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ILLUSTRATIONS OF THE IPA

Kalasha (Bumburet variety)

Alexei Kochetov

University of Toronto

al.kochetov@utoronto.ca

Paul Arsenault

Tyndale University College

parsenault@tyndale.ca

Jan Heegård Petersen

University of Copenhagen

janhp@hum.ku.dk

Sikandar Kalas

Central Film School, London

sikandarkalas@gmail.com

Taj Khan Kalash

Kalasha Heritage Conservation Initiative

himalayanleo@gmail.com

Kalasha (ISO 639-3: kls), also known as Kalashamon, is a Northwestern Indo-Aryan language spoken in Chitral District of Khyber Pakhtunkwa Province in northern Pakistan, primarily in the valleys of Bumburet, Rumbur, Urtsun, and Birir, as shown in Figure 1.ⁱ The number of speakers is estimated between 3000 and 5000. The *Ethnologue* classifies the language status as ‘vigorous’ (Eberhard, Simons, & Fennig 2019) but some researchers consider it ‘threatened’ (Rahman 2006; Khan & Mela-Athanasopoulou 2011). Kalasha has been in close contact with Nuristani and other Northwestern Indo-Aryan languages. Among the latter, the influence of Khowar has been particularly strong because it functions as a *lingua franca* of Chitral District (Liljegren & Khan 2017). The Kalasha lexicon includes many loanwords from Khowar, as well as from Persian,

Arabic, and Urdu (Trail & Cooper 1999). Early efforts to put the language in writing employed Arabic script but a Latin-based script was adopted in 2000 (Cooper 2005; Kalash & Heegård 2016).

An early study of the Kalasha sound system is Morgenstierne (1973 [based on fieldwork conducted in 1929]). More recent studies include Trail & Cooper (1985), Mørch (1995), Mørch & Heegaard (1997), Bashir (2003), Heegård & Mørch (2004), Cooper (2005), Heegård Petersen (2006), Di Carlo (2010), and Heegård Petersen (2015). A dictionary consisting of about 6000 words was published by Trail & Cooper (1999). A revised and searchable online version of this dictionary is being used for language education and revitalization (FLI n.d.).

<Insert Figure 1 about here>

Kalasha dialects can be classified into three groups: a northern group which encompasses the valleys Rumbur, Bumburet, Birir and Jinjiret, a southern group, which includes only the valley Urtsun, and a now extinct eastern group, which encompasses former Kalasha villages along the Kunar river and in the Shishi Kuh valley (Heegård & Mørch 2017). The present description is concerned with northern Kalasha, as spoken in the Bumburet (Mumuret) valley. It is based on the speech of two male speakers from the village of Krakal (*Kraka*’ [kraka-]). Both are co-authors of this paper: Sikandar Kalas (SK) and Taj Khan Kalash (TKK). The speakers are in their 30s. At the time of the recording, they were residing in Greece but continued to maintain close contact with the Kalasha community in Pakistan. Both have been involved in efforts to preserve and revitalize the Kalasha language and culture. Word examples presented below are from Trail & Cooper’s (1999) dictionary or its revised online version (FLI n.d.). All items were confirmed with our native speaker co-authors. The recordings were made in a quiet room using a Zoom H4n digital recorder and an AudioTechnica AT831b lavalier microphone, with a 44100 Hz sampling rate. Acoustic analysis of selected data was performed using Praat (Boersma & Weenink 2018). Sound files for words mentioned below are provided for one of the speakers, SK.

Consonants

	Bilabial	Dental/ Alveolar	Patalal- ized alveolar	Retroflex	Alveolo- palatal/ Palatal	Velar	Glottal

Plosive	p b	t̪ d̪		t̪ d̪		k g	
	p ^h b ^h	t̪ ^h d̪ ^h		t̪ ^h d̪ ^h		k ^h g ^h	
Affricate		ts ɖ		t͡s ɖ͡	t͡ʃ ɖ͡ʃ		
		ts ^h		t͡s ^h	t͡ʃ ^h ɖ͡ʃ ^h		
Nasal	m	n		(ŋ)			
Trill/Tap		r					
Fricative	(f)	s z		ʃ ʒ	ç ʝ	(x)	h
Approximant	w				j		
Lateral approximant		ɭ	ɭ ^j				

An important characteristic of the Kalasha consonant inventory is a robust set of place contrasts within the class of coronal obstruents, which includes a 3-way distinction between dental/alveolarⁱⁱ, retroflex, and alveolopalatal affricates and fricatives, and a 2-way distinction between dental and retroflex plosives. While retroflex plosives are typical of Indo-Aryan languages, retroflex affricates and fricatives are an areal feature of the Hindu-Kush region (Ramanujan & Masica 1969; Arsenault 2017). Another important characteristic is the 4-way laryngeal contrast in plosives and (to a lesser extent) affricates, which includes plain voiceless, plain voiced, aspirated voiceless, and breathy voiced categories. A 4-way contrast of this kind is quite common in Indo-Aryan languages of the subcontinent (at least in plosives); however, most languages of the Hindu-Kush region tend to have a reduced, 3-way contrast (plain voiceless, plain voiced, and aspirated voiceless; Hussain 2018). Sample words with these and other consonants in word-initial position are provided below, both in phonemic IPA transcription and in the Kalasha orthography.

Plosives	/p/	par	<i>par</i>	‘previous’
	/p ^h /	p ^h ar	<i>phar</i>	‘load’
	/b/	baw	<i>baw</i>	‘crowd’
	/b ^h /	b ^h as	<i>bhas</i>	‘heat’
	/t̪/	t̪ar	<i>tar</i>	‘(kind of) tree’

	/t̪ ^h /	t̪ ^h ar	<i>thar</i>	‘upper side’
	/d̪/	d̪ar	<i>dar</i>	‘wooden beam’
	/d̪ ^h /	d̪ ^h ar (d̪jek)	<i>dhar (dyek)</i>	‘to lean’
	/t/	tak	<i>t’ak</i>	‘stingy’
	/t̪ ^h /	t̪ ^h uk	<i>t’huk</i>	‘second’
	/d̪/	d̪uk	<i>d’uk</i>	‘top’
	/d̪ ^h /	d̪ ^h ũk (hik)	<i>d’hũk (hik)</i>	‘to meet’
	/k/	kaw	<i>kaw</i>	‘olive’
	/k ^h /	k ^h aw	<i>khaw</i>	‘threshing floor’
	/g/	gaw	<i>gaw</i>	‘cowhide’
	/g ^h /	(^l ɕuni) g ^h aw	<i>(shuni) ghaw</i>	‘place name’
Affricates	/ts/	tsaɬ	<i>tsat</i>	‘size’
	/ts ^h /	ts ^h ar	<i>tshar</i>	‘funeral food’
	/d͡z/	d͡zã ^l raj (mut) [d͡zã ^l rãj mut]	<i>dzã’ray (mut’)</i>	‘a kind of oak’
	/t͡s/	t͡sok	<i>c’ok</i>	‘unstable’
	/t͡s ^h /	t͡s ^h ok	<i>c’hok</i>	‘pulp’
	/d͡z/	d͡zɛt͡s	<i>j’ac’</i>	‘spirit beings’
	/t͡ɕ/	t͡ɕaw	<i>caw</i>	‘four’
	/t͡ɕ ^h /	t͡ɕ ^h ar	<i>char</i>	‘noise’
	/d͡ɕ/	d͡ɕa	<i>ja</i>	‘wife’
	/d͡ɕ ^h /	d͡ɕ ^h aw	<i>jhaw</i>	‘fence’
Fricatives	/s/	sar	<i>sar</i>	‘lake’

	/z/	zar	<i>zar</i>	‘shiny’
	/ʃ/	ša	<i>s’a</i>	‘king’
	/z̥/	z̥ek (hik)	<i>z’ek (hik)</i>	‘become tired’
	/ç/	çak	<i>shak</i>	‘vegetable’
	/z̥/	‘zo̯ei	<i>zhoshi</i>	‘spring festival’
	/h/	hak	<i>hak</i>	‘possessions’
Sonorants	/m/	mon (mondr)	<i>mon (mondr)</i>	‘word’
	/n/	non	<i>non</i>	‘sap’
	/t̪/	ṭap	<i>l’ap</i>	‘quickly’
	/l̪/	l̪aw	<i>law</i>	‘harvest’
	/r/	raw	<i>raw</i>	‘like’
	/w/	waṭ	<i>wal’</i>	‘protection’
	/j/	jar	<i>yar</i>	‘friend’

