Markedness and Complex Stops: Evidence from Simplification Processes[1]

Nick Danis[2]
Rutgers University

Abstract
Complex segments – segments with multiple, unordered place features – are most common in African languages. Understanding the phonology of clicks and labial-velars is a crucial step in understanding the phonology of African languages. This paper examines both these types of complex segments from the point of view of *simplification*, a special instance of segmental reduction. This is a type of process where a complex stop is realized on the surface as a simple stop, and it is related to neutralization processes in general. Empirically, labial-velars are found to reduce to either simple labials or simple dorsals. Clicks reduce to simple dorsals. The theory is based in OT and accounts for these simplification processes using general and independently-motivated constraints and place markedness hierarchies. All attested patterns of simplification are predicted, and constraints controlling for complexity within a language are derived from this universal hierarchy. This computational system allows for segmental representations to be simplified, without reference to an abstract, primary place.

Keywords: labial-velars, clicks, complex segments, markedness, phonology

1 Introduction

Complex segments, as defined by Sagey (1986), involve multiple, unordered articulations: "labiovelar [kp] will behave phonologically as both a labial and velar with respect to processes both on the left and on the right" (Sagey 1986: 99). This paper focuses on labial-velars, clicks, and the simplification processes they participate in. A simplification process is any process where a complex segment in the input is realized as a simple segment in the output.

This paper answers the following two theoretical questions: how does a phonological grammar control for (allow or disallow) complex segments, and when complex segments are realized as a simple segment, how does the grammar decide to which place the complex segment is reduced?

When a complex segment cannot be realized faithfully – as a segment with two place features – the segment will become a simple segment. The choice of place of this simple segment can be either one of the two places of the underlying complex segment. The ranking for a specific language determines the exact place. Labial-velars simplify to either [k] or [p], depending on the language. Coronal-dorsal clicks reduce to simple dorsals in Fwe and Yeyi, preserving accompaniment features of the click onto the simple segment. The theoretical assumptions make no reference to abstract primary place in the segmental representation, nor to the notion of "complexity" or "labial-velarity" in the constraint definitions. All patterns follow from a general system of markedness reduction, based on de Lacy (2006).

2 Survey of simplification processes

This section presents the results of an (ongoing) empirical survey on any and all processes or patterns that fit the rubric of simplification: instances where an underlying complex stop is realized phonetically as a simple stop. The cases discussed here are listed below.

(1) *Summary of simplification processes*

Language	Underlying place		Surface place	Type of alternation
Amele	labial, dorsal	→	labial	Morphological
Dagbani	labial, dorsal	→	labial	Phonotactic
Tampulma	labial, dorsal	→	dorsal	Phonotactic
Fwe	dorsal, coronal	→	dorsal	Free variation
Yeyi	dorsal, coronal	→	dorsal	Free variation

In Amele (Papuan, Papua New Guinea), the person-number morpheme contains the segment /gb/. Depending on how this is parsed prosodically, it is either realized faithfully (in onsets) or as [p] (in final position). In Dagbani and Tampulma, labial-velar stops are permitted in onsets but not in codas. This is a phonotactic distribution. However, in Dagbani, [b] is the only stop permitted in coda position, and [k] is the only stop permitted in Tampulma codas. This is evidence that labial-velars reduce to labial in Dagbani and to dorsal in Tampulma. In Fwe and Yeyi, there is inter- and intra-speaker variation in the realization of click consonants. The click is in alternation with a simple dorsal segment in these languages.

The survey looks both at existing phonological analyses of these processes and at individual grammars of languages that are known to contain complex segments.

2.1 Labial-velar reduction in codas/final position

2.1.1 Amele[3]

In Amele (Papuan, Papua New Guinea), the complex stop [gb][4] is realized as [p] in coda position. This is part of a more general devoicing pattern observed in Roberts (1987: 346). This alternation is also discussed in Cahill (1999: 163) and van de Weijer (2011).

(2) In final position:

/d/	→	[t]
/b/, /**gb**/	→	[p]
/g/	→	[k]

There is strong morphological evidence showing that labial-velars indeed reduce to simple labial place. The alternation is seen in the data below, from Roberts (p.c.). The ordering of syntactic morphemes differs between the two sets of data; when the person-number morpheme /ogb/ is realized finally, the stop is realized as [p], but as [gb] when the morpheme is word-internal and the labial-velar occupies an onset position.

(3) [gb] realized faithfully in onsets (person-number morpheme is word internal):

a.	/h+o**gb**+ona/	[ho'.**gb**ɔ.nə]	'we are coming' (present)
b.	/f+o**gb**+ona/	[fo'.**gb**ɔ.nə]	'we are seeing' (present)
c.	/h+o**gb**+a/	['ho.**gb**ə]	'we came' (today)
d.	/f+o**gb**+a/	['fo.**gb**ə]	'we saw' (today)
e.	/h+o**gb**+an/	[ho'.**gb**æn]	'we came' (yesterday)
f.	/f+o**gb**+an/	[fo'.**gb**æn]	'we saw' (yesterday)

g.	/h+o**gb**+an/	[ho'.**gb**æn]	'we will come' (future)
h.	/f+e**gb**+an/	[fe'.**gb**æn]	'we will see' (future)
i.	/h+o**gb**+a/	['ho.**gb**ə]	'we are about to come' (prospective future)
j.	/f+e**gb**+a/	['fe.**gb**ə]	'we are about to see' (prospective future)

