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Local Conjunction and Kikuyu Consonant Mutation

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1 Introduction

This article provides an optimal-theoretic analysis of consonant mutation in Kikuyu. Like other members of the Bantu family, Kikuyu exhibits a productive process of root-initial consonant mutation caused by the affixation of a prefix made up of a placeless nasal, which we represent as /N-/. Two types of root-initial consonants participate in this process: a) voiceless plosives and b) voiced fricatives. Under the /N-/ prefixation, root-initial voiceless plosives undergo voicing (1a) while voiced fricatives are hardened into stops (1b).

(1) Some representative examples of consonant mutation in Kikuyu

- | | | | | |
|----|---------------|---|---------------------------|--------------|
| a. | /ko-N-tom-a/ | → | [koo- ⁿ dom-a] | ‘to send me’ |
| b. | /ko-N-reh-a/ | → | [koo- ⁿ deh-a] | ‘to pay me’ |
| c. | /ko-N-θεεc-a/ | → | [koo-θεεc-a] | ‘to stab me’ |

The challenge presented by these Kikuyu data, however, lies not just in the analysis of the mutational outputs in (1a) and (1b), but in the treatment of the non-mutational data exemplified by (1c). Unlike affixation to roots with voiceless stops or voiced fricatives, /N-/ is deleted if it is affixed to roots with initial voiceless fricatives. Thus, two distinct types of outputs emerge from the prefixation of /N-/ in Kikuyu: one with the retention of /N-/ and consonant mutation and the other with the elision of /N-/ and the lack of mutation. The challenge is to explain how these two distinct types of outputs fall out from a single set of ranked constraints.

We demonstrate here that an optimal-theoretic analysis of Kikuyu consonant mutation calls for a conjunctive constraint that conjoins two faithfulness constraints: ID (voi) that enforces input-output identity in [voice] and ID (cont) that demands correspondence in [continuant]. In order for a voiceless stop to become a voiced stop, it must violate ID (voi), while a fricative must incur a violation of ID (cont) if it is to emerge as a stop. But in order for a voiceless fricative to emerge as a voiced stop, this segment must violate ID (voi) and ID (cont), something that the conjunctive constraint—ID(voi)&ID(cont)—is designed to prevent. This conjunctive constraint allows us to account for the generalization that while input and output segments may

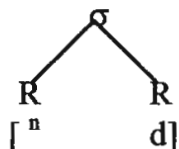
differ in either voice or continuancy, they may not differ in both feature specifications in Kikuyu. In what follows, we will analyse the mutational outputs before considering the non-mutational patterns.

2 Mutational Outputs

Kikuyu consonant mutation is triggered by the concatenation of the nasal prefix /N-/ to nominal, verbal and adjectival roots. Regardless of the types of roots that /N-/ is attached to, the surface patterns are completely identical. In what follows, we illustrate the patterns of consonant mutation using the prefixation of the objective marker meaning 'me' to verbal roots. The data reported here come from Armstrong (1967), unless otherwise noted. There are three types of roots whose surface patterns are mutational under the /N-/ prefixation: a) roots with initial voiceless plosives; b) roots with initial voiced fricatives; and c) vowel-initial roots. In order to limit the paper to the specified length, we will not analyse vowel-initial roots in c) here (see Peng (2002) for a complete analysis).

Before we analyse the mutational patterns, let's make one representational assumption clear. We follow Herbert (1977, 1986), Feinstein (1979), Clements (1987), Steriade (1993) and Trigo (1993) in adopting (2) as the representation of prenasalized segments.

(2)



In (2), we represent prenasalized segments as consisting of two root nodes contained within the same syllable. That is, we analyse prenasalized segments as a tauto-syllabic consonant cluster rather than as a single segment with two opposite specifications of [nasal] such as suggested in Sagey (1986). This representation has direct implications for the formal statement of postnasal voicing and hardening seen in mutational outputs. Under this representation, postnasal voicing cannot be analysed as the result of some segment-internal constraint on feature co-occurrence such as *[+nasal, -voiced]. Rather, it emerges from constraints on consonant sequencing such as *N_σ proposed here.