Plosives and affricates

The 4-way laryngeal contrast in plosives and affricates is maintained word-initially and word-medially and is neutralized to voiceless word-finally. The neutralized consonants are generally unaspirated, while showing some degree of aspiration utterance-finally or in careful speech (which can be regarded as a phonetic effect). Neutralization appears to be blocked when voiced plosives become prenasalized (see the section on Nasalization). As in Old Indo-Aryan (Whitney 1945), aspirated and breathy voiced segments do not occur more than once within a word. Breathily voiced consonants are somewhat unstable. The breathiness can be realized on adjacent vowels or lost completely; it may also appear sporadically with lexically plain voiced plosives/affricates (Mørch & Heegaard 1997: 9–10; Heegaard & Mørch 2004: 31–32, 50). In our data, the contrast is relatively well preserved in isolated forms; some loss of breathiness can be observed in the passage (see e.g. /g^ho^hi/ ‘quotative particle’ pronounced as [go^hi]).

Duration differences among the laryngeal classes can be seen in Figure 2, which plots average release durationsⁱⁱⁱ for word-initial plosives and affricates produced by our two speakers. In plosives, average release durations are 25 ms for plain voiceless, 110 ms for voiceless aspirated, 19 ms for voiced, and 103 ms for breathy voiced. This shows an average difference of 84 ms between the plain and aspirated/breathy categories. The contrast is somewhat smaller for the retroflex place. As would be expected, affricate releases are longer, but still maintain a sizable 67 ms duration contrast between plain and aspirated/breathy categories. On average, releases in our data are 103 ms for plain voiceless, 162 ms for voiceless aspirated, 74 ms for voiced, and 148 ms for breathy voiced affricates (the category that is limited to /ɖʱ/). These results show that the laryngeal contrasts are indeed well-differentiated by duration alone (see also Prosody on F0 differences).

<Insert Figure 2 about here>

Aspirated plosives are optionally realized in Kalasha as fricatives: /p^h/ as [f] or [ɸ], /t^h/ as [θ], and /k^h/ as [x] (or [kx]). At least [f] and [x] occur primarily in lexical loans (Trail & Cooper 1985; Heegård & Mørch 2004), and therefore can be considered marginal phonemes. In addition, the voiced bilabial /b/ is occasionally lenited to [w] (Mørch & Heegaard 1997: 47). All these realizations are present in the recorded passage.

Kalasha plosives are produced at the bilabial, dental, retroflex, and velar places of articulation. All affricates are sibilant coronals, occurring at the alveolar, retroflex, and alveolopalatal regions. This 3-way contrast is typical of languages in the Hindu-Kush region (cf. Khowar: Liljegren & Khan 2017; Palula: Liljegren & Haider 2009). All the place contrasts occur word-initially, medially, and finally. Retroflex plosives are typically retracted post-alveolars, which can vary in the degree of retraction and apicality. Affricates, on the other hand, tend to be more retroflex – produced with the tongue tip curled back (Trail & Cooper 1985). This was confirmed by Mørch & Heegaard (1997: 51–52) using static palatography.

As in other languages, Kalasha retroflex plosives are acoustically more salient in post-vocalic position than in prevocalic position (see Dave 1977 for Gujarati; Hussain, Proctor, Harvey, & Demuth 2017 for Punjabi). The following words illustrate the dental-retroflex contrast in

plosives post-vocalically: /b^hot/ *bhot* ‘evening meal’ vs. /p^hot/ *phot* ‘chaff, wood shavings’; /b^hut/ *bhut* ‘evil spirit’ vs. /mut/ *mut* ‘tree’.

In affricates, the place contrast is distinguished primarily by a combination of noise spectra and formant transitions with adjacent vowels. Spectra for sample tokens are shown in Figure 3. They indicate that the anterior affricate /ts/ is characterized by a greater concentration of high intensity noise at higher frequencies (centre of gravity, COG, is 7300-8200 Hz). In contrast, the two posterior affricates, /tʂ/ and /tɕ/, have a concentration of high-intensity noise at much lower frequencies (COG of 3300-3700 Hz). Both also show two main peaks, with the lower frequency one being more intense. The two posterior affricates differ from each other in the lower-frequency slope towards the peak, which is steeper for /tɕ/ than /tʂ/. The spectral differences among the affricates are further enhanced by CV transitions, with *F*2 being the highest for /tɕ/ and lowest for /ts/. *F*3 is lowered by /tʂ/. (For a more extensive acoustic investigation of the Kalasha affricates, the reader is referred to Kochetov & Arsenault, 2020.)

<Insert Figure 3 about here>

Voiced affricates can vary freely with fricatives for some speakers [dʒatʂ ~ zətʂ] *j’ac* ‘spirit beings’ (Trail & Cooper 1985), but they are realized consistently as affricates in our data. Other notable variation includes the realization of voiced plosives /b/ and /g/ as [m] and [ŋ] after a nasal vowel or before a nasal consonant. In utterance-final position, voiceless velar /k/ is sometimes unreleased or realized as [ʔ] or glottalization on the vowel (cf. Trail & Cooper 1985).

Fricatives

The main class of fricatives in Kalasha are sibilants, which, like affricates, occur at the alveolar, retroflex, and alveolopalatal places. As with affricates, this 3-way place distinction is typical of languages in the Hindu-Kush region (Bashir 2003; Ramanujan & Masica 1969; Arsenault 2017). Voicing is contrastive in sibilant fricatives, but only voiceless fricatives occur word-finally. Non-sibilant fricatives [ɸ, f, θ, x] occur as variants of aspirated plosives (see the discussion of plosives above).

Like affricates, the place of fricatives is distinguished by spectral shapes and vowel transitions. As shown in Figure 4, anterior /s/ has a higher-frequency concentration of energy, while the energy of posterior /ʂ/ and /ɕ/ is concentrated at lower and mid frequencies. Compared to the alveolopalatal affricate discussed above, the alveolopalatal fricative /ɕ/ shows an even sharper drop in energy at the lowest frequencies and a more defined primary peak. Like its affricate counterpart, it substantially raises F2 in CV transitions (Mørch & Heegaard 1997: 66). The retroflex fricative lowers F3 (Mørch 1995) in a similar way to the retroflex affricate.

<Insert Figure 4 about here>

The voiceless laryngeal /h/ is highly variable. Between vowels or next to sonorants, it is realized as breathy voiced [ɦ] or lost altogether. There are also cases of /h/ shifting to another syllable or [ɦ] being produced in words where it is absent phonemically. The latter has been observed in pretonic intervocalic position, where [ɦ]-insertion is an apparent hiatus resolution strategy (Mørch & Heegaard 1997: 47–48; e.g. /ʂo-ˈek/ [ʂo-ˈɦek] *s'o'ek* ‘to plug’ produced by SK). This highly labile behavior of /h/, combined with the variability of breathy voiced plosives/affricates (see above), suggests the possibility of analyzing aspiration/breathiness in Kalasha as a word-level prosody (Heegaard & Mørch 2004: 31–32).

Nasals

There are fewer place contrasts for nasals than for plosives. Bilabial /m/ and dental/alveolar /n/ are well established, contrasting in a variety of contexts. The status of retroflex /ɳ/ is more ambiguous. It contrasts marginally with /n/ in word-final position as a result of (variable) consonant cluster simplification: [moɳ ~ moɳɖr] *mond'r* ‘whey’ as opposed to [mon ~ monɖr] *monɖr* ‘word’. However, some researchers report that it may occur independently in a small number of words (Mørch & Heegaard 1997: 51; Trail, p.c., 2009). An articulatory investigation is required to confirm these observations, as dental and retroflex nasals are difficult to distinguish reliably on purely acoustic and auditory grounds. Moreover, native speakers do not appear to have clear intuitions about retroflex nasals, apart from those arising through final cluster simplification. The process of cluster simplification can also result in word-final alveolopalatal and velar nasals, which

are otherwise sub-phonemic, occurring only before homorganic affricates and plosives (cf. Mørch & Heegaard 1997).