(4) [gb] neutralizes to [p] when in final position (person-number morpheme is word-final):

a.	/h+ol+o**gb**/	[hɔ'.lɔ**p**]	we used to come' (past habitual)
b.	/f+ol+o**gb**/	[fɔ'.lɔ**p**]	we used to see' (past habitual)
c.	/h+um+e**gb**/	['hu.mɛ**p**]	we come and (we) ...' (SS.sequential)
d.	/f+im+e**gb**/	['fi.mɛ**p**]	we see and (we) ...' (SS.sequential)
e.	/h+uf+e**gb**/	['hu.fɛ**p**]	if we come and (we) ...' (SS. conditional)
f.	/f+if+e**gb**/	['fi.fɛ**p**]	if we see and (we) ...' (SS. conditional)
g.	/h+o**gb**/	['hɔ**p**]	as we come and (we) ...' (SS.simultaneous.punctual)
h.	/f+o**gb**/	['fɔ**p**]	as we see and (we) ...' (SS.simultaneous.punctual)

(underlying forms, surface forms, and translations are all from Roberts p.c.)

The alternation in Amele clearly shows that the [p] found in the forms in (4) must be a surface realization of /gb/, based on the morphosyntax – it is a paradigmatic alternation rather than simply a distributional pattern. Further, the fact that forms (4c-f) do not contain a rounded vowel before [p] show that the choice of [p] as the target of reduction is not due to assimilation to an adjacent round vowel.

Roberts (1987) analyzes this as a word-final alternation; however, clusters, and therefore word-medial codas, are extremely rare (found only in certain proper nouns, and a verb plus certain clitics, Roberts 1987: 347). The scope of the prosodic domain this alternation is sensitive to is not crucial for the analysis here, but it is included with other coda reduction processes for simplicity's sake.

Because the phonological realization of /kp/ is clear from the morphosyntax, Amele is solid evidence that /kp/ can be realized as [p] in certain languages.

2.1.2 Distributional patterns

While Amele is the only language found to contain a morphological alternation showing labial-velar reduction, the majority of languages involve distributional (phonotactic) labial-velar reduction. In fact, according to Cahill (2000: 72), no language allows contrastive labial-velars in word-final position, and labial-velars in coda position are extremely rare as well.

In a competition-based framework like Optimality Theory, Richness of the Base assumes there are no language-specific inputs. For example, the phonological grammar of English must ensure that the input /kp/ is realized as something *other* than [kp] in all contexts, as this sound is not part of English's phonetic inventory. However, the mechanics of OT do not prevent /kp/ from occurring in inputs. For languages like Efik, where labial-velars are only found in onsets (Welmers 1973), /kp/ is faithful in these positions, but /kp/ must be realized as something else in all other positions. The key is knowing *what* the input /kp/ is realized as in these situations. While this choice is not clear for Efik itself (see section 2.3.2), Tampulma and Dagbani are cases with better distributional clues as to the target of reduction for labial-velars in coda position.

2.1.2.1 *Tampulma*

The surface inventory of Tampulma (Gur, Ghana) includes voiced and voiceless labial, coronal, and dorsal stops, in addition to voiced and voiceless labial-velars. The only stop allowed in codas, however, is [k].

(5) Tampulma stop inventory (Bergman et al. 1969: 29-31)

Onsets					**Codas**
p	t	k	kp	→	k
b	d	g	gb		

There is some process that prevents certain stops form occurring in coda positions, while onsets are preserved. This could either be due to positional faithfulness (Beckman 1998) or a theory of labial-velar licensing constraints as in Cahill (2000). Either way, in Tampulma, the feature [dorsal] is preserved in codas along the stop dimension.[5] Because the input /k/ is faithful, it must also be the case that /kp/ → [k]. This is shown to follow from the analysis in Section 3. The mapping of /kp/ → [k] is more faithful than /kp/ → ∅, and since we know that [k] is allowed phonetically in codas (and therefore /k/ → [k]), we can conclude that /kp/ must also be realized as [k] in this context.

2.1.2.2 *Dagbani*

Dagbani (Gur, Ghana) shows a similar but crucially different distribution of segments between onset and coda position. In Dagbani, both [kp] and [gb] are allowed in onsets, but the only stop allowed in codas is [b]:[6]

(6) Dagbani stop inventory (Olawsky 1999: 166)

Onsets					**Codas**
p	t	k	kp	→	
b	d	g	gb		b

While all voiceless stops are (presumably) deleted, [labial] is preserved for voiced stops. The same logic applies here as it does for Tampulma: if /b/ → [b], then we must assume that /gb/ → [b] as well.

2.2 Click reduction in Fwe and Yeyi

In Fwe (Bantu K.402, Namibia and Zambia), there is both intra- and inter-speaker variation with respect to clicks (Gunnink forthcoming). Clicks alternate with velar consonants, with the nasality and voicing of the consonant preserved. That is, a voiceless click alternates with [k], a voiced click with [g], and a nasal click with [ŋ].

(7) Fwe click simplification (Gunnink forthcoming: (14, 16, 18)):

[ǀ]	→ [k]	[kùǀàpùrà] ~ [kù**k**àpùrà]	'to tear'
[g͡ǀ]	→ [g]	[mùg͡ǀênè] ~ [mù**g**ênè]	'thin (person)'
[ŋ͡ǀ]	→ [ŋ]	[ŋ͡ǀɔ́rɛ̀zà] ~ [**ŋ**ɔ́rɛ̀zà]	'resin'

This is a robust alternation, with "the majority of click words…realized both with and without clicks, be it by the same speaker or by different speakers" (Gunnink forthcoming: 7) and "all speakers substitute clicks with non-clicks in certain words" (Gunnink forthcoming: 8). Significantly, while all clicks have non-click variants, not all velars have click variants: "The vast majority of words with these phonemes [/k/, /ŋ/, and /$^{\text{ŋ}}$k/] do not have a click alternative" (Gunnink forthcoming: 9). This suggests that certain words contain underlying clicks which have a choice of realization (as a click or as a simple velar), while words with an underlying velar stop do not have the choice to be realized as a click.

