[To appear in V. Migio and B. Moren, eds., *Proceedings of the Hopkins Optimality Workshop/Maryland Mayfest 1997. Maryland Working Papers in Linguistics 5*. College Park: University of Maryland.]

EMERGENT TEMPLATES: THE UNUSUAL CASE OF TIENE

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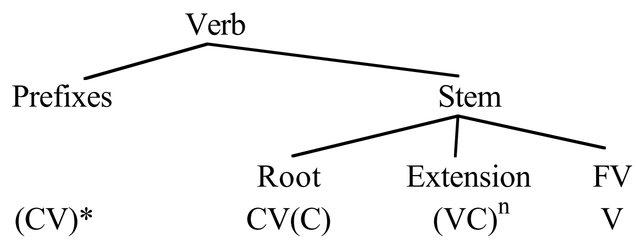
In this paper we analyze an unusual pattern of stem formation in Tiene (Bantu) which appears to involve a related pair of highly restricted prosodic templates.[1] In showing that these templates can profitably be reconstrued as the result of constraint interaction, we provide support for the program of McCarthy and Prince (in press) to derive prosodic templates from the grammar, rather than stipulating the templates as objects to which strings must be fitted.

1. Data

As background to the morphological and phonological structure of the Tiene verb, consider the following representation of the verb in Bantu languages:

(1)



Of particular interest to us in the present paper will be the Stem constituent of the verb, that containing the root, some number of derivational suffixes ("extensions"), and the obligatory final vowel (FV). Extension suffixes include such morphemes as the passive, applicative, causative, stative, reversive, and reciprocal, among others. The expected situation across Bantu is that a stem can contain in principle any

[1]We would like to thanks Myles Leitch for bringing Ellington (1977) to our attention, as well as the attendees of earlier presentations of parts of this paper at the Université Lumière Lyon2, the Université de Paris3, U.C. Berkeley and HOT.

number, including zero, of these suffixes, subject to syntactic, semantic and sometimes morphotactic constraints on their combinations.[2]

Tiene conforms to this general pattern for the verb stem, but with one very important and unusual deviation: the output of extensional suffixation is highly constrained *prosodically*. As sketched below, extended Tiene stems — those with at least one extension suffix — may be either CVVCV or CVCVCV in shape. The noninitial consonants are required to agree with one another in nasality, and in stems with three consonants (CVCVCV), the second must be coronal and the third must be noncoronal. All data in the paper are taken from Ellington (1977).

(2) Restrictions on extended stems in Tiene
  a. Prosodic shape: either CVVCV or CVCVCV
  b. Nasality: in CVCVCV stems, C2 and C3 must agree in nasality
  c. Place of articulation: in CVCVCV stems, C2 must be coronal, C3 must be grave (labial/velar)

Vowel quality in Tiene stems is also highly restricted. While the seven vowels /i, e, E, u, o, , a/ contrast only in V1 position, there is no contrast in stem-internal V2 position, the exact quality determined by vowel harmony. In addition, the quality of the FV is determined by a combination of morphological and phonological rules. Because of this predictability, we treat the extensions as purely consonantal.

The following examples illustrate the four logically possible effects of combining extensional suffixes with coronal or noncoronal consonants with roots ending in coronal or noncoronal consonants, such that the outcomes conform to the restrictions on place of articulation in (2c).[3] In (3a) we find the straightforward situation in which a coronal-final root combines with a suffix whose consonant is velar. Both the stative and the reversive surface as straight suffixes in this case. However, when the suffix consonant is coronal and the root ends in a velar, as in (3a), we find the opposite situation: infixation. Both the applicative and the causative infix into these velar-final roots (“T” = coronal, “K” = grave, “PB” = Proto-Bantu):

[2] See Hyman 1993 and references cited therein for a general statement on suffix concatenation in Bantu.

[3] Tiene has the following inventory of consonant phonemes (/N/ is not allowed in C1 position in stems, while /g/ occurs *only* in that position, and only after /N--/)/t, k, b, l, g, m, n, ł , N/.

(3) a. [[CVT] VK] → -CVTVK- ["normal" suffixation observed]

ból-a 'break' bólek-E 'be broken' < PB *-ek- [stative]
kót-a 'tie' kótek-E 'be untied' < PB *-uk- [reversive]

b. [[CVK] VT] → -CVTVK- [infixation required]

lók-a 'vomit' lósek-E 'cause to vomit' < PB *-es- [causative]
yók-a 'hear' yólek-E 'listen to' < PB *-ed- [applicative]

c. [[CVK] VK] → -CVTVK- [-VT allomorph used instead of -Vk]

kab-a 'divide' kalab-a 'be divided' ?< PB *-ad- [stative]
sook-E 'put in' solek-E 'take out' < PB *-od- [reversive]

d. [[CVT] VT] → -CVVT- ["imbrication" (=fusion) required]

mat-a 'go away' maas-a 'make go away' < PB *-es- [causative]
koɫ-a 'nibble' kooɫ-E 'nibble for' < PB *-ed- [applicative]

What happens when root-final and suffixal consonant are both grave, or both coronal? As it happens, the only suffixes with grave consonants in Tiene — the stative and reversive (3a), both have coronal allomorphs, and these allomorphs are selected exactly when, as in (3c), the root itself ends in a grave consonant. In this case we find infixation, just as in (3b). The applicative and causative, however, do not have velar allomorphs. When these suffixes combine with coronal-final roots (3d), the observed outcome is what Bastin (1983) has termed "imbrication", a fusion of C2 and C3 which results in a single surface coronal consonant. Thus in all four situations, the outcome of suffixation conforms to the templatic restrictions in (2c), whether by infixation, imbrication, or simple good fortune.