Laterals

Kalasha has two lateral approximants. /ɭ/ is a velarized apico-dental, while /li/ is a palatalized lamino-alveolar (Trail & Cooper 1985), as in /ɭap/ *l'ap* ‘quickly’ and /liaw/ *law* ‘harvest’. These differences of articulation were corroborated by Mørch & Heegård (1997: 52; Heegård & Mørch 2004) using static palatography. Acoustically, the laterals differ in F2 during the closure; F2 is lower for /ɭ/ and higher for /li/, indicative of moderate velarization and palatalization. The velarized lateral induces some backing in adjacent vowels, while the palatalized lateral induces fronting. This can be seen in Figure 5, which provides an annotated spectrogram of the two laterals occurring word-initially and word-finally. Note that the place difference in F2 during the closure is about 700-800 Hz. Our larger-scale acoustic investigation of Kalasha laterals (produced by 14 speakers of different age groups and genders) revealed that /ɭ/ velarization was clearly present in younger speakers and largely absent in older speakers (Kochetov, Heegård Petersen, & Arsenault, under review). This suggests that palatalization is the main distinctive feature of the contrast, while velarization has developed more recently, either as an enhancement strategy or due to the influence of Khowar.^{iv} Thus, the contrast can be alternatively classified as /ɭ/ vs. /li/.

<Insert Figure 5 about here>

Rhotics

The phoneme /r/ has a rather variable realization. It tends to be weakly trilled or fricated word-initially and after a plosive (Mørch & Heegaard 1997: 51). Similar, but devoiced, realizations occur utterance-finally. Intervocally, /r/ is often a tap. Our data confirm these observations, while also pointing to occasional retroflex approximant-like realizations (see e.g. [p^haɪ] *phar* ‘load’ by SK). Utterance-initially, /r/ may be preceded by a short vocoid (e.g. /ra/ *ra* ‘way’ as [ʔra]). Next to

a nasalized vowel, /r/ is optionally realized as [r̃] (e.g. the first instance of /^lsirã~/ *sirã* ‘wind’ in the passage, realized as [^lsiṛã̃]).

In addition to /r/, the Birir variety of Northern Kalasha has a retroflex flap /ɽ/. This phoneme does not occur in the Bumburet variety described here, which has retroflex vowels instead (see the discussion of vowels, below). (See also Mørch & Heegaard 1997: 63–64, 80–85; Heegård & Mørch: 2017: 243 on rhotics in other varieties of Kalasha).

Glides

There are two glides in Kalasha. The bilabial /w/ is often realized in onset position as labiodental [ɸ] or [ɸ̌], especially before front vowels (Trail & Cooper 1985; Mørch & Heegaard 1997: 52–55). The palatal /j/ shows little variation.

Consonant clusters

Onset clusters consist of obstruent + liquid or /j/. Examples include /praɐ/ *prash* ‘soft’, /t̪rip/ *trip* ‘sickness’, /t̪rits/ *t’rits* ‘kind of bird’, /^lkriṣna/ *kris’na* ‘black’, /b^lats/ *blats* ‘short’, and /k^lute/ *kl’uc* ‘quickly’. Sequences of dental plosive + /j/ are realized as (alveolo)palatal plosives (e.g. /d̪jek/ in *dhar dyek* ‘to lean’ as [d̪jek]). Some initial clusters can be broken up with a short epenthetic vowel (e.g. [s^əras(t)] *srast* ‘avalanche’; cf. Mørch & Heegaard 1997). Trail & Cooper’s (1999) dictionary also includes sequences of sonorant + /h/, as for example in /mhalⁱ/ *mhal* ‘curse’, /^hho-ʂt/ *l’ho’s’t* ‘charcoal’, and /rha/ *rha* ‘cedar’. In our data, however, these words tend to lack frication or breathiness. They are pronounced much like the single-onset sonorants in /malⁱ/ *mal* ‘goods’, /^hom/ *l’om* ‘a measure’, and /ra/ *ra* ‘way’. The word /^lhojak/ *lhoyak* ‘smooth’, as produced by speaker SK, is an exception: /h/ is realized here as breathy voiced [h̤] and preceded by a short epenthetic vowel ([^lə^hojak], which makes it clearly different from the onset in /lots/ *lots* ‘lightweight’). This indicates that sonorant + /h/ sequences are only marginally present in this variety of Kalasha.

Final coda clusters include: homorganic nasal + plosive; fricative + plosive; dental plosive + /r/; and approximant /w, j/ + consonant. Examples include /d̪oŋd̪/ *d'ond* 'double bride-price', /proʂt/ *prost* (*hik*) 'to bow', /goʂt/ *gos't* 'barn', and /t͡ʂʰet̪r/ *c'hetr* 'field'. In many lexical items final clusters are simplified by leaving the second consonant unpronounced, as for example in [d̪oŋ ~ d̪oŋd̪] *d'ond* 'double bride-price', [draʂ ~ draʂk] *dras'k* 'small amount', and [sʰras ~ sʰrast̪] *srast* 'avalanche'.

Vowels

<Insert Vowel chart about here>

Kalasha has five primary vowel qualities (plain vowels), as indicated in the cardinal vowel chart above. The positioning of these vowels on the chart is approximate and is based on F1 and F2 values produced by our two speakers in the words presented below (see also Figure 6). Note that the front mid vowel /e/ is somewhat low, relative to its back counterpart /o/, and could be transcribed as [ɛ].

plain vowels	/a/	pa	<i>pa</i>	'pail'
	/e/	pe	<i>pe</i>	'if'
	/i/	pi	<i>pi</i>	'from'
	/o/	po	<i>po</i>	'footprint'
	/u/	p ^h u	<i>phu</i>	'outcry'

Each of the five vowel qualities can be accompanied by contrastive nasalization (/ã ẽ ĩ õ ù/), retroflexion (or rhoticization; /ạ ẹ ị ọ ụ/), or both (/ạ̃ ẹ̃ ị̃ ọ̃ ụ̀/). As a result, the language has 20 vowel phonemes belonging to four classes: oral non-retroflex (plain), oral retroflex, nasalized non-retroflex, and nasalized retroflex. Nasalized and retroflex vowels bear a low functional load relative to their oral and non-retroflex counterparts (Cooper 2005). The phonemes /ị̃/ and /ị̣̃/ are particularly rare, probably due to the conflicting articulatory requirements of

retroflexion, on the one hand, and a high front (‘palatal’) tongue position, on the other (Hamann 2003). These contrasts are illustrated separately for each vowel quality in the table below. Phonetic transcriptions are provided in cases where the speaker’s realizations deviate from the phonemic form (due to various processes of neutralization, assimilation, or sporadic variation).

front close	/i/	plain	^l piik	<i>piik</i>	‘to drink’
	/ɪ/	retroflex	^l pɪk	<i>pɪ̣k</i>	‘to squeeze’
	/ĩ/	nasalized	^l ṣ ^h ĩik	<i>c^hĩik</i>	‘to summon’
	/ị̃/	nasalized retroflex	ṭị̃ ^l ek	<i>tị̃ek</i>	‘to awaken’
front mid	/e/	plain	ger (^l karik)	<i>ger (karik)</i>	‘to understand’
	/ẹ/	retroflex	kẹ	<i>kẹ</i>	‘step’
	/ẽ/	nasalized	k ^h ẽ	<i>khẽ</i>	‘how?’
	/ẹ̃/	nasalized retroflex	kẹ̃	<i>kẹ̃</i>	‘cave’
open	/a/	plain	bag [bak]	<i>bag</i>	‘garden’
	/ạ/	retroflex	wạ	<i>wạ</i>	‘scrotum’
	/ã/	nasalized	bãg (ḍjek) [bãŋ ʝek]	<i>bãg (ḍyek)</i>	‘to poke’
	/ạ̃/	nasalized retroflex	bạ̃g [b ^h ạ̃ŋg]	<i>bạ̃g</i>	‘suddenly’
back mid	/o/	plain	ṭok	<i>tok</i>	‘wet’
	/ọ/	retroflex	ṣọ ^l ek [ṣọ ^l hị̃k]	<i>s^lọ^lek</i>	‘to plug’
	/õ/	nasalized	õg [õŋg]	<i>õg</i>	‘thigh’
	/ọ̃/	nasalized retroflex	(^l kari) ṭọ̃ ^l ek [^l kari ṭọ̃ ^l hị̃k]	<i>(kari) t^lọ̃^lek</i>	‘to warn’
back close	/u/	plain	ku	<i>ku</i>	‘pen’
	/ụ/	retroflex	kụ (^l griik)	<i>kụ (griik)</i>	‘to get singed’