The fact that voicing and nasality are preserved shows that this is a reduction process from a click to a non-click. Assuming that the click has two place features, one for anterior place and one for posterior place, in addition to values for [voice] and [nasal], the anterior place feature of the click is not realized when the speaker produces the word with no click. Thus, this is another instance of a simplification process. This is shown in the representations below.

(8) Representation of Fwe click simplification

/ŋǀ/ → [ŋ]

[dorsal] [+voice] [coronal] [+nasal] … [dorsal] [+voice] [+nasal] …

In Yeyi (Bantu R.40, Namibia and Botswana), Seidel (2008) observes the same alternation. The click inventory of Yeyi is larger than that of Fwe, with voiced, voiceless, voiceless aspirated, voiceless prenasal, voiceless prenasal aspirated, and voiced prenasal varieties of dental and alveolar clicks possible (and a rare lateral click) (Seidel 2008: 41). Seidel states "…several [click] items seem to be characterized by a free variation with non-click counterparts, namely /g/ and /k/, or any aspirated or prenasalized combination thereof." (Seidel 2008: 41)

The processes in Fwe and Yeyi are not only further examples of complex segments reducing to simple segments, but they are also phonological evidence that clicks are indeed [dorsal], contra some recent arguments. While Sagey (1986) treats clicks as phonologically dorsal, Halle (1995) treats clicks as having one phonological place and the feature [+suction]. Under this analysis, not all clicks have a [dorsal] feature. Further, Bennett (2014) summarizes arguments that the Back Vowel Constraint from Traill (1985), used as the primary source of evidence for [dorsal] in Sagey (1986), is not actually evidence for [dorsal] place. This is following studies and analyses by Hudu et al. (2009); Miller et al. (2009); Miller-Ockhuizen (2003) showing that the Back Vowel Constraint actually refers to tongue root interaction, not [dorsal] place.

2.3 Borderline cases

The cases in this section are included because they have been described or analyzed as "simplification" in the literature, but do not fit in exactly with the processes here for various reasons. In the case of Margi, the segments in question, alleged labial-coronals, are argued to be clusters in Maddieson (1983, 1987). The examples of Efik and Ibibio involve a described kp~p alternation, but a further look at the evidence reveals that the target of reduction is ambiguous. Hyman (1979) describes a kp~p alternation in Aghem, but it is not clear which is the underlying segment. These cases are not problematic even if included, as the analysis accounts for their patterns, yet by themselves they do not provide strong evidence either way.

2.3.1 Margi

According to Hoffman (1963), Margi contains labial-alveolar stops that are "comparable with the labio-velars of so many languages in the West Sudan" (Hoffman 1963: 28). Additionally, the inventory of Margi contains labial-alveopalatal and labial-palatal affricates. Hoffman (1963) describes a process where speakers "reduce initial compound consonants to simple consonants, especially in a more colloquial type of speech" (Hoffman 1963: 43). This process also reduces the labial-alveopalatal and labial-palatal affricates to simple coronals. Examples for labial-alveolar stops are shown below.

(9) Simplification of labial-coronals:

a.	/bdəli/	→ [dəli]	'Dille'
b.	/ptəl/	→ [təl]	'chief'

This type of simplification is predicted by the assumptions here. However, although both Hoffman (1963) and Sagey (1986) assume these to be phonologically complex, Maddieson (1983, 1987) argues that these labial-coronals are in fact clusters of two stops, instead of a single stop with multiple places. If this is the case, then Margi is an example of cluster simplification, and not segment simplification, and provides evidence neither for nor against the arguments here.

2.3.2 Efik and Ibibio

Efik and Ibibio (Cross River, Nigeria) both restrict labial-velars from occurring in coda position. Welmers (1973: 48) describes Efik [kp] to be in complementary distribution with [p] between onsets and codas. In Ibibio, Kaufman (1968) describes the following distribution:

> [p] after a pause or juncture is a coarticulated bilabial velar stop, voiceless, unaspirated [kp] … before a pause it is a bilabial stop, unaspirated, or in careful speech weakly aspirated, voiceless, and in this position like t, k often unreleased [p]. (Kaufman 1968: 44)

Here, "juncture" refers to a syllable boundary (Kaufman 1968: 22), so the distribution can be reframed in terms of onset and coda. The same pattern is described in Urua (2000). However, both [p] and [k] are allowed in coda position in Ibibio, causing ambiguity as to what the input /kp/ maps to in this position.

