Gemination in Tashlhiyt whistled speech

Whistled speech is an ancient natural practice that consists in a phonetic transformation and emulation of the spoken signal into a simple melodic line made up of frequency and amplitude modulations of a whistled signal. This paper addresses this special traditional practice in Tashlhiyt, an Amazigh language spoken in Morocco. It questions more specifically how the key properties of Tashlhiyt lexical gemination in different prosodic positions are carried into a whistled signal.

Fieldwork was organized during November 2015 in the High Atlas. Audio materials were collected at this occasion with three different 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 singleton /t d k g/ to their geminate counterparts /tt dd kk gg/ in three different word positions: initial, intervocalic and final. Three traditional whistlers, whom we identify OT (34 years old), MO (33) and SA (35), 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. 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 consonant-vowel transitions for word-initial and word-intervocalic position and the frequency value at vowel-consonant transition for word-final position. An example of a Tashlhiyt whistled word is given in Figure 1.

Results show that the clearest cue to gemination in intervocalic position is closure duration. As shown in figure 2, the duration of the silent period corresponding to whistled stops is longer for geminates compared to singletons, the duration of the silent period corresponding to whistled stops is systematically longer for geminates compared to singletons. These duration differences are significant at the $p<.00001$ level. Pre-consonant vowel duration is also affected by gemination, as shown in figure 3: vowels preceding geminates are significantly shorter ($p<.01$). Gemination, on the other hand, has no significant effect on post-consonant vowel duration ($p>.01$). Looking at non-temporal parameters, our findings show that frequency values at the onset of consonant-vowel transitions is also affected by gemination: geminates displaying higher values compared to singletons (see figure 4).

The transposition of consonants in whistling involves mainly consonant-vowel transitions. This makes it impossible to measure consonant duration in word-initial position. Gemination in this position is primarily marked by significant differences in frequency values at the onset of consonant-vowel transitions, with significantly higher values for geminates compared to singletons (SA: 2113>1696 HzHz, MO: 2661>2299 Hz, OT: 2469>2145 Hz). Gemination contrast in word-final position is also primarily marked by consonant duration, geminates being produced with longer stop closures (253 ms, SD = 56) compared to singletons (158 ms, SD = 38). This parameter was measured only for forms produced with a whistled stop release (65 tokens out of 72). The other parameters did not so accurately distinguished singletons from geminates compared to word-initial and word-intervocalic positions. Indeed, only subject OT distinguished singletons and geminates in terms of duration of pre-consonantal vowel duration (167 ms for singletons vs 148 ms for geminates) and frequency values at vowel-consonant transitions (2434 HZ for singletons vs 2738 Hz for geminates).

Because of constraints inherent to the whistled production, whistled speech simplifies the phonetics of spoken speech but is still based on the phonological patterning of spoken languages (Cowan 1958, Rialland 2005, Meyer 2015). Compared to spoken forms, our results show that whistling transposes the basic strategies used in normal speech to convey lexical gemination contrast. As for normal speech, duration is used as the primary correlate to implement the singleton/geminate contrast in whistled Tashlhiyt, suggesting that the contrast is temporal in nature. This clearly supports a two X-slot representation reflected by the observed differences in consonant closure duration. Supplementary enhancing cues are also conveyed. Preceding vowel shortening and higher frequency values for whistled geminates may be interpreted as seconday cues which serve to enhance the primary correlate by contributing additional acoustic properties which increase the perceptual distance between singletons and geminates. These enhancing cues may take on distinctive function in cases where the primary correlate – duration – is not perceptually recoverable. This is, for instance, the case of higher frequency values in word-initial position where duration differences cannot be acoustically implemented.

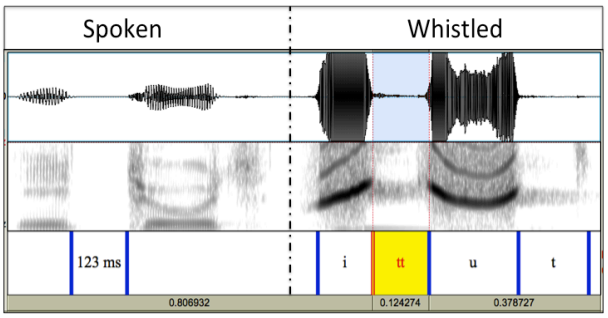

Figure 1. Spoken and whistled forms of [ittut] « he forgot him ». Note that closure durations in spoken and whistled forms are virtually identical.

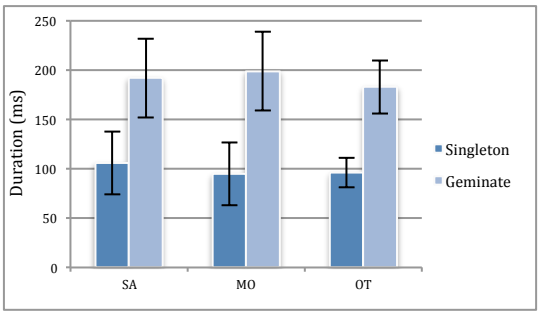

Figure 2. Mean duration values in (ms) showing the effect of gemination on closure duration in intervocalic position.

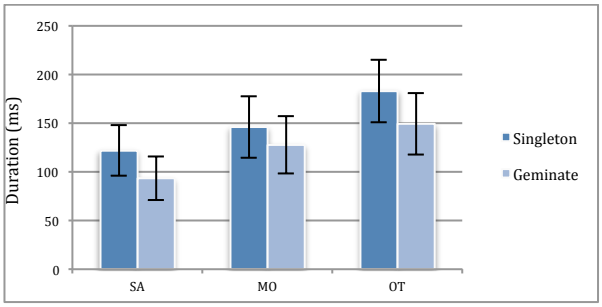

Figure 3. Mean duration values (ms) showing the effect of gemination on preceding vowel duration in intervocalic position

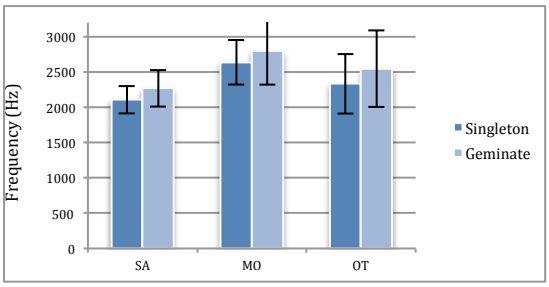

Figure 4. Frequency values (Hz) at the onset of consonant-vowel transitions for singletons and geminates in intervocalic position.

References

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