An acoustic and articulatory description of retroflex vowels of Kalasha

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Kalasha is an endangered Indo-Aryan (Dardic) language originally spoken in the valleys of Chitral, Northern Pakistan (3000-5000 speakers in Bumburate, Birir, and Rumbur valleys: Cooper, 2005). There are several typologically marked features of Kalasha that make it distinct among Indo-Aryan and other languages of the world. The most atypical aspect of Kalasha is its vowel system. There are five vowels with front, back, and height distinctions (Table 1: Cooper, 2005). Each vowel has a four-way contrast in quality: simple oral vowel, nasal vowel, retroflex vowel, and a combination of retroflex-nasalized vowel. A contrast between an oral and nasal vowel is a well-documented feature of Indo-Aryan languages (Masica, 1991). However, less than 1% of the world's languages have a retroflex vowel (Maddieson, 1984). Canadian French (Mielke, 2015), American English (Delattre & Freeman, 1968), Mandarin (Lee-Kim, 2014), and Yurok (Blevins, 2003) have only one or two retroflex vowels, but no retroflex-nasalized vowels (see also Badaga: Emeneau, 1939). In at least some of these languages, vowels described as retroflex are produced with both retroflex and non-retroflex (bunched) tongue shapes. The aim of the current study is to present an acoustic and articulatory description of the vowel system of Kalasha.

Nine Kalasha speakers were recorded in Bumburate valley, Chitral, Northern Pakistan. Data from four speakers are presented here (range: 33-37 years; mean age: 34.7 years). Wordlists of all the Kalasha vowels (Table 1: oral, nasal, retroflex, and retroflex-nasalized) in word-medial and final positions were created. Each target word was repeated five times. Simultaneous audio (44100 Hz), ultrasound (60 fps), and video (30 fps) data were collected. Ultrasound data were collected with Terason t3000 ultrasound machine and an Articulate Instruments headset for ultrasound probe stabilisation (Scobbie, Wrench, & Linden, 2008). The audio recordings were automatically segmented using P2FA and manually corrected where needed (Yuan & Liberman, 2008). Ultrasound and video frames and first three formants (F1-F3) were extracted from 25%, 50%, and 75% of the target vowels.

Table 1. Vowel contrasts of Kalasha (Cooper, 2005).

	Front	***Central***	***Back***
High	i ĩ i˞ ĩ˞		u ũ u˞ ũ˞
Mid	e ẽ e˞ ẽ˞		o õ o˞ õ˞
Low		a ã a˞ ã˞	

Figure 1 shows that the so-called retroflex vowels of Kalasha are produced with bunched tongue shape (body-up and tip-down, with or without tongue concavity). Phonological theory has been accommodating retroflex vowels since Chomsky and Halle (1968, p. 304) analyzed them as [+coronal] (referring to Badaga and English dialects), but little is known about how retroflex vowels are produced. Duanmu (2016, p. 147) includes [retroflex] as a tongue tip feature,

tentatively limited to back vowels. We have seen that Kalasha retroflex vowels are not articulated with tongue tip retroflexion and that this feature is not limited to back vowels.

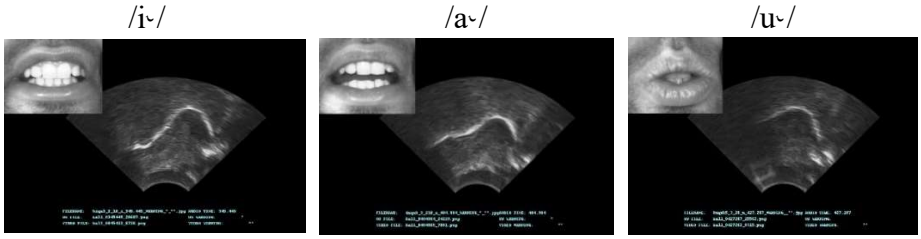

Figure 1. Ultrasound and video frames of tongue and lips from 50% of the three retroflex vowels: /iˠ/, /aˠ/, and /uˠ/.

Figure 2 presents F1-F2 and F2-F3 of one speaker of Kalasha from 50% of the simple oral and retroflex vowels. Retroflex vowels have higher F1 (except high front /iˠ/) than oral vowels (left panel). It can also be noted that retroflex vowels (particularly front vowels) are more central than their oral counterparts. F3 lowering, a key acoustic correlate of retroflexion/rhoticity (Mielke, 2015), is comparatively lower for the retroflex than oral vowels (right panel). These patterns of F1, F2, and F3 are more or less consistent across speakers.

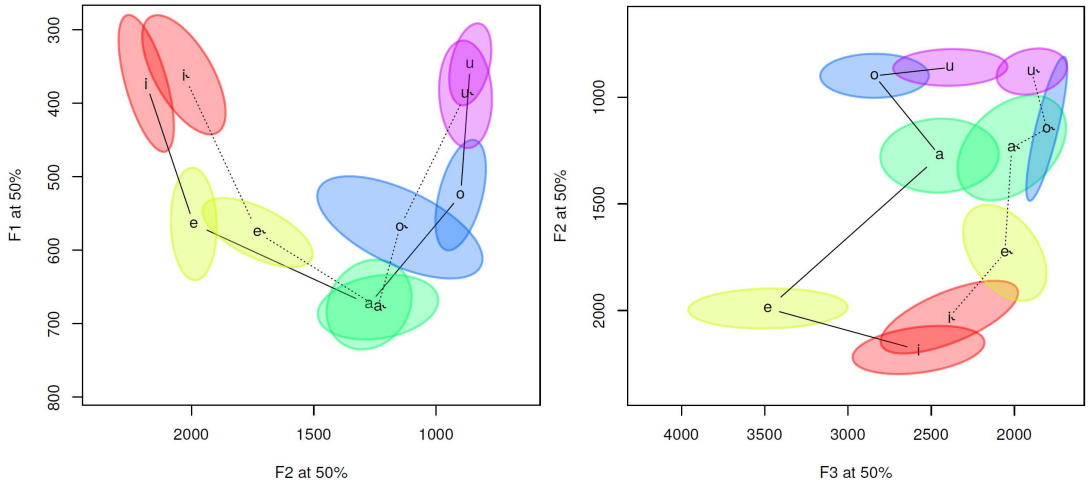

Figure 2. F1-F2 (left) and F2-F3 (right) of one speaker of Kalasha (Kal1) from 50% of the simple oral and retroflex vowels. X and Y axes are in Hz.

References

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