the corresponding variable. All variables except *dental* and *palatal* are highly statistically significant.

		estimate	std. error	df	t value	p-value	
(Intercept)		53.237	3.172	17.763	16.783	2.44e-12	***
poa	dental	-3.713	2.173	381.048	-1.709	0.0882	.
poa	palatal	8.609	3.575	431.867	2.408	0.0164	*
poa	uvular	26.464	3.152	391.254	8.397	8.54e-16	***
phonation	ejective	-23.091	2.622	430.611	-8.807	2e-16	***
phonation	voiced	-181.01	2.257	393.852	-80.197	2e-16	***

Table 2. Estimated coefficients from linear mixed effects regression

Overall estimated effects are as follows (see Figure 3.):

- average VOT values are increasing from labials and dentals to palatals and uvulars
- average VOT values for plain sounds are greater than ejectives, and of course voiced plosives have the lowest values of VOT

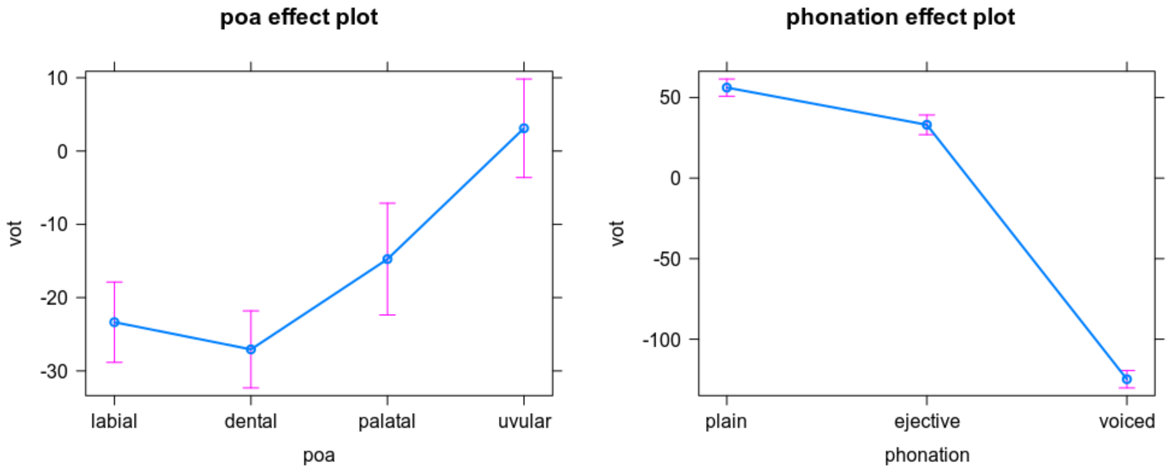

Figure 4. Fixed effects of linear regression created by the effects package (Fox, Weisberg 2019)

4. Discussion

The POA effect plot shows VOT values of consonants of different places of articulation. We see that the VOT depends on place of articulation. Dentals demonstrate the smallest VOT values. Labials also have small values. Then VOT values rise significantly: palatals and uvulars have the largest VOT values. Moreover, the graph demonstrates that predicted average VOT values of different places of articulation do not overlap.

The second graph shows that phonation also has an impact on VOT. As expected, voiced consonants have a negative VOT because of their articulational properties. Plain voiceless consonants have a bigger VOT than ejectives.

Based on the results of our research, we can state that typologically Abaza belongs to languages where VOT values of plain consonants is bigger than VOT values of ejectives. In fact, similar conclusions have been reached earlier for Circassian languages, which also belong to the Northwest Caucasian family.

It is worth noting, however, that the sample in our study was not balanced enough: it contains many labials and dentals, but only a few velar consonants. Further study of VOT features of Abaza consonants may include more detailed research of velars and how the VOT changes in different positions in the word.

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Appendix 1

Table with stimuli used in the survey.

