ACCOUNTING FOR THE REFLEXES OF LABIAL-VELAR STOPS

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ABSTRACT

This paper presents a phonetic description, summarizing evidence drawn from different instrumental techniques, of the voiceless labial-velar stop as it occurs in Ibibio, one of the Lower Cross languages of SE Nigeria[1]. The description is then drawn on to offer an account of the variety of reflexes attested for labial-velars, both within Lower Cross and elsewhere. Important characteristics are that a) that the timing of the two articulatory gestures involved is asynchronous, and b) that the degree of asynchrony, as well as other aspects of their articulation, is variable, both across and within speakers. Recognition of this variation is the key to understanding the associated diachronic developments.

1. INTRODUCTION

1.1. Descriptions of Labial-velars

Labial-velar stops are relatively rare in languages of the world (cf. Maddieson [9]) and have received scant attention in the phonetic literature. Instrumental phonetic analyses have been presented by Ladefoged [8], Garnes [7] for Ibibio, and by Dogil [5] for Baule. Painter [11] also gives some discussion of labial-velars in an article dealing primarily with laryngeal mechanisms, Ward [14] for Efik presents kymograph tracings of [kp], but no systematic analysis, and finally, Ohala and Lorentz [10] present a general discussion of phonetic characteristics of labial-velar articulations, though without focussing on stops. In this paper, I summarize the results of a set of instrumental investigations that have been conducted on Ibibio [kp], and then use these results to attempt to account for the variation in reflexes found for labial-velar stops where diachronic change has occurred.

Apart from instrumental work, impressionistic descriptions of articulatory and auditory characteristics labial-velar stops can often be found in the Africanist linguistic literature. Generally, the labial and velar articulations are said to be simultaneous (e.g., Westermann and Ward [15]. Other than this, Ladefoged's [8] remarks (p. 12) in comparing labial-velar stops to velarized labials [p^w, b^w], and that they have a tendency to impart a labialized quality to following vowels, emphasize the possibility of perceptual confusion with labials, and Ohala and Lorentz [10] have provided acoustically based explanations for these tendencies. Comparisons have also been made to labial implosives by Ladefoged [8], Painter [11], and by Elugbe [6], who sees this as a general characteristic of labial-velars in the Edoid languages. Bearth and Zemp [1] describe the labial-velar stops of Dan as having "strong bilabial implosion", and Puesch [12] reports a voiced implosive labial-velar for Bekwil.

1.2. Diachronic Developments

The earliest account of diachronic correspondences of labial-velar stops in the literature is found in Westermann and Ward [15], who cite evidence for sound change that, "where kp or gb are weakened, it is the labial element which disappears and the velar element remains, sometimes reduced to x or ɣ" (p. 58). Elsewhere in the text (p. 108), correspondences are presented from the Nupoid languages Gbari and Nupe, and also from Bari and Kakwa (k^w ~ kp, g^w ~ gb in both cases) which to some extent confirm their conclusions. However, it is no difficult task to find instances of sound change involving labial-velars where it is the labial element which survives. It is probable that the velarized voiced labial implosive of some dialects of Igbo is a reflex of Proto-Igboid *gb. In the Lower Cross languages, PLC *kp has evolved into a variety of reflexes, most commonly [p], but also [b], [k^w], and possibly [gb] (and [kp] is retained in many instances).

[1] Ibibio is the largest of the Lower Cross group, Niger-Congo languages which are spoken mainly in Akwa Ibom and Cross River States of SE Nigeria. Connell [3] provides an overview of the group.

2. INSTRUMENTAL ANALYSES OF IBIBIO [kp]

2.1. Methodology

A variety of instrumental techniques were used to investigate the characteristics of the Ibibio labial-velar, including spectrography, laryngography, aerometry, and electropalatography. These were done during a period of approxi-mately three years, and used different speakers for the different investigations. Material for the spectrographic study was recorded by eight native speakers of Ibibio in Calabar, Nigeria, and analysed in the Phonetics Laboratories at the Universities of Ottawa and Edinburgh; further investigations were done in Edinburgh using primarily one speaker of Ibibio who was resident there (the aerometry was done with two speakers). Methodology and results are reported in greater detail in Connell [2, 4]

Spectrographic measurements were done to examine total duration of closure (TD), voice termination time (VTT) and voice onset time (VOT), as well as formant transitions and burst spectra, and compared to similar measurements for labials and velars. Laryngography (Lx) was done with both aerometry and electropalatography (EPG) to determine VTTs and VOTs and other information about phonation. The aerometry and EPG provided further details concerning the articulatory nature of these stops.

2.2. Spectrographic Analysis

In broad terms, the results of the spectrographic investigation confirmed those of Garnes [7]. This was true with regard to formant transitions, especially for CV transitions, where there was similarity to those of simple labials except for being steeper, having a lower locus, and apparently being more intense or stronger. This latter observation also corresponds with findings of Dogil [5] for Baule. On the other hand, VC transitions were variable, most often tending to resemble those of simple velars, but occasionally resembling labial transitions. Regarding the timing of the two gestures involved, evidence from transitions suggests a consistently later labial release, but variability as to which closure occurs first. Fig. 1 presents a spectrogram of the word [ékpê] 'leopard' demonstrating the asymmetry of formant transitions.

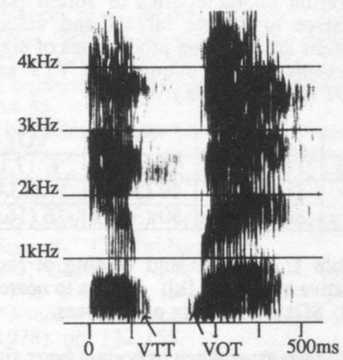

Fig. 1: Spectrogram of [ékpê] illustrating asymmetrical formant transitions of Ibibio [kp]. TD=156ms, VTT=38ms, VOT=-36ms. (Speaker E.E. Akpan.)

