Bantu imbrication and the nature of specific constraints*

Michael Key
University of Massachusetts Amherst

Contents

*I would like to thank John McCarthy and Joe Pater for their ideas which comprise a considerable portion of the analysis. Their patience and encouragement undoubtedly made this a better paper. I would also like to thank Tom Roeper for helpful suggestions on the exposition. I owe a debt of gratitude to Lee Bickmore, from whom I first learned about imbrication and who provided me at a moment's notice with innumerable data from his field notes. I have also benefitted from discussion of various ideas and issues in this paper with Michael Becker, Tim Beechey, Mokaya Bosire, Luigi Burzio, Paul de Lacy, Kathryn Flack, Shigeto Kawahara, Alexandre Kimenyi, Géraldine Legendre, Michael Marlo, David Odden, Alan Prince, Paul Smolensky, Matthew Wolf, and the audience at HUMDRUM 2006 (not necessarily disjoint from the preceding). Persisting defects of analysis or description are to be attributed to me alone.

1 Introduction

In many Bantu languages, a suffix /-il/ marks the perfective aspect, applicative, and other grammatical distinctions. Examples from the Zambian language Chilungu are shown in (1) and (2).

(1) Perfective /-il/

a. tw-aa-zuus-il-e 'we got cold'
b. tw-aa-fuz-il-e 'we washed'
c. tw-aa-beleenz-il-e 'we read'

(2) Applicative /-il/

a. tw-aa-ful-il-a 'we wash for'
b. tw-aa-cuul-il-a 'we suffer for'
c. tw-aa-paapaatiik-il-a 'we flatten for'

The behavior of these homophonous suffixes is unremarkable in the examples in (1) and (2).

When the perfective and applicative suffixes are attached to bases meeting certain phonological conditions (to be described below), the perfective is expressed by a complex unfaithful mapping known as *imbrication* (Bastin 1983).

(3) Perfective /-il/ undergoes imbrication

a. u-ku-paapaatik-a 'to flatten'
b. ya-a-paapaat**iik**-e from /ya-a-paapaatik-il-e/ 'they flattened'

c. u-ku-lamuk-a 'to greet'
d. ya-a-lamw**iik**-e from /ya-a-lamuk-il-e/ 'they greeted'

e. u-ku-kutumal-a ‘to keep quiet’
f. ya-a-kutum**iil**-e from /ya-a-kutumal-il-e/ ‘they kept quiet’

(4) Applicative /-il/ does not imbricate

a. u-ku-paapaatik-a ‘to flatten’
b. u-ku-paapaatik-il-a ‘to flatten for’

c. u-ku-lamuk-a ‘to greet’
d. u-ku-lamuk-il-a ‘to greet for’

e. u-ku-kutumal-a ‘to keep quiet’
f. u-ku-kutumal-il-a ‘to keep quiet for’

A schematic illustration of imbrication is provided in (5).[1]

(5) Schema of imbrication

$/\ldots V_1C_2\text{-}i_3l_4\text{-}e_5/ \rightarrow V_1V_3C_2e_5$

In (6), a subset of the generalizations about imbrication is provided, which are evident from the data in (3) and (4) and the schema in (5).

(6) Some generalizations about imbrication

a. Imbrication involves phonological metathesis (i.e. $/C_2\text{-}i_3/ \rightarrow V_3C_2$).
b. Imbrication involves consonant deletion (i.e. of l_4)
c. Imbrication involves vowel hiatus resolution phenomena (e.g. vowel deletion, gliding, compensatory lengthening).

However, there is one true generalization about imbrication that seems to have escaped notice in previous literature:

(7) Imbrication involves the creation of a bimoraic syllable that is penultimate in the word.

In the analysis to be presented, the generalization in (7) is argued to be the basic compulsion for imbrication – some pressure wanting a bimoraic penult is satisfied by metathesis which, in turn, creates ill-formed strings that are repaired by consonant deletion and hiatus resolution phenomena. The chain of causation is schematized in (8).

[1] Other terms for this phenomenon in previous literature include ablaut (Kisseberth and Abashiekh 1974), fusion (De Blois 1975), and formation of a modified base (Ashton et al. 1954, Givón 1970, Mould 1973).

(8) *Need for a bimoraic penult →*
Metathesis →
Consonant deletion/vowel hiatus resolution ≡
'imbrication'

By assuming a version of STRESS-TO-WEIGHT (discussed in Prince 1990, Kager 1999a, Gouskova 2003) that is lexically-indexed to the class of imbricating suffixes, the analysis captures the idiosyncrasy of the suffixes involved in inducing imbrication.

Beyond accounting for the most basic and systematic facts about imbrication, this paper attempts to answer some basic questions about the formal nature of certain types of *specific* constraints. Broadly speaking, specific constraints are those that apply in a certain domain, whether to certain morphemes or to certain prominent morphological (e.g. root) or morphophonological positions (e.g. root-initial syllable). Thus, the analysis of imbrication to be presented in this paper raises a number of issues in Optimality Theory (OT) (Prince and Smolensky 2004), particularly regarding the structure and formal character of CON:

First, this paper, following other work in OT on lexically-specific constraints (Coetzee and Pater 2005, Flack to appear, Fukuzawa 1999, Gelbart 2005, Itô and Mester 1999, 2001, Kraska-Szlenk 1997, 1999, Ota 2004, Pater 2000, to appear, Wolf and McCarthy 2007) aims to elucidate some aspects regarding the formal nature of arbitrary lexical indexation of morphemes and markedness constraints. This issue arises conspicuously in the study of imbrication because imbrication is exhibited by the perfective and other suffixes (of a historically well-defined class), but typically not by the applicative and other phonologically similar suffixes, which are standardly assumed to have a different etymology. In particular, the question of the domain of evaluation of lexically-specific constraints is addressed, and evidence from imbrication adduced to support the position that specific constraints apply if and only if some phonological exponent bearing the index is included in the locus of violation of the relevant constraint. In particular, this paper presents additional arguments for a schema for specific constraints first proposed in Pater (to appear). As such, this paper fails to find evidence for the less restrictive position that specific constraints apply within the entire morphological word of which the indexed morpheme is a member, as is argued in Flack (to appear), Ota (2004), and Wolf and McCarthy (2007).

A second related issue concerns the interpretation of faithfulness constraints that apply in specific domains, of which two basic types can be identified: (i) those with arbitrary specification; (ii) those with non-arbitrary specification. Faithfulness constraints with arbitrary specification include those that are indexed to particular morphemes or, via the assignment of an arbitrary index, a class of morphemes. In the course of the analysis of imbrication, versions of the correspondence constraints LINEARITY and CONTIGUITY, indexed to the class of morphemes failing to undergo imbrication, are defined in detail and application to empirical issues is discussed (see §4.2).

Faithfulness constraints with non-arbitrary specification apply in familiar domains such as initial-syllable, root, and stem. For imbrication, specific faithfulness to root-initial syllables (Beckman 1997, 1998) is needed to explain why imbrication does not apply when the preceding stem is too small. See §5 for discussion and analysis.

While faithfulness constraints of both types have been proposed in the OT literature, no general formal connection between the formulation of the two types has been explicitly made. As such, this paper proposes a uniform definition of specific constraints referring to multiple correspondence relations, particularly LINEARITY, CONTIGUITY, UNIFORMITY, and INTEGRITY (McCarthy and Prince 1995, 1999), with both arbitrary and non-arbitrary specification. The schema that underlies the proposed definitions of specific multiple correspondence constraints is stated in (9).

(9) Exhaustiveness of multiple correspondence
Let F be a multiple correspondence constraint. If F is specific to some position or index *S*, the relevant relation (e.g. precedence) holds between all the elements in *S* and between the elements in *S* and all other elements.

In effect this principle says that a specific constraint on multiple correspondence may not ignore elements outside of the domain of specification in evaluating whether correspondence holds. For example, consider a hypothetical input /ABCD/ and an output candidate [$A_s C_s$BD], where *s* is some specification, for example designating membership in the root-initial syllable. It is clear that metathesis has occurred, thus violating non-specific LINEARITY. The schema in (9) ensures that the specific version of LINEARITY, LINEARITY$_s$, is also violated. The precedence relations between the segments specified as S and all other segments in the word must be consistent with the precedence relations between the input correspondents of those segments, however the mapping /ABCD/ → [$A_s C_s$BD] shows that the precedence relation between /B/ and /C/ is contradicted by the corresponding precedence relation between [C_s] and [B]. The argument for this interpretation of specific multiple correspondence constraints over its logical alternative, in which specific constraints *only* consider correspondence between elements properly included in their domain of specification (e.g. between A_s and C_s), comes from the failure of the latter to correctly protect subminimal bases (§5) and certain non-imbricating suffixes (§4.2) from undergoing imbrication. As will be illustrated in detail in §3, the schema in (9) follows from a more general schema for lexically-specific constraints proposed in Pater (to appear).

The remainder of this paper is organized as follows: §2 presents the analysis of imbrication as metrically-driven metathesis. §3 discusses the formal nature of the specific constraints posited in the course of the analysis. Arguments for the general form of specific constraints are drawn from an examination of some problems in constraining imbrication both lexically (§4) and phonologically (§5). A comparison with certain alternative analyses of imbrication appears in §6. Finally, §7 concludes the paper and outlines issues to be pursued in future research.

2 Imbrication as metrically-driven metathesis

As claimed in (7), an examination of imbricated forms reveals a consistently bimoraic penultimate syllable. Having established that imbricated forms create a bimoraic penult, we now turn to the central question in the analysis of imbrication: what motivates the creation of a bimoraic penult?

I propose that the compulsion for imbrication is *metrical*. Positing a trochaic foot at the right edge of the word, while abstract in the sense that all imbricating languages to my knowledge are tonal, provides a reference for the markedness constraint preferring imbrication (to be defined momentarily) as well as provides a fresh explanation for the multitude of prosodic processes in Bantu that target the penult, as will be discussed below.

Putting things somewhat more formally, I propose that imbrication is metathesis that is motivated by the constraint STRESS-TO-WEIGHT (Kager 1999a, Gouskova 2003), which would prefer that the bimoraic penult that imbrication creates (assuming a word-final trochaic foot). Accordingly, imbrication will occur when STRESS-TO-WEIGHT dominates the anti-metathesis constraint LINEARITY (McCarthy and Prince 1995, 1999). Framing imbrication as metrically-driven metathesis, albeit a morpheme-specific variety, classifies it in with similar alternations found outside of Bantu, including Rotuman incomplete phase metathesis (McCarthy 2000) and Balantak metathesis exhibited by the 2SG.POSS suffix (Pater 2003).

This proposal converges with a great deal of evidence showing that the penult is targeted by a variety of prosodic phenomena in Bantu languages. For instance, a common process of unbounded H tone spreading in many of these languages stops at the penult. In Chilungu, the rightmost H in the phrase undergoes unbounded spreading to the penult. While one analysis of the failure of H tones to spread onto final syllables is a high-ranking of the constraint NON-FINALITY(H) ('Assign a penalty for each H that is final in the word.'), it seems one demanding that the right edge of a H tone span coincide with the metrically prominent syllable is equally viable. One possible formalization is the one below.

(10) ALIGN-R(H, V́)
Align the right edge of a H tone span with the metrical head of the PrWd.

The following tableau shows generally how the ALIGN constraint derives unbounded spreading to the penult in Chilungu.

(11)

/tú-ku-ful-a/	ALIGN-R(H, V́)	FAITH
a. ☞ túkú**fú**la		**
b. túkú**fú**lá	*!	***

Much work remains to compile existing descriptions and to converge upon a set of constraints that refer to the metrical structure proposed in this paper, however it is hoped that the lines for future research in this direction are sufficiently clear given the proposal below.

2.1 SWP and metrical structure

Before exploring a STRESS-TO-WEIGHT-based analysis of imbrication, we must account for the placement of stress (or possibly main stress, if footing is exhaustive) on the penult. Assuming metrical feet are invariably binary, there are, in principle, two options: a word-final trochaic foot or an iambic foot, the latter option available just in case final extrametricality could be motivated. In the absence of some advantage to an iambic analysis, we prefer the trochaic analysis on the grounds that it does not require extrametricality.

In adopting the trochaic foot analysis, I do not privilege any particular OT-based theory of foot construction and stress placement. The analysis I present below follows along the lines of McCarthy and Prince (1993), though the CLASH/LAPSE theory (Kager 1999b, Elenbaas and Kager 2004) should be equally viable.[2]

(12)

/kuŋgub-il-e/	ALL-FT-R	FT-BIN	PARSE-SYLL
a. ☞ ku(ŋgwii.be)			*
b. (ku)(ŋgwii.be)	*!	*!	

By ranking ALL-FT-R and FT-BIN above PARSE-SYLL, we force the foot to be aligned with the right edge of the word.

Next, the ranking of the foot-headedness constraints TROCHEE and IAMB derive a trochaic foot:

(13)

/kuŋgub-il-e/	TROCHEE	IAMB
a. ☞ ku(ŋgw**ii**.be)		*
b. (ku)(ŋgwii.**be**)	*!	

Having set up the needed metrical foot, we now enter the markedness constraint which will prefer metathesis (and will ultimately lead to the result dubbed imbrication).

(14) STRESS-TO-WEIGHT (SWP) (after Prince 1990, Kager 1999a, Gouskova 2003)
Metrical heads are bimoraic.

The constraint penalizing metathesis is LINEARITY-IO (McCarthy and Prince 1995, 1999):

(15) LINEARITY-IO
Let x, y be elements of the input and x', y' elements of the output. If x$\Re$x' and y$\Re$y', then x < y iff ¬[y' < x'].