	Transcription	translation	russian stimuli
1	Ába	where	куда, где
2	Abár	here	вот
3	Abán	there	вон
4	Adá	frog	лягушка
5	agá	howbeit	как бы то ни было
6	aqá	moth	моль
7	bába	shaggy	лохматый
8	bagá	fox	лиса
9	bzíta	good	хорошо
10	dabár	here (about a man)	вот (о человеке)
11	habár	news	известия
12	sabáp	benefit	польза
13	g^{w}abán	mattress	матрас
14	ẑabá	ten	десять
15	q’abát	layer	слой
16	tɕ’ága	dishes	посуда
17	dzgága	water pipes	водопровод
18	g^{j}ába	side	бок
19	lába	male dog	кобель

20	labá	stick	палка
21	sába	dust	пыль
22	tába	pan	сковорода
23	tɕába	gelding	мерин
24	tɕ’zába	widow	вдова
25	tŝ’ába	wax	воск
26	q^{w}bába	hairy	волосатый
27	pq’ága	threshing tools	орудия для молотьбы
28	qáda	without headgear	без головного убора
29	ʔdáb	good manners	воспитанность
30	qatáχ^{w}	cost price	себестоимость
31	ɕáta	root	корень
32	tŝgáta	evil	зло
33	tɕ’gáta	on an empty stomach	натощак
34	tɕq’áta	clear	чисто
35	χ^{w}áta	scarf	шаль
36	tʂ’aqá	face	лицо
37	maqá	arm	рука
38	ẑʕ^{w}aqá	shoulder	плечо
39	ẑáqa	the day before yesterday	позавчера
40	dzaqá	start	начало

41	mtʂ’t’át’a	linden	липа
42	q’ʲatá	slushy	слякотный
43	ɬʲag’án	basin	таз
44	gʲágʲa	a circle	круг
45	t’át’a	viscous	вязкий
46	qatátŝ’	private	личный
47	fatár	apartment	квартира
48	k’ʷatán	plow	плуг
49	g’atán	tarpaulin	брезент
50	qatá	side	сторона
51	g’áta	saber	сабля
52	sʕáta	low	низко
53	pʂdzáta	beautiful	красиво
54	lʕʷáta	smoky	дымно
55	ẑp’áta	thick	густо
56	ʕʷbáta	twice	вдвое
57	gʷtɕ’áta	eagerly	жадно
58	k’áta	net	сеть
59	ts’áp’a	vile	мерзкий
60	qáp’a	dandruff	перхоть
61	λáp’a	expensive	дорогой
62	qapáχ’	forehead	лоб

63	ƛapád	stocking	чулок
64	ʔápa	keys	клавиш
65	napa	face	лицо
66	ḳ’ápa	tail fat	курдюк
67	q’ʷápa	angle	угол
68	gʷápa	pleasant	приятный
69	nak’áh	marriage	брак
70	qaq’áb	with a pumpkin head	с головой как у тыквы
71	χbʁ’qáq’apɕ	clover	клевер
72	saq’át	disabled	инвалид
73	rqaq’áb	cucumber	огурец
74	žaḳ’áʒ	fishing rod	удочка
75	k’ak’án	nut	орех
76	qáq’apɕ	red-headed	красноголовый
77	ts’ák’ʲa	nit	гнида
78	qʷák’ʲa	fringe	бахрома
79	žák’ʲa	beard	борода
80	dzak’ʲá	edge	край
81	ts’ladágʷ	horse-chestnut	лжекаштан
82	hʷadagʷ	saltbush	лебеда
83	tšadá	donkey	осел
84	ʕwáda	slope	косогор

85	g’adáš’	chicken coop	курятник
86	zʕʷáda	healthy	здоровый
87	záda	steep	крутой
88	dáda	grandfather	дед
89	nχáda	lazy	ленивый
90	pts’áda	beardless	безусый
91	pχáda	unceremonious	бесцеремонный
92	tsáda	colourless	бесцветный
93	mšgága	pastime	времяпрепровождение
94	lága	fool	дурак
95	tŝsága	razor	бритва
96	kʷnága	merit	заслуга
97	nχága	tool	инструмент
98	ága	hoe	мотыга
99	χʷagá	shadow	тень
100	ž’ága	bait	приманка

Tatiana Mamonova
HSE University, School of Linguistics, t_mamonovaa@outlook.com

George Moroz
Linguistic Convergence Laboratory, HSE University, Junior Research Fellow,
agricolamz@gmail.com

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