

UNIVERSITY OF CALIFORNIA

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**NONITERATIVITY IS AN EMERGENT PROPERTY OF  
GRAMMAR**

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requirements for the degree of

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in

LINGUISTICS

by

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## Abstract

Noniterativity is an Emergent Property of Grammar

by

Aaron F. Kaplan

Many rule-based theories of phonology include an iterativity parameter so that rules can either be stipulated to apply as many times as possible or restricted to a single application. Optimality Theory cannot replicate this simple device: Constraints that produce iterativity (AGREE, ALIGN, SPREAD, PARSE. . .) do not produce noniterativity with a simple parameter switch. Furthermore, OT's architecture prevents the generation of true noniterativity: In order to determine whether or not a feature has spread just once, for example, the markedness constraint that imposes noniterativity must know the input configuration. But markedness constraints are not allowed to access the input. OT, then, is more restrictive than rule-based phonology on this point and predicts that truly noniterative phenomena—processes defined in part by a noniterativity requirement—should not exist.

This dissertation evaluates whether OT is too restrictive in this prediction by examining five seemingly noniterative phenomena in detail: vowel harmony in Lango, umlaut in Chamorro, tone spread in Chichewa, tone shift in Kikuyu, and postlexical spreading in various languages. The noniterative nature of these phenomena is argued to be a byproduct of a confluence of factors that are not concerned with noniterativity specifically. For example, in Lango and Chamorro,



spreading from affixes to the root is noniterative not because a parameter stipulates this kind of spreading, but because a constraint motivates spreading to the root. Once the root (which is adjacent to the affix) is reached, further spreading is unmotivated. Other factors that can lead to noniterativity are identified. The conclusion is that no noniterative phenomenon requires an analysis that explicitly calls for noniterativity, and thus rule-based phonology is wrong to adopt an iterativity parameter. The implication of this result is that phonological grammars are, as OT asserts, concerned with representations and not the processes that give rise to these representations. The absence of true noniterativity lends support for OT in an area that at first glance presents a strong challenge to the theory.

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improved Chapter 4 of this dissertation. (Of course, remaining errors in that chapter are my own.)

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# INTRODUCTION

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No snakes of any kind are to be met with throughout the whole island.

—(The complete text of)  
Chapter LXXII, Concerning  
snakes. Niels Horrebow, *The  
Natural History of Iceland*

## 1.1 The Emergent Noniterativity Hypothesis

To what extent are grammars concerned with the processes that turn underlying forms into surface representations? In a rule-based generative theory, grammars are composed nearly exclusively of lexical representations and rules. These rules are just formalized processes. Since processes are formal constructs in this kind of theory, it is reasonable to suppose that grammars have an interest in specifying how this large component of the grammar operates. For example, grammars might specify how many times a process can apply. In practice, phonologists have limited this kind of specification to a dichotomy between iterative and noniterative rules: Some rules are permitted to apply to their own outputs, but others are not.

On the other hand, in an output-oriented theory like Optimality Theory (OT; Prince & Smolensky 1993[2004]), processes are not formal constructs, but rather emerge from constraint interaction. Instead of dictating the number of times

a process applies, grammars are concerned with optimal satisfaction of output demands. When a process applies (non)iteratively, it does so because that happens to be the best way to satisfy some output desideratum, not because the process is specifically required to be (non)iterative. Because processes have no formal place in the theory, OT does not make available the ability to specify whether or not a process is allowed to apply to its own output.

Thus rule-based phonology and OT answer the question above in very different ways. As the existence of iterativity parameters and the like show, rule-based grammars are immensely concerned with the properties of processes. But in eschewing processes as formal entities, OT refrains from delineating their attributes.

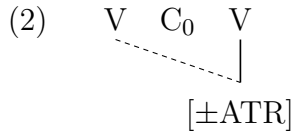
This dissertation supports the OT approach to processes by arguing that there are no noniterative phenomena in phonology,<sup>1</sup> and therefore grammars should not have the power to stipulate whether a process is iterative or noniterative:

- (1) **Emergent Noniterativity Hypothesis (ENH):** *No formal entity in phonological grammars may require noniterativity.*

What is meant by the terms *iterative* and *noniterative*? I take an iterative phenomenon to be one that must be analyzed with a self-feeding rule that is allowed to reapply to its own output. A self-feeding rule is one that creates an environment to which the rule can apply again (non-vacuously). For example, consider the rule in (2).

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<sup>1</sup>Just as Niels Horrebow (*The Natural History of Iceland. Translated from the Danish original of Mr. N. Horrebow. And illustrated with a new general map of the island.* London, 1758. Eighteenth Century Collections Online. Gale Group. <http://galenet.galegroup.com/servlet/ECCO> p. 91) devoted a whole chapter—quoted in its entirety above—to pointing out that snakes do not live in Iceland, this dissertation spends significantly more ink arguing for the same conclusion with respect to noniterativity in phonology.



This rule spreads the feature [±ATR] leftward from one vowel to the preceding vowel. This rule is self-feeding in that it results in a vowel that is newly specified for [±ATR] and would, were the rule to apply again, be a potential source of spreading so that [±ATR] could spread yet another syllable leftward. If the rule does in fact apply again and again, then it applies iteratively. This is exactly what we find in phenomena like vowel harmony; the rule in (2) is a good first approximation of an analysis of ATR harmony in Kinande (Archangeli & Pulleyblank 1994, Cole & Kisseberth 1994). In this language, verbal prefixes harmonize with root ATR specifications (*a* is invariant and transparent and roots are italicized):

- (3)
- |    |                           |   |            |                         |
|----|---------------------------|---|------------|-------------------------|
| a. | /E-rI- <i>lib</i> -a/     | → | ɛriliba    | ‘to cover’ <sup>2</sup> |
| b. | /tU-ka-kI- <i>lim</i> -a/ | → | tukakilima | ‘we exterminate it’     |
| c. | /E-rI- <i>huk</i> -a/     | → | ɛrihuka    | ‘to cook’               |
| d. | /tU-ka-kI- <i>huk</i> -a/ | → | tukakihuka | ‘we cook it’            |
| e. | /E-rI- <i>lm</i> -a/      | → | ɛrɪlɪma    | ‘to cultivate’          |
| f. | /tU-ka-kI- <i>lm</i> -a/  | → | tukakɪlɪma | ‘we cultivate it’       |
| g. | /E-rI- <i>hʊm</i> -a/     | → | ɛrihʊma    | ‘to beat’               |
| h. | /tU-ka-mU- <i>hʊm</i> -a/ | → | tukamʊhʊma | ‘we beat him’           |

Setting aside the transparency of *a* (but see Gick et al. (2006) for evidence that this vowel is not transparent), it is clear that the ATR feature of the root propagates leftward from vowel to vowel. Applying (2) iteratively achieves this.

<sup>2</sup>Archangeli & Pulleyblank (1994) state that the *E*- prefix is outside the domain of lexical harmony and is optionally harmonized postlexically.

On the other hand, if a rule applies just once, then it applies noniteratively. The Nilotic language Lango (Noonan 1992) provides an ostensible example of noniterative application of (2).

- |     |    |             |   |          |              |
|-----|----|-------------|---|----------|--------------|
| (4) | a. | /b̀̀̀́-ńí/  | → | b̀̀̀́ńí  | ‘your dress’ |
|     | b. | /c̀̀̀́-ńí/  | → | c̀̀̀́ńí  | ‘your beer’  |
|     | c. | /à̀̀̀́k-ńí/ | → | à̀̀̀́kkí | ‘your shoe’  |

In the examples in (4), [+ATR] spreads from the suffix vowel to the root-final vowel. Crucially, it does not spread any farther. It appears that [+ATR] is allowed to spread exactly one syllable leftward. Archangeli & Pulleyblank (1994), for example, account for Lango with explicitly noniterative versions of a vowel harmony rule. From this point of view, the only significant difference between the vowel harmony systems in Kinande and Lango is that the rule producing them is iterative in the former but noniterative in the latter. They are both analyzable with (something like) (2), a self-feeding rule that reapplies to its own output in Kinande but not in Lango.

The argument put forward in this dissertation is that the close similarity between Kinande and Lango is illusory, and that it is in fact incorrect to characterize Lango’s harmony as noniterative. More broadly, the claim is that true noniterativity is absent from the phonologies of the world’s languages: There is no phenomenon that must be analyzed with a self-feeding rule that is not permitted to apply to its own output. Subsequent chapters of this dissertation examine the best candidate examples of noniterativity and argue that these cases are best understood without resorting to formal noniterativity requirements. Chapter 2

addresses Lango, which I argue exhibits the effects of a desire for suffix features to be root-licensed rather than a proper noniterative harmony rule.

Chapter 3 discusses umlaut in Chamorro, where [-back] spreads from prefixes to root-initial vowels (see (5)), but only if the target vowel is stressed (cf. (6)).

- |     |           |                 |             |                     |
|-----|-----------|-----------------|-------------|---------------------|
| (5) | nána      | ‘mother’        | i náena     | ‘the mother’        |
|     | gúmaʔ     | ‘house’         | i gímaʔ     | ‘the house’         |
|     | cúpa      | ‘cigarettes’    | i cípa      | ‘the cigarettes’    |
|     | sónsuŋ    | ‘village’       | i séŋsuŋ    | ‘the village’       |
| (6) | pulónnun  | ‘trigger fish’  | i pulónnun  | ‘the trigger fish’  |
|     | mundónŋgu | ‘cow’s stomach’ | i mundónŋgu | ‘the cow’s stomach’ |

Umlaut appears noniterative in that it appears that [-back] is permitted to spread exactly one syllable rightward, and if its target—the stressed syllable—cannot be reached with this operation, spreading is not allowed. That is, we cannot spread iteratively to reach the stressed syllable (*\*i pilénnun*). I argue that there is a better way to view umlaut: Spreading is motivated by the weakness of pretonic syllables in Chamorro, and to compensate for this weakness, [-back] features in pretonic position must spread to the root. The lack of umlaut in (6) has nothing to do with noniterativity. Instead, the prefix’s [-back] feature is not pretonic, so it is not a valid umlaut trigger.

Of course, noniterativity might be expected to appear in domains other than segmental phonology. Chapter 4 takes up the issue of tonal phenomena. Tones commonly spread or move one syllable away from their underlying hosts. Consequently, these phenomena present the most convincing examples of noniterativity



that I am aware of. However, two developments, one empirical and one theoretical, provide alternative explanations for these phenomena. On the empirical front, Myers (1999) argues that what has been called noniterative tone spread in Chichewa is best understood as the consequence of peak delay, a crosslinguistically attested phenomenon in which a high tone's  $f_0$  maximum is reached relatively late in the tone's host syllable, or even in the next syllable. That is, tones do not spread or move noniteratively in Chichewa. Rather, their phonetic implementations give rise to this impression. Experimental evidence from Myers (1999) supports this contention, and Chapter 4 presents an Optimality Theoretic analysis of peak delay that is extendable to other languages with similar phenomena.

The second development is Optimal Domains Theory (Cole & Kisseberth 1994 *et seq.*), which posits that phenomena like harmony and tone spread/shift result from the extension of abstract domains (similar to feet) for some feature/tone beyond the underlying host syllable. In the case of spreading, the feature or tone is realized throughout the new larger domain. For shifting, only the last potential host in the domain realizes the feature or tone. So-called noniterative spreading or shifting result from the construction of binary domains.

Peak delay and Optimal Domains Theory present very different views of noniterative tonal phenomena, but neither explicitly calls on noniterativity. The one-syllable spreading/shifting limit results either from tones' pitch targets being reached "too late," or confinement of the tones to a binary domain.

Chapter 5 turns to noniterativity in domains larger than the word. It is not unusual to find a process that spreads some feature from the first syllable or segment of one word to the last syllable or segment of the preceding word.

Such spreading appears noniterative because just the last syllable or segment of the preceding word is targeted. Several such phenomena are examined in that chapter, and it is argued that they are driven by NONFINALITY. For example, in Nez Perce, vowel harmony extends throughout a word. But in fast speech, the last vowel of one word optionally harmonizes with the following word rather than its own word (harmonic domains are indicated with curly braces):

- (7) a. {ʔitam'yá't'as} {ʔewsí'x.} 'They are for sale.'  
           {ʔitam'yá'}{t'es ʔewsí'x.}

Postlexical spreading displaces the harmonic domain-final vowel from the last syllable of the word. If harmonic domains are right-headed, NONFINALITY can be used to motivate this minimal misalignment by preventing domain heads from falling in word-final syllables. Noniterative spreading results because further spreading (*\*{ʔita}{m'yé't'es ʔewsí'x.}*) is not motivated by NONFINALITY. No formal declaration of noniterativity is necessary.

Investigation of these postlexical phenomena leads the discussion in Chapter 5 to iterative optionality, a class of processes that Vaux (2003b) identifies as problematic for OT. In these phenomena, the decision to apply (or not) an optional process to one locus in a form is independent of the choice made at another locus in the same form. When an optional process is applicable at several points in a form, it may apply at some points but not others. Vata's postlexical spreading, which is similar to Nez Perce's, has this property. As shown in (8), in a string of monosyllabic words, [+ATR] may spread from the last word to any number of the preceding words.

- (8) a. ɔ́ ká zā {pī̄}                    ‘he will cook food’  
 b. ɔ́ ká {zā̄ pī̄}  
 c. ɔ́ {ká zā̄ pī̄}  
 d. {ó ká zā̄ pī̄}

I argue that like Nez Perce, postlexical spreading is driven by NONFINALITY in Vata, and the optionality is a product of Markedness Suppression, a modification of OT in which violation marks for designated markedness constraints may be ignored in the evaluation of a form. In essence, the forms in (8) without exhaustive spreading are possible outputs because we can ignore their violations of NONFINALITY.

Other (ostensible) cases of noniterativity, such as nasal place assimilation and noniterative foot assignment, are sufficiently straightforward that they do not warrant chapters of their own. They are discussed later in this chapter.

## 1.2 (Non)iterativity in Rule-Based Phonology

The contrast between iterative and noniterative processes has been a central area of inquiry since the advent of generative phonology with Chomsky & Halle (1968; henceforth *SPE*). Under the formalism of *SPE*, a rule may apply only once per cycle. When a rule applies, the string is scanned for all possible targets, and these targets are changed simultaneously. A first approximation of an SPE-style vowel harmony rule for Kinande is given in (9), assuming that only the root vowel is underlyingly specified for ATR.

- (9) [+syll] → [αATR]/\_\_\_ [-syll][αATR]

But even with *SPE*'s simultaneous application, this rule will only change the vowel immediately preceding the root vowel. Other vowels do not meet the structural description for the rule because they do not precede a vowel specified for ATR at the time the rule scans for applicable loci. To deal with this problem, *SPE* introduces the parenthesis-star notation, by which we can specify that any number (including zero) of a string in parentheses may be present in the string that the rule applies to. For example, we can amend (9) as in (10).

$$(10) \quad [+syll] \rightarrow [\alpha ATR]/\_\_\_ ([-syll][+syll])^* [-syll][\alpha ATR]$$

The new rule says that a vowel takes on the ATR feature of a vowel to its right, no matter how many CV sequences (i.e. syllables) intervene. (Formally, (10) is actually an abbreviation for an infinite set of rules, one rule with zero CV sequences between the target and trigger, another rule with one intervening CV sequence, a third rule with two such sequences, etc.) This rule will now change every vowel that precedes the root vowel.

The parenthesis-star notation is essentially the earliest implementation of an iterativity parameter. The parenthesis-star convention is needed precisely for self-feeding rules: such a rule applies at just one point in a form, but its application creates a new environment for a subsequent application, and parenthesis-star notation gives us a way to formalize this. Roughly speaking, rules that contain a parenthesis-star element are iterative (in the self-feeding sense), and those that lack it are noniterative. Anderson (1974) argues against this approach explicitly and in favor of one in which rules are tagged as either iterative or noniterative, and

the ungainly and repetitive<sup>3</sup> parenthesis-star notation has been largely abandoned in favor of simpler formalisms like an iterativity parameter.

The early generative phonology literature also makes the distinction between *linear* rules and *iterative* rules. Johnson (1970) argues in favor of linear rules (which start at one end of a string and change the first target they find, and then proceed to the next target without backtracking through parts of the string they've already scanned) as opposed to iterative rules (which are roughly the same except that they backtrack to the beginning of the string on each iteration). Linear rules are also roughly what Howard (1973) argues for, and Kenstowicz & Kisseberth (1977) point out that linear (what they call “directional”) rules can produce an iterative/noniterative contrast through reversals of the direction of application. For example, consider a rule that spreads some feature F rightward from vowel to vowel. Applied starting at the left edge to a form like /CVCVCVCV/, where underlining indicates the presence of F, this rule will generate /CVCVCVCV/, with each application of the rule feeding the next. This is the equivalent of iterative spreading. But applied from the right edge, /CVCVCVCV/ is the output, with seemingly noniterative spreading.

Finally, many rule-based theories adopt an iterativity parameter whereby a single rule such as (2) can be used for either iterative or noniterative processes depending on the parameter's setting. With respect to (2), when the iterativity parameter is turned on, the rule will spread ATR features leftward from one vowel to another until the beginning of the word is reached. But when it is turned off, the rule applies just once, producing a Lango-style assimilation pattern. This

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<sup>3</sup>Notice that the string in parentheses in (10) repeats the environmental context that must be stated elsewhere—namely the CV sequence that follows the target vowel.

kind of rule is proposed by Anderson (1971, 1974), Kenstowicz & Kisseberth (1973, 1977), Jensen & Strong-Jensen (1976), Vago (1973), Kiparsky (1985), Pulleyblank (1986), Myers (1987), Steriade (1993), and Archangeli & Pulleyblank (1994), among others. (Iterativity parameters are not exclusive to Autosegmental Phonology (Goldsmith 1976), of course, but I adopt the autosegmental rule formalism in this dissertation as an expository convenience.)

Rule-based theories, then, have several means at their disposal to make a distinction between iterative and noniterative phenomena. It is worth emphasizing that for all of the frameworks mentioned above, there is a very close formal connection between an iterative phenomenon and its noniterative counterpart. Returning to the Kinande and Lango examples, in *SPE*, the major difference between these harmony systems is that Kinande's harmony rule includes a parenthesis-star element that Lango's rule lacks. For systems with linear rules, Kinande and Lango differ only in the direction in which the harmony rule applies. And theories with an iterativity parameter account for both harmony systems with a single rule whose iterativity parameter takes different settings in the two languages. From this point of view, there is very little substantive difference between iterative and noniterative phenomena.

### 1.3 (Non)iterativity in OT

The picture is very different in Optimality Theory. The proper treatment of iterative vowel harmony (and similar phenomena) has been the subject of much debate. Many different formalisms that produce iterative spreading in OT have

been proposed, such as AGREE (Baković 2000, Lombardi 1996, 1999), ALIGN (Cole & Kisseberth 1995, Kirchner 1993, McCarthy & Prince 1993, Pulleyblank 1996, Smolensky 1993), Optimal Domains Theory, Headed Spans (McCarthy 2004), and feature co-occurrence restrictions (Pulleyblank 2002). Constraints like PARSE produce iterative syllabification, foot construction, etc. Research has uncovered various drawbacks of each formalism, and I wish only to point out the ease with which iterativity can be produced in OT. I remain neutral on the question of which formalization of iterativity is best.

The noniterative vowel harmony in Lango, on the other hand, presents OT with two related difficulties. The first problem is that OT cannot account for Lango and Kinande with analyses that differ only in the setting of a parameter. Thus OT seems to lose the insight that these are related harmony processes. (But I argue in Chapter 2 that this similarity is misleading.) To illustrate the point, two analyses of Kinande vowel harmony are sketched in (11) and (12) (abstracting away from the issue of vowel transparency) using AGREE and ALIGN, respectively. Each constraint motivates spreading throughout a word. AGREE motivates total spreading in an effort to avoid disharmonic sequences of vowels, and ALIGN motivates total spreading in an effort to match feature domains with word edges (in both cases setting aside the question of how to accommodate *a*).

(11)

/tU-ka-kI-lim-a/	IDENT[ATR]-Root	AGREE
a. tʊkakilima		*!
b. tʊkakilima		*!
☞ c. tukakilima		
d. tʊkakilima	*!	

(12)

/tU-ka-kI-lim-a/	IDENT[ATR]-Rt	ALIGN([±ATR],L;Wd,L)
a. təkakilima		*!***
b. təkakilima		*!*
☞ c. tukakilima		
d. təkakılma	*!	

However, AGREE and ALIGN cannot replicate the simple switch from iterative harmony to noniterative harmony seen in rule-based theories. The iterative force of these constraints is an emergent property, so it cannot be switched off in any easy way to transform the analysis of Kinande into an analysis of Lango. By their very nature, AGREE and ALIGN motivate spreading throughout a word, so they cannot be satisfied with the minimal spreading seen in Lango—iterativity is not a parameter. In terms of processes, the spreading process in Kinande is iterative not because it is explicitly required to be iterative, but because iterative spreading is the best way to ensure either that all vowels match in terms of [±ATR], or that all ATR domains are left-aligned. To produce noniterative spreading, we have to impose a new output condition—we need a different constraint. Rule-based approaches make it much easier to switch between iterativity and noniterativity, and this contrast appears to argue for derivational theories over OT.

The second problem OT faces is that it has no way to formalize the notion of “spreading to the next unit” because OT is output-oriented and process-blind. If it is correct to characterize Lango’s harmony as one in which [+ATR] spreads one vowel to the left, an adequate constraint-based analysis must compare the underlying distribution of ATR features with the output featural configuration and determine whether [+ATR] has spread to exactly one vowel. For exam-



ple, the inputs /b̀̀̀́-ńí/ and /b̀̀̀́-ńí/ (the latter is hypothetical) should yield the outputs *b̀̀̀́ńí* and *b̀̀̀́ńí*, respectively, if the correct generalization is that [+ATR] spreads exactly once. Obviously, to select correct output candidates, the markedness constraint that drives harmony must know which input is under consideration. This state of affairs is generally avoided in OT: markedness constraints must not compare inputs and outputs. With OT banned from adopting markedness constraints that access the input, it cannot formally require noniterativity.

OT therefore claims not only that iterative and noniterative phenomena are qualitatively different, but that noniterativity should not exist at all. This claim seems unlikely at first considering the existence of well-known (seemingly) noniterative processes like Lango's harmony, Chamorro's umlaut, tonal processes, and other cases discussed below, but this dissertation argues that it is correct.

This dissertation, in essence, raises the question of what noniterativity's place in phonology is. The argument advanced here is that noniterativity has no formal status in phonology. At best it is a descriptive label we can apply when grammatical factors conspire to produce certain patterns. The OT perspective is correct: The apparent minimal difference between Lango and Kinande is an illusion masking deeper, more fundamental differences. The two languages' harmony systems are not as related as the rule-based analysis claims.

This result means that OT does not need an explicit formalization of noniterativity, and in fact such a formalization would be misguided. Since the noniterative nature of the phenomena considered here can be captured by appealing to deeper motivations, the analyses developed in the following chapters are instructive in that they suggest that all cases of apparently noniterative spreading can be ex-

plained without recourse to a formalization of that notion. Therefore, OT, which cannot formalize noniterativity, has a leg up on rule-based phonologies that need (something like) iterativity parameters.

An investigation of noniterativity contributes to the broader understanding of the status of processes in phonology. This issue has received some attention recently, with some researchers (Nevins & Vaux 2008b, Vaux 2003b) returning to the question of rules versus constraints and others (McCarthy 2006, to appear) exploring the possibility of reintroducing serialism in a parallel framework. Noniterativity is a fact about processes, not phonological representations, and a linguistic theory can require noniterativity only if it explicitly recognizes processes. As we have seen, rule-based phonology can mandate (non)iterativity because it includes formal, explicitly stated processes in the form of rules. OT, in contrast, has no place for processes (but see McCarthy (2006, to appear) for an elaboration of the Gen component of OT in which processes become an explicit part of the theory). Epenthesis, deletion, spreading, etc., are terms that characterize the dimensions along which input and output forms differ, not steps that are taken to produce licit outputs. OT therefore cannot regulate processes through, e.g., an iterativity parameter.

Viewed in this way, the Emergent Noniterativity Hypothesis is a statement about the kinds of requirements grammars may impose on processes. In particular, grammars cannot regulate the number of times a process is allowed to occur. Other researchers (e.g. McCarthy 2003) have argued that grammars cannot count, or may not count beyond two. If that claim is correct, then grammars are also unable to designate a particular numerical location (such as the fifth syllable)

as the preferred site for a process to occur or an entity to appear. Like this earlier research, the current dissertation identifies and argues for a dimension along which grammars are prohibited from making demands of processes. Taken together, all of this research suggests that grammars may be unable to directly regulate processes. This conclusion supports the view that processes are not part of the grammar to begin with. If grammars cannot directly regulate how processes apply, processes themselves, as formal entities, become expendable. OT, whose architecture precludes processes and regulations on them, seems well suited for this state of affairs.

### 1.3.1 Conjoined Faithfulness

Conjoined constraints can be used to generate noniterativity.<sup>4</sup> The self-conjunction of IDENT[F] within an AGREE-style analysis would eliminate candidates in which the feature [F] is changed twice but permit a single segment to change its specification for [F]. That is, IDENT[ATR]<sup>2</sup> (=IDENT[ATR] & IDENT[ATR]) rules out *\*bòŋó-ní* but not *bòŋó-ní* because only the former has two violations of IDENT[ATR]. In this way, OT can mimic noniterativity.

There are reasons to dislike the self-conjunction approach. If IDENT[ATR]<sup>2</sup> is allowed, the conjunction of this constraint with IDENT[ATR] must also be allowed, yielding IDENT[ATR] & IDENT[ATR] & IDENT[ATR], or IDENT[ATR]<sup>3</sup>. The new constraint permits spreading through two syllables but not three. Yet another conjunction gives us IDENT[ATR]<sup>4</sup>, which permits spreading across three syllables but not four. Self-conjunction provides a way of counting syllables and permitting

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<sup>4</sup>I thank Armin Mester for pointing this out to me, as well as for raising the objections I repeat in this section.

spreading by  $n$  syllables but not by  $n + 1$  syllables for any  $n$ . This is surely too powerful. Others have argued that phonological mechanisms must not have the power to count past two (McCarthy 2003), and self-conjunction of faithfulness constraints violates this limitation.

Nonetheless, even this approach does not stipulate noniterativity directly, and OT analyses that adopt conjoined faithfulness are compatible with the Emergent Noniterativity Hypothesis. No part of a conjoined faithfulness analysis says “spread exactly once”—rather, the analysis permits as much spreading as one likes, provided it does not go beyond the arbitrary numerical stipulation. That is, there’s nothing special about noniterativity in this approach. It’s just one of many possibilities that fall short of full-fledged iterativity.

## 1.4 Simple Cases of Noniterativity

### 1.4.1 Foot Assignment

Iterative and noniterative foot assignment is a central distinction in prosodic phonology, but phonologists have come to tacitly agree that noniterative foot assignment is not in fact noniterative. Consider the data in (13) from Southeastern Tepehuan (Willett 1982):

- |      |             |                      |
|------|-------------|----------------------|
| (13) | níi’cartam  | ‘dancing’            |
|      | vacóocos’am | ‘they went to sleep’ |
|      | cóocroidya’ | ‘tadpole’            |
|      | tóohlguiom  | ‘mouse’              |

Stress appears on one of the first two syllables of the word depending on weight factors. Kager (1997) argues that each word contains a single word-initial iamb.<sup>5</sup>

The most common approach to this sort of system (and the one developed by Kager (1997) for Southeastern Tepehuan specifically) in OT follows McCarthy & Prince (1993) in ranking an Alignment constraint over the constraint that requires all syllables to be parsed into feet, PARSE- $\sigma$  (non-gradient replacements for Alignment proposed by McCarthy (2003) can be used instead). The Alignment constraint requires all feet to appear at one edge of the word and is therefore in conflict with PARSE- $\sigma$ : If we build multiple feet so that every syllable is footed, then some feet will necessarily not be at the correct word edge, in violation of Alignment. This is illustrated schematically in (14).

(14)

	/ $\sigma\sigma\sigma\sigma\sigma$ /	ALIGN(Ft,L;Wd,L)	PARSE- $\sigma$
a.	$(\sigma\sigma)\sigma\sigma\sigma$		****
b.	$(\sigma\sigma)(\sigma\sigma)(\sigma\sigma)$	*!*	

ALIGN(Ft,L;Wd,L) requires the left edge of every foot to be aligned with the left edge of some word. Obviously, only one foot per word can meet this requirement, so constructing multiple feet fatally violates this constraint, as candidate (b) shows. The only way to satisfy ALIGN is to construct just one foot (i.e. “non-iterative” foot construction). It should be clear that with the opposite ranking, the candidate with multiple feet (i.e. “iterative” foot construction) will win.

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<sup>5</sup>Syncope in subsequent syllables seems to point toward the presence of other (stressless) feet: Vowels in even-numbered open syllables are deleted. But Kager (1997) argues that these feet are unnecessary if we take into account the illicit consonant clusters that would be created if adjacent rather than alternating syllables were targeted for syncope.

Under this analysis, two forces are at work, and neither has any formal or explicit connection to (non)iterativity. One constraint demands exhaustive parsing of syllables into feet, and another requires all feet to be at one end of the word. When the former constraint outranks the latter, iterative foot-building results, and under the opposite ranking, only one foot is built. No mention of iterativity is needed; the (non)iterativity is derived from constraint interaction.

In fact, noniterativity need not be invoked even in rule-based analyses of languages like Southeastern Tepehuan. Halle & Vergnaud (1987) develop an analysis of languages with just one stress that rests on iterative foot construction. After a word is exhaustively parsed and main stress is assigned, their Line Conflation mechanism eliminates the grid marks over the non-main stressed syllables. These erased marks would otherwise lead to secondary stress, but Line Conflation creates the appearance of noniterativity in an iterative system.

McCarthy (2003) notes that skepticism toward claims of noniterative footing is warranted. He quotes Hayes (1995), who points out that languages may simply refrain from providing cues (i.e. stress) for the presence of iterative footing. Under this view, noniterative footing may not be an option in the first place, and it is therefore obviously unnecessary to require noniterativity.

Keeping McCarthy's caution in mind, this is a simple and widely accepted case in which a process that appears noniterative can be more insightfully understood by building an analysis on other principles and letting the noniterativity emerge from the interaction of these principles. The research presented in this dissertation reveals similar situations for other cases of apparent noniterativity. There is always an external reason for a process to stop after one iteration: the

impetus for performing the process may be satisfied at that point, or, as with foot assignment, independent constraints may intervene to temper the motivating constraint’s effect. In this way, the approach taken here follows the standard practice within OT of searching for independent motivations for phonological facts instead of settling on a stipulative solution such as an iterativity parameter. The current investigation is novel in that it puts noniterativity at the center of this analytical technique.

## 1.4.2 Emergent Noniterativity

### 1.4.2.1 Nati

There are many other processes that exhibit what I will call *emergent noniterativity*. These are phenomena that can but need not be analyzed with a self-feeding rule. The noniterativity is emergent because these processes may be analyzed with either an iterative rule or a noniterative rule, and thus noniterativity is not a defining characteristic of these processes. One such phenomenon is Nati, from Sanskrit. In Nati, retroflexion spreads from  $\dot{s}$  or  $r$  rightward to  $n$ . (Data from Gafos (1999) and Kiparsky (1985); see also Allen (1951), Cho (1991), Kiparsky (1985), Ní Chiosáin & Padgett (1997), Schein & Steriade (1986), Whitney (1889), among others. Following the practice of these authors, retroflexion is marked with a dot under the consonant, except that  $r$  is always retroflex.)

- (15) a. pūr-ṇā                    ‘fill’  
       b. vṛk-ṇa                ‘cut up’  
       c. bṛahmaṇ-ya        ‘devotion’

- |    |            |          |
|----|------------|----------|
| d. | kṛp-a-māṇa | ‘lament’ |
| e. | kṣubh-āṇa  | ‘quake’  |
| f. | cakṣ-āṇa   | ‘see’    |

Only the first *n* after *ṣ* or *r* is targeted. Thus /varn-anā-nām/ ‘descriptions (gen. pl.)’ becomes *varṇanānām*, not \**varṇaṇānām*. This noniterativity is emergent because, as Kiparsky (1985) and Gafos (1999) point out, a second iteration of spreading is impossible: Only *ṣ* and *r* trigger spreading, so in the configuration ...*ṣ*/*r*...*ṇ*...*n*..., the final *n* cannot become *ṇ* because retroflexion cannot spread from the preceding *ṇ*. Not even an appropriately formulated iterative rule will target the second *n* because the rule is not self-feeding. Kiparsky (1985:113) points out that Sanskrit is not alone in this regard, and that more generally, “processes only propagate when the target is itself a trigger of the rule.” Iterativity only becomes an option when this criterion is met. When it is not met, the result is emergent noniterativity.

OT analyses of Nati that do not rely on noniterativity are also available. For example, it is possible to construct a Positional Licensing analysis along the lines of the analysis developed for Lango in Chapter 2. Suppose only [–continuant] consonants can license retroflexion. That this is correct—for whatever reason—is suggested by the fact that the sources of spreading, *ṣ* and *r*, are the only [+continuant] retroflex segments in Sanskrit. With a constraint motivating spreading rightward to the next [–continuant] coronal for the purposes of licensing, spreading to *n*, *t*, *d* can be produced. High-ranking faithfulness to stops’ place of articulation can block this spreading when *t*, *d* are the targets, so only spreading to *n* is permitted, even though spreading to *t*, *d* would also satisfy Positional Licensing.



And once an acceptable spreading target has been reached, Positional Licensing motivates no further spreading.

#### 1.4.2.2 Bengali

As described by Mahanta (to appear), Standard Colloquial Bengali presents a case similar to Nati. In this language, only high vowels are appropriate triggers for regressive [+ATR] harmony. Some examples are shown in (16).

- (16) a.  $k\text{ɔ}^h\text{a}$  ‘spoken words’  $k\text{ɔ}^h\text{i}t\text{o}$  ‘uttered’  
 $k\text{ɔ}^h\text{o}n\text{i}y\text{o}$  ‘speakable’  
 b.  $\text{ɔ}f\text{ɔ}t$  ‘dishonest’  $\text{ɔ}f\text{ɔ}t\text{i}$  ‘dishonest (f)’  
 c.  $f\text{ɔ}k\text{t}\text{i}$  ‘might’

In each form, the vowel immediately before the high vowel is [+ATR]. The last example shows that the trigger need not be a suffix. Mahanta argues that this harmony is noniterative on the basis of forms like  $k\text{ɔ}^h\text{o}n\text{i}y\text{o}$ : The [+ATR] feature spreads just once to the left. (Although Mahanta does not herself characterize harmony as spreading *per se*.) But if only high vowels are triggers, then, as in Nati, we would not expect a second iteration of spreading in the first place ( $*k\text{ɔ}^h\text{o}n\text{i}y\text{o}$ ):  $o$  is not a valid trigger.

Standard Colloquial Bengali’s harmony is only (seemingly) noniterative because the language contains no [-ATR] high vowels. That is, there is no form  $/k\text{ɔ}^h\text{m}\text{i}y\text{o}/$  that can become  $k\text{ɔ}^h\text{i}n\text{i}y\text{o}$  through two iterations of spreading (once to  $/\text{ɪ}/$  to create  $i$ , which is a valid trigger for harmonization of the initial  $/\text{ɔ}/$ ). Since underlying high vowels are always [+ATR], they are never targets for harmony,

and this means that they cannot participate in a second (or third, or fourth...) iteration of spreading. They are always the first trigger.

Mahanta notes that in another dialect, Cachar Bengali, a vowel raising process can create new triggers. For example, *borluki* ‘lavishness’ is derived from /bɔr-loki/ (no morpheme-by-morpheme glosses are provided). The underlying /o/ raises to *u*, which can then trigger ATR harmony on the preceding /ɔ/.<sup>6</sup> Since raising and ATR harmony are both motivated by harmony constraints, Mahanta argues that this sort of example illustrates “iterativity in an apparently non-iterative language” (9). If we accept this characterization, then Bengali’s harmony (in both dialects) is revealed to be iterative under the right circumstances (which only arise in Cachar Bengali) and is thus not a counterexample to the Emergent Noniterativity Hypothesis. If we treat raising and ATR harmony as separate phenomena, then ATR harmony’s noniterativity is emergent for the reasons discussed above. I return to Bengali’s harmony in Chapter 2.

### 1.4.2.3 Umlaut and Metaphony

As another example, consider German umlaut (McCormick 1981, van Coetsem & McCormick 1982). Historically, [-back] spread from suffix vowels to the root-final vowel. While this seems to require spreading of [-back] one vowel to the left and no farther, McCormick (1981) has argued that Germanic umlaut is actually prosodically constrained. The root-final vowel is prosodically prominent while the suffix vowel is reduced, suggesting the presence of a word-final trochee. [-back] spreads throughout the foot, much like (Flemming’s (1994) description of) ATR

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<sup>6</sup>Standard Colloquial Bengali has the same raising process in verbs, but as verb roots are always monosyllabic, raising never leads to ATR harmony in that dialect.

harmony in Tudañca Spanish. Only one vowel is targeted because there are only two vowels in the foot. Alternatively, a Lango-style Licensing analysis is possible (see Chapter 2), with [-back] spreading to the root for licensing purposes. Again, no mention of noniterativity is necessary.

Similarly, in Tudañca Spanish (Flemming 1994, Walker 2004), laxness spreads regressively from word-final vowels to the stressed vowel. High vowels are obligatorily lax word-finally (Walker 2004). Following Flemming and Walker, capitalization indicates laxness ([-ATR]) and diacritics mark stress:

- (17)
- |    |             |                           |
|----|-------------|---------------------------|
| a. | pÍntU       | ‘male calf’               |
|    | pínta       | ‘female calf’             |
| b. | sÉkU        | ‘dry (masc.)’             |
|    | séka        | ‘dry (fem.)’              |
| c. | θÚrdU       | ‘left-handed (masc. sg.)’ |
|    | θúrdos      | ‘left-handed (m. pl.)’    |
| d. | ÓhU         | ‘eye (sg.)’               |
|    | óhos        | ‘eye (pl.)’               |
| e. | sekÁIU      | ‘to dry him’              |
|    | sekálo      | ‘to dry it (mass)’        |
| f. | ahambrÁU    | ‘hungry (masc.)’          |
|    | ahambráa    | ‘hungry (fem.)’           |
| g. | antigwÍsImU | ‘very old’                |
| h. | orÉgAnU     | ‘oregano’                 |
| i. | pÓrtIkU     | ‘portico’                 |
| j. | rakÍtIkU    | ‘rachitic’                |

- k. kÁrAbU ‘tawny owl’  
 l. pÚlpItU ‘pulpit’

Flemming adopts the view that Spanish has a word-final trochee plus, in some cases, an extrametrical syllable. Since extrametrical syllables are adjoined to the final foot in Flemming’s theory, he argues that spreading is confined to the foot (in OT terms, we might use  $\text{ALIGN}(\text{L}, [-\text{ATR}]; \text{Ft}, \text{L})$ ). Walker views the above assimilations as spreading to the stressed vowel and proposes a Positional Licensing analysis in which  $[-\text{ATR}]$  must be linked to the stressed syllable. Under either analysis, what might otherwise be analyzed as noniterative spreading is actually either exhaustive spreading within a small domain (the foot) or spreading to a prominent position. Although (17a)–(17f) appear to contain noniterative spreading, noniterativity doesn’t enter the discussion.

To arbitrarily adopt Walker’s characterization of Tudanca Spanish, a licensing constraint like the one in (18) can motivate metaphony. (This is a simplified version of Walker’s analysis.) “Noniterative” spreading satisfies LICENSE when the stressed syllable is penultimate (and therefore adjacent to the syllable containing the lax vowel). When a syllable intervenes between the stressed and word-final syllables, spreading through the intervening vowel is required if the  $[-\text{ATR}]$  feature is to reach the stressed vowel. In neither case is spreading beyond the stressed vowel a possibility. This is illustrated in (19). The extent of spreading varies with the distance between the source vowel and the target prominent position.

- (18) LICENSE- $[-\text{ATR}]$ /Stress:  $[-\text{ATR}]$  must be linked to a segment in a stressed syllable.

(19)

/oréganu/	*[+high, +ATR] <sub>wd</sub>	LICENSE	IDENT[ATR]
a. oréganu	*!		
b. orégAnU		*!	**
☞ c. orÉgAnU			***
d. OrÉgAnU			****!

Candidate (a) is ruled out by the ban on [+ATR] high vowels in word-final position. The remaining candidates have a [-ATR] final vowel, but only candidates in which this feature spreads to the stressed vowel avoid violations of LICENSE[-ATR]/Stress (candidates (c) and (d)). Of these, the winner is the one that incurs the fewest violations of IDENT[ATR]. In forms with penultimate stress, this will be the form in which [-ATR] has spread exactly one syllable, but when there is antepenultimate stress, as in (19), spreading cannot be characterized as noniterative under any theoretical framework. I argue in Chapter 2 that Lango’s harmony is like metaphony in Tudañca Spanish in that it involves minimal spreading to license particular features. Both cases argue against viewing assimilatory phenomena in terms of (non)iterativity because some configurations in each language require ostensibly noniterative spreading and others require what looks like iterative spreading. The two sets can only be unified under an analysis that takes the target, not the extent, of spreading to be the crucial factor. The appearance of iterativity or noniterativity is not analytically significant.

#### 1.4.2.4 Emphatic Spread in Palestinian Arabic

In Northern Palestinian Arabic, emphasis (= [RTR]) spreads leftward from the underlyingly emphatic consonant to the beginning of the word and rightward to the

next syllable nucleus following the underlyingly emphatic consonant (Davis 1995, McCarthy 1997; following the latter, capitalization marks underlying emphasis and underlining marks emphatic spread):

- (20) a. manTaka ‘area’  
 b. ʔaDlam ‘most unjust’ ( $D = \delta$ )  
 c. Snaaf ‘brands’  
 d. Sabaah ‘morning’

A noniterative rule for rightward spreading could easily be written to spread [RTR] from any segment to the next low vowel and through the intervening segments. While it is true that [RTR] can continue spreading rightward through a sequence composed of laryngeals, pharyngeals, and *a* (the “low” segments) as shown in (21), this additional spreading is blocked by non-low segments whereas spreading to the first *a* (20) is blocked only by [+high] segments.

- (21) a. maSlaha ‘interest’  
 b. Sahaha ‘he awakened her’  
 c. Sahan ‘he ground’  
 d. Sahhab ‘he leveled a layer of small stones’  
 e. Taafan ‘he stabbed repeatedly’

The different blocking segments indicate that two rightward spreading operations are at work. The first spreads [RTR] noniteratively to the next low nucleus through any non-high segments, and the second spreads [RTR] iteratively through only low segments. Davis (1995) proposes a rule-based account that does just this,

except that he derives noniterative spreading through an iterative rule whose domain of application is limited to the following syllable nucleus.

But McCarthy (1997) shows that the noniterative nature of the first spreading operation can be produced with an Alignment constraint requiring the right edge of an [RTR] domain to align with *a*. Outranked by \*[RTR, +high], this constraint motivates spreading through all segments except ones that are [+high]. The spreading in (21) is motivated by a low-ranking constraint requiring [RTR] to align with the right edge of the word. Its effect is curtailed by a constraint against nonlow [RTR] segments.

A Positional Licensing analysis for these data is also imaginable. Apparent noniterative spreading to the next low vowel can be motivated by a constraint stating that [RTR] is licensed only on low vowels. This would have to be formulated as a COINCIDE (Itô & Mester 1999, Zoll 1998a) constraint requiring the *right edge* of an [RTR] domain to be licensed by *a*. Otherwise leftward spreading that happens to include *a* in its domain (as in (20a)) would obviate rightward spreading. Crucially, the noniterative appearance of the spreading in (20) can be characterized in iterativity-neutral terms; the noniterativity is emergent.

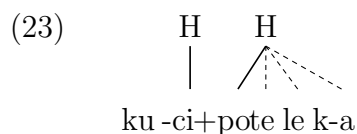
#### 1.4.2.5 High Tone Spreading in Ikalanga

The phenomena discussed so far in this section involve processes that appear noniterative, but noniterative rules can be used in combination with other rules to produce complex patterns that do not exhibit any noniterative character on the surface. For example, Hyman & Mathangwane (1998) make use of three rules of high tone spreading (HTS) to account for the tonology of verb stems in Ikalanga.

Two of these rules are noniterative, but, as (22) shows, tones do not simply spread by one syllable.<sup>7</sup>

- (22) a. ku-cí+pótélék-á... ‘to surround it...’  
 b. ku-cí+fúmík-á bu-sîkú ‘to cover it at night’  
 c. ku-cí+táfún-á bu-sîkú ‘to chew it at night’  
 d. ku-cí+bákílíl-á bu-sîkú ‘to fence it in at night’  
 e. ku-cí+pótélék-á bu-sîkú ‘to surround it at night’  
 f. ku-cí+túm-á bú-sî:kú ‘to send it at night’

The symbol ‘+’ marks the boundary between prefixes and the verb stem. In each example, H links to the first syllable of the stem and spreads rightward as illustrated in (23) for (22a).



H spreads throughout the stem, and in the case of (22f), H spreads also to the first syllable of the next word, *bu-sîkú* ‘at night.’ All disyllabic and shorter stems (henceforth “short stems”) exhibit spreading to the next word:

- (24) a. ku+ch-á bú-sîkú ‘to fear it at night’  
 b. ku+tól-á bú-sîkú ‘to take it at night’

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<sup>7</sup>All forms discussed here are crucially internal to Intonational Phrases. IP-final verbs show some complications that do not concern us here. See Kaplan (2006, 2007) for a treatment of these forms in OT.



The derivational analysis of HTS proposed by Hyman & Mathangwane (1998) works like this. H is linked to the stem-initial syllable. The first rule, HTS<sub>1</sub>, spreads this H one syllable to the right. In the case of short stems, this means the domain of H already encompasses the entire stem. Next, the final syllable of the stem is declared extrametrical (i.e. impervious to further HTS). HTS<sub>2</sub> then spreads H iteratively to the end of (the visible portion of) the stem. HTS<sub>2</sub> applies vacuously in short stems (HTS<sub>1</sub> already exhausted the available stem syllables), but in longer stems the result is that all but the last syllable of the stem is linked to H. Finally, extrametricality is removed, and HTS<sub>3</sub> spreads H one more syllable to the right. This last rule has two effects: (i) it links H to the previously extrametrical stem-final syllables in longer stems, and (ii) it spreads H from the final syllable of short stems to the first syllable of the next word. Two representative derivations are given in (25).

(25)	/ku-cí+pótelek-a (bu-sîkú)/	/ku-cí+túm-a (bu-sîkú)/
HTS <sub>1</sub>	ku-cí+pótelek-a (bu-sîkú)	ku-cí+túm-á (bu-sîkú)
EM	ku-cí+pótelek-<a> (bu-sîkú)	ku-cí+túm-<á> (bu-sîkú)
HTS <sub>2</sub>	ku-cí+pótélék-<a> (bu-sîkú)	—————
HTS <sub>3</sub>	ku-cí+pótélék-á bu-sîkú	ku-cí+túm-á bú-sîkú

There is nothing noniterative about HTS in these examples. The only reason Hyman & Mathangwane employ noniterative rules in the forms under discussion is to account for the spreading of H to the next word in short stems. Clearly the surface generalization is that H spreads throughout the stem plus one more syllable in the case of short stems. A simple ALIGN-R constraint or something

similar is enough to account for the spreading throughout the stem, and either line of analysis proposed in Chapter 4 will suffice to effectively impose a minimum limit on the breadth of high-tone domains to motivate the “extra” spreading in short stems. See Kaplan (2006, 2007) for an analysis of Ikalanga along these lines (although that analysis does not use the analyses of Chapter 4 specifically). The noniterativity in Hyman & Mathangwane’s analysis is simply an artifact of their derivational approach. Nothing in the data above demands a noniterative treatment. Thus we see another way in which noniterativity can seem relevant from a rule-based perspective. This impression disappears in the light of OT’s orientation toward outputs rather than processes.

#### 1.4.2.6 Lardil

Deletion of word-final material in Lardil is a particularly famous phenomenon, and it is worth addressing here. The discussion and data in this section come from Prince & Smolensky (1993[2004]) and Kurisu (2001), but many others have addressed this phenomenon. Lardil allows only coronal word-final codas. Underlying word-final non-coronals are deleted:

(26)	<i>Stem</i>	<i>Nominative</i>	<i>No-Future Acc.</i>	<i>Gloss</i>
	ŋaluk	ŋalu	ŋaluk-in	‘story’
	wuŋkunuŋ	wuŋkunu	wuŋkunuŋ-in	‘queen-fish’
	waŋalk	waŋal	waŋalk-in	‘boomerang’

In the unsuffixed nominative forms, the stem-final consonants are word-final, and since they are not coronals, they are deleted.

Word-final vowels are also deleted in the nominative:

(27)	<i>Stem</i>	<i>Nominative</i>	<i>No-Future Acc.</i>	<i>Gloss</i>
	yiliyili	yiliyil	yiliyili-n	‘oyster sp.’
	mayaña	mayañ	mayaña-n	‘rainbow’
	kaŋkari	kaŋkar		‘father’s father’
	wiwala	wiwal		‘bush mango’

Vowel deletion feeds consonant deletion. If vowel deletion leaves a word-final non-coronal consonant, that consonant is deleted:

(28)	<i>Stem</i>	<i>Nominative</i>	<i>No-Future Acc.</i>	<i>Gloss</i>
	yukařpa	yukař	yukařpa-n	‘husband’
	wuɕaltʸi	wuɕal	wuɕaltʸi-n	‘meat’
	ŋawuŋawu	ŋawuŋa	ŋawuŋawu-n	‘termite’
	muřkunima	muřkuni	muřkunima-n	‘nullah’

Notice that C-deletion in (26) and (28) can yield word-final vowels. The latter examples are particularly striking: the failure of the new word-final vowels to delete is puzzling, especially in light of the fact that deletion has already targeted the original final vowel. Why doesn’t V-deletion apply again to eliminate the new word-final vowels? From this perspective, V-deletion appears noniterative.<sup>8</sup>

But the OT analyses of Prince & Smolensky (1993[2004]) and Kurisu (2001) are couched in terms that do not invoke noniterativity. In both analyses, C-deletion is driven by a coda condition that prohibits word-final non-coronals. For Prince

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<sup>8</sup>The data presented here might also suggest that C-deletion is noniterative, but it is not, as shown by examples such as /muŋkumuŋku/ → *muŋkumu* ‘wooden axe.’ Two consonants delete in this word.