'The precedence structure of the input is consistent with that of the output, and vice-versa.'

By ranking SWP over LINEARITY-IO, we derive metathesis that creates a long penult.

(16)

/kuŋgub-il-e/	SWP	LINEARITY-IO
a. ☞ ku(ŋgwii.be)		*
b. kuŋgu(bi.le)	*!	

2.2 Consonant deletion and OO-faithfulness

Metathesis alone would create a phonotactically illicit consonant cluster (e.g. /kuŋgub-il-e/ → *kuŋgui**bl**e). As shown by the imbrication data, one of the consonants deletes, and languages can in fact vary with respect to which consonant is deleted.

As seen in the following examples, several languages always delete the consonant of the imbricating suffix (17a-g), while Ciluba (Lukusa 1993) (17h-i) shows that the base consonant is deleted.

[2] The analysis of foot construction I present assumes that metrical footing need not be exhaustive. This is only for simplicity of presentation and for lack of evidence that other syllables have a metrical status. The basic idea would, however, be compatible with an analysis in which footing were exhaustive and would therefore require that the *main stress* fall on the penult.

(17) a. /kuŋgub-il-e/ → kuŋgwiibe ‘gathered’
b. /sakat-il-e/ → sakeete ‘seized’
c. /fimb-uk-il-e/ → fimbwiike ‘become uncovered’ (Cibemba)

d. /ya-a-ziik-an-il-e/ → yaaziikiine ‘we buried each other’
e. /ya-a-fupam-il-e/ → yaafupiime ‘they lay on their face’
f. /ya-a-zakaz-il-e/ → yaazakiize ‘they shivered’
g. /ya-a-fuuŋg-ik-il-e/ → yaafuuŋgiike ‘they were unlocked’ (Chilungu)

h. /mon-ɪʃ/ → mweeʃ ‘cause to see’
i. /suk-ul-ɪʃ/ → sukwiiʃ ‘cause to be clean/wash’ (Ciluba)

In languages where the consonant of the imbricating suffix is the one that is deleted, a constraint that demands faithfulness to the base (MAX-OO) ensures that the consonant of the imbricating suffix is deleted to satisfy *COMPLEX.[3]

(18) *COMPLEX (*CC)
Assign a penalty for each pair of tautosyllabic adjacent consonants.

(19) MAX-OO
Every segment of the base form has a correspondent in the output affixed form.

The definition of MAX-OO in (19) relies on a particular assumption about morphological structure of stems, whereby OO-correspondence is reckoned recursively over the stem (Baković 2003): each affix that is introduced, along with its base, forms an output with respect to the base without that affix. Thus, each new affix effectively adds a dimension of OO-correspondence. Recursive OO-identity is schematized below.

(20) Recursive OO-correspondence relation

[[[[*root*] –*suffix*$_1$]. . .] –*suffix*$_n$]

(21)

	/[[[[ziik]-an]-il]-e]/	*CC	MAX-OO	MAX-IO	LIN-IO
a.	☞ ziikiine			*	*
b.	ziikiile		*!	*	
c.	ziikiinle	*!			

The [n] of the (root + reciprocal /-an/) base cannot be deleted because this violates MAX-OO, thus dooming candidate (21b). By retaining the consonant of the perfective, candidate (21b) satisfies SWP without metathesizing perfective material into a string of exponents of the base. Therefore, LINEARITY-IO prefers a loser and must be ranked below MAX-OO.

The Ciluba data introduced above shows that illicit consonant clusters created by metathesis can in fact be resolved by retaining the consonant of the imbricating suffix. To account for this alternative choice of repair, we need only rerank LINEARITY-IO above MAX-OO, as shown in (22).

[3] Deletion also satisfies NO CODA and CODACOND; see (Prince and Smolensky 2004: 108) for discussion of the status of *COMPLEX.

(22)

	/[[sukul]-iʃ]/	*CC	LIN-IO	MAX-OO	MAX-IO
a. ☞	sukwiiʃ			⁕	⁕
b.	sukwiil		⁕!		⁕
c.	sukwiilʃ	⁕!			

This view of OO-correspondence is unlike the more common view that OO-faithfulness only holds between finished outputs of the grammar (Benua 1997 et seq.). To appreciate the difference between the two models in view of imbrication, a comparison of [[ziik]-an] and [[ziik]-iin] (from underlying /[[[[ziik]-an]-il]-e]/) by OO-faithfulness constraints is necessary to explain the choice of consonant deletion (i.e. the base consonant or the affixal consonant). However, this comparison impossible on Benua's view because [[ziik]-an] and [[ziik]-iin] may not stand as pronounceable output forms without the final vowel /-e/. In contrast, Bakovic's model allows OO-correspondence to hold between intermediate forms that differ by the presence of a single concatenative morpheme.

A consequence of assuming recursive OO-correspondence is that LINEARITY is not the only faithfulness constraint that is violated by imbrication. To appreciate the nature of the correspondence relations that hold between a base and an affixed form, consider the following illustration.

(23) /[[[k$_1$u$_2$ŋ$_3$g$_4$u$_5$b$_6$]-i$_7$l$_8$]-e$_9$]/ $\rightarrow$

k$_1$u$_2$ŋ$_3$g$_4$w$_5$iː$_7$b$_6$e$_9$

Notice that in addition to the metathetic substring ⟨iː$_7$b$_6$⟩, the substring ⟨u$_5$b$_6$⟩ of the root stands in correspondence with the substring ⟨w$_5$iː$_7$b$_6$⟩ in the perfective form. However, the element ⟨iː$_7$⟩ does not have a correspondent in the root (or, more generally speaking, its base of affixation). This type of unfaithful mapping violates the correspondence constraint O-CONTIGUITY-OO, defined in (24).[4]

(24) O-CONTIGUITY-OO (after McCarthy and Prince 1995, 1999)
Let x, z be elements of the base. If x and z form a contiguous substring and x$\Re$x' and z$\Re$z', then $\nexists$y in the output such that [[x' $<$ y and y $<$ z'] and [$\nexists\alpha$ in the base such that $\alpha\Re$y]].

We now see that, in addition to dominating LINEARITY-IO, SWP also must outrank O-CONTIGUITY-OO, as proven in the following tableau.[5]

(25)

	/[[[k$_1$u$_2$ŋ$_3$g$_4$u$_5$b$_6$]-i$_7$l$_8$]-e$_9$]/	SWP	O-CONTIGUITY-OO
a. ☞	k$_1$u$_2$(ŋ$_3$g$_4$w$_5$iː$_7$.b$_6$e$_9$)		⁕
b.	k$_1$u$_2$ŋ$_3$g$_4$u$_5$(b$_6$i$_7$.l$_8$e$_9$)	⁕!	

[4]Another member of the CONTIGUITY family, M-CONTIGUITY, is proposed by Landman (2003) and is likely relevant here. Because the role of CONTIGUITY is not crucial in this analysis, I do not include it in tableaux.

[5]It should be clear that LINEARITY-OO is not relevant because there is no precedence relation that holds in the base that is contradicted in the output.

Additionally, DEP-μ (26) must dominate LINEARITY-IO and O-CONTIGUITY-OO to assure that metathesis, and not epenthesis of a mora, repairs SWP.

(26) DEP-μ
Every mora in the output has an input correspondent.[6]

(27)

/[[[kuŋgub]-il]-e]/	DEP-μ	LINEARITY-IO	O-CONTIGUITY-OO
a. ☞ ku(ŋgwii.be)		*	*
b. kuŋgu(bii.le)	*!		

2.3 Vowel hiatus resolution

A consequence of metathesis is vowel hiatus resolution. In the examples above, we have seen gliding and vowel deletion accompanied by compensatory lengthening, as well as coalescence. In each case, the patterns of hiatus resolution reflect the independently observed strategies in each language. Examples of each from Chilungu and Cibemba are provided in (28).

(28) Gliding and compensatory lengthening

a. /ya-a-fuuŋg-ul-il-e/ → yaafuuŋgwiile ‘they unlocked’ (Chilungu)
b. /tomon-il-e/ → tomweene ‘kissed’ (Cibemba)
c. /tu-a-poomb-ol-ol-il-e/ → twaapoombolwiile ‘they untangled’ (Chilungu)

Vowel deletion and compensatory lengthening

e. /ful-an-il-e/ → fuliine ‘they washed each other’ (Chilungu)

Coalescence

f. /sakat-il-e/ → sakeete ‘seized’ (Cibemba)

As (28a–c) illustrate, a round vowel will glide before the metathesized vowel, which itself undergoes compensatory lengthening.[7]

Taking the case of gliding and compensatory lengthening first, the following pair of tableaux demonstrate that gliding and compensatory lengthening, analyzed here as violating IDENT-μ, is the net result of high-ranking ONSET and MAX-μ. [8]

(29) IDENT-μ
Let x be a segment and μ a mora attached to x in the input. If x and μ have correspondents x’ and μ’ in the output, then μ’ is attached to x’.

[6] Note that (23) also violates DEP-μ-OO under the model of OO-correspondence assumed here.

[7] Of further interest is the fact that the metathesized vowel undergoes mid vowel harmony in Cibemba (28b), but not in Chilungu (28c). Though an analysis of this fact would take us beyond the aims of this section, we can observe that the failure of the perfective to undergo mid vowel harmony is a case of counterfeeding opacity.

[8] For simplicity, I assume glides are syllabified into the onset. See Key (2006) for an argument that post-consonantal glides share a mora with a following vowel in Luganda.

(30) MAX-μ
Every mora in the input has a correspondent in the output.

(31)

/CuV/	ONSET	IDENT-μ
a. ☞ CwVV		*
b. CuV	*!	

(32)

/CuV/	MAX-μ	IDENT-μ
a. ☞ CwVV		*
b. CwV	*!	

Next, we turn to vowel deletion in Chilungu. As the examples above and in (28d) substantiate, [a] deletes before a following non-identical vowel, which compensatorily lengthens. I assume here that this resolution is driven by the constraint NODIPH, which is consistent with the fact that Chilungu lacks diphthongs entirely.

(33)

/Cai/	NODIPH	MAX-V
a. ☞ Cii		*
b. Cai	*!	

High-ranking MAX-μ ensures that compensatory lengthening accompanies vowel deletion:

(34)

/Cai/	MAX-μ	MAX-V
a. ☞ Cii		*
b. Ci	*!	

Along the lines of analysis proposed by Casali (1997), I assume that the choice of which vowel to delete is subject to the constraint MAX-MI, defined in (35).

(35) MAX-MI
Every morpheme-initial segment in the input has an output correspondent.

Related in stringency to general MAX, MAX-MI preserves V_2, which is the vowel and initial segment of the perfective morpheme:

(36)

/Ca_1i_2/	MAX-MI	MAX
a. ☞ Cii		*
b. Caa	*!	*

Finally, (28f) shows us a simple contrast in hiatus resolution between Cibemba and Chilungu. In Cibemba, [a] fuses with a following non-identical vowel, while in Chilungu the same input sequence results in deletion plus compensatory lengthening. Hence, assuming NODIPH is the constraint motivating an unfaithful mapping of /ai/, the difference between the two languages is reduced to a choice of repair.

The correspondence constraint that penalizes coalescence is UNIFORMITY, defined below.

(37) UNIFORMITY-IO (McCarthy and Prince 1995, 1999)
Let x and y be elements of the input and let z be an element of the output. If x$\Re$z and y$\Re$z, then x = y.

By ranking NODIPH and MAX-V above UNIFORMITY-IO, erstwhile /ai/ sequences are fused to [eː]:

(38)

/Cai/	NODIPH	UNIFORMITY
a. ☞ Cee		∗
b. Cai	∗!	

(39)

/Cai/	MAX-V	UNIFORMITY
a. ☞ Cee		∗
b. Cii	∗!	

In contrast to Cibemba (39), Chilungu displays the opposite ranking, which produces deletion and compensatory lengthening instead.

(40)

/Cai/	UNIFORMITY	MAX-V
a. ☞ Cii		∗
b. Cee	∗!	

2.4 Blocking by NC-final bases

Hyman (1995) and Bickmore (in prep.) show that if the base ends in an NC cluster, imbrication is blocked:

(41) Base-final NC blocks imbrication

a. /pilimpint-il-e/ → piliimpiintile 'went all over the place'
b. /pulumpunt-il-e/ → puluumpuuntile 'staggered' (Cibemba)

c. /tu-a-belenz-il-e/ → twaabeleenzile 'we read'
d. /tu-a-kazinz-il-e/ → twaakaziinzile 'we fried' (Chilungu)

The fact that vowel length, which is contrastive in many other contexts in Bantu languages, is neutralized to long when preceding an NC cluster is the key insight in explaining the otherwise mysterious failure of imbrication into such bases. Previous analyses of similar alternations have relied on the assumption that the nasal bears a mora underlyingly, thereafter transferring it to the preceding vowel by a rule of moraic delinking and a universal relinking convention (Clements 1986, Hayes 1989).

Richness of the Base does not grant us the luxury of assuming that nasals of NC clusters are moraic nor that any nasals are moraic. We must therefore consider inputs with NC clusters both with and without moraic nasals, as well as those containing intervocalic singleton moraic nasals. Considering the latter class of inputs ensures that lengthening is predicted in pre-NC context and not simply in pre-nasal position.

