1 GLOBAL OPTIMIZATION IN ALLOMORPH SELECTION

TWO CASE STUDIES

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1.1 Introduction

The nature of the interface between phonology and morphology has long been a matter of intense debate. One area that has received increased attention in recent years concerns a class of allomorphy called phonologically conditioned suppletive allomorphy (PCSA). By way of an illustration, consider an example of PCSA from Dja:bugay, a Pama-Nyungan language. In this language, the genitive morpheme has two allomorphs, *-n* and *-ŋun*. The allomorph *-n* appears after vowel-final stems, whereas the other allomorph appears after consonant-final stems.

(1) Dja:bugay (Patz 1991, Paster 2006b)

a. Vowel-final stem	b. Consonant-final stem
guludu-n "dove-GEN"	girrgirr-ŋun "bush canary-GEN"
gurra:-n "dog-GEN"	gaɲal-ŋun "goanna-GEN"
djama-n "snake-GEN"	bibuy-ŋun "child-GEN"

From the so-called globalist perspective, one may view the selection of a phonologically conditioned suppletive allomorph as a matter of the phonological well-formedness of the output (Kager 1996, Mascaró 1996). The Optimality Theoretic approach to phonology-morphology interaction, as laid out in McCarthy & Prince 1993b, is a paragon example of such a globalist view of allomorph selection where the phenomenon of phonologically conditioned allomorphy is subsumed under the constraint schema, P » M. That is, the interface between phonology and morphology is reduced to a matter of phonological constraints superseding morphological ones when they come into conflict. Thus, for example, the choice of *-n* or *-ŋun* in Dja:bugay depends on whether suffixing a particular allomorph would engender more violations of the *COMPLEX constraint, which penalizes complex syllable margins, relative to suffixing the other. As shown in (2), given a consonant-final stem like *bibuy*, the addition of *-n* would incur a violation of *COMPLEX, but the suffixation of *-ŋun* would not. The allomorph, *-ŋun*, is therefore chosen even though the winning candidate, (2b), violates the GENITIVE = /-n/ constraint, which requires the GENITIVE morpheme to be spelled out as *-n*.

(2) bibuy-ŋun "child-GEN"

	*COMPLEX	GENITIVE = /-n/
a. bi.buyn	*!	
☞ b. bi.buy.ŋun		*

On the other hand, the allomorph *-n* that is preferred when selecting this allomorph would not incur any unnecessary violations of *COMPLEX (3).

(3) guludu-n "dove-GEN"

	*COMPLEX	GENITIVE = /-n/
☞ a. gu.lu.dun		
b. gu.lu.du.ŋun		*!

Localist approaches to PCSA, on the other hand, would argue that the choice of an allomorph must be determined by grammatical or phonological information that is visible at the point when insertion occurs (Paster 2006a, 2009, Bye 2007, Embick 2010). The phonological well-formedness of the output plays no role in the proper selection of an allomorph from the strictly localist perspective. One class of localist theories argues for the adoption of subcategorization frames in capturing such selectional restrictions (Paster 2006b). In a subcategorization model, affixation is conceptualized in terms of the satisfaction of missing elements specified in the lexical entries of morphemes. Suppletive allomorphy, for example, can be modeled as the result of two or more phonologically distinct affixes with the same meaning having different subcategorizational requirements. The phonological condition is stated within the subcategorization frame for the specific allomorph. No global evaluation of phonological well-formedness is assumed. Thus in the case of Dja:bugay, Paster (2006b) maintains that the *-n* allomorph is left-subcategorizing for a noun that ends in a vowel, whereas the *-ŋun* allomorph has a less restricted subcategorization frame, targeting any nouns. The application of these subcategorization restrictions follows the Elsewhere Condition, or Panini's Theorem, namely, the rule or constraint with the more specific conditions should apply before the more general ones. In fact, in Paster's model, references to output phonological condition are explicitly rejected. Thus, all else being equal, (4a) would apply to all nouns that end in a vowel, whereas (4b) will apply elsewhere (i.e. nouns that end in a consonant).

(4) Subcategorization analysis (Paster 2006b)

a. Dja:bugay genitive construction A
$[[\ldots V]_{noun} - n]_{genitive\ noun}$

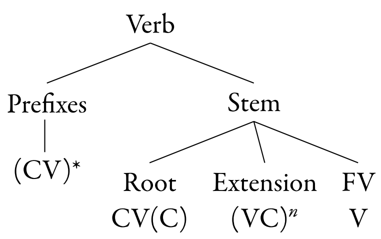
b. Dja:bugay genitive construction B
$[[\ ]_{noun} - ngun]_{genitive\ noun}$

This chapter offers two case studies of PCSA, one from Tiene (Section 1.2), a Bantu language, and another from Katu (Section 1.3), a Mon-Khmer language. The PCSAs in these languages are unique in that they both involve infixation. Our investigation suggests that a strictly input-driven subcategorization-based approach to PCSA does not offer a satisfactory account of this class of PCSA. Global optimization, which crucially references the well-formedness of output structures, is needed in allomorph selection to complement the often times limited selectional power of subcategorization restrictions.

1.2 Tiene infixation

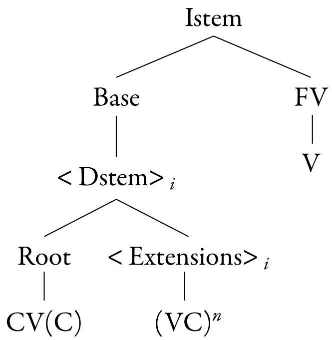
The subcategorization approach to PCSA as laid out in Paster 2009 makes, among others, one important prediction, namely, that PCSA is argued to be sensitive to only phonological elements in underlying/input forms, not in surface forms. As such, allomorph selection that is conditioned by output phonological well-formedness is out of the picture because such consideration is only possible if the surface form is referenced. The infixal PCSA in Tiene, a Bantu language spoken in the Democratic Republic of Congo, offers a curious conundrum from the perspective of a strictly input-oriented subcategorization approach to PCSA. Similar to other languages in this family, verbs have the internal structure as shown in (5), where the verb root contains three crucial subparts: the root, verbal extensions, and the final vowel (FV).

