THE VOICED LINGUOLABIAL PLOSIVE IN KAJOKO

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In this paper we present visual and acoustic documentation of a voiced linguolabial plosive in Kajoko (Guinea-Bissau), in which the front part of the tongue blade makes contact with the inner surface of the upper lip. The sound patterns as a labial in Kajoko, contrary to the Articulator Model's prediction that it should be classified as a coronal. It replaces **/b/** in the consonant system, and it contrasts with the other labial phonemes and **/d/**. Sound correspondences with **/b/** in Kagbaaga demonstrate that the linguolabial plosive derived historically from ***b**. In addition, Crioulo **/b/** is borrowed into Kajoko as the linguolabial plosive.

Dans cet article, nous présentons la documentation visuelle et acoustique d'une plosive linguolabiale en Kaioko (Guinée Bissau), dans laquelle la partie antérieure de la lame de la langue est en contact avec la surface intérieure de la lèvre supérieure. Ce son se comporte comme une labiale en Kaioko, contrairement à la prédiction du modèle articulatoire qui voudrait qu'il soit classifié comme une coronale. Il remplace **/b/** dans le système consonantique, et il contraste avec les autres phonèmes labiaux et le **/d/** . Les correspondances des sons avec **/b/** en Kagbaaga prouvent que la plosive linguolabiale provient historiquement de ***b**. En outre, le **/b/** du Crioulo est emprunté dans le Kaioko comme une plosive linguolabiale.

0. INTRODUCTION[1]

In this paper we present visual and acoustic documentation of a voiced linguolabial plosive phoneme **/d̪/** in the Kajoko variety of Bijago (ISO 639–3 code [bjg]), a language generally classified in the Atlantic subgroup of Niger-Congo and spoken by about 27,500 people in the Bijagós Archipelago (Bolama Province) in Guinea-Bissau. Kajoko is spoken on the islands of Orango and Uno. Wilson (2000/2001) and Segerer (2000, 2002) attest the sound in Kajoko, and according to Segerer (2002:12, 25) the Anhaqui variety of Bijago spoken on the island of Canhabaque also contains the sound. Given the general rarity of linguolabials worldwide, as well as the somewhat surprising occurrence of the sound in Guinea-Bissau, we consider it important to build on the previous descriptive work by providing primary data in order to confirm its occurrence.

This is the first known case in the world's languages of a plain voiced linguolabial plosive **/d̪/** (i.e. not prenasalized) patterning as a phoneme. It is also the

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first documented case of a linguolabial sound in the basic sound system of a language in a geographic region distinct from Vanuatu.

Guinea-Bissau could not be further away from Vanuatu on the globe, so its occurrence in this region is likely independent of the occurrences in Vanuatu and not due to contact. Consequently, linguolabials are not an anomaly limited to a single geographic region but rather can arise independently in various regions. This, along with the fact that the sound is common in Kajoko, suggests that linguolabials are less marked than previously thought (cf. Postal 1968:169ff).

Gibbon (1973) accounts for their crosslinguistic rarity on the grounds that they are easily confused perceptually with bilabials and alveolars, and Maddieson (1989:369) adds that they are difficult to articulate, contra Postal (1968:82). Another possible contributor to their rarity is stigmatization due to the visibility of the tongue (Key 1975:89–90, Ladefoged 2007:164).

The phoneme **/d̼/** patterns as a labial in Kajoko both synchronically and diachronically. This counters the prediction of phonological theories that establish larger groupings based on the active articulators, where linguolabials are necessarily coronal since the active articulator is the tongue tip or blade.

1. PREVIOUS RESEARCH

Linguolabial consonants are rare. Until now, their phonemic status has only been attested in nine[2] Austronesian languages in Vanuatu, shown in Table 1. ISO 639–3 codes are provided for reference (Lewis et al. 2013). These languages are found on the southeastern part of Espiritu Santo Island, on the northwestern part of Malakula Island, and on various small islands in the Bougainville Strait between these two main islands.

Table 1: Languages of Vanuatu that include linguolabial phonemes.

