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Whistled Moroccan Tamazight: phonetics and phonology

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ABSTRACT

This paper reports the results of a pilot phonetic study of whistled Moroccan Tamazight. Whistled speech is an ancient traditional and natural practice that consists in a phonetic emulation and transformation of the spoken signal into a simple melodic line made up of frequency and amplitude modulations of a whistled signal. It is primarily used for long distance communication. We recorded four Moroccan Tamazight speakers in the High Atlas producing this special speech register. Given its particular characteristics, namely the extensive presence of words and syllables without vowels, the opportunity Tamazight affords for the execution of whistling may be particularly challenging. We show how speakers whistle a selected set of words and sentences and discuss the preliminary results from phonetic and phonological perspectives.

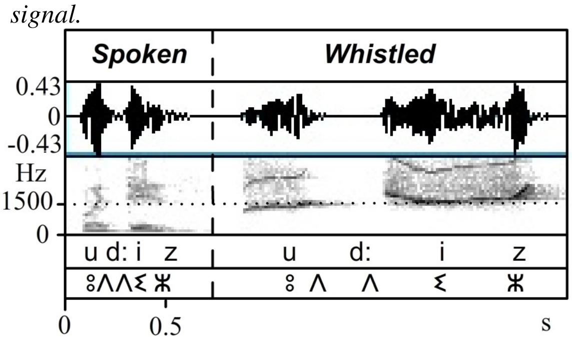
Keywords: Whistled speech, Tamazight, Syllable, Schwa, Segments.

1. INTRODUCTION

This paper addresses a special and little-known traditional language practice based on whistling – called whistled speech - in a language characterized by typologically unique phonetic and phonological properties – Tamazight Berber. Whistled Tamazight was recently found among shepherds of the High Atlas in Morocco, an area which greatly shades into Tashlhiyt and shares with it major phonological properties. Among these properties, the one we are interested in here concerns syllable structure. The Tamazight whistlers learn since childhood to copy any sentence of their language into a simpler whistled signal carrying key phonetic cues of the original acoustic and articulatory features. These are sufficient to guarantee high levels of intelligibility of the information encoded in the whistles. An example of a whistled word is given in Fig. 1.

Whistling is one of the multiple modes of expression for some languages. To date, all over the world, around 40 low-density and remote populations are known to have developed their local language into this special and complementary speech register which has the advantage to increase the audible range of speech and to enable dialogues when speakers are far from each others (for a review, see [1]). It is mostly found in mountainous and densely vegetated landscapes. Whistled Spanish of La Gomera Island – locally called “El Silbo”, i.e., “The Whistle” - is the most studied of them [2-5], and was declared a Masterpiece of the Oral and Intangible Heritage of Humanity by the UNESCO due to its historical and cultural importance for the Canary Islands. Indeed, “El Silbo” is one of the few remnants of the islands’ ancient Tamazight language (Guanche) and this special whistled register has only survived by being adapted to the conqueror’s language (Spanish).

Figure 1: The Tamazight word [ud:iz] ‘punch’ (transcribed in the instituted Moroccan Tamazight alphabet Tifinagh). *In all the figures of this paper, the spoken signal is amplified of 15 dB to be more visible and easy to compare with the whistled signal.*



For historians, the discovery of a whistled tradition of speech in the High Atlas is of a great scientific interest. Indeed, besides the ancient presence and extensive cultural exchanges that the Berber populations of Africa have had with the Canarians, there is also evidence of ancient cultural exchanges with Andalucía, Greece and Bearn in the Pyrenees, three geographical locations where a whistled speech practice has been reported during the 20th century. Moreover, ancient historians such as Elien and Herodotus made reports of the existence of whistled traditions related to language in other speaking communities of North Africa [1].

Whistled Tamazight is also of importance for the community of researchers in phonetics and phonology. Examining how the rare phonotactic patterns of this language are transposed in such a special way will provide, we believe, some important new insights on the organization and malleability of the phonology/ phonetics system.

1.1. Whistled speech: a review

From previous research, it is known that whistled speech profoundly modifies the phonetics of standard speech by operating a reduction in the frequency domain (from the complex frequency spectrum of the voice to a simple pitch variation of whistles). During this procedure, certain phonetic details present in standard speech are lost. A major distinction in strategy is however noted for tonal versus non-tonal languages.

