FEATURE GEOMETRY AND THE FORMATION OF LABIAL-VELARS: A REPLY TO MUTAKA AND EBOBISSÉ

Bruce Connell
University of Oxford

Mutaka and Ebobissé (1996/97) examine the development of labial-velars in the Sawabantu languages of South-west Cameroon, arguing these are reflexes of earlier labialized labials and velars. Their analysis is presented within the framework of feature geometry (FG), as this theory, they argue, is more illuminating than the alternative segmental analysis. In this reply, I review the phonetic, phonological, and diachronic characteristics of labial-velars. While agreeing with Mutaka and Ebobissé's reconstruction, I show that labial-velars are problematic for FG, both synchronically and diachronically, and suggest that FG is not well suited to illuminating the processes involved in phonological change. An alternative, gesture-based, analysis is offered.

Mutaka and Ebobissé (1996/97) discutent le développement des labio-vélaires dans les langues sawabantu, parlées au sud-ouest du Cameroun. Leur argument de base est que ces consonnes sont le résultat d'un processus de labialization, et ils soutienent que le 'feature geometry' est la théorie phonologique qui permet le mieux de comprendre ce développement diachronique. En réponse, je présente ici quelques caractéristiques phonétiques, phonologiques et diachroniques des labio-vélaires, et je montre que ces consonnes présentent des problèmes pour la théorie dite, 'feature geometry'. Je présente une analyse alternative basée sur la phonologie articulatoire.

0. INTRODUCTION

Mutaka and Ebobissé (1996/97) examine the historical development of labial-velars in the linguistic grouping West Sawabantu (WSB), comparing these with cognate labials and labialized velars in East Sawabantu (ESW). (The Sawabantu languages are Guthrie's A20 grouping.) A FEATURE GEOMETRY (FG) analysis is offered by Mutaka and Ebobissé to account for the proposed diachronic development on the primary grounds that it is more illuminating than the alternative segmental analysis. In this reply I argue that the FG analysis also has serious drawbacks and is little, if at all, more enlightening than the segmental account they reject. An alternative analysis is offered—one not considered by Mutaka and Ebobissé, though it is one which has already been proposed in the literature, but not elaborated.

The article is structured as follows. I first give a brief sketch of some of the relevant literature on labial-velars with respect to the phonetics, phonology, and historical development of these doubly-articulated consonants. Second, I consider Mutaka and Ebobissé's data—some of the variation they describe is particularly interesting with respect to the issues at hand—and their reconstruction. Asserting that the labial-velars of WSawabantu are innovations is not an 'open and shut case', but it does appear to be the most reasonable conclusion. The problems labial-velars present for feature geometry, both synchronically and diachronically, are re-examined in §3. Mutaka and Ebobissé, in fact, reveal one of the crucial problems, though apparently do not recognize its centrality to the broader issue, with a question they pose but are unable to answer: "why does the [preceding] nasal acquire its place node from the dorsal features rather than the labial feature of the complex segment **gb**?" (p.13). In §4 an alternative account is presented in the framework of ARTICULATORY PHONOLOGY, in which the gesture rather than the feature is taken as primitive. This permits greater insight into the processes involved in the formation of labial-velars than either feature geometry or a segmental analysis. Section 5 examines some of the problems found in the articulatory phonology approach, and §6 gives a summary and conclusion.

1. PREVIOUS WORK ON LABIAL-VELARS

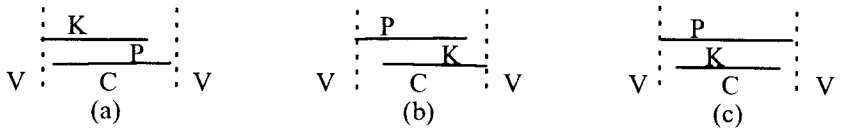
While there are still a number of interesting questions yet to be answered concerning labial-velars, the literature on them is reasonably substantial, particularly if one includes their frequent appearance in the phonological literature; labial-velars

have often been used as evidence for or to illustrate particular claims made in FG and other theories.

1.1 THE PHONETIC CHARACTERISTICS OF LABIAL-VELARS

Phonetic properties of labial-velars have been explored most notably in Connell (1987, 1991, 1994), Demolin (1991), Dogil (1988), Ladefoged (1964), Maddieson (1993), Maddieson and Ladefoged (1989), and Ohala and Lorentz (1977). The bulk of this research indicates that, despite the usual description found in the literature concerning the simultaneity of the two articulations labial and velar, one of the key phonetic properties of these doubly articulated stops is the asynchrony, or staggering, of the component articulations: the labial closure and release typically occur slightly later than the velar closure and release, respectively. This is shown graphically in (1a), where the horizontal lines represent the duration of closure of each component, the vertical lines the onset and offset of the entire consonant.[1] Interestingly, one of the only multiple-speaker studies of labial-velars (Connell 1994) showed variability in the phase relations of the component articulations, though never to the point of a measurably earlier labial closure or later velar release. To my knowledge there are no attested cases of the reverse; i.e., the articulation depicted in (1b) is not found. A possible reason for this is the relatively longer duration of bilabial stops over velar stops:[2] should, through changes in phasing of the two gestures, the labial closure come to lead the velar closure, it is conceivable that the labial release would still trail the velar release, thereby leaving the velar gesture entirely hidden, as shown in (1c); its resulting imperceptibility would result in its eventual deletion.

(1)



Other interesting phonetic characteristics of labial-velars are their overall duration, their voicing characteristics, and the airstream mechanisms involved in their production. As implied in (1), they are generally longer than either simple velars or labials, though typically not as long as geminate consonants or labial and velar clusters. Voiced labial-velars are typically voiced throughout the closure, while voiceless labial-velars are often accompanied by a voiced release. This may be associated with the possible use of different airstream mechanisms, resulting in the presence of suction or implosion at release. While production involving a pulmonic egressive and a velaric ingressive airstream mechanism seems most common, the addition to these of a glottalic ingressive mechanism is also possible, apparently variably within some languages. It is this addition of a glottalic airstream which seems to be accompanied by the voiced release.