Language	*linguo-labials*	*Sources*
Aore [aor]	**t̼ , z̼, n̼**	Tryon 1976:52–53, Maddieson 1989:352
Araki [akr]	**z̼, n̼**	Tryon 1976, Maddieson 1989, François 2002
Mafea [mkv]	**t̼ , z̼, n̼**	Tryon 1976, Maddieson 1989, Guerin and Aoyama 2009
Mpotovoro [mvt]	**t̼ , z̼, n̼**	Tryon 1976, Maddieson 1989
Nese	**n̼ ⁀d̼ , z̼, n̼**	Lynch 2005, Crowley 2006

[2] Aore is now extinct (Lynch and Crowley 2001:57). Araki and Tangoa are likely mutually intelligible (Lynch and Crowley 2001:53). Lynch (2005:390) is uncertain if Nese is a distinct language from the surrounding speech varieties. There is evidence that additional languages in the region had linguolabials at an earlier time in their historical development. These include: Tolomako [tml], Roria [rga], Tambotalo [tls], Butmas-Tur [bnr], Lorediakarkar [lnn], Shark Bay [ssv], Sakao [sku], Mae [mme], Vovo [no ISO code], and Tikar [no ISO code] (Clark 1985:205, Lynch 2005:389, Naito 2006, and Lynch and Brotchie 2010).

Tangoa [tgp]	**t̪, z̪, n̪**	Tryon 1976, Maddieson 1989, Camden 1979:113
Tutuba [tmi]	**n̪ ͡d̪, n̪**	Naitou 2004, Naito 2006
Vao [vao]	**n̪ ͡d̪, z̪, n̪**	Tryon 1976, Maddieson 1989
V'ënen Taut [nmb]	**t̪, z̪, n̪**	Tryon 1976, Maddieson 1989, Fox 1979:1–2

In these languages the phonemes **/t̪, z̪, n̪/** are generally attested, with a couple of exceptions. First, Araki lacks **/t̪/**. Maddieson notes, "According to Tryon's wordlists, Araki has only the linguo-labial nasal…" (p. 352), but Maddieson's research shows the presence of **/z̪/** as well. Second, Tutuba lacks **/z̪/**. Third, [**s̪**] occurs as an allophone of **/z̪/** in V'ënen Taut. Fourth, the voiced prenasalized linguolabial plosive **/n̪ ͡d̪ /** occurs in Nese, Tutuba, and Vao rather than **/t̪/**. Maddieson (1989:352) states, "[T]he reported voiceless stops in Vao are in fact prenasalized voiced stops." Crowley (2006:39) notes that all voiced stops in Nese are prenasalized in most environments, specifically, "initially and when preceded by a vowel or a non-nasal consonant." This implies that the allophone [**d̪**] occurs in the environment following a non-homorganic nasal consonant.

Floyd Lounsbury attested a voiceless linguolabial plosive **/t̪/** in Umotína [umo] in the Mato Grosso State of Brazil when he did fieldwork there in 1950 (Hockett 1955:34, 99, 228, Martin 1956:683, Postal 1968:82, Ladefoged 1971:38, Gibbon 1973:62–63, Ladefoged and Maddieson 1996:18, Pullum and Ladusaw 1996:256, Conklin 2000:862). Unfortunately, the language is now extinct, the researcher has died, and to our knowledge the data were never published. Lounsbury's field notes are archived at the American Philosophical Society library in Philadelphia, so perhaps an examination of them will provide additional information.

Linguolabials also occur in marginal and disordered speech. A voiceless linguolabial plosive [**t̪**] has been attested in a couple of expressive words in the Mochi [old] variety of Chaga in Tanzania (Maddieson 1989:350, 363, p.c. 2009), e.g. [**t̪o**] 'surprise or relief', and the linguolabials [**t̪, d̪, n̪, r̪, s̪, z̪, l̪**] occur in disordered speech (IPA 1999:190, Ball and Müller 2005:310), where they typically exhibit more tongue protrusion than in normal speech.

Use of the term *linguolabial* follows the practice (going back at least to Pike 1943:123) of employing a truncated Latinate form to mark the active articulator prefixed to the Latinate form for the passive articulator. In this practice the labels *apico-labial* or *lamino-labial* would be the default candidates for the sounds under consideration (Catford 1977:151–152). Some works (e.g. Tryon 1976, Fox 1979, Clark 1985, Segerer 2002:25, Lynch 2005) refer to the sounds in question as apico-labial, but Maddieson (1989) points out that "they are often laminal rather than apical" (p. 351). As a result Lounsbury suggested the prefix *linguo-* in order to capture the broader range of possible articulations (Ladefoged and Maddieson 1996:18).