In most non-tonal languages (Greek, Spanish, Turkish), whistlers approximate the vocal tract articulation used in spoken form; this approach provokes a whistled adaptation of vowel and consonant qualities carried by the timbre of the voice. In Greek, Spanish and Turkish, whistled vowels are emitted at different pitch levels depending on the frequency distribution of their timbre: typically, /i/ has the highest pitch, /e/ is lower, /a/ is even lower [5]. Consonants are represented by continuous or interrupted modulations of these vocalic frequencies [1, 4]. The description of the mechanism of bilabial whistling production has shown that a whistle frequency is always captured by either the second or third formant of the vocal tract and that a frequency jump between the two occurs when these formants are close [6]. This latter effect is most likely to occur in front vowels and in some consonant transitions [1].

In tonal languages (see [1 and 4] for reviews), in what is called pitch-based whistling, the situation is different: whistles are not focused on emulating the timbre but instead the pitch of the voice, transposing the fundamental frequency of the vibration of the vocal folds to primarily encode the lexical tones. Therefore, in the whistled form of a tonal language, the vowel quality is completely excluded. This exclusion of timbre occurs even where the functional load of information carried by tones is lower than that carried by vowel quality.

Tamazight, which is a non-tonal language, is expected to behave like Spanish, Turkish and Greek as far as whistled syllables with full vowels are concerned (see Fig. 1). The question arises, however, concerning syllables without vowels. How are these forms transposed in whistling in the absence of a full vowel? This question has been raised and examined both for singing [7] and for spoken language [8, 9]. It was shown that forms containing neither a vowel nor a sonorant consonant may either display no peak at all or more frequently have a peak on a schwa vowel [@] occurring within the consonant string of the target form.

2. DATA COLLECTION

Fieldwork was organized during September 2014 in the High Atlas. Two different types of audio materials were collected at this occasion with four different traditional whistlers:

- First, a corpus was built from a list of selected isolated words that were recorded in a situation of elicitation in a room isolated from noise. Two traditional whistlers were asked to speak and whistle twice each word. One of them was also asked to over articulate the spoken form at the same pace as his whistled productions to enable the experimenters to locate where a @ would appear in this case.
- Another corpus was recorded in the context of a real dialogue between two other whistlers separated by a distance of 250 meters (outdoors, mountainous and dry landscape, recording at 1 meter of the whistler who initiated the conversation semi spontaneously). The second whistler systematically asked for repetition of each sentence for the experimenters to obtain two audio recordings of a same sentence.

These corpora were double checked by two linguists, experts of whistled speech. With the help of a linguist who is both expert and fluent speaker of Tamazight, they transcribed the corpora based on visual inspection of the acoustic signals with auditory confirmation. For the present study the productions of one whistler of each corpus are examined. We first measured the frequency distribution of the three full vowels /a, i, u/. The value selected for the frequency of each whistled vowel corresponded to the maximum of amplitude of this segment. In the absence of a clear maximum, the measure was taken at the median duration of the vocalic segment. Vocalic transitional elements [@] were measured in clusters with no full vowel. Because of the over articulations of whistled speech, vowel-like modulations appeared even if they were not present in standard spoken form (for example, in voiceless clusters or clusters with homorganic consonants). Interestingly, these vocalic elements were also present in speakers' 'exaggerated' spoken repetitions of the same items, trying to pace them.

3. RESULTS

3.1. The vocalic system

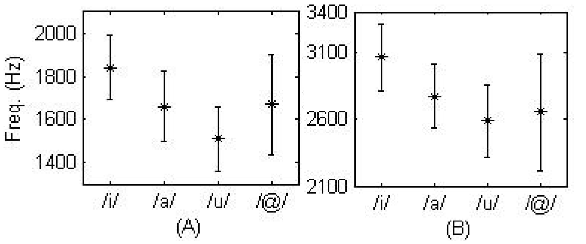
Figure 2 presents the frequency distribution of whistled vowels and whistled vowel-like [@].

Several observations can be made from these data:

(i) the underlying vowels /i, a, u/ are whistled in intervals of frequencies that follow the same logic as in Turkish or Spanish, with /i/ statistically higher in frequency than /a/ which is also higher than /u/ (see data in (ii)).

(ii) The intervals of /i/, /a/, and /u/ are statistically different (multiple t-tests with Bonferroni correction) albeit important overlap, particularly between /a/ and /u/ (/i/ vs. /a/: [p<.0001] for AL, [p<.0001] for MO. /a/ vs. /u/: [p<.01] for AL, [p<.05] for MO). /i/ pulls the frequency to high values, /a/ is intermediate and /u/ pulls the frequencies to low values of the whistled vocalic space.