& Smolensky, V-deletion is the product of FREE-V, a constraint that prevents word-final vowels from being parsed. Their analysis makes use of Containment Theory, in which “deleted” segments are still present but not parsed. This means that *ɲawuɲa* is actually *ɲawuɲa⟨wu⟩*, and FREE-V is not violated by *a* because that vowel is not technically word-final. The word-final vowel, *u*, is not parsed and therefore satisfies FREE-V. In this analysis, the apparent noniterativity of V-deletion is a consequence of there being at most one word-final vowel in each form. FREE-V motivates no further deletion after the first vowel is deleted.

In Kurisu’s analysis, deletion is driven by REALIZE MORPHEME, a constraint that requires each morphological category (such as nominative case) to have some phonological exponent. That is, derived forms must be phonologically distinct from their bare forms. Since nominative case in Lardil is not expressed by an overt morpheme, this morphological distinction must be realized through some change in the stem. Kurisu argues that V-deletion is the exponent of nominative case. Deletion ensures that the nominative form is distinct from the bare form, as required by REALIZE MORPHEME. When a consonant is deleted in accordance with the coda condition, further deletion is not required because the C-deletion form (e.g. *ɲalu*) is already distinct from the bare form (*ɲaluk*), and REALIZE MORPHEME is satisfied. Likewise, additional V-deletion in (28) is unmotivated because deletion of the original word-final vowel (not to mention the subsequent C-deletion) has already satisfied REALIZE MORPHEME. As with the FREE-V analysis, the first iteration of deletion is enough to satisfy the motivating constraint.

Both of the analyses summarized here treat the noniterativity in Lardil's deletion as emergent. Neither makes reference to deleting just one vowel, and both propose independent reasons for deletion to target just one vowel.

#### 1.4.2.7 Other Miscellaneous Processes

German provides yet another case of emergent noniterativity: final devoicing. Word-final (or syllable-final) obstruents devoice, but since just one segment can be word-final, only one segment can be devoiced. An iterative rule that targets word-final segments has just one segment to change no matter how many times it reapplies—it is not self-feeding. Likewise, in dialects of English in which vowels become nasalized when before a nasal (Beddor 1983), a rule that iteratively spreads nasality from nasals to adjacent preceding vowels will never affect more than one vowel because only one vowel can precede and be adjacent to a nasal consonant. And in nasal place assimilation (Padgett 1997), if nasals in NC clusters must acquire the place features of the immediately following consonant, no more than one nasal will assimilate in any instance because only one nasal segment can immediately precede a consonant. It does not matter whether one adopts an iterative or noniterative rule for this process, and a constraint-based analysis can be built on constraints promoting certain featural combinations in adjacent segments as in Pulleyblank (2002). These phenomena display emergent noniterativity because they do not require noniterative rules. They contrast with noniterative processes whose rules must be prevented from reapplying to their own outputs.

It is the latter that I claim to be nonexistent: there is no phenomenon that



occurs at the left edge of the root—the revision would produce umlaut in other environments.

Of course, evidence is needed to show that analyses of Lango’s harmony and Chamorro’s umlaut that treat the noniterativity as emergent are preferable to truly noniterative analyses. Chapters 2 and 3 argue for this position explicitly and show that truly noniterative characterizations of Lango and Chamorro are flawed.

Incidentally, it is possible to view noniterativity in footing as emergent from a rule-based perspective. Footing can be produced with a rule like the one in (31), and an iterativity parameter determines whether or not this rule applies iteratively. A directionality setting can also be invoked.

$$(31) \quad \sigma \sigma \rightarrow (\sigma \sigma)$$

But we could alternatively adopt (32) or its mirror image for noniterative footing instead. This rule applies just at a word edge and therefore is applicable only once in a word. From this point of view, noniterativity in Southeastern Tepehuan’s footing is emergent: making (32) iterative would still leave us with just one foot.

$$(32) \quad \sigma \sigma \rightarrow (\sigma \sigma) / \left[ \text{Word} \text{---} \right]$$

It might be objected that (32) misses the obvious similarity between iterative and noniterative foot assignment. But the only difference between (31) and (32) is that the latter specifies an environment for application while the former does not. Under the approach that applies (31) iteratively in one case and noniteratively in

the other, there must be a formal change in the rule that produces iterativity on the one hand and noniterativity on the other. It seems no simpler for that change to be located in an iterativity parameter than in the addition or removal of an environmental condition, especially since the latter obviates both a directional specification (for the noniterative case at least) and (under the proposed revision suggested in Chapter 6, p. 326) the iterativity parameter.

Non-assimilatory processes can also reflect emergent noniterativity. The case of foot/stress assignment just mentioned is one example. Another well-known case is schwa insertion in English plurals (Baković 2005, Borowsky 1987):

- (33) books  
rags  
masses  
dishes  
churches

In contrast with *books* and *rags*, stems ending with a sibilant like *s*, *f*, or *ʃ* surface with an epenthetic vowel between that sibilant and the plural morpheme. This is obviously an OCP effect in which adjacent sibilants are avoided. The point here is that schwa insertion occurs at most once in these and all other plural forms. But this noniterativity is clearly emergent. A rule inserting schwa between sibilants is not self-feeding. We cannot apply this rule non-vacuously a second time. Similarly, an OT constraint that bans adjacent sibilants is satisfied when just one schwa is inserted, so there's no reason to epenthesize again.<sup>10</sup>

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<sup>10</sup>The same points could be made for English past-tense morphology as well, of course, where schwa is inserted to break up a cluster of coronal stops.





discussion shows that the same move is available in a rule-based framework, too, although no evidence has yet been presented in favor of these revisions. Outside of segmental phonology, we've already seen that erstwhile noniterativity in prosody is understood in modern phonology in other terms, and experimental work on tonal phenomena, I will argue, indicates that noniterativity in this domain is also only illusory. The conclusion is simply this: There are no phonological phenomena that must be analyzed with a noniterative self-feeding rule.

## 1.5 The Abundance of Iterativity

The dearth of true noniterativity is particularly striking in light of the pervasiveness of undeniably iterative phenomena. For example, syllabification is always iterative. No language builds just one syllable no matter how long the word is. And since every language has syllables, every language has this iterative process. Thus iterativity is found in every language in the world.

Nasal harmony and vowel harmony are also always iterative (notwithstanding Lango, which I argue in Chapter 2 does not in fact exhibit vowel harmony). These are not unusual phenomena either—Walker's (2000) condensed database of nasal harmony includes more than 80 languages, for example. (Some of these cases involve very local spreading, such as harmony within a syllable. This is analyzable as an iterative process confined to certain domain, as with German umlaut.)

Secondary stress assignment can also be iterative. (I know of no languages that permit just one secondary stress no matter how long a word is, so secondary stress

assignment may be obligatorily noniterative.) While languages like Southeastern Tepehuan may assign just one stress per word, other languages allow secondary and even tertiary stress, and when word length permits, multiple secondary or tertiary stresses can be assigned. Again, this phenomenon is widespread crosslinguistically.

As another indication of the rarity of phenomena that require noniterative rules, consider the (surely nonrandom) sample of rules in Archangeli & Pulleyblank (1994). Of the 24 rules Archangeli & Pulleyblank develop within their formalism, half are specified as iterative, and the other half are noniterative. But a closer look at these rules reveals a different picture. First, six of the noniterative rules are developed for Lango's harmony alone to account for the complex system of which (4) is just a small part (see Chapter 2). This leaves six noniterative rules. Three of these use noniterativity to account for systems in which an inserted feature surfaces only if its host is word-initial or word-final. An example is palatalization in Japanese mimetics (Itô & Mester 1989), which appears on a coronal preferentially (*kas<sup>y</sup>a-kas<sup>y</sup>a* 'noisy rustling sound of dry objects'), but can occur only on the initial consonant of the mimetic form in the absence of a coronal:

- (35)    *h<sup>y</sup>oko-h<sup>y</sup>oko* 'lightly, nimbly'                    \**hok<sup>y</sup>o-hok<sup>y</sup>o*  
           *g<sup>y</sup>obo-g<sup>y</sup>obo* 'gurgling'                            \**gob<sup>y</sup>o-gob<sup>y</sup>o*  
           *p<sup>y</sup>oko-p<sup>y</sup>oko* 'jumping up and down'           \**pok<sup>y</sup>o-pok<sup>y</sup>o*

When the initial consonant is an ineligible host for palatalization (it cannot be followed by *e*), palatalization does not appear at all:

(36)	keba-keba	‘gaudy’	*k <sup>y</sup> eba-k <sup>y</sup> eba, keb <sup>y</sup> a-keb <sup>y</sup> a
	neba-neba	‘sticky’	*n <sup>y</sup> eba-n <sup>y</sup> eba, neb <sup>y</sup> a-neb <sup>y</sup> a
	gebo-gebo	‘gurgling’	*g <sup>y</sup> ebo-g <sup>y</sup> ebo, geb <sup>y</sup> o-geb <sup>y</sup> o
	teka-teka	‘shining’	*t <sup>y</sup> eka-t <sup>y</sup> eka, tek <sup>y</sup> a-tek <sup>y</sup> a

Archangeli & Pulleyblank use noniterativity to account for this. Their rule linking the floating palatalization feature to a consonant operates from left to right noniteratively. If the first consonant is not a possible target, the rule stops searching for a target—this is what it means to be noniterative in their theory, but it is not what is usually meant by noniterativity in works such as the current one. We can instead account for the failure to palatalize in (36) by building the left word boundary into the palatalization rule or adopting a high-ranking constraint requiring palatalization to be left-aligned.

A noniterative rule is used to nontraditional effect in the analysis of Kukuya tone association. In this language, the tonal pattern LH associates with a trisyllabic form to yield the pattern L-H-H rather than the expected (according to standard association conventions such as those found in Goldsmith (1976)) \*L-L-H: *m<sup>w</sup>àrègí* ‘younger brother.’ To account for this, Archangeli & Pulleyblank adopt a noniterative rule that associates the H to the final syllable. Subsequently the “normal” rules of association yield L-H-H.

Another noniterative rule accounts for tonal polarity in Yoruba. In this language, object clitics surface with H after verbs with L or M, but they surface with L after verbs with H:

- (37) a. rà á            ‘buy it’  
           lù mí        ‘beat me’  
       b. jẹ ẹ        ‘eat it’  
           pa mí       ‘kill me’  
       c. rí i        ‘see it’        \*rí í  
           rí mi       ‘see me’       \*rí mí

A noniterative rule inserts H on the object clitic, and this rule is blocked from applying by the OCP when the preceding verb has H. The rule is noniterative because, in Archangeli & Pulleyblank’s formalism, an iterative rule will avoid an OCP violation by fusing the clitic’s H and the verb’s H into a single H. Noniterative rules, because they stop after the first target, cannot do this. This is yet another unconventional use of noniterativity that is specific to the theory at hand.

This leaves just one noniterative rule, which is used to account for tone spread in Kinande. I argue in Chapter 4 that this sort of phenomenon is best understood in terms that do not invoke noniterativity.

Thus of the twelve noniterative rules in Archangeli & Pulleyblank (1994), seven are adopted for phenomena that are explicitly argued to be not truly noniterative in this dissertation, and the other five use noniterativity to exploit certain properties of the theory to produce patterns that are not noniterative as that term is used in this dissertation. In contrast with the twelve rules that are iterative (most of which are used for traditional iterative purposes like vowel harmony and tone spread), this state of affairs does not suggest that noniterativity is at all common. (Archangeli & Pulleyblank seem to recognize this fact by making their iterativity parameter default to “iterative.”)

Vaux (2003b) argues against OT and in favor of derivational phonological theories from the point of view of iterative and optional phenomena. He presents examples of each kind of phenomenon that, in his view, OT is unequipped to account for. I have little to add with respect to his examples of optionality, but see §5.3.2.2 in Chapter 5 for attempts to deal with some problems he points out. It is true that the correct implementation of optionality in OT is far from clear, and the issue is the subject of current research (e.g. Anttila 2007, to name an approach that comes up in Chapter 3, plus the frameworks in Chapter 5). Iterativity—whereby a phenomenon (foot construction, stress assignment, assimilation, lenition, etc.) occurs at multiple positions in a form—is easily producible by OT. In fact, this is the standard result in OT (and one reason optionality is difficult to pin down in OT): If a constraint ranking produces the configuration  $\chi$  in the context  $\psi$ , then every instance of  $\psi$  will result in  $\chi$ , all things being equal. The specific phenomena that Vaux considers may be problematic for OT, but every theoretical framework has similar defects. For example, Baković (2007) points out that there are opaque phenomena that are problematic for derivational phonology despite that framework’s general superiority over OT in terms of opacity. One of Vaux’s examples (vowel raising and elision in Uyghur) is problematic for OT not because it is iterative, but because it is opaque. It would not be surprising if this were the case with his other examples.

Derivational theories account for optionality and iterativity in Vaux’s proposal with the diacritics  $[\pm\text{optional}]$  and  $[\pm\text{iterative}]$  that tag rules as optional and/or iterative. Vaux’s point is that these diacritics allow rule-based phonology to effortlessly capture the phenomena that are intractable in OT. He is certainly right

that the diacritics give us the tools to specify when a grammar may refrain from applying a process and when it may choose to apply the process over and over. But this dissertation argues the resulting theory is too powerful: we can tag a rule as [-iterative] just as easily as we can mark it as [+iterative], but no phenomenon requires the [-iterative] diacritic. Vaux may be right to criticize OT for its handling of optionality and iterativity, but derivational phonology encounters its own problems with noniterativity and is therefore not an analytical panacea. From the point of view of noniterativity, surface-oriented OT is superior.

## 1.6 A Typology of Pseudo-Noniterativity

The argument put forth here is that any time a process occurs exactly once, it is due to a confluence of factors, not a stipulation of noniterativity. It is worth cataloging the factors that can lead to the appearance of noniterativity. The following list contains the factors that I have identified along with phenomena that instantiate each factor. The list is surely incomplete.

**Adjacency** The source and trigger are or must be adjacent. (Nasal Place Assimilation, Lango vowel harmony, Chamorro Umlaut, Irish C-palatalization)

**Edge Alignment** The phenomenon in question is confined to one or the other edge of some domain. (Foot assignment, final devoicing)

**Domain Confinement** The phenomenon reaches every possible target in a domain, but the domain is small enough that only one target is present. (Ger-

man umlaut, tone spread/shift under Optimal Domains Theory, Tudaanca Spanish metaphony under Flemming (1994))

**Distinct Trigger and Target** The trigger and target are not the same, so the rule cannot be self-feeding. (Nati, Chamorro umlaut, Bengali harmony)

**Attraction to Prominence** The element that is moved or spread is attracted to a prominent position, such as the root or stressed syllable. Spreading farther is not motivated once this position is reached. (Lango vowel harmony, Chamorro umlaut, Tudaanca Spanish metaphony under Walker (2004))

**Non-Finality** Some element is banned from a domain-final position, so it is minimally relocated to avoid this position. (postlexical harmony in Nez Perce and Vata, Irish *i*-palatalization)

**Uniqueness** There is just one possible target in any form. (English aspiration, final devoicing, Japanese Rendaku (e.g. Itô & Mester 1986))

**Minimality** An element's underlying domain is too small, so it expands to encompass a larger (e.g. binary) domain. (tone spread/shift under Optimal Domains Theory, although Chapter 2 argues that there are problems with this view)

To reframe the claim of this dissertation, the Emergent Noniterativity Hypothesis is that no phenomenon is noniterative because of a stipulation of noniterativity. Instead, there is always a reason for a process to apply noniteratively. The list above gives some of the reasons for noniterativity. If this claim right,



it means that noniterative is always emergent because noniterativity universally results from some factor besides a noniterativity requirement.

## 1.7 True Noniterativity

What would a truly noniterative phenomenon look like? The fact that such a hypothetical process applies just once cannot be attributable to any of the factors listed in previous section. For example, that means it cannot be foot-constrained or obligatorily cross a morpheme boundary. (The latter would indicate attraction to prominence.)

Let's construct an example. Consider a language that has noniterative right-to-left backness harmony. Suppose this is a dominant/recessive system, with [+back] as the dominant feature. Since this is noniterative, only a back vowel and the preceding vowel harmonize, regardless of the morphological configuration. To rule out prosodic confinement, let's suppose this language has just one left-aligned trochee. Here are some examples of possible words in this hypothetical language (in bimorphemic forms, assume the configuration is root-suffix):

- (38) a. /tikepo/ → (tíko)po  
b. /katineva/ → (káti)nova  
c. /piku/ → (púku)  
d. /ketinove/ → (kétu)nove  
e. /pike-sena/ → (píke)-sona  
f. /pareti-no/ → (páre)tu-no

In all these forms, one vowel assimilates in backness to a following back vowel.

This happens whether spreading crosses a foot boundary (38a) or not (38b). Harmony can be wholly foot-internal (38c) or not (the rest of the examples). Both roots (first four examples) and suffixes (last two) can trigger harmony, and harmony may cross a morpheme boundary (38f) or not (the remainder). Harmony does not always target the root (38e). The trigger and target may be word-internal (38d) or word-final (the remainder).

The only available generalization is that backness spreads from a back vowel to the preceding vowel. No single position, like the stressed syllable or root-final vowel, is targeted. Harmony does not interact with prosodic structure, so it cannot be foot- or prosodic word-bound. The target is not confined to some edge of the form. This harmony system is truly noniterative: in rule-based terms, there is no way to analyze it except with a self-feeding, noniterative rule that spreads [+back] leftward.

To my knowledge, no language exhibits a phenomenon like this. The various parts of the harmony system are themselves attested, except for the noniterativity. Dominant/recessive harmony systems exist in languages like Nez Perce (see Chapter 5), and regressive harmony appears in Kinande. Backness harmony occurs in Turkish. The element that makes the hypothetical language unusual is that its harmony is truly noniterative. The harmony system appears strange, and this strangeness highlights the nonexistence of true noniterativity in phonology.

## 1.8 Outline

The remainder of this dissertation marshals evidence in favor of the Emergent Noniterativity Hypothesis. Each chapter discusses a possible counterexample to this hypothesis in detail and argues that the phenomenon in question is best understood in terms that do not invoke noniterativity; i.e., it is not truly noniterative. The phenomena that are discussed in these chapters are Lango's vowel harmony (Chapter 2), Chamorro umlaut (Chapter 3), tonal noniterativity (Chapter 4), and postlexical spreading (Chapter 5). Chapter 6 summarizes and contains concluding remarks.

# VOWEL HARMONY IN LANGO

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## 2.1 Introduction

Vowel harmony in Lango, a Nilotic language spoken in Uganda, spreads [+ATR] from suffix vowels to the root-final vowel:

- (1) a. /b̀̀̀̀́-ní/ → b̀̀̀̀́ní ‘your dress’  
 b. /c̀̀̀̀́-ní/ → c̀̀̀̀́ní ‘your beer’  
 c. /à̀̀̀́k-ní/ → à̀̀̀́kkí ‘your shoe’

Lango’s harmony presents the strongest argument for the existence of true noniterativity in segmental phonology that I am aware of. This chapter argues that this noniterativity is illusory: The assimilation shown in (1) is not truly noniterative, and it therefore does not refute the Emergent Noniterativity Hypothesis. Rather than reflecting a requirement that [+ATR] spread exactly once, Lango’s harmony is driven by an imperative to spread [+ATR] from the suffix to the root. Since spreading just one syllable leftward satisfies this demand, no further assimilation is motivated.

In rule-based theories such as autosegmental phonology (Goldsmith 1976) and Grounded Phonology (Archangeli & Pulleyblank 1994), the spreading in (1) is easily captured with a noniterative rule like the one in (2), which spreads [+ATR] regressively from one vowel to the preceding vowel.



Accounting for Lango's harmony is simple from a rule-based perspective, but as explained in Chapter 1, Lango presents OT with two related difficulties. First, OT cannot produce noniterativity in general, so if Lango's harmony is truly non-iterative, it presents a strong challenge to OT's parallel framework. Second, OT cannot account for Lango and Kinande with analyses that differ only in the setting of a parameter. Thus if we accept the premise that these are related harmony processes, OT loses this insight. To illustrate, we might account for Kinande's harmony with the AGREE constraint in (4).

- (4) AGREE-[±ATR]: Vowels in adjacent syllables must have the same value for [±ATR].

AGREE-[±ATR] produces spreading throughout a word because without complete harmony, there will necessarily be adjacent mismatched vowels somewhere in the word. But since iterativity is not explicitly mandated by the constraint, it cannot be switched off in any easy way to transform the analysis of Kinande into an analysis of Lango. The issue of noniterativity aside, then, OT cannot formalize the similarity between these two harmony processes.

I claim in this chapter that the harmony seen in Lango is qualitatively different from Kinande's harmony. It is therefore a mistake to shoehorn Lango's ATR assimilation into a modification of standard analyses of harmony. Instead, Lango is best analyzed with Positional Licensing (Crosswhite 2000, Itô 1988, Itô & Mester 1994, 1999, Steriade 1994a,b, 1995a, Walker 2001, 2004, Zoll 1997, 1998a,b). In the same way the harmonizing feature in Tudanca Spanish is attracted to the stressed syllable (Walker 2004; see also Chapter 1), the driving force behind Lango's har-

mony is a need for suffix ATR features to be linked to a prominent position, namely the root. The noniterativity of Lango's harmony is coincidental: In each example in (1), the suffix is adjacent to the root, so spreading just once satisfies the licensing requirements. Other OT-based proposals for producing vowel harmony are shown to be inadequate, and there are even problems with the derivational approach founded on the rule in (2). Consequently, the argument in favor of OT's view of the contrast between Lango and Kinande is not just a matter of theoretical taste, and Positional Licensing is not merely a convenient crutch that masks OT's shortcomings. The rule-based approach is empirically inadequate.

The Positional Licensing analysis of Lango is therefore the first piece of the argument that noniterativity does not have a place in phonology. At best noniterativity is a descriptive label we can apply when grammatical factors conspire to produce certain patterns. The seemingly minimal difference between Lango and Kinande is an illusion masking deeper, more fundamental differences. The two languages' harmony systems are not as related as the rule-based analysis claims.

This result means that OT does not need an explicit formalization of noniterativity, and in fact such a formalization would be misguided. Since the noniterative nature of Lango's vowel harmony can be captured by appealing to deeper reasons for spreading [+ATR] exactly once, the analysis presented below is instructive in that it suggests that all cases of apparently noniterative spreading can be explained without recourse to a formalization of that notion.

The process involved in Lango's harmony is secondary to the motivation for spreading, namely root-licensing. Once that motivation is formalized, the process—noniterative spreading—comes for free: it is an emergent rather than

primitive property of Lango’s harmony.

The chapter is structured as follows: §2.2 gives a more detailed picture of Lango’s harmony. §2.3 develops the Positional Licensing analysis, which builds on Walker (2004) and Smolensky (2006). §2.4 considers alternatives to Positional Licensing and argues against them, and §2.5 presents evidence in support of the Positional Licensing analysis in the form of data from harmony in fast speech. §2.6 briefly turns to the language Akposso, in whose harmony system support for the Positional Licensing analysis is found. §2.7 summarizes the chapter.

## 2.2 Harmony in Lango

The data in (1) are just a small part of Lango’s ATR harmony. There are five [+ATR] vowels and five [–ATR] vowels in the language, shown in (5) based on descriptions in Noonan (1992). The correspondences are the obvious ones, with *a* alternating with *ə*.

(5)	a.	i	u		b.	ɪ	ʊ
		e	ə	o		ɛ	ɔ
							a

Either value of [ $\pm$ ATR] may spread, and harmony can be either progressive or regressive, except that [–ATR] never spreads regressively. Suffixes but not prefixes participate in harmony. The data in (6) illustrate progressive spreading of [+ATR]. The suffixes shown are /-a/ ‘1st person singular possessive inalienable’ and /-ɛ/ ‘3rd person singular possessive inalienable.’ Underlying vowel quality is recoverable from disharmonic forms, some of which are shown in (21) below. All



Lango data are from Woock & Noonan (1979), Noonan (1992), and Smolensky (2006), and tones are given only when they are provided by these sources. See also Archangeli & Pulleyblank (1994) for a detailed discussion of the facts.

(6)	<i>Root</i>	<i>Gloss</i>	<i>1sg poss.</i>	<i>3sg poss.</i>
a.	ɲùt	‘neck’	ɲùt-ó	ɲùt-é
b.	wót	‘son’	wód-ó	wód-é
c.	ém	‘thigh’	ém-ó	ém-é
d.	ɲèt	‘side’	ɲèt-ó	ɲèt-é
e.	ɲím	‘forehead’	ɲím-ó	ɲím-é
f.	cíɲ	‘hand’	cíɲ-ó	cíɲ-é

The forms in (7) show the same suffixes when attached to stems with [–ATR] vowels. As those forms are underlyingly harmonic, no change is necessary, and the suffixes surface faithfully, in contrast with (6).

(7)	a.	bwóm	‘wing’	bwóm-á	bwóm-é
	b.	wàɲ	‘eye’	wàɲ-á	wàɲ-é
	c.	léb	‘tongue’	léb-á	léb-é
	d.	tyén	‘leg’	tyén-á	tyén-é
	e.	yìc	‘stomach’	yì-á	yì-é <sup>2</sup>
	f.	yíb	‘tail’	yíb-á	yíb-é

The Positional Licensing analysis developed below is based largely on the analysis of Smolensky (2006), which itself draws heavily on the analysis of Archangeli

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<sup>2</sup>Woock & Noonan (1979), from whom this example is taken, do not comment on the loss of *c*.

& Pulleyblank (1994). For Smolensky, harmony is driven by the AGREE constraint in (4), repeated in (8).

- (8) AGREE- $[\pm\text{ATR}]$ : Vowels in adjacent syllables must have the same value for  $[\pm\text{ATR}]$ .

With no directionality or morpheme dominance specified by AGREE, it falls to other constraints to filter the set of AGREE-satisfying candidates by ruling out certain spreading configurations. Smolensky’s filtering constraints are given in (9). Three constraints (with numerical subscripts) block  $[\text{+ATR}]$  spreading in certain cases, and three others (with alphabetical subscripts) block  $[\text{-ATR}]$  spreading.

- (9) *Summary of Constraints from Smolensky (2006)*

$\text{C}_1$ : No $[\text{+ATR}]$ spread from $[\text{-hi}]$ source in closed $\sigma$ .	}	<i>regulate <math>[\text{+ATR}]</math> spread</i>
$\text{C}_2$ : No regressive $[\text{+ATR}]$ spread from a $[\text{-hi}]$ source.		
$\text{C}_3$ : No regressive $[\text{+ATR}]$ spread from a $[\text{-front}]$ V onto a $[\text{-hi}]$ V in a closed $\sigma$ .		
$\text{C}_X$ : No regressive $[\text{-ATR}]$ spread.	}	<i>regulate <math>[\text{-ATR}]</math> spread</i>
$\text{C}_Y$ : No $[\text{-ATR}]$ spread from a $[\text{+front}]$ vowel.		
$\text{C}_Z$ : $*[\text{-ATR}, \text{+hi}]$		

These filtering constraints, which are adopted in the present analysis, are derived from the local conjunction (Smolensky 1995) of basic constraints. See Smolensky (2006:86–94) for the formal definitions and complete motivations for the filtering constraints. Only informal definitions are given here. For each form with  $[\text{+ATR}]$  spreading, one of the constraints above must rule out the candidate

with [-ATR] spreading, and *vice versa*. Consequently, explaining why one value of [ $\pm$ ATR] spreads consists of explaining why the other value cannot spread.

The first filtering constraint is at work in (6), where the root vowels' [+ATR] features spread to /-a/ or /-ε/. Regressive [-ATR] spreading from the suffixes to the roots is ruled out by the constraint in (10).  $\mathbb{C}_X$  prevents regressive spreading of [-ATR] and is responsible for the fact that only [+ATR] spreads regressively in Lango. Within Smolensky's theory, the source of spreading is the head of the harmonic domain, so formally,  $\mathbb{C}_X$  blocks right-headed [-ATR] domains.

(10)  $\mathbb{C}_X$ : No regressive [-ATR] spread.

To give more examples of progressive [+ATR] harmony, the data in (11) show harmony within finite verbs. The harmonizing suffix is /-a/ '1st person singular object.' A full gloss is given for (11a) only. The remaining sentences vary only in terms of the verb root. [+ATR] harmony is optimal because  $\mathbb{C}_X$  blocks [-ATR] harmony. The forms in (12) are underlyingly harmonic and verify that the suffix does indeed alternate.

- (11)
- |    |                                |                          |
|----|--------------------------------|--------------------------|
| a. | dákó ò-rùk-ó                   |                          |
|    | woman 3sg.subj-dressed-1sg.obj |                          |
|    | 'The woman dressed me.'        |                          |
| b. | dákó ò-rùc-ó                   | 'The woman confused me.' |
| c. | dákó ò-pwòd-ó                  | 'The woman beat me.'     |
| d. | dákó ò-pòn-ó                   | 'The woman avoided me.'  |
| e. | dákó ò-cèl-ó                   | 'The woman hit me.'      |
| f. | dákó ò-bìt-ó                   | 'The woman lured me.'    |
| g. | dákó ò-wìj-ó                   | 'The woman heard me.'    |

- (12)
- |    |      |          |                                |
|----|------|----------|--------------------------------|
| a. | dákó | ò-lòb-á  | ‘The woman followed me.’       |
| b. | dákó | ò-lwòk-á | ‘The woman washed me.’         |
| c. | dákó | ò-kòᵛ-á  | ‘The woman helped me.’         |
| d. | dákó | ò-jwàt-á | ‘The woman hit me.’            |
| e. | dákó | ò-kàn-á  | ‘The woman hid me.’            |
| f. | dákó | ò-nèn-á  | ‘The woman saw me.’            |
| g. | dákó | ò-tèl-á  | ‘The woman pulled me.’         |
| h. | dákó | ò-lìm-á  | ‘The woman visited me.’        |
| i. | dákó | ò-lik-á  | ‘The woman struggled with me.’ |

(13) and (14) show regressive spreading of [+ATR] with spreading from a suffix to a root. The suffixes in (13) are /-Ci/ ‘2nd person singular possessive,’ /-wu/ ‘2nd person plural possessive,’ and /-i/ ‘2nd person singular object.’

- (13)
- |    |     |          |        |                    |
|----|-----|----------|--------|--------------------|
| a. | kóm | ‘chair’  | kòm-mí | ‘your (sg) chair’  |
| b. | kóm | ‘chair’  | kòm-wú | ‘your (pl) chair’  |
| c. | bó  | ‘net’    | bó-wú  | ‘your (pl) net’    |
| d. | còᵛ | ‘chaff’  | cùᵛ-wú | ‘your (pl) chaff’  |
| e. | jò  | ‘people’ | jò-wú  | ‘your (pl) people’ |
| f. | dèk | ‘stew’   | dèk-kí | ‘your (sg) stew’   |
| g. | lè  | ‘net’    | lè-wú  | ‘your (pl) net’    |
| h. | pí  | ‘for’    | pì-wú  | ‘for you’          |

- (14) ò-kòᵛ-í ‘she helped you’ (cf. (12c))

Progressive [-ATR] harmony is ruled out by Smolensky for (13) and (14) by

$\mathbb{C}_Z$ , defined in (15). Progressive harmony would yield *ʊ* and *ɪ* in the suffixes, and high [-ATR] vowels are disfavored on articulatory grounds (Archangeli & Pulleyblank 1994): retracting the tongue root conflicts with the raising gesture required for a high vowel.<sup>3</sup>

$$(15) \quad \mathbb{C}_Z: *[-\text{ATR}, +\text{hi}]$$

In addition, the final three forms in (13) are subject to  $\mathbb{C}_Y$  (16). [-ATR] may not spread from a front vowel. This restriction is also articulatorily motivated (Archangeli & Pulleyblank 1994). Retraction of the tongue root conflicts with fronting the tongue body, so front lax vowels make poor heads of harmonic domains. For mnemonic reasons, Smolensky uses [ $\pm$ front] instead of [ $\pm$ back], but the two features are equivalent such that [ $\alpha$ front] = [ $-\alpha$ back].<sup>4</sup> Both  $\mathbb{C}_Y$  and  $\mathbb{C}_Z$  prevent [-ATR] harmony in the last three forms in (13).

$$(16) \quad \mathbb{C}_Y: \text{No } [-\text{ATR}] \text{ spread from a } [+ \text{front}] \text{ vowel.}$$

There are also constraints that militate against [+ATR] spreading in certain cases. Some examples of progressive [-ATR] spreading are shown in (17). The infinitival suffix /-Co/ alternates depending on the stem it is attached to. [-ATR] spreading is not blocked in these cases (i.e.,  $\mathbb{C}_X$ ,  $\mathbb{C}_Y$ , and  $\mathbb{C}_Z$  are not violated), and the constraint preventing [+ATR] spreading is  $\mathbb{C}_2$ , defined in (19). The forms

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<sup>3</sup>Smolensky (2006) gives two definitions of this constraint, one that is exactly like (15), and another that penalizes only unfaithful lax high vowels. He does not seem to favor one over the other, so I adopt the former:  $\mathbb{C}_Z$  penalizes any lax high vowel, unfaithful or not.

<sup>4</sup>The mnemonic device employed by Smolensky may be helpful here as well: The '+' values of [ $\pm$ ATR], [ $\pm$ hi], and [ $\pm$ front] are all compatible (they all involve raising or fronting of the tongue), as are the '-' values of each feature (involving backing or lowering of the tongue). Segments with a mixture of '+' and '-' values for these features require conflicting tongue gestures and are therefore marked.

in (18) are underlyingly harmonic and show the underlying specification of the suffix vowel.

(17)	<i>Root</i>	<i>Gloss</i>	<i>Infinitive</i>
a.	lwək	‘wash’	lwək-kə
b.	lɔb	‘follow’	lɔb-bə
c.	ɲən	‘step on’	ɲən-nə
d.	jək	‘stop’	jək-kə

(18)	a.	riŋ	‘run’	riŋ-ŋo
	b.	ket	‘put’	ket-to
	c.	ruc	‘entangle’	ruc-co
	d.	pwod	‘beat’	pwod-do

(19) C<sub>2</sub>: No regressive [+ATR] spread from a [-hi] source.

Just as the articulatory gestures required by [-ATR] and [+hi] make conflicting demands on the tongue, so do [+ATR] and [-hi]. Since non-high tense vowels are marked, they make poor heads of [+ATR] domains.

Additionally, C<sub>3</sub> (20) rules out [+ATR] harmony in (17a) and (17c). Both [-front] and [-hi] conflict with the articulatory demands of [+ATR], so tense back vowels make poor heads of harmonic domains, and spreading [+ATR] to a [-hi] vowel is discouraged.

(20) C<sub>3</sub>: No regressive [+ATR] spread from a [-front] V onto a [-hi] V in a closed syllable.

Finally, in some cases, harmony fails and a disharmonic word appears. Ex-

amples of this sort are given in (21). Here, spreading of each value of  $[\pm\text{ATR}]$  is ruled out by one of the filtering constraints. For example, in (21i),  $[\text{+ATR}]$  spreading is blocked by  $\mathbb{C}_2$  (the non-high vowel cannot be the source of leftward spreading), and  $[\text{-ATR}]$  spreading is blocked by  $\mathbb{C}_Y$  (the front vowel cannot be the source of  $[\text{-ATR}]$  spreading). With neither harmonic option escaping the filtering constraints, **AGREE** is violated by the optimal candidate. Smolensky (2006) uses these forms to argue that the filtering constraints must outrank **AGREE**: harmonic candidates only win if they incur no violations of the filtering constraints. Notice also that disharmonic forms can be used to verify the underlying specifications of the suffixes discussed above.

- |      |    |         |                |    |          |                  |
|------|----|---------|----------------|----|----------|------------------|
| (21) | a. | twòl-lá | ‘my snake’     | i. | lm-mo    | ‘to visit’       |
|      | b. | gwók-ká | ‘my dog’       | j. | way-o    | ‘to pull’        |
|      | c. | búk-wá  | ‘our book’     | k. | cam-mo   | ‘to eat’         |
|      | d. | búk-gí  | ‘their book’   | l. | nɛn-no   | ‘to see’         |
|      | e. | gwèn-ná | ‘my chicken’   | m. | dɛp-po   | ‘to gather’      |
|      | f. | rwót-tá | ‘my chief’     | n. | dèk-wú   | ‘your (pl) stew’ |
|      | g. | dòk-ká  | ‘my cattle’    | o. | ò-cèl-wá | ‘she hit us’     |
|      | h. | ɲèŋ-ŋá  | ‘my crocodile’ | p. | ò-cèl-gí | ‘she hit them’   |

The forms in (21a)–(21h) motivate another filtering constraint. Since they only block (certain instances of) regressive  $[\text{+ATR}]$  spreading, neither  $\mathbb{C}_2$  nor  $\mathbb{C}_3$  prevents progressive  $[\text{+ATR}]$  harmony in these forms. Smolensky adopts  $\mathbb{C}_1$  (22) to account for (21a)–(21h). Again,  $[\text{+ATR}]$  and  $[\text{-hi}]$  conflict, so a vowel with these features makes a poor domain head.

(22) C<sub>1</sub>: No [+ATR] spread from [-hi] source in closed syllable.

Compare (21a)–(21h) to (23), where [+ATR] harmony whose source is in a closed syllable is allowed because the source vowel in those forms is high.

(23)	<i>Root</i>	<i>Gloss</i>	<i>1sg. poss.</i>
a.	búk	‘book’	búk-kó
b.	òpúk	‘cat’	òpúk-kó
c.	píg	‘juice’	píg-gó

To reiterate a point made above in passing, if the root and suffix vowels are already harmonic, nothing changes, as the examples in (24), plus many of the examples above, show:

(24)	a.	dèk-ká	‘my stew’
	b.	òt-tá	‘my house’
	c.	ɲóɲ-ɲí	‘your (sg) crocodile’
	d.	rwót-tí	‘your (sg) chief’
	e.	búk-kí	‘your (sg) book’
	f.	ɲìɲ-wú	‘your (pl) name’

To summarize, Lango has four strategies for dealing with disharmonic root-suffix combinations: progressive [+ATR] spreading (6), regressive [+ATR] spreading (13), progressive [-ATR] spreading (17), and no spreading at all (21).

The question of which feature spreads when and in which direction is an interesting one, but a deeper discussion of the patterns would detract from the issue of noniterativity. The reader is referred to Archangeli & Pulleyblank (1994) and



Smolensky (2006) for insightful discussion. See also Noonan (1992) for a different perspective.

Smolensky's theory of directionality makes liberal use of Local Constraint Conjunction and his theory of domain-headedness. Although those filtering constraints are an important part of the Positional Licensing analysis developed here, they are largely tangential to this chapter's main argument, which is that the extent of spreading in Lango is driven by Positional Licensing. Any constraint(s) that correctly predict(s) the direction of spreading can replace Smolensky's filtering constraints without threatening the Positional Licensing approach's success. Smolensky's constraints are adopted for expedience, and the current analysis is not committed to the theoretical positions of Smolensky (2006). The Positional Licensing and directionality pieces of the analysis stand or fall on their own independent merits. I argued against Local Constraint Conjunction in Chapter 1, and in Chapter 5 I adopt Smolensky's theory of domain headedness. Smolensky (2006) argues for the filtering constraints himself, and evaluation of his arguments must await future research.

Noonan's (1992) view of Lango's harmony is very different from Smolensky's. Noonan claims that [+ATR] is the dominant feature, and it may spread progressively or regressively. Harmony is blocked by CV suffixes unless the suffix vowel (and for some speakers also the root vowel) is [+high]. [-ATR] is claimed not to spread, and the forms in (17) are treated as exceptions since they all involve what Noonan identifies as the stem-vowel suffix /-o/. In the discussion above (17), I identified that suffix as the infinitival /-Co/, following Smolensky (2006) and Woock & Noonan (1979), rather than the stem-vowel suffix because of the

gemination induced by this suffix on verbs. This gemination suggests that the suffix in those examples is distinct from other instances of Noonan’s stem vowel, which doesn’t trigger gemination. As I argue below, the stem-vowel suffix (apart from the reanalysis of some cases as an infinitival suffix) may be better identified as part of the root, not a separate morpheme. I have selected Smolensky’s analysis as the basis for mine because Smolensky’s analysis incorporates the data from (17) into the more general harmony system so that they are not exceptional. However, the [+ATR]-dominance approach is equally compatible with Positional Licensing, as I discuss below.

The implication of Noonan’s characterization of Lango is that ATR is privative, and only [+ATR] is phonologically present. Noonan claims that the [–ATR] suffix in (17) only appears when the root contains  $\text{ɔ}$  or  $\text{ʊ}$ . This seems to necessitate spreading [–ATR], which is incompatible with privativity (and hence privativity is not adopted here). But it is tempting to skirt the issue by invoking allomorph selection: The suffixes in (17) and (18) are separately listed allomorphs, and the one specified for [+ATR] (more accurately, under privativity, just [ATR]) is the default. The one lacking an ATR feature is selected just when the root contains a back non-low vowel that also lacks an ATR feature. Now we don’t need to spread the unspecified feature. However, Noonan (1992:272 fn. 31) notes that some speakers additionally allow the [–ATR] allomorph when the root contains  $\text{ɛ}$ . Since  $\text{ɛ}$ ,  $\text{ɔ}$ ,  $\text{ʊ}$  is not a natural class in Lango, the rules governing allomorph selection would have to be more complex for these speakers, and more importantly it remains a coincidence that the allomorph unspecified for ATR only appears with root vowels that are also unspecified for ATR. The inability of a phonological process to re-

quire a feature’s absence is one of the attractions of privativity in general, but this principle prevents us from formalizing the generalization concerning the [-ATR] allomorph’s distribution. Specifying that the lax suffix is the default and that the [+ATR] variant appears only with [+ATR] root vowels is not a viable alternative: Forms like *wàlô* ‘to boil (intransitive),’ *ryèttò* ‘to winnow (intransitive),’ and *nyìkò* ‘to move slightly away’ show that this is an incorrect generalization. It seems simpler to abandon privativity and allow [-ATR] to spread.<sup>5</sup>

The pieces of Smolensky’s (2006) analysis are now in place. The filtering constraints (henceforth the “ $\mathbb{C}$  constraints”) are recapitulated in (25).  $\mathbb{C}_1$ ,  $\mathbb{C}_2$ , and  $\mathbb{C}_3$  determine when [+ATR] may spread, and  $\mathbb{C}_X$ ,  $\mathbb{C}_Y$ , and  $\mathbb{C}_Z$  determine when [-ATR] may spread. No ranking among these constraints is posited. For perspicuity, the definitions of  $\mathbb{C}$  constraints that assign violations in subsequent Tableaux are repeated below those Tableaux.

(25) *Summary of Constraints from Smolensky (2006)*

$\mathbb{C}_1$ :	No [+ATR] spread from [-hi] source in closed $\sigma$ .	}	<i>regulate [+ATR] spread</i>
$\mathbb{C}_2$ :	No regressive [+ATR] spread from a [-hi] source.		
$\mathbb{C}_3$ :	No regressive [+ATR] spread from a [-front] V onto a [-hi] V in a closed $\sigma$ .		
$\mathbb{C}_X$ :	No regressive [-ATR] spread.	}	<i>regulate [-ATR] spread</i>
$\mathbb{C}_Y$ :	No [-ATR] spread from a [+front] vowel.		
$\mathbb{C}_Z$ :	*[-ATR, +hi]		

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<sup>5</sup>Taking a wider view, the strong claim—which Noonan does not make—that ATR is a universally privative feature is untenable. If we adopt [-ATR] as the unspecified feature on basis of Lango’s harmony, we cannot account for Nez Perce (see Chapter 5), where, according to Hall & Hall (1980), [-ATR] is the active feature and both [+ATR] and [-ATR] spread postlexically.

In (26)–(28), Tableaux show Smolensky’s analysis in action, with IDENT[ATR] replacing the equivalent F[ATR] from his Tableaux. In (26), the candidate with [–ATR] harmony—candidate (c)—violates both  $\mathbb{C}_Y$  (because the source of the [–ATR] feature is a front vowel) and  $\mathbb{C}_Z$  (because harmony yields a [+high, –ATR] vowel) and is therefore eliminated. Candidate (b), with [+ATR] harmony, violates none of the  $\mathbb{C}$  constraints and therefore emerges as the winner, candidate (a) having been eliminated by AGREE-[±ATR].

(26) *[+ATR] Spreading*

/lè-wú/	$\mathbb{C}_1$	$\mathbb{C}_2$	$\mathbb{C}_3$	$\mathbb{C}_X$	$\mathbb{C}_Y$	$\mathbb{C}_Z$	AGREE	ID[ATR]
a. lè-wú							*!	
b. lè-wú								*
c. lè-wú					*!	*!		*

$\mathbb{C}_Y$ : No [–ATR] spread from a [+front] vowel.

$\mathbb{C}_Z$ : \*[-ATR, +hi]

Conversely, in (27), candidate (b), with [+ATR] harmony, violates  $\mathbb{C}_2$  because the source of the [+ATR] feature is a non-high vowel and the spreading is regressive. Also,  $\mathbb{C}_3$  is violated because [+ATR] spreads regressively from a back vowel, and the target vowel is non-high and in a closed syllable. Consequently, the [+ATR] harmonic candidate is eliminated. But the [–ATR] harmonic candidate (candidate (c)) doesn’t violate any of the  $\mathbb{C}$  constraints and is optimal. As before, the disharmonic candidate (a) is eliminated by AGREE-[±ATR].

(27) *[-ATR] Spreading*

/lwək-Co/	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>X</sub>	C <sub>Y</sub>	C <sub>Z</sub>	AGREE	ID[ATR]
a. lwək-ko							*!	
b. lwok-ko		*!	*!					*
☞ c. lwək-kɔ								*

C<sub>2</sub>: No regressive [+ATR] spread from a [-hi] source.

C<sub>3</sub>: No regressive [+ATR] spread from a [-front] V onto a [-hi] V in a closed  $\sigma$ .

Finally, (28) shows a form in which the disharmonic candidate is optimal. Here, the [+ATR]-spreading candidate is ruled out by C<sub>3</sub>, and the [-ATR]-spreading candidate fatally violates C<sub>X</sub> and C<sub>Z</sub>. With both harmonizing candidates eliminated, the disharmonic form wins because it violates only the lower-ranked AGREE-[±ATR].

(28) *No Spreading*

dək-wú/	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>X</sub>	C <sub>Y</sub>	C <sub>Z</sub>	AGREE	ID[ATR]
☞ a. dək-wú							*	
b. dək-wú			*!					*
c. dək-wú					*!	*!		*

C<sub>3</sub>: No regressive [+ATR] spread from a [-front] V onto a [-hi] V in a closed  $\sigma$ .

C<sub>Y</sub>: No [-ATR] spread from a [+front] vowel.

C<sub>Z</sub>: \*[-ATR, +hi]

A further option is possible: Suppose neither the [+ATR]-spreading candidate nor the [-ATR]-spreading candidate violate the C constraints. Which one wins? Smolensky is silent on the issue. Such a form would require an input with the schematic shape /...V<sub>1</sub>(C<sub>1</sub>)-(C<sub>2</sub>)V<sub>2</sub>/, where V<sub>1</sub> can be  $\text{ɔ}$  or  $a$ , and V<sub>2</sub> can be

either *i* or *u*. At least one of  $C_1$  and  $C_2$  must be present to avoid hiatus resolution via coalescence (see Noonan 1992), and both consonants can be present only if  $V_2 = i$ . Without evidence one way or the other, I cannot say which harmonic candidate actually emerges. Perhaps even free variation exists in these cases. Selecting an optimal harmonic candidate is reasonably simple, and several strategies are possible: Dividing IDENT[ATR] into IDENT[+ATR] and IDENT[-ATR] (Hall 2006, McCarthy & Prince 1995, Pater 1999) and ranking one over the other will suffice, as will invoking root faithfulness vs. affix faithfulness. Likewise, low-ranking headedness constraints (in the spirit of Smolensky (2006)) that prefer left- or right-headed ATR domains will select one harmonic candidate over the other. Yet another option is to posit crucial rankings between the  $\mathbb{C}$  constraints. Leaving this point unresolved does not affect the analysis below.

Smolensky (2006) is concerned with the direction and possibility of harmony, not the extent of the harmonic domain (which is the primary interest of this chapter). Consequently, the data from (1) are tangential to the goals of that work, but they bear crucially on the question of noniterativity's place in phonology. More examples showing incomplete harmony are given in (29). In all of these examples, the root contains more than one vowel and regressive harmony targets only the root-final vowel.<sup>6</sup> Other root vowels retain their underlying features. The resulting form has a disharmonic root, but as (30) shows, the analysis of Smolensky (2006) predicts complete harmony. ( $\ominus$  marks the predicted output, and  $\left(\boxtimes\right)$  notes the correct output.)

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<sup>6</sup>In fast-speech, a regressive harmonic domain can include the final *two* root vowels as long as the first of those two vowels is stressed. Consequently, some—but not all—of the forms marked ungrammatical in (29) are grammatical in fast speech. I set this complication aside for now but return to it in §2.5.