(10) Ibibio stop inventory (Akinlabi and Urua 2002: 144-145)

Onsets					**Codas**		
p	t	k	kp	→	p	t	k
b	d						

Purely distributional evidence is not enough to disambiguate the target of reduction for Ibibio (and also Efik) labial-velars.[7]

2.3.3 Aghem

As described by Hyman (1979), Aghem (Grassfields Bantu, Cameroon) also contains an alternation between simple labials and labial-velars. The characterization of the alternation is different from Amele and Efik/Ibibio: in Aghem, when [b]-initial roots occur with the plural prefix [o-], the labial is realized as a labial-velar. This is part of a more general process that adds rounding to other initial consonants in the same context:

(11) Aghem

a. [kɨ́-nâŋ]	'cocoyam'	pl. [ó-nwâŋ]	
b. [kɨ̀-tɛ̌ɛ]	'cricket'	pl. [ò-twɛ̌ɛ]	
c. [kɨ́-**b**áʔ]	'rope'	pl. [ó-**gb**áʔ]	
d. [kɨ́-**b**ɛ́]	'fufu'	pl. [ó-**gb**ɛ́]	(Hyman 1979: 2)

While a complete formalization will not be given here, this is a clear KP~P alternation, as the root remains constant. The initial root consonant agrees with the vowel in certain features, [labial] when the root consonant is [coronal] or [dorsal], and [dorsal] when the root consonant is already [labial]. However, it is also not obvious whether this is a simplification process, where a complex stop in the input is realized as a simple stop, or a *complexification* process, where a simple stop in the input is realized as a complex stop on the surface.

3 Analysis

The phonology of complex segments must account for both reduction processes (of which simplification is a subtype) and gapped inventories, such as coda inventories allowing only dorsals or only labials. The mechanisms for treating complex segments here *also* account for reduction and gapping patterns for simple segments, as explored in de Lacy (2006). The goal here is to then *preserve* predictions for simple segments while also accounting for the attested patterns of complex segments. This is done by building a general theory of scaled universal markedness for building constraints. The term *general* in this sense means that the definitions refer only to features, not segment type (e.g. simple or complex). However, the constraints are defined in such a way that the differences in simple versus complex segments emerge from the definitions. The analysis here is an extension of Danis (2014), which focuses solely on labial-velars with a single place faithfulness constraint.

This paper focuses on the place alternations between simple and complex segments, so voicing is ignored. Also, the assumptions here are indifferent as to whether clicks contain an additional feature, such as [+suction] (Halle 1995) or [+lingual] (Miller 2007; Miller et al. 2009), to further differentiate them between egressive pulmonic segments.

The crucial featural specifications of the segments investigated are shown below.

(12) *Crucial segmental feature specifications*

IPA	Place
[t]	[coronal]
[p]	[labial]
[k]	[dorsal]
[kp]	[labial], [dorsal]
[tp]	[coronal], [labial]
[!]	[coronal], [dorsal]

The symbol for the alveolar click [!] is meant as a stand-in to represent any click that has a coronal articulation (so, any click except the bilabial click). The labial-velar segment is assumed to be both phonologically [labial] and [dorsal], as it is in Cahill (1999); Clements and Hume (1995); Sagey (1986), and many others. However, Cahill (2006) argues that it is sufficient to treat labial-velars as phonologically only [labial], as very few if any processes reference the [dorsal] feature. However, these segments are assumed to be [dorsal] here. One additional piece of evidence for the [dorsal]-ity of labial-velars comes from Vietnamese, where /k/ is realized as [kp] in coda position after back, round vowels (Hajek 2009; Kang et al. 2014). This suggests that, at least in Vietnamese, labial-velars are phonologically dorsal.[8]

A flat geometry is assumed for all place features. Whether there is a nearly flat structure, such as in Padgett (1995b, 2002), or a more articulated structure as in Clements and Hume (1995), there is no need here to assume that one place feature in a segment's representation has a different status than the other for clicks and labial-velars. This point is discussed further in Section 4.

3.1 Markedness

The markedness constraints in this system are built from the following set of place features. The universal place markedness hierarchy below is assumed:

(13) [dorsal] > [labial] > [coronal]
where > indicates *more marked than*

Prince and Smolensky (1993/2004) treat [coronal] as less marked than both [dorsal] and [labial], as does Lombardi (2001), who adds [glottal]/[pharyngeal] as the least marked place. The hierarchy is further refined in de Lacy (2006), where [dorsal] is argued to be more marked than [labial]. For the purposes here, [glottal] is ignored for simplicity, but its inclusion does not change the conclusions (as long as it is represented featurally, as it is in de Lacy 2006; Lombardi 2001).

It must be stressed that the significance of this hierarchy is not to say that [dorsal] is *always* more marked than [labial], but that [labial] is *never* more marked than [dorsal] (and likewise for [coronal]: it is never more marked than [labial]). The purpose of the hierarchy is to control for the targets of reduction. When a segment such as /k/ cannot be realized faithfully, and it is not deleted, it must be realized as something else. This hierarchy (or rather, the constraints based on this hierarchy) control the possible targets of /k/. It predicts that /k/ never reduces to [p], but can reduce to [t] (or whatever the lowest point on the scale happens to be). In the case of complex segments, the constraint set based on this scale determine whether /kp/ is realized faithfully, as [p], or as [k] (or in extreme situations, as [t]).

The constraints themselves are defined stringently based on this hierarchy; every constraint assigns a violation to [dorsal] segments, a subset to [labial] segments, and a subset of that to [coronal] segments. In the definitions below, assume S to be the set of features for some segment.