Example (4) illustrates further alternations triggered by the templatic restrictions in (2b). The requirement that C2 and C3 agree in nasality leads in some contexts to nasalization, e.g. of the applicative and stative suffixes in (4a), and in others to oralization, e.g. of the root-final consonant in (4b).

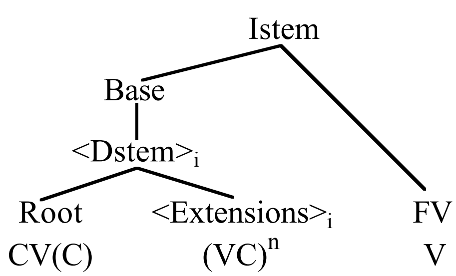
(4) a. nasalization (L → n, K → N)
dum-a 'run fast' dunem-E 'run fast for' [applicative /L/]
s n- 'write' s n N- 'be written' [stative /K/]
b. denasalization (m → b)
dim-a 'become extinguished' diseb-E 'extinguish' [causative /s/]

(Surface nasality and voicing are totally predictable for the applicative and stative consonants; we therefore represent them underlyingly as underspecified archisegments to avoid arbitrary decisions as to their featural specification.)

2. Morphological domains in the Tiene verb

Before introducing our phonological analysis of the Tiene verb stem, we must first cover some important morphological preliminaries. (5) provides a more articulated structure of the Bantu verb than was covered earlier, introducing two new constituents. The first is the constituent which Bantuists traditionally call the “base”, which excludes the final vowel. The Base contains the root and any extensions. It is the domain of phonological constraints holding over underived as well as extended roots. The second is a constituent whose existence is dependent on the existence of extension suffixes in the stem. Derived — i.e. extended — roots will be dominated by what we call the “Derivational Stem” or Dstem (borrowing a term of Downing 1997, in press a,b and Odden 1996). It is associated with of constraints holding *only* over derived (extended) roots. We assume that the Dstem and Base nodes are each associated with their own cophonology (set of ranked constraints), and that each cophonology is imposed on that string dominated by its corresponding morphological node (see e.g. Orgun 1996).

(5) More articulated Bantu stem structure:



2.1 Derived environment (Dstem) conditions on Tiene stems

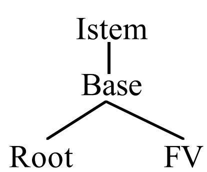
The cophonology associated with the Dstem constituent enforces certain prosodic conditions which hold only on extended stems. Example **Error! Reference source not found.**) demonstrates that the prosodic lower bound of two moras (CVCVC or CVVC) is *not* enforced on nonderived roots or on Bases, which can be as small as a single consonant. Nor is this lower bound enforced on Istems, which can be CV in shape. It is a property of Dstems alone:

(6)

	C	CV	CVC	CVVC	CVCVC
Root, Base	+	+	+	+	+
Dstem (2 possibilities)				+	+
Istem (+ final vowel)	+	+	+	+	+

The dependence of the Dstem constituent, and its associated lower bound of two vocalic moras, on the presence of extension suffixes in the verb, is the expected effect of Level Economy, the proposal of Inkelas and Orgun (1995, in press) that morphological structure is present in words only if it must be. In Tiene, extension suffixes must be dominanted by the Dstem node, but are the only morphemes that must be. There is no source for the Dstem node, and hence no opportunity for its associated cophonology to apply, in nonderived stems.

(7) Representation of an unextended verb stem: no Dstem constituent



Tiene provides striking morphological support for the proposal that only extended stems contain the Dstem constituent. As illustrated below, the final vowel (FV) exhibits an allomorphic alternation between /-E / and /-a/ which depends on whether or not an extension suffix is present in the stem. In terms of the morphological structure we are advocating, the alternation is straightforward: /-E/ is used when sister to a branching Base (one containing a Dstem) **Error! Reference source not found.**) and /a/ is used when sister to a nonbranching Base (dominating only the bare root) (7).

(8) Bare roots take -/a/ FV, but suffixed ones (Dstems) take /-E/

a.	[binem]-a	‘sleep’			[underived]
	[kótok]-a	‘gnaw’			
b.	[ból]-a	‘break’	[bó-le-k]-E	‘be broken’	[stative]
	[vwuɫ]-a	‘mix’	[vwu-ɫe-N]-E	‘be mixed’	
c.	[dum]-a	‘run fast’	[du-ne-m]-E	‘run fast for’	[applicative]
	[bót]-a	‘give birth’	[bó-o-t]-E	‘wrap for’	

Note that vowel harmony merges /a, E/ after certain vowels but not the ones shown in these examples.[4]

In contrast to the Dstem, the Base constituent is obligatorily present in every verb, derived or not. (One way of ensuring this would be to make the final vowel obligatorily subcategorize lexically for attachment to a Base constituent.) As a result, all verb stems obey its associated prosodic requirements, namely the bimoraic maximum, the nasal harmony requirements, and the place of articulation requirements. The following forms illustrate that the prosodic properties which we illustrated with derived stems in examples (3) and (4) also hold of nonderived roots, contained in Bases. The reconstructed forms show that in some cases the constraints have been enforced diachronically ("GCB" = Guthrie Common Bantu):

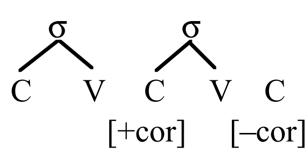
(9)	kótok-	'gnaw'	C-t-k-	GCB *-kókot-
	vútek-	'come back'	C-t-k-	GCB *-bútok-
	tóleb-	'pierce'	C-l-b-	GCB *-tóbod-
	dínem-	'get lost'	C-n-m-	GCB *-dímed-

3. Characterizing the Dstem cophonology: Templates vs. constraints

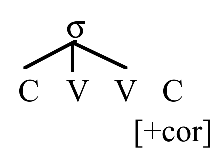
Having isolated the morphological constituents within which the various prosodic requirements hold in Tiene stems, we now turn to the issue of whether to use prosodic templates or a series of Optimality Theory constraints to characterize the phonotactics of Bases and Dstems. Let us consider, in particular, the conditions on prosodic size and on place of articulation.