- (29)
- |    |         |          |            |                    |               |
|----|---------|----------|------------|--------------------|---------------|
| a. | bòŋó    | ‘dress’  | bòŋó-ní    | ‘your (sg) dress’  | (*bòŋó-ní)    |
| b. | còŋò    | ‘beer’   | còŋò-ní    | ‘your (sg) beer’   | (*còŋò-ní)    |
| c. | àmók    | ‘shoe’   | àmók-kí    | ‘your (sg) shoe’   | (*àmók-kí)    |
| d. | àtín    | ‘child’  | àtín-nî    | ‘your (sg) child’  | (*àtín-nî)    |
| e. | ìmáŋ    | ‘liver’  | ìmáŋ-í     | ‘your (sg) liver’  | (*ìmáŋ-í)     |
| f. | pàlà    | ‘knife’  | pàlè-wú    | ‘your (pl) knife’  | (*pàlè-wú)    |
| g. | òkwé!cé | ‘bitch’  | òkwé!cé-ní | ‘your (sg) bitch’  | (*òkwé!cé-ní) |
| h. | òkwé!cé | ‘bitch’  | òkwé!cé-wú | ‘your (pl) bitch’  | (*òkwé!cé-wú) |
| i. | lèm’un  | ‘orange’ | lèm’un-wú  | ‘your (pl) orange’ | (*lèm’un-wú)  |
| j. | mòtòkà  | ‘car’    | mòtòkà-ê   | ‘cars’             | (*mòtòkà-ê)   |
| k. | dàktàl  | ‘doctor’ | dàktàl-ê   | ‘doctors’          | (*dàktàl-ê)   |
| l. | ìdíkè   | ‘leech’  | ìdík-ê     | ‘leeches’          | (*ìdík-ê)     |

(30)

/bòŋó-ní/	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>X</sub>	C <sub>Y</sub>	C <sub>Z</sub>	AGR	ID[ATR]
a. bòŋóní							*!	
(*) b. bòŋóní							*!	*
⊖ c. bòŋóní								**
d. bòŋóní						*!		*

C<sub>Z</sub>: \*[-ATR, +hi]

Noonan (1992) identifies some of the root-final vowels in (29)—notably the *o* in the first two examples—as a suffix he calls the “stem vowel” and which joins with the root to create the noun or verb stem. This suffix is typically *o* or *ɔ*, matching the ATR feature of the other root vowel(s), but any other vowel may also be a stem vowel. Noonan identifies certain behavioral characteristics







such blockers), Alignment cannot be satisfied with spreading to just the root-final syllable. To be more specific, if, say,  $\text{ALIGN}([\pm\text{ATR}],\text{L};\text{Word},\text{L})$  motivates harmony (by requiring all ATR domains to be left-aligned within a word, counted by syllables for expository purposes), then spreading the suffix's [+ATR] feature leftward one syllable to eliminate one violation of ALIGN will always be inferior to spreading yet another syllable to the left, which removes a second violation.

Consequently, standard harmony constraints like AGREE and ALIGN cannot account for the full range of facts in Lango. What constraint(s) should be used instead? If harmony in Lango is truly noniterative (in the sense described above), the harmony-driving markedness constraint must be able to compare the output to the input in order to judge the extent of spreading. To correctly produce both *òpúk-kə* ‘my cat’ (from (23b)) and *bə̀ŋó-ní* ‘your dress’ (1a), constraints must know that the first form underlyingly has two [+ATR] vowels, and so the output should have three, while the second form has one [+ATR] vowel, and its output should have two. This power is typically unavailable to markedness constraints, which must evaluate outputs on their own merits without regard for inputs.

We are therefore confronted with two problems: First, if the assimilation seen in Lango is a case of vowel harmony, it should be produced with standard harmony-driving constraints in the way a single rule can account for both Lango and Kinande with just a change in one parameter. But any constraint that produces full harmony in Kinande cannot be satisfied with minimal harmony in Lango. Second, the constraint that must replace standard harmony drivers to account for Lango should require strictly noniterative spreading, and this seems impossible given the standard assumptions of OT.

These conundrums disappear if we abandon the assumptions that Lango exhibits genuine vowel harmony (perhaps the assimilation is more closely related to metaphony andumlaut, to which parallels were drawn above) and that this assimilation is fundamentally noniterative. A closer look at Lango reveals that both assumptions are in fact wrong. It is therefore unsurprising—and even desirable—that Lango and standard harmony necessitate distinct analyses. Furthermore, some data presented below show spreading beyond what noniterativity would permit, and it is therefore a mistake to stipulate that assimilation is necessarily noniterative. Under the Positional Licensing analysis pursued here, the impetus for minimal harmony is couched in terms that do not refer to noniterativity, although spreading to just the adjacent syllable is the typical result.

## 2.3 Licensing as an Alternative to Iterativity

### 2.3.1 The Licensing Analysis

There are several reasons to think that Positional Licensing (Crosswhite 2000, Itô & Mester 1994, Zoll 1997, 1998b), and not a traditional harmony-driving mechanism, is responsible for ATR harmony in Lango. We've already seen that root-affix assimilation creates disharmonic stems (see (29)). Harmonic systems, in which all (non-transparent or -opaque) vowels in a domain have the same specification for a feature, do not typically undo an existing harmonic domain to produce another harmonic domain. If Lango had genuine vowel harmony, we'd expect all root vowels to change under suffixation in (29). The fact that underlyingly harmonic roots can become disharmonic is evidence that root harmony *qua* harmony is no



is not synchronically active in the language. Even languages that uncontroversially have full-fledged harmony systems often contain disharmonic exceptions, but taken with the other evidence against a harmony system in Lango, these roots suggest that this language does not have vowel harmony *per se*.

Consequently, we don't have to shoehorn the one-syllable spreading into a harmony system. Rather, the disharmonic forms in (32) indicate that some other mechanism is responsible for Lango's "harmony."<sup>12</sup> Furthermore, harmony-inducing constraints such as ALIGN and AGREE have been shown to be particularly troublesome in terms of the too-many-solutions problem (Blumenfeld 2006). For example, AGREE suffers from the sour-grapes problem whereby no harmony occurs at all if complete harmony is impossible (McCarthy 2003, 2004, Padgett 1995). ALIGN can, in principle, trigger bizarre and unattested repairs such as deletion of all non-harmonic vowels (McCarthy 2004). More satisfactory solutions are needed for harmony in general, and this fact frees us to seek alternative analyses of Lango's harmony in particular.

If Lango does not exhibit "harmony" as the term is traditionally understood, what is the motivation for the one-syllable spreading seen in (29)? The argument put forth in this section is that harmony in Lango is best understood as an effect of Positional Licensing. An analysis of the data presented in the previous section is developed here, building on the analysis of Smolensky (2006).

The property that all the cases of harmony share is that after assimilation, the suffix vowel shares its ATR specification with some root segment. I claim that

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<sup>12</sup>I will continue to use the term "harmony" both to maintain terminological consistency with previous analyses and because—arguments in this section notwithstanding—this is harmony in the sense that some string of vowels must have some feature in common. The label we assign the phenomenon is less important than how we analyze it.

this is the goal. Roots are “prominent positions which license more contrasts than other non-prominent positions” (Urbanczyk 2006:194; see also Beckman 1999, Steriade 1995b and Chapter 3 below). Consequently, the suffix vowel’s ATR feature is more prominent (i.e. more likely to be correctly perceived) if it is also carried by a root vowel. This is exactly the intuition captured by Positional Licensing: The feature  $[\pm\text{ATR}]$  is *licensed* on roots (cf. Generalized Licensing (Walker 2004) and Indirect Licensing (Steriade 1995b)):

(33) LICENSE-[ATR]:  $[\pm\text{ATR}]$  features must be linked to root segments.<sup>13</sup>

This constraint says, essentially, that a contrast based on  $[\pm\text{ATR}]$  is only permitted in roots, and the justification is that roots are more prominent than affixes. (See Chapter 3 for a discussion of root prominence.) Of course, non-root vowels in a well-formed surface structure must be specified for this feature, but LICENSE-[ATR] does not penalize such specifications as long as they’re shared by some root segment. Notice also that LICENSE-[ATR] is satisfied by spreading in either direction. Given a disharmonic root/suffix vowel pair, it does not matter which segment’s feature survives in the output as long as the feature on the suffix vowel is also linked to a root vowel. (LICENSE-[ATR] is also satisfied by deletion of suffix vowels since this would eliminate non-root ATR hosts. This means MAX or possibly REALIZE-MORPH (Kurusu 2001) must be highly ranked in Lango.)

It is important to note that this Positional Licensing constraint is very differ-

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<sup>13</sup>It is equally possible to formalize this constraint in the vein of COINCIDE (Itô & Mester 1999, Zoll 1998a). The result would be a constraint requiring the scope of  $[\pm\text{ATR}]$  to coincide with the scope of the root. The LICENSE and COINCIDE formulations seem to be functionally equivalent in the present case (“coincide with” = “be linked to”) and they are designed to capture the same intuitions.



date (a) violates LICENSE-[ATR]. Crucially, candidate (b) no longer violates the harmony-driving constraint (cf. (30) above).  $\mathbb{C}_Z$  eliminates the candidate in which the suffix vowel takes on the ATR feature of the root vowels. ATR spreading must be regressive if LICENSE-[ATR] is to be satisfied. The question now is: How large is the optimal domain of harmony? LICENSE-[ATR] is satisfied equally by candidates (b) and (c). The decision falls to lower-ranked constraints in the normal OT fashion. IDENT[ATR] selects the candidate that does minimal violence to the input. The form in which the suffix's [+ATR] feature spreads only to the root-final vowel wins: One violation of IDENT[ATR] is required by LICENSE-[ATR], but a second violation is unnecessary. In this way, LICENSE-[ATR] (combined with lower-ranking Faithfulness) motivates minimal spreading. Noniterative spreading is a consequence of the word's morphological configuration and represents the minimal unfaithfulness to the input necessary to satisfy LICENSE-[ATR]. No explicitly noniterative constraint is necessary because noniterativity falls out from other considerations. That is, Lango's harmony exhibits emergent noniterativity.

Recall that Noonan (1992) identifies some of the root-final vowels in (29) as suffixes. If Noonan is right in his analysis of this morpheme, it means only that LICENSE-[ATR] should be amended to require licensing by the *stem* rather than the *root*: Suffixes other than the stem vowel must share their ATR features with the noun or verb stem. Alternatively, the stem vowel may be one of Selkirk's (1982) root-affixes which, when attached to a root, yields a larger root rather than a stem. To ensure that the stem vowel itself harmonizes with the root, we can either use LICENSE-[ATR] (the stem vowel must share its ATR feature with the stem it attaches to—i.e. the root proper), or we can invoke some kind of



low-ranking stem-level harmony constraint. (As support for the latter approach, recall that most roots are fully harmonic.)

Further evidence that root-licensing is the goal of spreading comes from (36).

- (36)
- |    |           |                            |
|----|-----------|----------------------------|
| a. | tòj-érê   | ‘beat up’                  |
| b. | wùc-érê   | ‘throw’                    |
| c. | nèk-érê   | ‘kill’                     |
| d. | rwèŋ-érê  | ‘lose’                     |
| e. | cèg-érê   | ‘close’                    |
| f. | kòb-èrê   | ‘transfer’                 |
| g. | mè-èrê    | ‘intoxicate’ <sup>14</sup> |
| h. | à-câŋ-èrê | ‘I healed myself’          |
| i. | cul-lerè  | ‘penis (3sg alien)’        |
| j. | kùl-lérê  | ‘wart hog (3sg alien)’     |
| k. | gwòk-kérê | ‘dog (3sg alien)’          |

Two suffixes are illustrated here: the middle voice suffix /-érê/ in (36a)–(36h), and the third-person singular possessive alienable suffix /-mérê/. Both suffix vowels harmonize.<sup>15</sup> These forms are incompatible with a strictly noniterative view of Lango’s harmony. An analysis built on the noniterative rule from (2) predicts (once we allow the rule to apply as written and as its mirror image would require) outputs such as \*tòj-érê. Only the first suffix vowel changes because

<sup>14</sup>This form comes from /mɛr-èrê/ (Noonan 1992:101), but Noonan is silent on the loss of *r*.

<sup>15</sup>I follow Noonan (1992) and Smolensky (2006) in assuming these suffix vowels are underlyingly lax. The data in (36) are also compatible with an assumption that tense vowels are underlying. In that case, the same argument presented here holds except that roots with lax vowels trigger spreading rather than roots with tense vowels.

[+ATR] is allowed to spread exactly once, just as only the first root vowel changes in cases of regressive spreading. A noniterative rule is fatally flawed, and an additional iterative rule must be invoked to account for (36). The Licensing analysis, in contrast, already produces these words:

(37)

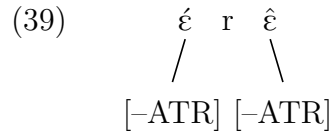
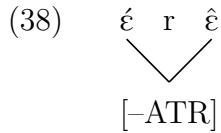
/tòj-érê/	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>X</sub>	C <sub>Y</sub>	C <sub>Z</sub>	LIC-[ATR]	ID[ATR]
a. tòj-érê							*!*	
b. tòj-érê							*!	*
☞ c. tòj-érê								**
d. tòj-érê				*!	*!			*

C<sub>X</sub>: No regressive [-ATR] spread.

C<sub>Y</sub>: No [-ATR] spread from a [+front] vowel.

Licensing is not satisfied unless both suffix vowels harmonize. If just one vowel harmonizes, the other's ATR feature will not be adequately licensed. In the candidate with noniterative spreading, \*tòj-érê, the final vowel's [-ATR] feature is not linked to the root.

The noniterative rule-based analysis can be salvaged by assuming the vowels in /-érê/ represent a single set of features linked to two timing slots, as shown in (38). The alternative is (39), with separate features for each vowel.



With just one [-ATR] feature for the two vowels, noniterative spreading can target this feature and simultaneously change both vowels. Without evidence one way or the other for this representational assumption, the superior analysis is the

one that requires no assumption. This is the Licensing analysis, which must cope with both (38) and (39) under Richness of the Base. Unless all [-ATR] features are replaced by [+ATR], some [-ATR] feature will remain unlicensed. Licensing has the power to change one feature as in (38) or two features as in (39).

Another related point casts doubt on the rule-based analysis. Recall that two suffixes are shown in (36). The rule-based analysis must claim that both /-érê/ and /-mérê/ have the configuration in (38). But why should this be? No part of the rule-based analysis leads us to expect the underlying representations of these suffixes to have the same feature structure. They could just as easily have different structures: One could look like (38) underlyingly, and the other could look like (39). In the rule-based analysis, it is a coincidence that the suffixes harmonize in exactly the same way. But the Licensing analysis generates the same output for both suffixes regardless of their underlying configurations and thereby explains their identical behavior.

The Tableaux in (35) and (37) demonstrate that LICENSE-[ATR] can trigger both one-syllable spreading in one case and two-syllable spreading in another case. The reason is that these are the minimal spreading domains necessary to satisfy LICENSE-[ATR] in the two forms. LICENSE-[ATR] is successful and an analysis based on noniterativity fails because the former is output-oriented and the latter is process-oriented. The contrast between *bàŋó-ní* and *tòj-érê* shows that despite the appearance of noniterative spreading, it is the resulting configuration that matters, not the extent of spreading. At the outset, rule-based phonology seemed superior to OT in the face of Lango's harmony because rules can capture the iterative/noniterative dichotomy more readily than OT-style constraints, but

the contrast between *b̀̀̀́-ńí* and *t̀̀̀-éřê* reveals an advantage in the opposite direction. The Licensing analysis straightforwardly predicts both forms, while a noniterative rule cannot produce both forms. (Of course, an iterative rule may better account for *t̀̀̀-éřê*, but it cannot produce *b̀̀̀́-ńí*.) The success of the Licensing analysis lies in the fact that it specifies a desirable output configuration and accepts any process, iterative or not, that generates this configuration. The rule-based analysis necessarily ties harmony to a single process.

The data in (36) also show that Lango’s harmony cannot be foot-bound. There is no evidence for ternary feet in Lango, but these forms have a three-syllable harmonic domain. An analysis that invokes standard (i.e. “iterative”) harmony drivers and requires harmony just within a foot cannot account for these forms. Also, stress is generally root-initial (see especially Noonan 1992 but also Tucker & Bryan 1966), so the location of assimilation does not coincide with the only foot that is motivated by the data. But even if we take assimilation to indicate a word-final foot, the forms in (36) are underlyingly harmonic within this foot, and assimilation is unmotivated. Thus Lango’s spreading does not belong in the set of foot-bound phenomena discussed in Flemming (1994) and in Chapter 1.

Most importantly, (36) shows that Lango’s harmony is not truly noniterative. These data reinforce the conclusion that the assimilatory noniterativity that we began this chapter with is emergent. Just as, e.g., Nasal Place Assimilation stops after one iteration (see Chapter 1) because there is only one preconsonantal nasal in a typical example, ATR spreading in Lango usually stops after one iteration because the relevant constraint is often satisfied at this point. But the constraint does not require noniterativity, so in the right context iterative spread-

ing is produced. Rather than stemming from a noniterativity requirement, the noniterativity seen in Lango is a configurational byproduct.

The remaining Tableaux in this section are included to illustrate the range of harmony options as produced by the Licensing analysis; cf. the Tableaux in Smolensky (2006:95–97). Beginning with the simplest cases, (40) shows regressive [+ATR] spreading between a monosyllabic root and a monosyllabic suffix in *jò-wú* ‘your people.’  $\mathbb{C}_Z$  blocks progressive harmony in this case.

(40)

/jò-wú/	$\mathbb{C}_1$	$\mathbb{C}_2$	$\mathbb{C}_3$	$\mathbb{C}_X$	$\mathbb{C}_Y$	$\mathbb{C}_Z$	LIC-[ATR]	ID[ATR]
a. jò-wú							*!	
☞ b. jò-wú								*
c. jò-wó						*!		*

$\mathbb{C}_Z$ : \*[-ATR, +hi]

Progressive [+ATR] harmony is shown in (41) with *píg-gá* ‘juice (1sg alien).’ As usual,  $\mathbb{C}_X$  blocks regressive [-ATR] spreading, and in this case the [-ATR] configuration is ruled out by  $\mathbb{C}_Z$  as well because of the [+hi, -ATR] vowel.

(41)

/píg-Cá	$\mathbb{C}_1$	$\mathbb{C}_2$	$\mathbb{C}_3$	$\mathbb{C}_X$	$\mathbb{C}_Y$	$\mathbb{C}_Z$	LIC-[ATR]	ID[ATR]
a. píg-gá							*!	
☞ b. píg-gá								*
c. píg-gá				*!		*!		*

$\mathbb{C}_X$ : No regressive [-ATR] spread.

$\mathbb{C}_Z$ : \*[-ATR, +hi]

(42) also shows progressive harmony but this time the spreading feature is [-ATR]. The form is *lwəkkə* ‘to wash.’ Regressive harmony is illicit in this case

because the source of spreading is a [-hi] vowel.

(42)

/lwək-Co/	$\mathbb{C}_1$	$\mathbb{C}_2$	$\mathbb{C}_3$	$\mathbb{C}_X$	$\mathbb{C}_Y$	$\mathbb{C}_Z$	LIC-[ATR]	ID[ATR]
a. lwək-ko							*!	
b. lwok-ko		*!	*!					*
☞ c. lwək-kɔ								*

$\mathbb{C}_2$ : No regressive [+ATR] spread from a [-hi] source.

$\mathbb{C}_3$ : No regressive [+ATR] spread from a [-front] V onto a [-hi] V in a closed  $\sigma$ .

In the next Tableau, root-suffix harmony actually improves the harmony of the underlyingly disharmonic root, *cúpá* ‘bottle.’ Spreading from the suffix to the root in *cúpóní* ‘your bottle’ creates a fully harmonic word. Compare this Tableau with (35) above, where a harmonic root becomes disharmonic through suffixation. But *cúpóní* is not optimal because it is fully harmonic. Rather, it wins because regressive spreading violates none of the  $\mathbb{C}$  constraints. Progressive [-ATR] spreading is ruled out by  $\mathbb{C}_Z$  because the target vowel is [+hi]. The other fully harmonic possibility, candidate (d), incurs two violations of  $\mathbb{C}_Z$  and also violates  $\mathbb{C}_X$ . Under the Licensing analysis, the complete harmony in the optimal form is coincidental, and rightly so because, as we’ve already seen, an analysis that enforces complete harmony fails to produce the cases of one-syllable spreading.

(43)

/cúpá-ní/	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>X</sub>	C <sub>Y</sub>	C <sub>Z</sub>	LIC-[ATR]	ID[ATR]
a. cúpá-ní							*!	
☞ b. cúpó-ní								*
c. cúpá-ní						*!		*
d. cópá-ní				*!		*!*		**

C<sub>X</sub>: No regressive [-ATR] spread.

C<sub>Z</sub>: \*[-ATR, +hi]

Finally, (44) illustrates a form with no harmony. The disharmonic *gwènná* ‘chicken (1sg alien)’ emerges faithfully because the harmonic alternatives both run afoul of the C constraints. The [+ATR] harmonic form violates C<sub>1</sub> because the source of spreading is a [-hi] vowel in a closed syllable. [-ATR] harmony isn’t allowed either because regressive [-ATR] spreading is ruled out by C<sub>X</sub>. Since the disharmonic candidate only violates LICENSE-[ATR], it is optimal in this case.

(44)

/gwèn-Cá/	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>X</sub>	C <sub>Y</sub>	C <sub>Z</sub>	LIC-[ATR]	ID[ATR]
☞ a. gwèn-ná							*	
b. gwèn-nó	*!							*
c. gwèn-ná				*!				*

C<sub>1</sub>: No [+ATR] spread from [-hi] source in closed  $\sigma$ .

C<sub>X</sub>: No regressive [-ATR] spread.

A Positional Licensing analysis of vowel harmony has the flexibility to account for the full range of harmonic and disharmonic configurations found in Lango. Taking the vowel alternations to be indicative of a full-blown harmony system leads to trouble because there are many cases in which the attested form is not fully harmonic. On the other hand, if we view harmony in Lango as driven

by prominence and licensing considerations, these otherwise unexpected forms are easy to account for. Harmony does not always target every vowel in a word because the spreading required to achieve complete harmony is overkill. One obvious way to account for incomplete harmony is through a noniterative spreading rule, but as we saw, that approach fails to account for more complex forms. These complex forms share the property of attraction-to-prominence with the one-syllable-spreading forms, and Positional Licensing provides a unified account of both kinds of words without mentioning (non)iterativity. Minimal spreading between the root-final vowel and the suffix vowel(s) is sufficient to satisfy the pressures of Positional Licensing.

Mahanta (to appear) raises objections to the Positional Licensing analysis developed above. Her first objection is that it cannot distinguish the hypothetical mapping /bɔnɔnɔ-ni/ → *bonononi* from the equally hypothetical /bonɔ-nɔni/ → *bonononi*. But as (35) above shows, IDENT prevents spreading beyond the root-final vowel in the former mapping, so that possibility is ruled out by the Licensing analysis. In personal communication, Mahanta clarifies her concern about the second mapping: The output is ambiguous between the structures in (45a) and (45b), but the Licensing analysis is satisfied only by (45a).<sup>16</sup> How do we know that this is indeed the correct output?




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<sup>16</sup>Actually, the Licensing analysis doesn't predict spreading from the first root vowel to second, as shown in (45b), but I will assume that this spreading is motivated on independent grounds for purposes of the present discussion.



The correct output of Mahanta’s hypothetical input is difficult to determine because there seem to be no underlyingly disharmonic suffixes like /-nɔni/ in the language. Nonetheless, the Licensing analysis does indeed prefer (45a) over (45b) because the latter contains an unlicensed [+ATR] feature. (There is yet another possibility, *bonɔnɔni*, with spreading from the last root vowel. This incurs just one violation of IDENT, so there is reason to suspect it might be the preferred output in the Licensing analysis.)

Notice that Mahanta’s objection is not that the Licensing analysis produces the wrong pronunciation, but rather that it might produce the right pronunciation with the wrong abstract featural configuration. This criticism is only valid if (45b) is shown to be the correct output. There is, to my knowledge, no diagnostic in Lango that we can call on to determine which is the correct configuration, and therefore it is of no consequence that the Licensing analysis permits one and not the other. Moreover, there is an independent reason to prefer (45a): This form satisfies the OCP, so unless we adopt a version of Correspondence Theory that includes MAX-feature constraints, there is no reason to retain both [+ATR] features and a good reason to fuse them.

Mahanta also expresses concern about the Licensing analysis’s reliance on autosegmental phonology: Suffix vowels will always violate LICENSE-[ATR] unless their features can behave independently of the segments link to multiple vowels. There are two responses to this objection. First, autosegmentalism seems sufficiently well-substantiated that analyses couched within that framework are on reasonably solid ground. Second, only minimal changes would be necessary to import the Licensing analysis into another framework. For example, within

Headed Spans (McCarthy 2004) or Optimal Domains Theory (Cole & Kisseberth 1994), LICENSE-[ATR] might require *spans* or *domains* rather than *features* to overlap with the root. (But see §2.4.2 below for arguments against analyses that use tools specific to these two theories.) In an SPE-style framework in which segments consist of non-overlapping feature matrices, LICENSE-[ATR] could require each ATR feature to have a correspondent in a root segment (Walker 2004). This would trigger an INTEGRITY violation whereby the underlying [+ATR] feature of the suffix has two output correspondents, one in the suffix and the other in the root.

One final note: Recall that Noonan (1992) describes Lango’s harmony in terms of [+ATR] dominance. For him, [-ATR] is inert.<sup>17</sup> Under this view, only [+ATR] spreads, and harmony is blocked by CV suffixes unless the source of harmony is [+high]. This analysis is not incompatible with Positional Licensing. [+ATR] still spreads just once in *bòŋó-ní* and twice in *tòj-érê*. As I’ve argued, only Licensing predicts both of these. Two minor elements of the analysis change under Noonan’s approach: The conditions that block harmony are different, so the constraints outranking LICENSE-[ATR] must change, and a low-ranking \*[-ATR] is needed to prevent [-ATR] from spreading. But \*[-ATR] cannot be ranked high enough to eliminate lax vowels altogether. Of course, the cases where [-ATR]

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<sup>17</sup>Despite the objections raised above, it is tempting to say ATR is a privative feature and [-ATR] is nonexistent, even though this renders us wholly incapable of producing the cases where [-ATR] spreads. If this is the case, progressive spreading seems puzzling for the Licensing account: Why should [+ATR] spread to a lax suffix vowel if the suffix vowel has no ATR feature to begin with and therefore doesn’t violate Licensing? But this is easy enough to fix if the analysis is modified to require suffix vowels to have licensed ATR features. Segments, not just their features, must meet licensing conditions (see Itô & Mester 1993 for more on this line of reasoning). This would more directly capture the implication of Licensing that an ATR contrast is only permitted in roots.

spreads remain unexplained under this analysis, and therefore Smolensky’s approach seems superior.

### 2.3.2 Benefactive Verbs

Benefactive verbs appear at first glance to cause problems for the Licensing analysis. Noonan (1992:142) gives the following paradigm to illustrate benefactive verbs with object suffixes:

- (46)
- |    |                  |   |               |                             |
|----|------------------|---|---------------|-----------------------------|
| a. | /ò-wìllò-ì-á/    | → | ò-wìll-á      | ‘he bought it for me’       |
| b. | /ò-wìllò-ì-í/    | → | ò-wìll-í      | ‘he bought it for you (sg)’ |
| c. | /ò-wìllò-ì-é/    | → | ò-wìll-é      | ‘he bought it for him/her’  |
| d. | /ò-wìllò-ì-wá/   | → | ò-wìll-ì-wá   | ‘he bought it for us’       |
| e. | /ò-wìllò-ì-wùnù/ | → | ò-wìll-ì-wùnù | ‘he bought it for you (pl)’ |
| f. | /ò-wìllò-ì-wú/   | → | ò-wìll-ì-wú   | ‘he bought it for you (pl)’ |
| g. | /ò-wìllò-ì-ú/    | → | ò-wìll-ú      | ‘he bought it for you (pl)’ |
| h. | /ò-wìllò-ì-gí/   | → | ò-wìll-ì-gí   | ‘he bought it for them’     |

The morphemes in these forms are: /ò-/ ‘he,’ /wìllò/ ‘buy’ (which loses the stem-vowel ò with vowel-initial suffixes), /-ì/ ‘benefactive,’ /-á/ ‘me,’ /-í/ ‘you (sg),’ /-é/ ‘him/her,’ /wá/ ‘us,’ /wùnù/, /wú/, /ú/ ‘you (pl),’ /gí/ ‘them.’


A suffixal *i* spreads [+ATR] to the root only in (46b) and (46g). In all other forms, the root vowel remains lax. In (46e) and (46f), [+ATR] spreads from the second suffix to the first suffix but, unexpectedly for Licensing, not to the root. A noniterative rule unifies the behavior of (46b) and (46g) on one hand, and (46e) and (46f) on the other. The procedure is this: locate the leftmost tense suffix

vowel and spread [+ATR] left once. Spreading targets the root in (46b) and (46g) because the source is immediately adjacent to the root. Spreading falls short of the root in (46e) and (46f) because the source of spreading is farther from the root, and noniterative spreading leaves the root untouched. Licensing seems at a loss to explain why spreading stops short of the root in some cases but reaches the root in other cases in exactly the way a noniterative rule predicts.

Fortunately, these forms are immediately accounted for by the Licensing analysis once a morphological idiosyncrasy is recognized. Each word in (46) contains the benefactive suffix /-ì/, which precedes the pronominal object suffixes. Noonan (1992:99) points out that this vowel deletes when it is followed by a vowel-initial morpheme: /téddò-ì-é/ becomes *téd'd-é* ‘to cook for him/her,’ for example. Deletion of the benefactive morpheme is apparent in (46a), (46c), and (46g). It also happens in (46b), where the surviving suffix must be the object suffix: this vowel has the object suffix’s tone, and if the benefactive suffix survived in this case, there’d be no source of [+ATR] harmony. In all these cases, when the surviving suffix is tense, [+ATR] spreads to the root as the Licensing analysis predicts.

Significantly, the benefactive suffix is retained in all the cases where [+ATR] unexpectedly fails to spread to the root. Noonan (1992:98) explains that this suffix never acquires a harmonizing feature from a root: we find *ò-bínn-ì* ‘she came at,’ not \**ò-bínn-ì*. One way to account for this is with an Alignment constraint (such as the one in (47)) requiring the left edge of the benefactive suffix to align with the left edge of an ATR domain. This constraint rules out configurations like (48a), with an ATR feature straddling the left boundary of the benefactive suffix, in favor of (48b).

(47) ALIGN(Benefactive, L; ATR, L): The left edge of the benefactive morpheme must align with the left edge of some ATR domain.

(48) a. \*ò-bínn-ì  
  
 [+ATR]

b. \*ò-bínn-ì  
  
 [+ATR] [-ATR]

(49)

/ò-bínn-ì/	ALIGN	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>X</sub>	C <sub>Y</sub>	C <sub>Z</sub>	LIC-[ATR]	ID
☞ a. ò-bínn-ì							*	*	
b. ò-bínn-ì	*!								*
c. ò-bínn-ì	*!				*	*	**		*

C<sub>X</sub>: No regressive [-ATR] spread.

C<sub>Y</sub>: No [-ATR] spread from a [+front] vowel.

C<sub>Z</sub>: \*[-ATR, +hi]

The forms in (46e) and (46f) show that the benefactive suffix additionally never permits spreading to the root.<sup>18</sup> When it acquires [+ATR] from a following suffix (the Alignment constraint only makes demands of the suffix's left edge, so it can still harmonize with following vowels), it cannot pass this feature on to the root, exactly as the Alignment constraint predicts. This suffix forms a barrier that harmony cannot cross, so satisfying Licensing is impossible in (46e) and (46f), although spreading from the object suffix to the benefactive suffix reduces the number of unlicensed features:

<sup>18</sup>Presumably, Noonan didn't note this himself because, e.g., \*ò-nèkk-ì has regressive [-ATR] spreading which is ruled out independently.

(50)

<i>/ò-wìll-ì-wú/</i>	ALIGN	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>X</sub>	C <sub>Y</sub>	C <sub>Z</sub>	LIC	ID
a. ò-wìll-ì-wú							**!	**	
☞ b. ò-wìll-ì-wú							*	*	*
c. ò-wìll-ì-wú	*!								**
d. ò-wìll-ì-wú						*!	**!*		*

C<sub>Y</sub>: No [-ATR] spread from a [+front] vowel.

C<sub>Z</sub>: \*[-ATR, +hi]

The winning candidate has just one violation of Licensing because LICENSE-ATR requires features, not segments, to be licensed. There is just one unlicensed feature in this form that is shared between two vowels.

On the other hand, when the benefactive morpheme is deleted, this barrier is removed, and spreading can reach the root as normal, as in (46b) and (46g).

Let's consider each configuration in (46) individually. In */ò-wìll-ì-á/* (46a), the object suffix begins with a vowel, so the benefactive morpheme deletes. We're left with *ò-wìll-á*, which is already harmonic. The two [-ATR] features can coalesce, and Licensing is satisfied. The same thing happens in (46c).

In */ò-wìll-ì-í/* (46b), the benefactive morpheme again deletes. [+ATR] can spread from the object suffix to the root to create *ò-wìll-í*. The same thing occurs in (46g).

In */ò-wìll-ì-wá/* (46d), the benefactive morpheme doesn't delete because the object suffix begins with a consonant. This means that spreading to or from the root as in (51a) is ruled out by the benefactive-specific Alignment constraint, but harmony between the suffixes (in the form of coalescence of their [-ATR] features)

can occur to minimize Licensing violations as in (50), yielding (51b).<sup>19</sup> The same thing happens in (46h). The difference between these cases and (50) is that the surviving root vowel’s ATR feature is the same as the harmonizing suffix feature.



In /ò-willò-ì-wùnù/ (46e), [+ATR] can spread from the object suffix to the benefactive suffix, but spreading to the root is disallowed by the benefactive’s Alignment constraint. The evaluation of this form is virtually identical to (50). As with (50), spreading from one suffix to another leaves just one unlicensed feature. Licensing can’t be satisfied, but it can be minimally violated.

The Alignment constraint that produces the benefactive morpheme’s special behavior is another blocking condition on par with Smolensky’s  $\mathbb{C}$  constraints. Taking the benefactive  $\grave{\text{i}}$ ’s idiosyncrasy into account, what looks like noniterative spreading is revealed to be spreading to the root where Licensing can be satisfied, and spreading among the suffixes to minimize Licensing violations where the benefactive morpheme blocks spreading to the root.

## 2.4 Alternatives

The analysis above characterizes all the instances of less-than-complete harmony in Lango as spreading to the root. But there are other ways one might characterize

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<sup>19</sup>If the OCP is ranked high enough, it can compel violations of the benefactive-specific Alignment constraint, favoring (51a) over (51b). Since the two forms are homophonous, I will simplify the analysis by assuming that the OCP is not ranked high enough to be relevant and that the Alignment constraint is always satisfied.

this harmony, and analyses that build on these alternatives are conceivable. This section addresses such competing accounts. All are shown to be inadequate.

### 2.4.1 Positional Faithfulness with Agree

Much of the data in (29) is ambiguous between spreading by one syllable and spreading to all but the root-initial vowel. In the latter characterization, we might say that harmony is complete except that the first vowel doesn't participate. The theory of Positional Faithfulness (Beckman 1999) is designed to capture exactly this sort of preferential preservation of segments/features in privileged positions, and we might add the constraint in (52) to the AGREE-based analysis of Smolensky (2006).

(52) IDENT[ATR]-[ $\sigma$ : Corresponding segments in root-initial syllables have identical values for [ $\pm$ ATR].

With IDENT[ATR]-[ $\sigma$  outranking AGREE, no harmonic form that changes the ATR feature of the root-initial syllable can be optimal. The prediction is that harmony will target all vowels in a word except for the root-initial vowel. We must examine roots longer than two syllables to evaluate the accuracy of this claim. (53) shows that harmony in longer roots does not in fact target all non-initial vowels. Rather, harmony spreads just to the root-final vowel as the Licensing analysis predicts:<sup>20</sup>

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<sup>20</sup>The harmony domain can be longer in fast speech (see §2.5), but the Positional Faithfulness analysis predicts longer harmony at all speech rates.





Assuming this problem can be resolved, either by adding a lower markedness constraint that favors candidate (c) or by replacing AGREE with something more satisfactory, a more significant problem remains besides the one mentioned in connection with (53). IDENT[ATR]-[ $\sigma$ ] prevents us from producing the correct harmonic forms when the root is monosyllabic:

(55)

/lè-wú/	ID[ATR]-[ $\sigma$ ]	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>X</sub>	C <sub>Y</sub>	C <sub>Z</sub>	AGREE
⊖ a. lè-wú								*
( <del>⊖</del> ) b. lè-wú	*!							
c. lè-wú						*!	*!	

C<sub>Y</sub>: No [-ATR] spread from a [+front] vowel.

C<sub>Z</sub>: \*[-ATR, +hi]

Compare this Tableau with the Licensing-based Tableau in (56) immediately below. With a high-ranking Positional Faithfulness constraint, we now predict no harmony at all if minimal regressive spreading would alter the root-initial vowel and progressive spreading is blocked by the C constraints. This is obviously disastrous, as the correct form in this case is *lè-wú*, with regressive harmony.

(56)

/lè-wú/	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>X</sub>	C <sub>Y</sub>	C <sub>Z</sub>	LIC-[ATR]	ID[ATR]
a. lè-wú							*!	
( <del>⊖</del> ) b. lè-wú								*
c. lè-wú					*!	*!		*

C<sub>Y</sub>: No [-ATR] spread from a [+front] vowel.

C<sub>Z</sub>: \*[-ATR, +hi]

To correct this problem, we need yet another constraint that requires minimal spreading no matter what and outranks IDENT[ATR]- $[\sigma]$ .<sup>21</sup> But this move clearly puts the Positional Faithfulness account in a bad position. The task of motivating harmony has been uneconomically divided between two constraints, AGREE and the minimal-spreading constraint. It is certainly preferable—on conceptual grounds at least—to consolidate the impetus for spreading in a single constraint.

Furthermore, the minimal-spreading constraint essentially reproduces the Licensing analysis. LICENSE-[ATR] motivates “minimal spreading no matter what” because it requires just enough spreading to ensure that the suffix’s ATR feature is also linked to the root. The Licensing account also tells us why such spreading is required: ATR features need a prominent host. Unless it adopts Licensing itself, the Positional Faithfulness account loses this insight.

In terms of its candidacy as a potential limiting factor of spreading in Lango, Positional Faithfulness must be rejected for several reasons. It predicts too much spreading with roots longer than two syllables and not enough spreading in monosyllabic roots. Positional Faithfulness also requires a more complex analysis than Licensing. We need constraints to resolve the indeterminacy of (54) and to enforce minimal spreading in (55). In the end, a successful Positional Faithfulness account replicates the simpler Licensing analysis in effect but not in explanatory power or simplicity. Licensing compares very favorably to Positional Faithfulness.

Once again, AGREE- and ALIGN-based analyses are unsuccessful. AGREE fails because, in the absence of complete harmony, it favors no harmony at all. ALIGN requires spreading of  $[\pm\text{ATR}]$  to the left edge of the root, and its effect must be

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<sup>21</sup>Simply promoting AGREE won’t work: The whole point of pursuing a Positional Faithfulness account was to provide a higher-ranking constraint that reins in AGREE.

curtailed by factors like Positional Faithfulness. Since an ALIGN-based analysis requires the additional machinery of Positional Faithfulness, it inherits the defects of Positional Faithfulness and must be discarded for the same reasons that doom Positional Faithfulness.

McCarthy (2004) notes that SPREAD (Padgett 1997, 2002b, Walker 2000; see also Kaun 1995, who uses EXTEND rather than SPREAD) has roughly the same problems as Alignment. SPREAD encourages complete harmony by penalizing segments that aren't linked to the appropriate feature value. Harmony can be blocked with feature co-occurrence constraints or Positional Faithfulness. Like other approaches that rely on these methods to prevent total harmony, SPREAD is not a viable foundation for an analysis of Lango.

### 2.4.2 Optimal Domains Theory and Headed Spans

Optimal Domains Theory (ODT; Cassimjee & Kisseberth 1998, 1999b, Cole & Kisseberth 1994, 1997, 1995) and Headed Spans McCarthy (2004) are theories whose goal is to eliminate the sour grapes problem. ODT separates the extent of a harmonic domain from the expression of the harmonizing feature within that domain. This means a disharmonic segment (i.e. a transparent vowel) may appear within a harmonic domain. In Headed Spans, certain segments are required to head harmonic domains of the feature  $[\alpha F]$ , and such segments block the propagation of  $[-\alpha F]$ . AGREE, ALIGN, etc., are replaced with a constraint banning adjacent (and therefore a proliferation of) feature domains. Both theories are relevant because they provide ways to mark certain segments as impervious to harmony.

Both ODT and Headed Spans block harmony on certain segments by appealing to feature co-occurrence restrictions or something similar. A segment fails to harmonize not because of its position in the word, but because constraints prevent segments with certain featural configurations from acquiring the harmonizing feature. But as we've seen, position within the word is the crucial factor in Lango. All vowels may undergo harmony in principle, provided they're either suffix vowels or root-final vowels. ODT and Headed Spans do not allow us to impose the right kinds of restrictions on harmony that Lango requires.

However, ODT and Headed Spans are compatible with the Licensing analysis in the way described at the end of §2.3.1. The point here is that the tools that are specific to these theories are inadequate to account for Lango. ODT and Headed Spans become viable competitors to Positional Licensing only when they adopt Positional Licensing itself!

### 2.4.3 Banning Disharmony

Pulleyblank (2002) proposes a novel way of achieving harmonic outputs. Rather than adopting constraints that encourage harmony, he proposes constraints that ban disharmony. Constraints of the form  $*[\alpha F][-\alpha F]$  militate against sequences of mismatched features in a way similar to the OCP's ban on adjacent matching features. Thus harmony is optimal because it minimizes mismatched features.

Lango requires both  $*[+ATR][-ATR]$  and  $*[-ATR][+ATR]$ . In consecutive syllables, vowels with mismatched ATR features are banned. Unfortunately, these constraints have the same sour-grapes problem that plagues AGREE. Unless harmony is complete, one of these constraints will be violated just as if there were no

harmony at all. Also, as with other theories and for exactly the same reasons, supplementing these constraints with Positional Faithfulness or feature co-occurrence constraints does not improve the analysis.

In an effort to produce noniterative harmony, Mahanta (to appear) elaborates on Pulleyblank's (2002) system by adding features to the conditioning constraints. Her analysis of ATR harmony in various dialects of Bengali was mentioned briefly in Chapter 1. Relevant data are repeated here.

- (57)
- |    |                    |                |                        |                 |
|----|--------------------|----------------|------------------------|-----------------|
| a. | kɔt <sup>h</sup> a | ‘spoken words’ | kɔt <sup>h</sup> ito   | ‘uttered’       |
|    |                    |                | kɔt <sup>h</sup> oniyo | ‘speakable’     |
| b. | ɔʃɔt               | ‘dishonest’    | ɔʃoti                  | ‘dishonest (f)’ |
| c. | ʃokti              | ‘might’        |                        |                 |

Mahanta argues that high [+ATR] vowels induce ATR harmony on the immediately preceding vowel. Rather than adopting a constraint like \*[-ATR][+ATR], she produces this harmony with \*[-ATR][+high, +ATR]. Thus harmony is triggered only when the second of two mismatched vowels is high.<sup>22</sup>

How would this approach fare with Lango? Restricting ourselves to regressive spreading (because this is the only direction in which spreading is *prima facie* noniterative), the strategy is to identify a category of triggers such that the failure of harmony to iterate is attributable to the failure of the first iteration's target to fall into this category. Is there some requirement that all targets fail to meet that prevents them from triggering another instance of spreading?

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<sup>22</sup>As discussed in Chapter 1, this constraint does not produce truly noniterative harmony since the lack of [+high, -ATR] vowels in the language prevent a target from becoming a trigger. That is, this harmony's noniterativity is emergent because the set of targets is distinct from the set of triggers.

A short glance at the data reveals that the answer is “no”: triggers and targets do not fall into distinct categories as they do in Bengali. For example, the form  $\hat{i}d\hat{i}k-\hat{e}$  ‘leeches’ (cf.  $\hat{i}d\hat{i}k\hat{e}$  ‘leech’) does not show spreading from the derived  $i$  to the underlying initial  $i$ . In Mahanta’s approach, this must mean that  $i$  is not a valid trigger. For example, we might say that the constraint that triggers harmony is  $*[-ATR][-high, +ATR]$ —only non-high vowels trigger harmony.<sup>23</sup> We don’t find  $*\hat{i}d\hat{i}k-\hat{e}$  because the middle vowel does not meet the  $[-high]$  requirement.

But many examples demonstrate that  $i$  is an acceptable trigger, contrary to the claim of this constraint. To pick just one example given above,  $\hat{a}t\hat{i}n-\hat{n}\hat{i}$  ‘your (sg) child’ shows spreading triggered by  $i$  (cf.  $\hat{a}t\hat{i}m$  ‘child’). So the reason we don’t find a second instance of spreading in  $\hat{i}d\hat{i}k-\hat{e}$  is not because  $i$  is an invalid trigger.

Perhaps the problem lies in the target:  $*\hat{i}d\hat{i}k-\hat{e}$  is incorrect because the initial vowel is an illicit target. A constraint like  $*[-high, -ATR][+ATR]$  can reflect this—only non-high vowels undergo harmony. This hypothesis is also falsified by  $\hat{a}t\hat{i}n-\hat{n}\hat{i}$ , where the medial vowel,  $/i/$ , falls outside the set of targets as determined by the new constraint yet still harmonizes. Furthermore,  $\hat{i}d\hat{i}k-\hat{e}$  itself shows that this is not the correct approach:  $/i/$  is a possible target.

We could appeal to the intervening consonants: Maybe we can’t spread across  $d$ . Our constraint could be something like  $*[-ATR][non-/d/][+ATR]$ . I know of no examples with spreading across  $d$  specifically, but  $\hat{i}d\hat{i}k-\hat{e}$  itself shows spreading across a stop, and  $b\hat{\eta}o-\hat{n}\hat{i}$  ‘your (sg) dress’ shows spreading across a voiced coronal, so the evidence suggests that  $d$  is probably not a blocker. In any case, our harmony-driving constraint has become very bizarre: Why would an AGREE

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<sup>23</sup>Instead of inserting  $[-high]$  into the constraint, we could insert  $[+back]$  or any other feature that eliminates  $i$ , and the argument made here would still be valid.

constraint (which is what these feature co-occurrence constraints amount to) care about non-ATR features of the consonant between the harmonizing vowels? It should be clear that introducing requirements about the structure of the target or trigger's syllable or other factors would lead to similar awkwardness.

Other examples could illustrate the point. There is no feature that is common to all triggers and absent from all targets. The examples given above show that any vowel can be the target of harmony in the right circumstances, and therefore we cannot rein in otherwise iterative harmony by requiring triggers or targets to meet an extra requirement. Whether or not Mahanta's (to appear) analysis is correct for Bengali, it cannot be correct for Lango.

There are other reasons to be skeptical of Mahanta's analysis as it operates in Bengali. The constraint that motivates harmony,  $*[-ATR][+high, +ATR]$ , seems not well-founded. The configuration  $[+high, +ATR]$  is unmarked (see the discussion above, plus Archangeli & Pulleyblank (1994) and Smolensky (2006)), so it is not clear why it would be the target of a negative constraint. And as Mahanta notes, the larger framework in which this analysis is couched suffers from the sour-grapes problem. Nonetheless, despite these questions and this analysis's inapplicability in Lango, it is possible that Mahanta has identified another type of constraint that can lead to the appearance of noniterativity. There is no reason to expect Positional Licensing to be unique in this regard.

#### **2.4.4 Summary**

This section has examined a number of alternatives to the Licensing analysis. All the rival approaches are faulty and must be rejected. Only Licensing achieves



both explanatory and descriptive adequacy. One other analysis, self-conjunction of IDENT, was not discussed here. See Chapter 1 for arguments against that approach.

This is not to say that these alternatives should be dispensed with altogether. Each may prove essential in one way or another, but only Licensing can account for Lango’s harmony, and therefore any phonological theory must at least incorporate Licensing regardless of whatever other theoretical mechanisms it adopts.

## 2.5 Fast-Speech Licensing: Attraction to Stress

Noonan (1992:32, 79) notes that in fast speech, harmony does not have to stop with the root-final syllable. It may optionally extend into the root-penultimate syllable, as shown in (58). Underlining marks stress.

- (58) a.  $b\underline{\partial}\eta\underline{\acute{o}}\text{-}\acute{n}\acute{\imath} \sim b\underline{\partial}\eta\underline{\acute{o}}\text{-}\acute{n}\acute{\imath}$       ‘your (sg) dress’  
 b.  $b\underline{\partial}\eta\underline{\acute{o}}\text{-}\acute{w}\acute{u} \sim b\underline{\partial}\eta\underline{\acute{o}}\text{-}\acute{w}\acute{u}$       ‘your (pl) dress’  
 c.  $p\underline{\partial}l\underline{\partial}\text{-}\acute{n}\acute{\imath} \sim p\underline{\partial}l\underline{\partial}\text{-}\acute{n}\acute{\imath}$       ‘your (sg) knife’  
 d.  $p\underline{\partial}l\underline{\partial}\text{-}\acute{w}\acute{u} \sim p\underline{\partial}l\underline{\partial}\text{-}\acute{w}\acute{u}$       ‘your (pl) knife’  
 e.  $\acute{o}kw\underline{\acute{e}}\text{!}\acute{c}\acute{e}\text{-}\acute{n}\acute{\imath} \sim \acute{o}kw\underline{\acute{e}}\text{!}\acute{c}\acute{e}\text{-}\acute{n}\acute{\imath}$       ‘bitches’<sup>24</sup>

Why would [+ATR] spread an extra syllable in these cases? And why is this limited to fast speech? I suggest the answers to these questions are related. First, it is important to note that the vowels that are optionally targeted in (58) are all explicitly marked as stressed by Noonan. Also, Noonan (1992:71) shows that

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<sup>24</sup>Note that the initial vowel in this form is underlyingly [+ATR] so the fast-speech extra spreading variant does not show spreading by an extra two syllables.

the second vowel of a disyllabic stem (his stem-vowel suffix) is optionally deleted under suffixation. Thus *bòŋɔ́-ná* ‘my dress’ may be rendered as *bòŋŋá*. Deletion of this sort often accompanies unstressed, prosodically weak vowels, and these vowels may be severely reduced in fast speech. Consequently, a root vowel may not necessarily be sufficiently prominent to license ATR features in fast speech. In speech styles where otherwise prominent segments can be reduced or deleted, Licensing imposes stricter standards, in this case requiring [ $\pm$ ATR] to be linked to a stressed vowel, not just a root vowel. Thus the extra spreading seen in (58) isn’t spreading by one extra syllable as Noonan indicates but is instead spreading to the stressed vowel, which happens to be just one syllable beyond the normal edge of the harmony domain.