In 1989 the Council of the International Phonetic Association approved the employment of the seagull diacritic <◌̪> subscripted to alveolar base symbols to represent linguolabial sounds in phonetic transcription (IPA 1989:71). These base symbols were likely chosen because the tongue tip or blade is the active articulator (Maddieson 1987:28). However, subsequent transcription practice has been inconsistent. The *IPA Handbook* employs dental base symbols <**θ̪, ð̪**> instead of

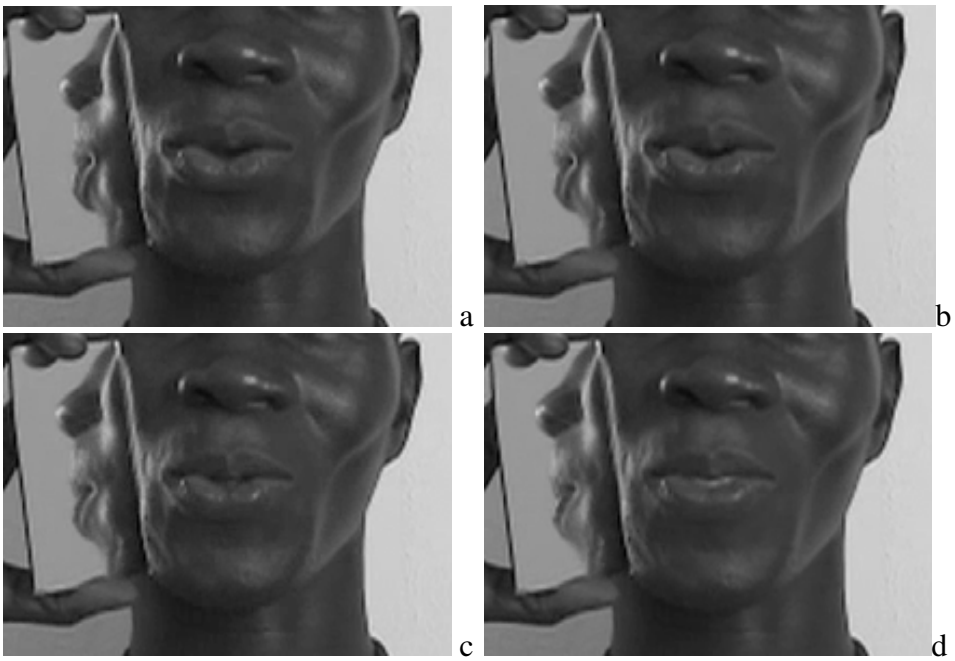
alveolar ones for linguolabial fricatives in disordered speech (IPA 1999:193), and Ladefoged and Maddieson (1996) employ both dental **<ð̼>** (p. 19) and alveolar **<z̼>** (p. 40) base symbols for these sounds. Guerin and Aoyama (2009) employ labial base symbols **<p̼, m̼, v̼>** in their Illustration of the IPA for Mafea. Pullum and Ladusaw (1996:235, 256) suggest the use of the subscript turned bridge diacritic <◌̪> to represent linguolabials, but this diacritic indicates a specifically apical rather than laminal articulation. Since the sounds can be either apical or laminal, employment of this diacritic is unsuitable.