Figure 2: Frequency distribution and standard deviation of whistled full vowels and /@/ in Tamazight for a whistler of each corpus: (A) AL whistling words in a task of indoor elicitation; (B) MO whistling sentences in a natural context of outdoor long distance dialog;



(iii) The vowel-like element [@] overlaps greatly with the three other whistled vowels, suggesting that this element is not attached to a particular vowel target and transposes various timbre configurations. As such it is a phenomenon observed for the first time in whistled speech research.

(iv) The relative distribution of [@] is the same for the two whistlers whistling in different conditions (even if the whole distribution is transposed to higher frequencies for the whistler who whistles stronger to reach a greater distance).

3.2. The consonantal clusters

3.2.1. 'Consonant-only' syllables.

Syllables made-up of underlying consonants only are present in our data. These may be of the types C (e.g. [**k**.ʃm] 'come in', CC (e.g. **s**k.su] 'couscous, a traditional Amazigh dish' or CC (e.g. [z**ʕ**.fat] 'be angry') where the nucleus is bolded and underlined. An important constraint that regulates boundaries between syllables is the prohibition against complex onsets [10]. A consequence of this is that all prevocalic consonant clusters are heterosyllabic. That is, XCCVX forms (where X is a word boundary or any string of consonants and vowels) are systematically parsed as XC.CVX [11]. We are interested in assessing whether this heterosyllabicity is also reflected in the way whistlers delineate consonant clusters.

Figure 3: Spoken and whistled forms of (A) [ʃm.mart] and (B) [k.ʃm] (where . indicates syllable boundary).

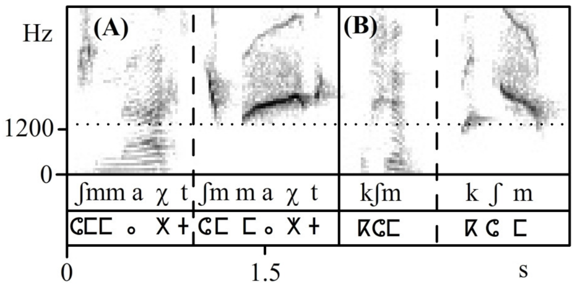


Fig. 3 presents an illustration of the verb [kʃm] produced in isolation. From a phonological point of view, this form is bisyllabic [k.ʃm], where the first consonant stands for a syllable of its own. The way this form is rendered in whistling shows that it is partitioned in two parts with a period of silence between [k] and [ʃm]. In doing so, whistlers seem to delineate parts of this form in just the same was as a clear bisyllabic form such as [izi] 'fly', which also has two parts [i] and [zi], or [uddiz] shown in Fig. 1 above. Fig. 3 also presents an illustration of the word [ʃm.maxt] 'I smelt it'. The syllable [ʃm] also stands on its own in this form but displays different acoustic characteristics from [ʃm] of [k.ʃm]. A possible explanation to these differences relates to prosodic considerations. Unlike in [ʃmmaxt], the syllable [ʃm] in [k.ʃm], because it occurs in final position and has a sonorant segment, bears the tonal event which makes it louder and longer [12, 13].

Figure 4: Spoken and whistled forms of (A) [am.zil] and (B) [a.mk.sa].

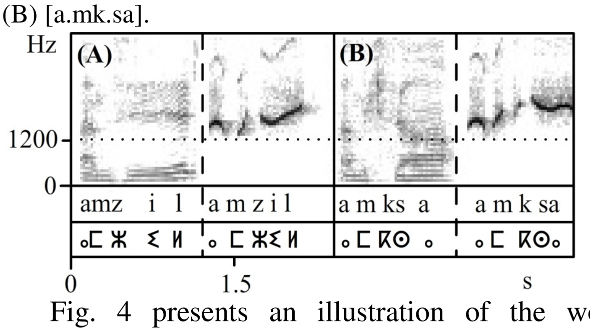
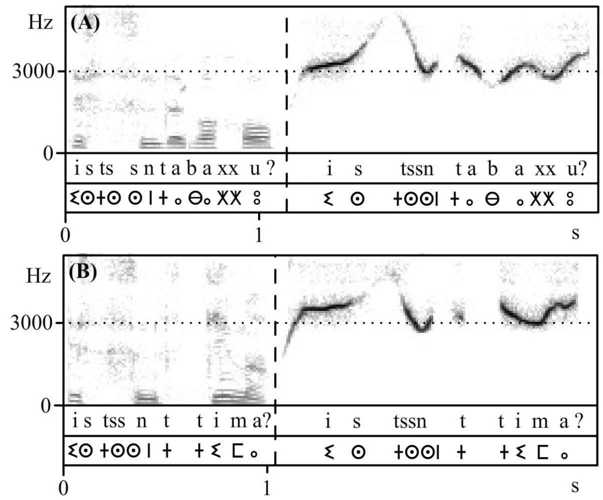


Fig. 4 presents an illustration of the word [amksa] 'shepherd'. Here too, the form is whistled in a way that suggests that it is consciously partitioned in three parts, reflecting its underlying syllable structure (i.e. [a.mk.sa]). A more accurate transcription of what is heard when this item (and the like) is whistled or spoken in an exaggerated way should be transcribed [a.m@k.sa], making the syllable sounding more like [mak] than [mk]. This type of phonetic mapping of the abstract /CC/ representation into a [CVC] sequence changes the weight of the syllable: having a coda makes heavy.