1.2 PHONOLOGICAL ASPECTS OF LABIAL-VELARS

With regard to the phonology of labial-velars, the main issue surrounding their representation has been the question of which of the two places of articulation should be considered primary. Early discussion (e.g., Anderson 1976, using SPE-type phonology) favoured a language-specific view based on symmetry and other types of phonological evidence. The question of which of the two places of articulation should be considered primary has persisted throughout the development of feature geometry. Labial-velars

[1] Capital letters are used here and elsewhere in the article to indicate the discussion applies to both voiced and voiceless variants. The ligature normally used to indicate double articulations is omitted throughout the article since **KP** sequences do not enter into the discussion.

[2] Connell (1994) compares consonant closure duration measurements for labial and velar consonants in five West African languages. Labial closures are found to be longer than velar closures of the same voicing status, a relation which appears to hold true for labial-velars. Maddieson (1993) provides estimates of labial and velar durations for labial-velars in Ewe based on articulography which confirm this.

have also played an important role in the development of FG with regard to the notion of the complex segment (e.g., Sagey 1986, 1988; Clements 1991, 1992): the presence of simultaneity of the two articulations within the place node, together with the (assumed) absence of 'edge effects' (e.g., different processes affecting the left side and right side of the segment), were major factors leading to the postulation of the complex segment in contrast with the contour segment, e.g., prenasalized stops and affricates. The two closely related issues of which articulation should be seen as primary and the presence or absence of edge effects are discussed in some detail below. Much of the work on labial-velars, however, seems to fly in the face of the phonetic facts and to be selective with the phonological facts. Labial-velars do, for example, demonstrate different effects of phonological processes in interaction with preceding and following sounds. Connell (1994) and Ohala and Lorentz (1977) provide details; as examples, we cite here preceding nasals typically tend to pattern as velars, while following vowels are affected as if next to labials. Most, if not all, instances of nasals patterning as velars are cases where the sound in question precedes the labial-velar; there are no clear cases reported where a sound preceding a labial-velar patterns as a labial.[3] On the other hand, in cases of interaction between a labial-velar and a following sound, the outcome involves a labial: in Dan (Béarth and Zemp 1967), for example, /gb̰V/ surfaces as [gm̰V]; i.e., the nasality of the vowel spreads only to the labial release portion of the labial-velar. This asymmetric patterning is no accident, but is clearly due to the asymmetry of the timing of the articulatory gestures discussed above.

In feature geometry, the two place specifications of a complex segment are said to be temporally unordered, since order is apparently not contrastive, i.e., since, as mentioned above, **PK** is not attested, it never contrasts with **KP**. The asynchrony of the two components, then, is considered to be a matter of phonetic implementation. This is problematic if, as is usually considered to be the case, the task of phonology is to account not only for contrastiveness in a language, but also for its phonological processes. If FG is to account for the phonological processes described above, as well as others involving labial-velars, the asynchrony in the timing of the two gestures needs to be taken into account.

1.3 HISTORICAL DEVELOPMENTS INVOLVING LABIAL-VELARS

The historical development of labial-velars—both how they arise and what they evolve into—has been discussed in Connell (1991, 1994, 1995), Demolin (1995), Goldstein (1995), Kelly (1988, 1991), Ponelis (1974), Zima (1985), and elsewhere. There is considerable agreement in this body of work that, with respect to their history, labial-velars typically arise through what may be seen as the 'temporal compression' of **KUV** sequences, to **KWV** then **KPV**, with accompanying or subsequent fortition. Evidence also exists for **PUV** sequences becoming **KP** through similar processes. Mutaka and Ebobissé provide additional attestation of both of these scenarios in their exposé of historical developments in Sawabantu. The evolution from, or erosion of, labial-velars is less relevant for our present purposes but, briefly, seems most often to involve the decay of the velar element, resulting in a velarized labial consonant (e.g., in some Igbo lects; Ladefoged et al. 1976) or a simple labial consonant. The decreased saliency of the velar component, resulting from its release being hidden by the later labial release, could bring about the Igbo situation. The scenario mentioned above, whereby the labial gesture might shift sufficiently to the left that the entire velar gesture is hidden, could result in the latter, a simple labial reflex.

[3] This issue is sometimes confused by spelling conventions. Efik orthography, for example, renders some words with an initial sequence of **mkp** and others with the sequence **ŋkp**. Whatever the origin of the orthographic convention, in terms of the sound system of the language, with respect to syllabic nasals only **ŋ** or **ŋm** may precede **kp**.

2. SAWABANTU LABIAL-VELARS

Mutaka and Ebobissé describe the Sawabantu languages as being divisible into two groups on the basis of the presence or absence of labial-velars: **gb, kp, ŋm/ŋw, ŋgb** occur in West Sawabantu, corresponding to **ɓw, kw, mw, ŋgw** in East Sawabantu. The labialized consonants of ESawabantu are considered to be the more conservative forms, and it was these that were found in Proto Sawabantu (PSW). The labial-velars of WSawabantu and the labialized consonants of ESawabantu occur in both prefixes and stems. For both the labial-velar and labialized prefixes, their distribution is such that they only occur before vowel-initial stems, while stems beginning with a consonant take a CV- prefix. Examples given by Mutaka and Ebobissé are presented in the tables in (2) and (3). Additional information from data available to me for Kpè, (a.k.a. Bakueri, Bakweri, MòKpè; Kagaya 1992, Connell 1997), including noun class membership, is included. Missing tone marks (Mutaka and Ebobissé leave low tones unmarked) are added for clarity.