In order to handle inputs containing NC clusters without moraic nasals, some markedness constraint must dominate the anti-moraic epenthesis constraint DEP-μ. I assume that this constraint is WEIGHT-BY-POSITION, defined in (42).[9]

(42) WEIGHT-BY-POSITION (WBP)
Each segment parsed into coda position bears a mora.[10]

This analysis is necessarily opaque because NC clusters are always syllabified as onsets in these languages. Because it is well beyond the aims of this paper to argue for a particular approach to opacity, I present rankings holding in distinct serially-linked strata (i.e. Stratal OT), somewhat vaguely dubbed 'pre-surface' and 'surface', for ease of exposition.

(43) Pre-surface stratum:

		/u-ku-belenz-a/	WBP	DEP-μ
a.	☞	u.ku.be.len$_\mu$.za		∗
b.		u.ku.be.len.za	∗!	

The activity of WBP in compelling epenthesis of a mora implies a ranking of constraints on syllabification that is non-surface true. In particular, I assume that the constraint $*$COMPLEX^{Ons} outranks NOCODA in the pre-surface stratum, with the opposite ranking NOCODA $\gg$ $*$COMPLEX^{Ons} obtaining in the surface stratum to generate the observed fact that NC clusters are always parsed as onsets.

(44) Pre-surface stratum:

		/u-ku-belenz-a/	$*$COMPLEX^{Ons}	NOCODA
a.	☞	u.ku.be.len$_\mu$.za		∗
b.		u.ku.be.le.nza	∗!	

The ranking $*$COMPLEX^{Ons} $\gg$ NOCODA alone also generates VN$_\mu$.CV outputs of the pre-surface stratum for inputs with NC clusters in which the nasal bears a mora.

Now inputs containing intervocalic moraic nasals are considered. Because no ranking of the constraints on syllabification will syllabify /VCV/ as VC.V, all that is needed is a constraint that explains the loss of the input mora borne by the nasal. I assume this constraint is *ONSET-μ, defined below.[11]

(45) *ONSET-μ
Assign a penalty to each segment parsed into the onset that bears a mora.

By ranking *ONSET-μ above MAX-μ, the input mora borne by the nasal is deleted.

(46) Pre-surface stratum:

		/VN$_\mu$V/	*ONSET-μ	MAX-μ
a.	☞	V.NV		∗
b.		V.N$_\mu$V	∗!	

[9]Downing (2005) argues for a markedly different analysis of pre-NC lengthening: she presents evidence from a variety of Bantu languages for the existence of a constraint against short vowels preceding NC clusters.

[10]In addition to WBP, I assume the existence of constraints of the form *CODA/λ (Prince and Smolensky 2004) that regulate possible codas in the output of the pre-surface stratum and thus correctly dispense with inputs with intervocalic mora-bearing non-nasals.

[11]An alternative assumption is that onset moraicity is universally ruled out in the definition of GEN.

Deletion of such moras shows that moraic reassociation is unavailable in the pre-surface stratum:

(47) Pre-surface stratum:

/VN$_\mu$V/	IDENT-μ	MAX-μ
a. ☞ V.NV		*
b. VV.NV	*!	

Because the output of the pre-surface stratum for VN$_\mu$V inputs is identical to the observed outputs, no further discussion of these inputs is required.

To complete the analysis of inputs with NC clusters, we must explain their surface syllabification as V.NC (not VN.C) as well as account for the apparent moraic reassociation that results in long vowels in pre-NC position. As claimed above, the observed syllabification results from ranking NOCODA above *COMPLEX^{Ons} in the surface stratum.[12]

(48) Surface stratum:

/u.ku.be.len$_\mu$.za/	NOCODA	*COMPLEX^{Ons}
a. ☞ u.ku.be.lee.nza		*
b. u.ku.be.len$_\mu$.za	*!	

To account for the transfer of the mora borne by a nasal (in the output of the pre-surface stratum) to a preceding vowel, we similarly assume a different ranking of *ONSET-μ, MAX-μ, and IDENT-μ holds in the surface stratum.

(49) Surface stratum:

/u.ku.be.len$_\mu$.za/	*ONSET-μ	IDENT-μ
a. ☞ u.ku.be.lee.nza		*
b. u.ku.be.lee.n$_\mu$za	*!	

As transfer of the nasal's mora is preferred to deletion of the mora, we infer that IDENT-μ $\gg$ MAX-μ in the surface stratum:

(50) Surface stratum:

/u.ku.be.len$_\mu$.za/	MAX-μ	IDENT-μ
a. ☞ u.ku.be.lee.nza		*
b. u.ku.be.le.nza	*!	

We are now finally in a position to explain why NC clusters block imbrication. As the following tableaux show us, pre-NC length is derived by compensatory lengthening (which violates IDENT-μ), not by metathesis. Additionally, MAX-μ $\gg$ SWP blocks imbrication because moras must be conserved at the expense of imbrication.

(51) Surface stratum:

/yaa.be.len$_\mu$.zi.le/	LINEARITY	IDENT-μ
a. ☞ yaabeleen(zi.le)		*
b. yaabe(lii.nze)	*!	

[12] Inputs in tableaux illustrating surface stratum rankings are the outputs of the pre-surface stratum, not the underlying representation.

(52) Surface stratum:

	/yaa.be.len$_\mu$.zi.le/	MAX-μ	SWP
a. ☞	yaabelee(nzi.le)		*
b.	yaabe(lii.nze)	*!	

2.5 Summary

In this section, I have argued for a metrical account of imbrication. In addition, I have attempted to give a general description of the manner in which our understanding of various penult-targeting prosodic phenomena in Bantu might benefit from such a metrical analysis of imbrication. It is this potential benefit in particular that speaks in favor of this particular account imbrication, beyond achieving descriptive adequacy. As we will see in §6, alternative approaches either appear to lack comparable beneficial consequences, or far worse, they introduce undesirable consequences in various areas of phonological theory.

What remains to be accomplished in the analysis of imbrication is to properly constrain it – both lexically (to the perfective suffix) and in an interesting phonological context in which it unexpectedly does not obtain (after monosyllabic bases). The former task is the aim of §4, while the latter appears in §5. Before either task can be attempted, the formal nature of the specific constraints to be deployed in §§4–5 will be discussed and some unifying formal principles proposed.

3 The nature of specific constraints

Among the many dimensions along which constraints can be distinguished, the contrast between *general* and *specific* constraints has proven useful since the earliest work on OT (Prince and Smolensky 2004: chs. 5, 7, Prince 1997). Familiar applications of the general/specific contrast include positional faithfulness (Beckman 1997, 1998), positional markedness (Steriade 1995 et seq.), and a distinction between root and affix faithfulness (Alderete 1998, Baković 2000, McCarthy and Prince 1995).

Specific constraints can be distinguished into two basic types: (i) those with arbitrary specification; (ii) those with non-arbitrary specification. Constraints with arbitrary specification refer to particular morphemes or classes of morphemes, via the assignment of an arbitrary index. Constraints with non-arbitrary specification evaluate within familiar domains such as initial-syllable, stressed-syllable, root, and stem.

3.1 Constraints with arbitrary specification

Constraints with arbitrary specification are meant to evaluate specific morphemes or classes of morphemes, a natural approach to morphologically-specific phonology. However, even morpheme-specific phonology often involves changes to elements that are not phonological exponents of the specified morpheme(s). Thus, constraints with arbitrary specification present a locality issue: what is the domain of evaluation to which an arbitrary specific constraint is indexed?

Most work employing arbitrary specific constraints, either does not address the locality issue, or arbitrary specific constraints are implicitly assumed to apply only if the putative locus of violation includes a phonological exponent of the morpheme(s) bearing the index (Coetzee and Pater 2005, Fukuzawa 1999, Gelbart 2005, Itô and Mester 1999, 2001, Kraska-Szlenk 1997, 1999, and Pater 2000).

Among papers that have addressed the locality issue, some previous literature has argued that arbitrary specific constraints must be able to evaluate within the entire morphological word that contains the indexed morpheme(s), as in Flack (to appear), Ota (2004), and Wolf and McCarthy (2007). However, Pater (to appear) identifies some implausible systems predicted by specific constraints which are allowed to apply to the entire morphological word.

Pater (to appear) presents perhaps the most clear hypothesis bearing on the locality issue. He proposes a schema for the interpretation of arbitrary specific constraints by which the constraint applies if and only if the locus of violation includes a phonological exponent bearing the arbitrary specification. This schema appears in (53).[13]

(53) $^*X_L$
Assign a violation mark to any instance of X that contains a phonological exponent of a morpheme specified as L.

In the case of markedness constraints with arbitrary specification, the interpretation of (53) is straightforward: the markedness constraint bearing the index is violated if and only if the locus of putative violation includes a phonological exponent of a morpheme bearing the same index. In §4.1, a specific version of SWP is introduced that limits imbrication to being triggered by the perfective and thus partially addresses the question of why the perfective triggers imbrication, and the applicative does not.

Pater (to appear) notes that in order to make clear the interpretation of the schema for faithfulness constraints with arbitrary specification, they must be reformulated negatively. To appreciate why this is, recall that correspondence theory (McCarthy and Prince 1995, 1999) formulates faithfulness constraints as various assertions that certain elements in input and output correspond to one another in terms of a relation (namely, the correspondence relation $\Re$). For instance, MAX asserts that for every element in the input, there is some element in the output with which it stands in correspondence. If Pater's schema were applied to this positive statement of MAX, the arbitrary specific version of MAX, MAX_L, would have the following bizarre interpretation:

(54) MAX_L (positive defn.)
Assign a violation mark to any instance of [$\forall x \in S_1$, $\exists x'$ in S_2 such that $x \Re x'$] that contains a phonological exponent of a morpheme specified as L.

Paraphrased, this definition of MAX_L would assign a violation to all candidates in which the MAX relation held of a phonological exponent of a morpheme specified as L. In other words, MAX_L would effectively be a specific *anti*-faithfulness constraint, assigning violations just in case elements in the input bearing the index L were not deleted. By restating

[13] A necessary corollary assumption is that lexical indices are properties of morphemes and thus percolate onto all of the segments that compose them, an idea originating in rule-based generative phonology (Chomsky and Halle 1968, Kenstowicz and Kisseberth 1979).

MAX as a constraint militating against the 'deletion' relation, Pater's schema can apply to MAX to yield the desired interpretation:

(55) MAX_L (negative defn.)
Assign a violation mark to any instance of [$\forall x \in S_1$, $\nexists x'$ in S_2 such that $x\Re x'$] that contains a phonological exponent of a morpheme specified as L.

Pater assumes that arbitrary specific faithfulness constraints in general apply to any phonological exponent of the specified morpheme. This is because the faithfulness constraints examined in his study refer only to a single segment. As such, the question of whether this interpretation is correct for faithfulness constraints referring to more than one element (i.e. LINEARITY, CONTIGUITY, UNIFORMITY, INTEGRITY) remains to be answered.

In §4.2, I present arguments that an analysis of aspects of lexically constraining imbrication (i.e. to the perfective suffix) making use of arbitrary specific versions of LINEARITY and O-CONTIGUITY must indeed follow the interpretation of the schema in (53) assumed by Pater.

3.2 Constraints with non-arbitrary specification

Constraints with non-arbitrary specification evaluate within familiar domains such as initial-syllable, stressed-syllable, root, and stem. In contrast to studies in arbitrary specification, the domain of evaluation of non-arbitrary specific constraints has yet to become an issue. It has been typically assumed that for both positional markedness and positional faithfulness constraints that they evaluate only within the domain of the context for which they are specified (e.g. only in root-initial syllables). This assumption is well-justified – if positional constraints were able to evaluate marked structures and faithfulness relations outside their specified positions, the desiderata inspiring their creation would be lost (i.e. emergence of the unmarked in certain positions, protection of contrasts in certain positions).

The interpretation of the domain of evaluation of positional *multiple correspondence* constraints cannot be taken for granted. By multiple correspondence, I am referring to the constraints LINEARITY, CONTIGUITY, UNIFORMITY, and INTEGRITY proposed in McCarthy and Prince (1995, 1999), which are 'multiple' in the sense that each refers to multiple elements. Their definitions are provided in (56).

(56) a. LINEARITY
Let x,y be elements in S_1 and x', y' in S_2. If $x\Re x'$ and $y\Re y'$, then $x < y$ iff $\neg[y' < x']$.

b. (I-, O-)CONTIGUITY

i. I-
Let xyz be a contiguous substring in S_1. If $\exists x', z'$ in S_2 such that $x\Re x'$ and $z\Re z'$, then $\exists y'$ in S_2 such that $y\Re y'$ and x'y'z' forms a contiguous substring in S_2.

ii. O-
Let xz be a contiguous substring in S_1. If $\exists$x', z' in S_2 such that x$\Re$x' and z$\Re$z', then $\nexists$y in S_2 such that [[x' $<$ y and y $<$ z'] and [$\nexists\alpha$ such that $\alpha\Re$y]].

c. UNIFORMITY
Let x and y be elements of S_1 and let z be an element of S_2. If x$\Re$z and y$\Re$z, then x = y.

d. INTEGRITY
Let y and z be elements of S_2 and let x be an element of S_1. If x$\Re$y and x$\Re$z, then y = z.

The purpose of LINEARITY, CONTIGUITY, and UNIFORMITY have been discussed already in this paper. INTEGRITY penalizes diphthongization or phonological copying.