Evidence that this is correct comes from the fact that no alternate form *\*ìcòk-kí* accompanies *ìcòk-kí* ‘your (sg) sweet potato,’ even though this form is given in the same data set (p. 79) in which Noonan provides the alternations in (58). Presumably, this is because *\*ìcòk-kí* is not a possible fast-speech variant. And as the attraction-to-stress analysis predicts, *ìcòk-kí* has stress on *o*, not the initial *ɪ*. Likewise, *ìmɔ́n-í* ‘your (sg) liver’ (29e) is not given with the variant *\*ìmɔ́n-í* (p. 81), and the underlying *a* (which surfaces as *ə*) is marked as stressed. Requiring spreading to the stressed vowel in these cases gives the same result as requiring spreading to the root, but permitting harmony by one extra syllable permits the apparently incorrect *\*ìcòk-kí* and *\*ìmɔ́n-í*. These examples also show that the fast-speech extra spreading cannot be accounted for in phonetic terms, for example by enforcing spreading by some number of milliseconds that encompasses two vowels in fast speech but only one vowel in normal speech. As *ìcòk-kí* and

*imə́ɲ-i* demonstrate, spreading an extra syllable is conditioned not just by faster articulation but also by stress placement.

Noonan doesn't give any forms that rule out complete harmony in fast speech, but *icòk-kí* suggests that total spreading is an incorrect analysis—it's not clear why non-initial stress placement would suppress complete harmony. Instead, this form deviates from the normal pattern just as the attraction-to-stress analysis predicts. But in case fast speech does induce total spreading, there is still no need to invoke noniterativity. A fast-speech-only AGREE or something similar can produce complete harmony in these cases.

To incorporate the attraction-to-stress variants into the Licensing analysis, we need the constraint in (59). Without detailed evidence of its ranking, I assume fast-speech harmony is subject to the same conditions as “regular” harmony and rank (59) alongside LICENSE-[ATR].

- (59) LICENSE-[ATR]/Stress (fast speech): In fast speech, [ $\pm$ ATR] features that are linked to affixes must be linked to stressed vowels.

The new Licensing constraint requires only ATR features that are linked to affixes to be licensed by a stressed vowel. We cannot require all ATR features to be linked to a stressed vowel. Since there is just one stressed vowel in a word, the more general version of (59) would effectively require complete harmony because only one ATR feature can be licensed. Limiting this constraint's force to affix-linked vowels is not unprincipled: While all unlicensed ATR features may be at least somewhat non-prominent, unlicensed affix features are especially non-prominent, as argued above and in Chapter 3. Like the Licensing constraint that produces

Chamorro umlaut in the next chapter, the constraint in (59) bans the worst of the worst (WOW; see Chapter 3) by requiring only especially non-prominent features to be licensed rather than all features.

The Tableau in (60) shows the evaluation of the fast-speech form *bòŋó-ní* ‘your (sg) dress’ (cf. (35)). The crucial comparison is between candidates (b) and (c). In (35), which evaluated the normal-speech version of this word, candidate (b) was optimal because it satisfied LICENSE-[ATR] while minimally violating IDENT[ATR]. With LICENSE-[ATR](fast speech) active in (60), this form is no longer optimal. Regressive spreading must reach the first (stressed) syllable to satisfy the new licensing requirement, even though this incurs an extra Faithfulness violation. Progressive spreading as in candidate (d) incurs just one IDENT[ATR] violation, but this is ruled out by the higher-ranked  $C_Z$ . Naturally, the evaluation in (35) is not affected by the new Licensing constraint because that Tableau does not involve fast speech and LICENSE-[ATR](fast speech) assigns no violations to the candidates.

(60)

/bòŋó-ní/	$C_1$	$C_2$	$C_3$	$C_X$	$C_Y$	$C_Z$	LIC-root	LIC fast	ID
a. bòŋó-ní							*!	*!	
b. bòŋó-ní								*!	*
☞ c. 'bòŋó-ní									**
d. bòŋó-ní						*!			*

$C_Z$ : \*[-ATR, +hi]

Notice that licensing by a morphological unit is required under normal speech, but licensing by a prosodic head is required in fast speech. Perhaps this is not an

accident. Speech rate is a prosodic property, so it should not be surprising that altering an utterance’s prosodic properties activates a new prosodic constraint.<sup>25</sup>

The fast-speech data discussed here provide more evidence that ATR harmony in Lango is driven by licensing considerations. A suffix’s [+ATR] feature encroaches further upon root vowels in fast speech than in normal speech, but it still has a prominent vowel as its target. This being the case, noniterativity remains irrelevant to the analysis.

## 2.6 Akposso

Anderson (1999) gives a detailed description of ATR harmony in Akposso. Some of her data suggest that this harmony is noniterative, and in many ways the system is reminiscent of Lango. We will see, though, that (like Lango) the harmony is iterative, and the cases of apparent noniterativity are attributable to two exceptional morphemes and a Positional Licensing constraint of the sort that was used in the analysis of Lango above. The applicability of Positional Licensing to Akposso lends support to the analysis of Lango developed in this chapter.

According to Anderson, Akposso has the same vowel inventory as Lango (i.e. *i*, *e*, *ə*, *o*, *u* are [+ATR], and *ɪ*, *ɛ*, *a*, *ʊ*, *ɔ* are [−ATR]). Roots are fully harmonic:

- (61) a. [+ATR] Roots
- |      |                |     |                 |
|------|----------------|-----|-----------------|
| ísí  | ‘yam’          | únè | ‘type of fruit’ |
| ínē  | ‘animal trail’ | íkó | ‘box’           |
| úgbe | ‘grasslands’   |     |                 |

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<sup>25</sup>I thank Junko Ito for pointing this out to me.

b. [-ATR] Roots

úfi	‘marriage’	únā	‘type of trap’
óvê	‘sun’	ékú	‘thing’
ótá	‘rabbit’		

Each non-low vowel from one harmonic group alternates with the vowel at the same height and backness from the other group (e.g.  $e \sim \varepsilon$ ,  $u \sim \upsilon$ ). However, the distribution of  $\text{ə}$  is limited: It cannot occur word-initially, nor does it appear as  $a$ 's harmonic counterpart in affixes. Instead,  $a$  alternates with  $e$ . Harmony is root-controlled, so it is not easy to determine whether  $a$  alternates with  $\text{ə}$  root-internally.

Some of the data that make Akposso's harmony look noniterative are given in (62). In these forms, the first morpheme is the third-person subject prefix, the second is the incomplete aspect morpheme, and the third is the root.

- (62) a. á-ká-té      ‘they are building a nest’  
           á-ká-dá      ‘they are vomiting’  
           á-ká-kpɔ    ‘they are hitting’
- b. á-ké-lî      ‘they are closing’  
           á-ké-ylé    ‘they are taking the roof off’  
           á-ké-gbá    ‘they are borrowing’

In (62a), the roots have [-ATR] vowels, and both prefixes unsurprisingly surface with [-ATR] vowels themselves. But in (62b), the roots have [+ATR] vowels, and this time only the incomplete morpheme harmonizes. We might deduce from these forms that ATR harmony is noniterative. The ATR feature spreads to

the vowel to the immediate left of the root and no farther. The subject prefix is underlyingly [-ATR], so the apparent exhaustive harmony in (62a) is coincidental.

In fact, it appears that this is exactly the kind of data that could doom the analysis of Lango. The Licensing analysis predicts that when two suffixes appear in a form, progressive harmony should target both of them. The only such configuration I am aware of in Lango is the benefactive construction. But the benefactive suffix, it was argued above, does not harmonize with roots at all, so the prediction could not be tested. In Akposso, although we're dealing with prefixes instead of suffixes, we have data with multiple affixes, and only the one adjacent to the root harmonizes. It appears, therefore, that Akposso provides crucial evidence for true noniterativity.

This would be the wrong conclusion to draw, however. The data in (63) show iterative harmony in the same construction, but this time with the second-person singular subject prefix.

- (63) a.  $\varepsilon$ -ká-té      'you are building a nest'  
            $\varepsilon$ -ká-dá      'you are vomiting'  
            $\varepsilon$ -ká-kpɔ    'you are hitting'
- b. e-ké-lî        'you are closing'  
           e-ké-ylé      'you are taking the roof off'  
           e-ké-gbá      'you are borrowing'

Now the subject morpheme harmonizes with both [+ATR] and [-ATR] roots. The ATR feature spreads iteratively from the root to both morphemes. In fact, Anderson (1999) attributes the apparent noniterativity in (62) to exceptionality

in the third-person plural subject morpheme. This is the only subject prefix that does not harmonize:

- (64)
- |    |           |                        |
|----|-----------|------------------------|
| a. | ni-ká-kpɔ | ‘I am hitting’         |
|    | ni-ké-kû  | ‘I am driving’         |
| b. | ɛ-ká-kpɔ  | ‘you are hitting’      |
|    | e-ké-kû   | ‘you are driving’      |
| c. | ɔ-ká-kpɔ  | ‘he is hitting’        |
|    | ó-ké-kû   | ‘he is driving’        |
| d. | wɔ-ká-kpɔ | ‘we are hitting’       |
|    | wu-ké-kû  | ‘we are driving’       |
| e. | mi-ká-kpɔ | ‘you (pl) are hitting’ |
|    | mi-ké-kû  | ‘you (pl) driving’     |
| f. | á-ká-kpɔ  | ‘they are hitting’     |
|    | á-ké-kû   | ‘they driving’         |

These data show that the apparent noniterativity in (62) is caused by an exceptional morpheme. The subject morpheme in those forms must be lexically marked as impervious to vowel harmony.<sup>26</sup>

The iterative nature of Akposso’s harmony is also seen clearly in the imminent future, where both vowels preceding the root harmonize:<sup>27</sup>

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<sup>26</sup>That this is a morphological exception and not a language-wide exemption of *a* from harmony is shown by the incomplete affix, which itself contains an alternating *a*.

<sup>27</sup>Anderson (1999) transcribes this subject morpheme as [m<sup>j</sup>] before a vowel regardless of the harmonizing context, but she states that the vowel “remain[s] distinct at slower rates of speech, [m<sup>i</sup>]~[m<sup>j</sup>]” (p. 198, fn. 10). Before a consonant, as shown in (64), the vowel is unreduced. Anderson’s data include pre-reduced forms, so it is quite clear which vowel quality is present in each example. To make the harmony obvious, I give [m<sup>i</sup>] or [m<sup>j</sup>] instead of Anderson’s [m<sup>j</sup>].



- (65) a. m<sup>1</sup>-à-tfí ‘you (pl) will cut’  
           m<sup>1</sup>-à-té ‘you (pl) will build a nest’  
           m<sup>1</sup>-ǎ-kpɔ ‘you (pl) will hit’  
       b. m<sup>i</sup>-ě-mli ‘you (pl) will get up’  
           m<sup>i</sup>-è-ɣlé ‘you (pl) will take the roof off’  
           m<sup>i</sup>-è-kú ‘you (pl) will drive’

Apparent noniterativity arises in other contexts in Akposso, and in these cases it is the aspectual affix that blocks iterative spreading. But whereas the exceptional subject prefix does not undergo harmony, the aspect morphemes harmonize but don’t let harmony propagate to preceding prefixes. Anderson (1999:206) states that “in the aspectual sequence, only the syllable directly preceding the verb root harmonizes.” That is, when one or more aspectual morphemes are present, only the last vowel of the last aspectual morpheme harmonizes. This is illustrated below with the predictive *bá~bé* ‘to come’ and the prefix /à/ (for which Anderson (1999) provides no gloss, although she says (p. 199) that it “is presumably the same morpheme that is used with the imminent future”):

- (66) a. m<sup>1</sup>-à-bá-tfí ‘you (pl) will cut (one day)’  
           m<sup>1</sup>-à-bá-té ‘you (pl) will build a nest (one day)’  
           m<sup>1</sup>-à-bá-kpɔ ‘you (pl) will hit (one day)’  
       b. m<sup>1</sup>-à-bé-mli ‘you (pl) will get up (one day)’  
           m<sup>1</sup>-à-bé-ɣlé ‘you (pl) will take the roof off (one day)’  
           m<sup>1</sup>-à-bé-kú ‘you (pl) will drive (one day)’

These examples contrast clearly with (65). Neither vowel that precedes the

predictive morpheme harmonizes in (66b), and the apparent harmony in (66a) is coincidental in that the prefixes' underlying features match the harmonizing feature without spreading. The predictive morpheme itself harmonizes, but it prevents the other prefixes (which, as we saw in (65), can undergo harmony) from harmonizing. In particular, the /à/ prefix cannot harmonize—just the last aspectual vowel harmonizes. How to account for these facts is taken up below.

All aspectual morphemes harmonize when final in the aspectual sequence except the repetitive morpheme (*na-tfí-jè* 'I've eaten again' vs. *na-tfí-bõ* 'I've uprooted again'). Like the subject prefix *a-*, the repetitive morpheme is lexically tagged as non-alternating. Otherwise, aspectual morphemes harmonize when they're adjacent to the root. The morpheme *kɔna* (the form of the incompleted morpheme that follows the negative morpheme *nà*) drives the point home:

- (67)    *nɪ-nà-kɔna-kpɔ*        'I'm not hitting'  
           *nɪ-nà-kɔne-bó*         'I'm not uprooting'  
           *nɪ-nà-kɔna-tfí*        'I'm not cutting'  
           *nɪ-nà-kɔne-kù*        'I'm not driving'

Only the last vowel of the incompleted morpheme harmonizes. Once again, it is tempting to say that while harmony is generally iterative in Akposso, the aspectual morphology invokes noniterative harmony. This is a retreat from the position that Akposso's harmony is systematically noniterative, but it is still incorrect. ATR features spread to just one aspectual vowel, but if that target is the only vowel in the aspectual sequence, harmony can further target the subject morpheme, as was shown in (65). The correct generalization is that harmony is

iterative except that only one aspectual vowel may harmonize.

It is therefore wrong to say that harmony with aspectual morphemes is non-iterative. Harmony can target multiple vowels, even when aspectual morphemes are involved. What is prohibited is spreading within the aspectual sequence. This state of affairs is reminiscent of Shona's tone spread (see Chapter 4). There, high tones are allowed to spread iteratively as long as each iteration crosses a morpheme boundary:

- (68) a. *Vá-Má-zí-mí-chéro*  
2a-6-21-4-fruit  
'Mr. Big-ugly-fruits' (Odden 1981:77, gloss from Myers 1997:862)
- b. *Vá-Dámbudziko*  
honorific-Dambudziko  
'Mr. Dambudziko' (Odden 1981:76)
- c. Dambudziko (proper name) (Odden 1981:76)

Like Shona's high-tone spread, Akposso's harmony is clearly iterative, and therefore it does not contradict the Emergent Noniterativity Hypothesis. This is not to say that Akposso's harmony is simple to account for, but examples like (65) show that the proper analysis cannot require noniterativity.

There are several possible analyses of Akposso's harmony, and I will sketch just one of them here. This is a Licensing analysis reminiscent of the one proposed above for Lango. But rather than requiring *all* ATR features to be linked to the *root*, we can instead require *some* ATR feature of the aspectual sequence to be licensed by the *stem* to which the aspectual sequence attaches. (We will see below why it necessary to refer to the stem, not the root.) The constraint in (69) formalizes this:

- (69) LICENSE(aspect)-[ATR]: Some ATR feature from the aspectual sequence must be linked to a stem vowel.

Lango-style bidirectional harmony can be ruled out with high-ranking root faithfulness, and general faithfulness constraints can block spreading to all but the last aspectual vowel:

(70)

/mɪ-à-bá-mli/	LIC(aspect)-[ATR]	ID[ATR]-Root	ID[ATR]
a. m <sup>l</sup> -à-bá-mli	*!		
☞ b. m <sup>l</sup> -à-bé-mli			*
c. m <sup>l</sup> -è-bé-mli			**!
d. m <sup>l</sup> -à-bá-mli		*!	*

Candidate (a) violates LICENSE because no aspectual vowel shares its ATR feature with the stem. Candidate (b) spreads the [+ATR] feature of root to the last aspectual vowel, thereby satisfying LICENSE. Candidate (c) spreads this feature to both aspectual vowels and incurs an unnecessary violation of IDENT. Finally, candidate (d) spreads from the prefixes to the root, which satisfies LICENSE but runs afoul of the root faithfulness constraint. (Spreading to the first aspectual vowel, as in \* *m<sup>l</sup>-è-bá-mli*, is ruled out by the No Crossing Constraint (Goldsmith 1976) or any other locality requirement.)

Accounting for the subject prefixes' harmonization is simple at this point. Broadening the scope of the Licensing constraint is all that is necessary. Rather than requiring just the aspectual sequence to be licensed, we can require all affixes to share an ATR feature with the stems they attach to:

- (71) LICENSE-[ATR]: Some ATR feature in each affix group must be linked to a stem vowel.

“Affix group” is used to encompass the single subject morphemes and the potentially polymorphemic aspectual sequence: One ATR feature from each of these groups must be licensed. The aspectual sequence attaches to the root, so it must share an ATR feature with the root. Subject prefixes attach to the aspect+root stem, so they must share an ATR feature with this unit.

Notice that the form in (72) satisfies the new Licensing constraint without spreading to or from the subject prefix. Since the subject prefix’s vowel and the leftmost aspectual vowel are both [-ATR], no change is necessary beyond fusing these [-ATR] features into a single feature.

On the other hand, when there is just one aspectual vowel, both it and the subject prefix must change to satisfy LICENSE:

(72)

/mɪ-à-mli/	LICENSE-[ATR]	IDENT[ATR]-Root	IDENT[ATR]
a. m <sup>l</sup> -ě-mli	*!		*
b. m <sup>l</sup> -ǎ-mli	*!		
☞ c. m <sup>i</sup> -ě-mli			**
d. m <sup>l</sup> -ǎ-mli		*!	*

Spreading to just the aspectual vowel (candidate (a)) is ruled out because it leaves the subject prefix unlicensed. Making no change at all (candidate (b)) means that the prefix vowel can be licensed by sharing its ATR feature with the aspectual vowel, but the aspectual vowel is itself unlicensed. Spreading to the root (candidate (d)) is once again ruled out by root faithfulness. The only solution is

to spread to both prefixes, as in candidate (c).

Spreading just once is, as in Lango, the simplest way to satisfy LICENSE in some cases. But in other cases, LICENSE is satisfied by spreading to both an aspectual affix and the subject prefix. In both Lango and Akposso, a constraint that produces seemingly noniterative spreading also motivates iterative spreading in the right circumstances.

Before leaving this section, it is worth commenting on suffixes. There are very few suffixes in Akposso, and the only one that Anderson mentions is the definite article clitic. As shown in (73), this suffix harmonizes as expected:<sup>28</sup>

- (73) a.  $\acute{o}s^j\text{-}\acute{\epsilon}\acute{\epsilon}$             ‘the woman’  
            $\acute{i}v^w\text{-}\acute{\epsilon}$                 ‘the bird’  
            $\acute{\epsilon}g\text{-}\acute{\epsilon}$                  ‘the money’
- b.  $\acute{i}v^w\text{-}\acute{\epsilon}$                 ‘the raffia sack’  
            $\acute{\epsilon}d^j\text{-}\acute{\epsilon}$                 ‘the palm nut’  
            $\acute{i}n\bar{e}\text{-}\acute{\epsilon}$                 ‘the animal trail’

There is a free form of the definite article,  $j\acute{\epsilon}$ , which does not harmonize:  $\acute{i}n\bar{e} j\acute{\epsilon}$  ‘the animal trail.’ But since Akposso’s harmony is lexically bound, this is not a surprise.

Akposso’s ATR harmony is very similar to Lango’s in that they both involve interactions between roots and affixes. The primary differences lie in which affixes participate (primarily prefixes in Akposso, exclusively suffixes in Lango), the form of the Positional Licensing constraints that account for harmony (existen-

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<sup>28</sup>All of the roots are vowel-final, but these vowels either undergo glide formation or elision, presumably to resolve hiatus. The conditions under which lengthening occurs are not clear.

tially quantified stem-licensing in Akposso, universally quantified root-licensing in Lango), and whether or not root-faithfulness plays a role (as it does in Akposso but not in Lango).

With respect to the Emergent Noniterativity Hypothesis, Akposso is an important case study for two reasons. First, the applicability of Positional Licensing to this language's harmony system lends support for Positional Licensing as theoretical construct. Second, Akposso's harmony is a potentially truly noniterative phenomenon in its own right, and demonstrating that this noniterativity is emergent is a crucial step in supporting the ENH. This section has attempted to do just that.

## 2.7 Conclusion

This chapter has developed an analysis of ATR harmony in Lango grounded in Positional Licensing. Standard harmony-driving constraints like AGREE and ALIGN cannot produce the pattern found in Lango, which initially appeared to show non-iterative harmony that conflicts with the ENH. But a truly noniterative analysis is inferior to the Positional Licensing analysis, both empirically and explanatorily. In addition to generating the correct surface forms, the Licensing analysis sheds light on why minimal harmony might be desirable. In the case of Lango, minimal harmony places suffix ATR features in a prominent position, namely the root. The contrast between [+ATR] vowels and [-ATR] vowels is made more salient in this way. An examination of the harmony system in Akposso supports this analysis: Akposso's harmony is driven by the same mechanisms that give rise to

Lango's harmony, and predictions of the analysis of Lango are borne out (with some language-particular differences) by Akposso.

Kinande, whose harmony system looked at first like Lango's iterative counterpart, is fundamentally different from Lango. Evidence shows that Lango's harmony is driven by a need to place ATR features in a prominent position, but attraction to prominence cannot be the motivating factor in Kinande, where ATR features spread from prominent roots to less prominent affixes. The two harmony systems are not siblings driven by the same motivation while arriving at different results. Even their motivations must be different.

To return to the juxtaposition of rule-based theories against OT with respect to noniterativity, the prospect of noniterative harmony is not welcome from the point of view of OT. OT cannot differentiate between iterative and noniterative phenomena with a simple switch of a parameter the way rule-based theories can. But in closely examining what looked like true noniterativity in Lango, we saw that noniterativity was an emergent property of the grammar, and the constraint system does not need to explicitly recognize the noniterative nature of the harmony system. This investigation of Lango is the first piece of the argument in support of the ENH. If even Lango's harmony exhibits emergent noniterativity, chances are good that other seemingly noniterative phenomena are also not truly noniterative. As we will see in subsequent chapters, this speculation turns out to be correct.

More data are needed to fully test the Licensing analysis. For example, Licensing predicts that in a configuration in which [+ATR] spreads regressively from a suffix vowel that is not adjacent to the root, spreading will continue until the



root is reached. E.g., an input like /bɔŋɔ-na-ni/ should yield *bɔŋɔ-nə-ni*. So far I have not found a form with the appropriate configuration. The only construction I am aware of that includes two overt suffixes is benefactive verbs, which, as discussed in §2.3.2 above, show idiosyncracies that do not permit this prediction to be tested.

Another prediction, pointed out to me by Kazutaka Kurisu (p.c.), is that there should be a language with “edge-in” harmony: /i-mɔtɔka-e/ should be realized as *i-mɔtɔkə-e*, for example, with spreading from both prefixes and suffixes to satisfy Licensing. I know of no such language (Lango doesn’t have this spreading because prefixes don’t harmonize), but the prediction does not seem unreasonable. It is roughly just a combination of Lango’s assimilation and Chamorro’s umlaut, which is the subject of the next chapter.

The status of Noonan’s (1992) stem vowel also remains unsettled. I argued here that some instances of this morpheme are really an infinitival suffix and other instances represent a root-final vowel rather than a separate morpheme. It is clear, though, that at the very least this vowel is the remnant of a historically real suffix. More work is needed to determine the status of this vowel in the modern language, and if Noonan is correct in identifying a stem-vowel suffix, its interaction with the harmony system should be more fully investigated.

To summarize, Lango’s harmony at first seemed to be a counterexample to the claim of this dissertation that there is no true noniterativity in phonology. A closer look shows that an OT account, which by necessity claimed that the harmony’s noniterativity is emergent, is more empirically and conceptually satisfactory than a (truly) noniterative rule. Lango, therefore, does not challenge the ENH.

# UMLAUT IN CHAMORRO

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## 3.1 Introduction

Umlaut in Chamorro involves the fronting of stressed stem-initial vowels as a result of spreading backness features from certain prefix/particle vowels (almost all of which are *i*). This is illustrated in (1) with the definite determiner *i*.<sup>1</sup>

(1)	nána	‘mother’	i náena	‘the mother’
	gúmaʔ	‘house’	i gímaʔ	‘the house’
	cúpa	‘cigarettes’	i cípa	‘the cigarettes’
	sónʒsuŋ	‘village’	i séŋsuŋ	‘the village’
	hága	‘daughter’	i háega	‘the daughter’
	átcuʔ	‘rock’	i átcuʔ	‘the rock’
	dáŋkulu	‘big one’	i dáéŋkulu	‘the big one’
	láhe	‘male’	i láehe	‘the male’
	tómo	‘knee’	i témo	‘the knee’

Of interest here is the fact that umlaut appears noniterative. When stress is not stem-initial, umlaut can neither spread through the intervening vowels to

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<sup>1</sup>All Chamorro data are from the following sources: Chung (1983), Conant (1911), Crosswhite (1996), Klein (2000), Topping (1968, 1969, 1973), Topping et al. (1975), von Preissig (1918). I follow Chung’s transcription system except that *æ* is used in place of Chung’s *ä*, and *ɲ* is used instead of *ñ*. Primary stress is marked with an acute accent, and secondary stress is marked with a grave accent. I abstract away from certain alternations in the low vowels, showing only the front/back distinction as it relates to umlaut.

reach the stressed vowel, nor can it skip over these unstressed vowels. Instead, umlaut does not occur at all in this situation:<sup>2</sup>

- (2) pulónnun ‘trigger fish’ i pulónnun ‘the trigger fish’  
mundónġgu ‘cow’s stomach’ i mundónġgu ‘the cow’s stomach’

This pattern contrasts with Spanish metaphony, which exhibits either spreading through intervening vowels or skipping intervening vowels depending on the dialect (Walker 2004). It seems as though Chamorro umlaut is truly noniterative in the sense that if the target (stress) cannot be reached with one iteration of spreading, then umlaut is not permitted. This is roughly the characterization of umlaut that Klein (2000) adopts. Since the central claim of this dissertation is that truly noniterative phenomena are nonexistent, I argue in this chapter that the preceding characterization of Chamorro umlaut is incorrect. Rather than treating stress as the target of umlaut (i.e., the position to which [–back] is attracted), the analysis below argues that stress triggers spreading to the root: immediately pretonic prefixes/particles must spread their [–back] features to the root. When stress is not root-initial, as in (2), the prefix/particle is not immediately pretonic, and umlaut does not occur because its prerequisites are not met. Stress appears to be the target simply because it falls in the root-initial syllable, but in actuality [–back] targets the root. Thus there is no reason to expect spreading to seek out a non-initial stressed syllable.

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<sup>2</sup>But see §3.5 for cases of stress-insensitive umlaut.

## 3.2 The Facts and the Problem

### 3.2.1 Noniterativity in Chamorro

Other morphemes that trigger umlaut are shown in (3). Affix-root boundaries are marked with a hyphen, and particles are separated from roots by a space.<sup>3</sup>

(3)	káтта	‘letter’	ni káetta	‘the letter (obl.)’
	húŋjuk	‘to hear’	in-híŋjuk	‘we (excl.) heard’
	fógon	‘stove’	ni fégon	‘the stove’
	óksoʔ	‘hill’	gi éksoʔ	‘at the hill’
	túŋoʔ	‘to know’	en tíŋoʔ	‘you (pl.) know’
	góde	‘to tie’	g-in-éde	‘thing tied’
	lágu	‘north’	sæn-láegu	‘towards north’
	ótdot	‘ant’	mi-étdot	‘lots of ants’

Two properties distinguish this phenomenon from standard cases of umlaut such as that found in German (Klein 2000, McCormick 1981, van Coetsem & McCormick 1982). The first is the sensitivity to stress mentioned above. Second, whereas German umlaut occurs at the right edge of the stem with regressive spreading onto stem-final vowels from suffixes, Chamorro umlaut has progressive spreading at the left edge.

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<sup>3</sup>Glosses for affixes and particles: *ni* ‘oblique case,’ *in-* ‘1pl. exclusive,’ *-in-* ‘passive,’ *-in-* ‘nominalizer,’ *gi-* ‘local case,’ *en* ‘2pl.,’ *sæn-* ‘in the direction of,’ and *mi-* ‘abounding in.’

Chung (1983:45) notes that umlaut is partly morphologized in that “[t]he particles and affixes that trigger the fronting must be listed, and each is associated with a slightly different set of conditions.” Most of the literature on umlaut focus on cases in which the trigger is the definite article *i*. I do the same here, and I make the simplifying assumption that all umlaut triggers behave like *i*. See §3.2.2.2 for more discussion of the range of patterns.

One immediate question, and the one that is central to this chapter, is why doesn't [-back] spread through the unstressed syllables to the stressed syllable in (2)? If the impetus for umlaut is the desire to have the prefix or particle's [-back] feature appear on the stressed vowel, why aren't forms like \**i pilénnun* and \**i mindéngu* attested? Or, if, as I argue below, umlaut is better characterized as spreading to the root, why is it acceptable to alter a stressed vowel but not an unstressed vowel?

These questions are especially puzzling in light of standard conceptions of faithfulness within OT. Beckman's (1999) Positional Faithfulness model asserts that prominent positions are subject to stricter faithfulness requirements that are formalized in the form of position-specific faithfulness constraints. For example, IDENT[back]- $\acute{o}$  militates against changes to the backness features of segments in stressed syllables. This constraint exists alongside the more general IDENT[back], which prevents changes to any backness feature, regardless of its host segment's position in the larger phonological structure. These two constraints rule out grammars in which only stressed syllables' backness features can be changed. Since changes to a stressed vowel incur violations of both the stress-specific and generic IDENT constraints, candidates that change an unstressed vowel harmonically bound candidates that change a stressed vowel, as (4) shows.

(4)

dúpu	IDENT[back]- $\acute{o}$	IDENT[back]
a. dípu	*	*
☞ b. dúpi		*

For Chamorro specifically, the fact that umlaut changes stressed vowels entails the ranking  $\text{UMLAUT} \gg \text{IDENT}[\text{back}]-\acute{\sigma}$ , where UMLAUT is the constraint that triggers umlaut. But since unstressed vowels block spreading of  $[-\text{back}]$ , we must also have the ranking  $\text{IDENT}[\text{back}] \gg \text{UMLAUT}$ . As (5) shows, the combined rankings incorrectly block spreading to stressed vowels as well as unstressed vowels, as indicated by  $\ominus$ :

(5)

i gúma?	IDENT[back]	UMLAUT	IDENT[back]- $\acute{\sigma}$
$\ominus$ a. i gúma?		*	
<del>(*)</del> b. i gíma?	*!		*

This is not a defect of Positional Faithfulness. This is exactly what the theory is designed to do: Crosslinguistically, prominent positions are not targeted by processes unless their non-prominent counterparts are also targeted. Chamorro seems to be an exception. Umlaut spreads  $[-\text{back}]$  to stressed vowels, but spreading is blocked by unstressed vowels in exactly the way Positional Faithfulness predicts to be impossible.

An important claim of this chapter is that the noniterative characterization of umlaut is incorrect. Chamorro's umlaut is not truly noniterative. This chapter develops an analysis in which the (apparent) unstressed-vowel blocking effects and noniterativity are the result of a fixed constraint subhierarchy derived from a prominence hierarchy. The argument advanced here is that umlaut reflects a requirement that a subset of prefix/particle  $[-\text{back}]$  features must be linked to the root, just like suffixal ATR features in Lango. The prefix/particle features that must be root-licensed in Chamorro are those that are pretonic. As in Lango,

spreading to the root enhances the prominence of these affixes'/particles' features, and licensing is required only of immediately pretonic affixes/particles because, as argued below, pretonic syllables are particularly weak in Chamorro. Umlaut therefore involves spreading [-back] from a weak position to a stronger one just as we saw in Lango's harmony in the previous chapter. In fact, the analysis below, like the one developed for Lango, calls on Positional Licensing to produce umlaut. But whereas Lango's Licensing constraint required all ATR features to be root-licensed, Chamorro's Licensing constraint holds only for [-back] features in syllables that immediately precede primary stress.

By requiring only immediately pretonic [-back] features to be licensed, the interaction with stress is produced. Umlaut occurs only with root-initial stress because only in this context are prefixes immediately pretonic and thus subject to the Positional Licensing constraint.

The failure of umlaut in *i pulónnun* is not the result of blocking by unstressed vowels or a locality restriction. Instead, since the definite article is not immediately pretonic in this form, the Licensing constraint does not motivate spreading. In general, when the prefix/particle is separated from the stressed syllable by unstressed syllables, the Licensing constraint is not violated to begin with, and no repair strategy (i.e. spreading) is necessary. This analysis is developed in §3.3.1, but first I discuss some other properties of Chamorro umlaut that complete the empirical picture.





adáhi		gófadhìhi	
‘be careful’		‘be very careful’	
kwentúsi		ákwentùsi	
‘to speak to’		‘to speak to one another’	

When a stem-initial vowel acquires this kind of secondary stress (*cyclic* secondary stress), it may optionally undergo umlaut:<sup>4</sup>

(7)	púgas	‘uncooked rice’	mípìgas,	‘abounding in uncooked rice’
			mípùgas	
	gúmaʔ	‘house’	i gìmaʔníha,	‘their house’
			i gùmaʔníha	
	kóbbli	‘cash, money’	i kèbblinmámi,	‘our (excl.) cash’
			i kòbblinmámi	

Interestingly, this holds also for vowels whose stress has been deleted due to the clash prohibition:

(8)	cúpa	‘cigarettes’	i cupápa,	‘his cigarettes’
			i cipápa	
	sóʔsuʔ	‘village’	i suʔsóʔpa,	‘his village’
			i siʔsóʔpa	

Chung (1983) accounts for umlaut in these cases by appealing to transderivational relationships. In a way that is remarkably reminiscent of more recent transderivational frameworks developed for OT (e.g. Benua 1997), her analysis permits

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<sup>4</sup>According to Chung (1983), this optionality appears only in the Saipan dialect. Umlaut in with cyclic secondary stress may be obligatory in the Guam and Rota dialects.



rhythmic secondary stress (but not cyclic stress) is assigned in a stratum after the one in which umlaut occurs.

### 3.2.2.2 Exceptions

There are a number of cases that do not adhere to the above generalizations. Throughout this chapter I ignore these exceptions to keep the discussion focused.

Umlaut sometimes occurs when the prefix/particle lacks a front vowel:

- |      |        |              |            |                          |
|------|--------|--------------|------------|--------------------------|
| (11) | dónniʔ | ‘hot pepper’ | faʔ-dénniʔ | ‘to make hot sauce’      |
|      | hánom  | ‘water’      | faʔ-hánom  | ‘melt, cause to liquify’ |

Perhaps morphemes like *faʔ-* are diachronically related to morphemes with front vowels and therefore were formerly ordinary participants in umlaut. I assume that these morphemes are genuine exceptions in modern Chamorro, and I will not analyze them here.<sup>6</sup>

There are also front-voweled prefixes that unexpectedly do not trigger umlaut. For example, *kéʔ-*<sup>7</sup> ‘about to, try,’ when affixed to *túngoʔ* creates *kéʔ-tùngoʔ*, and there is unexpectedly no optional variant *\*kéʔ-tìngoʔ*. It is tempting to say that umlaut fails here because the prefix bears greater stress than the root-initial vowel (so spreading wouldn’t increase the feature’s prominence), but umlaut in fact can occur under such conditions, as (7) shows. Prefixes like *kéʔ-* and *faʔ-* are simply exceptional, and an account similar to the one Klein (2000) adopts for these exceptions seems most appropriate; see §3.4.2.

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<sup>6</sup>An obvious analysis involves positing a floating [-back] feature on *faʔ-*. The challenge for that approach is in ensuring that this floating feature only surfaces in umlaut contexts.

<sup>7</sup>I follow Chung (1983) in transcribing this morpheme as *kéʔ-* rather than Klein’s (2000) *ké-*.

Additionally, Chung (1983) notes that some loanwords do not undergo umlaut: *i bóti* ‘the boat.’ Umlaut may also occur without an obvious overt trigger: *tájaʔ ciʔcóiʔna* ‘He has no work/His work does not exist’ (cf. *cóʔcuʔ* ‘work’). Umlaut is also occasionally insensitive to stress, a point which is addressed in §3.5 below.

### 3.3 Canonical Umlaut in Chamorro

#### 3.3.1 The One-Syllable Spreading Limit

The data in (1) and (2) suggest that umlaut in Chamorro is limited to spreading by a single syllable. If spreading rightward exactly once does not place the prefix’s/particle’s [–back] feature in the stressed syllable, no spreading happens at all. Viewed this way, umlaut is a restricted version of an attraction-to-stress (e.g. Walker 2004) or vowel harmony process. This is in fact the position that Conant (1911:146) takes in comparing Chamorro to languages like Turkish, Hungarian, and Finnish. He speculates on

the analogies that may be found to exist between the phenomena produced by a limited operation of the [vowel harmony] law, as in Chamorro, and those produced by its more general and vigorous activity in languages of the purely agglutinative type.

This section develops an analysis of this property that uses Positional Licensing (Crosswhite 2000, 2001, Itô 1988, Itô & Mester 1994, 1999, Steriade 1994a,b, 1995a, Walker 2001, 2004, Zoll 1997, 1998a,b) and constraint subhierarchies (Padgett 2002a, Prince & Smolensky 1993[2004]). The analysis argues for the position

that Chamorro’s umlaut is neither attraction-to-stress nor vowel harmony. Instead, it involves, like Lango, simply spreading to the root (which is a prominent position, so umlaut is in that regard related to attraction-to-stress phenomena) triggered by root-initial stress. Conant’s comparison is certainly instructive in terms of the typological range of assimilatory processes it highlights, but the close kinship he sees between Chamorro and vowel harmony in “languages of the purely agglutinative type” is formally inaccurate.

I discuss constraint subhierarchies in §3.3.1.1, drawing significantly on Padgett (2002a), and then turn to their application in a Positional Licensing analysis in §3.3.1.2.

### 3.3.1.1 Constraint Subhierarchies: Metrical and Morphological Prominence

Universal constraint subhierarchies can be derived through what Prince & Smolensky (1993[2004]:141) call *Prominence Alignment*, “in which scales of prominence along two phonological dimensions are harmonically aligned.” In their example, the preference for sonorous syllable nuclei and nonsonorous syllable margins is derived from the two prominence hierarchies in (12), where ‘>’ means “is more prominent than.” The first hierarchy indicates that peaks are more prominent than margins, and the second hierarchy reflects the sonority scale.

- (12) a. Peak > Margin  
 b.  $a > i > \dots > d > t$

The scales can be “merged” as in (13). As Padgett (2002a:5) explains, “[t]he intuition here is that the most prominent syllable position (nucleus) is best associated with the most prominent kind of sound,” as indicated by ‘>,’ and the least prominent syllable position (margin) is best associated with the least prominent kind of sound.

- (13) a.  $P/a > P/i > \dots P/d > P/t$   
 b.  $M/t > M/d > \dots M/i > M/a$

These aligned hierarchies motivate a fixed constraint ranking expressing universal peak and margin preferences:

- (14) a.  $*P/t \gg *P/d \gg \dots *P/i \gg *P/a$   
 b.  $*M/a \gg *M/i \gg \dots *M/d \gg *M/t$

Padgett (2002a) argues for a more general understanding of constraint subhierarchies in which they reflect scales of universal articulatory, perceptual, or processing factors. He further proposes a method for projecting constraint subhierarchies:

- (15) *Projection of Universal Constraint Subhierarchies*
- a. Given a scale of articulatory/perceptual/processing difficulty  $D$ :  
 $D_n > D_{n-1} > D_1$   
 (where ‘>’ means ‘more difficult than’)
- b. Project a universal constraint subhierarchy:  $C_n \gg C_{n-1} \gg C_1$   
 (where  $C_i = *D_i$ )

To use an example that Padgett (2002a:5) cites from Walker (2000), the subhierarchy in (16b) can be projected “based on the principle that nasality is aerodynamically incompatible with increasing stricture.” This incompatibility is expressed by the scale in (16a).

- (16) a. Nas/Obst-stop > Nas/Fric > Nas/Liq > Nas/Glide > Nas/Vowel  
 b. \*NAS/OBST-STOP ≫ \*NAS/FRIC ≫ \*NAS/LIQ ≫ \*NAS/GLIDE  
 ≫ \*NAS/VOWEL

I adopt Padgett’s broadened view of constraint subhierarchies here. (See below for a demonstration that, as I understand it, Prince & Smolensky’s algorithm yields incorrect results for Chamorro.) These subhierarchies let us ban the “worst of the worst” (WOW; Padgett 2002a, Smolensky 2006): Nasalization is articulatorily marked, and obstruent stops are particularly poor candidates for nasalization, so \*NAS/OBST-STOP, the highest-ranking constraint from (16b), bans the worst kind of nasalized consonant.

Chamorro exhibits a WOW effect: Umlaut only targets the especially weak position of an immediately pretonic (henceforth simply “pretonic”) prefix/particle. Pretonic syllables on the one hand, and prefixes/particles on the other, are perceptually or cognitively weak elements, and, in WOW-like fashion, umlaut appears where these two dimensions of weakness converge. Evidence that pretonic position is weak, at least in Chamorro, comes from the fact that syllables in this position are destressed, as was shown in (6a). Furthermore, there is evidence that unstressed vowels in general are reduced in Chamorro. Unstressed *a* and *æ* reduce (in the sense of Crosswhite (2001)) to *a*. As there is already pressure to-

ward reduction of unstressed vowels generally, it is not unreasonable to think that there may be “extra” pressure on vowels in certain positions (crucially pretonic position).

One possible explanation for pretonic reduction is that Chamorro requires stressed syllables to contrast as much as possible with surrounding (and specifically pretonic) syllables, and therefore the pretonic syllables themselves must not be prominent. Rachel Walker (p.c.) suggests that Chamorro wants a sharp rise in intensity, etc., at the onset of primary stress, rather than the more gradual rise that a sequence of secondary stress followed by primary stress would entail. Perhaps this is motivated by a desire for the locus of primary stress to be clearly recoverable. In any case, I take metrical weakness (i.e. the perceptual differences between syllables in various prosodic contexts) to be a form of “articulatory/perceptual/processing difficulty” as required in (15a). The scale that instantiates this dimension of difficulty is given in (17). The term “non-pretonic” is used here to refer to unstressed syllables that do not immediately precede primary or secondary stress. Although distinctions among non-pretonic positions are possible (for example, post-tonic syllables may be crosslinguistically weaker than other non-pretonic syllables because they often reduce (Hyman to appear)), such distinctions are irrelevant to the current analysis.

- (17) Pretonic > Pre-Secondary > Non-Pretonic > Secondary Stress > Primary Stress

Some dialects of Russian have vowel reduction patterns that treat (immediately) pretonic vowels differently from other unstressed vowels (Crosswhite 2001).



In these cases, though, pretonic vowels undergo less drastic reduction than other vowels. But Crosswhite's (2001) analysis takes Russian to be iambic, and therefore the pretonic vowel is footed, whereas other unstressed vowels are not. In a trochaic language like Chamorro (Flemming 1994), pretonic vowels are not footed, and consequently they should not be protected from (extreme) reduction in the way pretonic vowels in Russian are. Instead, concerns like creating a sharp contrast between stressed and unstressed syllables are free to encourage greater pretonic reduction in Chamorro.

Other cases of vowel reduction before prominent syllables can be found cross-linguistically. In Irish, "a short vowel immediately before the accented syllable may be elided" (Ó Siadhail 1989:23). In Chi-Mwini, syllables to the left of the phrasal antepenultimate syllable are shortened (Kenstowicz & Kisseberth 1977): *nu:mba* 'house' → *numba: ŋk<sup>h</sup>uŋu* 'large house.' One possible interpretation of this fact is that the antepenultimate syllable is prominent (perhaps stressed). Like Chamorro, Chi-Mwini reduces the prominence of syllables that precede the word or phrase's prominent position.

Similarly, Nevins & Vaux (2008a), citing personal communication with José Olímpio Magalhães, characterize the optional raising of vowels to the left of stress in Brazilian Portuguese as vowel reduction. One consequence of the optional nature of raising is that vowels farther away from the stressed syllable raise only if all the vowels closer to stress also raise. This fact lends support to the claim above that immediately pretonic vowels may be especially weak: Other vowels may reduce only if the immediately pretonic vowel reduces.

Various Italian dialects have reduction phenomena that specifically target pre-tonic vowels (Maiden 1995). For example, in some dialects, all vowels to the left of stress reduce to ə, except that /a/ remains unreduced.

A final example comes from Shimakonde (Liphola 2001). Here, unstressed mid vowels to the left of the (penultimate) stressed syllable optionally reduce to a. The optionality is similar to that of Brazilian Portuguese except that a vowel may reduce only if every vowel to its *left* also reduces.

Of course, there are many other languages with post-tonic reduction. Either (17) is not a universal scale (which does not affect its utility for Chamorro), or languages that seem to contradict the scale possess other factors (such as Russian's iambs) that suppress the relationships expressed by the scale. (15) is intended to generate universal hierarchies, but in case (17) proves to be specific to Chamorro, it seems reasonable to expect (15) to be employed on a parochial basis as well in areas where articulatory, perceptual, or processing difficulty can vary across languages.

Turning to the second prominence scale in Chamorro's WOW effect, prefixes, and affixes more generally, are morphologically weak compared to roots. Roots are "prominent positions which license more contrasts than other non-prominent positions" (Urbanczyk 2006:194; see also Beckman 1999, Kaplan 2008a, McCarthy & Prince 1995, Steriade 1995b). As phonemic and prosodic contrasts are keys to correct identification of lexemes by hearers, affixes are at a disadvantage compared to roots. See Ussishkin & Wedel (2002) for an overview of the issues at hand.

Beckman (1999:192) cites three lines of psycholinguistic evidence pointing to the conclusion that roots are more prominent than affixes. First, affixed forms

prime their roots as effectively as the roots prime themselves (Fowler et al. 1985, Kempley & Morton 1982, Stanners et al. 1970). Fowler et al. (1985) show that when subjects are asked to decide whether a visually-presented string of letters is a word, they respond faster when they have already seen the same word or an inflected version of the word. They argue that this must be lexical priming and not simply recognition of a repeated stimulus (“lexical” vs. “episodic” priming) because non-words do not show the same priming effect. The priming effect even holds for orthographically and phonologically dissimilar members of a paradigm (*clear* vs. *clarify*; *heal* vs. *health*). Furthermore, their experiments reveal no statistically significant difference between the priming effects of inflectional and derivational affixes. They also argue against the view that their results reflect semantic rather than morphological priming. (E.g., derived words may be semantically distant from their roots.) A version of one of their experiments that uses auditory rather than visual stimuli confirms their results.

The particles that trigger umlaut in Chamorro share relevant properties with prefixes. They are function morphemes, and, as clitics, they are not phonologically independent units. With respect to the definite morpheme in particular, Chung (1983:50) says, “i gives no evidence of being a separate phonological word, despite the fact that it is traditionally written as such.” It therefore seems safe to treat these particles as prefixes for present purposes, keeping in mind that they are in fact morphosyntactically distinct from prefixes.

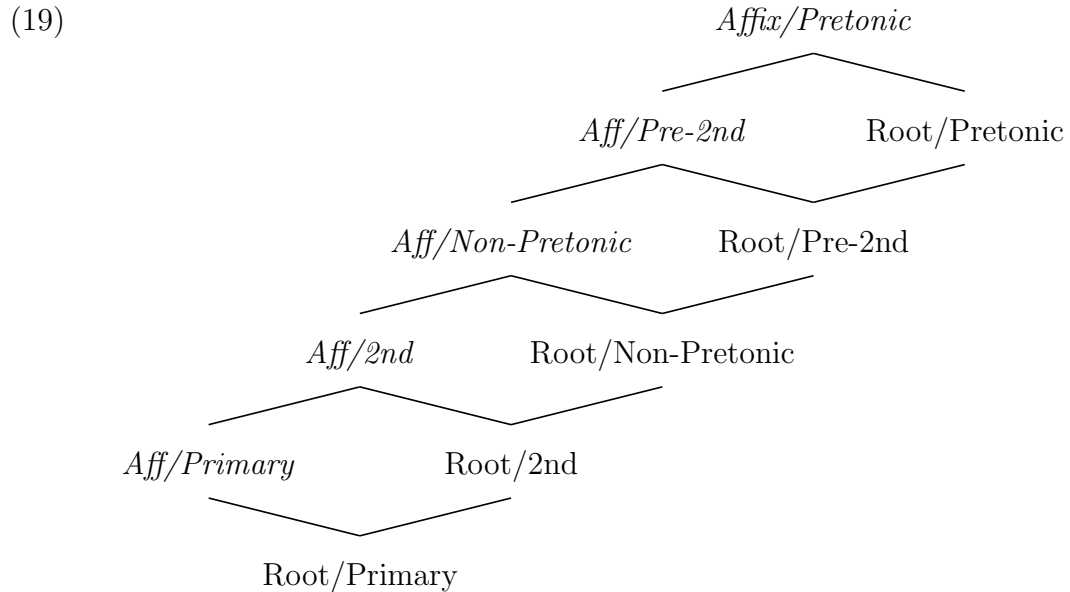
The research cited above offers various explanations for the weakness of affixes, and I take this weakness to reflect the “articulatory/perceptual/processing difficulty” from (15a). The scale for this dimension is shown in (18).