(2) Labialized and labial-velar prefixes in Sawabantu

Class (*per* Kpè)		ESawabantu	WSawabantu	
14/6	**(wò- \ mà-)**	**ɓw-èlé**	**gb-èlé**	tree
5/6	**(lì- \ mà-)**	**kw-àmbà**	**kp-àmbà**	cassava
1/2	**(mò- \ và-)**	**mw-ànà**	**ŋm-ánà**	child
3/4	**(mò- \ mè)**	**mw-èmbá**	**ŋm-èmbá**	age-group

(3) Stem-initial labialized and labial-velar consonants in Sawabantu

ESawabantu	WSawabantu	
kúɓwàkò	**kúgbàkò**	diarrhea
è-ɓwéà	**è-gbéà**	one hundred
kwàlé	**kpàé**	partridge
kwátá	**(mò-)kpátá**	sword
àŋgwà	**àŋgbá**	throw
kwédí	**kpélí**	death

A number of observations may be made of these data. First, the prefixes of (2) partake in singular ~ plural alternations; i.e., they are part of the noun class system of the language. The class pairings in question, as found in Kpè, are included in the first column of (2). Details of the allomorphic variation of these prefixes as found in Kpè are presented in Connell (1997) and Kagaya (1992); essentially, the labial-velar [gb-] occurs only before vowel-initial stems, as mentioned above, and when that vowel is a front vowel. The same is true of the other labial-velar prefixes in WSawabantu. These forms, therefore, do not reflect a diachronic development as suggested by Mutaka and Ebobissé, but are contextual variants of an underlying CV- prefix. This is supported by the fact that, before C-initial stems, this class prefix surfaces as [wò-].[4]

It is also noteworthy that, contrary to the data presented by Mutaka and Ebobissé, at least Kpè **kpàmbà** 'cassava', as indicated in (2), takes class 5/6 prefixes, suggesting that the initial **kp-** is not a true prefix, and that this item may be better placed in the table in (3). Moreover, although Kpè is clearly part of WSawabantu, the **ŋm-** prefix given for 'child' and 'age-group' is not attested in Kagaya (1992) or Connell (1997); rather the latter show the labialized realization as given for ESawabantu. In other words, it is only Class 14 **wò-** which has a labial-velar allomorph in Kpè, among the prefixes. Kpè similarly finds itself on the 'wrong' side of the **ŋgw – ŋgb** correspondence reported by Mutaka and Ebobissé, e.g., 'lick' **nyáŋgòà**, with **-ŋgò-** reflecting perhaps an even earlier form than the **ŋgw** they postulate for PSW. While these variations could be indicative of

[4] This analysis, however, sidesteps an interesting issue in historical phonology, that of phonologization. Mutaka and Ebobissé's argument presumably is that at an earlier period in the language, the allomorph of the prefix in question was not a labial-velar, but a labialized labial.

ongoing change within Kpè, Mutaka and Ebobissé also note similar variation for Isubu[5] and for some words throughout WSawabantu. These facts suggest, first that the change has affected different speakers at different rates, and second, the possible lexical diffusion of the change, not only areally, but perhaps also in terms of the structure of the lexicon. The significance of this variation is returned to later.

The items presented in (3), as well as other examples of stem-initial **KP** used by Mutaka and Ebobissé, may be problematic for seeing the labial-velar of WSawabantu as an innovation, since for some of these cognate items outside Sawabantu (and in fact outside Bantu) can be found with labial-velars as well: e.g., (Nupe) **kparo** 'partridge'; (Ibibio) **ŋm̀-kpá** 'death'.[6] Such evidence may well indicate that the labial-velar is the more conservative form, and that it has weakened to **kw** in ESawabantu (and, by implication, in most other Bantu languages). However, given that there is no similar contradictory evidence for the prefixes in (2), i.e., in these cases the labial-velar is clearly the innovation, it is reasonable to assume that the stem-initial labial-velars are also innovations. In any case, the question of whether all labial-velars in WSawabantu are the result of innovation becomes secondary to our present purposes.

In summary, Mutaka and Ebobissé have proposed that the labial-velars of WSawabantu are innovations. From their discussion, it is clear the developments involved a high back vowel desyllabifying when followed by another vowel, then labialization of the preceding consonant, and finally hardening or fortition. In short, the two processes identified above, **KUV > KWV > KPV** and **PUV > PWV > KPV**, are also attested in WSawabantu. Mutaka and Ebobissé present (and reject) a segmental analysis of these developments in a somewhat different form, as in (4), but it is clear they mean developments as outlined above.

(4) a. **ɓ > gb \ —— w**
b. **k > kp \ —— w**
c. **m > ŋm \ —— w**

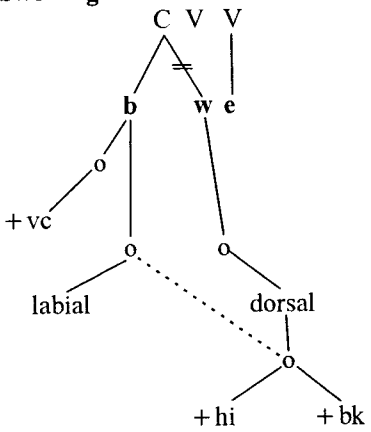
3. LABIAL-VELAR FORMATION AND THE FEATURE HIERARCHY

The notation in (4) is rejected by Mutaka and Ebobissé, first, because "it does not tell us why the **w** becomes either **g** or **p** or **ŋ** in the resulting segments" (p. 9). Second, it is said to imply an intermediary stage of **KPw**, i.e., **kp^{w}**, **gb^{w}**, though no evidence for this has been found. If there were an intermediate stage, then the question must be asked whether there was a rule which deleted the **w**. Rather than this segmental analysis, they assume the feature, not the segment, as primitive and the appropriateness of organizing features hierarchically. Adopting a feature geometry framework, they claim it can be argued that "**w** actuated the changes in the present labial-velar segments ... [because it] ... has the dorsal features [+high +back] and the labial feature [+round] ... [which] ... link, in various ways, in the hierarchical structure of **ɓ**, **k**, **m**" (p. 10). In terms of FG, the development of the different labial-velars can be expressed formally as shown below, with figures taken from Mutaka and Ebobissé. It is assumed in each case that the labialized C is a complex onset; in each case, then, the first stage of the change involves delinking of the **w** at the root node, leaving the features associated with **w**, i.e., [+hi, +back, +rnd], stranded. These features are then free to relink elsewhere.

[5] Mutaka and Ebobissé use the alternative name Isu; I adopt the full name to avoid confusion with another Cameroon language also called Isu (Grassfields, Ring).

[6] I am grateful to Roger Blench for drawing my attention to some of these.