(5) Representation of the verb in Tiene



Of interest here is the nature of the output of extension suffixation in Tiene, which Hyman & Inkelas (1997) called the DStem (6). The extension suffixes are derivational suffixes, such as the passive, applicative, causative, stative, reversive, and reciprocal, among others. A DStem can contain in principle any number, including zero, of these suffixes, subject to syntactic, semantic, and morphotactic constraints on their combinations.

(6) More articulated version of verb stem in Tiene



A unique aspect of Tiene verbal extensions is that they are highly prosodically constrained (7), namely, those with at least one extension suffix may be either CVVCV or CVCVCV in shape. The non-initial consonants must agree in nasality; and in stems with three consonants (CVCVCV), the second must be coronal and the third must be noncoronal.

(7) Restrictions on extended stems in Tiene

- Prosodic shape: either CVVCV or CVCVCV
- Nasality: in CV CV CV stems, C_2, and C_3 must agree in nasality
- Place of articulation: in $C_1VC_2VC_3$ stem, C_2 must be coronal, C_3 must be grave (labial/velar)

The prosodically restricted nature of the DStem leads to an interesting case of PCSA that is governed by the templatic restrictions in (7). For a given verbal extension that has two suppletive allomorphs (e.g. stative: /-Vk/ or /-lV/; causative: /-Vs/ or /-V-/), the choice of the allomorph is determined by the well-formedness of the output. When the root is coronal-final, suffixation of a velar allomorph is observed (8a). When the root ends in a velar and the affix is coronal, such as the applicative and the causative markers, the coronal allomorph is infixed into the velar-final root (8b). When the root-final consonant is labial or velar, such as the stative and reversive, each has both a coronal and a velar allomorph, and infix coronal allomorphs (8c) instead of selecting the suffixal velar allomorphs as shown in (8a). Finally, when the root-final consonant and suffixal consonant are both coronal, "imbrication" takes place. That is, C_2 and C_3 fuse into a single surface coronal consonant (8d).

(8) Tiene extension suffix suppletive allomorphy (Ellington 1977, Hyman & Inkelas 1997, Hyman 2010).[1]

a.	[[CVT]VK]	→	-CVTVK-	[normal suffixation observed]
	bol-a "break"		bole**k**-ɛ "be broken"	<PB*-ek- [stative]
	kot-a "tie"		kote**k**-ɛ "be united"	<PB*-uk- [reversive]
b.	[[CVK]VT]	→	-CVTVK-	[infixation required]
	lók-a "vomit"		ló**s**ek-ɛ "cause to vomit"	<PB*-es- [causative]
	yók-a "hear"		yó**l**ek-ɛ "listen to"	<PB*-ed- [applicative]
c.	[[CVK]VK]	→	-CVTVK-	[-VT allomorph used instead of -VK]
	kab-a "divide"		ka**l**ab-a "be divided"	?<PB*-ad- [stative]
	sook-ɛ "put in"		so**l**ek-ɛ "take out"	<PB*-od- [reversive]
d.	[[CVT]VT]	→	-CVVT-	["imbrication" = (fusion)]
	mat-a "go away"		maas-a "make go away"	<PB*-es- [causative]
	koɲ-a "nibble'		kooɲ-ɛ "nibble for"	<PB*-ed- [applicative]

The requirement of non-initial consonants to agree in nasality leads to nasalization of some affixes (9a) and oralization of the root-final consonant in others (9b). Because the nasalization and oralization associated with the extensional affixes do not directly affect the placement of the suppletive allomorphs, the readers are referred to Hyman & Inkelas (1997) for further treatment of this topic.

(9)

a.	Nasalization (L → n, K → ŋ)	
	dum-a "run fast"	du**n**em-ɛ "run fast for" [applicative /L/]
	tim-a "dig"	ti**n**em-ɛ "dig for" [stative /K/]
b.	Denasalization (m → b)	
	dim-a "become extinguished"	di**s**e**b**-ɛ "extinguish" [causative /s/]

Following Hyman & Inkelas (1997), the extension suffixes are assumed to be underlyingly consonantal, as the quality of the suffixal vowel is predictable, namely, identical to a preceding /ɛ, ɔ, a/; otherwise, [e] after /i, u, e, o/. For reference, I will continue marking the extension affixes with an empty vowel slot to indicate ultimate form of the extension affix. To summarize then, the extension affix allomorphy involves

1. Tiene has the following consonantal inventory: /t, k, b, l, g, m, n, ɲ, ŋ/. /ŋ/ is not allowed in C_1 position in stems, whereas /g/ occurs only in that position, and only after /ŋ-/. "T" = coronal, "K" = grave, "PB" = Proto-Bantu, "L" = Labial.

not only alternation in the phonological form of the affix but also its alignment (suffixation vs. infixation; (10)).

(10)	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)

A subcategorization approach to Tiene might posit subcategorization restrictions for the stative/reverse allomorphs as follows in (11).

(11) Subcategorization analysis of Tiene stative/reversive

(a) Tiene stative/reversive construction A

$$\left[\left[\ldots \underset{[+coronal]}{C}\right]_{Root} \mathbf{Vk}\right]_{DStem}$$

(b) Tiene stative/reversive construction B

$$\left[\left[\ldots \mathbf{lV} \underset{[-coronal]}{C}\right]_{Root}\right]_{DStem}$$

The subcategorization frame in (11a) indicates that the suffix *-Vk* (in bold) left-subcategorizes for roots that end in a coronal consonant, whereas (11b) shows that the allomorph *—lV* right—subcategorizes for a root with a final noncoronal.

On the other hand, the causative affix -Vs- and -V- would have a different type of subcategorization restrictions. The analysis in (12a) indicates that one way of forming the causative is to insert an extra vowel (in bold) before the root-final coronal. Otherwise, -sV- is inserted before the root-final, non-coronal consonant (12b).[2]

(12) Subcategorization analysis of Tiene causative

(a) Tiene causative construction A

$$\left[\left[\ldots \mathbf{V} \underset{[-coronal]}{C}\right]_{Root}\right]_{DStem}$$

(b) Tiene causative construction B

$$\left[\left[\ldots \mathbf{sV} \underset{[-coronal]}{C}\right]_{Root}\right]_{DStem}$$

Although a subcategorization analysis is conceivable for Tiene, what is missing in such an account is the intuition that Tiene PCSA is templatic in nature. There is no

2. The spirantization of the root-final coronal is assumed to be accounted for by some morpho-phonological process, as specified in the co-phonology of this construction.

sense that the distribution of the allomorphs across extensions is driven by the same factors in the subcategorization analysis laid out in (11) and (12).[3]

A globalist approach to Tiene extension allomorphy, on the other hand, is able to account for the affixal allomorphy and the prosodic restrictions of the DStem in a unified way. For example, Hyman & Inkelas (1997), adopting a treatment inline with the P » M constraint schema, argue that Tiene allomorphy is a matter of output phonological template satisfaction. They first define a prosodic domain, called the Trough (13), which is a substring of the DStem where certain phonological generalizations hold (e.g., nasal harmony and restrictions on coronal distribution).

