The acoustic manifestation of laryngeal contrasts in Dzongkha: A preliminary study

Seunghun Lee*, Shigeto Kawahara**, Hanna Kaji*, Haruka Tada*
*International Christian University, **Keio University
*{seunghun, c181433k, c181130s}@icu.ac.jp, ** kawahara@icl.keio.ac.jp

ABSTRACT

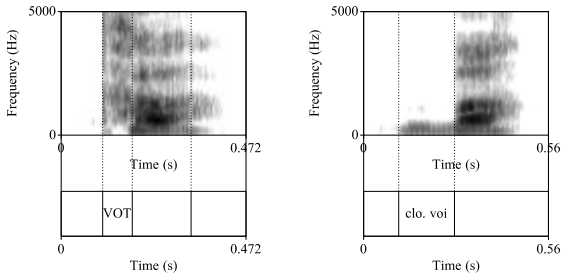
Dzongkha is the national language of Bhutan, but its phonetic nature has not been studied instrumentally. This paper reports acoustic analyses of the four-way laryngeal contrasts in the language: (1) aspirated, (2) voiceless, (3) voiced, and (4) "devoiced". The current analysis demonstrates that both VOT and F0 of the following vowels distinguish these four categories. Aspirated consonants have the longest VOT, whereas voiced consonants have long negative VOT (i.e. closure voicing). Voiceless and devoiced consonants show mildly positive VOT values. These two categories are distinguished in terms of F0 of the following vowels, in that voiceless consonants show higher F0 than devoiced consonants.

1. Introduction

Dzongkha (a.k.a. Bhutanese) is the national language of Bhutan, but its phonetic nature has not been explored using recent phonetic technologies, aside from the impressionistic description by [1] and a brief analysis by [2]. This paper reports a part of our on-going attempt to explore the phonetic nature of this and other related Sino-Tibetan languages. In particular, this paper focuses on the acoustic nature of the four-way laryngeal contrast that this language has been reported to have: (1) aspirated, (2) voiceless, (3) voiced, and (4) what has been described as "devoiced" by [1, 2]. Since our analysis is based on the data from a single speaker, we take the current results to be preliminary. However, we hope to situate the current study as a step stone toward more extensive phonetic analyses of this—and other related Sino-Tibetan—languages.

2. Method

The analysis is based on the syllabary reading of a single native speaker of Dzongkha, which is made available in [3]. All the obstruents followed by a vowel [a] were analyzed. The lag between the release of the consonant and the onset of the following vowel was annotated using Praat [4]. These intervals were taken to represent VOT of different types of obstruents (see Figure 1(a)). Voiced consonants showed clear voicing during closure, despite being word-initial (Figure 1(b)). The closure voicing interval was taken to be negative



(a) aspirated consonant (b) voiced consonant

Figure 1. Illustrative spectrograms.

VOT. The durations of these intervals were automatically extracted using a Praat script.

A preliminary analysis shows that "devoiced" consonants show lower F0 in the following vowel compared to voiceless consonants. [1] also notes that syllables with aspirated and "devoiced" onsets belong to H-tonal register, whereas those with voiceless and voiced onsets belong to L-tonal register. To expand on this observation, a 20 ms analysis window was created at the onset of the following vowel, and the average F0 within that analysis window was calculated for each type of consonants. Since F1 has also been reported to co-vary with a laryngeal contrast cross-linguistically [5], F1 values were also measured within these analysis windows. We admit at this point that our analysis is based on a small number of tokens produced by a single native speaker (aspirated=5; voiceless=7; devoiced=11; voiced=13). We thus take the results to be preliminary, and we do not attempt to apply statistic comparisons.

3. Results

Figure 2 shows the VOT values of the four laryngeal categories, grouped by different place of articulation. For all place of articulation, we observe that voiced consonants are separated out from the rest of the three categories in that they all have negative VOT values (i.e. closure voicing); their closure voicing is usually longer than 100 ms (= 0.1 sec). Among the rest of the three categories, aspirated consonants show the longest VOT values, which are about or slightly shorter than 100 ms. Voiceless and "devoiced" consonants show intermediate

values. One important question that arises is thus how these two categories are phonetically distinguished.