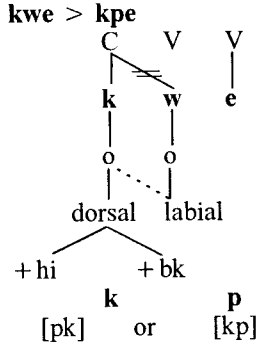
(5) **bwe > gbe**



skeletal tier
root nodes
laryngeal node
place nodes
labial and dorsal nodes
output

This representation (amended slightly to accord with their description, and following their representation for **mw > ŋm**, below) suggests the delinking of the **w** from the root node and the linking of its dorsal features, i.e., [+hi +back], to the place node of **b**. The delinking and relinking is argued to occur at the dorsal node of **w**, rather than at its place node, because the labial feature of **w**, [+round] (not depicted), is not transferred. The resulting output is a complex consonant whose components are unordered, i.e., either [bg] or [gb]. (The transcriptions provided by Mutaka and Ebobissé actually suggest, not an unordered output, but rather, two alternative orderings. It is probably more accurate, in the context of FG, to leave off the square bracket transcription since it implies a phonetic representation, whereas the Mutaka and Ebobissé output is presumably intended as the input to the phonetic component. And, as an anonymous reviewer points out, it is a failing of traditional transcription systems—e.g., the IPA—that overlapping articulations cannot readily be represented.)

(6) **kwe > kpe**



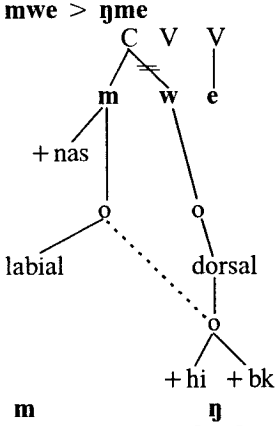
skeletal tier
root notes
place nodes
labial and dorsal nodes
output

The development of **kw** to **kp** is said to proceed in essentially the same manner, with the difference being that it is the labial feature of **w** which links to the place node of **k** rather than the dorsal feature which is stray-erased. Rather than generating **kw**, **kp** is the output since it is assumed that, when linking to the consonant, the feature labial assumes the value [+lab] rather than [+rnd] as when associated with vowels. Although it is not originally specified in Mutaka and Ebobissé's representation, the two components are again unordered; i.e., [pk] is an equally valid output.

The development **mw** to **ŋm** parallels that of **bw** to **gb**, with the obvious exception of nasality; again, as in the case of **gb**, it is claimed the [+rnd] feature of **w** is simply

unrealized, being a vowel feature. And again it is noted that the resulting components of the complex segment are unordered.

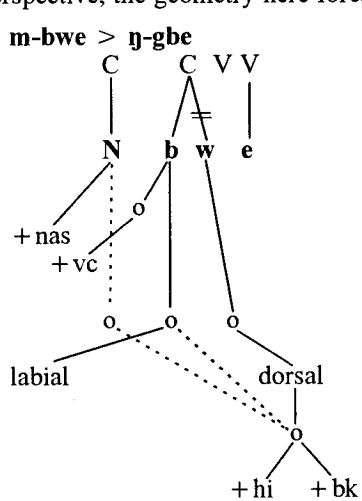
(7) **mwe > ŋme**



skeletal
root nodes
place nodes
labial and dorsal nodes
output

The development of **m-bwe** to **ŋ-gbe** is also represented. In this case, the nasal is said to constitute a separate root node which acquires its place features from the dorsal node of the following segment. In this case, Mutaka and Ebobissé have not stipulated that the output is unordered, though with respect to the components of the labial-velar it obviously must follow the pattern established in the previous examples. Considered from this perspective, the geometry here foreshadows the problems to be discussed below.

(8) **m-bwe > ŋ-gbe**



skeletal tier
root notes
laryngeal node
place nodes
labial and dorsal nodes
output

Finally, Mutaka and Ebobissé give a feature geometric representation of the development of the labialized velar, **ŋw** from **mw**. This case is different in that it is claimed here that it is not the **w** which initially delinks but, rather, the place specification for the nasal. The dorsal node of the remaining **w** then spreads to the delinked nasal (causing the delinking of the original labial feature) which then relinks to the **w** skeletal slot as **ŋ**. This may seem a curious strategy, but it is apparently necessary to avoid an **ŋm** output, depicted above.

A number of problems can be identified with the above treatment of the development of labial-velars from labialized consonants. First is the question of the nature of the feature [labial] in these cases. Its manifestation as a vocalic feature is said to be [+rnd], and as a

consonantal feature [+lab]. In each of the above derivations, **w** is treated as having the feature [+rnd] which either switches to [+lab] when linking to the place node (in the case of **kp**) or is left behind to be stray-erased. Yet **w** was already linked to a C slot at the outset, and so [labial] must already have had its consonantal value, obviating the need for a change from [+rnd] to [+lab]. Second, is the apparently arbitrary way in which features of **w** are selected to associate with the place node of the C or are left to be stray-erased; in some cases [+hi, +back] relink and [+rnd] is left behind, while in others the reverse occurs. An alternative, which would do away with this arbitrariness, would be the reasonable assumption that all features re-associate, but if a given feature is already present at the node where the re-linking occurs, matching features simply become redundant or are delinked. This, roughly speaking, appears to be the practice in much standard feature geometry. So, the dorsal feature of **w**, when linking to the place node of a consonant which is already dorsal (e.g., **k**) is not left behind nor does it need to be stray-erased. Rather it either causes the delinking of the dorsal feature of the target or associates redundantly with that place node. A second alternative, offered by an anonymous reviewer, would be to replace the binary features of **w** with privative features, [labial] and [dorsal]. This, it is suggested, solves the problem of what happens to [+rnd]. It also implies a rather different view of FG, closer to that of Clements and Hume (1995); problems this version of the theory has with labial-velars are discussed below. One further problem to be noted here is the failure to account for the change in degree of stricture necessary to allow **KP** to be distinct from **KW** or **PW**, and also **KF** from **PF**;[7] i.e., the necessary change from [+cont] to [–cont] is not taken into account.

