

D-6 An interaction between voicing and tone in Dränjongke fricatives

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Abstract

Dränjongke, a Tibeto-Burman language spoken in Sikkim, India, is a type of language with a 3-way laryngeal contrast in fricatives: voiced, voiceless, and devoiced (van Driem 2001). We propose that the fricative contrast in Dränjongke must consider both voicing and f_0 ; voiceless fricatives are followed by a vowel with high f_0 , and devoiced fricatives are followed with low f_0 . There was a gender-based difference in the production of voiced fricatives. Female speakers have voicing at the onset of the fricatives, while male speakers didn't produce such voicing.

1. INTRODUCTION

Dränjongke (a.k.a. “Bhutia”, “Hloke” or “Sikkimese”) is a Tibeto-Burman language spoken in Sikkim, India (see the green part on Fig.1) by currently about 80,000 speakers. However, it is a minority language in Sikkim, where the official languages are Nepali and English, and therefore endangered. In addition, the script used to write Dränjongke is based on classical Tibetan and is not representative of the vernacular language (Van Driem et al. 2017).

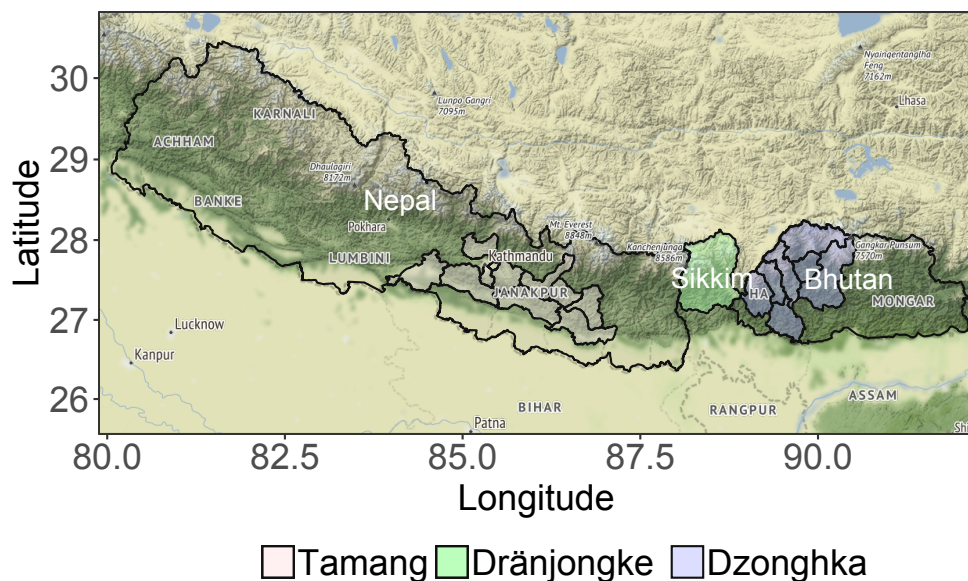


Figure 1. Tibetan languages map

2. ACOUSTICS OF FRICATIVES

The contrast between voiceless and voiced fricatives is found in many languages, but the two types of fricatives are not equally prevalent. Namely, voiceless fricatives are found more frequently (Maddieson 1984) because voiced fricatives are articulatorily more complex to produce; the velocity of air stream is impeded by narrowed vocal folds that produce voicing. Languages may have voicing contrast in fricatives (e.g. Japanese, French), or no voicing contrast in fricatives (e.g. Korean, Chang 2007).

Stevens et al. (1992) in a phonetic study on voicing in fricatives, shed light some acoustic characteristics of voiced fricatives. Compared to voiceless fricatives, voiced ones are found with

extended glottal vibration at boundaries, together with extensive F1 transitions from the preceding vowel to the consonant and the consonant to the following vowel. They also claim that apparent variations in the frication duration between voiceless and voiced fricatives are only due to differences in the timing of the glottal movement.

In the same study, the perception of voicing in fricatives is argued to be based on the duration and amplitude of glottal vibration during the fricative: To be perceived as voiceless, a fricative needs to have at least 60 ms of frication noise without glottal vibration. (see also a study on Dutch, Kissine et al 2003).

Dränjongke is a language with a 2-way tonal contrast (high and low), and these tones are realized as a function of a laryngeal contrast: voiceless consonants are followed by a high tone, voiced consonants by a low tone. This type of non-trivial interaction between consonants and tone, in which phonological restrictions on tonal distributions depend on the type of consonant, is not uncommon. Even in non-tonal languages, Hombert et al. (1979 et seq.) affirm that the voicing of an obstruent affects f0 of a following vowel so that voiced obstruents are immediately followed by a low f0, and voiceless obstruents by a high f0.