/ũ/	nasalized	^h tũkik	t ^h ũkik	‘to hammer’
/ụ̃/	nasalized retroflex	kụ̃	kụ̃	‘shriveled’

Nasalization

Following Trail & Cooper (1985; 1999), vowels that occur before a homorganic nasal + plosive sequence are analyzed as nasalized vowels followed by a plosive; the homorganic nasal is treated as non-phonemic. Thus, a broad transcription such as /õg/ for *õg* ‘thigh’, shown above, typically corresponds to [õ^hg] or [õŋg] in narrow transcription (cf. Masica 1991 for discussion of this issue in other Indo-Aryan languages). (Note that final devoicing does not apply here, being blocked by consonant nasalization.^v) In some cases, the nasalization spreads through the following plosive resulting in realizations such as [bãŋ] for /bãg/ (in *bãg dyek* ‘to poke’). In polysyllabic words, the precise locus of nasalization can vary, as nasalization optionally spreads to vowels in adjacent syllables (e.g. [ˈwẽ.a ~ ˈwe.ã ~ ˈwẽ.ã] *wẽa* ‘far upstream’; cf. Mørch & Heegaard 1997: 43–44).

Retroflexion

Retroflexion is the most intriguing aspect of the Kalasha vowel system. Kalasha may be the only known language with a fully symmetrical set of retroflex (or rhotacized) and non-retroflex vowel phonemes.^{vi} The precise articulatory mechanism involved in the production of these vowels is not clear. Trail & Cooper (1985) suggest that the vowels are produced by “slightly curling” the tip of the tongue, but Heegård & Mørch (2004) found variation among their informants, who produced the vowels either by curling the tongue tip or by raising and bunching the middle of the tongue (cf. Ladefoged & Maddieson 1996). Despite the variation, Heegård & Mørch favour the term ‘retroflex’ over ‘rhotacized’, arguing that retroflexion of the tongue tip appears to be the most common strategy for producing the vowels. Whether this is correct or not (see Hussain & Mielke 2018 for some ongoing articulatory work), the term ‘retroflex’ seems appropriate given the phonological patterning of the sounds (as part of a larger system of consonants and vowels) and their historical sources.

Historically, the retroflex vowels evolved from plain vowels primarily under the influence of a following intervocalic retroflex plosive or nasal, or Old Indo-Aryan (OIA) /r/ in its various phonetic forms. The consonants were eroded through lenition, leaving retroflexion on the vowels (and nasalization, in the case of [ŋ]); e.g. /a¹z̥a-i/ *az'a'i* ‘apricot’ < OIA /aṣad^hi:ja/; /¹g^hũ-i/ *ghũ'i* ‘goat-hair coat’ < OIA /go:ṇi:/ (Mørch & Heegaard 1997: 77–86, Trail & Cooper 1999; see also Morgenstierne 1973: 191; Heegård & Mørch 2004: 67–72). A retroflex flap [ɽ] is still preserved before /i/ in the Birir (Biriū) variety of Kalasha, and sporadically in others (compare Birir /a¹z̥aɽi/ ‘apricot’ and /¹gũɽi/ ‘goat-hair coat’ with their Bumburet cognates, listed above; Heegård & Mørch 2004, 2017; cf. Di Carlo 2010).^{vii}

Acoustically, retroflex vowels are more centralized than their plain counterparts, and are most clearly characterized by a lower F3 (cf. Heegård & Mørch 2004). This is evident in Figure 6, which plots the formants F1 and F2 (the top plots), and F2 and F3 (the bottom plots) for non-nasalized vowels produced by our two male speakers.^{viii} Note that the retroflex vowels produced by SK are more centralized (in F1 and F3) than those for TKK; both speakers, however, show similar differences in F3 (see also Kochetov, Arsenault, & Heegård 2019).

<Insert Figure 6 about here>

As with nasalization, the locus of retroflexion can vary in polysyllabic words, and sources differ as to which vowels are transcribed as retroflex (e.g. [ʼku.ək ~ ʼku.ək ~ ʼku.ək] *kua'k* ‘child’; see also the words ‘to plug’ and ‘to warn’ in the table above). Moreover, retroflexion tends to ‘spread’ from retroflex vowels to plain vowels in adjacent syllables, often permeating intervening consonants and crossing morpheme boundaries (Mørch & Heegaard 1997: 44; Arsenault & Kochetov 2019), as, for example, in [tra¹pu-i ~ tra¹pu-i ~ tra¹pu-i] *trapu'i* ‘eye disease’. In our data, retroflex harmony of this kind is bidirectional, but predominantly progressive, and tends to spread through non-coronal consonants (other than /j/).

Allophonic variation

Vowels show some moderate variation depending of the place of articulation of adjacent consonants, and most notably next to alveolopalatals and labials. As can be seen in Figure 7, the front mid vowel /e/ appears to be most variable, showing some differences in height, [e ~ ε] (cf. Trail & Cooper 1985; Mørch & Heegaard 1997: 41). All vowels are considerably fronted and show an [j]-like offglide/onglide next to alveolopalatals. As a result, back vowels in this context can be narrowly transcribed as [ʊ]/[ɯ], [ɔ], and [æ] (Mørch & Heegaard 1997: 41). In addition, all vowels show some lowering in F3 (not shown in the figure) next to retroflex consonants and /r/. The degree of this retroflexion appears to be greater in the context of retroflex fricatives. At least some of these cases can be considered categorical assimilation resulting in a neutralization of the retroflex contrast for vowels in that context.^{ix}

<Insert Figure 7 about here>

Vowel length

Vowel length is closely tied to prosody in Kalasha (discussed below) and is not generally considered phonemic. However, some researchers have suggested that there may be limited contrast. Bashir (1988: 35) notes that vowel length and stress may be independent variables in Kalasha, although she does not elaborate. Heegård & Mørch (2004) suggest that length may be contrastive, at least for /a/ in open stressed non-final syllables (cf. Heegård 1998), but they leave the question open for future, more focused studies.

Sequences of vowels

Sequences of two vowels are common and can include sequences of identical vowels. Vowel sequences are always syllabified as two syllables (e.g. /^hʂoː.ek/ s'o'ek 'to plug', /^hgri.ik/ in ku' griik 'to get singed') (and variably separated by [ɦ], as noted above). Hence, they are regarded as true sequences as opposed to diphthongs or long vowels.

Prosody

Stress is lexical and can fall on virtually any syllable, but some lexical items exhibit variable stress. The following minimal pair illustrates the stress contrast: /^hpaɬaw/ *pal'aw* '(he) falls', /paɬ^haw/ *pal'aw* 'apple'. In our data, stressed vowels are characterized by overall higher pitch (cf. Mørch & Heegaard 1997: 55–57), longer duration, and greater amplitude. This can be seen in Figure 8 which shows waveforms and spectrograms, along with pitch tracings, for the minimal pair mentioned above. The stressed variants of /a/ show differences in the pitch (white speckles), duration (annotated intervals), and intensity (amplitude of the waveform) compared to the unstressed variants. It should be noted that this generalization holds for words uttered in isolation, where pitch contours reflect a combination of stress and (declarative statement) intonation. A more systematic study of stress in Kalasha is required to determine if the generalization holds in connected speech.