A more crucial problem, in fact, perhaps the key problem labial-velars present for feature geometry, appears with the last derivation presented, that of **N-bwe** to **ŋgbe**, as depicted in (8). The problem is, why does **N** take its place feature from the dorsal place node of **gb** rather than the labial—or indeed from both dorsal and labial nodes. On one hand, it is possible to predict that any of these might be possible, given the unordered status of the component parts of a complex consonant in FG. On the other hand, one might argue that, since labial-velars are uncontroversially considered phonologically unitary stops, the theory should predict only the spread of both dorsal and labial place nodes; i.e., the preceding nasal in question should always surface as **ŋm**. In reality, as mentioned above and is apparently the case in Sawabantu, it is frequently a velar nasal found adjacent to labial-velars; the dorsal node of the labial-velar spreads to the nasal, itself unspecified for place. Less often, though not uncommonly, we find a labial-velar nasal. Mutaka and Ebobissé recognize the problem, admitting they "have no definite answer to this question" (p. 13), but suggest the dorsal features might be the default features for nasals. An alternative possibility, proposed in Sagey (1986), is to use the notion of major vs. minor articulation, equivalent to primary and secondary articulation though defined in phonological terms. A 'pointer' from the root node is used to indicate the major articulator, in this case the dorsal node. This is rejected by Clements and Hume (1995) and Cahill (1998), though for different reasons in each case. Clements and Hume point out that, while Sagey's model predicts that if the place node spreads, both the major and minor articulator nodes will spread with it, her model fails to account for those cases where the nondominant feature doesn't spread (i.e., in the present case, **N-KP** being realized as **ŋ-KP**). Cahill suggests Sagey's model allows not only the spread of the entire place node but also the independent spread of the major articulator node permitting partial assimilation, with a resulting **ŋ-KP**. His objection is that, without stipulating that only major articulations can spread, there is nothing preventing the spread of only the minor articulation (which in this case would give the unattested **m-KP**).[8]

[7] In other words, a possible contrast between labial-velars and labio-dentalized velars has not been ruled out.

[8] These contrasting critiques of Sagey may be compared with what she actually says: "In place assimilation, the entire place node spreads, with *all* the articulator nodes specified under it, regardless of whether they are major in the segment or not" (1986:207, my emphasis). That is, Sagey's model permits only **ŋm-KP**.

Clements and Hume's alternative (see also Clements 1991) maintains the major vs. minor articulation distinction but involves a re-organization of the geometry of the tree, incorporating under the C-place node a vocalic node which dominates the minor articulations (rather than employing a notational device such as the 'pointer'). All C-place features can spread, or simply the features of the major articulator. This would allow either **ŋ-** or **ŋm-** to be realized before **KP**; it is in its outcome essentially Cahill's interpretation of Sagey's model, and is subject to his criticism: if the major articulator can spread independently, what, other than an arbitrary stipulation, prevents the minor one from doing the same?

There are a number of problems with these solutions. First, they provide no principled way of predicting which possibility is preferred, in this case the spread of simply the major articulator. This is important given that, within FG, complete assimilation is arguably the more expected case, rather than the partial assimilation involved in the spread of only the major articulator. Second, in Clements and Hume's discussion, only examples of 'classical' secondary articulations are discussed, i.e., those traditionally described in the phonetics literature as 'adding a vowel-like articulation to a consonant'. (In fact, only palatalization is examined in depth.) Accordingly, in their geometry the minor feature is associated with the vocalic node. In the case of [dorsal] being the major articulator feature and [labial] the minor, or vocalic feature, [labial] would be [+rnd], and the expected complex segment would be **k^{w}**. Their solution, then, apparently provides no way of distinguishing between labial-velars and labialized velars. Moreover, it is intuitively difficult to see the labial component of a labial-velar represented at the vocalic node. It is perhaps a similar sentiment which earlier leads Clements (1991) to argue that a change from **k^{w}** to **kp** (and **g^{w}** to **gb**) involves the 'promotion' of [labial] in the V-place to primary status alongside [dorsal] in the C-place structure, i.e., giving a segment with two major articulations. However, this device, and the possibility of two primary articulations, is rejected in Clements and Hume; it is not discussed directly in connection with their own formalization,[9] though in a long footnote Sagey (1986) is taken to task for permitting two major articulations, with Clements and Hume suggesting "a maximally constrained phonological theory would exclude them in principle" (Clements and Hume 1995:304, fn. 32). Were such a representation permitted, however, it would accommodate a distinction between **KP** and **K^{w}** (but not one between **KP** and **KP^{w}**), and would also offer the interesting prediction that in languages with a **KP** – **K^{w}** contrast, an assimilation outcome of **ŋm-** only would be found before **KP** (since presumably both major articulations would spread), but either **ŋm-** or **ŋ-** before **K^{w}**.

Furthermore, the Clements and Hume treatment does not take account of possible conflicting evidence. In redefining the distinction between primary and secondary (i.e., major and minor) articulations in phonological terms, they cite Anderson (1976) with respect to labial-velars. Anderson's claim is that one can determine which of the two component articulations is primary on the basis of symmetry and other phonological evidence. By these criteria, in a great many languages it is the labial component which is primary; however, in a great many of these cases it is the velar articulation which must be considered primary if one considers anticipatory nasal place assimilation (or other phonological processes). Efik is one such example. The consonant inventory of Efik includes /b/ and /k/, but not /p/; **kp** is therefore proposed to be, phonologically, /p/. Yet, as mentioned earlier, only **ŋ-** or **ŋm-** precede **kp** in Efik. Kaufman (1985), on similar grounds, proposed Ibibio [kp] to be an allophone of /p/, but again, in Ibibio only **ŋ-** or **ŋm-** may precede **kp**. Gwari (Rosendall 1992) is even more problematic for proponents of the view that labial-velars should be seen as having only one primary place of articulation; or, if there are two major articulations, both must engage in phonological processes such as assimilation. With respect to labials, velars, and labial-velars, Gwari already

[9] It is mentioned briefly in a subsequent section where it is said that the promotion of a minor articulation involves the replacement of the original major articulation. This avoids the problem they see in Sagey's model, but it doesn't, however, allow them to escape the present dilemma as the promotion of [labial] would mean either the delinking or demotion of [dorsal].

has a symmetrical inventory, with voiced and voiceless consonants at each place of articulation; either or both of the labial-velars (depending on dialect) may also occur labialized;[10] and, as seen elsewhere, nasals preceding the labial-velars surface as **ŋ**. Unusually, Gwari also permits nasal consonants following labial-velars;[11] these always surface as **m**, and in at least one dialect (Giri) nasals may occur both before and after a labial-velar, e.g., **wʲédʒíŋgbmà** 'dark'. Clearly Gwari presents a problem for any theory that attempts to analyze labial-velars as having one primary and one secondary articulation, whether this is based on symmetry or evidence from phonological processes, and equally for a theory that favours two primary articulations, where both of these are required to spread.