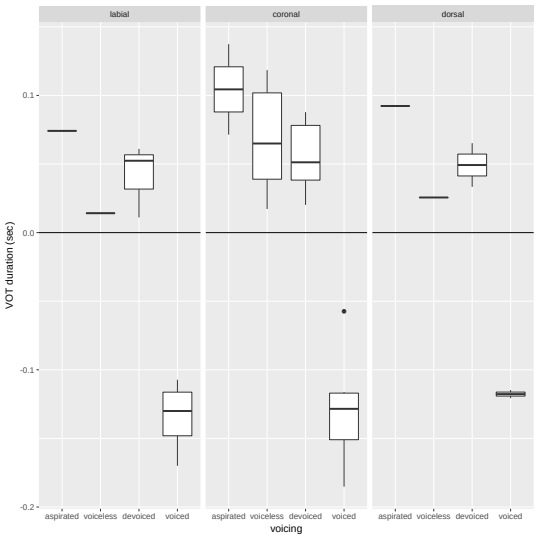


Figure 2. VOT (sec), shown by different place.

Figure 3 shows the results of the F0 analyses. It shows that voiceless and "devoiced" consonants, which show comparable VOT profiles, are separated out in terms of this measure. In addition, voiced consonants show lower F0 than voiceless consonants, an observation that is compatible with the cross-linguistic observation [5].

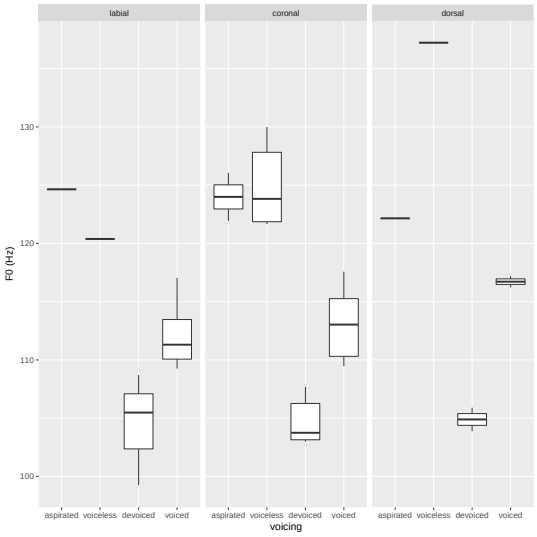


Figure 3: F0 (Hz).

Finally, Figure 4 shows the analyses of F1 values. Recall that all the vowels are [a], so that differences due to vowel height is controlled. The separation between the four categories is not as clear as the one for F0. However, one consistent pattern is that voiceless obstruents show higher F1 compared to other categories. This patterning is also compatible with the cross-linguistic observation made by [5].

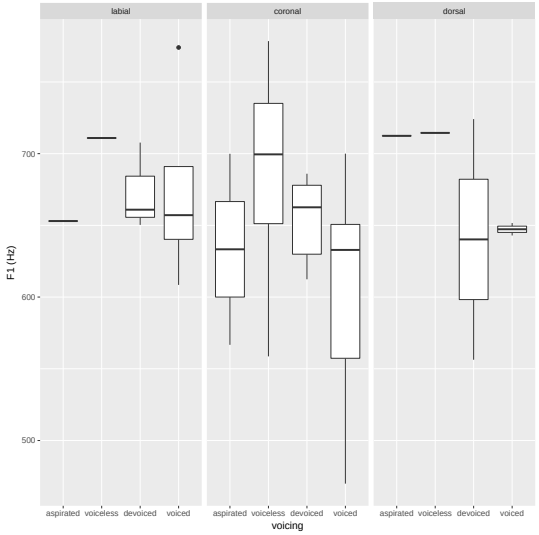


Figure 4: F1 (Hz).

4. Conclusion

The current paper offers the first acoustic analysis of the four-way laryngeal contrast in Dzongkha. It has shown that in terms of VOT, aspirated consonants are longest; voiced consonants have negative VOT; voiceless and "devoiced" consonants show intermediate VOT values. The F0 at the onset of the following vowels differed in such a way that aspirated and voiceless consonants show high F0; voiced consonants show lower F0; and "devoiced" consonants showed the lowest F0. The voiceless category is also characterized by high F1 in the following vowel.

The current results should be taken to be preliminary, as the analysis is based on a single speaker who produced each syllabary once. Further analyses should be conducted to confirm the current findings with more tokens and more speakers. The analysis of actual words, instead of syllabary readings, is on-going.

References

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