(13) Tiene DStem Trough: <C> τ <V> (where τ = VCVC, VVC)

The DStem and the prosodic Trough are subject to a co-phonology that imposes strict templatic requirements (14). To begin with, they propose the Nadir constraint, which requires that all intervocalic consonants within the trough be coronal. This constraint interacts crucially with an OCP[cor] (Obligatory Contour Principle [coronal]) constraint, which prohibits two adjacent coronals within the trough. Given that the prosodic trough can maximally admit two consonants, and because the intervocalic, thus medial, consonant must be coronal, when there are two consonants within the trough, the second consonant must be noncoronal.

(14) Co-phonology of Tiene DStem (Hyman & Inkelas 1997)

- Nadir: An intervocalic C must be coronal.
- OCP[Cor].Trough: No two adjacent coronals in the Trough.
- Align-R: Extensional affixes must be suffixed.

To illustrate the basic tenet of the analysis, consider the evaluation of an input like /lok, s/ "to vomit (caus)." Following the so-called Displacement Theory to infixation (see Yu 2007), as laid out in McCarthy & Prince 1993a, Hyman & Inkelas 1997 propose the constraint Align-R, which requires an extensional affix to be suffixal, to govern the distribution of extensional affixes. As there is not an equivalent constraint requiring extensional affixes to be infixal, their analysis essentially assumes the suffixal position to be the default position for extension affixes in general. As illustrated in (15), the default suffixal preference is subverted due to the phonological templatic restrictions of the DStem, which requires the intervocalic consonant to be coronal, all else being equal. Allowing *-s-* to appear stem-finally (15b) would incur a fatal violation of Nadir.

3. This is the morphological analog to the type of conspiracy effects commonly observed in phonology.

To avoid flouting the templatic restrictions, *-s-* is displaced from the right edge, giving rise to the semblance of infixation (15a). Crucially, *-s-* cannot appear stem-initially, as gratuitous deviation from the right edge would incur more violations of ALIGN-R, which is evaluated gradiently (15c).[4]

(15) "Infixation" without subcategorization. The trough is delineated by the parentheses.

/lok, s/	NADIR	OCP[Cor].TROUGH	ALIGN-R
☞ a. l(ósek)			*
b. l(ókes)	*!		
c s(elók)			**!

To be sure, the realization of the extension affix inside the root is not always necessary. The tableaux in (16) and (17) illustrate the surface realization of the stative, which is representative of the behavior of the reversive as well. Both the stative and reversive have two suppletive allomorphs, one coronal, represented here as /L/ as it alternates between [l] and [n] according to nasal harmony, and one velar /K/, which alternates between [k] and [ŋ]. When the root ends in a coronal, the velar allomorph is selected because the affixing of *-L-*, either as a suffix (16bi) or as an infix (16bii), would incur a fatal violation of OCP[Cor].TROUGH. The velar allomorph appears as suffixing because realizing *-K-* infixally would incur a fatal violation of NADIR, which requires the medial consonant to be coronal.

(16) No gratuitous morpheme interruption

☞ a. /yat, -K/	*NADIR	OCP[Cor].TR	ALIGN-R
☞ i. y(ata**k**)			
ii. y(a**k**at)	*!		*
b. /yat, -L/	***NADIR**	**OCP[Cor].TR**	**ALIGN-R**
i. y(ata**l**)		*!	
ii. y(a**l**at)		*!	*

When the root ends in a noncoronal consonant, infixing *-L-* is preferred because selecting the *-K-* allomorph either as a suffix (17ai) or as an infix (17aii) would incur fatal violations of NADIR. Realizing *-L-* as a suffix (17bi) would also incur a similar NADIR violation.

4. Although this study does not hinge on this technicality, it is worth noting that McCarthy (2003) argues that gradient evaluation of ALIGN leads to undesirable predictions in OT (Optimality Theory) and proposes an alternative family of ALIGN constraints that are evaluated categorically.

(17) Coronal infix selected if root ends in a noncoronal consonant

a. /kab, -K/	*Nadir	OCP[Cor].Tr	Align-R
i. k(aba**k**)	*!		
ii. k(a**k**ab)	*!		*
☞ b. /kab, -L/	*Nadir	OCP[Cor].Tr	Align-R
i. k(aba**l**)	*!		
☞ ii. k(a**l**ab)			*

Finally, for extension affixes that have only one listed allomorph, such as the causative *-s-* and the applicative *-L-*, infixation is the only viable option when the root ends in a noncoronal consonant. However, when the root is coronal-final, Tiene avoids the violation of OCP[Cor].Tr by eliminating one of the coronals in the trough. As illustrated in (18), neither suffixing (18a) nor infixing (18b) the causative *-s-* would avoid the OCP[Cor].Tr violation. Tiene satisfies this phonotactic restriction by eliminating of one of the two coronals in the prosodic trough (18), that is, imbrication.

(18) Imbrication

/mat, s/	OCP[Cor].Tr	Max(seg)
a. m(at-as)	*!	
b. m(a-s-at)	*!	
☞ c m(a-a-s)		*

As noted in Hyman & Inkelas 1997, whereas the surviving coronal always occurs at the end of the output, the identity of the surviving coronal is predictable phonologically and may be captured in terms of markedness relations in OT. That is, assuming that Max(Strident) » Max(Obstruent) » Max(Sonorant), the identity of the surviving coronal would follow the preference of preserving stridents over obstruents, which in turn are more important than sonorants.