One final note: none of the feature geometry models discussed are able to account for a contrast including labialized velars and labialized labial-velars together with the plain stops. The **KP – KP^{w}** contrast may be rare, but it is attested. In the majority of cases where it is found, a cluster analysis such as that apparently preferred by Rosendall is usually adopted: Longtau (1993) does so for Tarok, though R. Blench (pers. comm.) prefers to see them as labialized labial-velars and further suggests there is a number of other Platoid languages demonstrating this contrast. Welmers (1973:63) describes Nupe as having a 'minimal contrast' between **kp** and **kp^{w}** (i.e., only before **/a/**, though **gb** and **gb^{w}** also partake). Kwanja (Bantoid, Mambiloid), though, has a full range of labialized consonants (including prenasalized) where an analysis of **KP + w** is less felicitous; /kp^{w}/, /gb^{w}/, /ŋm^{w}/ are realized as [kf^{w} ~ kf, gv^{w} ~ gv, ŋv^{w} ~ ŋv], respectively (Connell, field notes; Weber and Weber, ms.).

4. AN ALTERNATIVE TO A FEATURE GEOMETRY ANALYSIS

Mutaka and Ebobissé claim that a feature geometry analysis is preferable to a segmental analysis in that, being feature based, it is more illuminating, providing insight into *why* **w** becomes either **g**, **p**, or **ŋ** as the result of diachronic change. Specifically, and as quoted earlier, they suggest that "**w** actuated the changes ..." (p. 10). The problems labial-velars present for FG, demonstrated above, cast doubt on this assertion. These problems aside, we might more generally question the suitability of FG as a theory of phonological change and ask whether it really does provide insight into the processes of phonological change. To accept FG as a theory of phonological change suggests that change comes about primarily as a result of the delinking, re-associating, etc. of features. To the extent that these formal mechanisms have anything at all to do with change, they can do no more than express change after the fact, i.e., the beginning and end points of a given change. Though they may possibly be useful devices for describing some aspects of phonological change, it should not be assumed that they are, or even represent, the mediating factors, the 'hows and whys', of sound change. They say nothing about the actual processes involved in sound change. Viewed from this perspective, it is questionable whether such an account is indeed more enlightening as to the 'hows and whys' of sound change than the segmental account rejected by Mutaka and Ebobissé—both do no more than expresses different states or stages. But even if we were to accept that in some respects the FG view is an improvement over the segmental one (e.g., by arguing that it is features rather than segments that ultimately change), the question of whether there is yet another framework which may provide a more insightful analysis remains open.

Articulation data from a wide range of studies show that sound change often involves processes such as gestural overlap, changes in the magnitude of gestures, or reassignment of gestural attributes; see Browman and Goldstein (1991), Pagliuca (1982), and Pagliuca and Mowrey (1987) for general treatments. Similarly, Kelly and Local

[10] Rosendall's analysis of the labialized labial-velars of Gwari is not clear; they are listed in chart form as being phonetic rather than phonemic, but they are also found in phonemic transcriptions. It seems likely what she intends in these cases is an analysis of a sequence of **KP** + glide.

[11] Rosendall describes these as post-nasalized consonants; their precise status is still unresolved.

(1989:133), though not explicitly using a gestural approach, present an example involving a labial-velar in at least one language which, in their detailed transcription, shows clearly that sound change involves a reorganization of gestures in terms of their timing and attributes. Their example draws on forms representing the word 'dog' from four Bantu languages; in the table in (9) I present these and add the forms from Sawabantu given in Mutaka and Ebobissé together with Meeussen's Proto-Bantu reconstruction.[12] The ESawabantu form appears to be the most conservative; both the Lutooro and Swahili forms show the temporal compression of the labial and velar gestures such that the labial is velarized, and in the case of Swahili also labialized. (It is conceivable that a more detailed transcription would also show velarization in ESawabantu.) Venda and WSawabantu both show this process having pushed still further, with the development of a labial-velar.

(9) Forms for 'dog' from a range of Bantu languages

Proto-Bantu	**m̀bóà**
Esawabantu	**mbwáà**
Wsawabantu	**ŋgbáà**
Lutooro	**ɛmbwa**
Swahili	**mʲbʷwa**
Xhosa	**nʲd͡ʒʷɪa**
Venda	**mm̂ŋ^{gb}ɣɪa**

Mutaka and Ebobissé's description of the Sawabantu developments, presented earlier in general terms as **KUV > KWV > KPV** and **PUV > PWV > KPV**, suggests just these sorts of processes—the increasing overlap (or temporal compression) of dorsal and labial gestures and reassignment of gestural attributes—are at work. Pagliuca and Mowrey's theory of ARTICULATORY EVOLUTION (AE) attempts to understand the 'hows' of sound change through reference to these kinds of processes (though slightly different terminology is used); it addresses the 'why' of sound through the specific claim that the directionality of change is in no sense random, but is governed primarily by what may be termed evolutionary forces, i.e., with reference to articulation, and frequency. Browman and Goldstein's ARTICULATORY PHONOLOGY (AP) is a general theory of phonology couched within a broader theory of human movement (for an overview see Browman and Goldstein 1992a and references therein; Hawkins 1992 provides an accessible introduction to task dynamics). The analysis it provides of sound change resembles that of Pagliuca and Mowrey, though with at least two major differences: first, the term 'gesture' in articulatory evolution refers to a neuromuscular event; in AP it refers not to a physical movement, but to an abstract entity which controls physical movement. Second, whereas Pagliuca and Mowrey admit no mediating role for perception in sound change, Browman and Goldstein do suggest acoustic/auditory factors are involved in some types of sound change following, for example, Ohala (e.g., Ohala 1992; see Browman and Goldstein 1991:372 ff.).[13] A key characteristic which the two approaches share is that both are dynamic: rather than merely listing beginning and end points, and possibly including intermediate stages, they refer to the processes involved in change.