Recall from **Error! Reference source not found.**) that there are only two licit Dstem shapes, namely CVVC and CVCVC. If we were to characterize the prosodic constraints on the Dstem in the form of morphological templates, we would therefore require two, in which C2 is specified as being [+cor] and C3, if any, as being [-cor]:

(10) a. Long template
(e.g. *dunem-* 'run fast for')



b. Short template
(e.g. *bóot-* 'wrap for')



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[4] Briefly put, stem-internal mid vowels and all low vowels totally assimilate to the preceding low vowels /E, , a/. Thus, thedifference between the FV's /-E/ and /-a/ will be seen only when the preceding vowel is high or mid.

There are at least four reasons to reject this approach in favor of characterizing the “templates” in terms of constraints regulating Dstem and Base. First, the templates are so similar that stipulating both would miss generalizations (bimoraic minimum, final consonant, coronal C2). Second, some components of the templates are quite general and needn’t be stipulated (e.g. syllable onsets). Third, the requirements are actually drawn from different morphological levels, belying the appearance of atomic templates. The bimoraic *upper* bound, the place of articulation constraints and the nasal harmony are true of Base constituents and would be redundant if specified of Dstems, while the bimoraic minimum and final consonantality are properties of Dstems only. Finally, if we assumed two templates we would still have to rely on the grammar to choose which template is appropriate in any given case; if the grammar has to be brought in anyway, why not make it entirely responsible for prosodic shape?

We now turn to an implementation in Optimality Theory of the constraints needed to guarantee the attested properties of Dstems and Bases.

4. Deriving the CVCVC and CVVC “templates”

The relevant restrictions classify as SIZE and SHAPE. SIZE is a family of constraints ensuring that Bases and Dstems are maximally CVVC or CVCVC in length, while Dstems are also minimally CVVC or CVCVC; SHAPE constraints govern nasal harmony and place of articulation restrictions in Bases.

4.1 SIZE

The family of constraints known as SIZE contains the following members:

(11)	BIMORAIC MAX:	A string contains no more than two vocalic moras
	BIMORAIC MIN:	A string contains no fewer than two vocalic moras
	ONSET	A syllable must have an onset
	FINALC	ALIGN-R (C, string)

BIMORAIC MIN and FINALC are ranked high only in the Dstem cophonology; in the Base cophonology, they are ranked lower than the constraints which would cause ungrammaticality or augmentation of monomoraic or vowel-final forms. The other two constraints are ranked high in both Dstem and Base cophonologies.

Tableau (12) illustrates how the SIZE constraint family controls distribution of vocalic moras (in this case in the Dstem), rejecting the candidate with three vocalic moras. This particular example illustrates the pervasive shortening of long vowels in roots under extensional suffixation; the cause is the bimoraic upper bound, coupled with syllable well-formedness in Bantu (unexpressed here).

(12)

	/yaat, -k/	SIZE	FAITH
a.	yaatak	*!	
☞ b.	yatak		*

The FINALC constraint, whose high ranking in the Dstem cophonology ensures that Dstems are consonant-final, is consistent with a broad generalization about the internal structure of the Bantu verb stem: bases of affixation are typically consonant-final, and affixes vowel-initial. It is also motivated outside of Bantu; see e.g. McCarthy and Prince (1994) for a discussion of its relevance to Makassarese.

Unlike in Makassarese, however, the obligatory Dstem-final consonant is not word-final and not even syllable-final. The Dstem-final consonant always surfaces as an onset to the syllable containing the final vowel of the Istem. Because this particular consonant is never a coda and because, more generally, Tiene has no codas at all, we assume that at the level of the Dstem and Base, the final consonant is unsyllabified.[5]

4.2 SHAPE and the *prosodic trough* (TROUGH)

The SHAPE family of constraints governs nasal harmony and place of articulation within Dstems and Bases.

4.3 Nasal harmony

The operative generalization about nasal harmony is that if either C2 or C3 is nasal in the input, then both must be nasal in the output, unless either is /s/ in the input, in which case both must be oral in the output. Examples of the possible outcomes of different combinations of root and affix suffixes are shown below:

(13)	a.	Oralization:	m → b	di-*s*e-*m*	→	di*s*e*b*-
	b.	Nasalization:	K → N	s *n*- *K*	→	s *n* N-
	c.	Nasalization:	L → n	du-*L*e-*m*	→	du*n*e*m*-

To implement this pattern, we invoke the three constraints in (14). Top-ranked NASAL.HARMONY represents any (set) of the various constraints that have been proposed in the Optimality Theory literature (e.g. Walker 1994, Cole &

[5] Ellington (1977:6) does document a not well-understood process of final vowel deletion following non-coronals in nouns; we abstract away from this effect here.

Kisseberth 1994, Cohn 1995) to ensure that all consonants in a given domain bear identical specifications for [nasal]. IDENT.NASAL, ranked above IDENT.ORAL, ensures that if any consonant is underlyingly nasal, all will surface as nasal, since preservation of nasality is more important than preservation of orality. The tableau illustrates the effect of these ranked constraints on a Dstem composed of the root /dum-/ 'run fast' and the (infixed) applicative suffix /-L/.