Dränjongke has a 4-way laryngeal contrast in plosives, but a 3-way laryngeal contrast in fricatives: voiced, voiceless, and devoiced (van Driem 2001). The term “devoiced” is based on diachronic considerations, and refers to fricatives that were historically voiced but underwent devoicing (which corresponds to a loss of the prefixed character in the Uchen writing system). Our acoustic analysis shows that this devoiced fricative category in Dränjongke is unique because it is characterized both by an absence of glottal vibration indicating voicelessness and by a lowered f0 for the vowel that follows (contra to Hombert et al. 1979).

The phonetic and phonological features of Dränjongke are understudied, and previous studies presenting phonological analyses of the language (Yliniemi 2005, van Driem 2001, 2016) were mostly based on impressionistic observations. As such, there is a need for phonetic investigation of its characteristics and the present study proposes to investigate some phonetic properties of Dränjongke fricatives.

3. PHONETIC DATA AND RESULTS

The phonetic Dränjongke data used in the present study was collected by the second author in 2017 in Sikkim, India. Stimuli were presented as syllables from the Dränjongke syllabary in isolation, words in isolation and words embedded in a carrier sentence, presented to the speakers in the Uchen Tibetan script on a slide using Keynote and a Macintosh computer. All participants were primary or secondary school teachers and also spoke English and Nepali. We analyzed fricative tokens from the syllabary recorded by 5 speakers (4 male, 1 female) who produced the 6 items with 5 repetitions: /sa/, /ʃa/ (voiceless), /za/, /ʒa/ (voiced) and /ʒ̥a/, /ʃ̥a/ (devoiced). After excluding six tokens with disfluent speech, we analyzed 144 tokens in total. Annotation and acoustic analysis were conducted using Praat (Boersma 2001). A summary of the results is reported in Table 1:

Table 1. Results on the syllabary reading

	Voiced	Voiceless	Devoiced
<i>SIP001 (F)</i>	Voicing Low F0 (avg. 167Hz)	Voiceless High F0 (avg. 190Hz)	Voiceless Low F0 (avg. 179Hz)
<i>Other speakers (M)</i>	Voiceless Low F0 (avg. 130Hz)	Voiceless High F0 (avg. 143Hz)	Voiceless Low F0 (avg. 130Hz)

3.1. F0

While voiceless fricatives are followed by higher f0 (high tone) and voiced ones by lower f0 (low tone), devoiced fricatives show both lower f0 as well as the absence of glottal vibration. For all speakers, the f0 was lower (difference ranging from 10 to 40Hz) for the devoiced fricative, when compared to the voiceless category. These findings suggest the crucial role of f0 as a predictor of the devoiced category. The difference in terms of f0 between the voiceless and devoiced category is illustrated in the spectrograms in Figure 2.

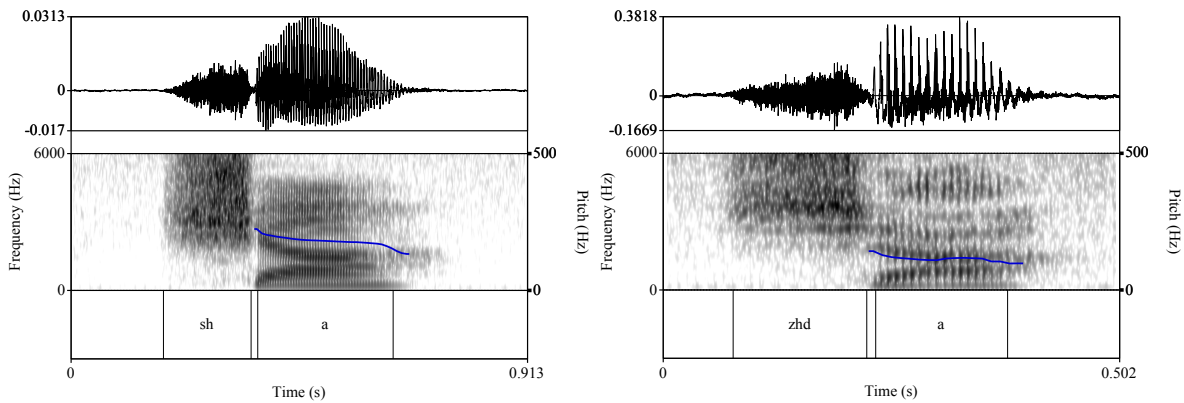


Figure 2. Comparison of the voiceless fricative /ʃa/ (left) to the devoiced fricative /ʃ̥a/ (right)