The following sections re-examine the Sawabantu developments from the perspective of articulatory phonology.[14] No phonological theory yet has been able to provide answers to all the questions surrounding sound change; however, as a general theory of

[12] Kelly and Local's transcription has been modified to follow current IPA conventions. Regarding the Venda form, they presumably do not intend anything significant to be read into the varying order, **m̂ŋ** vs. **gb**.

[13] Unlike Ohala, Browman and Goldstein do not argue that acoustic/auditory events operate independently of articulation in the mediation of sound change.

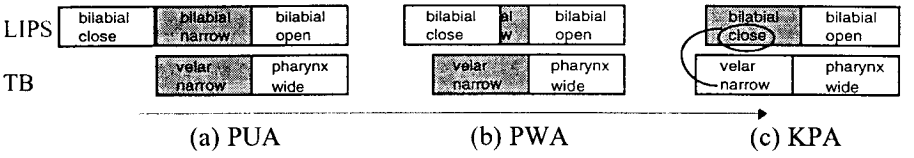
[14] I opt for articulatory phonology here rather than articulatory evolution primarily because it is a more general theory. With regard to the specific goals of this article, both of these theories provide a more illuminating analysis of sound change than feature geometry. However, it may ultimately prove to be the case that sound change (and other historical concerns) requires a separate theory which need not necessarily be compatible with synchronic theories.

phonology, AP goes farther than others in elucidating the processes and mechanisms involved in sound change and how these relate to synchronic phonological processes.

4.1 ARTICULATORY PHONOLOGY AND THE DEVELOPMENT OF LABIAL-VELARS

The types of process most commonly referred to by articulatory phonology in its analysis of sound change are those found in casual speech or assimilation, overlap of gestures, reduction in magnitude of gestures, etc. In addition, one finds apparent cases of the reassignment of gestural attributes or gestural misparsing. It is these that are attributed to acoustic/auditory factors, i.e., to the listener. Goldstein (1995) presents a gestural score for an AP analysis of a sound change of [6] > [gb]. In (10) I elaborate this to model the development of Proto Sawabantu [bu] to WSawabantu [gb] in general terms. Certain aspects which are not directly relevant to illustrating the change, e.g., the laryngeal specification and nasal specifications, are omitted. (10a) shows a partial gestural score representing the PSW form. (10b) shows increasing overlap of the gestures for **U** with those of **P**, resulting in labialization through 'hiding' and apparent shortening of **U**. (10c) shows near complete overlap of the gestures on the Tongue Body and Lips tiers and the reassignment of the constriction specification for Lips to Tongue Body. Within AP, this reassignment of the constriction parameter value 'close' from Lips to Tongue Body is attributed to the listener, who associates these with the Tongue Body gesture as it increasingly overlaps with Lips.

(10)

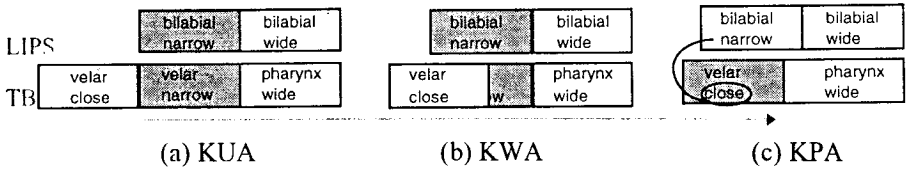


(a) PUA (b) PWA (c) KPA

A number of interesting predictions follow from this account which are seldom mentioned in descriptions of the development of labial-velars. First, the labial consonant is not only labialized, but also velarized. That this is indeed the case is verified instrumentally, for example, by Demolin (1995) discussing Lendu, and in the detailed transcriptions of Kelly and Local above in (8). Second, the voicing associated with **U/W** (not diagrammed here) could also conceivably overlap the consonant articulation in cases where the original C was voiceless. This too is the case: phonologically voiceless labial-velars are often accompanied by a voiced release, as discussed earlier. Third, the possibility of a labialized release **KP^{w}** is suggested by a gestural configuration intermediate to (10b) and (10c) (or (11b) and (11c), below); this is also attested in the literature. (This labialization need not become phonologized. It has frequently been noted that in many languages labial-velars are accompanied by a labial offglide, e.g., Welmers 1973:47).

A partial gestural score for a gestural analysis, modeling the development of Proto Sawabantu [ku] to WSawabantu [kp], is presented in general terms in (11). The progression from (11a) to (11c) shows the increasing overlap of the Tongue Body and Lips gestures, again to the point of near synchrony and, in (11c), the reassignment of the constriction specification for Tongue Body to Lips, again for reasons like those discussed above.

(11)