The property that unites these four constraints within the larger correspondence family is that these constraints evaluate relations between pairs of elements. As such, it's conceivable that a pair of segments referred to by any of these constraints could be partly inside and partly outside the domain of a non-arbitrary specific version of any of these constraints. Therefore, the question presents itself: do multiple correspondence constraints evaluate relations between the pairs of segments to which they refer *exclusively*, or the relations between the pairs of segments to which they refer and all others in the word? Consider a hypothetical input /AB_sC_sD/ and an output candidate [B_sAC_sD], where *s* is some arbitrary specification. Now we ask whether LINEARITY$_s$ is violated.

As claimed above, arbitrary specific constraints must be able to evaluate all and only the exponents of the indexed morpheme(s). Therefore, a lexically-specific version of LINEARITY like LINEARITY$_s$ must be able to evaluate precedence relations between the exponents of the indexed morpheme(s) and all other segments (but not precedence relations exclusively between non-indexed segments). In other words, LINEARITY$_s$ is violated because the precedence relation between [A] and [B_s] has changed, though the precedence relation between exponents of *S* (i.e. [B_s] and [C_s]) is unchanged. In the aim of maximal generality, we might wonder whether the interpretation of locality for non-arbitrary specific constraints might not also follow Pater's schema.

We can now see that the schema dubbed Exhaustiveness of Multiple Correspondence in (9), repeated here in (57), is really a consequence of Pater's schema, repeated in (58).

(57) Exhaustiveness of multiple correspondence (EMC)
Let F be a multiple correspondence constraint. If F is specific to some position or index *S*, the relevant relation (e.g. precedence) holds between all the elements in *S* and between the elements in *S* and all other elements.

(58) $*X_L$
Assign a violation mark to any instance of X that contains a phonological exponent of a morpheme specified as L.

To reiterate, EMC ensures that the only multiple correspondence relations ignored by the relevant constraints are those that hold exclusively between elements that do not bear a specification. To put the locality in perspective for non-arbitrary specific constraints, consider a hypothetical input /ABCD/ and an output candidate [A_sC_sBD], where *s* designates, for instance, membership in the root-initial syllable. The schema in (57) ensures that the root-initial version of LINEARITY, LINEARITY$_s$, is also violated. The precedence relations between the segments specified as S and all other segments must be consistent with the precedence relations between the input correspondents of those segments, however the mapping /ABCD/ → [A_sC_sBD] shows that the precedence relation between /B/ and /C/ is contradicted by the corresponding precedence relation between [C_s] and [B], though the precedence relation between [A_s] and [C_s] is faithful.

The EMC is a logical consequence of adopting (58) and applying it to multiple correspondence constraints. All relations in which elements bearing the specification participate are evaluable by specific multiple correspondence constraints.

In §§4-5, I present arguments that demonstrate the correctness of the EMC insofar as LINEARITY and O-CONTIGUITY are concerned.[14] As for UNIFORMITY and INTEGRITY, I cannot provide evidence from imbrication to evaluate the validity of the EMC. The principle is nonetheless stated in its most general form until evidence for the correct domain of evaluation of specific versions of all four multiple correspondence constraints can be obtained.[15]

4 The role of arbitrary specification: Constraining imbrication

4.1 Lexically-specific markedness: SWP$_L$

Unaided, the ranking [SWP ≫ LINEARITY-IO] would produce disastrous results. All words of at least size CVCVCV would undergo metathesis to satisfy SWP. Thus, we must ensure that metathesis is a repair *idiosyncratically* induced by the perfective. In principle, a number of approaches can accomodate morpheme-specific processes driven by markedness constraints. Following Flack (to appear) and Pater (to appear), I will pursue an analysis that invokes lexical indexation of markedness constraints to the imbricating suffix(es), in this case indexation of SWP. The general argument for lexically-indexed markedness made in the above cited work is that lexically-indexed faithfulness alone is insufficient for certain types of morpheme-specific phonology.[16]

[14]For an alternative definition of specific LINEARITY, whereby only the precedence relations holding exclusively between segments bearing the index are considered by the constraint, see Pater (1999).

[15]The status of UNIFORMITY and INTEGRITY is controversial. Setting aside empirical matters, recent work asserts that GEN is inhibited such that candidates may only differ from their inputs by the application of one primitive phonological change each (McCarthy 2006a, 2006b). Thus the question remains as to whether coalescence and diphthongization are primitive operations of GEN, or whether apparent instances of either are the result of the application of multiple more primitive operations. For example, coalescence could be construed as assimilation followed by deletion (e.g. /an/ → ãn → ã).

[16]Pater (to appear) argues that both lexically-indexed markedness and faithfulness are necessary for an account of Finnish and Chumash derived-environment effects as well as for learnability reasons. Flack (to appear) demonstrates the need for lexically-indexed markedness to capture certain morpheme-specific templatic effects in a variety of languages.

Insofar as the issue of the locality of the relevant phonological alternation is concerned, Pater's schema, repeated in (59), applies straightforwardly.[17,18]

(59) $*X_L$
Assign a violation mark to any instance of X that contains a phonological exponent of a morpheme specified as L.

Returning to imbrication, a lexically-indexed markedness analysis will lead us to assignng an index for the perfective, permitting it alone to undergo metathesis (i.e. by virtue of indexed $SWP_L \gg$ LINEARITY-IO), but not for the applicative, to which SWP_L does not apply.

(60) a. Perfective: /-il$_L$/
b. Applicative: /-il/

The definition of SWP_L follows straightforwardly from the schema in (59).

(61) SWP_L
Let x be an exponent of an indexed morpheme L. If x is parsed into a syllable *s* that is a metrical head, *s* must be bimoraic.

(62) Perfective:

/kuŋgub-i$_L$l$_L$-e/	SWP$_L$	LINEARITY-IO	O-CONTIGUITY-OO	SWP
a. ☞ ku(**ŋgwi**$_L$**i**$_L$.be)		*	*	
b. kuŋgu(**bi**$_L$.l$_L$e)	*!			*

Applicative:

/kuŋgub-il-e/	SWP$_L$	LINEARITY-IO	O-CONTIGUITY-OO	SWP
a. ☞ kuŋgu(**bi**.le)				*
b. ku(**ŋgwii**.be)		*!	*!	

By ranking SWP_L above LINEARITY-IO and O-CONTIGUITY-OO, which in turn dominate general SWP, we obtain imbrication by the perfective suffix, which bears the lexical index, but not by the applicative suffix, which lacks the index.

4.2 Lexically-specific faithfulness: LINEARITY$_L$ and CONTIGUITY$_L$

A lexically-specific faithfulness analysis is also in principle available. Insofar as the most conspicuous potential triggering morphemes are concerned, it would be the applicative that would bear the index, thus winning special protection for itself (i.e. blocking of metathesis) by deploying indexed versions of LINEARITY-IO and O-CONTIGUITY-OO, which, recall from §2, are the general faithfulness constraints violated by imbrication.

(63) a. Applicative: /-il$_L$/
b. Perfective: /-il/

[17]Note that that the notation '*X' does not presuppose that the markedness constraint in question is negatively defined. In fact, the very example which seems to have inspired the formula in (59) is an indexed ALIGN constraint Pater deploys in his analysis of Piro syncope.

[18]The issue of the locality of the alternation is also problematic for anti-faithfulness and various homophony avoidance approaches, as I explore in some detail in §6.

Given EMC, repeated here for convenience, the definition of the lexically-specific versions of LINEARITY-IO and O-CONTIGUITY-OO is straightforward.

(64) EMC
Let F be a multiple correspondence constraint. If F is specific to some position or index *S*, the relevant relation holds between all the elements in *S* and between the elements in *S* and all other elements.

(65) LINEARITY-IO$_L$
Let x, y be elements of the input and x', y' elements of the output. If x bears some arbitrary index L and if x$\Re$x' and y$\Re$y', then x $<$ y iff $\neg$[y' $<$ x'].

(66) O-CONTIGUITY-OO$_L$
Let xz be a contiguous substring in the base. If $\exists$x', z' in output such that x$\Re$x' and z$\Re$z', then $\nexists$y$_L$ in the output such that [[x' $<$ y$_L$ and y$_L$ $<$ z'] and [$\nexists\alpha$ in the base such that $\alpha\Re$y$_L$]].

Informally, this definition says that LINEARITY-IO$_L$ is violated just in case any precedence relation between a segment of L and *any other segment*, both indexed and non-indexed alike, fails to obtain in the output, assuming that all the segments have output correspondents. Similarly, O-CONTIGUITY-OO$_L$ is violated just in case the output correspondents of a contiguous substring in the base do not form a contiguous substring. Recall that as this holds in the OO dimension, this means that violation will only result if some segment that is either epenthetic or at least has no correspondent in the base interrupts the contiguity of the substring in question.

To confirm that LINEARITY-IO$_L$ and O-CONTIGUITY-OO$_L$ provide special protection from imbrication for the applicative, consider the following example.

(67) Applicative

/kuŋgub-i$_L$l$_L$-e/	LIN-IO$_L$	O-CONTIG-OO$_L$	SWP	LIN-IO	O-CONTIG-OO$_L$
a. ☞ kuŋgu(**bi**$_L$.l$_L$e)			*		
b. ku(**ŋgwi**$_L$**i**$_L$.be)	*!	*!		*	*

Perfective

/kuŋgub-il-e/	LIN-IO$_L$	O-CONTIG-OO$_L$	SWP	LIN-IO	O-CONTIG-OO$_L$
a. ☞ ku(**ŋgwii**.be)				*	*
b. kuŋgu(**bi**.le)			*!		

To justify the statement of LINEARITY-IO$_L$ and O-CONTIGUITY-OO$_L$ as driven by the EMC, we begin by specifying all of the relevant precedence and contiguity relations that hold in the applicative input and base (for contiguity purposes) /kuŋgub-i$_L$l$_L$-e/.[19]

(68) a. Precedence: {[k...b $<$ i$_L$], [k...b $<$ l$_L$], [i$_L$ $<$ l$_L$...e], [l$_L$ $<$ e]}
b. Contiguity: {{[k$\asymp$u], [u$\asymp$ŋ], [ŋ$\asymp$g], [g$\asymp$u], [u$\asymp$b]}$_{base}$ [b$\asymp$i$_L$], [i$_L$$\asymp$l$_L$], [l$_L$$\asymp$e]}

We then inspect all of the relevant precedence relations holding in each of the applicative candidates:

[19] I employ the symbol $\asymp$ to denote contiguity relations. Thus, $\alpha \asymp \beta$ is read as 'α and β form a contiguous string'.

(69) a. kuŋgubi$_L$l$_L$e

i. {[k. . . b < i$_L$], [k. . . b < l$_L$], [i$_L$ < l$_L$. . . e], [l$_L$ < e]} (same as (68a))
ii. {{[k≍u], [u≍ŋ], [ŋ≍g], [g≍u], [u≍b]}$_{base}$ [b≍i$_L$], [i$_L$≍l$_L$], [l$_L$≍e]} (same as (68b)).

b. kuŋgwi$_L$i$_L$be

i. {[k. . . w < i$_L$], [i$_L$ < b. . . e]}
ii. {[k≍u], [u≍ŋ], [ŋ≍g], [g≍w], [w≍i:], [i:≍b], [b≍e]}

From a comparison of these sets, we see that just the imbricated candidate (69b) contains the precedence relation [i$_L$ < b. . . e], which contradicts the precedence relation [k. . . b < i$_L$] in the input. In addition, (69b) contains the contiguous substrings [w≍i:] and [i:≍b], which jointly contradict the contiguous substring [u≍b] in the base.

Notice that if the specific versions of LINEARITY-IO and O-CONTIGUITY-OO were alternatively defined so as to only penalize precedence and contiguity relation contradictions between exponents of L, imbrication could never violate them because /-il/ has only two phonological exponents and one of them deletes.

Because lexically-specific faithfulness alone has almost always been adequate to analyze various cases of morpheme-specific phonology (see, for example, Itô and Mester 1999, 2001), there is a natural objection against increasing the power of lexical indexation by introducing lexically-specific markedness constraints. It is not clear that we need both lexically-specific markedness *and* faithfulness to properly restrict imbrication to being triggered by the perfective, so what considerations help to decide between the two analyses? First, due to the fact that imbrication involves metathesis between segments belonging to distinct morphemes, the lexically-indexed faithfulness approach will require the assignment of an index not only to the applicative (which does not imbricate) but to many other morphemes that can occur in the same morphological position (i.e. before the final vowel). This is a decidely odd state of affairs: imbrication is intuitively the morpheme-specific phenomenon, yet lexically-indexed faithfulness must treat every morpheme that does not show imbrication as 'exceptional'.

A second and more serious problem for lexically-indexed faithfulness arises when we consider instances of imbrication into bases ending in a suffix.[20] In particular, if the base ends with the applicative suffix, imbrication in fact applies, as shown by the following Chilungu examples.

(70) a. /tu-a-ciis-il$_{appl.}$-il$_{perf.}$-e/ → twaaciisiile **twaaciisilile*
b. /tu-a-ziik-il$_{appl.}$-il$_{perf.}$-e/ → twaaziikiile **twaaziikilile*

It should be clear that if the applicative is assigned the index L, then the outputs in (70) both violate LINEARITY$_{\text{L}}$, as defined above. This means that imbrication, construed as

[20] As pointed out by John McCarthy, the nail in the coffin for this analysis is that every root in the language must be specified as L to prevent imbrication into it.

metathesis, with respect to the applicative suffix is *opaque*: exponents of the L-indexed applicative suffix have participated in a metathesis, motivating SWP ≫ LINEARITY$_L$, which contradicts LINEARITY$_L$ ≫ SWP motivated in (67).