Consider postnasal voicing first, the effects of which are seen in roots with voiceless plosives [t, c, k]. In (3), the stems on the left-hand side consist of the infinitive prefix *ko-*, the object prefix *mo-* ‘him’, the root and the FV suffix if it is present. These data provide a comparison with those on the right, which differ only with respect to the /N-/ prefix marking the 1st person singular object.

- | | | | |
|-----|------------------|--------------------------|--------------|
| (3) | Inf.-him-Root-FV | Inf.-me-Root-FV | Gloss |
| a. | ko-mo-tom-a | koo- ⁿ dom-a | ‘to send’ |
| b. | ko-mo-cuuk-a | koo- ⁿ juuk-a | ‘to slander’ |
| c. | ko-mo-kuu-a | koo- ⁿ guu-a | ‘to carry’ |

In (3), the stems with the 3rd person singular prefix surface with voiceless stops in root-initial position. But when /N-/ is attached, these roots surface consistently with voiced prenasalized stops in root-initial position.

We propose that the interaction of two constraints in (4) is responsible for postnasal voicing.

- (4) Constraints responsible for postnasal voicing
- a. ID (voi): Corresponding input and output segments are identical in their voicing specification.
 - b. *NC̥

ID (voi) is a member of the IDENT family of constraints proposed in McCarthy and Prince (1995). These constraints are responsible for ensuring featural correspondence between input and output segments, penalising departures from a segment’s input featural specification. *NC̥, proposed in Pater (1995, forthcoming), is a context-sensitive markedness constraint prohibiting nasal-voiceless consonant sequences. As (5) shows, *NC̥ must dominate ID (voi); otherwise, there would be no pressure for an input segment to depart from its featural specification.

(5) Tableau for *koo-ⁿdom-a* ‘to send me’

	/ko-N-tom-a/	*NC̥	ID (voi)
	a. [koo. ⁿ to.ma]	*!	
☞	b. [koo. ⁿ do.ma]		*

As Pater (1995, forthcoming) argues, *NÇ is superior to alternative accounts such as Itô, Mester and Padgett's (1995) licensing account. *NÇ captures a directional asymmetry that is evident from the attested nasal-oral consonant clusters in the world's languages. Crosslinguistically, postnasal voicing is common, but prenasal voicing – that is, voicing of obstruents triggered by the immediately following nasals alone – is rare, if attested at all (Hayes and Stivers 1995). *NÇ captures this asymmetry. It penalises only nasal-voiceless consonant sequences, not voiceless-nasal consonant sequences. According to (4b), nasal-oral consonant clusters incur a *NÇ violation if an oral voiceless consonant follows a nasal, not if it precedes a nasal. Alternative accounts such as the licensing account do not discriminate between prenasal and postnasal voicing.

In addition to the directional asymmetry, *NÇ captures the functional unity of a number of seemingly unrelated strategies (Pater 1995, forthcoming). Nasal-voiceless consonant sequences are crosslinguistically marked. When these sequences are formed, they are often eliminated. But languages differ in how they deal with nasal-voiceless consonant clusters. Some languages opt for postnasal voicing. Other languages resort to nasal deletion (e.g. Indonesian, Malay), denasalization (e.g. Toba Batak, Mandar, and Kainingang), nasal substitution (e.g. Oshikwanyama), etc. In languages such as Kikuyu, two of these strategies are used to eliminate nasal-voiceless consonant clusters in one language: a) postnasal voicing and b) nasal deletion. An ideal analysis should be able to capture the functional unity of the different strategies used in different languages or within the same language while expressing the crosslinguistic and language-internal variations.

The advantage of *NÇ is that it accomplishes precisely this goal. *NÇ does not dictate postnasal voicing as the only strategy by which it can be satisfied. In addition to [koo.ⁿdo.ma] with postnasal voicing, there are other outputs such as [ko.NV.tom-a] with vowel epenthesis or [ko.tom-a] with nasal deletion, both of which comply with *NÇ. [ko.NV.tom-a] and [ko.tom-a] are not optimal, not because of *NÇ, but because of the high-ranking anti-epenthesis DEP-IO and anti-deletion Max-IO. In Kikuyu, DEP-IO is undominated, because vowel epenthesis is never exploited to break up illicit consonant clusters. As (6) shows, Max-IO must dominate ID (voi); otherwise, the /N-/ deletion candidate in (6c) would wrongly be predicted to be the optimal candidate. With the ranking of DEP-IO and Max-IO, we see why [ko.NV.tom-a] and [ko.tom-a] are less than optimal, as exemplified by the tableau in (6):