(14) NASAL.HARMONY, IDENT.NASAL >> IDENT.ORAL "Nasality spreads"

	duLem	NASAL.HARMONY	IDENT.NASAL	IDENT.ORAL
F a.	du*n*e*m*			
b.	du*l*e*m*	*!		
c.	du*l*e*b*		*!	

Note that the underspecification of the applicative "L" for [nasal], which we assume here, is not crucial; since IDENT.ORAL is ranked low, a fully specified oral /l/ would nasalize also.

As noted earlier, nasal harmony takes the form of oralization if /s/ is one of the participating consonants. The constraints in (15) ensure that the only way to comply with NASAL.HARMONY is to denasalize an input nasal, which occurs in this example when the root /dim-/ 'be extinguished' combines with causative /-s/:

(15) IDENT[STRID]: Corresponding segments agree in stridency
*NAS-STRID A segment cannot be strident and nasal (e.g. Padgett 1994)

Ranking: IDENT.STRID, *NAS-STRID >> NASAL.HARM >> IDENT.NASAL

	disem	IDENT.STRID	*NAS-STRID	NASAL.HARM	IDENT.NAS
a.	dinem	*!			
b.	disem			*!	
F c.	diseb				*
d.	dis̃em		*!		

We have now illustrated how nasal harmony operates between C2 and C3 in the Dstem. An unresolved problem is why C1 does not participate in the nasal harmony process. There are three possible approaches to its inertness.

The first is positional prominence (Trubetzkoy 1929[1964]:127, 1939[1969]:236), according to which faithfulness to C1 would be ranked so high that C1 would never alternate (for C1 prominence effects see Paulian 1975, Hyman 1987, 1990; for V1 prominence effects see, inter alia, Garde 1967, Haiman

1972, Goldsmith 1985, Hyman 1989, Steriade 1995, Beckman 1995, Casali 1996). The downfall for this approach is that it offers no insight into why C1 does not act as the *trigger* for nasal harmony: that is, why, in (14), is the applicative of /dum/ 'run fast for' realized as *dunem* instead of the fully oral **dudeb*; why is the applicative of /ƚak/ 'tear' ƚ*alaka*, rather than the fully nasal ƚ*ana*N*a*?

The second approach is the CRISP constraint family (Itô and Mester (in press)), which bans output-output correspondence (in this case specifically involving C1). By being unable to share features with any other segment, C1 would be effectively invisible to the nasal harmony process, the seemingly correct result. For reasons to be disclosed shortly, however — in brief, the fact that C1 also fails to participate in what can be seen as a *dissimilatory* effect with no feature sharing — we, however, choose to implement a third option, namely, the prosodic TROUGH.

In the most general terms, the prosodic TROUGH is a substring of the form under review in which (i) contrasts are suppressed and/or (ii) special input-output relations obtain. For example in Koyo, the prosodic TROUGH is that substring of the stem which excludes C1 and the FV; in the TROUGH, underlying /t, k/ surface as [r, g], whereas in C1 position they surface as [t, k] (Hyman, unpublished notes).

We define the TROUGH (τ) in Tiene as a substring of the Base which, like the Koyo TROUGH, excludes C1 and the FV.

(16) Tiene DStem TROUGH: < C> τ <V> (where τ = VCVC, VVC)

The TROUGH is demarcated in specific examples by parentheses, as below:

(17)

Root	Dstem with TROUGH marked	gloss
/bák/	b(álak)-	'reach-applicative (=reach for)'
/ból/	b(ólek)-	'break-stative (=be broken)'
/dum/	d(unem)-	'run-applicative (=run fast for)'
/kab/	k(alab)-	'divide-stative (=be divided)'

TROUGH effects are widespread in Bantu languages, where the more typical TROUGH consists of that part of the Istem excluding the initial CVC and final V sequences. Yaka, analyzed by Hyman 1997, presents a classic example of this common pattern in (18). Perimeter V's in the Yaka Istem — those *not* included in the TROUGH — can be any of five vowels, while those V's inside the TROUGH are limited, underlyingly, to three. Only TROUGH vowels are subject to vowel harmony, and vowel sequences within the TROUGH are severely restricted. Consonants bear out the pattern as well. The set of consonants within the

TROUGH is noticeably smaller than the set of consonants which can appear in the perimeter of the Istem:

(18) Yaka, where in an Istem of the shape <CVC>VCVC<V>:
  a. Perimeter V's (root, FV) = /i, e, u, o, a/ vs. TROUGH V's = /i, u, a/
  b. Only TROUGH V's are subject to height harmony
  c. The only licit VCVC TROUGH sequences = -iCiC-, -uCuC-, -aCaC-, --uCiC-
  d. The only C's in the TROUGH are /m, t, l, n, s, k, ng/ vs. a much larger inventory in perimeters

The technicalities of defining the TROUGH substring, which we will simply assume hereafter in the paper, are covered in (19); the TROUGH must be right-aligned with the Dstem, and misaligned at the left edge by a single consonant. The misalignment is handled by the requirement that the TROUGH be vowel-initial:

(19) Align(TROUGH, R, DSTEM, R)
Align(TROUGH, L, DSTEM, L)
Align(TROUGH, L, V, L)

Making use of the TROUGH for purposes of excluding C1 from nasal harmony is now trivial: NASAL.HARMONY holds only within the TROUGH.