Consequently, LINEARITY-IO$_L$ must be redefined so as to be violated only by metathesis with segments that were to the left of L material in the input (as in (67). This appears highly undesirable. To my knowledge there is no independent evidence for 'direction-specific' LINEARITY constraints, and thus introducing the formal power to distinguish between precedence and succession relations (w.r.t. L-indexed material) seems quite ad hoc.

Though ultimately inappropriate for protecting the applicative from imbricating, and hence inappropriate for constraining imbrication to the perfective, the discussion of lexically-indexed faithfulness has not been in vain. In the following subsection, I show that lexically-indexed faithfulness is a possible approach to prevent satisfaction of SWP$_L$ by metathesis of other suffixes from the right.

4.3 Blocking metathesis from the right

4.3.1 Applying lexically-indexed faithfulness

That the bimoraic syllable that imbrication creates is in penultimate position might be considered to be something of an accident of Bantu verbal morphology; the morphotactic principles of Bantu allow only two morphemes to occur in between the perfective and the final vowel, which is also the most crucial piece of evidence supporting a bimorphemic analysis of the perfective ending. The suffixes that may intervene are passive /-u/ and short causative /-i/, which both glide to form the onset of the final syllable, as seen in the following Chilungu example.

(71) Imbrication with passive /-u/ and short causative /-i/

a. /ya-a-paapaatik-il-u-e/ → yaapaapaatiikwe 'they were flattened'
b. /ya-a-lamuk-il-i-e/ → yaalamwiikye 'they caused to greet'

The analysis as currently constructed has a defect. If SWP$_L$ ≫ LINEARITY-IO and O-CONTIGUITY-OO, as argued above, notice that the penult could be made bimoraic by metathesis of either passive /-u/ or causative /-i/ with the preceding perfective suffix. This follows directly from the definition of SWP$_L$: as long as a phonological exponent of the indexed morpheme is in a bimoraic penultimate syllable, SWP$_L$ is satisfied. The ranking SWP$_L$ ≫ LINEARITY-IO and O-CONTIGUITY-OO does not ensure that it is the perfective which must undergo metathesis – metathesis of a following vocalic morpheme into the perfective equally well-satisfies SWP$_L$, as is illustrated in the following tableau.

(72)

/ya-a-[[[[lamuk]-il]-i]-e]/	SWP$_L$	LINEARITY-IO	O-CONTIGUITY-OO
a. ☞ yaalamwi$_L$i$_L$kye		*	*
b. ☞ yaalamuki$_L$ile		*	*

The two candidates in (72) are not identical in their constraint violation profiles. Candidate (72a) violates MAX-C, because the consonant of the perfective is deleted, and MAX-μ

because the output correspondent of the causative input /-i/ is a moraless glide. IDENT-μ is not violated under the definition assumed here because the mora attached to the causative in the input does not have an output correspondent. Candidate (72b) violates no other faithfulness constraints. Thus, in the absence of some other constraint that penalizes (72b), it will incorrectly harmonically bound (72a).

Lexically-specific faithfulness provides a potential solution to this problem. We begin by assigning an arbitrary index M (to avoid confusion with the index L) to the passive and short causative suffixes. We then index LINEARITY and O-CONTIGUITY to M; the definitions are straightforwardly provided by the EMC.

(73) a. Passive /-u_M/
b. Short causative /-i_M/

(74) a. LINEARITY$_M$
Let x, y be elements of the input and x', y' elements of the output. If x bears some arbitrary index M and if x$\Re$x' and y$\Re$y', then x $<$ y iff $\neg$[y' $<$ x'].

b. O-CONTIGUITY-OO$_M$
Let xz be a contiguous substring in the base. If $\exists$x', z' in output such that x$\Re$x' and z$\Re$z', then $\nexists y_M$ in the output such that [[x' $< y_M$ and $y_M <$ z'] and [$\nexists\alpha$ in the base such that $\alpha\Re y_M$]].

By ranking LINEARITY$_M$ or O-CONTIGUITY-OO$_M$ above MAX-μ and MAX-C, we correctly block the creation of a heavy penult via metathesis *into* the perfective.

(75)

/ya-a-lamuk-$i_L l_L$-i_M-e/	LIN-IO$_M$	O-CONTIG-OO$_M$	MAX-μ	MAX-C
a. ☞ yaala(mwii.kye)			*	*
b. yaalamu(ki$_L$i.le)	*!	*!		

4.3.2 OO-faithfulness revisited

While descriptively adequate, the lexically-specific faithfulness analysis suffers a loss of explanation. Because the short causative and passive are the only suffixes in a position to imbricate, yet fail to do so, assigning lexical indices to these morphemes is little more than a stipulation.

Instead, an analysis making use of OO-faithfulness constraints can elegantly explain why these suffixes fail to imbricate without resort to lexical specification. In §2.2, the constraint MAX-OO, repeated below, served to decide which of the two consonants in an illicit cluster created by metathesis would be preserved (i.e. the base consonant).

(76) MAX-OO
Every segment in the base has a correspondent in the affixed form.

Recall that the definition of MAX-OO relies on a particular assumption about morphological structure of stems, whereby OO-correspondence is reckoned recursively over the stem (Baković 2003): each affix that is introduced, along with its base, forms an output with respect to the base without that affix. Thus, each new affix effectively adds a dimension of OO-correspondence. The recursive OO-identity schema is repeated below.

(77) Recursive OO-correspondence relation

[[[[*root*] –*suffix*$_1$]. . .] –*suffix*$_n$]

A re-inspection of the candidates in (72) with the recursive OO-identity schema in our purview reveals other OO-constraints violated by the candidate in (72b). The relevant notion of *base* is the root plus perfective suffix and the notion of the *affixed form* is the base plus the short causative/passive suffix. The following comparison illustrates this.

(78) Base: [[lamwi$_L$i$_L$k]-i]
Candidate affixed form (72b): lamuki$_L$il

As can be seen, *w* in the base stands in correspondence with *u* in the imbricated affixed form, thus violating DEP-μ-OO:

(79) DEP-μ-OO
Every mora in the affixed form has a correspondent in the base.

Additionally, notice that the base contains the precedence relation [i$_L$ $<$ k], whereas the affixed form contains the contradictory precedence relation [k $<$ i$_L$], which violates LINEARITY-OO:

(80) LINEARITY-OO
Let x, y be elements of the base and x’, y’ elements of the affixed form. If x$\Re$x’ and y$\Re$y’, then x $<$ y iff $\neg$[y’ $<$ x’].

The OO-faithfulness analysis of the failure of the short causative and passive suffixes to imbricate is now straightforward. If MAX-OO and/or DEP-μ-OO and/or LINEARITY-OO outrank the IO-faithfulness constraints violated by candidate (72a) (namely MAX-IO and MAX-μ), metathesis from the right is correctly blocked, as shown in the tableau below.[21]

(81)

		/[[lamwi$_L$i$_L$k]-i]/	MAX-OO	LIN-OO	DEP-μ-OO	MAX-IO	MAX-μ-IO
a.	☞	yaalamwi$_L$i$_L$ky				*	*
b.		yaalamuki$_L$il	*!	*!	*!		

4.4 Summary

While ultimately lexically-specific faithfulness constraints are not particularly well-motivated in an effort to constrain imbrication, I hope the discussion of the mechanics by which lexically-specific faithfulness constraints can and must work has been fruitful. Note that the preference for alternative explanations in the preceding two subsections does not constitute a general argument against lexically-specific faithfulness, but rather reflects an appeal to ideas forged in areas of phonology that are still better understood (i.e. cyclic effects) than the interaction between the lexicon and CON.

[21] The final vowel has been ignored here for clarity of exposition.

5 The role of non-arbitrary specification: Minimality effects

The most striking generalization about the occurrence of imbrication is the prosodic size of the base of affixation of the perfective. In Cibemba and Chilungu, a necessary condition for imbrication is that the base be greater than one syllable. As can be seen in the following examples, the base constitutes all material from the left edge of the root until the potentially imbricating suffix, in this case perfective /-il/. Bases are shown in boldface.

(82) Base must be greater than one syllable

a. /**umfu**-il-e/ → umfwiile ‘had heard’
b. /**cit**-il-e/ → citile **ciite* ‘had done’ (Cibemba)

c. /tu-a-**salul**-il-e/ → twaasalwiile ‘we fried’
d. /tu-a-**ziik**-il-e/ → twaaziisile **twaaziike* ‘we ground’ (Chilungu)

The base minimality condition as a purely prosodic condition is further supported by the fact that when subminimal roots are extended by another suffix (that occurs before the perfective), imbrication will apply.

(83) Imbrication applies to extended subminimal roots

a. /**cit-an**-il-e/ → citeene ‘had done for each other’ (Cibemba; cf. (82b))
b. /tu-a-**ziik-iʃ**-il-e/ → twaaziisiiʃe ‘we caused to grind’ (Chilungu; cf. (82d))

(84) CVVC bases block imbrication

a. /puut-il-e/ → puut-il-e ‘blew’
b. /leep-il-e/ → leep-il-e ‘was long’ (Cibemba)

c. /tu-a-zuuk-il-e/ → twaazuusile ‘we got cold’
d. /tu-a-lyaat-il-e/ → twaalyaasile ‘we ran over, stepped on’ (Chilungu)

Following Beckman (1997, 1998), I assume that root-initial syllables, as ‘strong licensors’ of constrasts, are afforded special protection via positional faithfulness constraints that will prevent metathesis into the root-initial syllable. Given that LINEARITY-IO and O-CONTIGUITY-OO are the faithfulness constraints violated by imbrication, it is logical that the positional faithfulness constraints that are needed to block it must be specific versions of them. Following the EMC, they are defined in (85) and (86).

(85) LINEARITY-IO-σ_1
Let x and y be elements of the input and x’ and y’ elements of the output. If x$\Re$x’ and y$\Re$y’ and [x’ $\vee$ y’ $\in \sigma_1$], then x $<$ y iff $\neg$[y’ $<$ x’].

(86) O-CONTIGUITY-OO-σ_1
Let xz be a contiguous substring in the base. If $\exists$x’, z’ in output such that x$\Re$x’ and

z$\Re$z' and [x' $\vee$ z' $\in \sigma_1$], then $\nexists$y in the output such that [[x' $<$ y and y $<$ z'] and [$\nexists\alpha$ in the base such that $\alpha\Re$y]].

Once again, to ensure the correct definition of the constraints is being applied, we must argue from empirical data. We begin by considering an input with a subminimal base and comparing its precedence and contiguity relations with those in a pair of candidates. First, the precedence and contiguity relations holding in /cit-il-e/ are as follows:

(87) a. Precedence: $\{$[c $<$ i…e], [i $<$ t…e], [t $<$ i_L…e], [i_L $<$ l_L…e], [l_L $<$ e] $\}$
b. Contiguity: $\{\{$[c$\asymp$i], [i$\asymp$t]$\}_{base}$ [t$\asymp i_L$], [$i_L \asymp l_L$], [$l_L\asymp$e]$\}$

Next we compare the relations in the relevant candidates:

(88) a. citi$_L$l$_L$e

i. $\{$[c $<$ i…e], [i $<$ t…e], [t $<$ i_L…e], [i_L $<$ l_L…e], [l_L $<$ e] $\}$
ii. $\{\{$[c$\asymp$i], [i$\asymp$t]$\}_{base}$ [t$\asymp i_L$], [$i_L \asymp l_L$], [$l_L\asymp$e]$\}$

b. cii$_L$te

i. $\{$[c $<$ i], [i $<$ i_L], [i_L $<$ t], [t $<$ e]$\}$
ii. $\{$[c$\asymp$i], [i$\asymp i_L$], [$i_L\asymp$t], [t$\asymp$e]$\}$

The precedence relation [i_L $<$ t] in candidate (88b) contradicts the relation [t $<$ i_L] that holds in the input. The contiguous substrings [i$\asymp i_L$], [$i_L\asymp$t] in (88b) contradict the contiguous substring [i$\asymp$t] in the input. We note that if positional LINEARITY-IO and O-CONTIGUITY-OO were defined so as to hold only of segments parsed into the root-initial syllable, neither would be violated and thus imbrication would incorrectly fail to be blocked.

We can now account for the failure of imbrication when the base is subminimal by ranking LINEARITY-IO-σ_1 and O-CONTIGUITY-OO-σ_1 over SWP$_L$, which itself dominates O-CONTIGUITY-OO and LINEARITY-IO, as seen in (89):

(89) Imbrication into subminimal bases blocked

/[[[cit]-i$_L$l$_L$]-e]/	LIN-IO-σ_1	O-CONTIG-σ_1	SWP$_L$	LIN-IO	O-CONTIG-OO
a. ☞ ci(ti$_L$.l$_L$e)			*		
b. (cii$_L$.te)	*!	*!		*	*

There is a candidate that has not yet been considered that could render the introduction of LINEARITY-IO-σ_1 and O-CONTIGUITY-OO-σ_1 spurious, namely one in which the mora of the perfective suffix shifts into the root-intial syllable to cause lengthening, as seen in the hypothetical example in (90).

(90) /fu$_{\mu_1}$t-i$_{\mu_2 L}$l$_L$-e/ $\rightarrow$ *fu$_{\mu_1\mu_2}$te

While this would not wreck an analysis of the minimality effect described, it would suggest the replacement of LINEARITY-IO-σ_1 and O-CONTIGUITY-OO-σ_1 with the constraint IDENT-μ-σ_1, essentially prohibiting lengthening of the root-initial syllable. IDENT-μ-σ_1 could then be argued to replace LINEARITY-IO-σ_1 and O-CONTIGUITY-OO-σ_1 precisely because all candidates that violate LINEARITY-IO-σ_1 and O-CONTIGUITY-OO-σ_1 would also violate IDENT-μ-σ_1.

