How is lexical gemination transposed in Tashlhiyt whistled speech?

Rachid Ridouane¹ & Julien Meyer²

¹LPP (CNRS / Sorbonne Nouvelle) & ²GipsaLab (CNRS / Université Grenoble-Alpes)
rachid.ridouane@univ-paris3.fr & julmeyer.lab@gmail.com

This paper addresses a traditional language practice based on whistling – called whistled speech – in Tashlhiyt, a variety of Moroccan Amazigh known for its typologically rare phonotactic patterns. As part of a larger database on various phonological aspects of the language, the current study examines how the key phonetic properties of lexical gemination in different prosodic positions are carried into a whistled signal. The comparison of the whistled forms with what we know about spoken forms of speech is bound to provide important insight into the organization and malleability of the phonology/phonetics system.

Whistled speech is an ancient natural practice that consists in a phonetic transformation and emulation of the spoken form. Because of constraints inherent to the whistled production, whistled speech simplifies the phonetics of spoken speech but is still based on the general patterning of spoken languages (Busnel & Classe 1976, Cowan 1958, Rialland 2005, Meyer 2015). Consider the signal and spectrogram of a Tashlhiyt spoken and whistled word given in Figure 1. Here, the whistler transposed the acoustic characteristics of the spoken [ittut], into a simple formant-based signal with specific amplitude envelope.

Similar to what has been reported for other whistled languages (for e.g. Silbo in Rialland 2005), vowel transposition targets the F2 contour which may be copied into a strikingly similar H1 contour in its whistled counterpart (note also that closure durations in spoken and whistled forms are virtually identical).

To date, all over the world, around 40 populations, mostly in mountainous or densely vegetated landscapes, are known to have developed their language into this special and complementary speech register (e.g. Greek, Spanish of La Gomera (called Silbo), Turkish, Siberian Yupik, Wayápi, Hmong, etc. See Meyer (2015) for a review). Complementary to spoken forms, whistling has the advantage of increasing the audible range of speech and to enable dialogues when speakers are far from each others.

In what follows, we examine how gemination contrast for voiced and voiceless stops is rendered in whistled speech and how position in the word shapes variability in the way this contrast is transposed.

Data collection

Fieldwork was organized during November 2015 in the High Atlas. Audio materials were collected at this occasion with three traditional whistlers. A corpus was built from a list of selected isolated words that were recorded in a situation of elicitation. The corpus was composed of four minimal or near-minimal pairs contrasting singletons /t d k g/ to their geminate counterparts /tt dd kk gg/ in three different word positions: initial (e.g. [gar] ’bad’ vs. [ggar] ‘be last’), intervocalic (e.g. [tadawt] ‘back’ vs. [taddart] ‘house’) and final (e.g. [ikat] ‘he gave it, masc.’ vs. [ikatt] ‘he gave it, fem.’). The whistlers, whom we identify SA (35), MO (33) and OT (34 years old), were asked to speak and whistle three times each word. The whistled material was segmented based on visual inspection of the acoustic signals and spectrograms (see figure 1 whish also illustrates how these data were segmented). Temporal and non-temporal measurements were taken from the signal. The temporal parameters include duration of pre-consonantal vowels in intervocalic and final positions, duration of stop closure, and duration of post-consonantal vowels in initial and intervocalic positions. Non-temporal parameters include the frequency value at C-to-V transitions for word-initial and word-intervocalic positions (i.e. at the onset of the H1 contour of the vowel following the target stop) and the frequency value at V-to-C transition for word-final position (i.e. at the offset of the H1 contour of the vowel preceding the target stop).

Results

The clearest cue to gemination in intervocalic position was closure duration. As shown in figure 2, the duration of the silent period corresponding to whistled stops was systematically longer for geminates compared to singletons. These differences were highly significant $F(1,70) = 64.68$, $p<0.001$. Pre-consonant vowels were also significantly shorter before geminates $F(1,70) = 9.362$, $p=0.003$ (figure 3).

Gemination, on the other hand, had no significant effect on post-consonant vowel duration $F(1,70) = 2.059$, $p=0.156$. Looking at the non-temporal parameters, our findings showed that geminates tended to display higher frequency values at the onset of C-to-V, but these differences were only marginally significant $F(1,70) = 3.084$, $p=0.083$. 


The transposition of consonants in whistling involves mainly consonant-vowel transitions. This made it impossible to measure consonant duration in post-pausal word-initial position. Looking at non-temporal parameters, our findings showed that geminates displayed higher frequency values at the onset of C-to-V transitions compared to singletons. These differences were highly significant $F(1,70)=28.77$, $p<0.001$ (figure 4). Again, post-consonant vowel duration was not affected by the presence or absence of gemination $F(1,70)=1.764$, $p=0.188$.

Geminaton contrast in word-final position was primarily marked by consonant duration, geminates being produced with significantly longer stop closures compared to singletons $F(1,63)=62.28$, $p=0.001$. This parameter was measured only for forms produced with a whistled stop release (65 tokens out of 72). Note, however, that his release was weak and couldn’t presumably be heard from a long distance. The other parameters did not accurately distinguish singletons from geminates (pre-consonantal duration: $F(1,70)=0.255$, $p=0.615$; V-to-C frequency: $F(1,70)=1.764$, $p=0.188$).

**Discussion & conclusion**

The most salient acoustic cue differentiating whistled singletons and geminates in different word positions is duration of closure. Preceding vowel duration is another cue to gemination, though clearly a secondary one, since it is contextually limited and presents some variability depending on word position. The higher frequency values at C-to-V transitions for geminates may also be considered as a secondary cue as it also presents some variability across subjects and word position.

Compared to spoken forms (Ridouane 2007), whistling, while adapting to the specific constraints imposed by the medium, seems to transpose the basic strategies used in normal speech to convey lexical gemination contrast. As in normal speech, duration is not used alone to implement the singleton/geminate contrast in whistled Tashlhiyt. Rather, supplementary cues are conveyed which may serve to enhance the primary correlate by contributing additional acoustic properties increasing the perceptual distance between the two lexical categories. These enhancing cues may take on distinctive function in cases where the primary correlate – duration – is not implemented. This is, for instance, the case of higher frequency values in word-initial position where duration differences cannot be acoustically implemented using whistled speech.

**References**