1.2.1 Summary

In this section, we examined the case of extensional affixal allomorphy in Tiene. This PCSA not only involves suppletion, but it also exhibits differences in morphological alignment. The choice of locating an affixal exponent inside or outside of the root, following Hyman & Inkelas (1997), is determined by high ranking output well-formedness constraints. The appeal to output phonological templatic considerations is not available within an input-oriented and strictly localist subcategorization approach to PCSA. To be sure, the subcategorization approach can accommodate the facts of Tiene extension allomorphy. However, the loss of generalization regarding the templatic restrictions seems to be a clear missed opportunity. The globalist approach, as articulated in Hyman & Inkelas 1997, has the advantage of being able to capitalize on the output templatic generalization of the DStem and derive the choice and positioning of the extensional affixal allomorphs via the same phonological mechanisms that give rise to the templatic restrictions.

In the next section, we consider a case of PCSA where a purely input-oriented subcategorization approach to PCSA is clearly inadequate. We advance an analysis of PCSA, within the framework of Sign-Based Morphology, that retains the virtues of both the subcategorization approach to PCSA as well as the globalist mantra of output-oriented phonological optimization, without the trappings of the strictly globalist P » M approach, by restricting the interaction of morphological alignment and phonological optimization.

1.3 Katu nominalization

Katu is a Mon-Khmer language spoken in Vietnam and Laos. The data discussed here are based on the dialect spoken in Laos as reported in Costello 1998. Deverbal nominalization in Laotian Katu denotes the "result of the action performed, or that which is acted upon, the direct object of the root action" (Costello 1998:36). Deverbal nominalization has multiple exponents. Some verbs are deverbalized via prefixation, whereas others via infixation. There are a variety of prefixes, the most common variant being *phar-* (19a); others include *ar-* (19b), *aN-* (19c), *tar-* (19d), *tri-* (19e), and *i-* (19f).

(19) Examples of Katu prefixal nominalization[5]

a.	vôôch	"to go"	**phar**vôôch	"behavior"
	cha	"to eat"	**phar**cha	"something eaten"
	châng	"to use"	**phar**châng	"something used"
	laat	"to make a sign"	**phar**laat	"a sign"
	at	"to remain"	**phar**at	"place to remain"
	mamông	"to be alive"	**phar**mông	"livelihood"
	hiên	"to study" (Lao)	**phar**hiên	"study, education"
	chut	"to make comma" (Lao)	**phar**chut	"comma"
	lôp	"minus" (Lao)	**phar**lôp	"minus"
	haan	"to divide" (Lao)	**phar**haan	"division"
b.	a	"to judge"	**ar**a	"judgment"
	kâl	"to exchange"	**ar**kâl	"goods exchanged"

5. The forms are cited in the romanized transcription (Quôc ngữ) of the language, which was also employed in Costello 1998. The International Phonetic Alphabet correspondences are as follows: ê = [e], e = [ɛ], ô = [o], o = [ɔ], ơ = [ɤ], ư = [ɯ], ï£¡ = [ə], ch = [ts], ó = [ɒ], nh = [ɲ], d = [d], đ = [ʔd], dy = [ʔj], b = [b], ƀ = [ʔb], ng = [ŋ], q = [ʔ].

	oop	"to wrap"	**ar**oop	"wrapping"
	chuh	"blow on (to kill)"	**ar**chuh	"the blowing on (to kill)"
	teek	"to break"	**ar**teek	"breakage"
	mimưưl	"to perform ritual with rice and sword"	**ar**mưưl	"ritual with rice and sword"
c.	suôr	"to relate story"	**an**suôr	"folktale, story"
	baat	"to be very sick"	**am**baat	"serious sickness"
	ƀes	"to have bad luck"	**am**ƀes	"bad luck"
	kuôt	"to tie knot"	**ang**kuôt	"a knot"
d.	nil	"to make a pattern"	**tar**nil	"a pattern"
e.	trơs	"to chase spirits away"	**tri**trơs	"chasing away of spirits"
	traas	"to wipe spirits away"	**tri**trras	"the wiping away of spirits"
f.	lêh	"to free"	**i**lêh	"the freeing"
	hai	"to remember"	**i**hai	"regret"

Of particular interest here are the infixal variants. Like the prefixal variants, the derived noun is usually "the result of the action performed, the direct object of the root action, but sometimes the derived noun with the infix /*an*/ has the meaning of location, the place where the action was performed" (Costello 1998:39). Unlike the prefixal variants, however, the distribution of the infixal allomorphs appears to be phonologically governed. When the root is disyllabic, -*r*- is infixed after the first vowel (20a). When the root begins with two consonants, the vowel -*a*- is inserted between the initial consonants (20b).[6] When the root is monosyllabic, -*an*- is inserted before the nucleus (20c). The only exception noted in Costello 1998 involves the infix -*arn*- (e.g., *tôôp* "to begin" ~ ***tarn**ôôp* "beginning"; *teh* "to hammer" ~ ***tarn**eh* "hammer")

(20) Examples of Katu infixal nominalization

a.	katas	"to name"	ka**r**tas	"name"
	kachêt	"to kill"	ka**r**chêt	"dead"
	kanoq	"to think"	ka**r**noq	"thinking"
	mamông	"to be alive"	ma**r**mông	"characteristics of life"
	saveeng	"to be between"	sa**r**veeng	"place between"
	tapưưng	"to put roof on"	ta**r**pưưng	"roof"
	achia	"to give"	a**r**chia	"things given"
	alôôm	"to offer gift"	a**r**lôôm	"gift offered"

6. The only exception to this is *phlâi* "to buy" where -*ar*- appears (***phar**lâi* "something bought"), instead of -*a*-. However, it is possible that this is an example of prefixing nominalization with *phar*- already mentioned in (19a), rather than with the infixing -*ar*-, particularly because Katu regularly truncates roots to accommodate prefixes (see discussion related to (33) for more information).