3.2.2 Heavy and light syllables

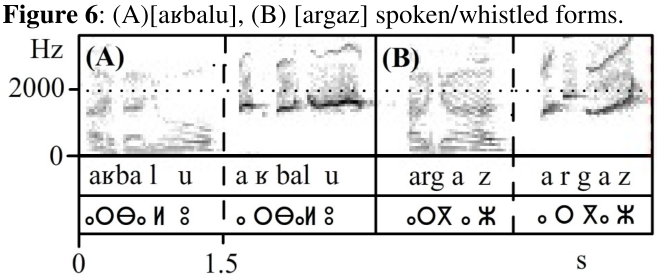
Syllable weight plays an important role in the phonological system of Tamazight. Versification of song poems, for instance, can't be accounted for without making a distinction between heavy and light syllables [10, 14]. The form [ts.snt] 'you know', shown in figure 5, provides an interesting example to illustrate differences between whistled CV and CVC syllables,

Figure 5: Sentence (A) [is tssnt abaxxu] 'do you know [the word] earthworm?') syllabified [is.ts.snt.ta.bax.xu] in the spoken form and (B) /is tssnt tima/ ('do you know Tima?, a proper name') syllabified [is.ts.snt.ti.ma] in the spoken form. Both sentences are interrogative marked by a rising whistled frequency at the end.



The form [tssnt] 'you know' is whistled in two different sentential contexts: (i) followed by a vowel, where /t/ is resyllabified as onset of the next syllable (i.e. [ta]), and (ii) followed by a consonant, with /t/ being the coda of the preceding syllable (i.e. [snt]). As is clear from the figure, the coda /t/ is whistled with sufficient details so as to appear as an independent segment. This is not the case of onset /t/ which is represented as an interrupted modulation of the vocalic frequencies (see also figure 1). This pattern was almost always observed for internal coda consonants. Two others forms, [argaz] 'man' and [aʁbalu] "water source", are shown in figure 6.

Figure 6: (A)[aʁbalu], (B) [argaz] spoken/whistled forms.



4. CONCLUSION AND DISCUSSION

This study has presented results of a pilot phonetic study of whistled Tamazight. We examined how some phonological properties of this language are rendered in whistled speech, focusing more specifically on syllable structure and how it relates to the vocalic and consonantal system of the language.

As far as full vowels are concerned, we have shown that they are whistled in intervals of frequencies that follow the same pattern as was observed for other non-tonal languages (e.g. Spanish, Turkish, and Greek). Tamazight schwa elements are whistled within a much larger frequency range that greatly overlaps with the full vowels. This is probably due to the absence of a specific target for [@]; the whistled frequency levels associated to [@] depend on the locus of articulation of the neighboring consonants: coronals modulate towards high frequencies; labials, labiodentals and uvulars modulate towards low frequencies. This suggests a principle of phonetic inertia: as for vowel-like elements in spoken forms, the presence and quality of [@] results from the gestural timing configuration of the surrounding consonants [10, 15]. While in whistled Turkish, Greek or Spanish, consonant clusters resulting from two consecutive syllables concatenate the frequency shapes of each constituent by truncating them at their encounter [1, 16] (e.g. Greek [ksp] simplified into [kp] [1]), Tamazight clusters are not only maintained but are over articulated making schwa elements within them highly discernable. This over articulation is not essentially different from what occurs in shouting: when consonants within a cluster display a low degree of gestural overlap and longer delay between events, a period of no constriction occurs that is overtly realized as a vowel-like element in the signal.

The way Tamazight consonant clusters are whistled probably reflects the underlying syllable structure of these sequences, as shown by the fact that a form like [kʃm] is partitioned in two parts, and that differences between light and heavy syllables are quasi systematically rendered. These results are preliminary and need to be confirmed from additional data and subjects. Current and future work should therefore continue to determine to what extent, whistlers rely on abstract cognitive abilities which they possess as native speakers of a language where a single consonant or a sequence of two consonants constitute well-formed syllables.

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