<Insert Figure 8 about here>

Our acoustic analysis of a larger data set revealed that unstressed plain vowels are about 30% shorter than stressed vowels in duration. They are also considerably more variable (being affected by consonant contexts) and centralized, compared to stressed vowels. This can be seen in Figure 9.

<Insert Figure 9 about here>

Some languages of northwestern South Asia have developed lexical tone contrasts (often triggered by the loss of breathy voicing in plosives; Masica, 1991: 102). Kalasha is not generally counted among them (cf. Strand, in press), although Bashir (2003: 851) has noted the occurrence of “salient pitch/tone contours” in northern Kalasha. In our data, some pitch differences can be observed depending on the laryngeal specification of preceding plosives (or affricates). For speaker SK in particular, *f*₀ is lower at the vowel onset after aspirated and breathy voiced plosives than after plain voiceless and voiced plosives (by 17–21 Hz on average). For TKK, *f*₀ differences are mostly between voiceless (plain/aspirated) and voiced (plain/breathy) categories, with the latter having lower values (by 18–24 Hz on average). While some of these differences are presumably automatic (e.g. *f*₀ suppression next voiced stops; Kingston & Diehl 1994), others

appear to be language-specific, most notably the lowering of f0 after voiceless aspirated stops). This might be indicative of emerging pitch patterns in Kalasha. Similar low or low-rising pitch contours have been reported after aspirates in other Northwestern Indo-Iranian languages, including Khowar (Liljegren & Khan 2017) and Kalam Kohistani (Baart 2004). Thus, a closer examination of pitch variation in Kalasha is required.

Transcription of a recorded passage

The following text is a free translation of the ‘North Wind and the Sun’ fable produced by one of the authors, Sikandar Kalas (speaker SK).

The order of the presentation is:

Broad phonetic transcription

Orthographic version

Morphemic glossing

Translation

'wenaw	'sirã	ze	'suri	'tãn	'motɕuna
<i>Wenaw-sirã'</i>	<i>zhe</i>	<i>suri</i>	<i>tan</i>	<i>moc-una</i>	
upriver-wind	and	sun	REFL	middle-LOC	

aiga'ni	'aini	ki	'kura	ta'kɬa	'g ^h oĩ
<i>aigani</i>	<i>a-ini</i>	<i>ki</i>	<i>kura</i>	<i>taɬ'a</i>	<i>ghoĩ</i>
arguing	be.ANIM-3PL.PST	that	who	strong	QUOT

‘The North Wind and the Sun were arguing between themselves (about) who is stronger;’

ɕohõta'mio	'ek	p ^h õ'gros
<i>shohõ=ta=mi=o</i>	<i>ek</i>	<i>phõgros</i>
until=CONTR=EMPH=TOP	one	traveler

çu'k ^h a	sam'bi	'tasi	'roiṭu	'prau
<i>shukha</i>	<i>samb-i</i>	<i>tasi</i>	<i>roitu</i>	<i>pr-au</i>
coat	wear-PTCP	3P.REM.OBL	meeting	give.PST.A-3SG

‘All of a sudden a traveler wearing a cloak stumbled upon them.’

'p ^h aṭo	te	tan	'motçuna	p ^h aisa'lja	'aran	ki
<i>Phato</i>	<i>te</i>	<i>tan</i>	<i>moc-una</i>	<i>phaisala</i>	<i>ar-an</i>	<i>ki</i>
then	3PL.REM.NOM	own	middle-LOC	decision	do.PST.A-3PL	that

'kura	a'wel ^j	'tasa	p ^h ō'grosas
<i>kura</i>	<i>awel</i>	<i>tasa</i>	<i>phōgros-as</i>
who	first	3SG.REM.OBL	traveller-GEN.OBL.SG

to	çu'k ^h a	ni' ^l ɖek	baau	haw
<i>to</i>	<i>shukha</i>	<i>nij-ek</i>	<i>ba-au</i>	<i>haw</i>
3SG.REM.ACC	coat	take.off-INF	be.able-PRS.3SG	SBJV

ça'se	ta'kṭa	'g ^h oĩ
<i>sha=se</i>	<i>takl'a</i>	<i>ghō'i</i>
EMPH=3SG.REM.NOM	strong	QUOT

‘Between them they decided that who(ever) can make the traveler take off his cloak first is the stronger one.’

'p ^h aṭo	se	'wenaw-'sirã	ubu'nau
<i>Phato</i>	<i>se</i>	<i>wenaw-sirã'</i>	<i>ubun-au</i>
then	3SG.REM.NOM	upriver-wind	blow-PST.A.3SG

‘Then the North Wind blew,’

se	ki'mon	'k ^h atɕa	t ^h i	'sirã	'pr-au	haw
<i>se</i>	<i>kimon</i>	<i>khaca</i>	<i>thi</i>	<i>sirã'</i>	<i>prau</i>	<i>haw,</i>
3SG.REM.NOM	however much	wild	become.PTCP	wind	give.PST.A-3SG	SBJV

‘(but) no matter how strong and wild he blew,’

ɕohõ'mio	se	p ^h õ'gros
<i>shohõ=mi=o</i>	<i>se</i>	<i>phõgros</i>
until=EMPH=TOP	3SG.REM.NOM	traveler

ta'tai	ɕuk ^h a'motɕaj	mat ^h o'l'a	'hawau
<i>tal'-ai</i>	<i>shukhamoc-ai</i>	<i>mat'hola</i>	<i>haw-au</i>
there.REM-LOC	coat.middle-LOC	wrapped-up	become.PST.A-3SG

‘the traveler only covered himself with the cloak;’

'p ^h ato	se	'wenaw 'sirã	na'kam	'hawau
<i>phato</i>	<i>se</i>	<i>wenaw-sirã'</i>	<i>nakam</i>	<i>haw-au</i>
then	3SG.REM.NOM	upriver-wind	fail	become.PST.A-3SG

‘then the North Wind gave up.’

'p ^h ato	se	'suri	ba'ta	tan	pe'tsi	pa'ɕaaue
<i>Phato</i>	<i>se</i>	<i>suri</i>	<i>bata</i>	<i>tan</i>	<i>pec'i</i>	<i>pash-a-au=e</i>
then	3SG.REM.NOM	sun	CONTR	own	heat	show-TR-PST.A.3SG=while

‘Then as the Sun showed his heat,’

se	p ^h õ ^l gros	ẓar	ṭan	ṭo	ɕu ^l k ^h a	a ^l niḍau
<i>se</i>	<i>phōgros</i>	<i>z’ar</i>	<i>tan</i>	<i>to</i>	<i>shukha</i>	<i>a-nij-au.</i>
3SG.REM.NOM	traveller	quickly	own	3SG.REM.ACC	coat	PST-take.off-PST.A.3SG

‘the traveler immediately took off his cloak.’

‘p ^h ato	se	‘wenaw	‘sirã	maḍuba ^l ran	mani ^l hau
<i>Phato</i>	<i>se</i>	<i>wenaw-sirã’</i>	<i>majubaran</i>	<i>manih-au</i>	
then	3SG.REM.NOM	upriver-wind	unwillingly	accept-PST.A.3SG	

‘Then the North Wind conceded’

ki	‘suri	zi ^l aṭ	ṭa ^l kṭa	‘g ^h oĩ
<i>ki</i>	<i>suri</i>	<i>ziat</i>	<i>ta^lkl’a</i>	<i>ghōi</i>
that	sun	much	strong	QUOT

‘that the Sun is stronger.’

3 = third person

A = actual (past)

ACC = accusative

ANIM = animate

CONTR = contrastive

EMPH = emphasizer

GEN = genitive

INF = infinitive

LOC = locative

NOM = nominative

OBL = oblique

P = plural (verbs)

PL = plural (nouns)

PRS = present

PST = past tense

PTCP = participle

QUOT = quotative particle

REFL = reflexive

REM = remote (pronoun)

SBJV = subjunctive particle

SG = singular

TOP = topicalizer

TR = transitivity

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Footnotes

ⁱ Kalasha belongs to the so-called ‘Dardic’ group of languages, but the status of Dardic as a genetic sub-group of Indo-Aryan remains controversial (Liljegren 2016: 13-16).