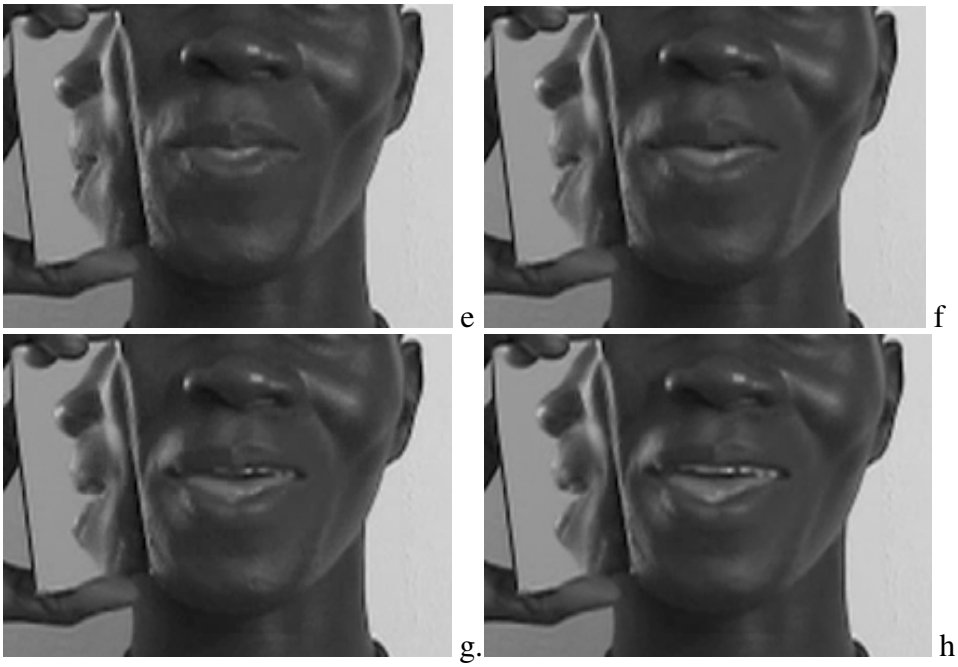
2. ARTICULATION

The video frames in Figure 1 demonstrate the articulation of the voiced linguolabial plosive in the word **/ŋósóɖ̼è/** 'two' in Kajoko. Our language consultant, the fourth author, is a male native speaker of Kajoko from Uno Island, 25 years old at the time of the recording, who has completed secondary school. He left the region for his studies but continues to maintain regular contact with the language group. Besides Kajoko, he also speaks Upper Guinea Crioulo [pov], Portuguese [por], and English [eng].

The video was made in October 2007 in Lendem, Guinea-Bissau using a Canon Elura 100 digital video camcorder operated by the second author. The subject was standing in a room and produced the word in isolation five times. The frames are in 30 msec intervals.

Figure 1: Articulation of a portion of the word **/ŋósóɖ̼è/** 'two' (Kajoko, Guinea-Bissau). Frames are 30 msec apart.





During the first part of the articulation (frames a–c), the tongue tip is brought forward between the upper and lower lips (cf. Ladefoged and Maddieson 1996:18). The front part of the tongue blade then makes contact with the inner surface of the upper lip (frames d–e), while at the same time the underblade of the tongue rests on the lower lip. The closure between the tongue blade and the upper lip is the salient feature of the articulation, as this is what impedes the airflow within the oral cavity. The plosive is then released and the oral configuration moves towards the position for the following vowel (frames f–h).

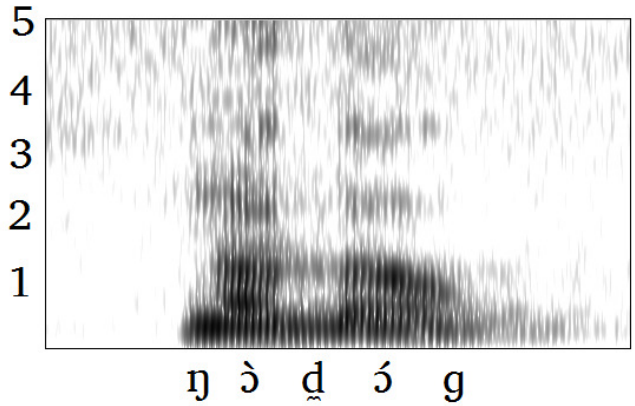
Concomitant with the tongue movement is a slight lowering and retracting of the upper lip. This gesture begins during the articulation of the **/o/** immediately preceding the linguolabial sound in **/ŋósód̪ɛ̀/**. This is particularly evident if we compare the positioning of the lips during the articulation of the two **/o/** vowels in the word. The first **/o/** (Figure 2) shows lip protrusion typical for that vowel, whereas during the second **/o/** (Figure 1, frame a) the upper lip has been lowered and retracted in preparation to meet the tongue. This lowering and retraction was also noted by Maddieson (1989:363, cf. Ladefoged and Maddieson 1996:18–19) for the linguolabial sounds in Vanuatu. A similar lowering and retracting of the upper lip has been attested in the production of the bilabial flap in Mono [mnh] (Olson and Hajek 1999:106, Olson 2005:27).