(20) NASAL.HARMONY → NASAL.HARMONY.TROUGH

FAITHFULNESS constraints prevent nasal harmony from affecting any consonant not in the TROUGH, as NASAL.HARMONY.TROUGH has no mandate in the perimeter.

4.4 Place of articulation

Having handled C2-C3 nasal harmony by appealing to the prosodic TROUGH, we now turn to the most puzzling and unusual of the conditions in Tiene, namely the place of articulation constraints on C2 and C3 in CVCVC Bases. These are restated below:

(21) CVCVC implies CVTVK, where "C" = any consonant, "T" = coronal, "K" = grave

The grammar must specifically rule out the following types of Base: *CVKVK, *CVTVT, *CVKVT. There are a number of ways to enforce the desired situation. Four different constraints are considered in the following chart. The first two govern C2 directly: "C2=coronal" stipulates that the second consonant be coronal, while "C3≠coronal" stipulates that it be noncoronal. The second two allow C2 to vary freely but constrain it to disagree with C3. "OCP[Cor]" bans consecutive coronals, while "OCP[±grave]", which treats [grave] as a binary feature, bans agreement in the feature [grave]. Each of these four constraints rules out one or two of the undesirable Bases.

(22)

Candidate constraints:	C2=coronal	C3≠coronal	OCP[Cor]	OCP[±grave]
Bases correctly ruled out:	*CVKVK			*CVKVK
		*CVTVT	*CVTVT	*CVTVT
	*CVKVT	*CVKVT		

We opt to use C2=coronal and OCP[Cor], the only pair of constraints with no overlap in the set of Bases which they prohibit.

Although the intuition behind these constraints is clear, their implementation presents two serious difficulties. The first problem is that C2=coronal identifies C2 via a numerical index, assumed in the past (McCarthy & Prince 1986) to be an undesirable property in a rule and which we take to be an undesirable property in a constraint as well. The second problem is that OCP[Cor] incorrectly rules out attested forms like *s´n-* 'write' ~ *s´n* N-'write-stative', with coronals in C1 and C2 positions. We are again faced with the problem of excluding C1 from the scope of a constraint. How can this be done?

The solution to the first problem is straightforward. C2 uniquely occupies intervocalic position within the Base, and can be identified in that way:

(23) NADIR (lowest point of τ): An intervocalic C must be coronal.

The solution to the second problem is no more difficult: in fact, it is already at hand. C1 can be excluded from the purview of OCP[Cor] by making the latter specific to the TROUGH, which includes C2 and C3 but not C1.

(24) OCP[Cor].TROUGH: no two adjacent coronals in the TROUGH

The tableau in (25) illustrates the ability of these two constraints to rule out impossible Bases. NADIR rules out the illicit **l(abab)* and **l(abas)*, both of which contain intervocalic noncoronal consonants; OCP[Cor].TR rules out the illicit **l(asas)*, whose TROUGH contains two coronals. Only the licit *l(asab)* passes muster by satisfying both constraints.

(25)

		NADIR	OCP[COR].TR
licit Base shape:	l(asab)		
illicit Base shapes:	l(abab)	*!	
	l(abas)	*!	
	l(asas)		*!

Both NADIR and OCP[Cor] enjoy cross-linguistic support. NADIR is reminiscent of the Mathi-Mathi condition, discovered by Gahl 1997 (data from Hercus 1969, 1986), to the effect that intervocalic consonants in roots are exceptionlessly coronal, while other root consonants can be coronal or noncoronal.[6]

(26)

CVCVC roots:	C1	C2	C3
[+cor]	25	104	30
[–cor]	79	0	74

Both NADIR *and* OCP[Cor].TR also find support in languages related to Tiene. As sketched below, Kukuya and Teke both show TROUGH effects in which the place of articuluation is highly constrained; though neither language emulates the Tiene pattern exactly, both show coronality and or velarity restricted to particular TROUGH positions.

(27)

	C2	C3	
Tiene	cor	lab, vel	
Kukuya	cor, lab	lab, vel	(Paulian 1975, Hyman 1987)
Teke	cor, lab	vel	(Hombert 1993)

A number of other African languages also show positional restrictions on stem consonants, showing the generality of the pattern of which Tiene is a very special case. For example, in Gokana [Benue-Congo, Nigeria] (Hyman 1985, 1990), whose stems are maximally biconsonantal, C2 consonants, unlike C1 consonants, do not contrast in voice and cannot be palatal, labiovelar, glottal or fricative.[7]

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[6] For other examples of the templatic treatment of coronality, see Macken 1996a,b for developmental evidence of the templatic treatment of coronality, and Buckley (1997, this volume) for Kashaya, where the constraint that codas must be coronal forces infixation.

[7] In Efik [Benue-Congo, Nigeria] (Welmers 1966, 1973; Cook 1969, 1985; Hyman 1990), where the maximal stem is C(G)VCV, C2 consonants, unlike C1 consonants,

5. Allomorphy and infixation: SHAPE and SIZE >> Alignment

We now show how the constraints we have just developed account for the templatic properties of infixation, imbrication and also reduplication, which are triggered by affixational constructions in Tiene. Recall that the contrastive property of a suffix is the place (and stridency) of its consonant. The skeletal shape of a suffix (whether CV, VC, V or C) is entirely predictable, as its the quality of its vowel and its linear position in the Dstem.

The range of behaviors that we will need to capture is summarized below. Four suffixes, the stative, reversive, applicative and causative, are infixed under certain conditions; the applicative is imbricated in other circumstances, and the definitive is always reduplicative.