(14) **m.KPT** ***"Don't be dorsal, labial, or coronal"***
Assign one violation:
for every segment S where [dor] $\in$ S *and*
for every segment S where [lab] $\in$ S *and*
for every segment S where [cor] $\in$ S

(15) **m.KP** ***"Don't be dorsal or labial"***
Assign one violation:
for every segment S where [dor] $\in$ S *and*
for every segment S where [lab] $\in$ S

(16) **m.K** ***"Don't be dorsal"***
Assign one violation:
for every segment S where [dor] $\in$ S

Crucially, there are no constraints m.P and m.T individually. This is necessary to preserve the types of reduction processes observed among only simple stops. This is discussed in detail in de Lacy (2006). Among simple segments, the target of reduction is *always* to the least-marked feature on the scale. Complex segments, however, can reduce to *either faithful place* of the original segment. The original mechanisms – the set of universal constraints – are refined here to predict *both* kinds of behavior. Instead of adding new mechanisms to only account for complex stops, the desired patterns are predicted with targeted refinements of independently-needed mechanisms – a desirable result.

A tableau of the violation marks assigned by these constraints is given below.

(17) *Place Markedness Violation Profiles*

	m.KPT	**m.KP**	**m.K**
t	1	0	0
p	1	1	0
k	1	1	1
kp	**2**	2	1
tp	**2**	1	0
!	**2**	1	1

In essence, the increased markedness of complex stops is due simply to their having more place features than simple stops. Further, because all places are represented featurally, the constraint assigning a violation to all places, m.KPT, acts as a *de facto* constraint violating against complexity. All violations are either 2 or 1, which is essentially 1 versus 0.

An assumed constraint like *ComplexSegment (e.g. in Padgett 1995b: 10) would presumably assign a violation to any segment with more than one place. Its violation profile is shown below, compared with m.KPT above.

(18) *m.KPT versus hypothetical *ComplexSegment*

	m.KPT	***ComplexSegment**
T	1	0
P	1	0
K	1	0
KP	2	1
TP	2	1
!	2	1

Among these candidates, the two constraints are effectively identical; each only differentiates between complex stops and simple stops. However, m.KPT is independently motivated by the constraint building mechanism from the universal markedness scale. The *ComplexSegment constraint would have to be assumed separately.

3.2 Faithfulness

In each of the processes surveyed in Section 2, a complex segment is realized unfaithfully as a simple segment whose place features is also present in underlying segment. Therefore, place faithfulness must be defined such that a complex segment with places A and B reducing to place A or B must be more faithful than that same complex segment reducing to place C.

Place is subject to a single faithfulness constraint. The constraint treats the place features of a segment as a set, and returns a gradient number of distinctions based on the type of mapping. In terms of Padgett (2002)'s Feature Class Theory, the types of unfaithful complex segment mappings observed in certain languages constitutes instances of *partial class behavior* along the input-output dimension. The constraint, named f.KPT, is defined below, and it assigns between 0 and 3 violations in this system.

(19) **f.KPT** **"Don't add or remove place features"**

If S_{in} and S_{out} are input/output segments in correspondence,

Assign a violation if S_{in} is [αdor] and S_{out} is [¬αdor], and

Assign a violation if S_{in} is [αlab] and S_{out} is [¬αlab], and

Assign a violation if S_{in} is [αcor] and S_{out} is [¬αcor]

(20) *Violation Profile for f.KPT*

I	O	f.KPT	Comment
kp →	t	3	[dor] and [lab] not in output, [cor] not in input
kp →	p	1	[dor] not in output
kp →	k	1	[lab] not in output
kp →	kp	0	No change in place

This constraint is equivalent to the sum of three separate Ident-style constraints, one for each of the features [dorsal], [labial], and [coronal].

There is assumed to be a set of faithfulness constraints whose definitions mirror the stringent set of markedness constraints, just as in de Lacy (2006). Their definitions are given below.

(21) **f.KP** **"Don't add or remove [dorsal] or [labial] place features"**

If S_{in} and S_{out} are input/output segments in correspondence,

Assign a violation if S_{in} is [αdor] and S_{out} is [¬αdor], and

Assign a violation if S_{in} is [αlab] and S_{out} is [¬αlab]

(22) **f.K** **"Don't add or remove [dorsal] place features"**

If S_{in} and S_{out} are input/output segments in correspondence,

Assign a violation if S_{in} is [αdor] and S_{out} is [¬αdor]

Crucially, there are *no* constraints f.P and f.T which only control for [labial] or [coronal] faithfulness individually. That is, a constraint assigns a violation to unfaithful [labial] place *only if* it also assigns a violation to unfaithful [dorsal] place. Likewise, [coronal] violations entail [labial] violations.

Place features are treated here as binary in the faithfulness constraint definitions, but this is for ease of exposition and is not crucial. The definition of f.KPT can be understood in a number of ways. Pater (1999) defines IdentIO and IdentOI constraints for the privative feature [nasal]; the constraint f.KPT is a combination of IdentIO and IdentOI constraints for the features [labial], [coronal], and [dorsal]. The single place faithfulness constraint also treats all place features as a thematic class of features, following the Feature Class Theory of Padgett (2002). Note that the /kp/ → [p] mapping is still partially faithful, more so than /kp/ → [t]. This is necessary to explain the range of simplification processes observed empirically. In terms of Padgett (2002), simplification processes are an example of partial class behavior along the input-output dimension.

Additionally, positional faithfulness is assumed (Beckman 1998; Lombardi 1999), as complex segments are found largely in onset position. Beckman (1998) herself uses positional faithfulness to control for click distribution with respect to roots and affixes, with the additional use of an airstream mechanism feature (Beckman 1998: 195). Bennett (2008) expands on this in arguing only the positional versions of the faithfulness constraints exist for clicks, capturing the generalizations that clicks are *never* found outside of onset positions. Cahill (2000) defines a set of labial-velar licensing constraints, which are similar to a positional markedness approach.