However, it is not the case that IDENT-μ-σ_1 is *required* to rule out the candidate in (90). This is because by shifting the mora of the perfective and deleting its vocalic features, the candidate in (90) also violates MAX-MI (see §2.3), whose definition is repeated below.[22]

(91) MAX-MI
Every morpheme-initial segment in the input has an output correspondent.

Therefore, by ranking MAX-MI above SWP_L, the candidate in (90) is correctly ruled out.

(92)

		/fu$_{\mu_1}$t-i$_{\mu_2 L}$l$_L$-e/	MAX-MI	SWP_L
a.	☞	fu$_{\mu_1}$ti$_{\mu_2\ L}$l$_L$e		*
b.		fu$_{\mu_1\mu_2}$te	*!	

Note too that MAX-MI cannot penalize authentic imbricated candidates, because if they satisfy SWP_L (i.e. the constraint driving imbrication), then the vocalic features of the perfective must be present, else no exponent of L would stand in the penult, thus violating SWP_L. Put another way, I assume the representation of the imbricated forms whose violation profiles were detailed above to be like the one in (93a), and unlike the one in (93b).[23]

(93) a. fwi$_{\mu_1}$i$_{L\ \mu_2}$te
b. fwi$_{\mu_1,\mu_{2L}}$te

As such, this claim constitutes the hypothesis that only melodic content (and not moraic content) may serve as the phonological exponent of a morpheme insofar as schemata for the interpretation of specific constraints such as Pater's and the EMC are concerned. Of course, this hypothesis awaits future investigation as to its merit.

6 Alternative analyses of imbrication

There are a variety of proposals in the OT literature that are potentially compatible with imbrication and it is the purpose of this section to explore a few of them in some detail. Analyses of four fundamental characters will be discussed: (i) those based on principles of homophony avoidance; (ii) those that rely on anti-faithfulness; (iii) those that make use of alternative markedness constraints; (iv) those which rely on idiosyncratic representations of idiosyncratic morphemes. Possible analyses of each of these four types, along with their concomitant issues and typological implications, will be discussed in turn.

[22] Another possibility would be to introduce a lexically-specific MAX-V constraint, which would equally well protect the vocalic content of the perfective suffix.

[23] Of course, this is not to exclude (93b) as a *possible candidate* emitted by GEN.

6.1 Imbrication as homophony avoidance

There is a three-way contrast in behavior in [*i]-suffixes (e.g. the perfective) versus their homophonous [i] counterparts (e.g. the applicative).[24] Consider the following set of examples from Chilungu.

First, as seen in (94) and (95), the perfective /-il/ fails to undergo a process of root-initial syllable-controlled mid vowel harmony, while the applicative /-il/ undergoes the rule.[25] All Chilungu data are from Bickmore (in prep.).

(94) Applicative /-il/ undergoes MVH

a. u-ku-ziik-a ‘to bury’
b. u-ku-ziik-il-a ‘to bury for’

c. u-ku-leet-a ‘to bring’
d. u-ku-leet-el-a ‘to bring for’

e. u-ku-kom-a ‘to cut’
f. u-ku-kom-el-a ‘to cut for’

(95) Perfective /-il/ fails to undergo MVH

a. u-ku-ziik-a ‘to bury’
b. ya-a-ziik-il-e ‘they buried’

c. u-ku-leet-a ‘to bring’
d. ya-a-leet-il-e ‘they brought’

e. u-ku-kom-a ‘to cut’
f. ya-a-kom-il-e ‘they cut’

Second, the perfective triggers mutation of a preceding consonant, while the applicative does not:[26]

(96) Perfective /-il/ induces mutation of a preceding consonant

[24] The [*i] label is meant to recall the historical reconstruction of such suffixes in Proto-Bantu (Guthrie 1967-71). Guthrie proposes that [*i] suffixes had a super-closed high front vowel in Proto-Bantu and that this contrast has been lost in most Bantu languages.

[25] For an OT analysis of mid vowel harmony in Bantu, see Beckman (1997, 1998).

[26] Other suffixes that contain [i]’s which are synchronic reflexes of Proto-Bantu super-closed [i] also induce mutation.

a. u-ku-ful-a ‘to wash’
b. ya-a-fuz-il-e ‘washed’

c. u-ku-imb-a ‘to dig’
d. ya-a-imv-il-e ‘they dug’

e. u-ku-ziik-a ‘to bury’
f. ya-a-ziis-il-e ‘they buried’

(97) Applicative /-il/ fails to cause mutation

a. u-ku-ful-a ‘to wash’
b. u-ku-ful-il-a ‘to wash for’

c. u-ku-imb-a ‘to dig’
d. u-ku-imb-il-a ‘to dig for’

e. u-ku-ziik-a ‘to bury’
f. u-ku-ziik-il-a ‘to bury for’

Finally, the perfective induces imbrication, while the applicative typically does not.

(98) Perfective /-il/ induces imbrication

a. u-ku-paapaatik-a ‘to flatten’
b. ya-a-paapaatiik-e ‘they flattened’

c. u-ku-lamuk-a ‘to greet’
d. ya-a-lamwiik-e ‘they greeted’

e. u-ku-kutumal-a ‘to keep quiet’
f. ya-a-kutumiil-e ‘they kept quiet’

(99) Applicative /-il/ does not imbricate

a. u-ku-paapaatik-a ‘to flatten’
b. u-ku-paapaatik-il-a ‘to flatten for’

c. u-ku-lamuk-a ‘to greet’

d. u-ku-lamuk-il-a 'to greet for'

e. u-ku-kutumal-a 'to keep quiet'

f. u-ku-kutumal-il-a 'to keep quiet for'

The correlation of these three processes with the [*i] *vs.* [i] distinction suggests that imbrication is merely the most bizarre alternation that obtains in the former class in order to avoid the creation of potential homophony with the latter set. As such, it is worth considering possible analyses which incorporate constraints that directly attempt to generate distinctive phonological realization of distinct morphemes.

In surveying previous OT-based theories of homophony avoidance (HA), one can make a fairly clear-cut distinction between theories which make use of inter-paradigmatic relations between related forms and those which do not.

6.1.1 Intra-paradigmatic approaches to HA

(100) *MERGE (Padgett 2003, Kawahara 2003)
Underlyingly distinct forms within a paradigm must receive a different phonological exponence.

*MERGE is not directly relevant to imbrication because of the stipulation that the underlying forms be distinct. It is clear that *MERGE is only relevant for cases in which homophony might be expected as a result of regular phonological processes.

Another intra-paradigmatic approach to HA is the theory of homophony avoidance laid out in Crosswhite (1999). In homophony avoidance, the correspondence relation (McCarthy and Prince 1995, 1999) is reckoned over pairs of words that are related paradigmatically:

(101) Homophony avoidance
All the segments in a pair of paradigmatically-related words, S_1 and S_2, stand in correspondence.

Adopting Crosswhite's general schema, an anti-faithfulness constraint is required to ensure distinctive realization of the perfective and applicative suffixes. ANTI-LINEARITY, defined informally in (102), would then be the constraint that would force an alternation in the realization of input /-il/.

(102) ANTI-LINEARITY
There is some precedence relation in S_1 that is contradicted in S_2.

However, Crosswhite (1999) tells us that S_1 and S_2 are not 'the same' – this ensures that anti-faithfulness won't apply to any two words with identical URs. As in the case of *MERGE, the reason for this stipulation is reflected in the language-particular agenda of accounting for the blocking of a regular phonological rule (in this case, vowel reduction in Bulgarian) when it would *create* homophony. Thus HA in Crosswhite's approach is in the dynamic sense, one obviously not relevant to the analysis of imbrication.[27]

[27] Note that even if the URs were not stipulated to be distinct, the two properties of intra-paradigmatic HA mentioned below persist, rendering it somewhat more deeply inapplicable to imbrication.

6.1.2 Non-paradigmatic HA

(103) CONTRAST (Siddiqi 2003)
Semantically-different affixal morphemes must be realized as phonologically different from one another when affixed to the same stem.

CONTRAST shows improvement over all approaches to HA considered thus far, at least insofar as locality is concerned; the locus of unfaithfulness is the right edge of stem material up to the perfective/left edge of the perfective. However, like the intra-paradigmatic approaches to HA, CONTRAST doesn't have a way to tell us that it is the perfective (and not the applicative) that should be unfaithful.[28]

6.1.3 Evaluating homophony avoidance

A survey of various extant approaches to HA has turned up two issues which appear to make them inviable:

(104) a. *Indeterminate identity of unfaithfulness*
Intra-paradigmatic HA says nothing about which member of the pair in question should be unfaithful. In our case, it may as well be the applicative as the perfective.

b. *Locality*
Nothing in the statement of Padgett and Kawahara's *MERGE or Crosswhite's intra-paradigmatic anti-faithfulness constraints constrains the locus of unfaithfulness.

None of the above approaches to HA appears to combine these two properties, though we could imagine that some kind of marriage of CONTRAST and transderivational anti-faithfulness (to be discussed in §5.2) would get us close.

However, to the extent that imbrication is displayed by other suffixes with a historically super-closed [i] (e.g. causative [-iʃ] in Ciluba (Lukusa 1993)) which lack a potentially homophonous counterpart, it is far from clear that imbrication does in fact exist in order to avoid homophony in verbal paradigms. Moreover, the correlation of the set of [*i]-suffixes with imbrication, consonant mutation, and mid vowel harmony does not necessitate a purely constraint-based solution; the set of [*i]-suffixes exhibit idiosyncratic behavior and I argue this is best captured in an analysis that assigns lexical marking to exceptional morphemes, as in the analysis proposed in §3 as well as in the remaining alternatives to be discussed.

6.2 Imbrication as transderivational anti-faithfulness

Transderivational anti-faithfulness (TAF) (Alderete 1998, 2001) presents a competitive approach to imbrication because it introduces lexically- indexed constraints, albeit of a differ-

[28]MORPHREAL (Kurisu 2001) ('The phonological realization of an affixed form must not be identical to the phonological realization of the related unaffixed form.') is obviously inapplicable to imbrication since imbrication regularly applies to preceding stem material irregardless of whether it is affixed (i.e. containing other extensions) or unaffixed (so long as the stem constitutes at least two syllables).

ent formal character. The advantage afforded by TAF lies in the insight that dominance effects like imbrication are triggered by affixes with an idiosyncratic property, dubbed [+dominant] by Alderete. By lexically-indexing anti-faithfulness constraints to [+dominant] affixes, TAF recognizes idiosyncratic behavior directly in CON.

The relevant anti-faithfulness constraint for the [+dominant] affix we are concerned with (the Bantu perfective) is the pro-metathesis constraint defined in (105).

(105) ¬OO-LINEARITY
Let x,y $\in S_1$ and x',y' $\in S_2$. If x$\Re$x' and y$\Re$y', then x' < y' iff ¬[x < y].
'The precedence structure of S_2 is not consistent with that of S_1.'

(106)

		/fuuŋg-ul-il-e/	¬OO-LINEARITY$_{perf}$	OO-LINEARITY
a.	☞	fuuŋgwiile		*
b.		fuuŋgulile	*!	

Despite its advantage on the issue of which member of the paradigm should behave unfaithfully, TAF shares the liability displayed by all of the above approaches in that its demand for unfaithfulness can in principle be satisfied anywhere in the relevant string. (Alderete 2001: 211fn.) mentions that a combination of markedness, faithfulness, positional faithfulness, and possibly positional anti-faithfulness constraints should pinpoint the site of unfaithfulness – an appeal to a property of anti-faithful mappings he calls *grammar-dependence*. This is certainly plausible, but it is far from clear what the relevant constraints would be for a multisyllabic base, beyond root-initial faithfulness.[29]

Another suggestion (Alderete 2001: 246) makes employs *local constraint conjunction*. By locally conjoining ¬OO-LINEARITY$_{perf}$ with ANCHOR-R(Stem, PrWd) in the domain of the syllable, we could force the locus of unfaithfulness to be at the right edge of the base:

(107) [¬OO-LINEARITY$_{perf}$ & OO-ANCHOR-R(Stem, PrWd)]$_\sigma$

Informally, (107) says that it is prohibited to deanchor the right edge of the stem from the prosodic word via affixation of the perfective while also failing to metathesize. In short, this move effectively hard-wires locality of dominance effects into CON. However, because the both the combinatorial possibilities and domain possibilities are not successfully restricted, an account which relies crucially upon local conjunction faces the problem of massive overgeneration; as such, I will not pursue this analysis here.

Another solution to the locality problem in TAF is to reanalyze imbrication as essentially intrusion from a form affixed with an imbricating suffix into its morphologically simpler base.[30] If the OO-correspondence domain is defined such that any anti-faithfulness constraint could only be satisified by a change in the base, we could suppose that OO-LINEARITY is in fact *undominated*, and we could analyze the IO-LINEARITY-violating metathesis of the vowel of the perfective with the final segment of the base as *intrusion*.

The faithfulness constraint which penalizes intrusion generally is O-CONTIGUITY (McCarthy and Prince 1995, 1999), the relevant version of which is defined in (108).

[29]One approach along the lines discussed by Alderete would be to posit constraints regulating bases explicitly (as in some current proposals for reduplication (McCarthy and Prince in prep., Beechey 2005); we might be able to go a little further and posit constraints that rule out positions in the base to be unfaithful.

[30]Thanks to Joe Pater for suggesting this alternative analysis.

