Phonetic characteristics of double articulations in some Mangbutu-Efe languages

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ABSTRACT

This paper examines double articulations in three African languages. Mamvu. Lese and Efe. all belonging to the Central Sudanic language family. The phonetic inventory of these languages exhibit some very interesting facts. among which the most striking are voiceless labio-velars stops involving a trilled release and a labio-uvular stop which shows the combination of a voiceless and a voiced part in the same consonant. Acoustic and aerodynamic measurements describing the production of these sounds are presented.

1. INTRODUCTION

Vörbichler (1971) describes Mamvu has having two double articulations [ɡɓ] and [qɓ] i.e. a voiced implosive labio-velar stop and a labio-uvular stop combining a voiceless uvular part with a voiced bilabial implosive part. Lese as described by Vörbichler (1969) has two labio-velars [kp] and [ɡb]. However our own data and Vörbichler (1979) show that there are two more double articulations, [ɡɓ] and [qɓ], in Lese. In addition, [ɡb] has a regular allophone [ɡp] and [qɓ] has an allophone [qp]. Efe has three double articulations showing interesting variations. A voiceless labio-velar stop [kp] having an allophone [kP], thus showing a trilled release; a voiced labio-velar stop [ɡb] having two allophones [ɡɓ] and [ɡp]; and [qɓ] a labio-uvular stop combining a voiceless uvular part with a voiced bilabial stop. this consonant having an allophone [qp]. The phonetic variants of [kp] [ɡb] and [qɓ], i.e [kP] [gp] and [qp]. even if unusual. are easily identified. Acoustically the trilled release of [kP] shows two or three bursts and the devoicing of the labial part of [gb] and [qɓ] is identified on the sound signal. The description of these variations involves articulatory and aerodynamic factors.

The stop identified as [qɓ] in mamvu and in Efe is exceptional and needs accurate descrpition and explanation since it combines. in a double articulation. a voiceless part followed by a voiced part. One must therefore explain how in this double articulation the phonation regime changes from voiceless to voiced. Phonemically the identification of /qɓ/ as a contrasting double articulation makes no doubt since it is opposed to /ɡɓ/ or /gb/. In Lese and in Efe this consonant has a regular allophone [qp]. One could also think of a sequence of voiceless uvular stop [q] + voiced implosive [ɓ] but it would be the only C+C combination in these languages and in the whole language family. Even if this argument is not definitive, it makes such a combination of consonants rather improbable. No Mamvu or Efe speakers were available for aerodynamic investigations, but one Lese speaker, having these articulations in his consonant inventory, participated to some aerodynamic measurements.

2. MATERIALS AND METHODS

Acoustic data on Efe and Lese were recorded in the field at the Harvard Ituri research station using a Nagra IV tape recorder. Words containing double articulations (see table 1) were recorded with four Efe and three Lese speakers. Mamvu data were gathered with only one speaker. Aerodynamic parameters of pharyngeal pressure, oral pressure and oral airflow were recorded with one Lese speaker, at the phonology laboratory of the University of Brussels. As shown in figure 1, a simultaneous recording was made of the pharyngeal and mouth pressures. A small flexible plastic tube (ID 2mm) was inserted through the nasal cavity to the oropharynx. for the measurement of pharyngeal pressure behind the uvular or velar closures. Another small rigid plastic tube (ID 2mm) was inserted in the oral cavity, for the measurement of pressure in the interclosure air cavity. Oral airflow was measured with a flexible silicone rubber mouthpiece. The tubes and rubber mouthpiece were connected to a Physiologia workstation (Teston and Galindo 1990, 1995) consisting in a PC computer and an acquisition system equipped with various transducers and the signal editing and processing software Phonedit. The subject task was to pronounce and repeat 5 times each word of the list presented in table 1. Efe data recorded in the field are presented at table 2.