(18) Affix > Root

This scale assumes that prefixes and suffixes are treated the same, whereas Chamorro has umlaut only from prefixes. The analysis developed below accounts for this asymmetry independently, so I will not refine (18). However, it may be possible to assign prefixes and suffixes to different positions in the prominence scale, with the former being weaker than the latter. This would permit constraints that hold only for prefixes to be projected. Hyman (2008, to appear) points out that suffixes are crosslinguistically more common than prefixes, and there are few if any cases of prefix-controlled vowel harmony. In contrast, root-controlled harmony is very common, as is regressive harmony from suffixes.

In sum, prefixes and particles are weak positions, and pretonic prefixes and particles are weak along both prosodic and morphological dimensions and therefore especially weak. We need a scale that captures this two-dimensional weakness, and we can generate such a scale by merging the scales in (17) and (18) to produce (19). Diagonal lines in this lattice show prominence/weakness relationships that follow from the simple scales, with higher items being weaker or less prominent than lower items. For example, pretonic affixes are weaker than both affixes that immediately precede secondary stress (because pretonic syllables are weaker than pre-secondary syllables) and pretonic roots (because affixes are weaker than roots). Also, this scale shows that pretonic affixes are the weakest elements (of those considered here) and primary stressed roots are the strongest elements. Transitive relationships hold in this lattice, too, so pretonic affixes, for example, are necessarily weaker than pre-secondary roots because pre-secondary affixes and pretonic roots are stronger than the former but weaker than the lat-

ter. But no *a priori* relationship holds between items on the same row. There is no way to determine whether pre-secondary affixes are stronger or weaker than pretonic roots, for example.



Subhierarchies can be extracted from the lattice. The one relevant to the analysis below consists of the italicized items in (19). This subhierarchy is given in (20), where ‘>’ again means “more difficult than.” This hierarchy indicates that an affix’s position with respect to the metrical structure of a word affects the affix’s prominence.

- (20) *Affix/Pretonic* > *Affix/Pre-Secondary* > *Affix/Non-Pretonic* >  
*Affix/Secondary Stress* > *Affix/Primary Stress*

We now have a prominence scale that, like (16a), expresses a relationship between two linguistic dimensions. The constraint families that scales like (20) can motivate come in two varieties. In Prince & Smolensky (1993[2004]), Smolensky

(1995), Zoll (1998b), and Padgett (2002a), Positional Markedness<sup>8</sup> constraints like the ones in (21) are generated. Since pretonic prefixes are the least prominent elements in (20), a constraint banning pretonic affixes is projected at the top of the subhierarchy. Non-pretonic affixes are the next least prominent elements on the hierarchy, so a constraint banning them is second on the constraint subhierarchy, and so on.

- (21) \*AFFIX/PRETONIC ≫ \*AFFIX/PRE-SECONDARY ≫  
 \*AFFIX/NON-PRETONIC ≫ \*AFFIX/SECONDARY STRESS ≫  
 \*AFFIX/PRIMARY STRESS

But we can instead adopt constraints that recognize the markedness of weak positions by requiring elements to be licensed by strong positions. This is the style of constraint adopted by, e.g., Itô & Mester (1994), Walker (2001, 2004) and Crosswhite (2001), although their constraints are not explicitly derived from scales like (20). (Zoll (1997, 1998b) frames her constraints in terms of licensing, but her constraints are formally more similar to those in (21).)

Walker (2001) analyzes spreading of [+high] in Veneto Italian from suffixes to stressed syllables as spreading to a prominent position under pressure from Positional Licensing. I propose the same thing here. Front vowels are not banned from pretonic affixes in Chamorro. [-back] features in this position are simply required to spread to a more prominent position, namely the root. This is much

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<sup>8</sup>I use the term *Positional Markedness* to refer specifically to constraints that categorically ban elements from marked positions. This contrasts with *Positional Licensing* constraints, which state that elements must appear in unmarked positions but do not ban them outright from marked positions. This terminological distinction departs from the practice of others (e.g. Walker (2001), Zoll (1998b)), where both kinds of constraints are categorized as Positional Markedness.

like Lango (see Chapter 2), where suffixes' ATR features spread to the root so as to be linked to a more prominent position. In order to enhance their salience, affix features in Lango, Chamorro, and Veneto Italian must spread to a more prominent position, although what feature spreads and the conditions in which spreading occurs are different for each language. For all three, though, spreading is produced by Positional Licensing.

Both Crosswhite (1996) and Klein (2000) account for Chamorro umlaut with similar constraints. Crosswhite's constraint requires (some part of) the definite morpheme to align with primary stress, and Klein (2000) adopts a constraint requiring bases (i.e. roots) to begin with a front vowel. Although neither analysis is explicitly grounded in either Positional Licensing or markedness facts, either one can be viewed in this light. The key insight in these analyses is that umlaut is driven by a desire to place [-back] in a prominent position—either the stressed syllable or the root—rather than by, say, a desire to spread one syllable to the right. That is, umlaut's goal is to spread to a target rather than to simply spread. The analysis proposed here exploits this insight, but it departs from Crosswhite (1996) and Klein (2000) in a way which, we will see shortly, is very advantageous: It takes stress to be part of the trigger for umlaut rather than the target (cf. Crosswhite) or an irrelevant distraction (cf. Klein). See §3.4 for more about these alternatives.

Positional Licensing constraints can require segments and features to meet certain conditions that enhance their prominence. In Lango, suffix ATR features are licensed if they are also associated to a root segment. A similar statement can be made for Chamorro: Pretonic affix backness features are licensed if they are also

linked to a root segment. Rather than projecting the constraint subhierarchy in (21) from (20), we can project the constraint subhierarchy in (22) from (20). The principles are the same, except that instead of projecting constraints that ban non-prominent configurations, we project constraints that impose requirements that these non-prominent configurations must meet to be acceptable. Licensing constraints let us encode markedness desiderata in the constraint formalism without banning marked elements altogether.<sup>9</sup>

- (22) LICENSE-Pretonic  $\gg$  LICENSE-Non-Pretonic  $\gg$  LICENSE-Secondary  $\gg$   
 LICENSE-Primary

These constraints are defined in (23), and each is relativized to [-back] since this is the feature that spreads in Chamorro. Following Walker (2001), I assume that [-back] and [+back] are subject to distinct Licensing constraints.<sup>10</sup> Each constraint requires a backness feature in a position of greater or lesser (metrical) prominence to be also linked to a position of greater (morphological) prominence, namely the root.

- (23) a. LICENSE-Pretonic: Pretonic [-back] features must be linked to root segments.  
 b. LICENSE-Pre-Secondary: [-back] features that immediately precede secondary stress must be linked to root segments.

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<sup>9</sup>It is possible that this hierarchy—and thus the prominence scales it is based on—could be formulated as a stringency scale in the style of de Lacy (2002a). Such a reformulation would have no practical consequence for the current analysis, so I will not attempt it here.

<sup>10</sup>In the analysis of Lango in Chapter 2, I argued for a single LICENSE-ATR constraint that holds for both [+ATR] and [-ATR]. In that analysis, both values of [ $\pm$ ATR] spread, so the simplest analysis uses just one Licensing constraint. An equally plausible approach uses both LICENSE-[+ATR] and LICENSE-[-ATR] and ranks them adjacently.



- c. LICENSE-Non-Pretonic: Non-pretonic [-back] features must be linked to root segments.
- d. LICENSE-ò: Secondary stressed [-back] features must be linked to root segments.
- e. LICENSE-ó: Primary stressed [-back] features must be linked to root segments.

The same word of caution from Chapter 2, p. 75, holds here: Unlike Crosswhite's (2001)'s licensing constraints, these do not require [-back] to be wholly contained within the licensing category.

We now have constraints that, in combination with other constraints, can motivate umlaut just when stress is root-initial. The next section constructs an analysis of umlaut around these constraints.

### 3.3.1.2 Positional Licensing in Chamorro

When IDENT[back] is ranked between LICENSE-Pretonic and LICENSE-Pre-Secondary, only LICENSE-Pretonic can motivate spreading. Prefix backness features that are non-pretonic or stressed will not spread to the root because the Licensing constraints that would trigger spreading are outranked by IDENT[back].

Walker (2001), following Zoll (1998a,b), argues for a universal principle according to which Licensing constraints for marked values of features necessarily outrank their counterparts that refer to unmarked feature values. The idea is that marked elements are subject to greater restrictions than unmarked elements. In the present case, this would mean, e.g., that LICENSE-Pretonic[-back] (23a) is outranked by LICENSE-Pretonic[+back], predicting that both values of [ $\pm$ back]

undergo umlaut. The existence of languages like Chamorro and Veneto Italian (which Walker analyzes; [+high] but not [-high] spreads from suffixes to the stressed syllable) in which only the unmarked feature value spreads seems to call this principle into question, and I do not adopt it here. (However, see Walker (2001) for a strategy that renders the higher-ranked Licensing constraint for the marked feature inert when ranked under a constraint that essentially penalizes new specifications of the marked feature. This permits spreading of only the unmarked feature.)

(24) shows how LICENSE-Pretonic motivates umlaut in words such as *i g'íma?*. (I won't address other irrelevant segmental changes that affect this and other forms. See Chung (1983) for these phenomena.) The [-back] feature of the definite article *i* violates LICENSE-Pretonic because this vowel is immediately pretonic, and the [-back] feature is not linked to any root segment. Umlaut corrects this, as the winning candidate shows, and just the lower-ranked IDENT constraint is violated. For space, all Licensing constraints below IDENT[back] are subsumed under LICENSE-Elsewhere.

(24)

/i g'íma?/	LIC-Pretonic	IDENT[back]	LIC-Elsewhere
a. <i>i g'íma?</i>	*!		
☞ b. <i>i g'íma?</i>		*	

Umlaut does not occur in *i pulónnun* because the prefix segment is not pretonic, and therefore, as shown in (25), LICENSE-Pretonic is not violated. This form violates LICENSE-Non-Pretonic, but this violation is unavoidable: Spreading necessarily violates the higher-ranked IDENT[back]. Furthermore, spreading

through the root-initial unstressed syllable to the stressed syllable only exacerbates the problem by adding another IDENT[back] violation.

(25)

/i pulónnun/	LIC-Pretonic	IDENT[back]	LIC-Elsewhere
☞ a. i pulónnun			*
b. i pilónnun		*!	
c. i pilénnun		*!*	

The ranking used here ensures that only pretonic backness features will spread. The Licensing constraints motivate spreading from other positions, but IDENT prevents spreading from all but the pretonic position.

Notice that the constraint definitions in (23) do not make explicit reference to prefixes. That is, LICENSE-Pretonic does not require *prefix* pretonic features to be licensed. It requires *all* pretonic backness features to be licensed. This is not inconsistent with the claim that umlaut occurs because the relevant prefix/particle segments are both pretonic and prefixal. By requiring segments to be linked to the root, these constraints capture the fact that roots are more prominent than affixes.

If LICENSE-Pretonic requires all pretonic segments to be licensed, why don't we see spreading from all pretonic segments? For example, why doesn't *mímantikápa* 'more abounding in fat' (6a) surface as *\*mímantiképa*, with spreading from the antepenultimate vowel to the penultimate (stressed) vowel? The answer is that the actual form does not violate LICENSE-Pretonic because the [-back] feature of the pretonic vowel is already linked to a root segment. No spreading is necessary. This is shown in (26). This also explains why no other Licensing constraints

are violated in (24) and (25). While there are non-pretonic and stressed vowels in these forms, they're all root segments, and they therefore don't violate the Licensing constraints.

In other words, umlaut targets the root, not the stressed syllable. The fact that the source of spreading is always an affix follows from this. The fact that only prefixes—and not suffixes—trigger umlaut is addressed below. (In the case of (26), the suffix doesn't trigger umlaut because it lacks a front vowel.)

(26)

/m̀imantiká-ŋa/	LIC-Pretonic	IDENT[back]	LIC-Elsewhere
☞ a. m̀imantikáŋa			
b. m̀imantikáéŋa		*!	

Umlaut is motivated only when the pretonic prefix contains a front vowel. For example, *man-liʔof* 'they dove' and *naʔ-liʔof* 'cause to dive' do not surface as *\*man-luʔof* and *\*naʔ-luʔof*, with [+back] spreading from the plural subject marker *man-* and the causative prefix *naʔ-* to the verb root *liʔof* 'dive.' Spreading in these cases only creates gratuitous violations of IDENT[back] because LICENSE-Pretonic only requires [-back] to be licensed. The Tableau in (27) illustrates this.

(27)

/man-liʔof/	LIC-Pretonic	IDENT[back]	LIC-Elsewhere
☞ a. man-liʔof			
b. man-luʔof		*!	
c. mæn-liʔof		*!	

However, regressive spreading in */i gúmaʔ/* to create *\*u gúmaʔ* is still a

possibility and must be ruled out. Both the correct *i gúmaʔ* and *\*u gúmaʔ* avoid the violation of LICENSE-Pretonic that is incurred by the fully faithful candidate, so we need some way to choose between progressive and regressive spreading. Though incorrect, *\*u gúmaʔ* is superior to the correct output in that root faithfulness is satisfied at the expense of affix faithfulness, so this candidate better observes the Root-Faith  $\gg$  Affix-Faith metaranking proposed by McCarthy & Prince (1994, 1995). What makes *\*u gúmaʔ* ultimately suboptimal?

In umlaut, [-back] overwrites [+back] specifications, not *vice versa*. Splitting IDENT[back] into IDENT[+back] and IDENT[-back] (Hall 2006, McCarthy & Prince 1995, Pater 1999) and ranking IDENT[-back] over LICENSE eliminates *\*u gúmaʔ* but still permits *i gúmaʔ*:

(28)

/i gúmaʔ/	ID[-back]	LIC-Pretonic	ID[+back]	LIC-Else
☞ a. <i>i gúmaʔ</i>			*	
b. <i>u gúmaʔ</i>	*!			
c. <i>i gúmaʔ</i>		*!		

Next, why is umlaut limited to prefixes? The scale in (18) and the constraints projected from it treat all affixes equally. This means that suffixes' [-back] features must be licensed just like prefixes' features. Klein (2000) provides the form *kwentús-i* 'to speak to' (cf. *kwéntus* 'to speak'). Why don't we find *\*kwentís-i*? The answer is that the suffix vowel is not pretonic, so LICENSE-Pretonic does not affect it. It violates only the low-ranked LICENSE-Non-Pretonic, and IDENT prevents satisfaction of this constraint:

(29)

/kwentús-i/	ID[-back]	LIC-Pretonic	ID[+back]	LIC-Else
☞ a. kwentús-i				*
b. kwentís-i			*!	

This is not quite the whole story; the issue of suffix-triggered umlaut is addressed in more detail in §3.3.2.

Finally, yet another way to satisfy LICENSE-Pretonic is by deleting the offending vowel: *i gíma?* could be realized as *\*gúma?*. Placing MAX sufficiently high in the constraint ranking is sufficient to rule this option out. REALIZE MORPHEME (Kurusu 2001) might also account for this specific example, but it will not work when deleting the offending vowel does not erase the entire prefix.

Returning to the larger theoretical interest of Chamorro umlaut, the apparent noniterativity of this phenomenon is a byproduct of the Licensing constraints. Rather than enforcing spreading to the stressed syllable, LICENSE-Pretonic requires only spreading to the root. Because this spreading is only motivated in pretonic position, umlaut will always target the primary stressed syllable, not because it has primary stress, but because it is the first syllable in the root. Once spreading reaches the root-initial syllable, LICENSE-Pretonic is satisfied, and further spreading is ruled out by IDENT[+back]. This is illustrated in (30). In short, spreading by one syllable is all that is ever needed to satisfy Licensing, and this is why umlaut seems noniterative. We saw exactly the same thing in Chapter 2, where [+ATR] spread just one syllable leftward in Lango because that was all that was needed for this feature to reach the root.

(30)

/i gúmaʔ/	ID[-back]	LIC-Pretonic	ID[+back]	LIC-Else
☞ a. i gímaʔ			*	
b. i gímæʔ			**!	

Additionally, spreading through unstressed syllables to reach the stressed syllable (as in \**i pilénnun*; see (25)) finds no motivation under the Licensing analysis. The target of spreading is the root, not the stressed syllable, so spreading to a non-root-initial stressed syllable accomplishes nothing. The puzzle that umlaut creates when viewed through the lens of Positional Faithfulness is straightforwardly solved here. The Positional Faithfulness approach seemed to require special faithfulness constraints for non-prominent syllables (see (4)). But under Licensing, spreading through unstressed syllables to reach the stressed syllable is unattested for two reasons. First, the conditions for spreading to occur simply aren't met. If the source of spreading isn't adjacent to the stressed syllable, LICENSE-Pretonic is not violated in the first place, so there is no reason to spread. It's not that unstressed syllables block umlaut; rather, they simply don't trigger it. Second, the target of umlaut is the root rather than the stressed syllable, so spreading never specifically seeks a stressed syllable under any circumstance. Viewing umlaut as (i) triggered by stress adjacency and (ii) targeting roots means we do not need additional machinery to rein in umlaut's reach. Noniterativity comes for free, as predicted by the Emergent Noniterativity Hypothesis.

The Positional Licensing analysis of Chamorro sheds light on the puzzling aspects of umlaut and obviates "reverse" Positional Faithfulness. Under Positional Licensing, spreading to the root and failure to spread to unstressed syllables are two sides of the same coin. A single constraint motivates spreading in exactly

the right contexts. Chamorro umlaut provides further evidence that Positional Licensing is an indispensable tool in phonological theory.

As a final note for this section, one question for phonological research to answer is whether or not both Positional Licensing and Positional Markedness (i.e. constraints like \*UNSTRESSED-[-back]) are necessary. Positional Markedness has been used to account for phenomena in which weak positions host a reduced range of contrasts compared to strong positions. I argued above that only Positional Licensing can account for umlaut-like spreading. If Positional Licensing can also account for the reduced-inventory facts, Positional Markedness may be superfluous. Although detailed argumentation would be tangential here, I believe this position is at least conceivable. Coupled with constraints banning spreading, such as (Positional) Faithfulness, Positional Licensing can eliminate marked features from weak positions. For example, if Ident[back]-Root were highly ranked in Chamorro, the only way to satisfy LICENSE would be to eliminate the prefix's [-back] feature altogether. If this approach is tenable for concrete cases, then Positional Markedness is applicable in a proper subset of the phenomena that Positional Licensing accounts for, and the former is therefore expendable.

### **3.3.2 Predictions of the Licensing Analysis**

In this section I take up two salient predictions of the Positional Licensing analysis. Both concern the behavior of long affixes or strings of affixes. First, as noted above (see discussion surrounding (29)), pretonic vowels in suffixes are subject to LICENSE-Pretonic and should trigger umlaut on root-final vowels. The explanation given above for the absence of right-edge umlaut was that suffixes are never



pretonic. This point deserves more attention.

To my knowledge, all suffixes relocate primary stress to the word-penultimate syllable. Consequently, a pretonic (i.e. umlaut-triggering) suffix vowel must be in the antepenultimate syllable, and the Licensing analysis predicts umlaut from suffixes just when there is a suffix or string of suffixes three syllables long. The only instance of multiple suffixation in Chamorro that I am aware of appears in forms like *bidan-ji'jiha* ‘their doing,’ in which the first syllable of the third person plural possessive suffix *-jiha* is reduplicated. (The verb root is *bida* ‘do, work, act,’ and reduplication is a nominalizing process.) This would be the perfect form on which to test the Licensing analysis’s predictions but for the fact that stress remains on the antepenultimate syllable and does not shift rightward with reduplication, so there is no pretonic suffix syllable.

As for trisyllabic suffixes, the longest suffix I have identified is *-jaihon* ‘for a while’ (Topping 1973:181), and according to Topping (p. 24), the sequence *ai* is a diphthong. The only other polysyllabic suffix I am aware of is the benefactive focus marker *-iyi* (with allomorphs *-yiyi* after vowels and *-guiyi* after the diphthong *ao*), which is also disyllabic. So it appears that suffixal configurations cannot create the environment necessary to trigger umlaut, and umlaut at the right edge of the word is effectively (and correctly) ruled out.

However, assuming the right suffixation context exists and does not trigger umlaut, it is simple enough to further decompose the morphological prominence scale in (18) so that prefixes and suffixes occupy distinct positions on the scale. Then the constraints that are projected from this scale will be specific to one or the other kind of affix. Using just the constraints that require prefixes to be

licensed will rule out suffixal umlaut.

Alternatively, perhaps some kind of macrostem that includes roots and suffixes is the target of spreading, not the root. In this case, suffixal [–back] features are already licensed, just as root-internal features are. The viability of this approach depends on the plausibility of the macrostem, which can only be determined with a large-scale survey of the morphophonology of Chamorro. As the issue is tangential to the question of noniterativity, I will not pursue it here.

The second prediction is that longer prefixes or strings of prefixes can trigger umlaut over greater distances. For example, the ordinal marker *minaʔ-* (Topping 1973) contains a front vowel in its first syllable. (The remarks in this and the following paragraph also hold for *pinat-* ‘have more of.’) If the second syllable of this prefix is stressed, we expect umlaut to be triggered, with [–back] spreading through the prefix’s second syllable to the root-initial syllable. When affixed to *kuatro* ‘four,’ we should find \**minæʔ-kiatro* (or perhaps \**minæʔ-kuætro*, depending on the behavior of the *ua* sequence) if stress is peninitial. But the correct form is *minaʔ-kuatro* ‘fourth,’ with no spreading at all. Topping (1973), from whom this form is taken, says nothing about the stress pattern of this construction, so I can only speculate on the lack of umlaut.

One possibility is that stress in *minaʔ-kuatro* is not peninitial, in which case the Positional Licensing analysis correctly predicts no umlaut at all. Alternatively *minaʔ-* may be an exceptional prefix like *keʔ-*. Also relevant is the fact that Conant (1911:145) states (without elaboration) that only monosyllabic morphemes trigger umlaut. More satisfying explanations are these: *minaʔ-* affixes to words of Spanish origin, which belong to a lexical stratum that is not subject to um-

laut. See §3.4.2.2 below. (Conant (1911:144), though, says Spanish loans are not categorically exempt from umlaut.) The stratified-lexicon tactic will not extend to *pinat-*, which does affix to native Chamorro roots. (But Topping (1973:179) notes that *pinat-* may be separate word, not an affix, in which case umlaut is not expected to begin with.)

Alternatively, umlaut for *minaʔ-* involves spreading through another affix syllable, and this has the danger of causing homophony. So perhaps umlaut is blocked by affix faithfulness. See Ussishkin & Wedel (2002) for a discussion of the latter point. Of course, all these explanations are moot if the stress pattern isn't conducive to umlaut in the first place.

### 3.3.3 The Failure of Prominence Alignment

If I understand Prince & Smolensky's (1993[2004]) prominence alignment correctly, it cannot produce the desired outcome for Chamorro. I explain why here. First, we set up the prominence hierarchies (in the notation of Prince & Smolensky (1993[2004]), '>' means "is more prominent than"):

- (31) a. Primary Stress > Secondary Stress > Non-Pretonic > Pretonic  
 b. Root > Affix

These are aligned as in (13):

- (32) a. Root/Primary Stress > Root/Secondary Stress > Root/Non-Pretonic > Root/Pretonic  
 b. Affix/Pretonic > Affix/Non-Pretonic > Affix/Secondary Stress > Affix/Primary Stress

From these hierarchies, the constraint subhierarchies in (33) are projected:

- (33) a. \*ROOT/PRETONIC  $\gg$  \*ROOT/NON-PRETONIC  $\gg$   
\*ROOT/SECONDARY STRESS  $\gg$  \*ROOT/PRIMARY STRESS  
b. \*AFFIX/PRIMARY STRESS  $\gg$  \*AFFIX/SECONDARY STRESS  $\gg$   
\*AFFIX/NON-PRETONIC  $\gg$  \*PREFIX/PRETONIC

These subhierarchies successfully capture the generalization that, since they're already prominent, roots are better aligned with primary stress than with, say, pretonic positions. Likewise, since affixes are inherently weak, placing primary stress on an affix dampens the stress's salience. But these rankings fail to capture the generalization that since affixes are inherently weak, they will be more reliably perceived if they're assigned metrical prominence. Similarly, pretonic affixes are especially non-prominent, so they should be avoided. Hence the rankings in (33b) should be reversed for Chamorro. This is why the analysis above does not follow the prominence alignment procedure although it is inspired by prominence alignment.

In fact, I believe Prominence Alignment will fail to account for Chamorro regardless of the prominence hierarchies one selects. According to the current analysis,umlaut is a strategy for ameliorating non-prominence. Features in a weak position spread to a stronger position. But Prominence Alignment produces constraints that discourage prominence enhancement. As with the examples in (14) and (33), constraint hierarchies produced by Prominence Alignment always have at their top constraints banning weak elements in strong positions or strong elements in weak positions. The lowest-ranked constraints are those that ban

strong elements in strong positions and weak elements in weak positions. These hierarchies encode the fact that weak units (such as [p]) are most suitable for weak positions (such as syllable margins), and strong things (such as [a]) are most suitable for strong positions (such as syllable peaks). But what we need for Chamorro is a constraint discouraging weak elements from (exclusively) occupying weak positions: [-back] spreads from (weak) prefixes in the (weak) pretonic position, but this match of weak-and-weak is exactly what Prominence Alignment favors. To return to the terminology used in §3.3.1.1, Chamorro exhibits a WOW effect in that umlaut surfaces only when weak morphemes are prosodically weak, but Prominence Alignment produces anti-WOW constraints and encourages the intersection of different dimensions of weakness, such as low sonority and syllable margins or affixes and pretonic syllables.

## 3.4 Alternative Accounts of Umlaut

### 3.4.1 Crosswhite (1996)

Crosswhite (1996), whose analysis of Chamorro is primarily concerned with transderivational phenomena, presents an account of the noniterative nature of umlaut that rests on the two constraints defined in (34).  $\text{ALIGN}(\{\text{Def}\}, \text{Head})$  motivates spreading in the first place, and  $\text{LEFTMOST}\{\text{Def}\}$  is intended to confine umlaut to the left edge of the stem. These constraints refer specifically to the definite morpheme *i* because this is the morpheme Crosswhite uses to illustrate umlaut, but it is easy to see how other triggering morphemes can be accommodated, either by broadening the scope of these constraints or positing additional constraints for

each umlaut trigger.

- (34) a. ALIGN({Def}, Head): The definite morpheme must align with the head of a prosodic word.
- b. LEFTMOST{Def}: The definite marker must occur at the left edge of the stem.

The head of a prosodic word is the primary stressed syllable, so ALIGN({Def}, Head) instructs (some feature of) the definite morpheme to seek this syllable. This is much like the Licensing analysis in that umlaut is driven by a desire place [-back] in a more prominent position.

LEFTMOST{Def} penalizes forms that spread beyond the first stem syllable: \**i pilénnun* (cf. *i pulónnun* ‘the trigger fish’) satisfies ALIGN because the [-back] feature of the definite morpheme has spread to the stressed syllable, but LEFTMOST penalizes this candidate because [-back] has spread beyond the left edge of the stem. Consequently, the ranking LEFTMOST  $\gg$  ALIGN is required: spreading to the stressed syllable only occurs when LEFTMOST is satisfied.

In contrast, *i gíma?* ‘the house’ is acceptable because spreading does not stray from the left edge of the stem. Since primary stress is stem-initial, both constraints are satisfied.

These constraints may produce the correct surface forms, but they do not elucidate the principles behind umlaut. It is easy to view ALIGN({Def}, Head) as a Positional Licensing constraint requiring the definite article to appear in the main stressed syllable. But LEFTMOST{Def} is rather mysterious in that it sheds no light on why umlaut cannot spread beyond the first syllable.

Crosswhite’s analysis therefore shares the problem that arises in any approach (including one based on Positional Faithfulness; see §3.1) that treats umlaut as targeting a specific syllable such as the one with primary stress. In contrast, the Licensing analysis developed above claims that umlaut is instead triggered by this particular syllable and targets the root more generally. Spreading beyond the root-initial syllable is ruled out by Faithfulness and the fact that the Licensing constraint does not require spreading to a particular syllable within the root. Positional Faithfulness and limiting the extent of spreading do not enter the discussion under Licensing, so the extra machinery that reins in spreading in other approaches is unnecessary.

### 3.4.2 Representation as Pure Markedness

Klein (2000) develops a lengthy analysis of German and Chamorro umlaut under the framework of Representation as Pure Markedness (RPM; Golston 1996, Golston & Wiese 1998). RPM, as implemented by Klein,<sup>11</sup> captures the morphological conditioning of phonological processes by augmenting lexical entries with constraint violation desiderata—specifications that certain constraints must be violated by the winning candidate. Since umlaut is partially morphologically conditioned (not all prefixes with front vowels trigger umlaut; some prefixes with back vowel trigger umlaut), Klein argues that RPM is an appropriate framework for an analysis of Chamorro. I summarize the RPM analysis in §3.4.2.1 and discuss reasons to favor the Licensing analysis over the RPM analysis in §§3.4.2.2–3.4.2.4.

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<sup>11</sup>Golston (1996) and Golston & Wiese (1998) replaces entire underlying representations with constraint violation desiderata. Klein’s use of RPM is significantly less drastic.

Even though I argue against it, Klein’s analysis contains an important insight into how Chamorro’s stress system can be captured in a parallel system. This insight has a place in my own analysis of optional umlaut in §3.6.

### 3.4.2.1 The RPM Analysis

For Klein, umlaut is the product of the Alignment constraint in (35).

(35) L-ALIGN(BASE, [Cor]): All bases must begin with a front vowel.

Front vowels for Klein are assumed to be specified for [Coronal], as opposed to [Dorsal] for back vowels. A base is the unit to which an affix (i.e. the umlaut-inducing prefix or particle) attaches. L-ALIGN(BASE,[Cor]) would trigger umlaut under affixation of all types were it not outranked by DEP[Cor]<sub>V</sub>, which prevents insertion of coronal features on vowels. L-ALIGN(BASE, [Cor]) can trigger umlaut only when a [Cor] feature is already present on some non-base-initial segment. [Cor] spreads from the definite article in *i gímaʔ*, but [Cor] cannot be inserted in, say, *g-um-úpu* ‘to fly (sg.)’ (*\*g-um-ípu*), and L-ALIGN(BASE, [Cor]) goes unsatisfied.

To block umlaut in *i pulónnun*, Klein adopts the constraint in (36), which penalizes front vowels whose left edges don’t coincide with the left edge of a foot. With the footing *i pu(lónnun)*, umlaut cannot occur without violating this constraint.

(36) L-ALIGN([Cor], Ft): The left edge of all front vowels coincides with the left edge of a foot.



Klein's explanation for why umlaut may occur in *i gimáʔ-ɲa* 'his house' but not *i pulónnun* also relies on foot structure. One of Klein's goals is to account for umlaut without invoking transderivational relationships, so he cannot exploit the fact that *i gimáʔ-ɲa* is related to *i gímaʔ* while *i pulónnun* has no such related form. Instead, he devises an analysis of stress that places the root-initial syllable within a foot in *i gimáʔ-ɲa* but not in *i pulónnun*.

I will not recapitulate the analysis in detail, but here are the basics: Chamorro has by default right-aligned trochees, but two constraints disrupt this system. Alignment constraints require all roots to be right-aligned with a foot and all prosodic words to begin with a foot. (In essence, Klein posits three stress-assignment systems: one that places word-penultimate stress, one that places root-penultimate stress, and one that places prosodic word-initial stress. This is an efficient way to account for what looks like cyclic stress assignment, and it may have a place in the analysis of optional umlaut sketched in §3.6.) The latter requirement produces initial dactyls in words such as *(pùta)mu(néda)* 'wallet.' The former requirement produces parsings such as *(gumáʔ)-ɲa* rather than the expected *gu(máʔ-ɲa)*. (A constraint requiring stress as close to the right edge of the word as possible rules out *\*(gúmaʔ)-ɲa*.)

Klein's analysis essentially requires that trochees be built from right to left with the algorithm starting over when the root is encountered (as encoded by the constraint requiring a foot at the right edge of the root). Thus the root-internal foot structure of morphologically complex words mirrors that of the bare roots, even though this is not always reflected in the stress pattern. Umlaut can target syllables that once bore primary stress because these syllables are footed

exactly as they are in unaffixed forms, and umlaut therefore does not run afoul of the constraint requiring left-alignment of [Cor] within a foot. This, according to Klein, eliminates the need for transderivational computational power.

Notice that there is no direct connection between umlaut and stress. Umlaut is simply required to target base-initial syllables, but this is blocked when it places a [Cor] feature in an unfooted position. Stress itself (as distinct from foot structure) plays no role.

Recall that some prefixes with front vowels, such as *kéʔ-* ‘about to, try,’ do not trigger umlaut, while other prefixes with no front vowels, like *faʔ-* ‘to make, to change to,’ do induce umlaut. Morphemes such as these prompt the first use of RPM in Klein’s analysis. Under the RPM model, morphological conditioning of phonological phenomena is formalized through desiderata in lexical entries that require certain constraint violations. For example, *kéʔ-*, which does not trigger umlaut, contains the specification in (37) in its lexical entry.

(37) *kéʔ-*

L-ALIGN(BASE, [Cor])
*

The box with a constraint and an asterisk indicates a *distinctive constraint violation* that is required of this morpheme. Forms with *kéʔ-* must incur a violation of L-ALIGN(BASE, [Cor]). The constraint MORPHMAX monitors obedience of distinctive constraint violations by assigning violations to candidates that do not respect their morphemes’ desiderata. The Tableau for *keʔ-tungoʔ* ‘try to know’ is:

(38)

/keʔ tungoʔ/	MORPHMAX	L-ALIGN(BASE, [Cor])
a. keʔ-tingoʔ	*!	<*>
☞ b. keʔ-tungoʔ		*

Candidate (a) does not violate L-ALIGN(BASE, [Cor]), and ‘<\*>’ records its failure to obey the desideratum in (37). This in turn triggers a fatal violation of MORPHMAX. Candidate (b), with no umlaut, wins because it satisfies (37).

Similarly, *faʔ-* has the desideratum in (39). L-ALIGN(BASE, [Dor]), which is very low-ranked in Chamorro, must be violated in words with this prefix. Roots in these words must not begin with back vowels; i.e., umlaut must occur, as shown in (40). (L-ALIGN(BASE, [Cor]) and L-ALIGN(BASE, [Dor]) are abbreviated as L-[Cor] and L-[Dor], respectively, for space.)

(39)

<i>faʔ-</i>	L-ALIGN(BASE, [Dor])
	*

(40)

/faʔ hánom/	MORPHMAX	DEP[Cor]	L-[Cor]	L-[Dor]
a. faʔ-hánom	*!			<*>
☞ b. faʔ-háenom		*		*

Besides accounting for idiosyncratic triggering and blocking of umlaut, RPM is invoked to account for the failure of certain words with non-initial stress to undergo umlaut. For example, *lugát* ‘place’ is assigned the footing (*lugát*) via a distinctive constraint violation of FT-FORM(TROCH), which mandates trochees. The form *i lugát* ‘the place’ does not show umlaut: \**i ligát*. Under Klein’s analysis, this is unexpected because the root-initial syllable is footed. This form should

therefore pattern with *i gimáʔ-na*. The difference between these forms, of course, is that *i gimáʔ-na* is transderivationally related to *gímaʔ* (which has initial stress), but there is no *\*lúgat* to which we can compare *i lugát*. Since he aims to eliminate transderivational relationships from his analysis, Klein cannot use this distinction. Instead he must posit a second distinctive constraint violation for *lugát*. This form requires a violation of the umlaut-inducing L-ALIGN(BASE, [Cor]).

The same approach is taken with respect to words with initial rhythmic secondary stress, such as *pùtamunéda* ‘wallet.’ Umlaut fails to target these words, as (10) shows. Again, the lack of umlaut is unexpected because the root-initial syllables are footed. Klein declares that all words long enough to have initial rhythmic stress are lexically marked with a distinctive constraint violation for L-ALIGN(BASE, [Cor]).

In summary, the analysis in Klein takes umlaut to essentially target roots, as in the Licensing analysis, but with constraints on where features can appear in a form’s prosodic structure blocking umlaut in some cases. Other scenarios in which umlaut is impossible are treated as lexical exceptions through constraint violation desiderata. I turn now to the shortcomings of this analysis.

### 3.4.2.2 Generalizations Treated as Exceptions

The first reason to disfavor the RPM analysis is that it treats language-wide generalizations as lexeme-specific exceptions. Forms like *i lugát* don’t undergo umlaut because they are lexically marked as exceptional. All disyllabic roots with final stress must be so marked, and the generalization concerning umlaut’s sensitivity to stress becomes a mere happenstance of idiosyncratic lexical entries.

In contrast, the Licensing analysis needs no addition to explain *i lugát*: the clitic is not pretonic, so umlaut isn't motivated.

Similarly, by lexically marking all words long enough to have rhythmic secondary stress as unable to undergo umlaut, RPM misses the obvious generalization that these secondary stresses have no primary stress transderivational correspondent. The analysis predicts that a new word, say *lugád* or *pùgamunéda*, could be adopted by Chamorro speakers without the required lexical marking and therefore undergo umlaut. Since umlaut never targets this kind of word, such a prediction does not seem well-founded.

It seems reasonable to suggest that words that are long enough to have initial rhythmic stress belong to a separate cophonology (Inkelas & Zoll 2005, 2007). As Klein (2000) notes, most such words are Spanish loans. They may therefore be subject to a separate constraint ranking that prohibits umlaut, much as Itô & Mester (1995) argue that Japanese has multiple lexical strata based on etymological origin. Evidence for cophonologies comes from the fact that “loans syllabify somewhat differently from native words” (Chung 1983:39, fn. 3). This approach would differ from RPM by predicting uniform behavior within each stratum. Crucially, it would not rely on fortuitous lexical markings on every item in a stratum.

As we will see in §3.6, lexical tags and cophonologies are superfluous in the Licensing account's treatment of forms like *pùtamunéda*.

### 3.4.2.3 Foot Structure

The foot structures generated by the RPM analysis are highly unusual. Instead of the expected  $(pùlu)(lón-na)$  ‘his trigger fish,’ we are given  $(pù)(lulón)-na$  by the

requirement that the root coincide with a foot boundary. The sole reason to adopt this sort of structure is to account for forms like *i gimáʔ-ɲa* with transderivationally conditioned umlaut. Klein provides no evidence for the foot structure he posits for words like *i gimáʔ-ɲa*, and if we give up on the idea that syllables which were stressed on a previous cycle are still footed in the output, we can adopt more conventional foot structures for these words. Umlaut in *i gimáʔ-ɲa* can be produced either with the transderivational machinery of Chung (1983) and Crosswhite (1996) or the Stratal OT system adopted in §3.6.

#### 3.4.2.4 Alignment is too Powerful

By now it should be clear that the RPM analysis does not capture the facts as elegantly as one might hope. I will point out one final reason not to adopt it. The Alignment constraints in the RPM analysis invite strategies that Klein does not rule out.

Recall that *i pulónnun* ‘the trigger fish’ does not show umlaut because [Cor] is banned from unfooted syllables, and the root-initial syllable is unfooted. Notice that the same goes for the definite article: *i* is unfooted, yet it is permitted to have a [Cor] feature in violation of L-ALIGN([Cor], Ft). The [Cor] feature on this vowel should be eliminated in the output. MAX, which penalizes feature deletion in the framework of Klein (2000), cannot prevent that deletion. It must be ranked below L-ALIGN([Cor], Ft) to allow umlaut in the first place.<sup>12</sup>

In fact, L-ALIGN([Cor], Ft) causes more widespread problems. This constraint

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<sup>12</sup>More accurately, L-ALIGN([Cor], Ft) outranks the umlaut-triggering L-ALIGN(BASE, [Cor]) because the former blocks certain cases of umlaut, and L-ALIGN(BASE, [Cor]) itself must outrank MAX to generate umlaut at all. So by transitivity, we have the ranking L-ALIGN([Cor], Ft)  $\gg$  MAX.

assigns a violation for each front vowel that is not leftmost in a foot. Actual outputs like *i gímaʔ* violate this constraint. *\*u gímaʔ* should be optimal because no features have been deleted or inserted. Rather, the first two vowels have simply exchanged features. Nor is *\*gímaʔ* (for the meaning ‘the house’) ruled out, again because of the low ranking of MAX, with deletion of the article altogether. Likewise, *kóbbli* ‘money’ should be realized as *\*kébbli*, with the vowels swapping backness features in compliance with L-ALIGN([Cor], Ft).

The umlaut-driving L-ALIGN(BASE, [Cor]) favors similar problematic candidates. Consider the form *t-um-óhge* ‘to stand (sg.),’ which lacks umlaut. The [Cor] feature on the final vowel should be able to spread to the root-initial vowel. The analysis based on L-ALIGN(BASE, [Cor]) predicts that affixation should trigger fronting of the root-initial vowel as long as some [Cor] specification exists elsewhere in the word:

(41)

/um tóhge/	DEP[Cor] <sub>v</sub>	L-ALIGN(BASE, [Cor])
⊖ a. t-um-éhge		
(✖) b. t-um-óhge		*!

Perhaps a high-ranking LINEARITY can rule out the feature-swapping candidates. But since MAX must be low-ranked to permit umlaut, forms that simply delete vowels to avoid Alignment violations cannot be eliminated.

The Licensing analysis encounters none of these problems. Since IDENT outranks LICENSE-Non-Pretonic, faithfulness to all backness features is favored for *i pulónnun*. Likewise, *\*u gímaʔ* is harmonically bounded by *i gímaʔ* because the former contains more IDENT violations than the latter, and each candidate fully

satisfies LICENSE. Finally, the front vowel in *t-um-óhge* is not penalized by the Licensing analysis because this vowel is root-internal and therefore its features are licensed; no spreading is motivated.

### 3.4.2.5 Summary

I have argued in this section that the RPM approach to Chamorro umlaut in Klein (2000) is inferior to the Licensing analysis proposed here. It relies heavily on lexeme-specific distinctive constraint violations to capture language-wide generalizations. In order to eliminate (or more accurately, reduce) the role of transderivational correspondence in the analysis of umlaut, the RPM model requires unusual metrical parses for various forms. The constraint L-ALIGN([Cor], Ft) seems to incorrectly predict deletion of vowels and movement of features to ensure that all [Cor] specifications are foot-initial. Finally, the RPM analysis posits only a tenuous connection between stress and umlaut. Even Klein admits that there is a very close relationship between stress and umlaut in Chamorro, and the Licensing analysis captures this relationship directly: the constraint that motivates umlaut only requires spreading from pretonic position. The RPM analysis, on the other hand, mandates umlaut in all stress configurations and therefore requires other constraints to block umlaut in certain cases.

### 3.4.3 Summary of Alternatives

This section has considered two alternatives to the Licensing-based approach to umlaut. Both alternatives revolve around constraints—ALIGN({Def}, Head) and L-ALIGN(BASE, [Cor])—that motivate umlaut regardless of the stress pattern.



These analyses therefore require additional constraints that block umlaut when stress is not root-initial, and these constraints create analytical problems. In contrast, the Licensing analysis relies on LICENSE-Pretonic, which motivates umlaut just when stress is root-initial. Consequently, it does not need extra machinery to rein in umlaut.

### 3.5 Stress-Insensitive Umlaut

Both Klein (2000) and Flemming (1994) mention the existence of stress-insensitive umlaut in Chamorro and give examples like those in (42). Klein explains that *i* triggers umlaut on unstressed syllables in the dialect spoke on Guam, but not on the dialect spoken on Saipan.

(42)	a.	kutsínu	‘dirty person’	i kitsínu	‘the dirty person’
	b.	kulépbla	‘snake’	i kilépbla	‘the snake’
	c.	kuttúra	‘culture’	i kittúra	‘the culture’
	d.	tasáhus	‘dried meat’	i tæsáhus	‘the dried meat’

Similarly, Sandra Chung (p.c.) explains (by way of (43) from Chung 1983:45; see her (31)) that the infix *-in-*, which marks the passive, produces stress-insensitive umlaut.

(43)	tuláyka	‘to exchange’
	t- <i>in</i> -iláyka	‘to be exchanged; exchanging’

Flemming (1994) and Klein (2000) rightfully point out that examples like these show that umlaut is at least partially morphologized (i.e. conditioned by

specific morphemes). Flemming goes too far, in my opinion, by concluding that umlaut is entirely morphologized and therefore doesn't belong to the synchronic phonology. The existence of exceptions does not necessarily make an otherwise regular phenomenon unproductive.

Within his RPM framework, Klein assigns a distinctive constraint violation for *i* in the Guam dialect. Forms with this morpheme must include a violation of L-ALIGN(BASE, [Dor]), which means having a front vowel in root-initial position. Although he does not discuss it, one can imagine treating *-in-* the same way in all dialects. This seems reasonable if exceptional morphemes like *-in-* are isolated cases. But if stress-insensitive umlaut is more general (perhaps in the Guam dialect), a better approach might be to modify the constraint ranking, or at least adopt cophonologies that treat exceptional morphemes as a class.

I have no information about the extent of stress-insensitive umlaut in the Guam dialect, so I offer two analyses of the above data. Assuming that umlaut in the Guam dialect is never sensitive to stress, a simple demotion of IDENT[+back] in the Licensing analysis can produce umlaut with any front-voweled prefix. With the ranking in (44), every Licensing constraint outranks faithfulness, and therefore spreading to the root will occur in all situations.

- (44) LICENSE-Pretonic  $\gg$  LICENSE-Non-Pretonic  $\gg$  LICENSE-Secondary  $\gg$   
 LICENSE-Primary  $\gg$  IDENT[+back]

On the other hand, if stress-insensitive umlaut is restricted to a few isolated morphemes, we can posit either cophonologies (Inkelas & Zoll 2005, 2007) or lexically indexed constraints (Pater 2006) that impose (44) on forms that contain

exceptional morphemes. This approach works for the Saipan dialect discussed in Chung (1983), with the exceptional *-in-*.

## 3.6 Optional Umlaut

### 3.6.1 Stratal OT and Multiple Grammars

As noted in §3.2, when affixation relocates a word's primary stress, the syllable that would have had primary stress if the stress-moving affix were not present surfaces with secondary stress. That is, stress assignment is cyclic: A syllable with primary stress on one cycle will surface with secondary stress if some later cycle repositions the primary stress.<sup>13</sup> Such syllables with secondary stress may optionally undergo umlaut, as may syllables that formerly had primary stress but are now stressless because they are immediately pretonic:

(45)	púgas	‘uncooked rice’	mípìgas,	‘abounding in unc’d rice’
			mípùgas	
	gúmaʔ	‘house’	i gìmaʔníha,	‘their house’
			i gùmaʔníha	
	kóbbli	‘cash, money’	i kèbblinmámi,	‘our (excl.) cash’
			i kòbblinmámi	

On the other hand, vowels with rhythmic secondary stress cannot undergo umlaut:

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<sup>13</sup>The only exception to this generalization that I am aware of was mentioned above: immediately pretonic syllables must be unstressed, so a syllable that previously had primary stress will not surface with secondary stress if it is immediately pretonic.



This section develops an analysis along these lines.

The basic approach is this: Suppose all stress is assigned at one stage (call it Level 1) except for rhythmic secondary stress, which is assigned at a later level, Level 2. (Other phenomena discussed below are consistent with this ordering.) Also clash is only resolved at Level 2. This means Level 1 will contain only primary and cyclic secondary stress. LICENSE-Pretonic can then obligatorily trigger umlaut on the primary stress as in §3.3.1. Optional umlaut on secondary stress can be produced by optionally ranking LICENSE-Pre-Secondary over IDENT[back]. Subsequently, Level 2 enforces no umlaut but adds rhythmic secondary stress and removes stress from certain other syllables. With this order of events, cyclic—but not rhythmic—secondary stress will participate in umlaut. Pretonic syllables whose secondary stress is eliminated will participate in umlaut as well because their stress isn't eliminated until the Level 2, after umlaut has occurred.

Obviously a strictly parallel conception of OT cannot accommodate this approach, but a theory of Stratal OT (Kiparsky 2000, Rubach 1997, among others) in which inputs are passed through a series of Tableaux, with each Tableau providing the input for the next, might be successful. The number of derivational levels that are needed in such a theory is an important question that I will not address here. For present purposes, just three levels are necessary, which I assume are the stem, word, and postlexical levels.

Starting with the stem level, I assume that just the root morpheme is present here. Stress is generally penultimate, and constraints at this level assign primary stress to the root's penultimate syllable. See Prince & Smolensky (1993[2004]) and much subsequent research for treatments of this kind of stress system in OT.

If the root exceptionally has non-penultimate stress, that stress is assigned here, too.

The word level, where affixes are added, is responsible for assigning primary stress in accordance with these affixes. Suffixes always move stress to the penultimate syllable, and some prefixes attract stress of their own. Stress from the stem level is retained through faithfulness constraints, although it is demoted to secondary stress, perhaps through CULMINATIVITY (Hayes 1995, Liberman & Prince 1977), if affixes relocate the primary stress. Umlaut is produced here as described in more detail below. Thus the Level 1 identified above is actually two strata, the stem and word levels.

With the labeling of strata adopted here—and the division of labor among them—clitics like the definite article *i*, which are syntactically independent units, would be expected to appear at the postlexical level. This is obviously not a good result because the umlaut triggered by these particles occurs at the previous level. A simple repair is to reconsider what is meant by “word level” and “postlexical level.” If we take the word level to apply to phonological words rather than morphological or syntactic words, then these elements will in fact appear at the word level because, as clitics, they are part of the phonological word on their right.

It may be possible to conflate the stem and word levels, at least in terms of their stress-assignment responsibilities. By adopting both a constraint system that assigns root-penultimate stress and one that assigns stem-penultimate stress, as in Klein (2000), we can simultaneously assign the root-level and stem-level stresses. By giving the stem-assignment system “priority” (i.e. higher ranking) over the root-assignment system, these constraints can produce the effect of cyclic

demotion of root stress.

In some cases, such as *mi-sapatós-na* ‘more abounding in shoes,’ both a prefix and a suffix alter the stress pattern. Constraints at the word level are responsible for sorting out which affix gets the primary stress and which one must be content with secondary stress. This can be done either by ranking constraints pertaining to one affix over constraints pertaining to the other, or by assigning primary stress according to level of embedding, with the least embedded affixes receiving primary stress.