ⁱⁱ Among the consonants listed in the ‘dental /alveolar’ column, the plosives and the velarized lateral are dental, while /r/ and /l/ are alveolar (see Mørch & Heegaard 1997: 51-52 for some palatographic evidence); the place status of the other consonants is less clear and requires further research. Given this, we limit the use of the dental diacritic to /t̪, d̪, t̪ʰ, d̪ʱ/ and /ɭ/.

ⁱⁱⁱ Release durations for voiceless plosives/affricates are equivalent to their voice onset time (VOT). For Kalasha voiced plosives/affricates, however, VOT is consistently negative (given the prevoicing). In order to compare voiceless and voiced consonants, we used release durations. These were measured from the onset of the burst to the onset of the following vowel. The materials consisted of single words.

^{iv} Khovar has a lateral contrast between the velarized /ɭ/ and the plain /l/ (Liljegren & Khan 2017). The Khovar and Kalasha laterals have distinct diachronic origins (Bashir 1988: 38, fn. 23).

^v A similar process was reported for the nearby Dameli (Perder 2013: 43-44).

^{vi} Emeneau (1939) reported a similar system for Badaga, a Dravidian language in South India. However, more recent work on the language suggests that the contrast has not survived (Hockings & Pilot-Raichoor 1992). To the best of our knowledge, in all other languages with retroflex/rhoticized vowel phonemes, these segments constitute a small subset of the non-retroflex vowels. Typically, such languages have one or two retroflex/rhotacized vowels at most (Kochetov et al. 2019).

^{vii} Variation between retroflex flaps or approximants, on the one hand, and retroflex vowels, on the other, has also been reported in nearby Dameli (Perder 2013) and Nuristani languages, such as Waigali (Strand 2011; cf. discussion in Arsenault 2017).

^{viii} Here and below, vowel plots were produced using the PhonR package (McCloy 2016) for R (R Core Team 2014).

^{ix} There are no orthographic (i.e. phonemic) retroflex vowels between two retroflex consonants in Trail & Cooper’s (1999) Kalasha dictionary. This is expected if the contrast between retroflex and non-retroflex vowels is neutralized in that environment, where all vowels are predictably retroflex to some degree.

Figure 1. Map showing the location of Kalasha (created with QGIS 2.18.15)

Figure 2. Average release duration for initial (a) plosives and (b) affricates by place (labial, dental, retroflex, alveolopalatal and velar) and laryngeal features (plain and aspirated/breathy categories, voiceless and voiced), based on a total of 440 tokens; note that the breathy voiced dental and retroflex affricates are absent from the inventory.

Figure 3. Spectra (made with a 46 ms window centred on the peak of noise intensity) of the frication noise in /tsat/ *tsat* ‘size’, /tʃsar dʒek/ *c’ar dyek* ‘ripen’, and /tʃar/ *car* ‘grass’ (single tokens) produced by both speakers.

Figure 4. Spectra (made with a 46 ms window centred on the peak of noise intensity) of the frication noise in /sak/ *sak* ‘very great’, /ʃa/ *s’a* ‘king’, and /eak/ *shak* ‘vegetable’ (single tokens) produced by both speakers.

Figure 5. Formant patterns (Hz) in words with contrastive laterals: /tʃap/ *l’ap* ‘quickly’ vs. /lʰaw/ *law* ‘harvest’ (top), and /watʃ/ *wal* ‘protection’ vs. /wali/ *wal* ‘pity’ by speaker SK.

Vowel chart (no caption)

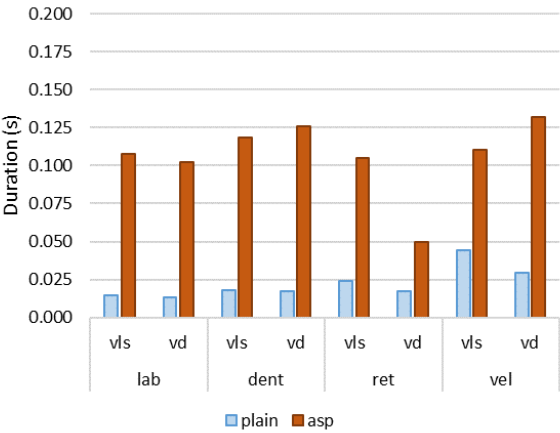
Figure 6. $F1/F2$ (top, Hz) and $F2/F3$ (bottom, Hz) plots showing means (indicated by IPA sound symbols) and 2 standard deviations (indicated by ellipses) for oral vowels produced by the speakers SK and TKK (based on 157 and 140 tokens respectively); the vowels occur in words with no other retroflex vowels, retroflex consonants or /r/.

Figure 7. $F1/F2$ (Hz) plots showing means (indicated by symbols) and 2 standard deviation ellipses for oral stressed vowels in CVC syllables by selected places of articulation of (a) the preceding and (b) the following consonant, as produced by SK (based on 334 and 267 tokens respectively); distinct vowel qualities are colour-coded; the place labels are ‘lab(ial)’, ‘pal(atal)’, and ‘vel(ar)’ (with other places, as well as the consonants /r/, /j/, and /w/ excluded).

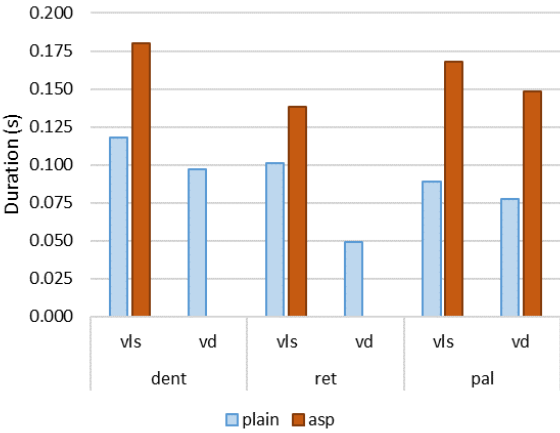
Figure 8. Waveforms and spectrograms of the words /^lpaṭaw/ *pal'aw* '(he) falls', /pa^lṭaw/ *pal'aw* 'apple' produced by speaker SK; pitch (Hz) is indicated by white speckles.

Figure 9. *F1/F2* (Hz) plots showing individual tokens (smaller IPA symbols), means (larger symbols), and 2 standard deviation ellipses for stressed and unstressed vowels produced by SK (based on 1219 and 480 tokens respectively).