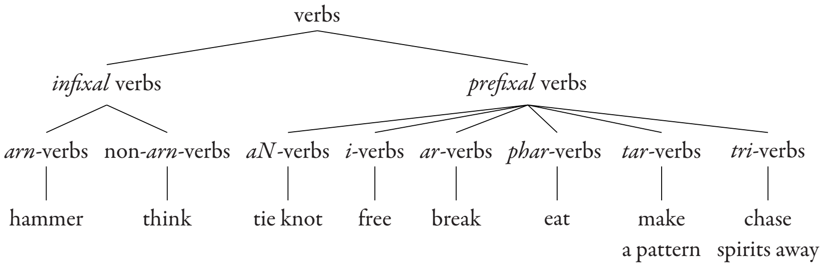
b.	kloos	"to exchange"	k**a**loos	"an exchange"
	klam	"make tree shrine"	k**a**lam	"tree shrine"
	kroong	"make fence"	k**a**roong	"fence"
	trooq	"make enclosure"	t**a**rooq	"enclosure"
	praang	"to cross bridge"	p**a**raang	"bridge"
	plah	"to divide"	p**a**lah	"division"
	pleh	"to turn on road"	p**a**leh	"crossroads"
c.	kui	"to carry on back"	k**an**ui	"something carried on back"
	tôl	"to put post in"	t**an**ôl	"post"
	pó	"to dream"	p**an**ó	"a dream"
	kuôl	"to have resources"	k**an**uôl	"resources, strength"
	pók	"to make idol"	p**an**ók	"idol"
	cai	"to judge"	c**an**ai	"judgement"
	kuuk	"to wear necklace"	k**an**uuk	"necklace"
	phaar	"to feed animal"	ph**an**aar	"food given to animal"

Several aspects of Katu deverbal nominalization are clear. To begin with, the choice between prefixal and infixal nominalization must be lexically determined, as Costello found no morphosyntactic/morphosemantic factors that govern the distribution. Second, the distribution of prefixal allomorphs must also be lexically determined, and it contrasts with the infixal variants, which are by and large phonologically conditioned. In what follows, we present an analysis of Katu deverbal nominalization that captures the lexical specificity as well as the partial phonological predictability of this case of suppletive allomorphy.

1.3.1 Analysis

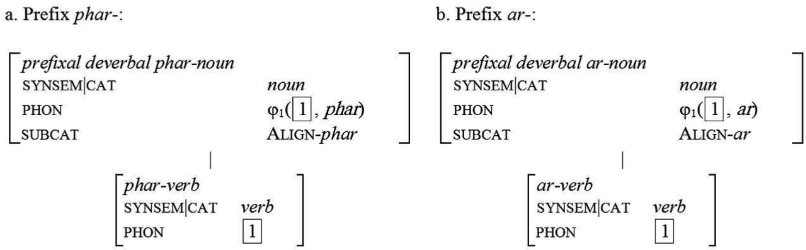
To account for the many morphological idiosyncrasies and phonological subregularities of deverbal nominalization in Katu, we couch our analysis within a framework of morphology called Sign-Based Morphology (SBM; Orgun 1996, 1999, Orgun & Inkelas 2002, Yu 2007), a declarative, non-derivational theory of the morphology-phonology interface that utilizes the basic tools one finds in any constituent structure-based unificational approach to linguistics (e.g. Construction Grammar: Kay & Fillmore 1999; and HPSG [Head-Driven Phrase Structure Grammar]: Pollard & Sag 1987, 1994). Briefly, SBM assumes that the fundamental objects of linguistic analysis are signs, modeled by feature structures, which are sorted (or typed). The sort indicates what kind of object is being described. Type hierarchy, a device that is already widely employed in the treatment of other morphological problems (Flickinger 1987, Koenig 1994, 1999, Koenig & Jurafsky 1995, Orgun 1995, Orgun & Inkelas 2002, Riehemann 2001), is generally represented as a lattice with the maximally general type at the top and the specific type at the bottom. Type hierarchy captures generalizations across constructions by extracting such generalizations into a supertype (i.e. the notion of subsumption). It provides a natural way to express which features are appropriate to which kinds of items and what range of specifications are possible for the value of a given attribute.

(21) Katu verbal lexicon: prefixal verb type vs. infixal verb type



Because of its reliance on type hierarchy, SBM is particularly suited to capture the complex web of interrelated morphological operations that are associated with the same morphosyntactic construction. To account for the dichotomy between verbs that take a prefixal nominalizer and those that take an infixal one, for example, we propose the type hierarchy in (21) for the Katu nominalizable verbs. To begin with, verbs are divided into two subtypes, *prefixal verbs* and *infixal verbs*. The lexical type, *prefixal verbs*, in turn, has six subtypes; each subtype is associated with one of the verb types that takes a unique prefixal nominalizer. Constraints such as those in (22) specify how to spell out different types of prefixal deverbal nouns. Thus, for example, a prefixal deverbal *phar*-noun would require an input of the lexical type *phar-verb*, whereas a prefixal deverbal *ar*-noun would require an input of the type *ar-verb*.

(22) Sample prefixal deverbal nominalization constructions



There are also multiple ways to spell out infixal deverbal nouns. To capture the idiosyncrasies of the verbs that take the infix *-arn-*, we posit a subtype of *infixal verbs*, called *arn-verbs*. The remaining set of *infixal verbs* is referred to as the *non-arn-verbs*.

These *non-arn-verbs* form their nominalized counterparts by one of the two exponents stated in (23).

(23) Infixal deverbal nominalization constructions

a. Infixing allomorph *-r-*:

$$\begin{array}{c} \begin{bmatrix} \textit{infixal deverbal non-arn-noun} & \\ \text{SYNSEM|CAT} & \textit{noun} \\ \text{PHON} & \varphi_1(\boxed{1}, r) \\ \text{SUBCAT} & \text{ALIGN-}r \end{bmatrix} \\ | \\ \begin{bmatrix} \textit{non-arn-infixal verb} & \\ \text{SYNSEM|CAT} & \textit{verb} \\ \text{PHON} & \boxed{1} \end{bmatrix} \end{array}$$

b. Infixing allomorph *-an-*:

$$\begin{array}{c} \begin{bmatrix} \textit{infixal deverbal non-arn-noun} & \\ \text{SYNSEM|CAT} & \textit{noun} \\ \text{PHON} & \varphi_1(\boxed{1}, an) \\ \text{SUBCAT} & \text{ALIGN-}an \end{bmatrix} \\ | \\ \begin{bmatrix} \textit{non-arn-infixal verb} & \\ \text{SYNSEM|CAT} & \textit{verb} \\ \text{PHON} & \boxed{1} \end{bmatrix} \end{array}$$