3.3 Reduction to dorsal place

Labial-velars in Tampulma and clicks in Fwe and Yeyi both reduce to dorsal place. The undominated f.K constraint prefers the candidates where a complex segment reduces to dorsal. In all such languages, f.K must dominate m.K, which is assigns violations to the output [k]. When clicks reduce in Fwe, the de facto complex segment constraint, m.KPT, crucially dominates f.KPT, the general place constraint. This is shown below.

(23) Fwe simplification ranking

/!/	**m.KPT**	**f.K**	**f.KPT**	**f.KP**	**m.K**	**m.KP**
!	2!	0	0	0	1	1
→K	1	0	1	0	1	1
T	1	1!	1	1	0	0

When clicks are faithful, place faithfulness now dominates markedness. In the tableau below, f.KPT crucially dominates m.KPT.

(24) Fwe click ranking

/!/	**f.KPT**	**f.KP**	**f.K**	**m.KPT**	**m.KP**	**m.K**
→!	0	0	0	2	1	1
K	1!	0	0	1	1	1
T	1	1	1!	1	0	0

Because the alternation in Fwe and Yeyi does not involve an alternation between onset and coda, the positional faithfulness constraints are omitted from the tableau for simplicity's sake. The ranking above is meant to explain the mappings possible in a simplification process. It also makes predictions about the inventory of Fwe that are not attested, namely that labial-velars should also be realized faithfully. This problem is left to future work, and this may suggest that clicks should have some principled difference from pulmonic complex stops, like a [+lingual] feature as Miller (2007); Miller et al. (2009) suggest.

Although a full theory of optionality will not be given in this paper, the above two tableaux are compatible with either a multiple-grammars analysis or a partially-ordered grammar analysis of variability within OT, as summarized in Anttila (2007). In either case, the input /!/ remains constant, and depending on the ranking, it is realized either faithfully (as in 24) or as a dorsal segment (as in 23).

Tampulma, like Fwe and Yeyi, involves a complex segment simplifying to dorsal place. However, in this language, it is a static, phonotactic alternation. In Tampulma onsets, voiced and voiceless simple stops and labial-velars are permitted. However, in codas, only the dorsal stop [k] is permitted. The fact that simple dorsals are allowed entails that /kp/ must reduce to [k] under the assumptions here. This is shown in the violation tableau below. The vowel [a] is arbitrary and is just meant to show the differences in onsets and codas.

(25) Tampulma onsets and codas

	/KPA/	f.K	f-ons.K	f-ons.KP	m.KPT	m.KP	m.K	f.KPT	f.KP	f-ons.KPT
a.	→KPA	0	0	0	2	2	1	0	0	0
b.	KA	0	0	1!	1	1	1	1	1	1
c.	PA	1	1	1!	1	1	0	1	1	1
d.	TA	1	1	2!	1	0	0	3	2	3
	/AKP/									
e.	AKP	0	0	0	2	2	1!	0	0	0
f.	→AK	0	0	0	1	1	1	1	1	0
g.	AP	1!	0	0	1	1	0	1	1	0
h.	AT	1!	0	0	1	0	0	3	2	0

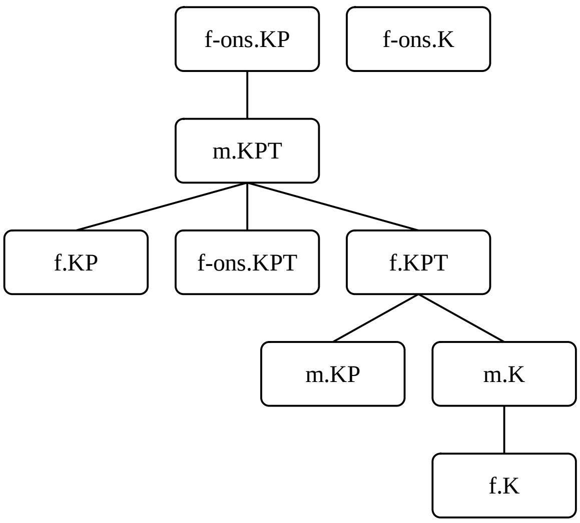
Just as with Fwe and Yeyi, dorsal faithfulness f.K crucially dominates dorsal markedness m.K. Observe that in (25f-g), f.K and m.K directly conflict. The only difference between the candidates /akp/ → [k] and /akp/ → [p] is between these two constraints.

3.4 Reduction to labial place

While reduction to [dorsal] place requires f.K to dominate m.K, reduction to [labial] place requires the opposite: m.K ≫ f.K.

Dorsal markedness m.K dominating f.KP effectively cancels out the effect of dorsal faithfulness on f.KP, making it behave as simply a labial faithfulness place. This allows /KP/ to reduce to simply [P], as it does in Amele and Dagbani.

(26) Minimal ranking for Amele- and Dagbani-like languages (/KP/ → [P] in coda position)



Undominated f-ons.KP ensures that labial-velars (and thus simple labials and dorsals) are faithful in onsets. This constraint dominates m.KPT, as this is the constraint that bans complex segments. The constraint m.KPT dominating all general faithfulness f.KPT, f.KP, and f.K ensures that there are no complex segments in other prosodic positions (in this case, either word-finally or in coda position).