In short, the output of the word level contains the root’s own (often demoted) stress plus any secondary and primary stresses added by affixes. In some cases, such as *swèddunmámi* ‘your (sg.) salary’ (see (6a)), the output of the word level contains the stress pattern of the final output form. For *i gimáʔ-na*, the word-level output (umlaut aside; see immediately below) is *i gùmáʔ-na*, with the root-penultimate stress retained for now as secondary stress. Clash resolution eliminates this stress at the postlexical level.

It is also at the word level where optional umlaut on secondary stress occurs. If the root-initial vowel has a secondary stress that was retained from primary stress assigned at the stem level, umlaut may occur. To produce this, the ranking adopted in §3.3.1 must be amended. Rather than the crucial ranking IDENT[+back] ≫ LICENSE-Pre-Secondary, we must allow the opposite ranking in some cases.

For simplicity, I assume that optionality is a product of non-crucial rankings between constraints, although other approaches (e.g. stochastic rankings (Boersma & Hayes 2001) or Markedness Suppression from Chapter 5) are equally

possible. IDENT[+back] and LICENSE-Pre-Secondary are not crucially ranked, and for each Tableau, either IDENT[+back]  $\gg$  LICENSE-Pre-Secondary or LICENSE-Pre-Secondary  $\gg$  IDENT[+back] is chosen at random. This is simply the multiple-grammars theory of variation proposed by Anttila (2006, 2007). When the first ranking occurs, no umlaut appears on secondary stress, and the latter ranking produces this umlaut. For other approaches to optionality, see Riggle & Wilson (2005) and Vaux (2003b).

Only cyclic stress is assigned at the word level. An analysis of the Chamorro stress system would take us too far from the goals of the current analysis, so the Tableaux below consider only candidates with correct stress. See Crosswhite (1996) and Klein (2000) for relevant OT analyses.

The Tableau in (48) and (49) show the word-level phonology for the (eventual) surface forms *i gimáʔ-ɲa* ‘his house’ and *i pùtamunéda* ‘the wallet.’ The stem-level phonology is trivial for our purposes (it just assigns penultimate stress), so I will not show Tableaux for that stage. The ranking LICENSE-Pre-Secondary  $\gg$  IDENT[+back] is shown here; see below for the opposite ranking. Following Rubach (1997), I use double slashes to mark underlying forms and single slashes to mark intermediate forms.

(48) *Word Level: i gimáʔ-ɲa*

	Id[-bk]	Lic-Pre	Lic-2nd	Id[+bk]	Lic-E]se
//i gùmáʔ-ɲa//					
a. /i gùmáʔ-ɲa/			*!		
☞ b. /i gìmáʔ-ɲa/				*	



Here, the first syllable of the root has cyclic secondary stress. Because LICENSE-Pre-Secondary outranks IDENT[+back], umlaut is required.

In contrast, the secondary stress in *i pùtamunéda* is rhythmic, so it is not assigned at the word level. Consequently, the prefix does not immediately precede stress of any kind, and LICENSE-Pre-Secondary doesn't trigger umlaut:

(49) *Word Level: i pùtamunéda*

	Id[-bk]	LIC-Pre	LIC-2nd	Id[+bk]	LIC-Else
//i putamunéda//					
☞ a. /i putamunéda/					*
b. /i pitamunéda/				*!	

Postlexically, rhythmic stress is assigned, but umlaut doesn't occur. I model this by promoting IDENT[+back] above all the Licensing constraints (subsumed under LICENSE for space) at the postlexical level. I also adopt the cover constraint RHYTHM to assign rhythmic stress (again, see Crosswhite (1996) and Klein (2000)), and \*CLASH penalizes stressed syllables that immediately precede primary stress. Both RHYTHM and \*CLASH are high-ranked at the postlexical level.

The postlexical evaluation of *i gimáʔ-na* is shown in (50). The input here is the optimal candidate from the word-level evaluation, so the input shows umlaut in this case. With high-ranking \*CLASH, the candidates that preserve the cyclic secondary stress on the root-initial vowel are eliminated. This leaves a choice between *i gimáʔ-na* and *i gumáʔ-na*, and IDENT[+back] selects the former because this candidate is faithful to the backness specifications of the input. RHYTHM is inert in this Tableau because the form under consideration isn't long enough to

require rhythmic stress assignment. The winning candidate violates none of the constraints shown in the Tableau, although it presumably violates low-ranking constraints that encourage stress preservation.

(50) *Postlexical Level: i gimáʔ-ɲa*

/i gímáʔ-ɲa/	RHYTHM	*CLASH	ID[+bk]	ID[-bk]	LIC
a. i gímáʔ-ɲa		*!			
☞ b. i gimáʔ-ɲa					
c. i gùmáʔ-ɲa		*!	*!		*
d. i gumáʔ-ɲa			*!		*

Although each candidate with *u* in the root-initial syllable violates a Licensing constraint, this is not what rules them out. Had the output of the stem-level phonology supplied a form with Licensing violations, the word-level phonology would still have selected the most faithful candidate because IDENT outranks the Licensing constraints at this level. In fact, this situation is exactly what we find in the postlexical Tableau for *i pùtamunéda*:

(51) *Postlexical Level: i pùtamunéda*

/i putamunéda/	RHYTHM	*CLASH	ID[+bk]	ID[-bk]	LIC
a. i putamunéda	*!				*
☞ b. i pùtamunéda					*
c. i pìtamunéda			*!		
d. i pítamunéda	*!		*!		

RHYTHM eliminates any candidate that doesn't assign root-initial secondary stress. This means that the forms that survive this constraint but don't have umlaut will necessarily violate LICENSE-Pre-Secondary. But the window for umlaut

has closed: IDENT[+back] now ensures that the winning candidate will have the same backness configuration as the input. *i pùtamunéda* is the optimal form, and this state of affairs renders umlaut insensitive to rhythmic secondary stress.

Now let's consider what happens if the ranking IDENT[+back]  $\gg$  LICENSE-Pre-Secondary is chosen at the word level. This is the ranking that gives us *i gumáʔ-ɲa*, with no umlaut. Once again, /i putamunéda/ is the optimal form, with no umlaut:

(52) *Word Level: i pùtamunéda*

	Id[-bk]	LIC-Pre	Id[+bk]	LIC-2nd	LIC-Else
//i putamunéda//					
☞ a. /i putamunéda/					*
b. /i pitamunéda/			*!		

But this time umlaut is blocked with the input //i gùmáʔ-ɲa//. This is because the constraint that triggers umlaut here is LICENSE-Pre-Secondary, and IDENT[+back] outranks it. Of course, a form like *i gíma* still obligatorily undergoes umlaut because the constraint that motivates umlaut in that case is LICENSE-Pretonic, which always outranks IDENT.

(53) *Word Level: i gímáʔ-ɲa*

	Id[-bk]	LIC-Pre	Id[+bk]	LIC-2nd	LIC-Else
//i gùmáʔ-ɲa//					
☞ a. /i gùmáʔ-ɲa/				*	
b. /i gímáʔ-ɲa/			*!		

The postlexical Tableau for *i pùtamunéda* is identical to (51). The Tableau for *i gumáʔ-na* is comparable to (50) in that the winning candidate preserves the underlying backness features, but the input (and therefore the faithful output) is different. Also unlike (50), the optimal candidate violates Licensing. But this is irrelevant at the postlexical level, where the overriding factor is preservation of input vowel quality:

(54) *Postlexical Level: i gimáʔ-na*

/i gùmáʔ-na/	RHYTHM	*CLASH	ID[+bk]	ID[-bk]	LIC
a. i gìmáʔ-na		*!	*!		
b. i gimáʔ-na			*!		
c. i gùmáʔ-na		*!			*
☞ d. i gumáʔ-na					*

This analysis correctly accounts for the facts of optional umlaut by segregating different stress-related phenomena in different strata. Depending on whether or not umlaut may occur at a particular stratum, the stress assigned at that stratum may or may not interact with umlaut.

### 3.6.2 Arguments against a Cyclic Approach

Chung (1983) argues against a cyclic approach to optional umlaut within a rule-based framework. As the analysis developed here is similar to a cyclic account, her concerns must be addressed. The cyclic umlaut rule she considers is one that produces umlaut when primary stress is root-initial. Thus it can generate *i gimáʔna* by spreading [-back] at an early stage when the root-initial vowel still has primary stress. This rule must be optional, otherwise it can't generate *i*

*gumáʔna* as well. But if the rule is optional, there is no way to ensure that it applies on at least one cycle to produce *i gímaʔ*, which obligatorily undergoes umlaut because of the root-initial primary stress. An optional rule predicts *\*i gúmaʔ* as well. We have a conflict: Either the rule is optional and we incorrectly predict *\*i gúmaʔ*, or the rule is obligatory and we cannot produce *i gumáʔna*. Recognizing this conundrum, Chung rejects a cyclic account of optional umlaut.

Chung’s argument holds only if a rule applies in exactly the same way at every cycle. Consequently, if umlaut is optional at one cycle, it must be optional at all other cycles as well. There is no way to mark the umlaut rule as both optional and obligatory. This predicament is what permits *\*i gúmaʔ* if umlaut is optional.

It is tempting to produce optionality by permitting two different morphological bracketings for *i gumáʔna/i gimáʔna*. The former is produced when we have the bracketing [i [gumáʔna]]. Here, suffixation moves the primary stress before the prefix appears, and therefore the prefix has no root-initial stress for umlaut. The other form comes from the bracketing [[i gimáʔ]na], where the prefix appears and triggers umlaut before the suffix relocates stress. Chung acknowledges the possibility that bracketing may be variable, and Crosswhite (1996) uses this variability to produce optional umlaut.

But Chung points out a problem with this approach. Vowel lowering (see §3.6.3.2) also optionally targets cyclic secondary stress, and the variable-bracketing analysis predicts that in words that can undergo both umlaut and vowel lowering, the two processes should be linked. For example, /i kupbli-hu/ ‘my cash’ permits two bracketings, [[i kupbli]hu] and [i [kupblihu]]. The first structure produces a form with both umlaut and vowel lowering (*i kebblékku*), and the

second one produces a form with neither (*i kubblékku*). The first bracketing entails a derivational stage where we have [i kúppli]. The root-initial stressed vowel undergoes both umlaut and lowering because it is stressed. But in the second bracketing, stress never appears on the first root vowel because of the suffix, which is added on the first cycle and requires penultimate stress: [kupblíhu]. The root-initial vowel is never stressed and therefore undergoes neither umlaut nor vowel lowering. The variable-bracketing approach, then, predicts that where umlaut occurs vowel lowering must also occur, and *vice versa*.

But this prediction is false. Umlaut and vowel lowering are completely independent of each other. In addition to the surface forms given in the previous paragraph, *i kibblékku* (with only umlaut) and *i kobblekku* (with only vowel lowering) are also attested. Variable bracketing cannot save the cyclic approach.

The Stratal OT analysis does not encounter these defects and therefore doesn't inherit the problems of the cyclic analysis. The *\*i gúma?* pitfall is avoided, yet umlaut on secondary stress is optional. This is because closely related but different constraints trigger umlaut in these cases. *\*i gúma?* is impossible because LICENSE-Pretonic always outranks IDENT[+back], but variability in other cases is permitted by the non-crucial ranking between LICENSE-Pre-Secondary and IDENT[+back]. Furthermore, umlaut is independent of the morpheme attachment sequence, so even if it is joined with an analysis of vowel lowering that is tied to bracketing, the undergeneration problem will not arise.

By reevaluating the underlying mechanisms behind umlaut—Licensing in various contexts instead of general attraction to (primary) stress—within Stratal OT, the problems that Chung sees in a cyclic analysis are avoided.

### 3.6.3 Corroboration for Stratal OT

According to the Stratal OT approach, rhythmic stress assignment is a relatively late process. There is evidence, also pointed out to me by Lev Blumenfeld, that this claim is correct. Two other phenomena, gemination and vowel lowering (both analyzed by Chung (1983)), are sensitive to the difference between cyclic and rhythmic secondary stress.

#### 3.6.3.1 Gemination

Gemination targets CV suffixes in words that meet the following conditions: (i) the syllable immediately before the suffix must be open, and (ii) there must be a closed stressed (or formerly stressed) syllable elsewhere in the word. Compare the words in (55a) with (55b). Stress on the initial syllable in each suffixed word is eliminated because it is pretonic. In (55b), gemination doesn't occur because the stressed syllable in the bare word is not heavy.

(55)	a.	kánta	‘song’	kantákku	‘my song’
		maléffa	‘forgetting’	maleffámmu	‘your forgetting’
		máeypi	‘hot’	mæypín̄ɲa	‘hotter’ <sup>15</sup>
	b.	dúda	‘doubting’	dudámu	‘your doubting’
				* <i>dudámmu</i>	

As Chung (1983) points out, the effect of gemination is to maintain the weight of the stressed syllable. If the stressed syllable elsewhere in the word is heavy, the stressed syllable created by suffixation must also be heavy. Since suffixes relo-

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<sup>15</sup>*n̄ɲ* dissimilates to *nɲ*.

cate stress to the penultimate syllable, gemination of the suffix-initial consonant provides a coda for the new stressed syllable. (Crosswhite’s (1996) analysis of gemination follows this description closely.)

Secondary stress in a heavy syllable can also trigger gemination:

- (56) a. míbàtku ‘abounding in ships’  
           mìbatkónɲa ‘more abounding in ships’  
       b. mícòdda ‘abounding in green bananas’  
           mìcoddánɲa ‘more abounding in green bananas’

But this only holds if the secondary stress is cyclic. Rhythmic secondary stress does not trigger gemination. Although all the suffixed words in (57) have heavy stressed syllables, gemination is not possible because the heavy stressed syllables have rhythmic stress.

- (57) a. sitbésa ‘beer’                      sítbesá ‘his beer’  
       b. iskwéla ‘school’                    ìskweláɲa ‘his school’  
       c. cincúlu ‘fishing net’              cìnculúmu ‘your fishing net’

These patterns are entirely expected if gemination is a word-level process and rhythmic stress assignment is a postlexical process. When gemination occurs, the heavy syllables in (57) don’t have stress, so gemination fails in these forms. Once rhythmic stress is assigned, gemination—like umlaut—cannot reapply.



### 3.6.3.2 Vowel Lowering

Vowel lowering in Chamorro is a process whereby “[n]on-low vowels surface as mid in stressed closed syllables, and as high elsewhere” (Chung 1983:46). The forms in (58) illustrate this. Stress alternations yield changes in vowel height.

- (58) a. lápis ‘pencil’      lapéssu ‘my pencils’  
 b. maláegu? ‘wanting’      màlægó?mu ‘your (sg.) wanting’  
 c. hugáandu ‘playing’      hùgandónpa ‘his playing’

Like gemination, vowel lowering obligatorily targets cyclic secondary stress:

- (59) a. éttigu ‘short’      èttigónpa ‘shorter’  
 b. inéngulu? ‘peeping’      inèngulól?hu ‘my peeping’  
 c. óttimu ‘end’      òttimónpa ‘her end’  
 d. sénsin ‘flesh’      mísènsin ‘fleshy’

But it only optionally affects syllables with rhythmic secondary stress:

- (60) a. tintágu? ‘messenger’  
       tìntagó?ta, ‘our (incl.) messenger’  
       tèntagó?ta  
 b. mundóngu ‘cow’s stomach’  
       mùnduḡgónpa, ‘its stomach’  
       mònduḡgónpa  
 c. ispéyus ‘mirror’  
       ìspiyósna, ‘his mirror’  
       èspiyósna

If vowel lowering is obligatory at the word level but optional at the postlexical level, these facts are accounted for. Cyclic stress is assigned at the word level, so vowels in heavy syllables with cyclic stress must lower. But rhythmic stress is assigned only postlexically, so vowels in syllables with rhythmic stress are subject to optional lowering.

### 3.7 Conclusion

An initial look at umlaut in Chamorro suggests that it is truly noniterative in nature: umlaut seeks the stressed syllable, but only if it can be reached with noniterative spreading. This chapter has shown that umlaut can be accounted for without assuming a noniterativity requirement. When the stressed syllable is not adjacent to the prefix/particle from which [-back] might spread, umlaut fails not because the target of spreading is too far away, but because the form fails to meet the conditions that trigger umlaut.

The analysis developed here makes no use of foot structure. This is because I assume that Flemming (1994) is correct in his claim that Chamorro has trochees. If we assume instead that Chamorro has iambs (as suggested by the fact that pretonic syllables must be unstressed), then umlaut becomes a case of spreading within a foot and is amenable to the sort of analysis that Flemming adopts for similar phenomena. Such an analysis is obviously unavailable under a trochaic analysis, where umlaut always crosses a foot boundary and is banned when it does not do so. I have been unable to implement an analysis in OT that requires feature spreading to cross a foot boundary, so I am left to conclude that if Chamorro

indeed has trochees, an analysis like the one presented here must be correct.

Like Lango's vowel harmony, umlaut is driven by Positional Licensing. Pre-tonic syllables are weak in Chamorro, and to compensate for this the grammar requires a [-back] feature in this position to be linked to a root segment. As a result, when stress is not root-initial, umlaut is not motivated because the pre-tonic syllable is already part of the root, and the prefix is not pretonic. This analysis can be extended to account for optional umlaut on secondary stress, and to account for the different behavior of cyclic and rhythmic secondary stress it was necessary to invoke Stratal OT.

What of Conant's (1911) comparison between Chamorro and languages with full-blown vowel harmony, like Finnish, Turkish, and Hungarian? It is clear from the analysis developed here that characterizing Chamorro's umlaut as vowel harmony is misleading. Like Lango's vowel assimilation, Chamorro's umlaut is similar to vowel harmony only in that (i) it involves vowel assimilation, and (ii) the feature that spreads is often the active feature in harmony systems. At a formal level, umlaut, which involves attraction to prominence and is driven by Positional Licensing constraints, is quite different from vowel harmony, which involves a push toward vocalic homogeneity and is driven by constraints like ALIGN, SPREAD, AGREE, etc.

Aside from its apparent noniterativity (which is the basis for Chung's (1983) preference for "umlaut" over "vowel harmony"), the assimilation seen in Chamorro is typologically unusual in an important way: vowel harmony systems are typically either root-controlled or have a right-to-left directionality (Hyman 2008, to appear). Chamorro fits neither pattern. Viewed as vowel harmony, umlaut is ei-

ther prefix-controlled or left-to-right (or both), making it a highly unusual system. This is further evidence that umlaut is formally distinct from vowel harmony.

It is worth applying the same scrutiny to the term “umlaut.” Is there some common set of properties that unites the umlaut phenomena in Chamorro and Germanic languages? Perhaps, but just as it is a mistake to let our terminology blind us to important differences between Lango’s vowel harmony and standard cases of vowel harmony, we should not expect—or force—Chamorro and German umlaut to submit to similar analyses simply because they’re both called “umlaut.” It is true that the analysis of Chamorro umlaut presented here will not easily be transferred to German, but this is only a drawback if these two cases of umlaut are demonstrably the same phenomenon. I am not convinced that they are.<sup>16</sup>

This chapter’s investigation of Chamorro umlaut reveals that this phenomenon is not truly noniterative. The noniterative nature of umlaut is, like the noniterativity in Lango, a product of root-adjacency. LICENSE-Pretonic only requires [–back] to spread to the root, so spreading just one syllable rightward from a prefix is sufficient. Umlaut therefore shows emergent noniterativity in that the impetus for spreading is satisfied after the first iteration, not because of a stipulation for noniterativity. In fact, as was pointed out in Chapter 1, even a rule-based analysis of umlaut predicated on the rule in (61) claims that umlaut’s noniterativity is emergent. This rule is not self-feeding, so the iterativity specification for this rule is inconsequential.

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<sup>16</sup>Here are some ways in which German umlaut differs from Chamorro: In German, stress is clearly the target, and umlaut is triggered by suffixes. Unstressed vowels that fall between the stressed vowel and the triggering suffix are skipped over. See McCormick (1981), van Coetsem & McCormick (1982), and Klein (2000).

$$(61) \quad \begin{array}{c} V \ C_0 \ [_{\text{Root}} \ C_0 \acute{V} \\ | \ \text{---} \\ [-\text{back}] \end{array}$$

Lango’s harmony and Chamorro’s umlaut present the best non-tonal arguments for the reality of true noniterativity that I am aware of. Since these phenomena are amenable to analyses that do not invoke noniterativity, they do not constitute evidence against the Emergent Noniterativity Hypothesis. Moreover, the analyses developed in this chapter and the preceding one are more insightful than rule-based analyses that require noniterativity because they identify reasons besides an iterativity parameter that spreading stops after one iteration. This means that the analyses which support the ENH are an improvement on alternative rule-based analyses that would refute it. These OT analyses—and therefore the ENH—are therefore preferable to a theory of phonology that permits true noniterativity.

The results of the analyses of Lango and Chamorro lay the groundwork for the next chapter, in which noniterative tonal phenomena are considered. If true noniterativity outside of tone is unattested, it is worth investigating whether the same can be said for tone.

# TONAL NONITERATIVITY

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## 4.1 Tone Spreading and Shifting

There are many claims for many languages to the effect that a tone spreads or moves by one syllable, typically to the right (Hyman & Schuh 1974). To pick just one example, Myers (1987) uses both iterative and noniterative rules to account for various tone spread phenomena in Shona. As Kisseberth (2007:663) states in his recent review of Yip (2002), “the proper way to get at [noniterative tone shift] is a significant issue in OT.” A completely satisfactory account of such phenomena within OT has so far eluded phonologists. This chapter adds to research in this area by building on the reasoning that motivates this dissertation as a whole.<sup>1</sup>

If, as I have argued in previous chapters, the appearance of noniterativity elsewhere in phonology is the result of factors that do not explicitly call for noniterativity, we might ask whether or not similar conclusions can be drawn for tonal phenomena. This chapter investigates noniterative tonal phenomena with this question in mind. I present two very different analyses that aim to reduce tonal noniterativity to a confluence of factors that do not explicitly require noniterativity.

The first analysis, which is based on what I will call Peak Delay Theory (PDT),

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<sup>1</sup>I am grateful to Larry Hyman and Michael Marlo for their thoughtful comments on an earlier draft of this chapter.

builds on work suggesting that noniterative tonal phenomena reflect facts about phonetic implementation and not the languages' phonological grammars. The evidence for this view from two languages, Chichewa (Myers 1999) and Kinyarwanda (Myers 2003), is compelling. I argue below that it is worth viewing all noniterative tonal phenomena in this light, although whether all relevant cases are actually inherently phonetic remains an open question that can only be answered by future phonetic and experimental work.

The other approach is couched within Optimal Domains Theory (ODT), a framework developed by Cole & Kisseberth (1994, 1997, 1995) as a way of understanding opacity and transparency in harmonic systems and extended to tonal phenomena by researchers such as Cassimjee (1998), Cassimjee & Kisseberth (1998), and Downing (2008).<sup>2</sup> This theory rejects Autosegmental Phonology's formalism of features and tones as autosegments that are associated with individual timing units. Instead, abstract domains corresponding to specific features are posited, much like feet, and features can be realized or not in their corresponding domains. Spreading results when a domain extends beyond the input featural "sponsor" and each host within the domain expresses the feature. Shifting is similar except that only one host within the domain expresses the feature. Transparency and opacity result when a host is barred from expressing a feature. For noniterative tone spread and shift, Cassimjee & Kisseberth (1998) posit a constraint requiring non-unary domains. To satisfy this constraint, bimoraic domains are built, and tones are either expressed on both units in the domain (spreading) or just one of them (shifting).

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<sup>2</sup>I thank Laura Downing for reminding me of the relevance of ODT to this chapter.

Both the peak delay analysis and ODT are appealing in various ways, but each has shortcomings. With this in mind, a lack of conclusive evidence for one over the other prevents a choice between these alternatives from being made here. It should be stressed, however, that either theory supports the Emergent Noniterativity Hypothesis in that neither stipulates noniterativity. Movement or spreading of a tone by one syllable or mora is produced by independent principles. The choice between these theories is immaterial for the purposes of this dissertation, although I argue for PDT elsewhere (Kaplan 2008b).

If these proposals prove unsatisfactory and no suitable alternative can be found, we have the option of concluding that tone is simply different from other phonological entities in that it manifests true noniterativity after all. This would be a disappointing result: As Autosegmental Phonology has developed, tones have been increasingly viewed as rather closely related to segmental features in that, as autosegments, both tones and features can behave as autonomous units that are independent of the timing units that host them. It might be a step backward to conclude now that tones and features really are formally different entities after all. But this might be the conclusion we are led to. In this case, the ENH should be revised as in (1):

- (1) **Emergent Noniterativity Hypothesis (possible revision):** *No **non-tonal** formal entity in phonological grammars may require noniterativity.*

We can then posit markedness constraints for tone that access the input and can therefore require noniterativity. The next question we should ask is why tone should be exempt from the ban on formal noniterativity. What makes tone



so special that it can do what featural assimilation, foot assignment, syllable construction, etc., cannot? No obvious answer presents itself, so we are left no more enlightened (and actually significantly less enlightened, I would argue) than we are if we assume that tone is not in fact exempt from the ENH and seek alternative explanations for the apparent counterexamples.

Philippson (1998) explicitly argues for a conceptual dichotomy between iterative (“unbounded”) tone spread/shift and noniterative but otherwise identical phenomena. For an example of the latter, in Kikuyu, tones appear one syllable to the right of their underlying hosts (Clements 1984, Clements & Ford 1979; data from Clements 1984). The data in (2) show this for verbs.

- (2)    *to rər ay a*            ‘we look at’  
           *to mo rər ay a*        ‘we look at him/her’  
           *to ma rór ay a*        ‘we look at them’  
           *má rór ay a*            ‘they look at’  
           *má mó rər ay a*        ‘they look at him/her’  
           *má má rór ay a*        ‘they look at them’

The first two forms establish that the root *-rər-* ‘look at’ and the object prefix *mo-* ‘him/her’ are low-toned morphemes. In the third form, the introduction of the object prefix *ma-* ‘them’ causes a high tone to appear on the root. The conclusion we’re led to is that this H is part of the object prefix and shifts to the following morpheme. Similarly, when the subject prefix *ma-* ‘they’ appears instead of *to-* ‘we’ in the last three forms, the following morpheme surfaces with a high tone. Again, since we’ve already seen that *-rər-* and *mo-* are low-toned, the

obvious conclusion is that the subject prefix supplies the H, which links not to the subject prefix but to the following morpheme (and then, in Clements & Ford's (1979) and Clements's (1984) analyses, spreads leftward back to the subject prefix so that this morpheme isn't left toneless). In the last form, both high-toned *ma*-prefixes are present (one the subject, the other the object), and H appears on the morpheme following each prefix.

Similarly, a high-toned root such as *-tom-* 'send' causes the following morpheme to surface with H. The data in (3) show this. Whereas the habitual suffix *-ay-* was low-toned throughout (2), here it is high-toned because the preceding morpheme now contributes a high tone.

- (3) to tom áy a            'we send'  
       to mo tom áy a        'we send him/her'  
       to ma tóm áy a        'we send them'  
       má tóm áy a            'they send'  
       má mó tom áy a        'they send him/her'  
       má má tóm áy a        'they send them'

Both Clements & Ford (1979) and Clements (1984) produce this pattern with an early rule that associates the first tone, whether H or L, to the second tone-bearing unit (TBU). The normal tone association conventions subsequently apply, with the second tone associating to the third TBU, etc. Then, since the first TBU was skipped, a repair rule spreads the first tone leftward back to this TBU.

The same thing occurs in nouns. For example, the root in *mo-yatě* 'bread' (where the root is preceded by a noun-class prefix) belongs to the tone class

LH. But instead of associating with the first root syllable, L associates with the second syllable along with H. Clements’s account for this form works as follows: The prefix (like all noun-class prefixes) contributes a low tone of its own. As with verbs, the first tone—here the prefix’s L—associates with the second TBU. This means that the first root syllable bears the L of the prefix, and the root’s final syllable bears the root’s LH. The first L then spreads leftward to the prefix.

Similarly, in Chichewa (Hyman & Mtenje 1999, Kanerva 1990, Moto 1983, Mtenje 1987, Myers 1999, Myers & Carleton 1996, Peterson 1987), it is claimed that “a high tone spreads rightward onto the following syllable *only if the high tone is not in the last three syllables of a phrase*” (Myers 1999:215; emphasis original). Mtenje (1987:174) specifically identifies this as the product of a noniterative rule. Compare the pairs of examples in (4). In each pair, the first item has a high tone in the antepenultimate syllable of the phrase, and the tone does not spread. But when the phrase or word is lengthened, as in the second items, the high tone is no longer in the phrase’s last three syllables, so it spreads to the following syllable:

- (4) a. mtsíkaana            ‘girl’  
           mtsíkána uuyu      ‘this girl’
- b. zidzábeera        ‘they will steal x for/with you’  
           zidzábéraana      ‘they will steal x for each other’

It is reasonably common to encounter diachronic explanations for this kind of phenomenon (e.g. Schuh 2005, 2007, Silverman 1997) grounded in “peak delay” (e.g. Myers 1999). Spreading and shifting begin, as the claim goes, with tones

spilling over into adjacent syllables. For shifting, eventually this leads to the pitch target being reached only in the adjacent syllable. A generation of learners encounters this situation and mistakenly assumes that these tones are actually moving or spreading, when they are actually simply not being articulated strictly within the boundaries of their hosts. This is a straightforward and appealing explanation, but it leaves an important question unanswered: When these learners assume that they've encountered spreading or shifting, what exactly do they add to their grammars? There may be clear diachronic reasons for these phenomena, but they don't explain how speakers produce them in their synchronic grammars.

The most obvious solution is to posit a noniterative rule or other mechanism that produces the shifted tone.<sup>3</sup> But if noniterative mechanisms are unavailable to phonological grammars, this cannot be the correct solution. In the first part of this chapter I argue that phenomena like Kikuyu's tone shift are phonetic at root. There is no active phonological process in Kikuyu that docks tones one syllable to the right of their expected hosts. Rather, the phonetic pitch correlate of a tone is delayed, resulting in the pitch peak being realized on the following syllable.<sup>4</sup> This is the conclusion that Myers (1999) draws, based on phonetic data, for Chichewa: The spreading illustrated in (4) is not phonological spreading, but rather phonetic

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<sup>3</sup>However, if tone shift involves the lexical tone pattern in monomorphemic contexts (or solely within morphemes) in a language being shifted one syllable (or other unit) to the right compared to related languages, analysis is trivial. This is part of the situation in Kikuyu (Schuh 2007). For example, the tonal pattern in the Kikuyu form *mòtě* 'tree' appears to be shifted to the right compared to the cognate from Mwimbi, *mòté* 'tree.' In languages where this is the entire story, the solution is rather simple: lexical representations are simply different, and the surface forms reflect this. Unfortunately, this is not the entire story in Kikuyu, as the discussion above makes clear. Schuh (2007), in contrast, argues that a tone-shift pattern in Ngamo that is very similar to Kikuyu's pattern is purely a diachronic effect, in which case it is subject to this simple analysis.

<sup>4</sup>I use the term "peak" for both the  $f_0$  maximum for high tones and the  $f_0$  minimum for low tones. The analysis is easily extendable to other tone levels.

encroachment of one syllable's H onto the next syllable.

However, while it might be tempting to chalk up tone shift to peak delay entirely and absolve phonologists of any analytical responsibility, there is evidence that peak delay is at least somewhat phonologically controlled. For example, while a historically final H in Kikuyu docks onto the word-final syllable to create a rising contour tone with the preceding shifted (and historically penultimate) L as in (5a), a historically final L does not appear on the final syllable. Instead, as (5b) shows, this displaced L remains afloat, as evidenced by the downstep it induces on the following word. The forms in (5c) verify that the initial words in in (5b) are responsible for the downsteps.

- (5) a. moyatě 'bread'  
       némátéŋerayã 'they run'  
       némátómírě 'they sent'
- b. moayáhijá 'né moeyá 'the weakling is good'  
       kariokí 'né moeyá 'Kariũki is good'  
       keayárarɔ 'né keeyá 'the stile is good'  
       βiriβiri 'né ɲeyá 'chillies are good'
- c. moβake né moeyá 'the tobacco-plant is good'  
       βaŋgírí né ɲeyá 'bangles are good'

The downstep indicates that there is a phonological floating L, and in fact this L is quite mobile under certain conditions (Clements & Ford 1981, Clements

1984, Clements & Ford 1979). For example, as Clements & Ford (1981) describe it, the downstep operator (which they do not explicitly identify as L, although other research cited in this paragraph makes this connection) may move from the right edge of a [+assertive] verb to the right edge of the verb's complement. This is illustrated in (6) with examples drawn from Clements & Ford (1981). In (6a), the matrix verb lacks a complement, so it induces downstep on the immediately following word. The verb in (6b) has a complement (*móγeraniá* 'examiner'), and its downstep operator moves to the right side of this complement and triggers downstep on the word after the complement. The same verb appears in (6c), but here it is not [+assertive]. Its downstep operator cannot move across the NP complement and therefore stays on the verb.

- (6) a. nderá:kamíre <sup>1</sup>kɪŋa áké<sup>1</sup>rúγá mbó:có  
 I-milked until he-cooked beans
- b. ndɔ:niré móγeraniá <sup>1</sup>ðéine oá nóm̩ba  
 I-saw examiner inside house
- c. ndioní<sup>1</sup>re móγeraniá ðéine oá nóm̩ba  
 I-didn't-see examiner inside house

Were the downstep-inducing L associated with the verb-final syllable in (6b), it would be expected to be bound to this word and unable to travel across the NP complement. It is therefore not tenable to claim that this L is phonologically associated with the word-final syllable while its associated pitch trough is simply unrealized by the phonetic component since there's no following syllable in the word. We must derive a phonological representation that includes a floating L.

Consequently, the PDT analysis developed in this chapter attributes what has

been called tone shift to peak delay, but this peak delay is itself controlled by the grammar. This approach is very similar to the one taken by Gafos (1999), who uses formal constraints on articulatory gestures to produce phonological phenomena. An even closer predecessor is Xu & Wang (2001). The analysis below also builds on Morén & Zsiga (2006) and Zsiga & Nitisaraj (2007), who seek to transparently connect the seemingly complex pitch patterns in Thai to simple phonological representations, and especially Li (2003), who adopts constraints on phonetic implementation (as distinct from formal tone association) in an OT analysis of Mandarin tones. The upshot, with respect to (5b), is that the grammar blocks an L whose associated pitch contour will not be realized from being associated with any TBU. On the other hand, a high-ranking constraint banning floating high tones requires the creation of a contour in (5a).

Of course, the claim that Kikuyu's tone shift is inherently phonetic is subject to experimental verification. One interesting consequence of placing peak delay in the grammar is that a simple reranking of constraints can produce phonological tone shift under pressure from the constraints responsible for peak delay. This means that whether or not tone shift is purely phonetic, an analysis that treats it as driven by phonetic considerations can account for it.

A treatment of all examples of tonal noniterativity and its interaction with the larger tonal systems in which they are found would be a worthwhile endeavor, but it deserves an entire dissertation of its own. My goals here are much more modest—a demonstration that analyses compatible with the ENH are possible—so I will only discuss Chichewa and Kikuyu in any detail. See Myers (2003) for another application of (what amounts to) PDT in another language, and Cassim-

jee & Kisseberth (1998) for detailed analyses of languages in ODT.

It is worth emphasizing that I do not claim that all cases of tone spread/shift—bounded or not—fall under the purview of the PDT or ODT analyses developed below. Many phenomena submit to wholly different analyses, and I discuss some salient examples in §4.8 below. For example, tones are often attracted to specific position in a word such as the stem-initial or -penultimate syllable. Rather than coopting the analyses developed here for such phenomena, and it seems better to account for them with constraints requiring edge-alignment or coincidence with specific positions. PDT and ODT may eventually prove applicable to (some of) these cases, but here I wish to pursue the more modest hypothesis that they're relevant to phenomena for which one might be tempted to write a truly noniterative rule.

The chapter is organized as follows: In §4.2, I discuss the existing research that establishes the reality of peak delay. In §4.3, I develop an analysis of Chichewa tone spread based on this research, and §4.4 presents a similar analysis of Kikuyu's tone spread. In §4.5, ODT analyses of Chichewa (§4.5.1) and Kikuyu (§4.5.2) are developed.

## 4.2 Peak Delay

Peak delay is a phenomenon whereby the  $f_0$  target for a tone is reached some time after the beginning of the syllable with which that tone is associated. The peak may appear sometime late in the host syllable, or it may appear in the following syllable—i.e., the  $f_0$  target for a high tone need not fall within the (phonologically)



high-toned syllable. (All studies of peak delay that I am aware of focus on high tones.) Both patterns may occur in a language. As I describe below, in both English and Chichewa, a high tone's peak by default appears in the syllable after the stressed or high-toned syllable, but under certain circumstances, it falls within the high-toned syllable itself.

Peak delay has been reported for a variety of languages, including English (Silverman & Pierrehumbert 1990, Steele 1986), certain dialects of Swedish (Bruce & Gårding 1978), Danish (Thorsen 1978), Navajo (deJong & McDonough 1993), Spanish (Prieto et al. 1995), Mandarin (Li 2003), and Chichewa (Myers 1999). See also Ladd (1983) for explicit discussion and analysis of delayed peaks. Morén & Zsiga (2006) find perseverative coarticulation of tones in Thai that resembles peak delay, although they argue against peak delay as an explanation for that particular phenomenon. In this section I discuss the English and Greek cases. Chichewa is discussed in §4.3.

Silverman & Pierrehumbert (1990) investigate the timing of prenuclear H accents in English. They find that the corresponding  $f_0$  peak appears at some regular interval after the beginning the stressed syllable (or more accurately, the beginning of the rime) with which the H is associated. The precise length of the delay depends on various factors. First, speech rate affects peak delay: When the stressed syllable is shortened in fast speech, peak delay is also shortened. Likewise, when slow speech increases the syllable's length, peak delay is also increased.

Second, word boundaries and stress clash affect peak delay. Word-final syllables are systematically lengthened, as are syllables at other syntactic and prosodic boundaries (e.g. Horne et al. 1995, Lehiste 1972, Lehiste et al. 1976, Lunden 2006,

Oller 1973, Wightman et al. 1992), and a stressed syllable that immediately precedes another stressed syllable is lengthened. But whereas lengthening caused by speech rate increases peak delay, lengthening caused by word boundary-adjacency and clash result in a proportionally shorter delay. While the reason for word-final peak delay reduction is not immediately clear, reduction due to clash is plausibly a result of the need to articulate two pitch targets in close succession. This can be facilitated if the first of these targets is shifted leftward. (This explanation, called “tonal crowding” by Myers (1999), is among the ones that Silverman & Pierrehumbert accept as a possible model of their findings.) One of the two subjects in the Silverman & Pierrehumbert study showed a gradient effect of clash: the closer the following stressed syllable was, the greater the reduction in peak delay.

If the stressed syllable is neither word-final nor subject to clash, the  $f_0$  peak typically falls in the syllable after the stressed syllable. Both word boundaries and clash can push the peak leftward, back into the stressed syllable.

Arvaniti et al. (1998) find that the high-tone target of Greek’s prenuclear accent, which they conclude is best represented as L+H\*, “is very precisely aligned just after the beginning of the first postaccentual vowel” (23). They show that peak timing is correlated with the duration of the interval from the onset of the accented syllable to the beginning of postaccentual vowel. That is, in ... [C $\acute{V}$ C]V..., where  $\acute{V}$  is the accentual vowel, the peak’s timing is correlated with the bracketed interval. Arvaniti et al. argue this model is better than a model that ties peak timing to the duration of the postaccentual vowel itself. The superiority of the first model over the second indicates that even though the tone’s peak appears after the accented syllable, it is still timed with respect to (and perhaps associated

with) that syllable. That is, we have a case of peak delay. Arvaniti et al. also argue that the peak's "alignment is probably phonologically, rather than phonetically, conditioned" (17) since it is aligned with respect to a phonological unit (the accented syllable) rather than a phonetic property of the utterance.

They also find tonal crowding for some speakers, whereby the prenuclear H is articulated earlier or with an attenuated pitch rise when another accent follows closely. Closeness of the following accent is determined by the number of intervening unaccented syllables, not a phonetic temporal measurement. Arvaniti et al. again point out that articulation of the prenuclear H is affected by phonological, not phonetic, factors. Their results are important for the analyses presented below because they establish that attributes that might be extra-grammatical artifacts of phonetic implementation (a lag in producing the target pitch or adjustments in the articulation of one pitch target to facilitate articulation of the following target) are sensitive to phonological properties and may therefore be governed by the phonology itself. This is the position I take later in this chapter.

Why does peak delay occur? Articulatory and perceptual answers are found in the literature. Myers (1999:224) speculates that "the vocal fold adjustments that determine  $f_0$  modulation are more sluggish than the supralaryngeal gestures that define the syllable." In other words, executing a high tone's  $f_0$  rise is inherently harder (as measured by the time required for the gesture) than gestures associated with other phonological units. Other researchers (Ohala & Ewan 1973, Sundberg 1979) offer similar physiological explanations.

Myers also cites work showing that the rise in pitch, as opposed to the  $f_0$  peak itself, is an important perceptual cue to the presence of a high tone. He notes that

“ $f_0$  cues are more easily perceived in regions of relative spectral stability, as in the midpoint of a vowel” (Myers 1999:224). Coordinating the  $f_0$  rise with the end of the syllable places an important perceptual cue in a position that maximizes its perceptual salience. A side effect of this alignment is that the  $f_0$  peak occurs late in the syllable or even in the next syllable.<sup>5</sup>

If either hypothesis is correct, we have an answer to a puzzle: Why are apparently noniterative processes particularly common for tone compared to other domains? That is, why do we find many cases of tone shift/spread by one syllable, but so few cases in which, say, vowel height spreads or moves by just one syllable? If noniterative tone spread/shift is a consequence of peak delay, then the answer is that only tone is subject to the articulatory or perceptual factors that give rise to a lag in timing, or at least that these factors are greater for tone than for other phonological entities. The hypotheses sketched above predict either that the articulators that control pitch are more sluggish than those that control vowel height, or that perception of vowel height is less dependent upon alignment with some other acoustic unit.

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<sup>5</sup>Evidence, perhaps weak, for this hypothesis comes from the observation in Prieto et al. (1995) that when factors like clash and word or phrase boundaries trigger a reduction of peak delay in Spanish, rather than the whole  $f_0$  articulation being shifted leftward, the beginning of the pitch rise is held constant and the rising slope becomes steeper. This means that under pressure, the  $f_0$  rise is executed more quickly, showing that the normal, unshifted peak delay doesn't represent the speaker's fastest possible  $f_0$  rise. However, this could also mean only that the default tonal articulation is comparatively sluggish but, like other gestures, can be sped up if necessary (e.g. under fast speech).

## 4.3 Peak Delay in Chichewa

### 4.3.1 Tone Spread as Peak Delay

Myers (1999) applies the findings summarized in the previous section to purported tone spread in Chichewa. This language has a privative tonal contrast between H and  $\emptyset$  (Kanerva 1990, Myers 1999); Myers (1999) notes that non-high-toned syllables have no pitch target, and instead acquire their pitch properties through interpolation from surrounding high-tone targets.

Both Kanerva (1990) and Myers (1999) take the TBU of Chichewa to be the mora, yet the latter showed that tones are most reliably timed with respect to syllables. Mtenje (1987) adopts syllables or vowels as the TBU. I will adopt a compromise: The mora is the TBU, but constraints can make demands about tones' (and their corresponding phonetic implementations') syllabic constituency—i.e., constraints can require or prevent association with (moras in) particular syllables. Also, throughout the analysis, I distinguish abstract tones (H, L, M, etc.) with formal autosegmental associations to TBUs from their phonetic pitch implementations, which have no formal autosegmental associations (although they “belong” to particular tones, of course) but merely temporally coincide with other elements such as syllables.

The data from (4), repeated and expanded in (7), illustrate the spreading of high tones one syllable rightward from a syllable that is not one of the last three syllables in a phrase.

- (7) a. mtsíkaana                    ‘girl’  
      mtsíkána uuyu                ‘this girl’

- b. chigawée<sup>n</sup>ga                    ‘terrorist’  
       chigawé<sup>n</sup>gá iichi            ‘this terrorist’
- c. zidzábeera                    ‘they will steal x for/with you’  
       zidzábéraana                ‘they will steal x for each other’
- d. mte<sup>n</sup>go wá dee<sup>n</sup>gu            ‘price of basket’  
       mte<sup>n</sup>go wá dé<sup>n</sup>gu iili        ‘price of this basket’  
       mte<sup>n</sup>go wá <sup>n</sup>thíwatiiwa      ‘price of ostrich’
- e. tinabá dee<sup>n</sup>gu                ‘We stole the basket.’  
       tinabá dé<sup>n</sup>gu iili            ‘We stole this basket.’  
       tinabá <sup>n</sup>thíwatiiwa        ‘We stole the ostrich.’

The data in (8) further illustrate the lack of spreading from the last three syllables in a phrase. No examples of phrase-final tones are available because such tones retract to the penultimate syllable.

- (8) dzíina      ‘name’  
       mtée<sup>n</sup>go    ‘tree’

My understanding is that Kanerva’s (1990) Focal Phrase is the relevant phrasal category. Aside from the lack of tone spread, two processes are characteristic of the right edge of this phrase. First, phrase-penultimate vowels are lengthened,

as can be seen in the data above. Second, phrase-final tones are retracted to the penultimate syllable:

- (9) a. mle<sup>n</sup>dó uuyu    ‘this visitor’  
          mleé<sup>n</sup>do        ‘visitor’
- b. pezá nyaama    ‘find the meat!’  
          peéza            ‘find!’

Both Myers (1999) and Kanerva (1990) transcribe retracted tones over the second half of (lengthened) penultimate vowels as in (9). Kanerva explicitly claims that this is the position to which tones retract (as opposed to the first half of the vowel), but Myers mentions some variability. He notes that two of his subjects produced retracted tones early in the penultimate syllable and thus exhibited neutralization with lexical penultimate tones such as those in (8). The third subject’s retracted tones were instead articulated later in the penultimate syllable. Myers suggests that the third subject retracted tones to the penultimate syllable’s second mora, which would motivate his and Kanerva’s transcriptions. The issue makes little difference for the analysis developed here, and I give transcriptions as they are provided by each author. But for simplicity, I adopt in my analysis the timing of Myers’s first two subjects with retraction to the first half of the long vowel. I will note analytical adjustments that are required by the other pattern (which I assume is a different dialect) where applicable. (See also Hyman & Mtenje (1999). While silent on the specific question at hand, they note that at least one dialect of Chichewa lacks retraction altogether.)

Myers's experimental data suggest that "high tone spread" is better characterized as peak delay.<sup>6</sup> For high-toned medial syllables (i.e. those from which H can spread), the tone's peak is regularly achieved only in the following syllable (i.e. the target of spreading). But the timing of the peak is still correlated with properties of the first syllable, primarily that syllable's duration. Furthermore, if Chichewa has genuine (phonological) tone spread, we might expect peak duration to be longer in spreading contexts than in non-spreading contexts since tones in the former context are, by hypothesis, linked to two syllables while the latter are linked to just one. Myers points out that while one of his two subjects show this pattern, the difference in duration (26.2ms in spreading contexts, 21.3ms in non-spreading contexts) does not approach the 2:1 ratio that would be naively expected of H linked to two TBUs versus H linked to one TBU. For the other subject, these tones' durations were 23.0ms in spreading contexts and 25.1ms in non-spreading contexts. This difference trends in the wrong direction, but it is not statistically significant. The importance of the second subject's data is that it does not remotely exhibit the expected timing difference.

Thus Myers identifies two measurable properties that might be expected of spreading tones—articulations that are timed with respect to their new hosts and greater durations compared to non-spreading tones—and he finds neither. From these data, Myers concludes that H does not in fact spread. It is formally associated only with its original host syllable, but phonetic implementation of the H leads to the impression that spreading has occurred.

Myers also has explanations for the lack of (supposed) spreading from the final

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<sup>6</sup>DeJong & McDonough (1993) make the same conjecture about Navajo.



three syllables in a phrase. First, spreading from phrase-penultimate syllables is not reported by transcribers because these syllables are lengthened. This means that even with peak delay, a penultimate high tone's peak is contained within its host syllable. That is, with penultimate lengthening, peak delay does not result in the peak falling in the following syllable. Furthermore, both Silverman & Pierrehumbert (1990) and Myers (1999) found a reduction of peak delay in lengthened syllables, a pattern which would increase the likelihood that a penultimate H's peak would appear in that syllable.<sup>7</sup>

Spreading from phrase-final syllables is unattested because H in this position is retracted to the penultimate syllable (see (9) above). An explanation of these tones reduces to the explanation given in the previous paragraph. (The same sort of measurements that lead Myers to conclude that spreading doesn't occur leads him to the conclusion that retraction is a real phonological process: Phrase-final H is timed with respect to the penult.)

Finally, Myers (1999) speculates that the lack of spreading from antepenultimate syllables is due to "tonal crowding." Other researchers (Arvaniti et al. 1998, Silverman & Pierrehumbert 1990) have found that "peak delay is reduced if another  $f_0$  target immediately follows" (Myers 1999:225). Boundary tones at the end of the phrase could lead to a reduction of peak delay in nearby syllables. Since Silverman & Pierrehumbert (1990) observed tonal crowding even when the two high tones were not syllable-adjacent, it is not unreasonable to think that it is applicable to Chichewa's antepenultimate syllables. See Myers (2004) for discussion

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<sup>7</sup>For the dialect with retraction to the penultimate syllable's second mora, the lack of spreading can be attributed to tonal crowding (see below) and the reduction of peak delay in lengthened syllables.

of the long-distance effects of boundary tones. Since boundary tones mark phrase boundaries, it is important that their articulations not stray too far from these boundaries. So when lexical and boundary tones are too close together, adjusting the articulations of the lexical tones (which mark lexical contrasts, not prosodic landmarks) might be less deleterious than adjusting the boundary tones. Tonal crowding may also contribute to the lack of spreading from penultimate syllables.

Another factor that Myers doesn't consider is the phrase boundary itself. Prieto et al. (1995) report that in Spanish, the closer a stressed syllable is to the end of a phrase, the shorter the observed peak delay becomes. Perhaps similar facts hold in Chichewa and contribute to the lack of tone spread at phrases' right edges.