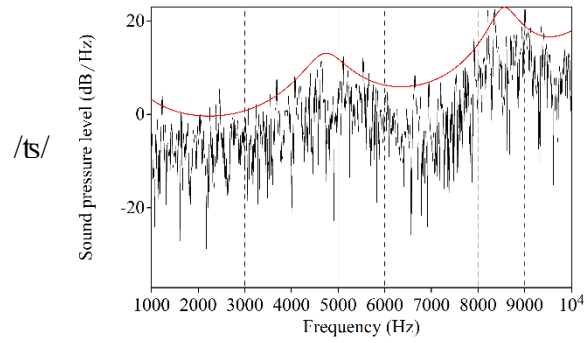


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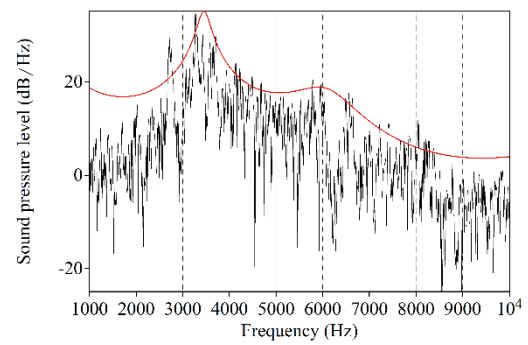
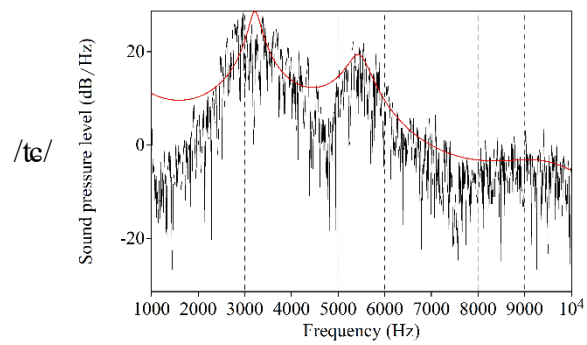
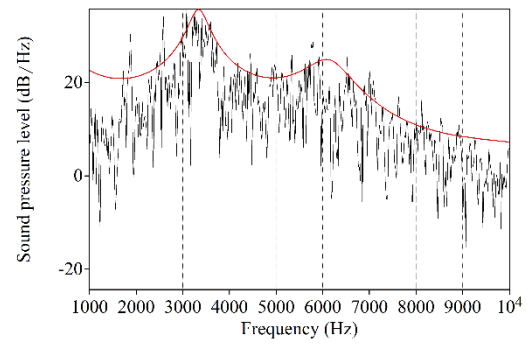
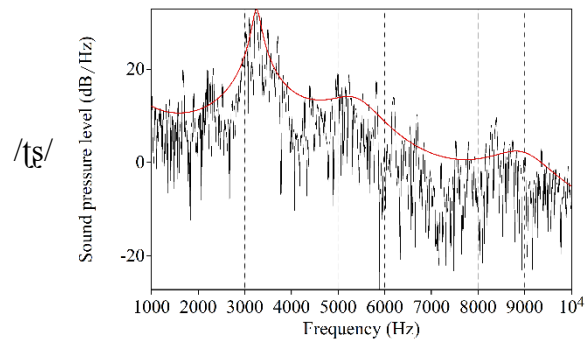
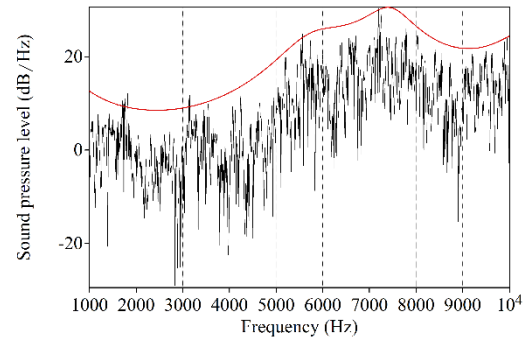


b.

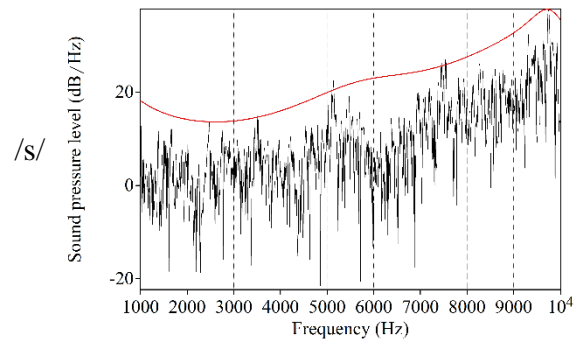
Speaker SK



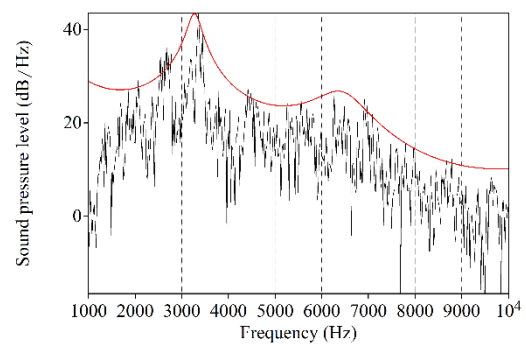
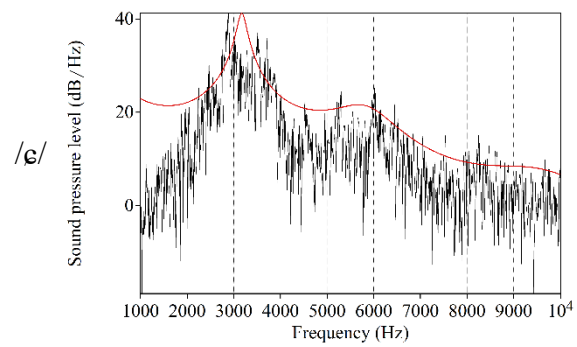
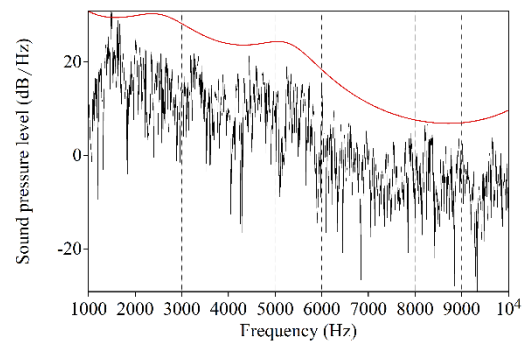
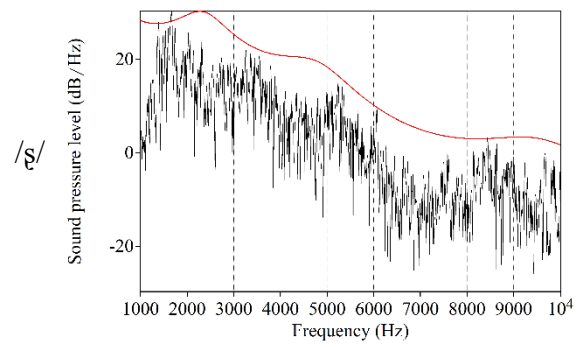
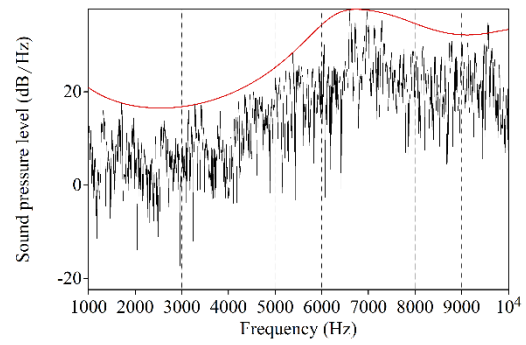
Speaker TKK