(27) Amele and Dagbani onsets and codas

/KPA/	f-ons.K	f-ons.KP	m.KPT	f.KPT	f.KP	f-ons.KPT	m.KP	m.K	f.K
KA	0	1!	1	1	1	1	1	1	0
PA	1!	1	1	1	1	1	1	0	1
TA	1!	2	1	3	2	3	0	0	1
→KPA	0	0	2	0	0	0	2	1	0
/AKP/									
AK	0	0	1	1	1	0	1	1!	0
→AP	0	0	1	1	1	0	1	0	1
AT	0	0	1	3!	2	0	0	0	1
AKP	0	0	2!	0	0	0	2	1	0

The sole choice of [ak] or [ap] for the input /akp/ is made by the ranking of m.K over f.K, opposite of what it is in Tampulma. A full analysis of Amele would also involve positional faithfulness for voicing between onsets and final position.

4 Previous accounts

Most previous accounts leave the target of simplification to the representation. The pointer in Sagey (1986), C- and V-place distinctions in Clements and Hume (1995) as extended to labial-velars in Cahill (1999), or dependency relations as in van de Weijer (1996, 2011) all have as one of their purposes the task of selecting the single place that a complex segment reduces to, given the right environment. See Cahill (1999: (23)) for some example representations showing abstract primary place for labial-velars.

However, as demonstrated here, this choice does not need to be made in the representation; the ranking accounts for this choice. An articulated feature-geometric structure is still compatible with the assumptions here, just not necessary for the processes investigated.

This itself is not a new idea. Padgett (1995a, 1995b, 2002) argues that constraints refer directly to sets of features, or Feature Classes, obviating the need for structure in the representation. Further, for labial-velar reduction, Cahill (2000: 87) controls for this with MAX(labial) and MAX(dorsal) constraints. As Cahill (2000), this predicts both kinds of reduction: /KP/ → [K] and /KP/ → [P], depending on the ranking. The analysis here differs in that its constraints are built from a universal place markedness hierarchy originally designed to capture reduction in simple stops, while Cahill (2000) better accounts for the distribution of labial-velars in terms of both prosodic positions, but also within morphemes and in clusters with other consonants.

5 Conclusion

In a empirical survey of complex segment reduction processes, labial-velars have the choice to reduce to either simple labial [p] (Amele, Dagbani) or simple dorsal [k] (Tampulma). Clicks reduce to dorsal [k] (Fwe, Yeyi), which is also phonologically significant because not all analyses of clicks assume they have phonological [dorsal] place (Halle 1995, Bennett 2014).

The main thrust of the analysis here is that the attested patterns of complex segment simplification are accounted for via stringent sets of markedness and faithfulness constraints based on a universal place markedness hierarchy. The constraints are defined in such a way to differentiate between complex and simple stops (e.g. in an increased number of violations), but the definitions themselves make no reference to a special notion of complexity.

Furthermore, no segmental representational assumptions need to be made to differentiate the languages where /KP/ → [P] or /KP/ → [K]. The choice of target of simplification is determined by the ranking for a particular language. This demonstrates that arguments about representation cannot be made without also taking into account the computational system. In an autosegmental theory, with only delinking and spreading of nodes or features, it might indeed be necessary to differentiate primary and secondary place in segment representations. However, in OT, the choice can be made via the ranking and constraint definitions (the same point made in Padgett 1995b; Padgett 2002 for spreading and vowel harmony processes), leaving the theory with a simpler (in terms of structure) set of representations. Further work must be done on the modeling the relationships between clicks, labial-velars, and simple stops in terms of inventory structure. Simplification processes are just one of the types of processes that complex segments participate in, and future work must model these processes as well.

Notes

[1] Thanks to Akin Akinlabi, Paul de Lacy, Alan Prince, Bruce Tesar, Mike Cahill, Will Bennett, Bruce Connell and the audience at WOCAL 8 for all help and comments along the way. Any and all mistakes and omissions are my own.

[2] nick.danis@rutgers.edu

[3] Discussion in this section is based on Danis (2014).

[4] Throughout this paper, [gb] and [kp] indicate single segments, not clusters. The tie bar is omitted. Other abbreviations: f. and m. indicate faithfulness and markedness constraints, respectively. Capital KP indicates a labial-velar stop, regardless of voicing, following Cahill (2000).

[5] The full coda inventory of Tampulma is [k m n ŋ l r].

[6] The full coda inventory of Dagbani is [b ɣ m n ŋ l r].

[7] Thanks to Bruce Connell for comments on these languages during the presentation.

[8] This process is also significant because it is one of the few times where labial-velars appear in coda position.

References

Akinlabi, Akinbiyi, & Eno E. Urua. 2002. Foot structure in the Ibibio verb. *Journal of African Languages and Linguistics, 23*, 119-160.

Anttila, Arto. 2007. Variation and optimality. In Paul de Lacy (Ed.), *The Cambridge Handbook of Phonology*. Cambridge: Cambridge University Press.

Beckman, Jill. 1998. *Positional Faithfulness.* University of Massachusetts Amherst.

Bennett, Wm. G. 2008. *False Nasality and the Typology of Click Distribution*. Ms., Rutgers University.

Bennett, Wm. G. 2014. Some differences between clicks and labio-velars. *South African Journal of African Languages, 34*(2), 115-126.

Bergman, Richard, Ian Gray, & Claire Gray. 1969. *Collected Field Reports on The Phonology of Tampulma*. University of Ghana: Institute of African Studies.

Cahill, Michael. 1999. Aspects of the phonology of labial-velar stops. *Studies in African Linguistics, 28*(2), 155-184.

Cahill, Michael. 2000. Positional Contrast and Labial-Velars. *OSU Working Papers in Linguistics*.