3. RESULTS

3.1. Acoustic

Efe and Lese have three phonemic double articulations. each of them having at least one allophone. i.e. /qɓ/ ~ [qp]; /gɓ/ ~ [gb]~ [gp]; /kp/ ~ [kP]. The allophone [kP] of the voiceless labio-velar stop is only found in Efe. Note that since the I.P.A. has no symbol for a voiceless trill. we have chosen to transcribe the trilled release of this consonant by the symbol [P]. Length measurements of double articulations in Lese show that. as expected. the voiced labio-velar stop [gb] has the shortest duration followed by [kp] and [qp] which are both voiceless. The labio-uvular articulation [qɓ] which combines a voiceless and a voiced part is the longest in duration (mean 185.4 ms). The voiced part of this consonant having an average value of 30.3 ms. Table 3 shows the mean length values for each of these consonants. figure 2 shows a spectrogram of the word aqɓi 'man'. F2 transitions of the vowel [ɑ]. measured before [kp] and [qp]. show that the frequency of the transition is lower before a velar stop (747.5 Hz) when compared to the transition before an uvular stop (689.1 Hz). Among the few Efe examples in our data which present a trilled release with the voiceless labio-velar stop, it is always possible to observe one or two additionnal bursts following the stop closure release.

3.2. Aerodynamic

Aerodynamic measures of pharyngeal and mouth pressures, made with one Lese speaker, show that these consonants are well distinguished from this point of view. Figure 3 presents aerodynamic data and the sound signal for the voiced labio-velar stop [gb] and for the labio-uvular stop [qɓ], in the word hagboqɓu 'toad'. Measurements show two very different behaviours for pharyngeal and mouth pressures. Pharyngeal pressure (II) raises immediately after the velar closure (0) and decreases after the labial closure release (3). Mouth pressure plot (III) shows that after a short increase, consequence of the labial closure. pressure is becoming negative (1). due to the lowering of the jaw and of the tongue body. This lowering of the tongue body has been found with all double articulations in Lese. The descent of the jaw and of the tongue body also provokes a lowering of the larynx which delays the increase of mouth pressure after the velar closure release (2). The effect of this lowering is to increase the amplitude of voicing before the end of the consonant. The labio-uvular stop shows the more complex behaviour. Pharyngeal pressure (II) is raising before the end of the vowel (4) triggering a rapid damping of voicing (5). About 30 ms before the end of the consonant (7) pharyngeal pressure decreases because the uvular closure has been released. This provokes an increase of mouth pressure (III) which has become negative after the jaw and tongue body lowerings (6). After the labial closure release (8) pressures are still negative both in the pharynx and in the mouth because of the low position of the larynx which has been lowered with the jaw and the tongue body. The voiceless labio-velar [kp] and labio-uvular [qp] behave aerodynamically in a similar way to the voiced labio-velar [gɓ] but with different pressure values. Pharyngeal and mouth pressures taken at their maximum or minimum mean values are given at table 4 for some Lese consonants. This shows that the higher pressures are found with the voiceless [qp] (8.92 Hpa) and [kp] (8.01 Hpa) followed by [qɓ] (6.44 Hpa) and by [gɓ] (3.35 Hpa). Negative mouth pressures are more important for [qɓ] (-4.93 Hpa) and [qp] (-4.02 Hpa) both involving an uvular point of articulation while it is much less important with the labio-velars [gɓ] (- 2.08 Hpa) and [kp] (-1.91). The moment of the tongue body and jaw lowering also differ from one consonant to the other as can be seen at table 5, were one can see that [kp] is lowered for the longest period of time followed by [qɓ], [qp] and [gb].

4. DISCUSSION

Acoustic observations suggest that the change in voicing regime is a consequence of a change in aerodynamic conditions. The sequence of events making a labio-uvular stop in Lese is presented at figures 4a and 4b. Shortly after the uvular closure (1), starting with some voicing, subglottal and pharyngeal pressure differences become too small to maintain voicing (2), which is therefore stopped for a moment but with the vocal folds still adduced. The labial closure (3) is made just after the uvular closure as it is suggested by the spectrogram of figure 2. Then, there is a lowering movement of the tongue body and of the jaw (4), similar to what is found in double articulations such as labio-velar stops (Demolin 1992, Connell 1994, Silverman and Jun 1995, Jun 1996, Ladefoged and Maddieson 1995, Demolin and Teston 1996). This movement creates a sudden increase of the mouth cavity volume and a decrease of pressure in this cavity. Next the uvular closure is released (6) triggering an airflow inside the mouth cavity (7). This airflow created by the pressure differences between the pharyngeal and the mouth cavities resets the vocal folds into vibration (8) before the labial closure release. Aerodynamic plot of pharyngeal pressure (II) of figure 4 shows that pressure can be negative at the labial closure release because of the lowering of the larynx (9) which accompagnies the movements of the jaw and of the tongue body. Therefore there is no need to involve an opening and a closure of the glottis to explain the existence of [qɓ]. but rather a change in aerodynamic conditions. Consequently it would also be more accurate to describe [qɓ], not as a complete but rather as a partial double articulation.