(6) Tableau for *koo-ⁿdom-a* 'to send me'

	/ko-N-tom-a/	DEP-IO	*NÇ	MAX-IO	ID (voi)
	a. [ko.NV.to.ma]	*!			
	b. [koo. ⁿ to.ma]		*!		
	c. [koo.to.ma]			*!	
☞	d. [koo. ⁿ do.ma]				*

As (6) shows, the candidate with vowel epenthesis in (6a) and the candidate with nasal deletion in (6c) are eliminated not by *NÇ, but by DEP-IO and MAX-IO, which are directly responsible for their demise. When we separate strategies from their function, it is easy to see how different languages may share *NÇ, yet differ in the ways in which they resolve *NÇ violations. Language-specific variations come about as a result of different rankings individual languages assign to constraints such as DEP-IO and Max-IO. Even though DEP-IO is ranked above MAX-IO in Kikuyu, it can be ranked below MAX-IO in another language, say, Language X, predicting the candidate with vowel epenthesis in (6a) as the optimal candidate. Kikuyu and Language X do not differ with respect to the constraints themselves, but with respect to the ranking of these constraints. In both Kikuyu and Language X, *NÇ serves as the motivating factor forcing the input segments to change. But what emerges as the outcome depends on the ranking of constraints such as DEP-IO and MAX-IO. Under this analysis, the functional unity of strategies such as postnasal voicing, vowel epenthesis, nasal deletion is directly captured by identical constraints, while at the same time the analysis accounts for the variations through different rankings of these same constraints.

Let us turn now to the account of postnasal hardening. Exemplified in (7), the contact of /N-/ with root-initial voiced fricatives including the two glides gives rise to prenasalized stops rather than prenasalized fricatives.

(7)	Inf.-him-Root-FV	Inf.-me-Root-FV	Gloss
a.	ko-mo-βaar-a	koo- ^m baar-a	'to look at, examine'
b.	wɔr-a	^m bɔr-a	'stings of bees' ¹
c.	ko-mo-rut-a	koo- ⁿ dut-a	'to teach or lead out'
d.	ko-mo-yur-i-a	koo- ^j jur-i-a	'to let somebody fill'
e.	ko-mo-ɣor-a	koo- ^ŋ gor-a	'to buy'

¹ The data in (7b) and (7d) are taken from McGregor (1905:13).

We attribute postnasal hardening to the interaction of two constraints in (8):

(8) Constraints responsible for postnasal hardening

- a. ID (cont): Corresponding segments are identical in their continuant specifications.
- b. *NF: A nasal must not be followed by a [+continuant] consonant.

Like ID (voi), ID (cont) is responsible for maintaining input-output identity in continuancy. In the case of roots with initial voiced fricatives, ID (cont) is clearly violated to satisfy a higher ranked constraint. We take this constraint to be *NF in (8b). Like *NÇ, *NF is a contextual markedness constraint on nasal-oral consonant clusters. It prefers nasal-stop or nasal-affricate clusters to nasal-fricative sequences. Built into *NF is a directional asymmetry like *NÇ, which captures the rarity of prenasal hardening. A markedness constraint that targets the postnasal context penalises only nasal-fricative—not fricative-nasal—sequences. Moreover, *NF expresses the functional unity of seemingly different strategies that languages might employ to circumvent nasal-fricative clusters. Apart from postnasal hardening, languages may opt for consonant epenthesis (English), nasal deletion (Kikuyu in some cases), fusion (Setswana), etc. to avoid nasal-fricative sequences (see also Padgett 1994). *NF unifies these seemingly unrelated outcomes, uncovering their functional unity without forcing a specific type of outcome.