The constraints in (23) show that the type *infixal deverbal non-arn-noun* can be satisfied in one of two ways. Unlike the prefixal deverbal nouns, where the suppletive exponents require different input lexical types, infixal deverbal *non-arn-nouns* take the lexical type *non-arn-infixal verb* as their input. However, in terms of the subcategorization restrictions, each construction in (23) is associated with its own subcategorization restriction requirement, modeled here using the schema of Generalized Alignment (McCarthy & Prince 1993a). Following the Pivot/Anchor Point Theory (Nevins & Vaux 2003, Yu 2003, 2007, Samuels 2010), the infixal property of the allomorphs is seen as a consequence of pivot subcategorization. That is, unlike prefixes and suffixes, infixes target pivots/anchor points whose edges do not necessarily coincide with any morphological boundaries. When a morph targets an edge of a pivot that does not coincide with a morphological edge and if the target edge of the pivot is followed by additional phonological materials, infixation obtains. As shown in (24), the *-an-* allomorph must come after the first consonant of the deverbal noun (24a),[7] whereas *-r-* must come after the first vowel of a deverbal noun (24b).

(24) SUBCAT requirements for the nominalization allomorphs for the infixal verbs

(a) ALIGN(*an*, L, C_1, R):
$\forall an \exists C_1$(Coincide(LEFT(*an*), RIGHT(C_1))
"The left edge of *-an-* should coincide with the right edge of the C_1 of the stem."

7. The reference to non-prosodic units, such as a consonant, as a pivot in alignment is not without precedent in OT; see formulation of the ONSET and NOCODA constraints (McCarthy & Prince 1993a, Ito & Mester 1999) for example.

(b) ALIGN(r, L, V_1, R):
$\forall r \exists V_1$(Coincide(LEFT(r), RIGHT(V_1))
"The left edge of *-r-* should coincide with the right edge of the first vowel of the root."

Thus far, the analysis proposed is consistent with the subcategorization approach articulated in Paster 2006b. Each allomorph is paired with its own subcategorization restriction. However, further examination reveals that the choice of allomorph cannot be determined solely by the subcategorization restrictions of the allomorphs alone. As illustrated in (25), there are many possible outputs that can satisfy the constraints in (23). In this case, given an infixal verb /katas/ "to name," there are at least four possible output forms predicted by (23). Yet, only (25e) is attested.

(25) Input /katas, {*-r-*, *-an-*}/ "name"[8]

		ALIGN-*an*	ALIGN-*r*
	a. ka**an**tas	*!	
	b. ka**n**tas	*!	
	c. k**r**atas		*!
	d. kat**r**as		*!
☞	e. ka**r**tas		
☹	f. k**an**atas		
☹	g. k**an**tas		
☹	h. k**a**tas		

The choice between the *-r-* and the *-an-* allomorphs, we argue, must reference the phonology of Katu.[9] To begin with, words in Katu are prosodically very restricted (26). Katu words are maximally disyllabic. The main syllable, which is always the rightmost syllable and stressed, is maximally (C_1)(C_2)V(C_3) where C_2, if present, must be /r/ or /l/. If a word is disyllabic, the syllable before the main syllable (i.e. the so-called presyllable) may be maximally (C)(C)V(C) where the second prevocalic consonant, if

8. For the sake of convenience, the evaluation of subcategorization requirement satisfaction is presented in tableau form, but subcategorization restriction satisfaction is not actually violable in the theoretical approach adopted in this work. Candidates with a sad face denote unattested outputs that are nonetheless predicted by (23).

9. A similar proposal appealing to the word prosody of Katu to account for the infixal allomorphy was also advanced in Horwood (2008). However, Horwood (2008) assumes a morphological analysis whereby there is only one underlying /ar/ infix whose three surface allomorphs, [ar], [r], [a], are assumed to be predicted by the word prosody of the language. No treatment of the *-an-* allomorph is given. It is thus difficult to compare Horwood's analysis with the analysis proposed here because the range of data accounted for is different.

present, must be /r/, the vowel is either /i/ or /a/, and the coda may be /r/ or /n/. The coda nasal of the presyllable must also be homorganic with the following consonant. The last bullet point of (26) illustrates the maximal disyllabic word allowed in Katu.

(26) Properties of words in Katu:

- Words are maximally two syllables.
- The main syllable may be $(C_1)(C_2)V(C_3)$. C_2 must be /r/ or /l/.
- The presyllable may consists of $(C_1)(C_2)V(C_3)$. V must be /i/ or /a/, C_2 must be /r/, and C_3 may be /r/ or /n/.
- $_{Prwd}[_{Ft}[(_{\sigma}[(\mathrm{C})(\mathrm{r})\{^{a}_{i}\}(\{^{N}_{r}\})])_{\sigma}[(\mathrm{C})(\{^{r}_{l}\})\mathrm{V}(\mathrm{C})]]]$

With these restrictions in mind, let us first account for the allomorphic choice when the root begins with a consonant cluster. Four constraints are relevant for this discussion. MAX-ROOT-SEG(MENT) and MAX-AFFIX-SEG(MENT) penalizes the deletion of input root segments and input affix segments, respectively. MAX-M(ORPHEME), which is undominated, penalizes outputs that do not have some correspondents of all input morphemes. Finally, CODACON(DITION) is a cover constraint that captures both the homorganicity requirement of coda nasal as well as the lack of coda clusters in the language.

(27) Constraints on allomorph realization

MAX-ROOT-SEG(MENT)	"All root segments in the input must have a correspondent in the output."
MAX-AFFIX-SEG(MENT)	"All affix segments in the input must have a correspondent in the output."
MAX-M(ORPHEME)	"All morphemes in the input must have a correspondent in the output."
CODACON(DITION)	"A coda nasal is only allowed when linked to a following consonant; complex coda is not allowed."