Noise in the signal (also evident to some extent in Fig. 1) made it difficult to determine burst spectra in my own data. However, indications are that the present work does not confirm Garnes' findings, which suggested that [kp] has a high frequency component (6 - 7 kHz) and weak energy spread throughout the higher frequencies (i.e., above 3.6 kHz), and, that energy in the lower frequency range was absent. The energy present in the spectra at release appears primarily in two areas - in the lower frequency range, i.e., below 1.2 kHz, and in the mid range, from 2 - 4 kHz. The lower concentration could indeed be a reflection of a labial release, as would be expected, given the evidence from F2 transitions discussed above. The energy found in the mid-range could possibly be associated with a velar aspect of the release, but it is in this range that the noise band mentioned normally occurs. Finally, on occasion there is energy present throughout the spectrum, extending quite high in the frequency range. In this connection it is worth noting that Traill [13] reports burst spectra for labial clicks extending throughout the frequency range and being particularly strong in the 4 - 14 kHz range.

Table 1 summarizes voicing and duration characteristics of Ibibio [kp] relative to simple labials and velars. Results are based on productions of eight speakers (Fig. 1 exemplifies VTT and VOT measurements.)

	TD	VTT	VOT
p	147 (29.0)	65 (35.7)	6 (7.1)
k	113 (28.5)	49 (29.4)	21 (13.0)
kp	162 (28.6)	50 (35.9)	-26 (16.0)

Table 1: Duration and voicing of [kp] relative to [p] and [k]. Values to nearest ms. SDs are given in parentheses.

Two aspects are important here; first that Ibibio [kp] is prevoiced, and second, that the there is a relatively high amount of variation (as indicated by the standard deviations) in the voicing characteristics.

2.3. Aerometry/Lx

The aerometric work revealed a substantial pressure drop during closure and ingressive airflow, indicating use of either or both of velaric and glottalic ingressive airstream mechanisms. A relatively consistent variation in the pressure drop was taken as indicative of an earlier velar release (Connell [2, 4]). The associated Lx analysis confirmed and clarified voicing characteristics revealed by the spectrographic investigation.

2.4. EPG/Lx

Voicing characteristics described above were confirmed, and made more precise when considered against the EPG evidence of closure and release (Connell [4]). Also interesting was evidence from the EPG investigation confirming the spectrographic evidence of an earlier velar release. This was revealed through comparison of the EPG record with the accompanying audio signal. Since the audio signal in the set-up used was only a gross representation of intensity of the signal, its onset could represent either the onset of the following vowel or the onset of voicing, recalling that the release is prevoiced. Either way, given that the consonant is prevoiced, release of the velar closure prior to the onset of the audio signal would be a clear indication of the velar release preceding the labial one. This happened in all tokens, and on average 38ms, but ranging from 10ms to 80ms, prior to the onset of the audio signal. (SD = 15; calculations are based on 4 repetitions of 18 words containing [kp] in controlled environments.) Further research is planned, to monitor lip closure in conjunction with EPG, permitting a more accurate assessment of relative timing of both closure and release.

2.5. Summary

The various instrumental techniques revealed, among other characteristics, that: a) the two articulatory gestures are not totally simultaneous, nor completely synchronized: the velar release almost invariably precedes the labial one. There is more variability as to which closure occurs first, though this is most often the velar one; b) there is a considerable amount of voicing in this nominally voiceless stop, manifested in both a voicing tail, and a pre-release voicebar; and c) there is a high degree of variability in the timing of the various components of the articulation, both individually and relative to each other. This variation was manifested both within and across speakers. Finally, although evidence has not been presented here, there was some indication that the cross speaker variation observed correlated with dialect.

3. EVOLUTION OF PLC *kp

Proto-Lower Cross *kp has, in addition to [kp], the following reflexes across the group (Connell [3, 4]): [p, b, gb, kʷ]. The phonetic characteristics of Ibibio [kp] allow us some insight into why such a range of reflexes should be manifested and, by extension, why yet others, such as [x, ɣ, ɓʷ] are also understandable.

The fact of the later labial release gives clear cause to expect a labial, or predominantly labial, reflex should the sound undergo change, as it would be the most salient. However, since the degree of asynchrony between the two releases demonstrated considerable variation, it is plausible to assume that a dialect of a language might exist where the two were much more closely simultaneous, or even with a later velar release; in these cases reflexes more predominantly velar might arise.

The variability in the duration of prevoicing in Ibibio also gives a clue as to why we find both voiceless and voiced reflexes; presumably those LC languages exhibiting PLC *kp > [p], originated in dialectal variation favouring a shorter voicebar, whereas those demonstrating PLC *kp > [b] would have emanated from ones with a longer voicebar. It is also possible that the existence of a relatively long voicing tail might have played a role in the development of voiced reflexes, particularly where PLC *kp > [gb] has been found.

An account of this nature fits the diachronic developments for Lower Cross based on the phonetic data for Ibibio. This implies that PLC *kp, at some stage in the history of the language was similar in its phonetic characteristics to that of Ibibio today. We might also expect that reflexes of labial-velars which are more predominantly velar (e.g., in the Nupoid languages cited above), or that are implosive (e.g., Igbo) came from parent languages whose labial-velars demonstrated characteristics conducive to those particular develop-ments. This is an empirical question which can, and hopefully will, be tested through a detailed phonetic analysis of language groups having the appropriate sets of reflexes.

4. REFERENCES

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