There are strong phonological and phonetic motivations for *NF. In an extensive study of nasal-oral consonant sequences, Herbert (1986) concludes that surface nasal-fricative clusters are rare crosslinguistically and fricatives often harden to stops or affricates in postnasal position. This conclusion has led Steriade (1993) and Padgett (1994) to propose representational solutions that eliminate nasal-fricative sequences in phonology. From the articulatory point of view, it is not hard to understand why a stop or affricate is more compatible with a preceding nasal. The production of a nasal requires two conditions. First, the velum must be lowered so that air may pass through the nasal cavity. Second, the oral passage must be sufficiently constricted to force air through the nose. In the production of nasal-oral consonant clusters, the production of an oral consonant right after a nasal requires the raising of the velic valve in order to seal the nasal air passage. If the raising of the velic valve is desynchronised with the release of the oral constriction, that is, if the velum is lifted prior to the release of oral closure, nasal-stop or nasal-affricate sequences result (Ohala and Ohala 1993). For this reason, nasal-stop

and nasal-affricate sequences are much more common than nasal-fricative clusters.

In Kikuyu, *NF must dominate ID (cont). This ranking yields postnasal hardening as an outcome. Consider the following tableau as an illustration.

(9) Tableau for *kooⁿduta* ‘to teach me’

	/ko-N-rut-a/	*NF	ID (cont)
	a. [koo. ⁿ ro.ma]	*!	
☞	b. [koo. ⁿ do.ma]		*

In (9), the faithful output with respect to the continuant specification is ruled out by *NF in favor of the postnasal hardening output in (9b).

Now that postnasal voicing and hardening are accounted for, let’s consider nasal-place assimilation. In Kikuyu, /N-/ comprises a placeless nasal when it functions as the objective marker. But when this nasal emerges as part of a prenasalized stop, it assimilates in place of articulation to the root-initial consonant, yielding [ᵐ], [ᵐ], [ᵑ] and [ᵑ]. The two constraints responsible for nasal-place assimilation are presented in (10).

(10) Constraints responsible for nasal-place assimilation

- a. ID (pl): Corresponding segments are identical in their place specifications.
- b. AG (pl): Adjacent consonants must agree in place of articulation.

AG (pl) (short for AGREE (place)) must dominate ID (pl) in Kikuyu as the tableau in (11) shows.

(11) Tableau for *koo-^mbaar-a* ‘to look at, examine’

	/ko-N-ᵑaar-a/	AG (pl)	ID (pl)
	a. [koo. ⁿ baa.ra]	*!	
☞	b. [koo. ^m baa.ra]		*

Note that AG (pl) does not discriminate an output in which a nasal assimilates to the oral consonant from an output in which the oral consonant assimilates to the nasal. Following McCarthy and Prince (1995:364), we assume that this results from the ranking of root faithfulness over affix faithfulness (see Pater (1995) and Kager (1999:75-78) for further discussions of root-specific constraints).

In summary, this analysis of segmental changes associated with mutational outputs of Kikuyu requires seven constraints. Three are markedness constraints, favoring some types of consonant sequences over others. Four are faithfulness constraints whose task is to ensure correspondence between input and output. In Kikuyu, these seven constraints are ranked as in (12).

(12) *NC̣, *NF, AG (pl) » MAX-IO » ID (voi), ID (cont), ID (pl)

The three markedness constraints are ranked highest, because they are undominated. The ranking of MAX-IO above the three identity constraints expresses the fact that /N-/ is preserved in mutational outputs. The reason for placing MAX-IO below the markedness constraints will become clear once we consider the non-mutational data in which /N-/ is deleted. We have intentionally left out DEP-IO as it does not directly contribute to the account of the segmental changes seen in the mutational and non-mutational data in Kikuyu.

3 Local Conjunction and Non-mutational Outputs

In Kikuyu, /N-/ is deleted when it is prefixed to two types of roots: a) roots with initial nasals and b) roots with initial voiceless fricatives. For reasons of space, we will not discuss the nasal-initial roots in this paper. Interested readers should consult Peng (2002) for a complete analysis.

In Kikuyu, /N-/ is elided in roots with initial voiceless fricatives, with compensatory vowel lengthening being the only indication of the /N-/ prefixation.

(13)	Inf.-him-Root-FV	Inf.-me-Root-FV	Gloss
a.	ko-mo-θεεc-a	koo-θεεc-a	'to stab'
b.	ko-mo-huut-i-a	koo-huut-i-a	'to touch'

In a derivational account, this missing nasal may be accounted for by a rule that deletes a nasal in the environment of a following voiceless fricative. This is not an option for an optimal-theoretic account that delegates the responsibility of deletion and other structure-altering operations to GEN. In an optimal-theoretic account, this missing nasal can be handled only by constraint rankings.