(108) OO-O-CONTIGUITY
The portion of the affixed form standing in correspondence forms a contiguous string.
Domain ($\Re$) is a single contiguous string in the affixed form.

Accordingly, the anti-faithfulness constraint has the following definition:

(109) ¬O-CONTIGUITY-OO
The portion of the affixed form standing in correspondence does not form a contiguous string.
Domain ($\Re$) is not a single contiguous string in the affixed form.

As seen in (110), ranking ¬OO-O-CONTIGUITY$_{perf.}$ above O-CONTIGUITY-OO produces minimal intrusion of the vowel of the perfective into the base.

(110)

	/[k$_1$u$_2$ŋg$_3$u$_4$b$_5$]$_{base}$-il-e/	¬O-CONTIGUITY-OO$_{perf.}$	O-CONTIGUITY-OO
a. ☞	[kuŋgw$_4$**ii**b$_5$]e		*
b.	[ku**u**$_4$ŋg$_3$b]ile	*!	

By ranking OO-LINEARITY over O-CONTIGUITY-OO, we produce a type of intrusion that isn't metathesis in the OO-dimension.

(111)

	/[k$_1$u$_2$ŋg$_3$u$_4$b$_5$]$_{base}$-il-e/	LIN-OO	O-CONTIG-OO	LIN-IO	O-CONTIG-IO
a. ☞	[kuŋgw$_4$**ii**b$_5$]e		*	*	*
b.	[ku**u**$_4$ŋg$_3$b]ile	*!			

While the example in (111) is an imperfect illustration of this idea (i.e. because (111b) obviously violates other constraints), the point is that intrusion (111a) doesn't actually disrupt the precedence structure of the base, whereas metathesizing anywhere else in the base will be literal OO-LINEARITY-violating metathesis. What is crucial in this approach is that the perfective be considered outside of the OO-correspondence domain. From this assumption it follows that only by metathesizing in the desired place can precedence relations in the base actually be preserved.

6.2.1 Evaluating transderivational anti-faithfulness

While descriptively adequate for Bantu imbrication, a particular typological liability of this analysis (and one shared by other TAF-based accounts) is that anti-faithfulness constraints can be accidentally satisfied by the relevant type of unfaithful mapping that occurs for independent reasons.[31] Suppose for instance a language that has imbrication as well as vowel epenthesis to relieve illicit consonant clusters. If the perfective is affixed to base of appropriate prosodic size that contains such a cluster, ¬OO-O-CONTIGUITY will be equally well satisfied by epenthesis in the base as it is by imbrication. This is illustrated with a hypothetical example in the following tableau.

[31] Thanks to Joe Pater and Matt Wolf for suggesting arguments against TAF along these lines.

(112) Anti-faithfulness accidentally satisfied by an independent repair

		/[$t_1u_2k_3$-$b_4u_5l_6$]$_{base}$-il-e/	OO-O-CONTIG	DEP-IO
a.	☠	[tuk**u**bw$_5$**ii**l$_6$]e	*	*
b.	☞	[tuk**u**bul]ile		*

If illicit consonant clusters are repaired by epenthesis, then *COMPLEX ≫ DEP-IO and if imbrication is the triumph of ¬OO-O-CONTIGUITY over OO-O-CONTIGUITY (and other faithfulness constraints), then the desired imbricating candidate (112a) will be harmonically bounded by a candidate like (112b), in which epenthesis into the base kills two birds with one stone (i.e. satisfies both *COMPLEX and ¬OO-O-CONTIGUITY).

Further, a more general objection to a TAF-based account can be raised. While TAF is successful in accounting for the locality of imbrication in all languages which exhibit the phenomenon at all (i.e. because these languages to my knowledge do not actually exhibit independent epenthesis processes), we still have come no closer to a general understanding of locality conditions on dominance effects. In other words, the distinction between intrusion into the base and metathesis into the base (i.e. between O-CONTIGUITY-OO and OO-LINEARITY) cannot be generalized as a solution to locality conditions on dominance effects because it is simply not the case that every kind of unfaithfulness can be reanalyzed as another type of unfaithfulness. More formally, it is merely a peculiarity of the correspondence theory of faithfulness that OO-LINEARITY has a convenient cousin in O-CONTIGUITY-OO that can be appealed to in the analysis of imbrication; for instance, IDENT presumably lacks such a counterpart. Therefore, while the above analysis achieves descriptive adequacy in the case of imbrication, such a language-particular solution appears to be ultimately unsustainable.

6.3 Imbrication as syllable economy

Yet another possible account of imbrication would make use of the generalization that, in comparing an imbricated candidate with its faithful counterpart, the former is invariably one syllable shorter (6g). Imbrication would thus be characterized as a kind of morpheme-specific prosodic economy effect, bearing an abstract relation to de Lacy's (2004) analysis of Maori.

Perhaps the simplest implementation of this idea would be to lexically-index the pure economy constraint *σ to the imbricating suffix. By ranking *σ over LINEARITY, metathesis would be compelled to reduce the number of syllables by one.

(113)

		/fuuŋg-ul-il$_L$-e/	*σ_L	LINEARITY
a.	☞	fuu.ŋgwii.le		*
b.		fuu.ŋgu.li.le	*!	

(114)

		/fuuŋg-ul-il$_L$-e/	MAX	LINEARITY
a.	☞	fuuŋgwiile		*
b.		fuuŋgule	*!*	

Despite the empirical validity of this generalization, an analysis positing syllable economy as the markedness force driving imbrication is subject to the arguments leveled against

against the existence of pure economy constraints in Gouskova (2003). Accepting these objections as sound, I abandon this approach altogether.

6.4 The input of [*i] suffixes

So far we have been assuming that the input of the perfective is /-il/. However, nothing about OT strictly requires this – the fact is that the perfective morpheme has two alternants: [il] (when imbrication is blocked) and [i] (when imbrication applies), whereas the applicative is always [il]. There are several ideas in the literature that are capable of distinguishing the two suffixes and a couple will be explored below.

6.4.1 Floating input elements

One way to understand to make sense out of the behavior of [*i] suffixes is to posit for them a different input representation than for their non-[*i] counterparts. Suppose that the [*i] suffixes were represented in the following way:[32]

(115) The representation of [*i] vs. [i] suffixes

a. [*i]-suffixes: /-μ, [+hi, -bk] C/
b. [i]-suffixes: /-iC/

In effect, the [*i]-suffixes would be comprised of a mora plus the relevant vocalic features (i.e. [+high, –back, etc.]) followed by whatever the relevant consonant for the particular suffix in question. In contrast, the [i]-suffixes would be represented normally – with a full-fledged [i] followed by some consonant. The crucial difference would presumably be that the former set lacks a root node.

There are a number of approaches to the docking of floating elements in the literature; I adopt that of Wolf (2006), which arguably has the greatest empirical coverage. The challenge is to propose some constraint to explain why, for instance, the perfective is realized by docking its mora and vocalic features onto its base.

Wolf (2006) proposes a constraint that militates against tautomorphemic docking of floating features and moras, as defined in (116).

(116) NoTauMorDoc
Floating autosegments cannot dock onto bearing units that are exponents of the same morpheme.

Ignoring the precise interpretation of 'bearing units' for a moment, we can appreciate how imbrication would be derived in such an approach: by ranking NoTauMorDoc above Linearity, the vocalic features and mora sponsored by the imbricating morpheme are forced to move to dock.

(117)

/kuŋgub-μ [+hi, -bk] l-e/	NoTauMorDoc	Linearity
a. ☞ kuŋgwiibe		*
b. kuŋgubile	*!	

[32] Thanks are due to Paul Smolensky for suggesting an approach along these lines.

Essentially the same account given in §5 for the failure of imbrication into subminimal bases can be applied in this analysis, as shown in the following tableau:

(118)

/cit-μ [+hi, -bk] l-e/	O-CONTIGUITY-OO-σ_1	NOTAUMORDOC
a. ☞ citile		*
b. ciite	*!	

Another advantage of this analysis is that it can be in principle extended to account for consonant mutation and lack of mid vowel harmony, which pattern with imbrication in being exemplified by exclusively [*i]-suffixes. To account for consonant mutation, we could construct an analysis much along the lines of Zoll (1995), in which the distinction between C- and V-place explains why the [*i]-suffixes trigger mutation, while [i]-suffixes do not. A variant of this analysis, suggested by Paul Smolensky, would be to assign an abstract [super-closed] feature to the vowel of the perfective, essentially adapting Guthrie's (1967-71) historical reconstruction into a synchronic account. To sketch how this analysis would proceed, we could imagine that the responsible pro-assimilation constraints demand agreement for the features relevant in the various observed mutations. To get [*i]-suffixes exclusively trigger the various mutations, we could posit a constraint requiring that segments specified as [super-closed] head spans of the various features involved. An example of this type in Span Theory (McCarthy 2004) is the constraint HEAD.

To account for the failure of [*i]-suffixes to undergo mid vowel harmony, we could again make use of the [super-closed] specification. For instance, the constraint(s) driving harmony might require height harmony only between segments specified as [–super-closed]. If [*i]-suffixes are [+super-closed], there will be no reason for them to harmonize.

While this analysis is capable of capturing the basic facts about imbrication and extends to an account of the correlating phonological processes, questions and challenges remain. First, at least a technical problem for this analysis is that without a root node, there is nothing to ensure that the vocalic features of the perfective are linearized as desired. Another issue for this approach, albeit a more parochial one, is to explain how a ban on tautomorphemic docking forces the mora plus features to dock *leftward*. As these issues cannot be properly resolved in this paper, I leave this approach as a possibility awaiting further research.

6.4.2 Listed allomorphy

The analysis of cases of allomorphy in which the alternants are phonologically dissimilar, but whose distribution is phonologically conditioned has become somewhat standard in recent work in OT. Such allomorphs cannot generally be derived from a common underlying representation, and thus they must be lexically listed. OT deals with listed allomorphy by supposing that each lexically-listed allomorph and the candidate outputs to which they map compete in a single tableau. Because all allomorphs are available as inputs, the output candidates are all equally faithful, hence the choice is made by the markedness constraints.

Because faithfulness to the inputs of the allomorphs must not select the alternant, we can actually only directly compare candidates which perform equally on LINEARITY and O-CONTIG-OO. The challenge is to define M, the constraint which compels metathesis of the perfective just in case the base to which it is affixed is long enough.

Thus, we consider candidates for inputs on each side of the phonological condition governing the occurrence of imbrication, namely base minimality (see §5). The context in which minimality is satisfied in examined in (119), while the monosyllabic blocking case in analyzed in (120).

(119)

	/lamuk-{i, il}-e/	M	Onset	*CC	Lin-IO	O-C
a. ☞	lamwiike (w.r.t /lamuk-i-e/)			*	*	*
b.	lamwilke (w.r.t /lamuk-il-e/)			**!	*	*
c.	lamukie (w.r.t /lamuk-i-e/)	*!	*!			
d.	lamukile (w.r.t /lamuk-il-e/)	*!				

By hypothesis, both imbricating candidates (119a-b) satisfy M, however imbrication with the /-il/ alternant results in an extra consonant cluster. The non-imbricating candidates in (119c-d) presumably violate M and or Onset, resulting in the partial ordering M, Onset $\gg$ *CC, Lin-IO, O-Contig-OO.

(120)

	/cit-{i, il}-e/	Lin-IO-σ_1	O-C-σ_1	Onset	M	*CC	Lin	O-C
a. ☞	citile (w.r.t /cit-il-e/)				*			
b.	citie (w.r.t /cit-i-e/)			*!	*			
c.	ciilte (w.r.t /cit-il-e/)	*!	*!		*	*	*	*
d.	ciite (w.r.t /cit-i-e/)	*!	*!				*	*

In the above case of a monosyllabic base, we assume M is violated by the optimal candidate and satisfied by its imbricating competitors. This fact is accounted for by ranking Lin-IO-σ_1 and O-Contig-OO-σ_1 above M (see also §5), thus giving the new partial ordering as Lin-IO-σ_1, O-Contig-OO-σ_1 $\gg$ M, Onset $\gg$ *CC, Lin-IO, O-Contig-OO.

However, without additional constraints, the current ranking predicts that the short causative suffix /-i/ should imbricate, yet it fails to. The following tableau shows that the observed output from a causative input (i.e. /lamuk-i$_{Caus.}$-e/ $\rightarrow$ lamukye) loses to the imbricated candidate in (121c).

(121)

	/lamuk-i$_{Caus.}$-e/	Onset	M	Lin-IO	O-C	*CC	Max-μ
a. ☠	lamukye		*!			*	*
b.	lamukie	*!					
c. ☞	lamwiike			*	*	*	

To reduce the argument to the ranking paradox, an examination of the causative alone would motivate Lin-IO and O-Contig-OO $\gg$ M, but this contradicts the ranking M $\gg$ Lin-IO and O-Contig-OO motivated in (119). In other words, such an analysis is opaque. While opacity in itself does not constitute an argument against a particular analysis, given the existence of the transparent analysis proposed above, it seems less desirable in the case of imbrication.

One sort of hybrid approach would be to posit that the allomorphs of an imbricating suffix are -μ, il. Depending on the nature of the proposal for M, this alternative would offer us a way out of the causative problem. However, such an approach would not be able to explain the epiphenomenal hiatus resolution patterns (see §2.3) simply because the moraic alternant of the imbricating suffix would not have any melodic content to contribute. This could be avoided as well by positing that the moraic allomorph also has unlinked featural content, but this has an arguably formally simpler alternative in the approach discussed above.