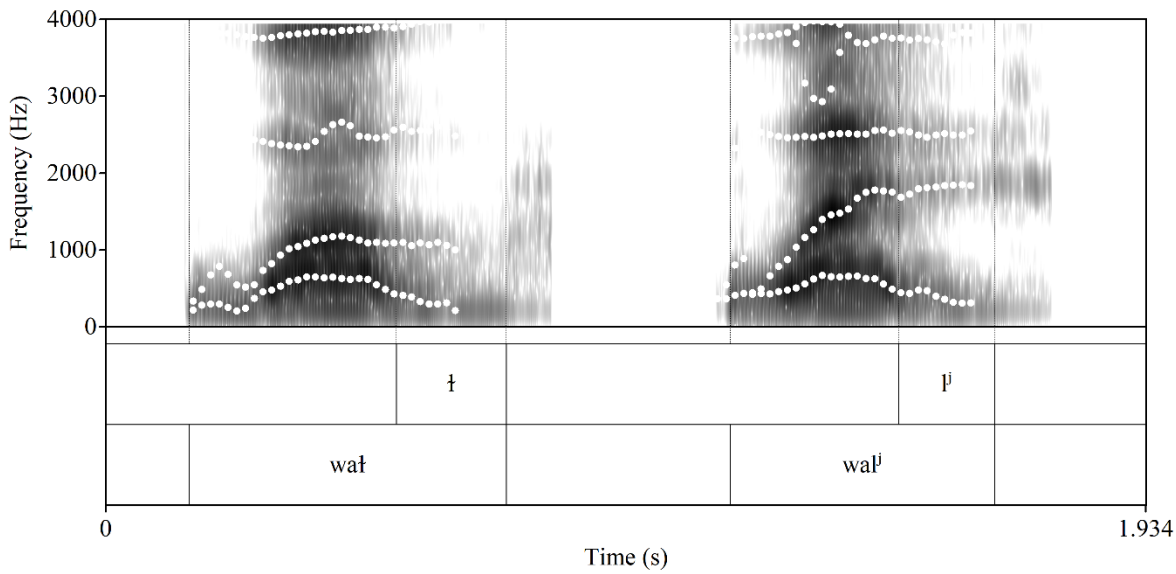
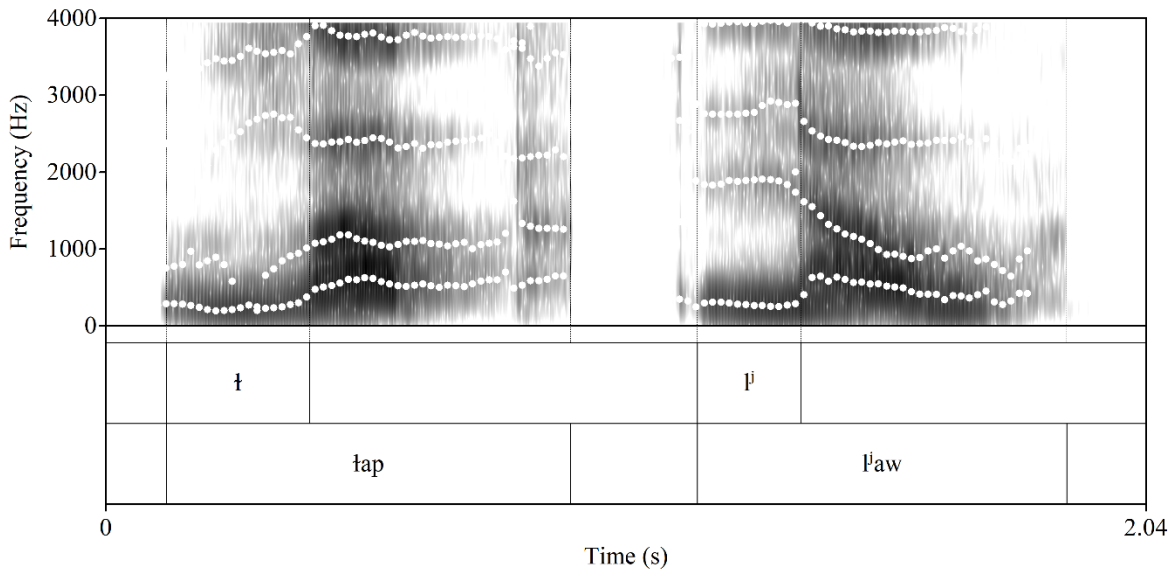


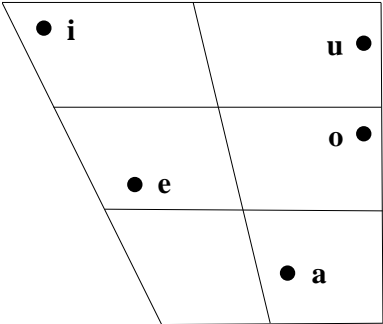
Speaker SK



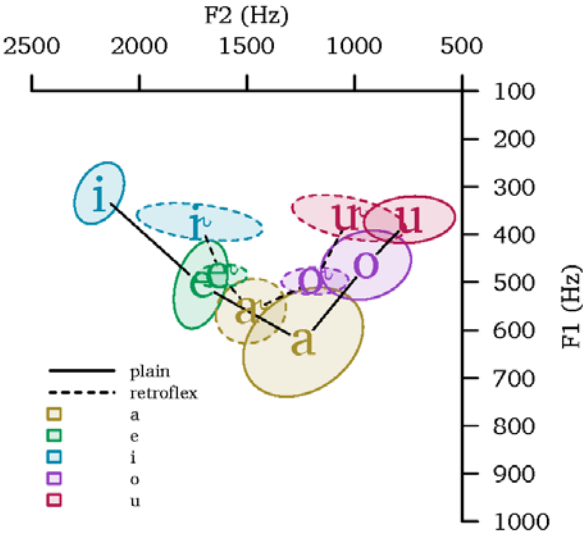
Speaker TKK



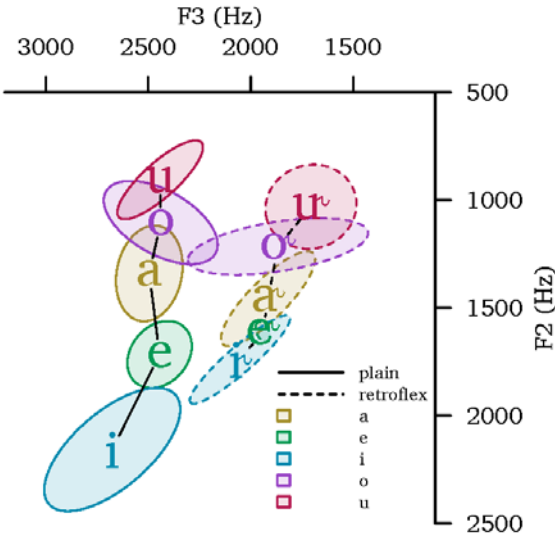
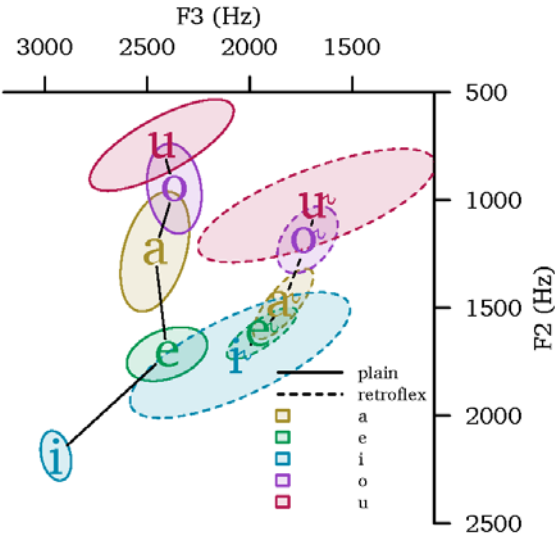
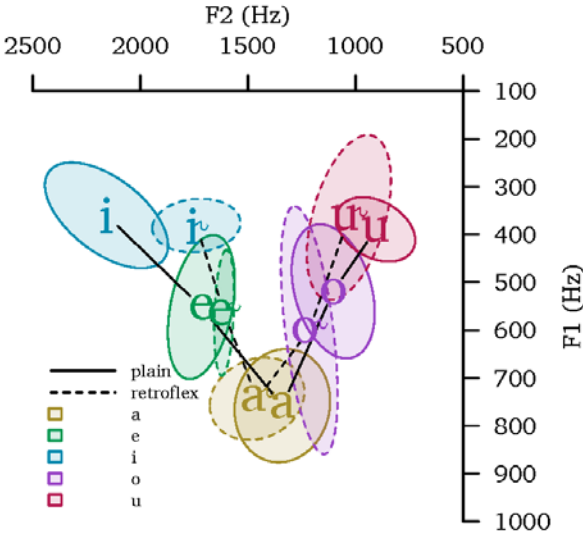




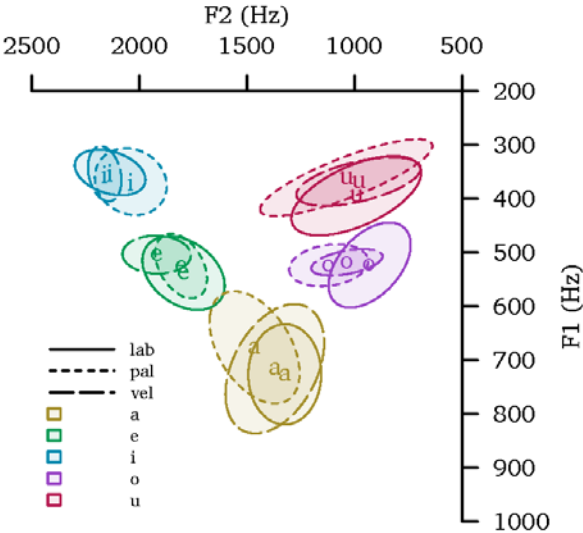
Speaker SK



Speaker TKK



Vowel variation by preceding consonant



Vowel variation by following consonant