As markedness constraints such as *NF and *NC̣ can be sensitive to contexts, one obvious move to remove /N-/ in the context of a voiceless fricative appears to invoke a context-sensitive markedness constraint on consonant

sequencing. This constraint, which we will refer to as $*NF_{\bar{c}}$, can be formulated in such a way as to bar nasal-voiceless-fricative sequences. Apart from partially duplicating $*NF$ and $*NC_{\bar{c}}$ and raising concerns of redundancy, $*NF_{\bar{c}}$ will not lead to /N-/s removal even if it dominates MAX-IO. Consider the possible outputs for an input consisting of a nasal and a voiceless dental fricative, that is, /N-θ/. One possible output is a prenasalized voiced dental fricative [$^n\delta$] with [n] representing a dental nasal, as in (14a). Though this output satisfies $*NF_{\bar{c}}$ and $*NC_{\bar{c}}$, it violates $*NF$ as it comprises a nasal-fricative sequence. A second output is a prenasalized voiceless dental stop [$^n\theta$], as in (14b). This output complies with $*NF$ and $*NF_{\bar{c}}$, but it violates $*NC_{\bar{c}}$. A third possible output is a prenasalized voiced dental stop [nd], as in (14c). This output cannot be ruled out by $*NF$ or $*NC_{\bar{c}}$. Nor can it be ruled out by $*NF_{\bar{c}}$, which a prenasalized voiced stop complies with because its postnasal portion is neither [-voiced] nor [+continuant].

(14)	Input	→	Output	$*NC_{\bar{c}}$	$*NF$	$*NF_{\bar{c}}$
a.	/N-θ/	→	[$^n\delta$]	√	*	√
b.	/N-θ/	→	[$^n\theta$]	*	√	√
c.	/N-θ/	→	[nd]	√	√	√

In order to obtain the effect of /N-/ deletion in roots with initial voiceless fricatives, we must eliminate [nd] as a contender, something that cannot be achieved by $*NF_{\bar{c}}$.

The difficulty that [nd] presents for an output-oriented account is obvious. Kikuyu allows prenasalized stops on the surface. What it does not allow are some prenasalized stops. Whatever constraint we adopt, this constraint must target outputs such as [nd] while allowing other prenasalized stops. Moreover, if voiceless stops can undergo postnasal voicing and voiced fricatives can undergo postnasal hardening, why cannot a voiceless fricative undergo both voicing and hardening to emerge as a voiced stop?

Note that we cannot appeal to structure preservation to distinguish [nd] from the attested prenasalized segments. This principle is exploited rather frequently in derivational accounts of consonant mutation (see, i.e. Rice 1989, Myers 1992-1994). One might conjecture that a prenasalized voiced dental stop is somehow not structure-preserving while those attested prenasalized stops are. Hence, only [nd] is blocked from appearing on the surface. Unfortunately, structure preservation is of no help in the case of Kikuyu for a

number of reasons. First, there is no need to posit underlying prenasalized segments in Kikuyu. Second, in a crosslinguistic study of prenasalized segments, Herbert (1977, 1986) concludes that there is no need to hypothesise underlying prenasalized segments in any language. In the case of Bantu languages, he argues that surface prenasalized segments originate from underlying nasal-oral clusters. In other languages, surface prenasalization may stem from phonetic adjustments. For instance, in a study of Mixtec prenasalization, Iverson and Salmons (1996) argue against positing underlying prenasalized segments and suggest instead that Mixtec prenasalization results from hypervoicing, that is, phonetic attempts to reinforce obstruent voicing. If there is no underlying prenasalized segment at all, none of the surface prenasalized segments can be structure preserving. Consequently, structure preservation cannot block [ⁿd̥] without blocking the attested prenasalized stops in Kikuyu.