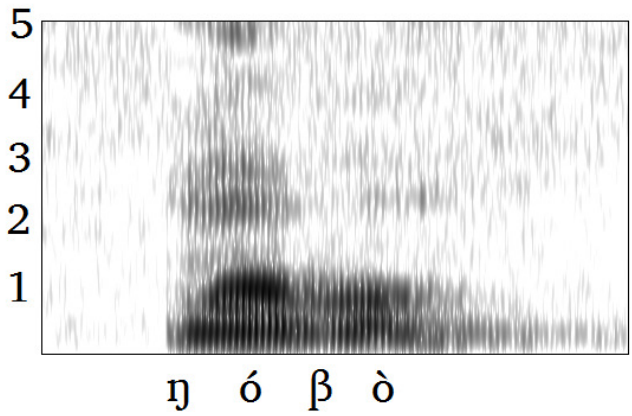
Figure 2: Articulation of the first **/o/** in the word **/ŋ́ósóɖ̰ɛ̀/** ‘two’ (Kajoko).

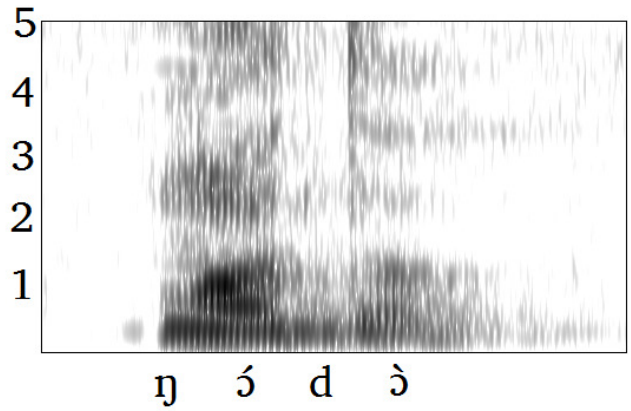
Figure 3 shows wide-band spectrograms of the Kajoko words **/nɔ̀-ɖ̰ɔ́ːg/** ‘stone’, **/ŋ́ó-βɔ̀/** ‘thing’, and **/ŋɔ́-dɔ̀/** ‘go’. These recordings were extracted from a video made on June 27, 2008 in Bissau, Guinea-Bissau (same subject, camera-operator, camera, and frame rate as the first recording). The subject was seated, and a mattress was placed behind him to absorb reflected sound. The spectrograms were produced using Praat 4.4.16 (Boersma and Weenink 2006). Formants were measured by visual examination of the wide-band spectrograms as well as by LPC analysis employing the default parameters of Praat, except that the maximum frequency for formant analysis was set to 5000 Hz instead of 5500 Hz, the former being the preferred setting in Praat for a male voice (Boersma and Weenink 2006).

The spectrogram containing the linguolabial plosive shows a significant break in the formant structure of about 70 msec corresponding to the closure period. The voicing bar continues throughout closure indicating that the sound is fully voiced. The locus of F_2 for **/ɖ̰/** during closure is approximately 1100 Hz and level as F_2 moves into the following vowel. In contrast, the locus of F_2 for **/β/** is 800 Hz and rising and for **/d/** is about 1400 Hz and falling. This corroborates Maddieson’s (1989:364–366) findings for Tangoa that the locus of F_2 for linguolabials is between those of labials and alveolars. This positioning of the F_2 locus for linguolabials is similar to that of interdental fricatives in English, which are also between those of labials and coronals (Ladefoged 2001:182, Maddieson 1987:26).

Figure 3: Sample spectrograms illustrating voiced obstruents in Kajoko. The words are **/nɔ̀-ɖ̰ɔ́ːg/** ‘stone’, **/ŋ́ó-βɔ̀/** ‘thing’, and **/ŋɔ́-dɔ̀/** ‘go’. Units on the y-axis are in kHz.