3.2. Voicing

Our results show that the female speaker had a clear voicing contrast in fricatives; periodicity was observed at the onset of the frication noise (see Fig. 3 left spectrogram). For male speakers, however, the voicing in voiced fricatives was mostly absent. Figure 3 illustrates the production of the syllable /ʒa/. The female speaker on the left panel shows voicing at the onset of frication noise that discontinues around the mid-point of the fricative. The male speaker on the right panel does not show any voicing throughout the production of the fricative.

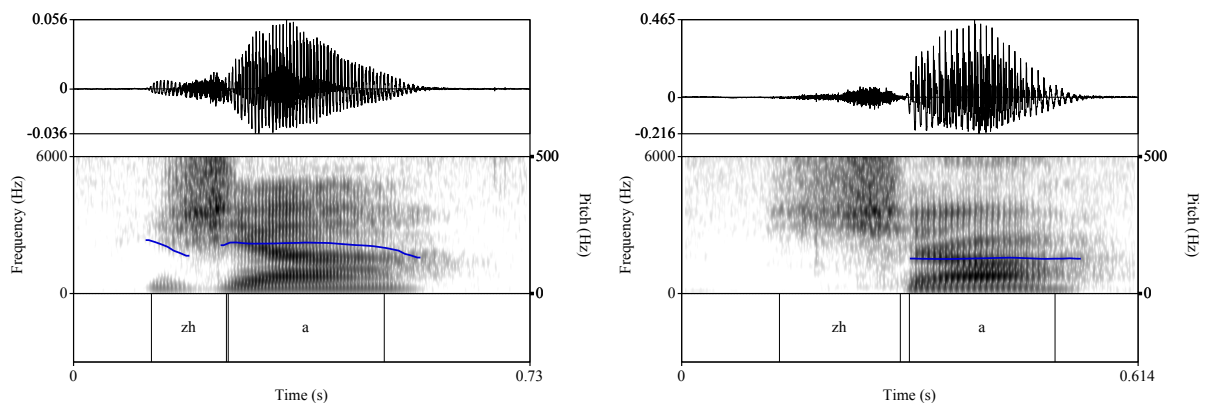


Figure 3. Realization of the voiced fricative /ʒa/ as voiced (left) for the female speaker and voiceless (right) for one of the male speakers

When compared with a voiceless fricative, the voiced fricative shows identical voicing profile, suggesting that male Dränjongke speakers have a 2-way laryngeal contrast in the fricative category (Figure 4).

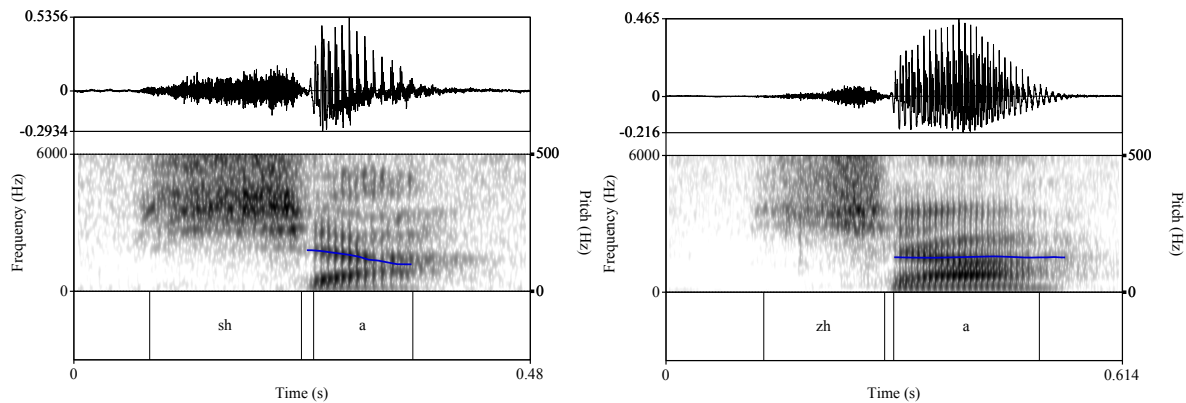


Figure 4: Voiceless fricative /ʃ/ and voiced fricative /ʒ/ by a male speaker

For the female speaker (Figure 5), voiced (left) and devoiced (right) categories show a clear voicing contrast, unlike in male speakers' production.