Given the constraints in (27), we see in (28) that the *-r-* allomorph (28c) is ruled out, as its presence in the coda would incur a fatal violation of CODACON. Avoiding the CODACON violation by reducing the complexity of the coda is not acceptable, as such a candidate, (28d), would fatally violate MAX-ROOT-SEG, which militates against unfaithful realization of input segments of the root in the output. To be sure, not realizing an exponent of the deverbal nominalizing morpheme is not an option either, as such a candidate would fatally violate the undominated MAX-M constraint (28e), which penalizes a candidate having the morphological feature not spelled out by some exponent in the output. Just because the *-r-* allomorph is not viable in this form, it does not mean that the *-an-* allomorph would get an automatic go-ahead. As shown in (28b), it is not viable to simply realize *-an-* in full because such a candidate would incur a fatal CodaCon violation as the coda nasal does not share place features with a following obstruent. In the end, the winning candidate partially realizes *-an-* by sacrificing the *-n-* of the infixal nominalizer (28a), thus avoiding any CodaCon violation. Relative to (28d), we see that it is more important to preserve root segments in the output (28a) than the affixal segments (i.e. Max-Root-Seg » Max-Affix-Seg).

(28) Input /plah, {*-r-*, *-an-*}/ "division"

	Max-M	Max-Root-Seg	CodaCon	Max-Affix-Seg
☞ a. p**a**lah				*
b. p**an**lah			*!	
c. pla**r**h			*!	
d. pla**r**		*!		
e. plah	*!			

Although the illustration in (28) showcases the selection of *-an-* as the allomorph, it is not clear under what circumstance would *-r-* be selected. The tableau in (29) illustrates this point. For a given disyllabic stem, there appears to be two possible outputs of deverbal nominalization. As shown in (29a) and (29b), both subcategorization requirements of *-an-* and *-r-* are satisfied, respectively. Neither violate any phonotactic restrictions given in (27).

(29) Input /katas, {*-r-*, *-an-*}/ "name"

	Max-M	Max-Root-Seg	CodaCon	Max-Affix-Seg
☞ a. ka**r**tas				
☹ b. k**an**atas				

Strictly speaking, from the perspective of OT, (29a) is preferred over (29b), given that (29b) has more segments than (29a), which would incur more *Struc violation, all else being equal. However, appealing to *Struc would predict the wrong outcome in (30) where the root is monosyllabic because the actual attested form, (30a), has more segments than the competitor, (30b).

(30) Input /pó, {*-r-*, *-an-*}/ "dream"

	Max-M	Max-Root-Seg	CodaCon	Max-Affix-Seg
☞ a. p**an**ó				
☹ b. pó**r**				

To be sure, there is nothing intrinsically problematic with having a coda /r/ in Katu monosyllables (31). So, what factor would favor the selection of (29a) and (30a) over (29b) and (30b) respectively?

(31) Examples of monosyllabic words

siêr	"to come down"
yuur	"to rise"
suôr	"to relate story"
tơr	"to go around"

We argue that proper allomorph selection of the deverbal nominalizer hinges on the satisfaction of the word maximality constraint (Ito & Mester 1992, de Lacy 2003) in (32).

(32) WORD=$FT_{\sigma\sigma}$

$\forall\omega(\omega = FT_{\sigma\sigma})$

"A lexical word must constitute an exact disyllabic foot."

Recall that words in Katu are maximally disyllabic in length. This requirement prevents affixation to create words that are longer than two syllables. Evidence for this maximality restriction can be seen even outside the domain of infixal allomorph selection. As illustrated in (33), when a prefix is added to a disyllabic root, the presyllable of the disyllabic root is "truncated" to accommodate the prefix (e.g. the verbal form of *pharhôôm* "breath" is *pihôôm* "to breathe," not **pipharhôôm*).

(33) Word maximality in Katu

ayuôq	"to be sour"	/pa+ayuôq/	payuôq	"to make sour"
mamông	"to steam"	/phar+mamông/	pharmông	"livelihood" (*pharmamông)
pharhôôm	"breath"	/pi+pharhôôm/	pihôôm	"to breathe"
mimưưl	"to perform ritual with rice and sword"	/ar+mimưưl/	armưưl	"ritual with rice and sword"

With the word maximality constraint in place, it is clear why (29a) with the *-r-* allomorph is favored over the (29b); (29b) is more than two syllables long, thus violating the disyllabic maximality requirement. This same maximality requirement also motivates the selection of (30a) over (30b). As illustrated in (34), all else being equal, Katu is predicted to prefer outputs to be disyllabic rather than candidates that are smaller in size. Thus, given the opportunity, Katu chooses an allomorph that yields disyllabic output, rather than monosyllabic ones.

(34) Input /pó, {*-r-*, *-an-*}/ "dream"

	Max-M	Max-Root-Seg	Word=Ft	Max-Affix-Seg
☞ a. p**an**ó				
b. pó**r**			*!	

Before closing, two aspects of this analysis require further qualification, however. Recall that when a disyllabic root is prefixed, the presyllable is truncated to accommodate the prefixal syllable. Yet, as argued previously, the ranking Max-Root-Seg » Max-Affix-Seg predicts the preservation of the root materials over the preservation of the affixal ones. The examples in (33) thus argue for the need to distinguish faithfulness to the presyllable from faithfulness to the main syllable. To this end, we argue that the constraint, Head-Dependence (35), which involves faithfulness with special reference to the prosodic head, such as the syllable heads of metrical feet or the main stress foot of a prosodic word, must be at work here. In the case of Katu, the stressed syllable is always the rightmost syllable of the word.

(35) Head-Dependence (Alderete 1999)

Every segment contained in a prosodic head in S_2 has a correspondent in S_1. If β is contained in a prosodic head in S_2, then $\beta \in \text{range}(\Re)$.

As illustrated in (36), morphological truncation of the root in prefixation results from the interaction between word maximality and faithfulness. That is, the fully faithful candidate, (36b), is not viable, as it fatally violates the word maximality constraint. Satisfying word maximality by not realizing the prefix *phar-* would in turn fatally violate Max-Morpheme (36d). The only viable option is to accommodate the prefix by reducing the root. There are two main options to root reduction: either the presyllable is truncated (36a) or the main syllable is (36c). Because of the dominance of Head-Dependence, the preservation of the stressed syllable (i.e. the final syllable) trumps the preservation of the presyllable, which is unstressed, thus allowing (36a) to be the winner.[10]

10. The introduction of Head-Dependence does not obviate the need of Max-Root-Seg. As seen in (29), faithfulness to root materials in the presyllable is needed to rule out possible realization of the *-an-* allomorph with disyllabic roots. Candidates like (29c) and (29d), which involve the deletion of the underlying presyllable nucleus in favor of the vowel of the infix, would be viable competitors to the winning candidate (29a) if Max-Root-Seg is replaced with Head-Dependence because Head-Dependence would have no control over the unfaithful realization of non-head materials.