3. PHONOLOGY

The voiced linguolabial plosive **/d̪/** is a contrastive speech sound in Kajoko. For reference the consonant inventory of Kajoko is shown in (1):

(1) Kajoko consonant inventory (Wilson 2000/2001:20)[3]

p	**t**	**ʈʂ**		**k**	**kp**	
d̪	**d**	**ɽ**		**g**	**gb**	
β	**s**		**ʒ**			**(h)**
m	**n**		**ɲ**	**ŋ**		
w	**r**		**j**			

Wilson (2000/2001:20) calls **/ɽ/** a "retroflex, lightly tapped stop" and considers **/ʈʂ/** to be retroflex. The phoneme **/s/** exhibits some variation [**s**] ~ [**ʂ**] ~ [**ʃ**]; it is pronounced as [**s**] in our data.

Contrasts between **/d̪/** and all of the labial phonemes in the language, as well as with the voiced alveolar plosive **/d/**, are given in (2):

[3] The transcriptions from the original sources have been brought in line with the extant version of the International Phonetic Alphabet (IPA 2006).

(2) Contrasts of **/ḓ/** with labial consonants and **/d/** (Wilson 2000/2001:29)

p	**ŋɔ̀-pɔ̀mɔ́**	‘fruit (singular)’
ḓ	**nɔ̀-ḓɔ́ːg**	‘stone’
β	**ŋó-βɔ̀**	‘thing’
m	**ŋɔ́-mɔ̀**	‘nose’
w	**ŋó-wɔ̀**	‘go’
d	**ŋɔ́-dɔ̀**	‘go’

A voiced bilabial plosive **/b/** is not attested in Kajoko. This fact, coupled with the contrast between **/ḓ/** and **/d/**, leads us to categorize **/ḓ/** as a labial consonant in the Kajoko synchronic phonological system, following the principle that “sounds systems have a tendency toward phonetic symmetry” (Pike 1947:59). This is the same analysis chosen by Wilson (2000/2001:20).

The voiced linguolabial plosive in Kajoko is attested before front, back, close, and open vowels **/e, ɛ, a, o, u, ɔ/**. It is not attested before **/i/**, but we consider this to be a gap in our data and not a phonotactic restriction. (It does occur following **/i/**.) It is found in a substantial number of words in the language, so it cannot be construed as marginal to the phonological system.

Comparative data bolsters the argument that **/ḓ/** patterns as a labial. Cognates between Kajoko and Kagbaaga (spoken on the island of Bubaque) suggest that **/ḓ/** derived historically from Proto-Bijago ***b**. The data in (3) establish the sound correspondence Kajoko **/ḓ/** : Kagbaaga **/b/**:

(3) Cognates showing Kajoko **/ḓ/** : Kagbaaga **/b/**

Kajoko (Wilson)	pg.	Kagbaaga (Segerer)	pg.	gloss
è-ḓóːʈʂù	22, 28	**e-boːʈi**	289	‘dog’
kɔ̀-ḓáj	22, 28	**kɔ-baj**	285	‘wing’
ka-ḓùɽá	27	**ka-buda**	288	‘ash heap’
è-nóḓò	28	**e-nobo**	298	‘rain’
kú-n̪ḓ͡óːnʈʂ	29	**ku-boːʈ**	293	‘fish hook’
kɔ́-ḓárù	32	**kɔ-barɔ**	297	‘skin’

This is a case of nonphonemic unconditioned change (Campbell 2004:19), since there is no change in the phonemic status of the sound.

The sound law ***b** > **ḓ*** is preferred over ***ḓ** > **b*** because the former leads to a more symmetrical and typologically common proto consonant system (Campbell 2004:129, 134, 143). There is strong evidence for a similar process in Vanuatu in which plain labials developed into linguolabials historically (Tryon 1976:52–53, Clark 1985:205–206, Maddieson 1989:352–361). The linguolabials then developed into alveolars or dentals in some of the geographically peripheral languages, where they merged with already-existing coronal sounds. Clark (1985:205) proposes the possibility of a linguolabial-to-labial reversal in some languages; Naito (2006) argues that such a reversal is in process in Tutuba and suggests that it is due to external factors.