If we take the relationship between tones' formal associations and their phonetic realizations to be non-arbitrary, Myers's data indicates that there is no tone spread in Chichewa to be analyzed. Only tones' retraction from final syllables is a phonologically real phenomenon, and that is analyzable as a Non-Finality effect. This means that Chichewa presents no counterexample to the ENH.

Of course, it remains to be seen if other cases of noniterative tone spread have similar phonetic properties. Citing data similar to the results he presents for Chichewa, Myers (2003) argues that leftward tone spread in Kinyarwanda is also a phonetic phenomenon. This time, a high tone's peak is not delayed to the following syllable, but its "onset"—the rise in pitch at the beginning of its articulation—falls in the preceding syllable. This is anticipatory coarticulation, Myers argues, not typologically unusual leftward tone spread.<sup>8</sup> As mentioned

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<sup>8</sup>Although this paragraph—and Myers's research—suggests a close connection between leftward and rightward tone spread, others, such as Hyman (2007), argue that these processes result

above, deJong & McDonough (1993) suggest that peak delay may be responsible for tone spread in Navajo.

Cassimjee & Kisseberth (1998:28) report informal anecdotal evidence for other languages that points toward a PDT analysis of these languages. Citing personal communication with David Odden, they state that in Kijita, which has rightward tone shift like Kikuyu, the original tone's host "is not fully low – rather, just not as high in pitch as the second mora." This is clearly reminiscent of Myers's (1999) description of Chichewa: The high tone hasn't moved (as evidenced by the onset's alignment with the original host), but its peak is simply delayed to the following syllable. Cassimjee & Kisseberth go on to say that they noticed something similar in the Imitthupi dialect of Emakhuwa, but in the Eerati dialect of Emakhuwa, the original host syllable is "fully low" and the following syllable is "fully high." Also, Michael Marlo (p.c.) reports similar observations for Lumarachi that may also be manifestations of peak delay. Myers's (1999, 2003) experimental results suggest that impressionistic data about tonal affiliation is unreliable, so these claims require further study. But they indicate that PDT may be applicable beyond the two languages that Myers has investigated.

Adopting a PDT treatment of Chichewa is not merely an analytical shortcut. As explained in the next section, it permits a better understanding of other tonal phenomena in the language. Nor is a PDT treatment of Chichewa necessarily a claim that there is nothing phonologically real about the phenomenon that has been called tone spread. I argue in §4.4 that it is possible to incorporate peak delay into a formal analysis; The account of Kikuyu developed there is extendable from quite different factors.

in obvious ways to Chichewa. A formal analysis of Chichewa is not presented here, as it would bog down the discussion and detract from the larger goal of this chapter, which is to offer possible analyses of tonal phenomena that do not invoke noniterativity. See Kaplan (2008b) for this analysis.

### 4.3.2 Peak Delay and the OCP

Evidence that Chichewa's tone spread is phonetic comes from its interaction with the OCP. As Kanerva (1990) shows, adjacent high tones are generally not permitted in Chichewa. Like many other Bantu languages, Chichewa has a process, known as Meeussen's Rule, by which the second of two high tones that are linked to adjacent TBUs is deleted.<sup>9</sup> This (as Kanerva points out) is probably best understood as a product of the OCP (Leben 1973). (10) illustrates the deletion pattern.<sup>10</sup>

- (10) a. on-aan-a            'see each other'  
           on-aán-e            'see each other (subjunctive)'  
       b. ʰd-aa-dya            'I-Perf-eat'  
           ʰd-a-líi-dya            'I-Perf-5OM-eat'  
       c. ʰdi-líi-dy-e            'I-5OM-eat-subjunctive'

The data in (10a) show that the subjunctive -é is high-toned. (Since these are citation forms and hence phrase-final, this H retracts.) Next, (10b) shows that

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<sup>9</sup>In certain conditions, the second H instead shifts rightward. I do not discuss this process here; see Chapter 6 of Kanerva (1990).

<sup>10</sup>Glosses follow those in Kanerva (1990). Numerals represent subject or object noun classes. For example, the morpheme *lí* '5OM' (which undergoes penultimate lengthening) is the noun-class 5 object marker.

the object marker *-lí* is also high-toned. But when these morphemes appear in adjacent syllables, as in (10c), only the object marker's H surfaces. We might expect a form like *\*<sup>n</sup>di-líí-dy-e*, where the subjunctive morpheme's tone retracts to the penultimate vowel, but since this results in two high tones on adjacent moras, the second one deletes.

As another example, (11a) shows that the reflexive object marker *-dzi-* carries a high tone (which undergoes the expected spreading) and assigns another high tone to the stem-penultimate syllable. But as (11b) shows, when the verb stem is monosyllabic, only the morpheme's own H surfaces. The one it assigns to the stem deletes because it is adjacent to the first H, either before penultimate lengthening (/y-a-dzí-dyá/) or after retraction (/y-a-dzii-dya/). Kanerva (1990:§2.2.4) provides ample additional evidence for OCP-induced deletion.

- (11) a. l-a-lemekeeza           ‘5-Perf-respect’  
           l-a-dzí-lémekéeza      ‘5-Perf-Refl-respect’
- b. y-a-dzii-dya           ‘9-Perf-Refl-eat’  
           z-a-dzii-pha          ‘10-Perf-Refl-kill’  
           u-ka-dzii-<sup>m</sup>va       ‘3-Cond-Refl-hear’

However, when two high tones occupy adjacent TBUs as a consequence of tone spread, no deletion occurs:

- (12) a. /bírimá<sup>n</sup>khwi/           → bírimáa<sup>n</sup>khwi  
           ‘chameleon’

- b. /<sup>n</sup>dí-ta-phíika/ → <sup>n</sup>dí-tá-phiika  
*'I-sequence perf.-cook'*
- c. /ch-a-dzí-sekétsa/ → ch-a-dzí-sékéetsa  
*'γ-Perf-Refl-laugh.Caus'*
- d. /mte<sup>n</sup>go wá galú uuyu/ → mte<sup>n</sup>go wá gálú uuyu  
*'price of this dog'*
- e. /y-á-i-kúlu/ → y-á-í-kúulu  
*'4-Asc-4-big'*

The noun in (12a) has underlying initial and penultimate high tones. In (12b), the tense marker *ta* assigns high tones to both the preceding and following syllables (indicated above as underlying tones). In (12c) the reflexive morpheme *-dzí-* bears H itself and assigns another H to the verb stem's penultimate syllable. In (12d), the associative marker *wá* and the following noun each has a lexical H. Finally, (12e) is an adjective, and I have been unable to find the details of its derivation or a full explanation of its gloss in Kanerva (1990), from which this form is taken. Nonetheless, Kanerva gives *y-á-i-kúlu* as the form's representation before spreading and penultimate lengthening occur. In all of these examples, the first H spreads to the syllable immediately before the second H. The resulting ostensible OCP violation is not rectified.

The analysis of tone spread adopted here predicts these facts. Rather than exhibiting (formal, phonological) tone spread, the examples in (12) display peak delay: The peak of the first high tone has been pushed into the syllable preceding the second high tone. The first high tone is not formally associated with the syllable before the second high tone, so there is no OCP violation, and deletion

is not motivated. The representations in (13) show the forms in (12) as they are produced by PDT. Underlining marks the extent of the phonetic implementation of the tone from onset to peak, with the peak marked by double underlining.

- (13) a. birimáa<sup>n</sup>khwi  
 b. <sup>n</sup>dí-ta-phíika  
 c. ch-a-dzi-sekéetsa  
 d. mte<sup>n</sup>go wá galú uuyu  
 e. y-á-i-kúulu

In a derivational approach, the correct tone patterns can be produced by ordering Meeussen’s Rule before tone spread (i.e. in a counterfeeding relationship). But this ordering is arbitrary<sup>11</sup>—the tone retraction rule could just as well be ordered after Meeussen’s Rule instead, and we’d find forms like \*y-a-dzií’-dya instead of (11b). For the peak delay approach, there is a principled reason that tone spread doesn’t trigger Meeussen’s Rule while tone retraction does: Only the latter actually manipulates tones’ associations, so of the two processes, it is the only one that might produce a configuration with two high tones formally associated with adjacent syllables.

Alternatively, the OCP violation caused by high tone spread could be resolved via fusion of the adjacent tones. But this solution seems unlikely in light of the evidence of above that OCP violations are resolved by deletion in Chichewa.

Kanerva (1990) posits another rule that is puzzling from the point of view of the OCP. When two high tones are separated by one mora, the first spreads to

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<sup>11</sup>It is also opaque, making it a marked ordering under the assumptions of Kiparsky (1971, 1973).

the intervening mora to create a plateau. In support of this, Kanerva (1990:65) gives data such as the following:

- (14) a. /mte<sup>n</sup>go wá galú/ → mte<sup>n</sup>go wá gáálu ‘price of the dog’  
 b. /tinabá galú/ → tinabá gáálu ‘We stole the dog.’  
 c. /ti-dzá-pezá/ → ti-dzá-pééza ‘we-Fut-find’

In each case, the final H retracts to the penultimate mora, and the first H spreads. This is not the same as the tone spread phenomenon considered above. The plateau process occurs even in the final three syllables of a phrase, and it requires an H after the spreading tone. Its effect is to create two high tones that are associated with adjacent TBUs, in direct contravention of the OCP. We seem to have a contradiction: Chichewa schizophrenically both actively eliminates such configurations (via Meeussen’s Rule) and actively produces them (via plateau).

Myers (1999) notes, however, that there are no low-pitch targets in Chichewa (hence the H vs.  $\emptyset$  rather than H vs. L tonal distinction). Syllables that are not specified as high-toned acquire their pitch values through interpolation. A toneless syllable between high tones will not have a pitch trough that is as pronounced as the trough in a similar syllable that is between other toneless syllables. In fact, one interpretation of the data in (14) is that a toneless syllable between two high-toned syllables shows sufficiently little pitch decrease as to be (impressionistically?) indistinguishable from a high-toned syllable. That is, the two high-pitch targets are not sufficiently separated to permit a noticeable descent toward neutral pitch. The plateau phenomenon is not a phonological rule, but a product of interpolation caused by two nearly adjacent high-tone targets and no intervening



low pitch target. This interpretation resolves the conflict mentioned in the previous paragraph by relegating the apparently OCP-flouting tone spread process to a non-phonological status. That is, by invoking interpolation, we can eliminate the rule that creates configurations that the language otherwise avoids. The forms in (14) comply with the OCP because there is in fact a mora separating the two high tones.

This is not the only possible characterization of plateau, of course. The OCP violation may be resolved by fusing the two high tones (as suggested by the lack of downstep between them; Bickmore (2000), Odden (1982)), although, as with the fusion approach to tone spread mentioned above, it is not clear why plateau induces fusion but other OCP violations trigger deletion. In other languages such as certain dialects of Emakhuwa (Cassimjee & Kisseberth 1999a,b), plateau effects are sensitive to morphological and moraic structure, and they can trigger or block other phonological processes. Such behavior points strongly toward a phonological plateau and away from interpolation.

In any case, the interest of these plateaus in the present context is that they do not surface when the configuration that triggers them is produced by tone spread. That is, high-tone spreading could in principle feed plateau creation, but it does not (cf. Lukhayo (Michael Marlo p.c.), where such feeding does occur). This is shown in (15).

- (15) a. /tinabá kalulú/ → tinabá káluúlu ‘We stole the hare.’  
 b. /mu-ná-lemerá/ → mu-ná-lémeéra ‘you.pl-past-be heavy’

Even though tone spread and retraction create two high-toned syllables that are separated by just one toneless mora, no plateau appears. This is not unexpected if both spreading operations involve manipulations of pitch contours rather than formal tone associations. If tone spread is just peak delay, then the two high-pitch targets are separated by two syllables. This means that pitch interpolation will not give rise to the appearance of a plateau: With more than one syllable between the two pitch targets, there is time for the pitch to drift toward the neutral position between these targets. Even if we take plateaus to be phonological, PDT can explain (15) because the two high-toned syllables are separated by two other syllables.

A derivational approach can account for (15) by ordering tone spread after creation of the plateau. But once again, this ordering is arbitrary and opaque, whereas no comparable arbitrary assumptions are needed under the peak delay analysis.

#### 4.4 Peak Delay in Kikuyu

In this section I apply the PDT approach to Kikuyu. Recall that a pervasive characteristic of Kikuyu is the shifting of tones one syllable to the right of their underlying hosts. The data from (2) and (3) are repeated below. The tone of each morpheme varies according to the identity of the preceding morpheme. We can tell that morphemes such as *-ma-* and *-tom-* are lexically specified with high tones, even though *-ma-* and *-tom-* may themselves surface low-toned, because when these morphemes appear, the following morpheme is always high-toned.



We cannot easily translate (17) into an OT constraint. The constraint producing tone shift must be a markedness constraint (since tone shift is clearly not the exponent of some faithfulness imperative), but there is no obvious markedness consideration that would motivate the first tone associating with the second TBU.

Fortunately, the peak delay facts discussed in §4.2 afford a solution. Without detailed phonetic information for Kikuyu of the sort that Myers (1999, 2003) brings to bear on Chichewa and Kinyarwanda, it is impossible to know whether Kikuyu's tone shift is phonetic or phonological in nature. Consequently, this section briefly considers two PDT analyses of Kikuyu tone shift, one that takes shifting to solely reflect peak delay, and another that produces phonological shifting of tones from one TBU to the next.

It is also here that we see how PDT can be implemented phonologically. Recall that tone shift leads to floating low tones in some cases, so if shifting is really just peak delay, the phonology must be aware of peak delay so that these low tones can be prevented from associating with TBUs. Under the hypothesis that Kikuyu's tone shift is an artifact of peak delay, the floating tones show that peak delay is not merely a low-level, extra-grammatical process.

The section proceeds as follows: §4.4.1 presents additional data to be accounted for. §4.4.2 presents the PDT analysis, and §4.4.2.2 shows how this analysis can produce the downstep facts illustrated in (5). §4.4.3 presents a revision of the PDT analysis that takes tone shift to be phonological, and §4.4.4 briefly shows how the formal PDT analysis is applicable to other tonal phenomena.

#### 4.4.1 Tone Shift in Kikuyu

Unlike Chichewa, Kikuyu has a phonological low tone: H contrasts with L rather than with the absence of tone. (Not every morpheme contributes a tone, so there are still toneless morphemes. But every syllable surfaces with some tonal specification.) The data below are taken from Clements & Ford (1981, 1979) and Clements (1984). For simplicity, I only indicate high tones except where this would create ambiguity.

Clements & Ford (1979) and Clements (1984) develop rule-based analyses of tone assignment in Kikuyu that are centered around tone shift. In this section I follow the latter's discussion of the data. I also follow Clements (1984) in adopting the syllable as the TBU (see also Kaplan (2007)).

The verbs in (16) illustrate tone shift, as do the nouns below:<sup>12</sup>

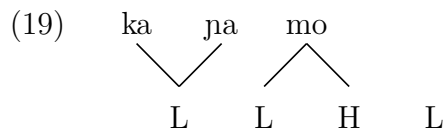
- |      |    |      |        |                |
|------|----|------|--------|----------------|
| (18) | a. | LL   | kemore | ‘torch’        |
|      | b. | LH   | moyatě | ‘bread’        |
|      | c. | HL   | moyeká | ‘rug’          |
|      | d. | HH   | mayokó | ‘bark’         |
|      | e. | LHL  | kapamö | ‘small animal’ |
|      | f. | HLHL | karání | ‘clerk’        |

Each noun stem contributes a specific tone pattern (indicated in the left-most column in (18)), and the noun-class prefix—the initial CV sequence in these examples—contributes an additional low tone. Tone assignment proceeds as fol-

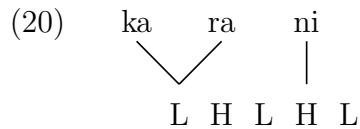
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<sup>12</sup>Clements (1984:284) states that the tone patterns illustrated in (18) “appear sentence-finally after affirmative verb forms that do not induce H Tone Spread upon following words.” Some of these patterns are changed in other contexts by rules that are not relevant here.

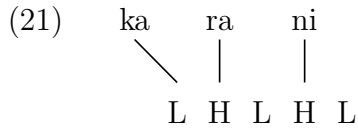
lows: The first tone—the L of the noun-class prefix—associates with the second syllable of the noun as required by (17). Subsequent tones associate to each of the following TBUs in a one-to-one, left-to-right fashion, with the last tone spreading to excess TBUs. The first tone spreads leftward, back to the word-initial syllable that was originally skipped. If there is a free H after all TBUs have been assigned a tone, this H docks on the final syllable, creating a contour as in (18b) and (18e). Free low tones remain floating and induce downstep, as was shown in (5) above. See also §4.4.2.2. To illustrate the tone-assignment schema, these rules yield the structure in (19) for (18e).



The exceptional behavior of *karání*, which we would expect to be (something like) *\*karani*, comes from an underlying association between the second H and the final syllable. Therefore, after the noun-class marker's L associates with the second syllable and spreads back to the first, we have the representation in (20).

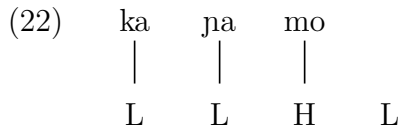


The first H then links to the second syllable by the same rule that creates a contour in (18b). This triggers delinking of the initial L from this syllable because contours are not allowed word-internally. Thus we end up with (21). As a full analysis of Kikuyu's tonal system would stray too far from the goals of this chapter, I will not consider exceptional cases like *karání* any further.



The verbal system is similar to the nominal system in terms of peak delay, but there are additional complexities. More morphemes are involved, and not all morphemes contribute a tone. The clearest evidence for tone shift was already presented in (16a) and (16b), and I will not recapitulate that here. The same principles are at work: The first TBU is skipped and is subsequently the target of leftward spreading, and other TBUs receive their tones via standard association rules. Excess low tones float, but excess high tones do not.

Before beginning the peak delay analysis, some technical issues must be dealt with. Since the analysis below takes tone shift to reflect peak delay, an unshifted representation is adopted for each form. For example, *kajamõ* is assumed to have the structure in (22) instead of (19). Because of peak delay, though, it appears that the first two low tones are associated one syllable rightward.



Also, I assume that a tone's phonetic onset begins as soon as the preceding tone's peak or trough is reached and thus coincides with the same mora that the preceding peak/trough coincides with. This is obviously an idealization since  $f_0$  targets can be maintained for some duration, but this assumption will streamline the analysis below and is necessary because of the lack of phonetic data about Kikuyu.

## 4.4.2 Tone Shift as a Phonetic Phenomenon

This section discusses Kikuyu tone shift under the assumption that this is a phonetic phenomenon in which the peak or trough of each tone appears on the syllable to the right of the one that hosts the corresponding H or L. Tones themselves do not shift. Obviously the viability of this analysis is contingent on verification of the phonetic nature of tone shift.

### 4.4.2.1 Peak Delay and Tone Shift

The claim advanced here is that what has been called tone shift in Kikuyu is really the same as tone spreading in Chichewa: both are grounded in peak delay. From a theoretical basis, Philippson (1998), e.g., argues that tone shift is just tone spread with an extra step: After a tone spreads to the adjacent TBU, its original association line is delinked. Beyond this representational connection, evidence that spreading and not shifting occurs in Kikuyu comes from word-initial syllables. In all of the examples given above in (16) and (18), the first syllable has the same tonal specification as the second syllable. This is expected under a spreading approach: The first syllable simply spreads its tone to the second syllable. But under a tone shift approach, where the first syllable is skipped altogether, this first syllable should surface either with an invariant default tone (if shifting is phonological; i.e. driven by (17)) or some neutral pitch level (if shifting involves displacement of the peak belonging to the first syllable's tone). That Kikuyu exhibits spreading is revealed by Clements's (1984) rule that spreads the initial tone leftward back to the syllable that was originally skipped (see (19)). This rule undoes the effect of tone shift; we might as well associate the first tone to the first



TBU and then spread that tone instead.

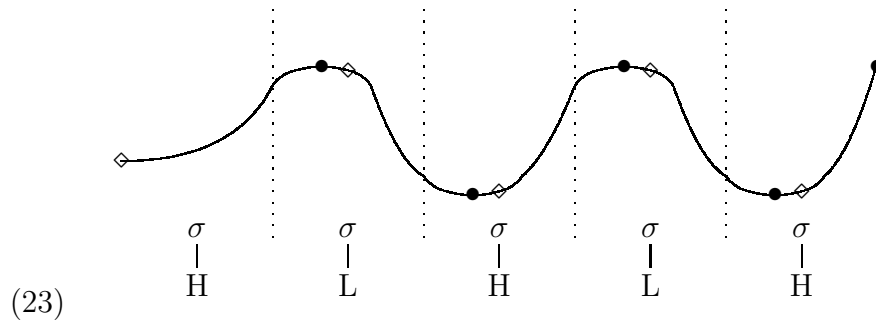
Under the analysis developed here, the details of the first two syllables of a word in Kikuyu are identical to the characterization of Chichewa's tone spread. The tone's onset appears on the first syllable, and Peak Delay requires the peak to be postponed until the next syllable.

Why, then, don't we find (reports of) spreading with all tones in Kikuyu? Since Kikuyu has phonological low tones, there are increased pressures in this language to avoid stretching out a tone's articulation for too long. Overextended articulations encroach upon neighboring tones and their own implementational requirements.

More specifically, consider the diagram in (23), which is a highly schematized representation of the pitch track for a Kikuyu word. Approximate locations of onsets are marked with  $\diamond$ , and approximate locations of peaks are marked with  $\bullet$ . These markers are merely an expository convenience and should not be interpreted as formal claims about where tonal articulations begin and end. In the first syllable, which is formally associated with a high tone, the onset for the tone begins in that syllable. Peak delay ensures that the peak is not reached until the second syllable. Once the peak is reached, the articulation for the low tone can begin immediately. The onset for the second syllable's low tone appears in that syllable, just after the first H's peak. This might mean that the trough associated with this L may appear in the third syllable while still providing sufficient distance between the onset and trough in accordance with peak delay—the low tone's trough is reached in the syllable after the one with which the L is associated.

Articulation of the third syllable's H cannot begin until this trough is reached.

This means that the onset for the H occurs in the third syllable, but again peak delay forces the peak into the fourth syllable. In the fourth syllable, the onset for the tone associated with this syllable again cannot begin until the peak from the first tone is reached. Peak delay forces the trough for the fourth syllable's L into the fifth syllable. In this syllable, which is the last in the form, the high tone's onset begins once the preceding L's trough is reached, at which point a steep rise is required: with no following syllable to host the H's peak, peak delay must be disregarded if the H's peak is to be articulated.



(It's important to keep in mind that this diagram and the ones below are merely idealizations that illustrate only the possible relative timing of peaks, onsets, and TBUs in a coarse way. I abstract away from factors like downdrift (Hyman & Schuh 1974). See, e.g., Myers (1999, 2003) for actual pitch tracks—from Chichewa—whose details I abstract away from here.)

Except for the first and last syllables, two important events occur in each syllable: the peak for the tone of the preceding syllable, and the onset for that syllable's own tone. The final syllable must also host its own tone's peak since there is no following syllable in which this peak can appear. These properties

give the impression of tone shift on each non-initial syllable, the appearance of a contour tone on the last syllable, and the impression of tone spread in the first syllable. The principles that drive this displacement are the same as the ones that drive peak delay in Chichewa, but “shifting” instead of “spreading” occurs because of the higher tonal density in Kikuyu.

(It is tempting to suggest that this reasoning holds universally: When there’s an H/∅ contrast we find spreading, and when there’s an H/L contrast we find shifting. But there is no such crosslinguistic correlation. Jita, for example, has a H/∅ contrast with tone shift (Downing 1996). Perhaps for Jita it is more accurate to claim that tone shift involves alignment of the tone’s onset with the end of the high-toned syllable. I won’t make this move for Kikuyu, however: Word-initial syllables are described as having the same tonal specification as the following syllable, so it is necessary to have some part of the high tone on the initial syllable.)

The first syllable is not preceded by another syllable, so it doesn’t host a preceding tone’s peak. In this way it is comparable to tones’ host syllables in Chichewa, where the OCP and lack of a phonological L ensure that tone-bearing syllables are never adjacent. This means that the entire duration of each tone-bearing syllable in Chichewa is available for the onset of that syllable’s tone. Similarly, a word-initial syllable in Kikuyu isn’t preceded by another tone-bearing syllable and therefore can devote its entire duration to its tone’s onset. In Chichewa and word-initial syllables in Kikuyu, similar tonal environments lead to impressionistic tone spread. Initial syllables in Kikuyu are reported as high-toned for the same reason tones’ original hosts are reported as high-toned in Chichewa: although the peak isn’t reached in that syllable, enough of the tone’s articulation—

i.e. its onset and rise—appear in there to signal the presence of a high tone.

Non-initial syllables in Kikuyu cannot make their whole durations available to the onsets of their tones because they must also cope with peaks from tones of preceding syllables. It is not surprising that this situation has been identified by transcribers and analysts as tone shift instead of tone spread. Since each tone’s onset is necessarily relegated to some rightward portion of a syllable, it can reasonably be interpreted as anticipatory coarticulation (the speaker is preparing for the tone that has shifted to the next syllable) rather than an indication that the onset’s tone has simply spread to the next syllable.

A proponent of PDT could stop here were it not for the floating low tones that become downstep operators. These tones show that if Kikuyu’s tone shift is really just peak delay, then the phonology must be aware of peak delay, and consequently PDT must be implemented formally. The next section shows how this can be done.

#### 4.4.2.2 Tone Shift and Downstep

Certain words in Kikuyu trigger downstep on the following word. Examples of this were given in (5), repeated in (24).<sup>13</sup>

- (24) moayáhipá <sup>1</sup>né moeyá      ‘the weakling is good’  
kariokí <sup>1</sup>né moeyá      ‘Kariũki is good’  
keayáraró <sup>1</sup>né keeyá      ‘the stile is good’  
βiriβiri <sup>1</sup>né njeyá      ‘chillies are good’

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<sup>13</sup>This downstep may be displaced to the right in certain contexts such as the one illustrated in (6); see Clements & Ford (1981) for a detailed discussion.

Clements & Ford (1979) and Clements (1984) explicitly connect these downsteps to the presence of a floating low tone. In each form, the result of tone shift is that after each TBU has been assigned a tone, there is a low tone left over that cannot be assigned to an unoccupied TBU, and this floating tone triggers downstep.

There is other evidence that this L floats and survives stray erasure. For example, a process called tonal flattening by Clements & Ford (1981) lowers a sentence-final H to L. The process holds for citation forms and certain kinds of sentences. Flattening is illustrated in (25). In each pair, the first form is a sentence type that is not subject to flattening. The final noun in each case ends with a high tone. But when this noun is in isolation, the high tone disappears.

- (25)
- |    |                       |                               |
|----|-----------------------|-------------------------------|
| a. | nderarórirɛ keɲaɲí    | ‘I watched the crocodile’     |
|    | keɲaɲi                | ‘crocodile’                   |
| b. | nderarórirɛ ŋgiŋgó    | ‘I watched a neck’            |
|    | ŋgiŋɔ                 | ‘neck’                        |
| c. | nderarórirɛ moβakě    | ‘I watched the tobacco-plant’ |
|    | moβake                | ‘tobacco-plant’               |
| d. | nderarórirɛ moyɛrɛniá | ‘I watched the examiner’      |
|    | moyɛrɛnia             | ‘examiner’                    |

Contrast these examples with those in (26). In these cases, the sentence-final nouns come from the set of nouns that induce downstep as in (24). Flattening does not affect their citation forms.

- (26) a. nderarórire moayáhipá ‘I watched the weakling’  
moayáhipá ‘weakling’
- b. nderarórire kariokĩ ‘I watched Kariũki’  
kariokĩ ‘Kariũki’
- c. nderarórire ihóá ‘I watched the flower’  
ihóá ‘flower’
- d. nderarórire ηgǒ ‘I watched the firewood (pl.)’  
ηgǒ ‘firewood’

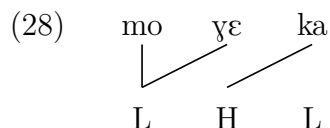
The reason these nouns are impervious to flattening is that the final high tones are not in fact final. The same floating L that caused downstep in (24) protects the words in (26) from flattening. Both downstep and flattening are explained if certain words possess floating low tones at their right edges.

Producing these floating tones seems to crucially rely on the tone shift rule in (17). For example, according to Clements (1984), the noun *moγeká* ‘rug’ contains a stem characterized by the tonal pattern HL. Adding the noun-class prefix’s L, we have LHL, and applying the normal tone-association conventions without (17) yields (27).

- (27) mo    γε    ka  
|        |        |  
L        H        L

There is no floating L in this structure and therefore no indication that this form induces downstep and blocks flattening. With the tone-shift rule added, we get (28), which does have a floating low tone because, once it comes time to

associate the rightmost L, all TBUs are already occupied.<sup>14</sup>



From this point of view it seems as though the traditional tone shift analysis is superior to PDT since the latter is committed to the structure in (27). But it is simple to grant peak delay admission into the phonological grammar where it will have the power to set certain tones afloat.

If peak delay is to be implemented formally, we need a constraint that motivates it. The constraint in (29) does this. This constraint ensures that an output allots enough time for a tone's rise or fall in pitch to be successfully executed. An effect of this constraint is that the onset of the pitch excursion (the point at which the rise or fall in  $f_0$  begins) and the  $f_0$  peak are sufficiently separated. If the onset is anchored to the tone's host syllable, this produces peak delay because the  $f_0$  peak must be held back until PEAK DELAY is satisfied. In some respects, this constraint is a more nuanced version of Hyman's (2005) LAG, which requires a tone's target to be reached in the syllable after the tone's host; see §4.7.2. See also Li (2003), whose RISETIME and FALLTIME families of constraints are similar to PEAK DELAY in that they favor the allotment of certain durations for phonetic rises and falls.

(29) PEAK DELAY: The  $f_0$  rise or fall for a tone must be allotted an adequate duration.

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<sup>14</sup>The rule that associates floating tones to already occupied TBUs as in (19) doesn't apply here because that rule is specific to floating H.

I am aware of no studies that have found “trough delay” for low tones, but there are several potential justifications for defining PEAK DELAY so that it affects both H and L. First, the same perceptual justification for peak delay given at the end of §4.2 holds here: with the  $f_0$  fall occurring late in the syllable, it is more likely to be reliably heard. Articulatorily, we can also suppose that if articulation of pitch excursions is sluggish for pitch rises, it may also be sluggish for pitch falls, although this sluggishness may be different for rises and falls.

Alternatively, if learners encounter a language that has peak delay for just high tones, they may extrapolate to all tones and thus posit a constraint like the one in (29).

What is “an adequate duration?” With respect to Chichewa, Myers (1999:222) states that peak delay “varies systematically as a function of syllable duration,” and he gives linear regression models that formalize this function. The model in (30), for example, is the model that (according to Myers) best accounts for the data from his subject SM.

$$(30) \quad \text{Peak delay} = (((-0.88P) + 1.43) * S) - 3.89$$

where  $P$  = syllable position (0 for medial, 1 for penult) and  $S$  = syllable duration

I’ll assume that PEAK DELAY references a function such as this one and assigns violations to candidates whose peak delay is not within some window around this function’s output. For a more nuanced view of how this sort of timing requirement might be modeled, see Byrd (1996) and Browman & Goldstein (1986). It might also be possible to build the timing specifications directly into the constraints



themselves, as Li (2003) does.<sup>15</sup> To simplify Tableaux, I will make the idealistic assumption that a violation is incurred when the peak and onset are contained within the same light syllable or the same half of a heavy syllable. Equivalently, the onset and peak must not coincide with the same mora.<sup>16</sup>

The function in (30) comes from a study of Chichewa and is surely incorrect for Kikuyu, but to my knowledge no appropriate phonetic studies have been conducted on Kikuyu, so there is no way to know what the correct function should look like. It also seems reasonable to suppose that pitch rises and falls might be subject to different functions; again, I know of no relevant data, but Ohala & Ewan (1973) and Sundberg (1979) report that pitch rises take longer to execute than equivalent falls. The simplifying rubric for assigning violations from the previous paragraph permits an analysis of Kikuyu despite these empirical gaps.

PEAK DELAY says nothing about where the pitch excursion occurs with respect to the larger phonological structure. There are a number of imaginable strategies that would or would not satisfy this constraint. For example, the peak could overlap with the tone's host syllable, forcing the pitch excursion's onset leftward into the preceding syllable to comply with PEAK DELAY. This is apparently what happens in Kinyarwanda, according to Myers (2003). Strictly speaking, to decide between shifting the peak rightward and shifting the onset leftward, we

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<sup>15</sup>However, Li's constraints, which mention specific intervals such as 120ms, lose the connection that peak delay has to factors such as syllable duration. And since those constraints specify minimum durations, another constraint is needed to prevent excessively long rises and falls. The windowed approach of PEAK DELAY simplifies matters by building maximum and minimum durations into one constraint.

<sup>16</sup>In languages that lack tone spread/shift of the sort discussed here, PEAK DELAY may not be ranked high enough to trigger displacement (see §4.4.4), or the separation between onsets and peaks required by that language's version of PEAK DELAY may not be long enough to move these landmarks into neighboring syllables.

need constraints like those in (31) (cf. Li's (2003) ALIGN-LO and ALIGN-HI constraints).

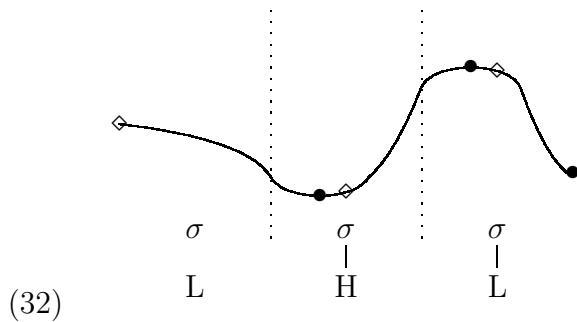
- (31) a. COINCIDE(Peak,  $\acute{\sigma}$ ): Every  $f_0$  target coincides with a syllable with which the target's tone is associated.
- b. COINCIDE(Onset,  $\acute{\sigma}$ ): Every pitch excursion's onset coincides with a syllable that hosts the target peak's tone.

In Kinyarwanda, COINCIDE(Peak) outranks COINCIDE(Onset), meaning that a tone's peak remains with the tone and the onset is displaced, and in Kikuyu and Chichewa we have the opposite ranking with the opposite effect. To simplify Tableaux, I will not show these constraints and will not consider candidates that have leftward displacement of a tone's onset. See Zsiga & Nitisaroj (2007) for evidence from Thai that alignment of tones' peaks with certain (sub)syllabic landmarks plays an important role in listeners' perceptions of tones. This result suggests that grammars have reason to enforce such alignments, and therefore the constraints in (31) (among other possibilities) are warranted.

The studies cited above that investigate peak delay report that the  $f_0$  peak is delayed with respect to some prosodic landmark such as the beginning of the tone's host syllable or a segmental landmark like the onset or nucleus of some syllable. But the definition of PEAK DELAY used here takes peak delay to be timed with respect to the beginning of the articulation of the tone, i.e. the onset. This discrepancy might be explained by a high ranking of COINCIDE(Onset) in the languages for which peak delay has been investigated. With the tone's onset fixed with respect to prosodic and segmental landmarks, it is no surprise that the

tone's peak is timed with respect to these landmarks, even if PEAK DELAY is defined as in (29).

The schematic pitch track for (27) as predicted by the peak delay approach is given in (32), with each tone's peak/trough appearing in the syllable after the one the tone is associated with, except for the last tone.



This configuration incorrectly predicts a falling pitch on the last syllable: \**moyɛkâ*. In fact, to my knowledge, falling contours do not appear in Kikuyu at all. Under the peak delay approach, this means that Kikuyu does not allow a high pitch target to be followed by a low pitch target in one syllable. We could adopt a constraint banning such configurations outright while still allowing rising contours, but this would contradict other research showing that rising contours are more marked than falling contours (e.g. Zhang 2001). Instead, I adopt the constraint in (33), which bans all phonetic contours (on the grounds that they're more marked than level pitch specifications).

(33) \*MULTI-PEAK: Multiple pitch targets on one syllable are disallowed.

Although this constraint may seem to duplicate the effect of PEAK DELAY in that both constraints favor greater spacing between  $f_0$  landmarks, the two constraints are quite different. PEAK DELAY requires sufficient space between onsets and their corresponding peaks, no matter where they fall with respect to syllable boundaries.<sup>17</sup> \*MULTI-PEAK is more like a constraint against contour tones (although I do not use \*CONTOUR for reasons that will become clear below) in that it penalizes multiple peaks/troughs on one syllable, no matter how far apart they are. Whereas PEAK DELAY cares about timing but not coincidence with prosodic elements, \*MULTI-PEAK cares about prosodic coincidence and not phonetic timing.

We can now see the impetus for setting certain low tones afloat: PEAK DELAY requires an L's  $f_0$  trough to appear in the syllable after the tone's host. When the low tone is associated with the word-final syllable, PEAK DELAY cannot be satisfied, and the trough must appear on the final syllable along with the preceding H's peak. However, this runs afoul of \*MULTI-PEAK. To avoid violating both PEAK DELAY and \*MULTI-PEAK, the tone is set afloat and not pronounced.

In addition, constraints requiring one-to-one, left-to-right association of tones to TBUs are needed. I will use ASSOCIATE to represent this set of constraints. It assigns a violation for every tone that is not associated with its "expected" host under a one-to-one, left-to-right system. E.g., if the third tone in a form does not associate with the third syllable, a violation is incurred. A more nuanced approach to tonal association is obviously desirable, but the simplification that ASSOCIATE provides will allow the current analysis to focus on more important

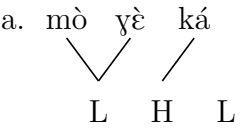
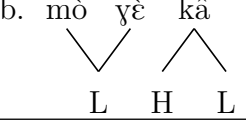
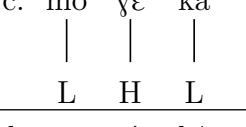
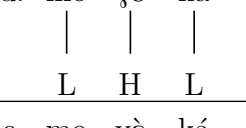
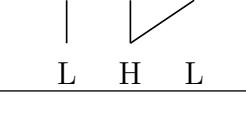
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<sup>17</sup>Recall that the practice adopted here of assessing violations of PEAK DELAY according to whether or not the onset and peak are on the same mora is just a convenient shortcut.

issues. See Yip (2002) for an overview of other possibilities and Kaplan (2008b) for a more explicit approach within PDT.

This is illustrated in (34). The following notation is used. Association lines mark formal phonological associations. Diacritics mark the location of each tone's peak. For clarity, indices in subsequent Tableaux identify which tone's peak is hosted by which syllable. Onsets are not marked explicitly, but they should be assumed to appear in the most advantageous location immediately after the previous tone's peak. This means wherever possible, an onset appears in the syllable before its corresponding peak. This means wherever possible, an onset appears in the syllable before its corresponding peak. Of course, if a peak is in the initial syllable, its onset must also be in that syllable. Likewise, when two peaks share a syllable, the onset for the second peak must of course also be in that syllable.

(34)

/mo-γɛka LHL/	PEAK DELAY	*MULTI	ASSOC	*FLOAT
a. mò yè ká 			**!	*
b. mò yè kâ 	(*!)	*!	*	
c. mò yé kà 	*!			
d. mo yè kâ 		*!		
e. mo yè ká 			*	*

I assume that tones are floating but ordered in the input. Under the traditional analysis in which each tone is linked to the syllable to the right of its otherwise expected host, candidate (a) is the expected form. It is ruled out here because of excessive violations of ASSOCIATE: The high tone, which is the second tone, is not associated with the second syllable, and the last tone is not associated with any syllable. That is, the traditional form is eliminated by the constraints that enforce the standard association conventions.

Candidate (b) violates \*MULTI-PEAK because of the phonetic contour on the last syllable. It may also violate PEAK DELAY if, as shown in the Tableau, the first L's trough appears on the first syllable. Candidate (c) obeys the standard association conventions, but it loses because the peaks are not delayed. Candidate (d) is similar except that it has delayed peaks: Each tone's peak or trough appears on the following syllable wherever possible. But this form loses because of the final contour. Candidate (e) avoids the problems that doom the other candidates by obeying the normal association conventions but leaving the final L floating. Both PEAK DELAY and \*MULTI-PEAK are satisfied because this candidate essentially reduces the number of tones that must be pronounced. Even though this form differs from the traditional form in terms of the formal associations of tones, it matches the traditional analysis in terms of the phonetic pitch profile, as indicated by the diacritics.<sup>18</sup>

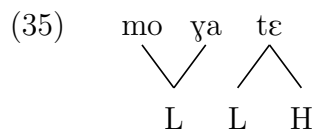
Candidate (d) shows why \*CONTOUR cannot be used. \*CONTOUR is typically invoked to prevent multiple tones from being linked to one syllable, so it would not

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<sup>18</sup>To be thorough, we may need another constraint preventing associated tones from being unpronounced, which would be another way to satisfy \*MULTI-PEAK and PEAK DELAY. Other constraints are needed to ensure that the last L floats, not some other L in the form. I will not consider these complications here.

penalize this candidate because each syllable is formally linked to just one tone. Consequently, a constraint like \*MULTI-PEAK, which deals with tones' phonetic implementations rather than their formal associations, is required.

Given free rein, \*MULTI-PEAK would correctly ban the falling contour in \**moyekâ* but also incorrectly ban the rising one in *moyatě* 'bread.' The difference between these forms, in terms of the tone shift analysis, is that whereas the leftover H from *moyatě* associates with the already occupied final syllable as in (35), the same does not happen when a low tone is leftover. Although I adopt a different configuration here, the insight that this analysis reveals is worth retaining: Kikuyu allows floating L but not floating H. By splitting \*FLOAT into two constraints, one banning floating H and one banning floating L, we can capture this difference. \*FLOAT-H outranks \*MULTI-PEAK, but \*FLOAT-L does not.<sup>19</sup>



Adding these constraints to the ranking, we can produce both *moyeká* and *moyatě*. \*FLOAT-H prevents the final H in *moyatě* from floating. Consequently, the strategy for satisfying both PEAK DELAY and \*MULTI-PEAK is unavailable, and one of these constraints must be violated. Since this form has a rising phonetic contour, it must be \*MULTI-PEAK that is violated. We therefore have evidence that both \*FLOAT-H and PEAK DELAY outrank \*MULTI-PEAK. \*FLOAT-L is ranked below all of these constraints. The Tableau and *moyatě* given below. The

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<sup>19</sup>Splitting \*FLOAT in this way might also shed light on *karání* 'clerk' (18f), which was labeled exceptional above because although the root's lexical tones are HLHL, the first L is skipped by the tone mapping system. Notice that skipping this L ensures that both Hs can be associated, leaving only Ls floating. This state of affairs is favored by the ranking \*FLOAT-H ≫ \*FLOAT-L.

new Tableau for *moyeká* is essentially the same as (34), so it is not recapitulated here.

(36)

	/mo-ɣatɛ LLH/	*FL-H	PD	*MULTI	ASSOC	*FL-L
a.	$\begin{array}{ccc} \text{mo} & \text{ɣà}_1 & \text{tě}_2 \\   &   &   \\ L_1 & L_2 & H \end{array}$			*		
b.	$\begin{array}{ccc} \text{mò}_{(1)} & \text{ɣà}_1 & \text{tě}_2 \\ & \diagdown \quad \diagup & \\ & L_1 & L_2 & H \end{array}$		(*)	*	*!*	
c.	$\begin{array}{ccc} \text{mò}_1 & \text{ɣà}_2 & \text{té} \\   &   &   \\ L_1 & L_2 & H \end{array}$		*!			
d.	$\begin{array}{ccc} \text{mo} & \text{ɣà}_1 & \text{tè}_2 \\   & \diagdown & \\ L_1 & L_2 & H \end{array}$	*!			*	

Candidate (b), which is the traditional tone-shift form, loses for two reasons. First, it violates the constraints enforcing the standard association conventions represented by ASSOCIATE. It could also be eliminated by PEAK DELAY depending on which of the first two syllables the first L's peak appears on. Candidate (c) obeys the association conventions, but it loses because the peaks and troughs aren't delayed. Candidate (d) leaves the H unassociated and thereby fatally violates \*FLOAT-H. Candidate (a) wins: All tones are associated in a way that obeys the association conventions, and peaks and troughs are delayed wherever possible. A violation of \*MULTI-PEAK is incurred by this form under pressure from PEAK DELAY and \*FLOAT-H.



It might be objected that candidate (a) violates PEAK DELAY because the onset and peak of the final H necessarily appear in that syllable. One response might be that due to final lengthening (e.g. Horne et al. 1995, Lehiste 1972, Lehiste et al. 1976, Lunden 2006, Oller 1973, Wightman et al. 1992), these syllables are long enough to host this onset with an appropriately delayed peak. Kaplan (2008b) fleshes out this strategy in detail.

This section has shown that when implemented formally, PDT (which is an inherently phonetic approach to tonal phenomena) is capable of producing the floating low tones that are traditionally considered a product of Kikuyu's tone shift. I argued above that PDT offers an elegant and insightful way to understand tone spread in Chichewa, and here we see that it can be a powerful tool in phonology. If PDT finds experimental support in Kikuyu and other languages, it adds to the growing body of evidence that phonological grammars may not be so distantly removed from measurable articulatory, acoustic, and phonetic facts.

This analysis follows Morén & Zsiga (2006) in that it proposes a phonological account of what is, at heart, a phonetic phenomenon. In Morén & Zsiga's analysis of Thai, they argue that pitch peaks are right-aligned with moras and develop an OT account that positions tones on the moras with which their peaks are aligned. The analysis developed here takes this a step farther by adding the alignment of pitch landmarks to the phonology.

However, I noted above that there is no experimental evidence (that I am aware of) showing that Kikuyu's tone shift is a phonetic phenomenon of the sort that Myers (1999, 2003) argues Chichewa's and Kinyarwanda's tone spread to be. Obviously, phonetic facts in Kikuyu that mirror Myers's results would support

PDT. But in the next section I show that PDT is also capable of producing phonological tone shift. By requiring tones' formal associations to follow their delayed peaks, PDT can produce the phonological structures that are traditionally posited for Kikuyu.

### 4.4.3 Tone Shift as a Phonological Phenomenon

This section shows how the PDT analysis developed in the previous section can be amended to produce phonological tone shift. Here I discard the assumption that tone shift is purely phonetic, and in this section I will treat it as a genuine phonological phenomenon in which each tone associates with the syllable to the right of the one it would be expected to associate with under normal tone association conventions. I will call this analysis the phonological analysis and the analysis from the previous section the phonetic analysis.

The constraint ranking adopted in §4.4.2.1 is repeated in (37).

(37) \*FLOAT-H, PEAK DELAY  $\gg$  \*MULTI-PEAK  $\gg$  ASSOCIATE  $\gg$  \*FLOAT-L

Recall that a more elaborated version of PDT must adopt constraints like those in (31) to account for the fact that tones' peaks appear after their phonological hosts in languages like Chichewa (and Kikuyu, under the assumptions of the preceding section), but in Kinyarwanda, peaks stay put and onsets are shifted leftward. In Chichewa and Kikuyu, PEAK DELAY and COINCIDE(Onset) outrank COINCIDE(Peak): To ensure that (i) sufficient time is given for a tone's  $f_0$  excursion and (ii) this excursion begins in the tone's host syllable, peaks are shifted to the following syllable. But in Kinyarwanda, PEAK DELAY and COINCIDE(Peak)

outrank COINCIDE(Onset). In this language, a sufficient time for the excursion is provided by shifting the onset under pressure from COINCIDE(Peak) to keep tones' peaks in their host syllables.

COINCIDE(Peak) has other applications though. By ranking it above the constraints that produce the normal left-to-right, one-to-one tone association pattern, tones' formal associations can follow their delayed peaks. PEAK DELAY is still ranked high enough to produce the pitch contours generated by the phonetic analysis, but now COINCIDE(Peak) ensures that tones' formal associations mirror these delayed peaks.

This is illustrated in (38). Compare this Tableau with (36) above. Whereas candidate (b) would have been eliminated by ASSOCIATE above, here it is the winner. This is because of the influence of COINCIDE(Peak): Candidate (a), which was the winner above under the assumption that tone shift was purely phonetic, now loses because there is a mismatch between tones and the alignment of their peaks.

There are two choices at this stage. Peaks can be retracted so that they line up with their tones' hosts, as in candidate (c), or peaks can be left where they are and the tones can be formally shifted, as in candidate (b), so that there is again a match between formal associations and peaks' positions. The first option runs afoul of PEAK DELAY. It is possible for the non-initial tones' onsets to shift leftward as in the Kinyarwanda pattern, but the initial tone's onset has nowhere to go because there is no syllable preceding this tone's host. Candidate (b) avoids this violation by instead disregarding the lower-ranked ASSOCIATE.<sup>20</sup>

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<sup>20</sup>I assume that the first tone associates with the first syllable—and not just the second—to satisfy a constraint requiring all TBUs to be associated with some tone.

(38)

/mo-yaɛ LLH/	*FL-H	PD	COIN(Pk)	*MULTI	ASSOC
a. mo yà <sub>1</sub> tǔ <sub>2</sub>               L <sub>1</sub> L <sub>2</sub> H			*!*	*	
☞ b. mo yà <sub>1</sub> tǔ <sub>2</sub> \     / L <sub>1</sub> L <sub>2</sub> H				*	**
c. mò <sub>1</sub> yà <sub>2</sub> tɛ́               L <sub>1</sub> L <sub>2</sub> H		*!			

This result is important: We saw above for both Chichewa and Kikuyu that PDT can cause mismatches between tones' formal associations and their phonetic implementations, and now we see that a high-ranking PEAK DELAY does not necessarily require such mismatches. With PEAK DELAY and COINCIDE(Peak) outranking ASSOCIATE, the normal tone association desiderata take a back seat to pitch timing requirements so that the formal tone configuration is partly dependent on the pitch profile. The interaction between tones and their phonetic implementations is a two-way street: Tones affect a form's phonetic pitch, but pitch considerations can also influence the tonal configuration.