The key to an account of roots with initial voiceless fricatives lies in the recognition that a voiceless fricative must undergo both postnasal voicing and hardening to become a voiced stop while a voiceless stop or a voiced fricative needs to undergo only voicing or hardening. According to our analysis, postnasal voicing and postnasal hardening emerge from the domination of ID (voi) and ID (cont) by *NÇ and *NF. In this account, a prenasalized voiced stop that originates from input sequences consisting of a nasal plus a voiceless stop or a nasal plus a voiced fricative incurs either a violation of ID (voi) or ID (cont), as in (15a) and (15b). In contrast, if a voiceless fricative is to become a voiced stop, it must violate both ID (voi) and ID (cont), as illustrated in (15c):

(15)	Input	→	Output	ID (voi)	ID (cont)
a.	/N-t/	→	[ⁿ d]	*	√
b.	/N-r/	→	[ⁿ d]	√	*
c.	/N-θ/	→	[ⁿ d̥]	*	*

What distinguishes [ⁿd̥] from [ⁿd] is the extent to which these outputs may deviate from their inputs. In Kikuyu, an output may deviate from an input in either the [voice] or [continuant] specification, but not both.

Now that we understand how unattested outputs such as [ⁿd̥] differ from attested outputs, it is not hard to see why an account of roots with initial voiceless fricatives calls for local conjunction of constraints, which is proposed in Smolensky (1993, 1995, 1997) and further explored in Alderete (1995), Kirchner (1996) and Mester and Itô (1998). In Kikuyu, the relevant

conjunctive constraint is ID(voi)&ID(cont), which conjoins ID (voi) with ID (cont). According to Smolensky (1993), a conjunctive constraint is violated only if both of its component constraints are violated. This means that only [ʎd] in (15c) violates ID(voi)&ID(cont). Outputs such as [nd] in (15a) and (15b) are in compliance with this conjunctive constraint, because they violate only one of the two identity constraints. ID(voi)&ID(cont) thus distinguishes the unattested outputs such as [ʎd] from the attested outputs. In the case of Kikuyu, the function of ID(voi)&ID(cont) is to impose limits on the degree to which an input segment must deviate from its output counterpart. Some amount of deviation is tolerated. But there is a limit on such featural deviation. The job of the conjunctive constraint is to impose the limit.

In order for ID(voi)&ID(cont) to restrict the degree of featural deviation and obtain the effect of /N-/ deletion, it must outrank MAX-IO. This ranking, together with *NÇ and *NF, guarantees /N-/’s deletion. As an illustration, consider the tableau for *koo-θεεc-a* ‘to stab me’.

(16) Tableau for *koo-θεεc-a* ‘to stab me’.

	/ko-N-θεεc-a/	*N Ç	*N F	AG (pl)	ID(voi) & ID(cont)	MA X- IO	ID(voi)	ID (co nt)	ID (pl)
	a. [koo. ^h θεε.ca]	*!	*						*
	b. [koo. ^h tεε.ca]	*!						*	*
	c. [koo. ^h ðεε.ca]		*!				*		*
	d. [koo. ^h dεε.ca]				*!		*	*	*
☞	e. [koo.θεε.ca]					*			

Included in this tableau are five possible outputs. The candidate in (16a) remains faithful to the input with regard to the voice and continuant specifications of the root-initial segment. This candidate fatally violates *NÇ and *NF. The two candidates in (16b) and (16c) alter either the voice or continuant specification of root-initial segments. Even though these two outputs may not violate both *NÇ and *NF, they do violate one of these constraints. The crucial comparison in (16) is that of (16d) and (16e). (16d), with a prenasalized voiced dental stop, violates the conjunctive constraint ID(voi)&ID(cont), because it violates ID (voi) and ID (cont) individually. As this conjunctive constraint outranks MAX-IO, (16d) is eliminated in favor of (16e). Clearly, without this conjunctive constraint, a prenasalized voiced dental stop would have emerged in roots with initial voiceless fricatives.

4 Conclusion

One major challenge presented by Kikuyu consonant mutation is that its surface effects include two distinct types of outputs: mutational and non-mutational. We have shown that an optimal-theoretic analysis of these patterns is possible if it incorporates local constraint conjunction. The proposed analysis captures the dependency of mutation on the presence of /N-/ and reveals the functional connection underlying mutation and deletion, both of which are viewed as strategies in response to the requirements of *NÇ and *NF.

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