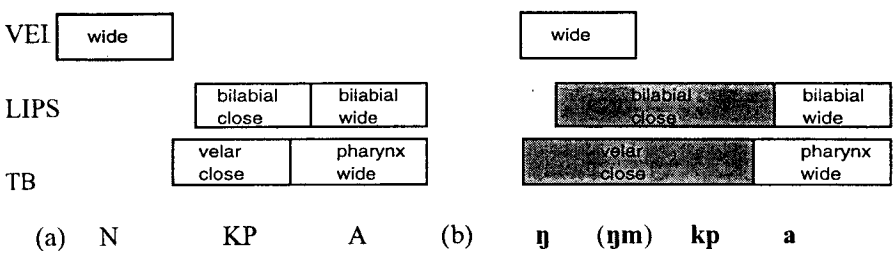


(a) KUA (b) KWA (c) KPA

4.2 LABIAL-VELARS AND NASAL PLACE ASSIMILATION

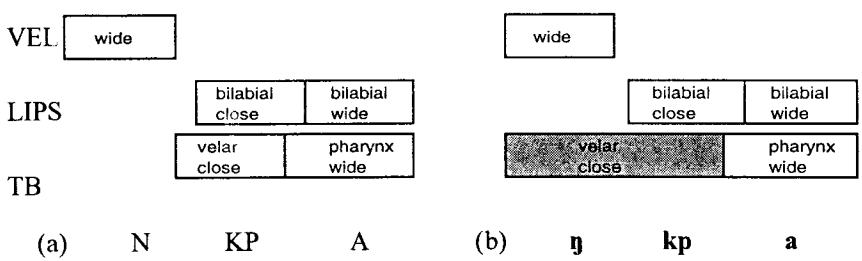
The gestural analysis therefore captures, in a natural and informative way, the facts of diachronic developments leading to the appearance of labial-velars. The issue of the assimilation of a nasal prefix to the place of articulation of a following labial-velar consonant is handled in a similar manner, as shown in (12), where the nasal prefix is assumed to be unspecified for place (12a). In (12b) the spread of the Lips and Tongue Body gestures to the nasal is depicted, giving the prefix **ŋm-**. This view also provides insight into why there is apparent variation between **ŋ** and **ŋm** in some languages, and especially why **ŋ** is most commonly found: assuming the two gestures spread together, as shown in (12), we have a predominantly labial-velar nasal, **ŋm**. This double articulation may, however, still give a percept of **ŋ** since it is the backmost closure (i.e., **ŋ** rather than **m**) which determines the acoustic characteristics of the nasal (cf. Ohala and Lorentz 1977). This, together with closing (velar) transitions and the absence of release transitions (since the nasal is essentially unreleased), would give the auditory impression of **ŋ**.

(12)



An alternative scenario, which may exist in some languages, is that the Tongue Body and Lips gestures do not spread together, but rather TB alone spreads, as depicted in (13).

(13)



4.3 SUMMARY

To summarize this section, the gestural approach appears to be more illuminating as to the processes involved in sound change than feature- or segment-based approaches which are only 'after-the-fact': they can show the input to and output from a process of change. Understanding the processes involved in change is clearly a large step towards understanding why change occurs. Moreover, variation of the sort noted earlier, i.e., where Kpè and Isubu don't always show the expected WSawabantu reflex, along with other types of variability inherent in sound change, fit more readily with a gesture-based account, and not at all with feature- or segment-based approaches, which predict a strict version of the regularity hypothesis. That is, recognition of the dynamic processes involved permit the further recognition that changes of this sort can occur at different rates for different speakers, different geographical areas, and conceivably for areas of the lexicon.

5. PROBLEMS WITH THE GESTURAL APPROACH

Though it is widely accepted that articulatory phonology is well suited to capturing the facts of many phonological processes (e.g., Clements 1992, Kohler 1992, Zsiga 1995), as well as a great many aspects of phonological change (cf. McMahon, Foulkes, and Tollfree 1994), this approach is not without problems. Regarding the issue at hand, Kingston and Cohn (1992:196) and Zsiga (1995:297–98), for example, both point out that the absence of constraints on the temporal order of gestures is a weakness of the theory. With respect to labial-velars, this means that AP fails to predict the nonoccurrence of **PK**, and additional constraints must be added to capture this fact. This is indeed a real problem, one which requires understanding; however, a first line of defense may be to point out that while AP may overpredict, and therefore requires additional constraints to be found, FG inherently cannot handle a phenomenon which is attested. It is presumably the first alternative which is more promising of an eventual solution. More generally, it has been suggested by an anonymous reviewer that AP is actually less constrained than the view here suggests, since it has no element such as the segment to provide built in constraints; for example, it predicts (it is claimed) the possible total absorption of the nasal into the labial-velar. Browman and Goldstein (1992b) admit they are unable to offer a movement-based explanation for this problem, and are unclear as to whether this reflects an inadequacy in AP or in the more general task dynamic approach. It may also be noted, though, that the abstract gestures of AP are the contrastive elements of which words are comprised; i.e., they exist at the lexical level. Even though casual speech processes, assimilation, and other forces reflect variation in phase relations among gestures, the fact that gestures can occur even when imperceptible indicates that at the lexical level they are more invariant (Browman and Goldstein 1992b:226). As such, the theory has built into it constraints of the same order other phonological theories enjoy through the presence of features or segments. Regarding the specific example of the total absorption of the nasal prefix into the labial-velar, it is by no means certain that this is something to be ruled out. While I know of no specific examples that attest this development, parallel developments may exist in the fusion and subsequent erosion of prefixes; the existence of prenasalized consonants in many Bantu and Bantoid languages, for example, may be attributable to the loss of the V portion of NV- prefixes. While there is some impressionistic evidence that the nasal may subsequently go on to gradually shorten and be deleted (Connell, unpublished field notes), the hypothesis that this comes about through gestural overlap has yet to be tested experimentally.

In short, in comparing articulatory phonology with feature geometry, weaknesses found in AP must be balanced against the problems described above for FG. The stipulation that the place specifications of a complex segment are unordered in FG requires additional machinery to account for phonological processes involving labial-velars, e.g., in the form of an *ad hoc* diacritic (as with Sagey's pointer) or a more complicated tree structure (as in Clements and Hume, though as shown even this fails to address the problem). The lack of temporal ordering in the tree structure considered desirable by proponents of FG therefore comes at cost—as yet undetermined. On the other hand, it may well prove easier to discover the additional constraints needed in AP; that needed to account for the non-occurrence of **PK** may possibly be found in the phonetic characteristics of labial-velars discussed earlier. That is, if in the course of their historical development the Lips gesture comes to precede that of the Tongue Body, its inherently longer duration could lead to the masking of the Tongue Body gesture and its eventual disappearance

6. SUMMARY AND CONCLUSION

In this article I have re-examined the account given by Mutaka and Ebobissé (1996/97) of the development of labial-velars in the Sawabantu languages. While the actual proposed developments are reasonable, confirming accounts reported in the literature for other languages, their analysis using feature geometry has been found wanting.

A number of problems labial-velars present for FG generally have been identified, and the appropriateness of FG as a vehicle for understanding the historical development of labial-velars questioned. An alternative account employing the insights of articulatory phonology has been presented which not only allows the modeling of the synchronic behaviour and diachronic development of labial-velars, but also affords insights into the relationship between the internal structure of speech sounds and their historical development, and also their synchronic behaviour. A number of weaknesses in AP have also been identified but it was argued that it may prove easier to address these problems than those inherent in FG.

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