It should be noted that Segerer (2002:25) posits a Kajoko **/ḓ/** : Kagbaaga **/d/** correspondence, and he provides the cognates Kajoko **/ḓɔ/** : Kagbaaga **/dɔ/** ‘to go’ as evidence. However, Wilson (2000/2001) transcribes the word for ‘go’ in Kajoko with a plain **/d/**, not a linguolabial **/ḓ/**, i.e. **/ŋɔ́-dɔ̀/** (pp. 29–30). We confirmed Wilson’s

transcription. The cognates in (3) provide stronger evidence that **/d̪/** corresponds with **/b/** rather than **/d/**.

Finally, evidence from language contact also supports this analysis. When Crioulo **/b/** is borrowed into Kajoko, it is realized as **/d̪/**, e.g. **/kò-ɽò:d̪ú/** 'hyenas' < Crioulo **/lobu/** (Wilson 2000/2001:28).

4. DISCUSSION

The linguolabial place of articulation falls into the class of "displaced articulations" (Pike 1943:122–123, Abercrombie 1967:51) in which the active articulator does not approach the passive articulator directly opposed to it (a "normal articulation"), but rather approaches a more distant passive articulator.

Theories that establish larger groupings based on the active articulator, such as Halle's (1983) Articulator Model, successfully model most displaced articulations. For example, the active articulator for labiodental sounds is the lower lip, and these sounds pattern phonologically as labials, while the active articulator for retroflex sounds is the tongue tip, and these pattern as coronals.

However, linguolabial sounds create a challenge for the Articulator Model. In this model linguolabials are necessarily coronal since the active articulator is the tongue tip or the tongue blade. The present transcription of linguolabials in the IPA treats the sounds as fundamentally coronal by placing the seagull diacritic underneath the symbol for an alveolar consonant of the appropriate manner of articulation class. Maddieson (1989) provides some evidence to support a classification of linguolabials among coronals. He notes that they have evolved into dental or alveolar articulations in some peripheral languages of the region in Vanuatu where linguolabials are found (p. 360). In addition, he argues that they are similar to alveolars both acoustically (pp. 351, 354, 364, 369) and articulatorily (p. 369) (cf. Maddieson 1987:26).

However, the phonological evidence from Kajoko suggests an interpretation of linguolabials as labials: (1) the linguolabial **/d̪/** in Kajoko patterns in the synchronic phonology as a labial, (2) the phoneme **/d̪/** in Kajoko derives historically from ***b**, adding to the similar cases attested in Vanuatu (Maddieson 1989:358), and (3) the phoneme **/b/** in Crioulo is borrowed into Kajoko as **/d̪/**. This interpretation also complements transcription and orthography choices: the majority of references dealing with linguolabials employ labial base characters to represent them, and the orthographies of the relevant languages do so as well (cf. Maddieson 1989:352).

How can this be accounted for in phonological theory? Maddieson (1989:370) suggests modifying feature geometry to allow the linking of two terminal place nodes (specifically labial and anterior in this case). That solution has not gained widespread acceptance, and Maddieson himself admits that it appears ad hoc.

Rather, a theory should capture the fact that linguolabial sounds are exceptional, while at the same time recognizing that broader categories such as labial and coronal are largely correct. This suggests abandoning a strict version of the Articulator Model and allowing for exceptionality by the incorporation of a mechanism such as violable or stochastic constraints.

5. CONCLUSION

In this paper, we have provided primary data in order to document a linguolabial phoneme in the Kajoko variety of Bijago, confirming the descriptive accounts of Wilson and Segerer. This is the first published documentation of a linguolabial phoneme in the basic sound system of a language in a region of the world distinct

from Vanuatu. It is also the first known case of a plain (non-prenasalized) voiced linguolabial plosive patterning as a phoneme in the world's languages.

This study leaves room for further research. First, our recordings are from one speaker of Kajoko. The descriptive accounts consider the sound to be present in the broader speech community, but recording a larger number of speakers would provide additional evidence for this. Ladefoged (2003:14) recommends recording half a dozen speakers of each sex. Second, in our comparative study we have only examined the Kajoko and Kagbaaga varieties of Bijago. A broader study incorporating the Anhaqui and Kamona varieties of Bijago could provide additional insights into the historical development of the sound. Third, such a broader study would also have the benefit of providing documentation for the presence of the sound in Anhaqui, as attested by Segerer (2002).

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