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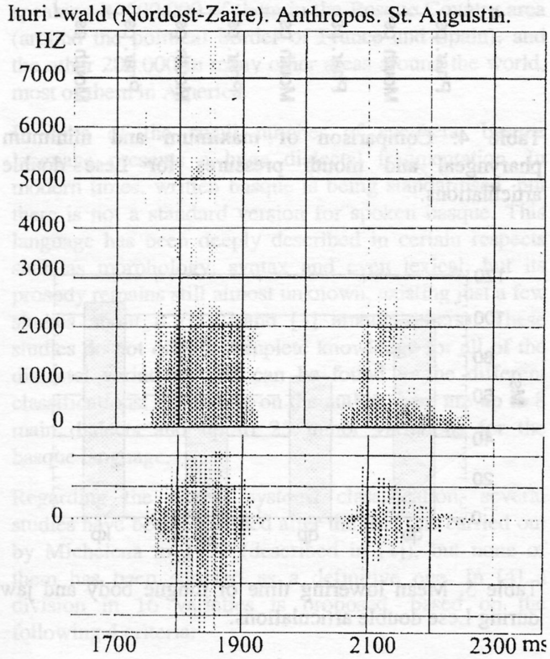

Figure 2. Sound signal and spectrogram of the word : aqɓi 'man'.

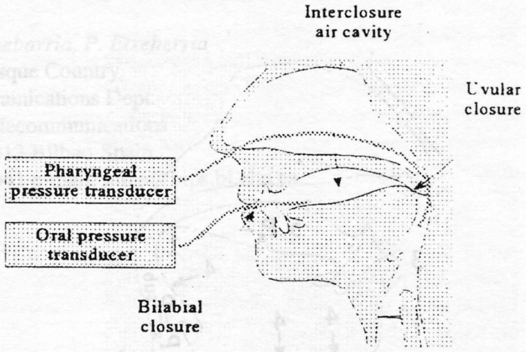

Figure 1. Method for measuring pharyngeal and mouth pressures during multiple closures.

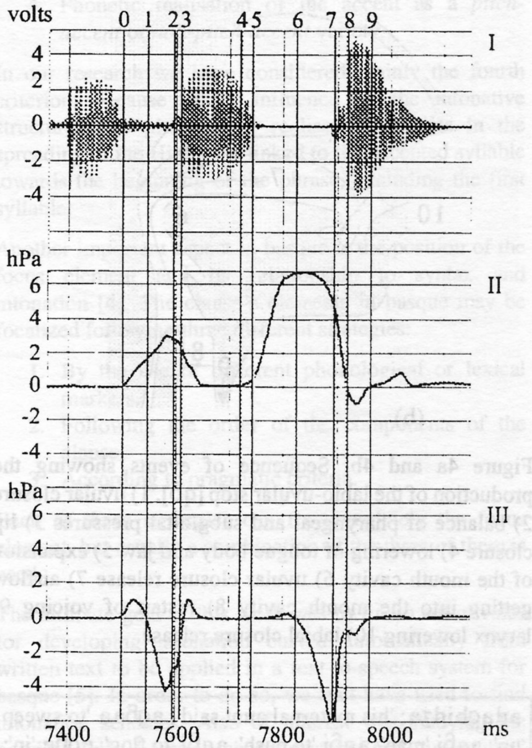

Figure 3. Speech signal (I), pharyngeal pressure (II) and mouth pressure (III) in the word haɡɓoqɓu 'toad' in Lese. Cursors 0 to 3 show events for [ɡɓ] and 4 to 9 for [qɓ]. 0) labial and velar closures 1) lowering of tongue body and jaw 2) effect of larynx lowering on mouth pressure and voicing 3) labial closure release 4) start of uvular closure 5) stop of voicing 6) start of tongue body and larynx

lowering 7) uvular closure release 8) labial closure release 9) return of larynx to normal position.