6.5 Evaluating alternative analyses

In this section I have discussed alternatives of four different types to the metrical account proposed in §2. Homophony avoidance-based approaches (§6.1) were argued to have two difficulties: determining the locus of unfaithfulness and selecting which member in a paradigm should participate in the relevant unfaithful mapping. Transderivational anti-faithfulness (§6.2) was able to overcome the identity problem in much the same way as the lexically-specific markedness approach advocated above, but ultimately was rejected on the basis of locality predictions: (i) it fails to provide a general solution across the observed range of dominance effects; (ii) it shows a propensity for accidental satisfaction by independent repairs. An analysis based on syllable economy (§6.3) was shown to be a non-starter on the view that CON lacks pure economy constraints altogether (Gouskova 2003). Finally, the two representational approaches discussed in §6.4 remain in principle possible, however they are faced with resorting to an opaque analysis or with the burden of a reasonable proposal for the constraint(s) that drives metathesis.

Of course, a possibility is that SWP is the markedness constraint under either a latent segment or listed allomorphy analysis. While not arguing specifically against either of these possibilities, note that the indexed-SWP analysis proposed above does without baroque representations to explain morpheme-specific phonology. While it is not in general possible to level arguments for lexicon-based versus CON-based solutions in the domain of morpheme-specific phonology, a CON-based solution has some consequences that a representational approach does not. Perhaps the best example of this is the observation made by Bickmore (in prep.), Hyman (1995), and others that imbrication of the perfective has actually affected the realization of other phonologically similar tense/aspect suffixes. An analysis making use of indexed constraints seems more plausibly suited to accomodate this observation – the learner simply would add an index to the analogizing suffix. The ranking of SWP_L would presumably already be fixed on the basis of the productively imbricating suffixes. In contrast, it seems a representational approach is forced to assume that the learner can create a baroque representation for the analogizing suffix.

7 Conclusion

In this paper, I have explored the phenomenon of Bantu imbrication in some depth, placing the variety of interesting issues regarding the phonological grammar and its relation to the lexicon above exhaustive empirical coverage. Specifically, I have made some proposals about the formal nature of specific constraints, of both arbitrary and non-arbitrary types. Specific versions of multiple correspondence constraints adopting the Pater's schema/the EMC were shown to be capable of §§4-5 correctly constraining imbrication both lexically and phonologically, while alternative interpretations of the domain of evaluation of these constraints were shown to be inadequate. Finally, alternative possible analyses of imbrication were discussed in some detail with some mixed results.

It remains for future research to determine the empirical validity of the proposals made about the nature of specific constraints as well as for the arguments against alternatives.

References

Alderete, John (1998). *Morphologically-governed accent in Optimality Theory*. Ph.D. thesis, University of Massachusetts Amherst.

Alderete, John (2001). Dominance effects as transderivational anti-faithfulness. *Phonology* **18**, 201–253.

Ashton, E.O., Mulira, E.M.K., Ndawula, E.G.M. and Tucker, A.N. (1954). *A Luganda grammar*. London: Longmans.

Baković, Eric (2000). *Harmony, Dominance, and Control*. Unpublished Ph.D. dissertation, Rutgers University, New Brunswick, NJ.

Baković, Eric (2003). Vowel harmony and stem identity. In *San Diego Linguistic Papers*, vol. 1, pp. 1–42. San Diego: UCSD Department of Linguistics.

Bastin, Yvonne (1983). *La finale verbale -IDE et l'imbrication en bantou*. No. 114 in Annales. Tervuren: Musée Royal de l'Afrique Centrale.

Beckman, Jill (1997). Positional faithfulness, positional neutralisation and Shona vowel harmony. *Phonology* **14**, 1–46.

Beckman, Jill (1998). *Positional Faithfulness*. Unpublished Ph.D. dissertation, University of Massachusetts, Amherst.

Beechey, Timothy (2005). Reduplication in Ngandi. Handout presented to UMass Phonology Group.

Benua, Laura (1997). *Transderivational Identity: Phonological Relations between Words*. Ph.D. dissertation, University of Massachusetts, Amherst. Distributed by GLSA Publications.

Bickmore, Lee (in prep.). Chilungu phonology. Ms. University at Albany, SUNY.

Casali, Roderic (1997). Vowel elision in hiatus contexts: Which vowel goes? *Language* **73**, 493–529.

Chomsky, Noam and Halle, Morris (1968). *The Sound Pattern of English*. Cambridge MA: MIT Press.

Clements, G.N. (1986). Compensatory lengthening and consonant gemination in Luganda. In Leo Wetzels and Engin Sezer (eds.), *Studies in Compensatory Lengthening*, pp. 37–77. Dordrecht: Foris.

Coetzee, Andries and Pater, Joe (2005). Lexically specific constraints: Gradience, learnability, and perception. In *Proceedings of the 3rd Seoul International Conference on Phonology*, pp. 85–119. Seoul: The Phonology-Morphology Circle of Korea.

Crosswhite, Katherine (1999). Intraparadigmatic homophony avoidance in two dialects of Slavic. *UCLA Working Papers in Linguistics* **1**, 48–67.

De Blois, K.F. (1975). *Bukusu generative phonology and aspects of Bantu structure, Annales*, vol. 85. Tervuren: Musée Royal de l'Afrique Centrale.

De Lacy, Paul (2004). Maximal words and the Maori passive. In John J. McCarthy (ed.), *Optimality Theory in Phonology: A Reader*, pp. 495–512. Oxford: Blackwell.

Downing, Laura J. (2005). On the ambiguous segmental status of nasals in homorganic NC sequences. In M. van Oostendorp and J.M. van der Weijer (eds.), *The internal organization of phonological segments*. Berlin: Mouton de Gruyter.

Elenbaas, Nine and Kager, René (2004). Ternary rhythm and the LAPSE constraint. In McCarthy (2004), pp. 178–190. ROA-364.

Flack, Kathryn (to appear). Templatic morphology and indexed markedness constraints. *Linguistic Inquiry* .

Fukuzawa, Haruka (1999). *Theoretical Implications of OCP Effects on Features in Optimality Theory*. Ph.D. thesis, University of Maryland, College Park.

Gelbart, Ben (2005). *Perception of Foreignness*. Ph.D. thesis, University of Massacusetts Amherst, Amherst, MA.

Givón, Talmy (1970). On ordered rules and the modified base of ChiBemba verbs. *African Studies* **29**, 47–54.

Gouskova, Maria (2003). *Deriving Economy: Syncope in Optimality Theory*. Ph.D. dissertation, University of Massachusetts, Amherst, Amherst. Distributed by GLSA Publications.

Guthrie, Malcolm (1967-71). *Comparative Bantu*. Farnborough: Gregg. 4 vols.

Hayes, Bruce (1989). Compensatory lengthening in moraic phonology. *Linguistic Inquiry* **20**, 253–306.

Hyman, Larry M. (1995). Minimality and the prosodic morphology of Cibemba imbrication. *Journal of African Languages and Linguistics* **16**, 3–39.

Itô, Junko and Mester, Armin (1999). The phonological lexicon. In Natsuko Tsujimura (ed.), *The Handbook of Japanese Linguistics*, pp. 62–100. Oxford: Blackwell.

Itô, Junko and Mester, Armin (2001). Covert generalizations in Optimality Theory: the role of stratal faithfulness constraints. *Studies in Phonetics, Phonology, and Morphology* **7**, 273–299.

Kager, René (1999a). *Optimality Theory*. Cambridge: Cambridge University Press.

Kager, René (1999b). Surface structure of metrical structure in Optimality Theory. In Ben Hermans and Marc van Oostendorp (eds.), *Derivational Residue in Phonological Optimality Theory*, pp. 207–245. Amsterdam: John Benjamins.

Kager, René, van der Hulst, Harry and Zonneveld, Wim (eds.) (1999). *The Prosody–Morphology Interface*. Cambridge: Cambridge University Press.

Kawahara, Shigeto (2003). Root-controlled fusion in Zoque: Root-Faith and neutralization avoidance. Ms. University of Massachusetts Amherst.

Kenstowicz, Michael and Kisseberth, Charles W. (1979). *Generative Phonology*. New York: Academic Press.

Key, Michael (2006). Moraic conservation and truncation in Luganda. Ms., University of Massachusetts Amherst.

Kisseberth, Charles W. and Abashiekh, Mohammad Imam (1974). A case of systematic avoidance of homonyms. *Studies in the Linguistic Sciences* **4**, 107–124.

Kraska-Szlenk, Iwona (1997). Exceptions in phonological theory. In *Proceedings of the 16th International Congress of Linguists*, 0173. Oxford: Pergamon.

Kraska-Szlenk, Iwona (1999). Syllable structure constraints in exceptions. In John Rennison and Klaus Kühnhammer (eds.), *Phonologica 1996: Syllables?!*, pp. 113–131. The Hague: Thesus.

Kurisu, Kazutaka (2001). *The Phonology of Morpheme Realization*. Ph.D. dissertation, University of California, Santa Cruz. [ROA-490].

Landman, Meredith (2003). Morphological contiguity. In Angela Carpenter, Andries Coetzee and Paul De Lacy (eds.), *University of Massachusetts Occasional Papers in Linguistics 26: Papers in Optimality Theory II*. GLSA.

Lukusa, Stephen Tchidiessa-Mulami (1993). Imbrication of extensions in Ciluba. *Afrikanistische Arbeitspapiere* **36**, 55–75.

McCarthy, John J. (2000). The prosody of phase in Rotuman. *NLLT* **18**, 147–197.

McCarthy, John J. (2004). Headed spans and autosegmental spreading. Ms. University of Massachusetts, Amherst [ROA-685].

McCarthy, John J. (2006a). *Hidden Generalizations: Phonological Opacity in Optimality Theory*. London: Equinox.

McCarthy, John J. (2006b). Restraint of analysis. In Eric Baković (et al.) (ed.), *Wondering at the Natural Fecundity of Things: Essays in Honor of Alan Prince*. Santa Cruz, CA: Linguistics Research Center. [Published electronically at http://repositories.cdlib.org/lrc/prince/.].

McCarthy, John J. and Prince, Alan (1993). Generalized alignment. In Geert Booj and Jaap van Marle (eds.), *Yearbook of Morphology*, pp. 79–153. Dordrecht: Kluwer.

McCarthy, John J. and Prince, Alan (1995). Faithfulness and reduplicative identity. In Jill N. Beckman, Laura Walsh and Suzanne Urbanczyk (eds.), *Papers in Optimality Theory*, University of Massachusetts Occasional Papers 18, pp. 249–384. University of Massachusetts, Amherst: UMOP.

McCarthy, John J. and Prince, Alan (1999). Faithfulness and identity in prosodic morphology. In Kager et al. (1999), pp. 218–309. ROA-216.

McCarthy, John J. and Prince, Alan (in prep.). Prosodic concordance in Axininca Campa. Ms. University of Massachusetts, Amherst and Rutgers University.

Mould, Martin (1973). On reconstructing the modified base of Bantu verbs. *Studies in African Linguistics* **3**, 107–125.

Ota, Mitsuhiko (2004). The learnability of the stratified phonological lexicon. *Journal of Japanese Linguistics* **20**, 19–48.

Padgett, Jaye (2003). Systematic contrast and Catalan rhotics. Ms. University of California, Santa Cruz.

Pater, Joe (1999). Austronesian nasal substitution and other NC̥ effects. In René Kager, Harry van der Hulst and Wim Zonneveld (eds.), *The Prosody–Morphology Interface*. Cambridge: Cambridge University Press.

Pater, Joe (2000). Nonuniformity in English stress: the role of ranked and lexically specific constraints. *Phonology* **17**, 237–274.

Pater, Joe (2003). Balantak metathesis and theories of possible repair in Optimality Theory. Ms., University of Massachusetts Amherst.

Pater, Joe (to appear). The locus of exceptionality: Morpheme-specific phonology as constraint indexation. In Leah Bateman et al. (ed.), *University of Massachusetts Occasional Papers in Linguistics: Papers in Optimality Theory III*, vol. 33. Amherst: GLSA.

Prince, Alan (1990). Quantitative consequences of rhythmic organization. In M. Ziolkowski, M. Noske and K. Deaton (eds.), *Parasession on the syllable in phonetics and phonology*, pp. 355–398. Chicago: Chicago Linguistics Society.

Prince, Alan (1997). Stringency and anti-Paninian hierarchies. Handout from LSA Institute.

Prince, Alan and Smolensky, Paul (2004). *Optimality Theory: Constraint Interaction in Generative Grammar*. Oxford: Blackwell. Previously distributed as Rutgers University RuCCS Technical Report 2. (1993).

Siddiqi, Daniel (2003). Obtaining lexical contrast in Optimality Theory: An analysis of derived homophony avoidance. Handout of presentation at the University of Arizona Recruit Weekend Conference.

Steriade, Donca (1995). Underspecification and markedness. In John Goldsmith (ed.), *The Handbook of Phonological Theory*, pp. 114–167. Oxford: Blackwell.

Wolf, Matthew (2006). For an autosegmental theory of mutation. In Leah Bateman et al. (ed.), *University of Massachusetts Occasional Papers in Linguistics: Papers in Optimality Theory III*, vol. 33. Amherst: GLSA.

Wolf, Matthew and McCarthy, John J. (2007). Less than zero: Correspondence and the null output. In *Modeling Ungrammaticality in Optimality Theory*. London: Equinox.

Zoll, Cheryl (1995). Consonant mutation in Bantu. *Linguistic Inquiry* **26**, 536–545.