(28)

	Morpheme(s)	UR	Behavior
a.	Stative, reversive	L~K	infixation (CVC → CV***L***VC) suffixation (CVC → CVCV***K***)
b.	Applicative, causative	L, s	infixation (CVC → CV***L***VC) imbrication (CVC → CVVC)
c.	Definitive	Ø	reduplication (CVC → CVCVC)

5.1 Place-driven infixation: Stative and reversive

Example (29) illustrates the range of surface consonantism in the stative, which is representative of the behavior of the reversive as well. Both the stative and reversive have two lexically listed allomorphs, one coronal (the /L/, which alternates between [l] and [n] according to nasal harmony context) and one velar (the /K/, which alternates between [k] and [N].)

(29) Surface consonantism of the stative:

Velar	/K/	[k]	yat-[ak]-a	'be split'	cf.	yat-
		[N]	vwuɨ-[eN]-E	'be mixed'	cf.	vwuɨ-
Coronal	/L/	[l]	ka-[la]-b-a	'be divided'	cf.	kab-
		[n]	ka-[na]-m-a	'be turned over'	cf.	kam-

---

do not contrast in voice and cannot be palatal, labiovelar, or fricative. In Basaá [Bantu, Cameroon] (Janssens 1986, Dimmendaal 1988, Hyman 1990), C1 stops are voiceless, while C2 stops are voiced; C2 cannot be /w/ and the only palatal is /j/. Williamson (1978) has documented similar restrictions for Ijo, in which stem consonants are distributed, statistically, by "strength", with stronger consonants appearing more frequently in more leftward positions in the stem.

A tableau des tableaux (term of Itô, Mester and Padgett 1995), à la Kager 1995 and Dolbey 1996, shows how NADIR and OCP[Cor].TR force the choice of the velar allomorph over the coronal in cases where the stative (or reversive) combines with a coronal-final root. The double hand points to the optimal output candidate, and the single hand points to the optimal input:

(30) Velar suffix selected if root ends in coronal:

F	a.	/yat-, -K/		NADIR	OCP[Cor].TR
FF		i.	y(atak)		
		ii.	y(akat)	*!	
	b.	/yat, -L/			
		i.	y(atal)		*!
		ii.	y(alat)		*!

If the root ends in a grave consonant, the only way to satisfy NADIR and OCP[COR].TR is to select the coronal allomorph of the stative (or reversive) — and *infix* it. This requires violating the basic alignment constraint on all suffixes:[8]

(31) ALIGN-R (suffix) [gradiently violable]
Ranking: NADIR, OCP[Cor].TR >> ALIGN-R

The following tableau shows how infixation is forced by the need to satisfy the higher-ranking NADIR constraint. In this example, the coronal allomorph of the stative combines with a labial-final root (kab- 'divide'):

(32)

	/kab, -L/	NADIR	ALIGN-R
a.	kabal	*!	
F b.	kalab		*

The tableau des tableaux in (33) illustrates selection of, and infixation of, the coronal allomorph of the stative when in combination with a labial-final root:

[8] This constraint is gradiently violable, and therefore belongs technically to the family of NO-INTERVENING constraints discussed by Ellison 1995 and Zoll 1996.

(33) Coronal infix selected if root ends in grave consonant (here, labial):

	a.	/kab-, -K/		NADIR	OCP[COR].TR
		i.	k(abak)	*!	
		ii.	k(akab)	*!	
F	b.	/kab, -L/			
		i.	k(abal)	*!	
FF		ii.	k(alab)		

5.2 Imbrication: coronal + coronal

Unlike the stative and reversive, the causative /-s/ and applicative /-L/ have only one lexically listed allomorph each, which is coronal. When combined with grave-final roots, these suffixes are infixed in order to conform to NADIR, as expected:

(34) Infixation of applicative /-L/ into grave-final root:

	/ y b, -L/	NADIR	ALIGN-R
a.	y(b- l)	*!	
F b.	y(-l -b)		*

(35) Infixation of causative /-s/ into grave-final root:

	/tom, -s/	SHAPE	ALIGN-R
a.	t(ob-es)	*!	
F b.	t(o-se-b)		*

But what happens when the causative or applicative is combined with a *coronal*-final root? Infixation is of no help here, as the failure of candidate (36c) illustrates. (Note that the morph boundaries in the output are somewhat arbitrary here; for all practical purposes we are considering the second stem vowel to be epenthetic, and hence it belongs to no surface morph.) Nor is allomorphy an option, since the causative and applicatives have only one form each underlyingly.

The solution Tiene adopts for this situation preserves the inviolability of NADIR and OCP[Cor].TR. Tiene employs a process well-known from other Bantu languages of imbrication (Bastin 1983), a fusion of the suffixal consonant with the root-final consonant which occurs when both are coronal. Imbrication typically results in lengthening of the vowel preceding the fused consonant; in Tiene, the vowel length that appears in the winning output candidate in (36c) is of course predictable, required by BIMORAIC MAX (not shown here).

(36) Applicativized coronal-final root: loss of suffix consonant

	/bot, -L/	OCP[COR].TR	MAX(SEG)
F a.	bo-o-t		*!(t)
b.	b(ot-el)	*! (C2, C3 both coronal)	
c.	b(o-le-t)	*! (C2, C3 both coronal)	

(37) Causativized coronal-final root: loss of root-final consonant:

	/mat, -s/	OCP[COR].TR	MAX(SEG)
a.	m(at-as)	*! (C2, C3 both coronal)	
b.	m(a-sa-t)	*! (C2, C3 both coronal)	
F c.	m(a-a-s)		*(t)

In example (36), the suffixal consonant gives way to the root-final obstruent. In example (37), however, it is the root-final consonant which surfaces. The identity of the surviving consonant is entirely predictable on phonological grounds. In competition with another coronal, /L/ always loses and /s/ always wins. This behavior can be construed in terms of markedness, in the Optimality Theory sense of that term (Prince and Smolensky 1993). The constraints in (38) stipulate that preservation of a strident is more important than preservation of other obstruents and that preservation of sonorants is the least important. This is sufficient to distinguish /s/ and /L/. (Note that the markedness of /s/ has already been established in our analysis of Tiene; /s/ was the only consonant immune to nasalization, and its presence in a nasal harmony domain forced oralization.)