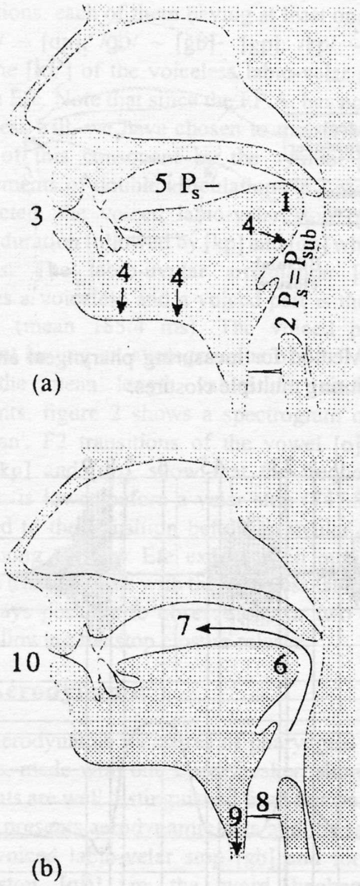

Figure 4a and 4b. Sequence of events showing the production of the labio-uvular stop [qɓ]. 1) uvular closure 2) balance of pharyngeal and subglottal pressures 3) lip closure 4) lowering of tongue body and jaw 5) expansion of the mouth cavity 6) uvular closure release 7) airflow getting into the mouth cavity 8) restart of voicing 9) larynx lowering 10) labial closure release.

adagbidʒa; 'his maternal aunt said'; agɓaa 'to sweep up'; aqɓi 'man'; aqɓi 'to push'; aqɓi 'to flog'; egɓe 'in'; eqɓea 'second'; eqɓe 'two'; gboɡbou 'trail'; hagɓoqɓu 'toad'; haitagbi 'dancing gesture'; heqɓe 'belly'; hofuhegbea 'in a hole'; iqɓi 'to burn'; kpagba 'shelter'; kpakpa 'old filed'; naugbaa 'your body'; negbe 'name'; okpi 'fire'; iragbani 'to sit on the ground'; uqpa 'tree'.

Table 1. Lese data recorded for acoustic and aerodynamic measurements.

tekpu 'cold'; ukPu 'head'; ɪʔɔkPu 'old'; egbe 'belly'; gbigbigbi 'bird'; gbɔlɔgbɔlɔ 'animal'; aqbi 'man'; ugbi 'child'; mukpa 'I found'; egbe 'in'; eqɓe 'two'

Table 2. Efe data recorded for acoustic measurements.

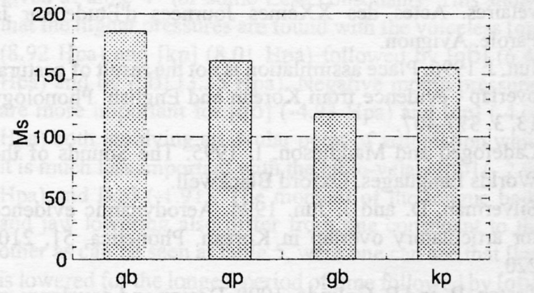

Table 3. Mean length values of Lese double articulations.

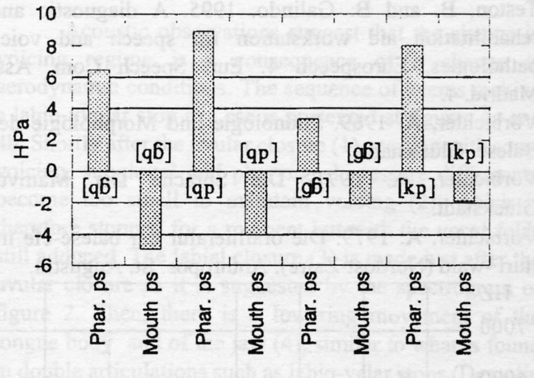

Table 4. Comparison of maximum and minimum pharyngeal and mouth pressures for Lese double articulations.

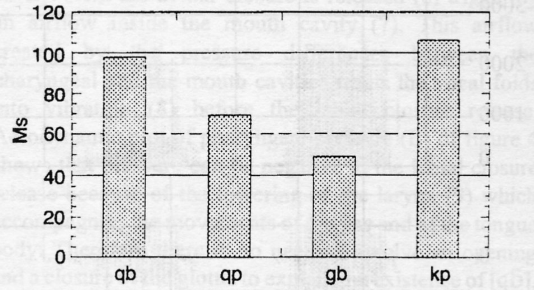

Table 5. Mean lowering time of tongue body and jaw during Lese double articulations.