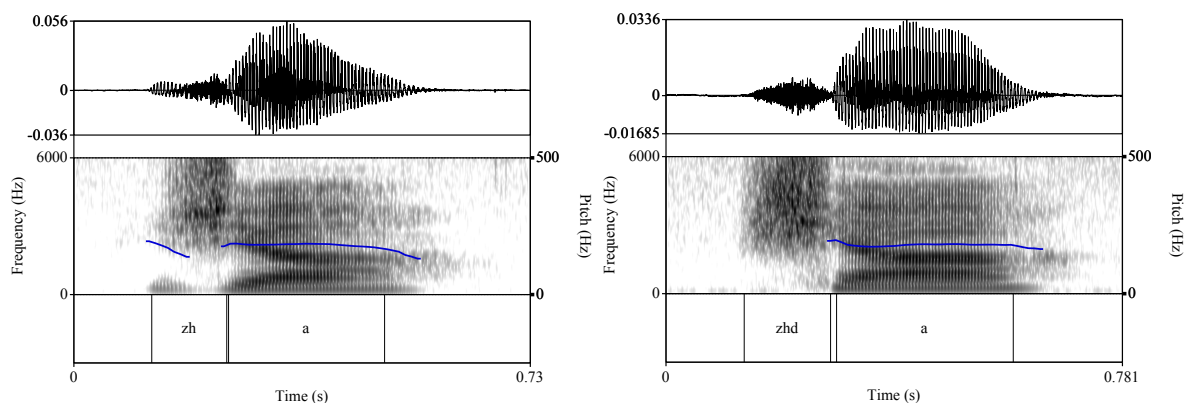


Figure 5: Voiced fricative and devoiced fricative (female speaker)

3.2. Laryngeal contrasts in fricatives by male speakers

In male speakers' production, the fricative contrast cannot be observed when voicing is concerned because all of them are produced without glottal vibration. When f_0 is considered, voiceless fricatives are immediately followed by higher f_0 than the other two types of fricatives. In order to investigate whether the contrast between voiced and devoiced is neutralized in male speakers' production we analyzed further acoustic measurements such as center of gravity, duration and intensity of the frication noise. Statistical testing of these parameters showed no significant difference between the two categories, even though a tendency to have a lower center of gravity for the voiced category (realized as voiceless) was observed.

4. DISCUSSION AND CONCLUSION

The analysis of the acoustic data recorded from the Dränjongke speakers supports previous descriptions (Van Driem 2001) of the 3-way laryngeal contrast at least in a female speaker. We found that the voiceless was followed by a high tone, while the low one follows a voiced fricative. Moreover, the devoiced category was followed by a lower tone than the voiceless one.

Although the literature suggests the influence of consonants on tone (high after a voiceless fricative, low after a voiced one, Hombert et al. 1979), our findings indicate that a low tone can occur

after a devoiced fricative. Namely, it implies that the acoustic influence of consonants on tone can be overridden by the phonological grammar that demands a particular tonal classification (manifested as f0).

Our findings for the syllabary reading also suggest that the voicing contrast might be neutralized in male speakers' production. A preliminary look at the same segments but presented in words in a frame sentence indicates the same results although devoicing was less frequent. Further perception research is needed to confirm whether the neutralization of voicing in male speech is incomplete or not (Port and O'Dell 1985).

One possible explanation for this neutralization for male speakers only, is the influence of education, considering that in Nepal and Sikkim, many of the men are monks or receive monastic education in Tibetan. In Lhasa Tibetan for example there is no voicing contrast in fricatives but only a tonal distinction as shown in Table 2.

Table 2: fricatives in Lhasa Tibetan

Low tone	High tone
ཨ sha (zha)	ཨ sha
ཨ sa (za)	ཨ sa

As the stimuli were presented in Tibetan script to the speakers, we can postulate that for male speakers the use of this script interferes with their reading.

The present study proposed a phonetic description of Dränjongke fricatives, that have been understudied until now. Our acoustic findings both confirm previous descriptions of a 3-way laryngeal contrast, and suggest the existence of a gender-based difference in the voicing contrast. This will be further investigated in further studies using different recording methodology in order to verify the influence of the Uchen Tibetan script.

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