(38) MAX(OBSTRUENT) >> MAX(SONORANT)
MAX(STRID) >> MAX(OBSTRUENT)

The tableaux in (39) illustrate the effect of these constraints in an imbrication environment, causing the applicative /L/ to delete and the causative /s/ to prevail:

(39) (Unmarked) applicative /L/ deletes:

	/bot, -L/	MAX(OBST)	MAX(SON)
F a.	b(o-o-t)		*(L)
b.	b(o-o-l)	*!(t)	

(40) (Marked) causative /s/ prevails:

	/mat, -s/	MAX(STRID)	MAX(OBST)
a.	m(a-a-t)	*!(s)	*(s)
F b.	m(a-a-s)		*(t)

The tableau des tableaux in (41) demonstrates that imbrication is resorted to only consonant deletion is the only means of satisfying SHAPE. Imbrication is never used with the stative and reversive, where the velar suffixal allomorph (and straight suffixation) is less costly choice for a coronal-final root.

(41)

F	/yat-, -K/	SHAPE	MAX(SEG)	ALIGN-R
FF	y(atak)			
	y(aat)		*!	
	/yat, -L/			
	y(atal)	*!		
	y(aat)		*!	

5.3 Nonimbricated CVVC Dstems

Imbrication is not the only source of CVVC Dstems in Tiene. CVVC stems also arise when vowel-final (CV or CVV) roots combine with suffixes:

(42) CV(V) + applicative → CVVL
CV(V) + causative → CVVs
CV(V) + stative, reversive → CVVL (not *CVVK)

In all such cases, the generalization is that the final consonant of the CVVC Dstem — i.e. C2 — is coronal. This generalization is reminiscent of the requirement that C2 be coronal in CVCVC Dstems. However, NADIR, the constraint responsible for C2 coronality in the latter case, does not extend to CVVC Dstems, in which C2 is not intervocalic, and thus misses the new generalization.

An initially appealing move would be to replace NADIR with a more general constraint holding over C2 in both types of Dstems; instead of identifying C2 as intervocalic, we can identify it as TROUGH-initial. The problem with this approach is that it is stipulative and arbitrary — why should initial consonants be coronal? No other language attests this pattern. In the case of CVVC Dstems derived through applicative and causative suffixation, the coronality of C2 falls out from lexical representations, and need not be stipulated in the grammar. It is only in the case of CV(V) roots which combine with the stative or reversive that there is any choice as to whether C2 is coronal or not; only this context provides the possibility of an alternation, in that the grammar must choose between the coronal and velar lexical suffixal allomorphs.

We prefer to derive the choice of coronal stative and reversive suffix for vowel-final roots from markedness constraints. Following Prince and Smolensky (1993), we assume that noncoronal places of articulation are more marked (again in the Optimality Theory sense) than coronal ones; the relevant constraints, detailed in Prince and Smolensky (1993), are abbreviated here as *MARKED.PLACE.

(43) *MARKED.PLACE "Noncoronal place of articulation is prohibited"

The hierarchy for which this constraint stands penalizes noncoronal consonants. It ensures that *kaal,* not **kaak,* is the outcome of stativizing the root /kaa-/. As shown in the tableau des tableaux below, the coronal allomorph of the stative suffix is the better choice for /kaa-/, as its optimal output candidate violates *MARKED.PLACE less than that of the candidate input with the velar allomorph.

(44)

F	/kaa-L/	*MARKED.PLACE
FF a.	k(aal)	*(k)
	/kaa-K/	
b.	k(aak)	**!(k,k)

6. Definitive: a special kind of Dstem

In this final section, we turn to reduplication, the third type of affixation in (28). Definitives are formed from consonant-final roots (CVC- or CVVC-) by reduplicating of C2 (and inserting a second vowel and shortening V1, as needed):

(45) Definitive aspect formation (< Proto-Bantu *-eded- completive)

a.	y b	'bathe'	y b b	'bathe thoroughly'
	mata	'go away'	matata	'go away once and for all'
	yaka	'believe'	yakaka	'believe once and for all'
	kéna	'dance'	kénena	'dance once and for all'
b.	k´´m	'sweep'	k´m m	'sweep once and for all'
	maasa	'cause to go away'	masasa	'cause to go away for good'

Vowel-final roots display a related but distinct pattern: as there is no C2 to reduplicate, these roots exhibit a double insertion of /L/.

(46) kaa ‘fasten’ kalala ‘fasten permanently’
n´ ‘look at’ n´l l ‘fix gaze on’
bEE ‘become ripe’ bElElE ‘ripen once and for all’
fuE ‘become violent’ fuElElE ‘become permanently violent’
su ‘show’ su l l ‘show once and for all’

In all cases, however, the CV(V)(C) root yields a canonical CVCVC Dstem, in which C2 and C3 are identical.

