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A preliminary study of the vowel length contrast in Drenjongke

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1. Introduction

Drenjongke (also known as "Bhutia", "Hloke" or "Sikkimese") is a Tibeto-Burman language which is spoken by about 80,000 speakers in Sikkim, India and whose phonetic properties are understudied (see the green part in Figure 1.). Although Drenjongke is one of the official languages in Sikkim, the lingua franca languages in Sikkim are Nepali and English. Drenjongke is considered as endangered due to the decrease in the number of younger speakers. The literacy of Drenjongke is also not high because the Tibetan orthography is used for writing Drenjongke, which does not always succeed in representing the vernacular language.



Figure 1. Map of the languages of the Himalaya

Descriptions of the language (vanDriem 2001, 2016; Yiliemni 2019) have reported a length contrast in some of the vowels of the phonological inventory of Drenjongke where 'short' vowels contrast with 'long' vowels. This contrast is involved in a variety of minimal pairs as exemplified in (1)

(1) Minimal pairs for the vowel contrast

a.	si	'trouble, envy	si:	'feel cool'	(Yiliemni 2019: 49)
b.	ka	'order'	ka:	'split'	(Yiliemni 2019: 49)
c.	ko	'dig'	ko:	'throw'	(Yiliemni 2019: 49)
d.	she	'explain'	she:	'know'	
e.	dru	'boat'	dru:	'six'	

However, what these studies also point out is that there is more to this contrast than a difference in vocalic duration. Both van Driem (2001, 2016) and Yiliemni (2019) report that only some of the vowels in the Drenjongke phonological inventory have this length contrast, and suggest that there is a complexity in the realization of this vowel contrast in relation to other acoustic differences such as vowel quality and the presence or absence of a glottal stop.

Although several impressionistic descriptions of this pattern are available, there is a lack of experimental studies examining acoustic properties of this vowel contrast. The current study offers a preliminary acoustic description of the production of the vowel length contrast by Drenjongke speakers in order to examine its acoustic realizations. After examining the durational cues, we looked at the different patterns of phonetic implementation exhibited by the 'long' vowels. Our findings, which are consistent with previous research results, confirm the complex nature of the contrast, and allow to identify a variety of patterns of phonetic realization for the 'long' vowel.

2. Methods

This study uses production data collected in March 2019 in Sikkim, India. The participants, eight native speakers of Drenjongke (5 male, 3 female), read a randomized list of words in a frame sentence with 5 repetitions. The list was made in order to include minimal pairs with a short vowel and its long counterpart for each vowel (e.g. [so] 'tooth' versus [so:] 'save').

The duration of each target segment was annotated using Praat (Boersma and Weenink 2018), and the extraction of measurements was automated with its scripting function. Statistical analyses were conducted using R (R core team 2017).

3. Results

We first investigated the annotated raw durations of the vowel segments. Our results are consistent with previous observations (van Driem 2001, 2016; Yiliemni 2019) that the vowel length contrast does not seem to be only based on a difference in vocalic duration.

The box plot in Figure 2 presents the distribution of the duration of short (left box) and long (right

box) vowels. In our aggregated data, the mean duration of all short vowels is 100 milliseconds (ms), while the mean duration for the long category is 110 ms, that is a durational ratio for the long/short vowel contrast of 1.1. Although the t-test indicated a significant difference between the two categories for the observed mean duration, the perceptual reality for native listeners of this difference (10 ms) is questionable. Moreover, what the box plots in Figure 2. also suggest is that considerable overlap exist in the distribution of the duration of the two categories.



Figure 2. Distribution of the duration for short and long vowel categories

When looking at the same data organized by speaker (in Figure 3), we observe that the vowel length contrast is subject to inter-speaker variation. Each panel in Figure 3 illustrates the distribution of the vowel distinction based on orthography for each speaker. The plots in figure 3 show that the vowel length contrast have three ways of being implemented. Some speakers show no clear difference in duration between the short and the long categories (e.g. SIP052), and some others have a longer 'short' vowel (e.g. SIP049) or a longer 'long' vowel (e.g. SIP050). The duration results themselves do not offer a possibility of distinguishing short vowels from long vowels.

The distribution of the duration for the two categories is also of interest when we look at each pair separately. These pairs were examined because impressionistic studies have reported the presence of short versus long contrast in them. In Figure 4, we observe three different patterns: (a) word-pairs with no length contrast (e.g. A3-A4), (b) word pairs with a contrast with longer 'long' vowel (e.g. AMP15-16), or (c) word pairs with a contrast with a shorter 'long' vowel (e.g. MP21-22). The presence of inter-speaker variations in the realization of the length contrast, as well as the different patterns observed for the different pairs suggest that the vowel duration might not be the only acoustic correlate active for the vowel length contrast production.