Cahill, Michael. 2006. *The Place of Labial-Velars*. Paper presented at Annual Conference on African Linguistics, Eugene, OR. April 7-9. 2006.

Clements, G. N., & Elizabeth V. Hume. 1995. The Internal Organization of Speech Sounds. In John Goldsmith, Jason Riggle & Alan C. L. Yu (Eds.), *The Handbook of Phonological Theory*: Blackwell Publishing.
Danis, Nick. 2014. *Deriving Interactions of Complex Stops*. Rutgers University. ROA-1220.
de Lacy, Paul. 2006. *Markedness: Reduction and Preservation in Phonology*. Cambridge, UK: Cambridge University Press.
Gunnink, Hilde. forthcoming. Click loss and click insertion in Fwe. In Bonny Sands (Ed.), *The Handbook of Clicks*. Leiden: Brill.
Hajek, John. 2009. On labial-velar stops and nasals in Vietnamese. *Mon-Khmer Studies, 38*, 217-221.
Halle, Morris. 1995. Feature Geometry and Feature Spreading. *Linguistic Inquiry, 26*(1), 1-46.
Hoffman, Carl. 1963. *A Grammar of the Margi Language*. London: Oxford University Press.
Hudu, Fusheini, Amanda Miller, & Douglas Pulleyblank. 2009. Ultrasound imaging and theories of tongue root phenomena in African languages. In Peter K. Austin, Oliver Bond, Monik Charette, David Nathan & Peter Sells (Eds.), *Proceedings of Conference on Language Documentation & Linguistic Theory 2*. London: SOAS.
Hyman, L.M. 1979. Part 1: Phonology and Sound Structure. In L.M. Hyman (Ed.), *Aghem Grammatical Stricture*. Los Angeles: University of Southern California.
Kang, Yoonjung, Andrea Hoa Pham, & Benjamin Storme. 2014. *French loanwords in Vietnamese: the role of language phonotactics and contrast in loanword adapation*. Paper presented at Annual Meeting on Phonology, MIT. September 20, 2014.
Kaufman, Elaine Marlowe. 1968. *Ibibio Grammar.* (Ph.D.), University of California, Berkeley.
Lombardi, Linda. 1999. Positional Faithfulness and Voicing Assimilation in Optimality Theory. *Natural Language and Linguistic Theory, 17*, 267-302.
Lombardi, Linda. 2001. Why Place and Voice are different: Constraint-specific alternations in Optimality Theory. *Segmental phonology in Optimality Theory: Constraints and Representations*.
Maddieson, Ian. 1983. The Analysis of Complex Phonetic Elements in Bura and the Syllable. *Studies in African Linguistics, 14*(3), 285-310.
Maddieson, Ian. 1987. The Margi Vowel System and Labiocoronals. *Studies in African Linguistics, 18*(3), 327-355.
Miller, Amanda. 2007. *The Phonology of Click Consonants*. Ms., Cornell University.
Miller, Amanda, Johanna Brugman, Bonny Sands, Levi Namaseb, Mats Exter, & Chris Collins. 2009. Differences in airstream and posterior place of articulation among N|uu clicks. *Journal of the International Phonetic Association, 39*(2), 129-161.
Miller-Ockhuizen, Amanda L. 2003. *The Phonetics and Phonology of Gutterals: A Case Study from Ju|'hoansi*. New York & London: Routledge.
Olawsky, Knut J. 1999. *Aspects of Dagbani Grammar*: Lincom Europa.
Padgett, Jaye. 1995a. Feature Classes. In Jill Beckman, S. Urbanczyk & L. Walsh (Eds.), *Papers in Optimality Theory*. Amherst, MA: University of Massachusetts.
Padgett, Jaye. 1995b. Partial Class Behavior and Nasal Place Assimilation. *Proceedings of the Arizona Phonology Conference: Workshop on Features in Optimality Theory*. Tucson, AZ: University of Arizona Department of Linguistics.
Padgett, Jaye. 2002. Feature Classes in Phonology. *Language, 78*(1), 81-110.
Pater, Joe. 1999. Austronesian Nasal Substitution and other NC effects *The Prosody Morphology Interface*: Cambridge University Press. Pre-print version. ROA-160. Accessed 17 July 2014.
Prince, Alan, & Paul Smolensky. 1993/2004. *Optimality Theory: Constraint Interaction in Generative Grammar*. Malden, MA, & Oxford: Blackwell Publishing.
Roberts, John R. 1987. *Amele*. Sydney: Croom Helm.
Sagey, Elizabeth. 1986. *The Representation of Features and Relations in Non-Linear Phonology.* (PhD), Massachusetts Institute of Technology.

Seidel, Frank. 2008. *A Grammar of Yeyi*. Köln: Rüdiger Köppe Verlag.
Traill, Anthony. 1985. *Phonetic and Phonological Studies of !Xoo Bushman*. Hamburg: Helmut Buske Verlag.
Urua, Eno-Abasi Essien. 2000. *Ibibio Phonetics & Phonology*. Port Harcourt, Nigeria: M & J Grand Orbit Communications Ltd. and Emhai Press.
van de Weijer, Jeroen. 1996. *Segmental Structures and Complex Segments*. Tübingen: Max Niemeyer Verlag.
van de Weijer, Jeroen. 2011. Secondary and Double Articulation. In Marc van Oostendorp, Colin J. Edwards, Elizabeth Hume & Keren Rice (Eds.), *The Blackwell Companion to Phonology*: John Wiley & Sons.
Welmers, Wm. E. 1973. *African Language Structures*: University of California Press.