(36) Input /phar+mamông/ "livelihood"

	MAX-M	HD-DEP	WD=FT	MAX-RT-SEG	MAX-AFX-SEG
☞ a. pharmông				**	
b. pharmamông			*!		
c. pharmam		*!*		**	
d. mamông	*!				

Another issue concerning the effects of word maximality is the fact that there exists plenty of underived forms that are monosyllabic (37), suggesting that word maximality is an instance of derived environment effects (Kiparsky 1993), as underived forms are exempted or not subject to the same output-size requirement as derived forms.

(37) Monosyllabic words in Katu

chô	"to return"
tri	"mushroom"
kre	"to be right"
yê	"to finish"
cha	"to eat"
a	"to judge"

Gratuitous enlargement of monomorphemic words, we argue, is prevented by the ranking of DEP, which penalizes output segments that do not have input correspondents, above WORD=FT$_{\sigma\sigma}$. This means that monosyllabic words cannot be expanded by way of epenthesis. The final constraint hierarchy for Katu deverbal nominalization is given in (38).

(38) MAX-M, HEAD-DEPENDENCE, DEP » WORD=FT$_{\sigma\sigma}$ » CODACON, MAX-AFFIX-SEG » MAX-AFFIX-SEG

1.3.2 Discussion

Katu deverbal nominalization allomorphy illustrates two important points. First, it shows that subcategorization alone does not always determine allomorph selection. Subcategorization restrictions, in this case, provide a means to handle linearization; they determine whether an exponence appears as an infix or not. The ultimate choice between the allomorphs is determined by global considerations, namely, the size of the output, rather than by the immediate adjacent environments relative to the allomorph. Katu deverbal nominalization suppletive allomorphy thus constitutes a counterexample to the restricted predictions laid out in Paster 2009. Katu infixal nominalization allomorphy relies on global prosodic well-formedness to adjudicate between allomorphs, thus runs counter to the prediction that phonological conditions on PCSA can come only from the "inside." Moreover, whereas affix allomorphs subcategorize for phonological elements of the stems that are adjacent to themselves, nonetheless, the subcategorized phonological elements themselves are not what determine allomorph selection.

It is worth noting that although we couched the analysis of Katu infixal PCSA within Sign-Based Morphology in part due to problems of the displacement ($P \gg M$) approach to infixation reviewed in Yu (2007), Katu infixal nominalizer can be analyzed in a strictly globalist $P \gg M$ approach. The next section briefly presents one such analysis.

1.4 A $P \gg M$ approach to Katu infixal allomorphy

The fact that Katu infixal allomorph selection relies heavily on the prosodic well-formedness of the output to adjudicate between allomorphs is very reminiscent of the type of Displacement-Theoretic approach to infixation alluded to in the treatment of Tiene affixal allomorphy. That is, the infixation of the allomorphs of Katu verbal nominalizer can be seen as the result of an affix being displaced from the edge in response to the prosodic restrictions the language imposes on the output.

(39) ALIGN-L: The nominalizing affix must be prefixed.

For example, assuming that affixes are prefixes by default (i.e. there exists an alignment constraint that requires the nominalizing affix to be prefixal (39)), in the case of *katas* "to name," the prefixing of *an-* (e.g. *an-katas) would violate the maximality requirement (40c). The prefixing of *r-* (*rkatas) would presumably violate some sonority sequencing requirement of the language that bans *-rC-* sequences as possible onset cluster (40d). Following the logic of P >> M, when the prosodic restrictions of the output trump the prefixal requirement of the nominalizers, the default alignment preference for affixes in the language could yield and allow an allomorph, in this case, *-r-*, to be infixed. Crucially, infixing *-an-* would not resolve the word maximality requirement (40b).

(40) Input /katas, {*-r-*, *-an-*}/ "name"

	WORD=FT$_{\sigma\sigma}$	*SONSEQ	ALIGN-L
☞ a. ka**r**tas			*
b. k**an**atas	*!		
c. **an**katas	*!		
d. **r**katas		*!	

To be sure, displacement from the edge is predicted to be minimal in a $P \gg M$ approach to infixation. Thus, all else being equal, displacing *-r-* to the right of the onset would have placated the sonority sequencing requirement (41b). Yet, *-r-* appears in the coda of the first syllable instead. The fact that (41a) is preferred over (41b) could be attributed to the emergence of the unmarked (McCarthy & Prince 1994). That is, although the language tolerates complex onsets in general, it is dispreferred in the context of nominalization.

(41) Input /katas, {*-r-*, *-an-*}/ "name"

	*Complex	*SonSeq	Align-L
☞ a. ka**r**tas			*
b. k**r**atas	*!		*
c. **r**katas		*!	

The dispreference of complex onset presumably also explains why *-a-* is infixed in words like *kroong* "make fence" as **kr**an**oong* would have more *Complex violation than *karoong* "fence." The nasal of the *-an-* is eliminated presumably due to the same CodaCon condition laid out in (27).

1.5 Conclusions

In this chapter, we reviewed two case studies of PCSA, demonstrating that a strictly localist that requires suppletive allomoprhy to be entirely input-driven, as laid out in Paster (2009) for example, is neither a necessary nor sufficient condition for PCSA. We demonstrate, in the study of Katu deverbal nominalization, that a subcategorization approach can fruitfully interface with output well-formedness optimization. Global phonological considerations can come into play in suppletive allomorph selection. This conclusion thus echoes that of Embick (2010), who also points out that global optimization is not intrinsically incompatible with localist approaches (see, e.g. Bye & Svenonius 2012). The case studies also highlight the conceptual distinction between the linear distribution and allomorphic selection aspects of morphological realization. These two aspects of morpheme realization are often conflated in adpositional affixation because the affix allomorphs are adjacent to the phonological elements of the stems that condition their distribution. As illustrated in the case studies previously, it is only when the stars misalign (i.e. when the element subcategorized by the allomorph does not coincide with what determines allomorph selection) that the morphological alignment and allomorph selection can be teased apart.

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