Figure 3. Distribution of vowel duration by Figure 4: Distribution of vowel duration by pair speaker

A further investigation of the recordings displays that there is no unique acoustic parameter that is responsible for the realization of the long vowel and that there is co-existence of several phonetic implementation patterns across the repetitions. Although short vowels consistently match the expected realization (i.e. a vowel with a short duration), we observe the following phonetic implementation patterns for long vowels:

(i) a longer duration of the vowel component when compared to its 'short' counterpart in the minimal pair (Figure 5.),

(ii) a short vowel followed by a consonant (Figure 6a.),

(iii) a difference in phonation: creaky voice (Figure 6b.),



(iv) a different vowel quality.

Figure 5. 'horse' [ta] vs. 'tiger' [ta:] minimal pair by speaker SIP071

Pitch (Hz)



velar stop by SIP054

Figure 6a. 'tiger' /ta:/ pronounced as [tak] with a Figure 6b. 'tiger' /ta:/ pronounced as [ta:] with creaky voice by SIP021

The spectrograms in Figure 5 and 6b illustrate three different types of phonetic implementation of the /ta/ 'horse' vs. /ta:/ 'tiger' [ta:] minimal pair. In Figure 5, we observe the expected realization of the short/long vowel contrast. On the left panel, the duration of the vowel for the short vowel is shorter than for its long counterpart in the right panel. In Figure 6a, the duration of the short vowel appears to be of similar duration with the short vowel in Figure 5, and the closure portion immediately following the vowel observed on the spectrogram suggests that the long vowel is realized as a short vowel followed by a stop. In Figure 6a, the consonant is a [k]. However, in other occurrences of long vowel we also observed glottal stops [?], as well as [r] or [l] in this post-vocalic position. Figure 6b is an example of the long vowel realized with creaky voice, as shown by the glottal pulses in the spectrogram. Lastly, another type of phonetic implementation of the long vowel that is not illustrated in the spectrograms here is the difference in vowel quality. The pair A3-A4 /so/ 'tooth' vs. /so:/ 'save' was consistently realized as [so] for the short vowel, and [so:] for its long counterpart. This is not surprising given that cross-linguistically vowel quality is a known correlate for vowel length contrast (Lehiste 1970, Maddieson 1984).

The four different patterns of phonetic implementation for the long vowel described above were not observed consistently. In fact, the patterns differ within an individual speaker (i.e. different realizations were observed through the five repetitions), between speakers (i.e. some speakers are more likely to lengthen or insert a consonant than others) and by item pairs (i.e. the same item pair may have various realizations). What our results suggest is that there is indeed a vowel length contrast in Drenjongke, but that the lengthening of the vowel duration is only one of the possible realizations and the contrast can be maintained using other cues.

4. **Discussion and conclusion**

This paper reports findings from the acoustic description of the vowel length contrast in Drenjongke. Although this language has been described in previous studies as having a contrast in terms of vowel length opposing 'short' vowels to their 'long' counterparts, it appears that other acoustic correlates beyond duration need to be considered. Confirming previous studies (vanDriem 2001, 2016; Yiliemni 2019), several patterns of phonetic implementation was observed for the 'long' vowels only. There was no single phonetic parameter that is consistently observed across all the short vs. long vowel pairs; the acoustic realizations of the contrast between short and long vowels instead differ by speaker, between speakers, and by item pairs.

Research has shown that cross-linguistically, when a short-long contrast has a low durational ratio, other cues can be deployed to keep the distinction salient. This is for example the case in Norwegian where the duration of the vowel preceding duration of preceding vowel: Fintoft 1961). We suggest that this may also be the case in Drenjongke. When the vowel contrast is not saliently realized with a duration difference, the long vowel category utilizes other types of phonetic cues to maintain the contrast: a consonant can be inserted, the vowel is laryngealized, or the vowel can be differentiated. An interesting challenge is how to model this inter-speaker and inter-item variability.

Several questions arise from the findings of the present study. Firstly, do native speaker assimilate all the different realizations of the long consonant as the same phonemic category. Second, are native speakers able to make a perceptual distinction between the long and short categories. These questions will be addressed in a further study using perceptual experiments.

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