The fact that definitives are subject to SIZE constraints is confirmed by Ellington (1977:93), who writes that “...verbs having the canonical shape -CVCVC- (including extended radicals)... do not accept the Definitive Aspect Morpheme. For such verbs, this aspect must be rendered by adding the expression *nkó m´te* to the conjugated verb in the Neutral Aspect.” Two obvious choices present themselves for the analysis of the definitive suffix. The first is that the definitive suffix is reduplicative, subject to the constraint DEFIN.RED=σ (the RED of Optimality Theory; see e.g. McCarthy & Prince 1993, et seq.). The second is that there is no definitive suffix per se; rather, the morphology requires definitive stems to be disyllabic, with reduplication being the phonologically optimal way to augment monosyllabic roots. We will entertain the second option here, preferring an analysis which derives reduplication to one which stipulates it. It is true that disyllabicity is also a stipulation, but it resembles another stipulation which we independently need to make, namely the bimoraic minimal size of Dstems.

6.1 The definitive as a zero morpheme

Implementing the idea that the definitive construction is “zero derivation” rather than overt suffixation requires the definition of a special cophonology for definitive Dstems, one which, unlike the more general Dstem cophonology, requires the stem to be disyllabic. The construction which invokes this new cophonology is schematized below. In (47), compare the zero-derived definitive, on the left, with the suffixed applicative, on the right:

(47) Dstem | Root — *Definitive cophonology*   Dstem → Root -/L/ — *General cophonology*

The definitive cophonology differs minimally from the general Dstem cophonology. The only constraint reranking that is required is that in the definitive cophonology, DISYLLABIC must outrank DEP(C) and DEP(σ), such that the only possible Dstem template is CVCVC. In addition, the definitive cophonology needs a ranking which was undetermined in the general cophonology, namely that between DEP(C) and MULTCORR. This ensures that in the case of a CV(V)C root which must be augmented in the definitive, reduplication (of C2) is preferred over the insertion of a brand-new, albeit unmarked, consonant.

The effect of these constraint rankings is illustrated in the following tableau, which determines the optimal outcome of definitivizing a CVC root, *mat*:

(48)

DEF cophonology	/mat/	DISYLLABIC	DEP(C)	*MULTCORR
☞ a.	$ma_it_ja_it_j$			**(at)
b.	ma_ia_it	*!		*(a)
c.	ma_ita_il		*!(l)	*(a)

The candidate exhibiting reduplication (a) does better than those that do not. The losers are either monosyllabic (b), violating DISYLLABIC, or show gratuitous epenthesis of new consonantal material (c), violating DEP.

The looming question for this analysis (which would also loom for the analysis in which the definitive suffix is lexically stipulated to be reduplicative, had we pursued that option) is: why can only C2 reduplicate? C1 reduplication would seem to be a better option for definitives in that it would, at least in some cases, permit NADIR and/or OCP[Cor].TR to be satisfied. As it is, the definitive of every coronal-final root violates OCP[Cor].TR; the definitive of every grave-final root violates NADIR. The following tableau shows that both constraints could be satisfied in the definitives of *mat-* (which has one coronal and one grave consonant) if C1 were allowed to copy:

(49)

DEF cophonology	/mat/	DISYLL	OCP[Cor].TR	*MULTCORR
a.	$ma_it_ja_it_j$		*!	**(a,t)
M b.	$m_ja_ita_im_j$			**(a,m)

But reduplication of C1 is the wrong outcome. Why?

We contend that the failure of C1 to reduplicate is related to its failure to participate in nasal harmony and in place of articulation restrictions. In dealing with these latter two phenomena we have accounted for the apparent invisibility of C1 by placing it outside of the TROUGH, that substring of the Dstem in which the interesting constraints in Tiene hold. Exactly the same approach can extend to the definitive. The reason C1 doesn't reduplicate, even when C1 reduplication would yield an otherwise more well-formed candidate, is that reduplication is restricted to elements in the TROUGH. As shown below, DEP.TROUGH prohibits the insertion of new consonants into the TROUGH. Since the original of C2 belongs to the TROUGH, its reduplicated counterpart does not count as a DEP.TROUGH violation. But since the original C1 is *not* in the TROUGH, its reduplicated counterpart *does* violate DEP.TROUGH. This is why candidates (50b,c) are out:

(50)

DEF cophonology	/mat/	DEP.TROUGH
F a.	$m(at_iat_i)$	
b.	$m_i(atam_i)$	*!(m)
c.	$m_i(am_iat)$	*!(m)

7. Conclusions

In conclusion, we have shown that the templatic restrictions on Dstems and Bases in Tiene can be derived through a combination of markedness statements and more explicit constraints on domain shape. Which "template" emerges is predictable from the segmental makeup of root and affix. Thus Tiene provides supporting evidence of a new kind for the program of McCarthy and Prince (1994) to derive templatic effects from general constraints in grammar.

Tiene has also provided evidence for defining a substring of the output (the TROUGH) which is the domain of certain specified constraints in the grammar. This move is related to proposals by Inkelas (1990) to handle extrametricality by excluding peripheral segments from a specified substring and to more recent efforts in Optimality Theory to use substrings for harmony domains (see e.g. Cole and Kisseberth 1994 et seq.) and to define the "base" and "reduplicant" in reduplication constructions (McCarthy and Prince 1993 et seq.)

A striking implication of the Tiene facts is the clear demonstration that place-driven infixation, although apparently quite rare in languages, is possible (cf. also Buckley 1997), making it necessary to ask a question which has been somewhat neglected in Optimality Theory: if segmental constraints, along with ones on syllable structure, can drive infixation, how can we account for the strong cross-linguistic generalization (see Moravcsik 1977) that infixation skips over no more than a single prosodic constituent? Tiene Bases are too short to illustrate the potential for this phenomenon, but Tiene shows that it is a realistic possiblity to consider. We leave this question for future research to illuminate.

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