This concludes the PDT analysis. We've seen how a phonetic approach to noniterative tone spread and shift can cope with the facts. For Chichewa, the situation as Myers (2003) describes it is simple: tones do not spread, but their peaks are reached in the syllable after the one their tones are associated with. For Kikuyu, a similar situation holds, but with one complication. PDT must be implemented phonologically so that floating low tones can be produced. Simply adding constraints like PEAK DELAY and \*MULTI-PEAK to the grammar is

sufficient to produce these floating tones.

But PDT can be understood in an even more phonological way. We can use constraints like `PEAK DELAY` and `COINCIDE(Peak)`, which are primarily concerned with the phonetic implementation of a phonological structure, to generate a traditional tone-shift representation. This is a natural consequence of admitting PDT into the formal phonology, a move which was independently necessitated by Kikuyu's floating tones. The result is that PDT provides an analysis of Kikuyu tone shift whether or not this is a purely phonetic phenomenon.

Giving control of peak delay to the phonological grammar results in a theory in which phonetics and phonology are not wholly distinct. Much recent work (such as Dispersion Theory (e.g. Flemming 2002, Padgett 2003)) has argued for a phonetically sophisticated phonological grammar in which acoustic, articulatory, and perceptual factors play direct roles in the formal phonology. The analyses proposed here obviously support this view, but they are not incompatible with the view that "phonological constraints must in some cases operate at a level distinct from the phonetics" (Morén & Zsiga 2006:172). I have argued here that separate, independent constraints may exist for phonological elements and their phonetic exponents. In this way, phonetics and phonology interact but are not conflated.

The greatest drawback for PDT is the lack of phonetic evidence supporting it. Myers (1999, 2003) gives strong evidence in favor of PDT for two languages, but for this approach to be viable more broadly, experimental work on more languages is necessary. We might also ask how deeply phonetics and phonology are connected. The PDT analysis of Kikuyu makes the very strong claim that there is essentially no difference between phonetics and phonology in that even an

undeniably phonetic process like peak delay can be under grammatical control. I am not in a position to say whether or not this is a good result, but it must be kept in mind as PDT is evaluated.

Another concern is the factorial typology predicted by PDT. The constraints used above predict many tonal patterns. Most of these may be reasonable, but there are some that seem unusual. A complete factorial typology is not germane to the goals of this chapter, so I will mention just one predicted language. Consider a language with Kinyarwanda-style onset anticipation. In this language, PEAK DELAY, COINCIDE(Peak), and constraints for the language's association conventions outrank COINCIDE(Onset). If DEP- $\mu$  (or another constraint that prevents lengthening syllables) also outranks COINCIDE(Onset) and is ranked below the other constraints, then this language will exhibit initial-syllable lengthening when this syllable hosts a tone. This is because the normal onset-anticipation strategy is unavailable word-initially, so to have a delayed peak and conventionally associated tones, the first syllable must lengthen. I am unaware of any language like this, and if it is indeed unattested, it casts doubt on PDT.

#### 4.4.4 Other Tonal Alignment Patterns in PDT

This section very briefly illustrates how other tonal patterns can be produced in PDT. The preceding sections have shown how PDT can produce languages in which a tone spreads rightward by one syllable, but this is just one of the systems that PDT can generate. Languages with no tone spread or shift are produced with the ranking in (39).<sup>21</sup> This example, from Ruciga (Cassimjee & Kisseberth 1998),

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<sup>21</sup>This is not to deny that a language may have “faithful” tone in general with specific movement, shifting, etc., operations in particular contexts. In such languages, the ranking in

contains one high tone. There is no spreading or shifting of this tone. (Cassimjee & Kisseberth (1998:16) state that the output in (39) is correct when this word stands in “medial position before a toneless modifier.”) The onset and peak are indicated with underlining, just as in (13).

(39)

	/e-ságama/ ‘blood’	ID-T	COIN(Onset)	COIN(Peak)	PD
a.	<u>es</u> á <u>gama</u>			*!	
b.	es <u>á</u> gama				*
c.	es <u>á</u> gama		*!		
d.	es <u>á</u> gá <u>ma</u>	*!			

Under this ranking, it is more important for the onset and peak to be contained within the host syllable than to have an adequate peak delay. Alternatively, it seems plausible to suppose that the function that informs PEAK DELAY is determined on a language-particular basis. This means that PEAK DELAY might be less stringent in other languages so that it is satisfied by configurations in which the onset and peak are tautosyllabic, so even a language with a highly ranked PEAK DELAY might exhibit no spreading or shifting.

For Kinyarwanda, where a tone’s onset appears in the syllable before the one with which the tone is associated, COINCIDE(Peak) and PEAK DELAY must outrank COINCIDE(Onset):

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(39) holds, but higher constraints can subvert the faithfulness that this ranking promotes.

(40)

/umusóre/ ‘youth’	ID-T	COIN(Peak)	PD	COIN(Onset)
a. <u>u</u> mu <u>só</u> re		*!		
b. u <u>mu</u> sóre			*!	
☞ c. <u>u</u> mu <u>só</u> re				*
d. <u>u</u> mu <u>só</u> re	*!			

As these Tableaux show, PDT has applications beyond the rightward tone spread and shift of Chichewa and Kinyarwanda.

## 4.5 Optimal Domains Theory

### 4.5.1 Chichewa in ODT

The first part of this chapter presented a phonetically oriented approach to non-iterativity in tone. The rest of this chapter deals with Optimal Domains Theory, a far more abstract and representationally oriented theory that can also make sense of these phenomena. I follow here the particular version of ODT developed by Cassimjee & Kisseberth (1998), who aim to account for exactly the kind of phenomenon under discussion here.

In ODT, phonological strings are parceled into domains. Each domain corresponds to one feature or tone. Thus a segment may belong to many domains, each of which may or may not be coextensive with the next domain. In this theory, every feature is privative, so, for example, a form with all non-nasal segments need not have a domain for nasality at all. On the other hand, there may be a [nasal] domain, but the [nasal] feature might not be realized (“expressed” in the ODT terminology) on any segment in that domain. In other words, domains



specify a string of segments that may legitimately express a certain feature, and it is up to constraints to determine the number and extent of the domains, as well as whether and where a feature will be expressed in its domain.

Let's begin with the first task. In ODT, there are two kinds of Alignment constraints that regulate domain size. The first is Basic Alignment (BA), which is responsible for building a domain around a feature or tone's underlying host (the feature or tone's "sponsor"). The constraints in (41), adapted from Cole & Kisseberth (1994), are BA constraints. Each requires one edge of a sponsor to be aligned with the same edge of some domain for the relevant feature.

- (41) BA-Left: Align(Sponsor,L; F-domain,L)  
 BA-Right: Align(Sponsor,R; F-domain,R)

Left to their own devices, these constraints prohibit spreading or shifting of features/tones. Wide-Scope Alignment (WSA) is responsible for extending a domain's reach. WSA constraints are simply standard Alignment constraints (McCarthy & Prince 1993) that require one or the other edge of a domain to coincide with some edge of a morphological or prosodic category. When a WSA constraint for one edge of a domain outranks the BA constraint for that same edge, spreading of the domain is produced. This is illustrated schematically in (42). Parentheses show domain edges, and the sponsor is underlined.

(42)

/xxx <u>xxx</u> /	BA-LEFT	ALIGN-R	BA-RIGHT	ALIGN-L
a. xx( <u>x</u> )xx		*!*		**
b. (xxx) <u>xx</u>	*!			**
☞ c. xx( <u>xxx</u> )			*	**

BA-LEFT requires the left edge of the sponsor to be aligned with the left edge of the domain, so leftward spreading is not permitted. But since ALIGN-R outranks BA-RIGHT, spreading the domain to the right edge of the word is favored over limiting the domain to the sponsor.

The winner from (42) is a form in which the feature or tone spreads or shifts to the right edge of the word. Whether we get spreading or shifting is dependent on other constraints. The constraint EXPRESS requires every feature in a domain for the feature F to express F. In the context of (42), EXPRESS produces spreading:  $xx(\underline{x}x\acute{x})$  fully satisfies EXPRESS, assuming we're dealing with a high-tone domain.

Another constraint,  $*(F, \text{NONHEAD})$  discourages expression of domain's feature on all elements except the domain's head. Cassimjee & Kisseberth (1998) assume that the head of a domain is correlated with the direction of spreading: If a domain extends rightward, the rightmost element in the domain is the head. If the domain spreads leftward, the leftmost element is the head. Thus  $*(H, \text{NONHEAD})$  (the version of this constraint for high tones) favors shifting over spreading:  $xx(\underline{xx}\acute{x})$  is preferred over  $xx(\underline{x}x\acute{x})$  because the latter has two non-heads that express the high tone.

There are other constraints that ensure that each sponsor projects a domain and is included in that domain, but I will not discuss them here.

Obviously, WSA constraints do not produce spreading or shifting by just one unit unless the sponsor happens to be one unit away from the domain edge specified by WSA. Cassimjee & Kisseberth (1998) posit the constraint in (43) to produce noniterativity. (This constraint is virtually identical to MULTI-TBU SPAN, which is used by Kaplan (2007) to similar effect.)

(43) \*MONOHD: A high-tone domain must not be monomoraic/monosyllabic.

In a language in which the BA constraints outrank WSA, \*MONOHD can still trigger spreading a high tone's domain beyond the sponsoring syllable. Making the domain just two syllables long satisfies this constraint. The relative rankings of EXPRESS and \*(H, NONHEAD) determines whether the result is spreading by one syllable or shifting by one syllable.

\*MONOHD is very similar to the constraint MINIMALITY adopted by Zerbian (2006) in an analysis of languages in the Sotho family of Bantu. MINIMALITY, however, explicitly demands a binary tonal domain. These constraints encounter conceptual problems that I discuss at the end of this section, but for the time being I adopt \*MONOHD without comment.

We are now in a position to account for Chichewa's tone spread. Recall that in this language H spreads one syllable rightward. Consequently, BA and \*MONOHD must outrank WSA. Also, since Chichewa has rightward spreading, \*MONOHD must outrank BA-RIGHT. The Tableau in (44) illustrates the analysis with the form *zidzábéraana* 'they will steal x for each other.'

(44)

/zidzáberaana/	BA-L *MONOHD EXPRESS	BA-R	ALIGN-R ALIGN-L *(H,NONHEAD)
a. zi(dzá)beraana	*!		*** * -
☞ b. zi(dzábé)raana		*	** * *
c. zi(dzabé)raana	*!	*	** * -
d. (zídzá)beraana	*!		*** - *
e. zi(dzábérááná)		**!*	- * *

Candidate (a) is the faithful candidate with a high domain built around just the H's underlying host. It loses because it does not satisfy \*MONOHD. Candidates (b) and (c) both extend the domain one syllable rightward to satisfy \*MONOHD. The former expresses the high tone on both syllables. The latter expresses the tone on just the domain's head, so it fatally violates EXPRESS. Candidate (d) shows that BA-LEFT must be high-ranked to prevent leftward spreading under pressure from \*MONOHD. Also, BA-RIGHT must outrank ALIGN-R to produce minimal rather than unbounded rightward spreading, as candidate (e) shows. \*(H,NONHEAD) must be low-ranked in Chichewa (specifically, it must be ranked below EXPRESS) to generate spreading rather than shifting.

This is the core of the ODT analysis of Chichewa. There are two remaining pieces. First, recall that phrase-final H is retracted to the penultimate syllable. Cassimjee & Kisseberth (1998) account for this kind of phenomenon with a NONFINALITY constraint preventing a phrase-final mora or syllable from being included in a high domain.

Second, we must block spreading from the last three syllables of a phrase. In the analysis of Cassimjee & Kisseberth (1998), AVOID PROMINENCE prevents a prominent syllable from being part of a high domain. Many researchers (e.g. Cassimjee & Kisseberth 1998, Philippson 1998) identify the lengthened phrase-penultimate syllable in Chichewa and other Bantu languages as stressed or otherwise prominent. So AVOID PROMINENCE will block spreading to this syllable:

(45)

	BA-L	AVOID	EXPRESS	*MONOHD	BA-R	ALIGN-R	ALIGN-L	*(H, NONHEAD)
/zidzábēera/								
☞ a. zi(dzábē)era				*		***	*	
b. zi(dzábē)ra		*!		*		**	*	*
c. (zídzá)beera	*!					***		*
d. zi(dzabē)ra		*!	*!		*	**	*	
e. zi(dzabee)ra		*!	*!	*		**	*	

In this form, which means ‘they will steal x for/with you,’ a unary high tone domain is required by AVOID PROMINENCE. Candidate (b) has the normal tone spread, but it loses because the penultimate syllable—which is prominent—is part of a high tone domain. Candidate (c) spreads in the other direction, where a prominent syllable is not encountered. This fatally violates BA-LEFT. The remaining candidates show that abstaining from expressing the high tone on one syllable or another doesn’t save the normal rightward spreading: AVOID PROMINENCE penalizes any form with a domain that includes the penultimate syllable, even if the high tone is not expressed on that syllable. (However, since BA-LEFT

outranks AVOID PROMINENCE, a form with an underlying penultimate H will surface faithfully.)

### 4.5.2 Kikuyu in ODT

In the ODT system developed by Cassimjee & Kisseberth (1998), tone shift is a very close relative of tone spread. \*MONOHD again requires a binary domain, but instead of EXPRESS requiring all syllables in that domain to express the high tone, \*(H, NONHEAD) prevents all but one of the syllables from expressing the tone. Therefore, an analysis of Kikuyu should be simple now that an analysis of Chichewa is in place. We will see, perhaps surprisingly, that this is not so.

First, (46) shows a Tableau adapted from Cassimjee & Kisseberth (1998) that illustrates tone shift in Kijita (see Downing 1996). In this language, H shifts one syllable rightward. For example, in *okuβónána* ‘to see one another,’ the underlined vowel underlyingly hosts the high tone, but the following syllable surfaces with the tone.

(46)

/okuβónana/	BA-L	*(H, NONHEAD)	*MONOHD	BA-R
a. oku(β <u>ó</u> )nana			*	
b. oku(β <u>ón</u> )na		*!		*
c. oku(β <u>óná</u> )na		*!		*
☞ d. oku(β <u>óná</u> )na				*
e. o(k <u>ú</u> β <u>ó</u> )nana	*!			

Just as in Chichewa, BA-LEFT and \*MONOHD require the high tone’s domain to expand rightward so that it includes the syllable following the sponsor. Now

that EXPRESS is replaced by \*(H,NONHEAD), it is better to express the high tone on just the head of the domain (which is the rightmost syllable since we have rightward spreading) instead of throughout the domain. Therefore, candidate (d) wins.

Why won't this analysis succeed in Kikuyu? The reason is that beyond the first two syllables of a Kikuyu word, there is no evidence for the binary domains required by \*MONOHD. Consider *totomáya* 'we send.' \*MONOTD (\*MONOHD is specific to high tone domains, so I adopt \*MONOTD for all tone qualities) can correctly require the first two syllables to be parsed into a low-toned domain, but it will also penalize the monosyllabic high and low tones on the final two syllables. We therefore predict an output like \*(*tòtò*)(*mayá*), where diacritics reflect the fact that only the head of each domain expresses the tone. Eliminating \*MONOTD is not possible because it drives tone shift in the first place.

We might argue that the effect of \*MONOTD in non-initial domains is suppressed because \*(*toto*)(*máyá*) fails to preserve the second underlying L. We need unary domains in order to preserve all tones. The constraint used by Cassimjee & Kisseberth (1998) to require one domain for each underlying feature is DOMAIN CORRESPONDENCE. This constraint must outrank \*MONOTD because it is responsible for the lack of non-initial binary domains:

(47)

/totomaya LHL/	DOM COR	*MONOTD
a. ( <i>tòtò</i> )( <i>mayá</i> )	*!	
☞ b. ( <i>tòtò</i> )( <i>má</i> )( <i>yà</i> )		**

It is simple enough to select (*tòtò*)(*má*)(*yà*) over \*(*tò*)(*tóma*)(*yà*) or

\**(tò)(tó)(mayà)* by invoking an ALIGN-R constraint forcing domains to be as close to right-aligned in the word as possible. Notice also that the correct form has a low tone on both vowels in the initial domain. This indicates that in ODT, like PDT, Kikuyu’s tone shift is best understood as spreading, as in Chichewa. Using EXPRESS instead of \*(H,NONHEAD) will produce *(tòtò)(má)(yà)* instead of \*(*totò)(má)(yà)*, putting us back into ODT’s tone-spread territory.

We are not out of the woods yet. The floating low tones still must be accounted for.<sup>22</sup> Recall that in the rule-based analysis, tone shift bumps these tones off the final TBU. In ODT, this means \*MONOHD (which replicates tone shift) forces a violation of DOM COR:

(48)

/mo-ɣɛka LHL/	*MONOHD	DOM COR
☞ a. (mòyè)(ká) L		*
b. (mò)(yé)(kà)	*!	

We have a ranking paradox. Candidate (b) follows the same strategy that was successful before: There are too many tones for each to receive a binary domain, so it posits just enough unary domains to accommodate each tone. Candidate (a) is the correct output. It has an initial binary domain and floating L. As the Tableau shows, selecting the correct winner here requires \*MONOHD ≫ DOM COR, but (47) showed that the opposite ranking is also required.

<sup>22</sup>The status of the unpronounced tones in ODT is difficult to determine. ODT rejects autosegments, so it seems that this L is simply deleted if it doesn’t have a domain in the output. But this is problematic because the downstep facts of Kikuyu point strongly toward the survival of this L, which means this tone must be an autosegment: It is a phonological object that is formally distinct from its host. Furthermore, it is clear that tones in Kikuyu are not underlyingly associated with their hosts, which also points to autosegmentalism. The proper account of these conflicts in ODT is unclear to me, so I will assume that floating tones are still possible in this theory.



The problem, it seems, is that \*MONOTD requires binary domains for every tone, but the actual forms have binary domains only for initial tones. A scaled-back version of \*MONOTD is needed, one that requires a non-unary domain for just the leftmost tone. The justification for this constraint is not obvious, though. I am aware of no evidence outside of the tone-shift facts suggesting that the first syllable or pair of syllables in Kikuyu is special, so the revised \*MONOTD arbitrarily singles out these syllables. A possible solution is overlapping binary domains throughout the word (Key 2007).

The ranking paradox is a major stumbling block for ODT, but not an intractable one in principle. The revised \*MONOTD allows ODT to produce Kikuyu's tone shift. This is demonstrated in (49) and (50).

(49)

/totomaya LHL/	EXPR	*MONO-INIT	DOM COR	AL-R
a. (tòtò)(máyá)			*!	**
☞ b. (tòtò)(má)(yà)				***
c. (totò)(má)(yà)	*!			***
d. (tò)(tó)(màyà)		*!		*****

(50)

/totomaya LHL/	EXPR	*MONO-INIT	DOM COR	AL-R
☞ a. (mòyè)(ká) L			*	
b. (mò)(yé)(kà)		*!		
c. (moyè)(ká) L	*!		*	
d. (mò)(yéká) L		*!	*	

There are many reasons to be skeptical of the ODT analysis. It cannot account for Kikuyu without the sort of stipulative constraint used in (49) and (50). There

is also little evidence for the domains posited by the theory. In Chichewa and Kikuyu, this is not a significant issue since tones are expressed throughout each domain, but in languages with tone shift over longer distances, ODT posits domains that encompass large amounts of a form even though the tone is expressed on only one syllable in that domain. Cassimjee & Kisseberth (1998) offer some evidence for these domains based on what appear to be long-distance OCP effects in Isixhosa: A high tone at the right edge of a verb stem affects the realization of a prefix high tone. In ODT, this is because the left edge of the stem tone's domain abuts the prefix tone's domain. To give just one example, in *(bá)ya(boníí)sa* 'they show,' the prefix *bá*'s high tone is prevented from shifting rightward because this would create adjacent domain edges: *\*(bayá)(boníí)sa*. But it is equally plausible to suppose that an OCP constraint prohibits multiple high tones within a verb stem (a morphological category that excludes subject prefixes). Verb stems in Isixhosa seem to be restricted to hosting at most one high tone anyway, so the ODT prohibition on adjacent domain edges does not achieve better empirical coverage than a non-ODT account. Better evidence for ODT's domains is desirable.

As noted above, the status of floating tones in ODT is unclear. The theory explicitly rejects autosegments, yet it seems clear that tones in Kikuyu and elsewhere can be separated from their segmental and prosodic hosts. The Basic Alignment constraints that define where each domain begins crucially rely on tones being associated (or their sponsors indicated) underlyingly. But since tones can surface on morphemes other than the ones that contributed them, the simplest analysis is one that doesn't take these tones to be linked to their contributing morphemes

in the first place.

Similarly, the representation of contour tones in ODT seems problematic. In Autosegmental Phonology, contours are simply two tones linked to one TBU, but this structure is of course unavailable in ODT. Two possibilities are immediately obvious: Either contours are formally distinct from level tones and have their own domains, or syllables that host contours belong to overlapping domains for different tone levels. The former is unappealing in light of widespread evidence that contours are composed of level tones, and in the latter approach it is not clear how to specify that overlapping H and L domains should yield a rising tone in one case and a falling tone in another. Yet another approach, adopted by Cassimjee & Kisseberth (1999b), is to use half-moras. A domain for one tone level encompasses the first half-mora of a vowel, and a domain for a different level encompasses the second half-mora. With the vowel split between two domains, a contour results. Of course, independent evidence for half-moras would be desirable.

Finally, the constraint \*MONOHD is problematic. There is no clear reason why tone but not, say, vowel height tends toward binary groupings. This means that \*MONOHD gives no answer to the question addressed at the end of §4.2: Why are virtually no apparent cases of noniterativity found in phonology except in tonal phenomena? For PDT, this restriction is explained if the articulatory or perceptual factors that give rise to peak delay asymmetrically affect tone as compared to other phonological units. But for \*MONOHD, the answer must be that there is no \*MONO constraint for other phonological entities. But since \*MONOHD is grounded in abstract an notion like the desirability of binarity, which cannot be independently verified, there is no obvious explanation for why

this state of affairs should hold. An identical objection can be raised for Zerbian's (2006) MINIMALITY. Short of a stipulation about which entities can be referenced in a \*MONO or MINIMALITY constraint, these analyses predict spreading or shifting by one syllable on a much larger scale than is actually attested.

Perhaps \*MONOHD can be recast in metrical terms. Metrical units, after all, often exhibit binarity, so maybe noniterative tonal phenomena are metrical in nature. If this strategy works, then these phenomena can be accounted for as if they were foot-constrained phenomena. That is, we have iterative spreading/shifting throughout a binary domain (see Domain Confinement from Chapter 1), not noniterative spreading or shifting.

## 4.6 Comparison of PDT and ODT

We have seen in the preceding sections that two very different frameworks can account for noniterative tone spread and shift. The choice between PDT and ODT is immaterial for the purposes of this dissertation in that neither explicitly invokes noniterativity. In PDT, apparent noniterativity results from a demand that a tone's onset and peak be sufficiently separated. One result of this separation is that the peak can fall in the syllable after the one that hosts the phonological tone. In ODT, apparent noniterativity reflects the satisfaction of a constraint prohibiting unary tonal domains. Extending the tone's domain by one syllable satisfies this constraint while minimally violating the Basic Alignment constraints.

In this respect, the ODT analysis is similar to the Positional Licensing analyses of Lango and Chamorro developed in previous chapters of this dissertation. In

those languages, spreading just one syllable to the right or left is sufficient to satisfy Positional Licensing constraints that demand that the relevant feature be linked to a root segment. Since the affixes from which the features spread are adjacent to the root, spreading just once satisfies the Positional Licensing constraints and minimally violates faithfulness constraints.

PDT and ODT are quite different in an important respect. The former takes the relevant tonal phenomena to be directly driven by phonetic considerations while the latter attributes them to abstract, structural requirements. The choice between these theories comes down, in part, to decisions about how formally phonological phenomena should be tied to the articulatory, acoustic, perceptual, and diachronic facts that underly them. However, PDT and ODT share an important common theme. They both claim that tone spread and shift result from conditions that interfere with precise matches between tones' articulations and abstract phonological structures. This is obvious in PDT, and it becomes clearer in ODT if we view EXPRESS and  $*(H, NONHEAD)$  as constraints militating for or against articulations that match domains.

It is interesting to note that successful accounts of Kikuyu in both PDT and ODT must treat this language's tone shift as if it were tone spread. The first two syllables of a word in Kikuyu have the same tonal properties, so an analysis of this language cannot simply ignore the first syllable altogether. In PDT, this means the first tone's articulation begins in the first syllable, and in ODT this means EXPRESS (the spreading constraint) must outrank  $*(H, NONHEAD)$  (the shifting constraint). Even the rule-based treatment of Kikuyu posits what amounts tone spread because, while the first syllable is initially skipped, a later rule spreads the

tone of the second syllable back to the first syllable. These results suggest that there may not be as big a difference between tone shift and tone spread as one might think. Indeed, traditional analyses (e.g. Philippson 1998) often characterize tone shift as spreading followed by delinking.

Lastly, both PDT and ODT have drawbacks. PDT lacks empirical support from a wide range of languages. If more languages are found to exhibit the timing properties of Chichewa, the range of languages for which PDT is applicable will grow, and PDT will become more plausible. ODT has theory-internal problems related to the representation of floating tones and contours, as well as certain undesirable predictions made by \*MONO-style constraints. (If there are existing satisfactory solutions to the objections to ODT, I am unaware of them.) ODT also suffers from a lack of conclusive evidence for the reality of the hypothesized domains.

In sum, PDT and ODT are two promising solutions to the challenge noniterative tone spread and shift presents to the Emergent Noniterativity Hypothesis. Although I make no choice between these analyses here, I argue in favor of PDT in Kaplan (2008b). In the rest of this chapter I argue against other approaches to noniterative tone shift/spread that have been proposed within OT, and I discuss other kinds of tonal phenomena.

## 4.7 Other Analyses of Noniterativity in Tone

In this section I discuss competing OT analyses of noniterative tonal phenomena. I argue that they are inferior to the PDT and ODT analyses developed above on

conceptual grounds: Each opens the door to constraints that produce noniterativity in a widespread fashion, contrary to the claim of this dissertation that OT is better off for not permitting such phenomena.

#### 4.7.1 Local

Myers (1997) adopts the constraint LOCAL to account for noniterative tone shift in Rimi. I give Yip's (2002) definition in (51) because this version is also capable of producing noniterative tone spread.

- (51) LOCAL: An output tone cannot be linked to a TBU that is not adjacent to its host.

This constraint penalizes candidates whose high tones stray too far from their input hosts. But Kisseberth (2007:663) notes that:

The problem, however, is that in current OT, a phonological constraint such as Local can access only the output candidates to see whether they violate the constraint. However, one cannot determine whether Local is satisfied in a given output candidate . . . because one cannot see which mora is the host of the H tone in the input.

Kisseberth goes on to note that faithfulness constraints *are* allowed to access the input, but LOCAL is clearly not a faithfulness constraint. Adopting LOCAL amounts to a modification of OT that permits the formalization of noniterative processes, and this is the sort of thing that I claim no language requires.

Similar remarks could be made for Bickmore's (1998) **EXTEND**, but whereas **LOCAL** blocks spreading past the adjacent TBU, **EXTEND** requires featural/tonal domains to extend beyond their input boundaries. Both constraints require access to the input.

### 4.7.2 Lag

Hyman (2005) adopts the constraint **LAG** (52) to account for tone spreading. Developing and defending an account of noniterative tonal phenomena is not Hyman's central goal, so the defects of **LAG** discussed below reflect the preliminary nature of the proposal. Nonetheless, **LAG** represents a tempting analytical approach, and examining it is instructive in the present context.

(52) **LAG**( $\alpha$ T): An input tone should reach its target on the following output TBU.

We might interpret the reference to targets to mean that this constraint cares about how tones are articulated, but Hyman's subsequent examples and discussion make clear that **LAG** is satisfied when an output tone is linked to the TBU after its input host. So this constraint deals with phonological representations, not their phonetic implementations.

**LAG** creates tone shift, but it is not a sound account. It is apparently meant to be a faithfulness constraint since the definition refers to input tones, and because '-IO' is suffixed to it in specific instances (e.g. **LAG-IO**(H)). But **LAG** does not maintain faithfulness. It states a fact about markedness instead. We can't reinterpret it as a markedness constraint because markedness constraints are barred



from access to the input, and LAG clearly requires this access.<sup>23</sup> Emphasizing the mention of the tone's *target* in the constraint definition, we might interpret LAG as a markedness constraint that requires a mismatch between tones and their phonetic implementations. But in this case, LAG reduces to (something like) PEAK DELAY.

One objection to the above argument is that if our theoretical assumptions render us unable to account for certain phenomena, we should modify our assumptions rather than shoehorn the phenomenon into an awkward analysis. Our theory should adapt to new phenomena, not the other way around. Perhaps the tonal phenomena considered in this chapter indicate that markedness constraints should have access to the input after all. This would mean we can adopt LAG and thereby have a simple account of noniterative tonal phenomena that doesn't require a theory of peak delay.

The problem with this move is that it admits the possibility of noniteratively oriented constraints for other phenomena. For example, we could adopt (53) to account for Lango's vowel harmony:

- (53) LAG-ATR: An input ATR feature should reach its target on the following (or preceding) output vowel.

(Where again, despite the reference to targets, we take this constraint to require ATR features to be linked to vowels adjacent to their input hosts.)

Aside from the incorrect predictions this constraint makes about progressive harmony with polysyllabic suffixes (see Chapter 2), if LAG-ATR is a full-fledged

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<sup>23</sup>Even if we remove the reference to inputs tones, LAG can't tell whether or not a tone appears "on the following output TBU" without seeing what the original TBU was in the input.

OT constraint on par with ones that produce iterative vowel harmony, noniterative harmony should be as common as iterative harmony: just as many grammars with a highly ranked LAG-ATR are possible as grammars with a highly ranked SPREAD-ATR, for example, are. Yet noniterative harmony is vanishingly rare, if existent at all, suggesting that constraints like LAG are superfluous. Even though LAG lets us sidestep issues like peak delay and gives us a simple account of noniterative tonal phenomena (at the cost of abandoning what might be a trivial and pedantic theoretical tenet), it sets the stage for massive overproduction for OT.

Both LOCAL and LAG are unsatisfactory because they take noniterative tone spread/shift to be purely phonological processes that involve adding exactly one association line between a tone and a TBU. Consequently, when these constraints evaluate candidates, they must know which association lines are new and which are underlying, and this is what leads to the conflict with the ban on access to the input. On the other hand, the PDT and ODT accounts proposed in the preceding sections do not have this problem. PDT takes these noniterative phenomena to reflect articulatorily motivated mismatches between phonological representations and phonetic implementations, and it doesn't need to manipulate association lines. ODT produces the correct outputs by building binary tonal domains. Both approaches stay within existing restrictions on markedness constraints. In particular they obey the restriction that prevents the formalization of noniterativity, a restriction that this dissertation argues is well-founded.

## 4.8 Other Tonal Phenomena

The PDT analysis takes many tonal phenomena to be artifacts of timing discrepancies between  $f_0$  and other articulations. But this does not mean the proponent of PDT is committed to the position that all tonal phenomena are phonetic in nature. For example, in Chichewa, the infinitive/progressive marker *-ku-* induces a high tone on the following syllable. The transcriptions below follow Kanerva (1990).

- (54)    *ku-phíika*            ‘I am cooking’  
          *ku-lémeera*        ‘I am rich’  
          *ku-fótókooza*    ‘I am explaining’

The lack of spreading in the second example indicates that the tone is associated with the first stem syllable, rather than this being a case of Kikuyu-style peak delay. Furthermore, if the tone shift in (54) were merely the phonetic result of peak delay, we’d expect to see this kind of shift everywhere in the language. Also, along with the last example from (54), the data below, from Moto (1983) (who doesn’t transcribe penultimate lengthening), show that the shifted tone undergoes the usual spreading that was discussed in §4.3:

- (55)    *kuphíká ndíwo*        ‘to cook relish’  
          *kulírá maliro*        ‘to mourn’  
          *kupémpá ndaláma*    ‘to ask for money’  
          *kusámála mkázi*     ‘to care for a woman’

Since the tones in (55) are transcribed over the first two stem syllables, the reasonable conclusion is that the tone has shifted to the first stem syllable and then spread from that syllable. If H remained associated with the prefix, we'd expect transcriptions like \**kúlíra maliro* and \**kúpémpha*. Instead, the transcriptions are consistent with the assumption that these tones are underlyingly associated with the stem-initial vowel.

The tones in these examples phonologically shift—H is formally associated with the stem-initial syllable. Once this shift is produced, the spreading facts fall out from the analysis in §4.3. How are we to produce tone shift? Since the shift seen here is confined to specific contexts (words with the *-ku-* prefix, and also the recent past *-na-* and habitual *-ma-*) in contrast with the pervasive tone shift from Kikuyu, we could adopt a morpheme selection constraint like the one in (56).

(56) H ON *-ku-* STEM: *-ku-* must affix to an H-initial stem.

This constraint encodes the observation that *-ku-* selects a high-toned stem allomorph. Since the prefix itself supplies a high tone, we don't have to lexically list each verb stem with a high-toned variant. Instead, the prefix's H docks onto the stem—the prefix provides the means for satisfying its own selectional requirements.

Alternatively, we could adopt an Alignment constraint like the one in (57). This requires high tones affiliated with the infinitive prefix to be left-aligned within a verb stem. Ranked over IDENT-T, this will correctly place a high tone on the stem-initial syllable.

- (57) ALIGN-L( $H_{\text{Inf}}$ , Stem): The left edge of every high tone from an infinitive morpheme is aligned with the left edge of some verb stem.

Similar constraints could be adopted for other verbal prefixes in the language, such as the present habitual *-ma-*, which requires two high tones, one on the preceding syllable and another on the stem-penultimate syllable.

These solutions are workable here because of the limited scope of Chichewa's tone shift. Since the prefix's H always lands in the same position in the same morphological unit, we can posit a specific constraint that produces this state of affairs. Compare this to the sweeping constraint or army of specific constraints that would be necessary under approaches based on (56) or (57) for Kikuyu.

A Positional Licensing constraint (in the style of Crosswhite (2001)) would even work. By declaring that *-ku-*'s H is licensed only in the stem, we can achieve tone shift similar to the way spreading to the root was produced in previous chapters.

Whatever the correct analysis is, it is clear that Chichewa's tone shift is morphologically governed. In this light, it is similar to the ATR harmony of Lango and Chamorro's umlaut in that some property of an affix is attracted to the morphological unit to which the affix attaches. While this appears to be a noniterative movement, we can appeal to other factors that don't stipulate noniterativity.

Other cases of tone shift involve high tones moving to specific position in a word or phrase. The target syllable is often a final syllable in some domain. For example, in Digo, the last H of a word moves to the final syllable (Kisseberth 1984). Kisseberth also argues that the rightmost H in a phrase moves to the phrase-final syllable in Digo. Tone shift can also reflect the pressure of a NONFINALITY

constraint: in Nkore (Odden 2005) and Somali (Saeed 1999), H moves from the phrase-final syllable to the penultimate syllable. Also relevant is the retraction phenomenon in Chichewa discussed above and similar cases that are noted in Myers (1999).

Similarly, many researchers (e.g. de Lacy 1999, 2002b, Downing 2003, Peterson 1987) have noted that high tones often gravitate toward prosodically prominent positions. Digo's shift-to-final-syllable phenomenon may involve attraction to prominence or simply right-alignment, and Philippson (1998) argues that retraction in Chichewa is really attraction of the phrase-final H to the stressed penultimate syllable. Downing (2003), who points out many similarities between accentual systems and the tonal systems of Chichewa and Xhosa, argues that in Chichewa, when a prefix's H moves to the stem-penultimate syllable in a way comparable to *-ku-*'s placement of a stem-initial H, this is attraction to prominence. Peterson (1987), also working with Chichewa, adopts essentially the same analysis: Extra prominence (via grid marks) is assigned to certain syllables, and a rule or well-formedness principle requires tones to associate with these prominent syllables. Since specific positions are targeted in these cases, straightforward accounts that do not run afoul of the ban on markedness constraints accessing the input are available. This is even true of certain cases that involve shifting to an adjacent position, such as movement from the final to the penultimate syllable in Chichewa. Simply put, tone shift of this nature is not noniterative, so it is neither a counterexample to this dissertation's thesis nor problematic for existing OT constraints.

Shona has a particularly interesting tone spread phenomenon (Myers 1987, 1997, Odden 1981). High tones in this language can engage in unbounded rightward spreading as long as every pair of adjacent syllables in the spreading domain belongs to different morphemes. (This is far from the whole story about tone spread in Shona—see the work cited immediately above for more comprehensive discussion.) Thus we have (58a), where the high tone on the first morpheme spreads all the way to the penultimate syllable. It can reach this position because each spreading “step” crosses a morpheme boundary. Compare this to *ma-zimi-cheró* ‘Big ugly fruits,’ which shows that the non-initial morphemes in (58a) contribute no high tones themselves. On the other hand, in (58b), spreading just to the antepenultimate syllable is allowed because spreading to the penultimate syllable would involve spreading within the morpheme *ǎambudziko* (cf. (58c), which shows that the root has no high tone of its own).

- (58) a. *Vá-Má-zí-mí-chéro*  
 2a-6-21-4-fruit  
 ‘Mr. Big-ugly-fruits’ (Odden 1981:77, gloss from Myers 1997:862)
- b. *Vá-Dámbudziko*  
 honorific-Dambudziko  
 ‘Mr. Dambudziko’ (Odden 1981:76)
- c. Dambudziko (proper name) (Odden 1981:76)

Myers (1997) accounts for this pattern by positing unbounded rightward tone spread that is reined in by a constraint requiring successive high-toned syllables to be in different prosodic or morphological domains. Although examples like (58b)

seem to show noniterative spreading, forms such as (58a) reveal this noniterativity to be a happenstance of the morphological configuration.

PDT can also interact with some of these other analytical approaches. Michael Marlo (p.c.) provides the data in (59) from Lukhayo and Lutura. In these languages, H spreads leftward to the peninitial stem syllable (stems are marked with square brackets). That is, the stem-initial syllable is off limits for spreading. But if the stem is disyllabic, the initial syllable *is* targeted. The generalization is this: spreading by one syllable is mandated, and then if there are other stem syllables available besides the initial syllable, further spreading occurs.

(59)	Lukhayo	Lutura	Gloss
	a-li[fw-á]	a-li-[fw-á]	‘he will die’
	a-li[xín-á]	a-li[xín-á]	‘he will dance’
	a-li[reéβ-á]	a-li[rééβ-á]	‘he will ask’
	a-li[βukúl-á]	a-li[βukúl-á]	‘he will take’
	a-li[siindíx-á]	a-li[siindíx-á]	‘he will push’
	βa-li[karááng-ír-án-á]	βa-li[karááng-ír-án-á]	‘they will fry for each other’

Some constraint—call it *ALIGN-L*—motivates spreading to the stem-initial syllable, and another constraint (say, *NONINITIALITY* (Bickmore 2000)) outranks *ALIGN-L* and prevents complete satisfaction of *ALIGN-L*. *PEAK DELAY*, when it outranks *NONFINALITY*, effectively produces the minimal-spreading requirement by encouraging the tone’s onset and peak to appear in separate syllables. When the stem is trisyllabic, satisfaction of *ALIGN-L* (to the extent possible) entails the satisfaction *PEAK DELAY*. E.g., in *βa-li[karááng-ír-án-á]*, the high tone’s domain



is long enough for the peak and onset to appear in separate syllables without either one falling outside the tone's formal, phonological domain. But when the stem is disyllabic, PEAK DELAY motivates the otherwise banned spreading to the initial syllable.

It is worth noting, though, that \*MONOHD and the other mechanisms that produce minimal tone spread and shift in ODT can replace PEAK DELAY in the analysis sketched in the previous paragraph, so PEAK DELAY has no monopoly on the data in (59).

We've seen in this section that there are phenomena that need not (and probably should not) be accounted for under the peak delay umbrella. Phonological analyses of these phenomena are not inconsistent with my claim that noniterativity doesn't exist in phonology because even the cases of minimal tone shift (like Chichewa's *-ku-* morpheme) are amenable to analyses that do not require noniterativity. The prediction the Emergent Noniterativity Hypothesis makes is that all cases of seemingly noniterative tone shift/spread will target a specific position (as in many of the cases mentioned here), reflect unbounded spreading that is curtailed by other forces (as in Shona), or be the result of phonetic implementation or spreading within a small domain (as in Chichewa's spreading and Kikuyu's shifting).

## 4.9 Conclusion

This chapter has considered the implications of tonal phenomena for the ENH. This is an important testing ground for this dissertation's thesis because nonit-

erative tonal phenomena are widespread. I have argued that there are ways to account for these phenomena that do not explicitly invoke noniterativity. I do not claim that this chapter resolves the question of how to account for these facts once and for all, and certainly not for every language exhibiting noniterative tonal phenomena. Only a broader examination of tonal processes will determine if either of the analyses discussed here can account for every case of noniterativity. It would not be surprising to find that a variety of approaches are needed. Maybe some languages require a PDT analysis, while others are best understood with ODT. Each framework is just one of the many tools available to grammars. Some other framework may of course prove better than PDT and ODT, but the prediction of this dissertation is that the most satisfactory framework will not directly require tones to spread or move exactly once.

# POSTLEXICAL NONITERATIVITY: NONFINALITY AND MARKEDNESS SUPPRESSION

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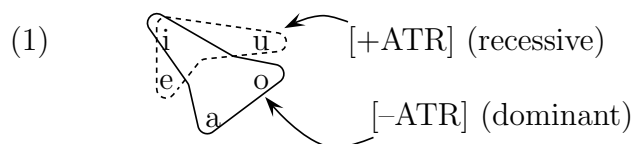
## 5.1 Introduction

So far this dissertation has focused on word-level noniterativity. This chapter examines noniterative postlexical phenomena, processes that extend beyond the word. Constraints such as NONFINALITY make demands of word edges, and it would not be surprising to find that neighboring words are called on to help satisfy these demands through (noniterative) spreading across the word boundary.

For example, it has been suggested that harmonic domains are headed (Cassimjee & Kisseberth 1998, McCarthy 2004, Smolensky 1993, 1995, 2006). In a language with right-headed domains, NONFINALITY can discourage word-final domain heads. Harmony will be disrupted minimally so that the rightmost syllable in the word's harmonic domain is the penultimate syllable rather than the final syllable, which joins the harmonic domain of the following word. Such a configuration avoids harmonic domains that end on word-final syllables. To put it differently, NONFINALITY can motivate spreading leftward across word boundaries by just one syllable so that the word-final syllable is not the rightmost

member of a harmonic domain.

This is exactly what we find in Nez Perce, which has a dominant/recessive vowel harmony system with the vowel inventory in (1).<sup>1</sup> Dominant vowels are enclosed by the solid line, and recessive vowels are enclosed by the dashed line. Data and discussion follow Aoki (1966, 1994), although I interpret the harmonizing feature as ATR following Hall & Hall (1980), with [-ATR] being the dominant feature.



Notice that *i* belongs to both harmonic sets. Aoki (1966) argues that this designation is necessary. For reasons we will see below, it is insufficient to say that this vowel is simply neutral.

If any vowel in a word is underlyingly dominant (i.e. [-ATR]), the other vowels harmonize with it. Thus the only way a [+ATR] vowel can surface is if all the vowels in a word are underlyingly [+ATR]. The pair in (2) illustrates this.

- (2) cé'qet            'raspberry'  
       ca'qát'ayn    'for a raspberry'

The noun *cé'qet* 'raspberry' has recessive vowels, and the suffix *-'ayn* 'for,' which contains a dominant vowel, triggers the change /e/ → *a* in the root.

Of interest for the present chapter is that postlexically, both [+ATR] and [-ATR] can spread leftward across a word boundary to the final vowel of a pre-

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<sup>1</sup>It should be kept in mind that what is transcribed as *e* is closer to [æ] (Aoki (1970) describes *e* as a low vowel), and *u* can be realized as [u].





other hand, Nez Perce presents a strong challenge to the hypothesis.

Unfortunately, I am aware of no data that bear on this question. I therefore assume that Nez Perce does challenge the ENH, and the bulk of this chapter is devoted to developing an OT analysis of this phenomenon that does not rely on noniterativity and follows the reasoning sketched above. Under the assumption that harmonic domains in Nez Perce are right-headed, we can invoke a NON-FINALITY constraint to prevent heads from appearing in the last syllable of a word. To satisfy NON-FINALITY, harmonic domains are minimally adjusted so that word-final syllables are not rightmost in their harmonic domains.

Other sandhi phenomena similar to Nez Perce's postlexical harmony are also considered in this chapter. Within Lexical Phonology (Kiparsky 1982, 1985), spreading across a word boundary is traditionally taken to be diagnostic of a postlexical rule (e.g. Pulleyblank 1986) because it is only at the postlexical stratum that the phonology ceases to consider words in isolation and permits words to interact with each other. We will see that NONFINALITY-induced effects are attested in many languages.

These phenomena are relevant to larger goals of this dissertation because they often appear to be noniterative: an element spreads from one word to the first or last syllable, segment, etc., of an adjacent word and no farther. Examples are found at all levels of phonology. For example, Pulleyblank (1986) gives many examples of postlexical tone rules in which a tone spreads minimally across a word boundary. Many (if not all) of the examples he gives show cases in which a rule is simply not restricted to word-internal (that is, lexical) application, so when the trigger and target span a word boundary, a rule that normally spreads

tones within words spreads across words. I assume that these postlexical processes are amenable to the analyses discussed in Chapter 4 since they are just special instances of more general “noniterative” tone spread. Non-tonal processes with similar properties (applying both within and across words) likewise submit to analyses of emergent noniterativity mentioned elsewhere in this dissertation. The focus here is on exclusively postlexical processes.

An interesting kind of phenomenon called iterative optionality by Vaux (2003b) is revealed by this investigation. “Iterative optionality” is a label for a special kind of optional process: In forms with multiple loci at which the process may apply, whether or not each loci undergoes the process is independent of whether or not the other loci undergo it. In a single form, the process may apply at some positions but not others. Iterative optionality contrasts with all-or-nothing optionality, where either every locus undergoes the process or none of them do.

An example of iterative optionality is encountered in Vata, where postlexical spreading of the sort schematized in (6) is possible, but the extent of leftward spreading may vary. Vaux argues that iterative optionality is incompatible with OT, but I propose a new addition to OT called Markedness Suppression that predicts iterative optionality.

The chapter is structured as follows: The analysis of Nez Perce is developed in §5.2. An analysis of the language’s lexical harmony is presented in §5.2.1, and it is extended to account for postlexical harmony in §5.2.2. The detailed analysis of this language shows how apparently noniterative postlexical phenomena can be generated without invoking noniterativity, although it is probably unrealistic to expect the particular analysis proposed here to account for every relevant case.



Other languages with apparently noniterative postlexical phenomena similar to Nez Perce are discussed in §5.3: Somali (§5.3.1), Vata (§5.3.2), and Akan (§5.3.3). A different sort of postlexical process, Irish palatalization, is discussed in §5.4, and §5.5 summarizes the chapter.

## 5.2 Nez Perce Vowel Harmony

### 5.2.1 Lexical Harmony

Before we can address Nez Perce's postlexical harmony, we need an analysis of the lexical harmony. More examples of lexical harmony are given in (7) and (8).

- |     |    |              |   |
|-----|----|--------------|---|
| (7) | a. | tísqeʔ       | ‘skunk’   |
|     |    | tísqaʔlaykin | ‘near a skunk’                                      |
|     | b. | céʔqet       | ‘raspberry’   |
|     |    | caʔqátʔayn   | ‘for a raspberry’                                   |
|     | c. | /méq/        | ‘paternal uncle’ (noun stem)                        |
|     |    | neʔméx       | ‘my paternal uncle’                                 |
|     |    | méqeʔ        | ‘paternal uncle!’                                   |
| (8) |    | /ʔáʔt/       | ‘go out’ (verb stem)                                |
|     |    | /wéʔyik/     | ‘go across’ (verb stem)                             |
|     | a. | /-se/        | ‘sing. subject, indicative present, s-class marker’ |
|     |    | ʔáʔtsa       | ‘(I) am going out’ <sup>2</sup>                     |

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<sup>2</sup>Aoki (1966:760 fn. 6) notes that “[t]he form is without an overt subject pronominal prefix and may mean either ‘I am going out’ or ‘you (sg.) are going out.’” I follow Aoki in representing the ambiguity with ‘(I).’

	wé·yikse	‘(I) am going across’
b.	/-ne/	‘remote past’
	ʔá·tsana	‘(I) went out long ago’
	wé·yiksene	‘(I) went across long ago’
c.	/-qa/	‘recent past’
	ʔá·tsaqa	‘(I) went out recently’
	wá·yiksaqa	‘(I) went across recently’
d.	/weye-/	‘hurry’
	weyewé·yikse	‘(I) am hurrying across’
	weyewé·yiksene	‘(I) hurried across long ago’
	wayawá·yiksaqa	‘(I) hurried across recently’
e.	/wat-/	‘wade’
	watwá·yiksa	‘(I) am wading across’
	watwá·yiksana	‘(I) waded across long ago’
	watwá·yiksaqa	‘(I) waded across recently’

As shown in (7a) and (7b), roots can harmonize with suffixes. (7c) shows that when all the morphemes in a word have recessive vowels, these vowels surface faithfully. In (8), the behaviors of two verb stems are contrasted. The first root has a dominant vowel and the second has recessive vowels. As (8a)–(8c) show, /ʔá·t/ is invariant and triggers alternations in recessive-voweled suffixes. /wé·yik/, on the other hand, only surfaces faithfully if the suffixes also have recessive vowels. Finally, (8d) and (8e) show that prefixes participate in and trigger harmony.

The *a* ~ *e* alternation is illustrated in above; examples with the *o* ~ *u* alternation are given in (9).

- (9) a. /luʔuqí/                    ‘to get warm’  
       luʔuqíce.                    ‘I am getting warm’  
       hiluʔuqíce.                ‘It is getting warm’  
       hiluʔúqin.                ‘It just turned warm’  
       hiloʔxnóʔqa.              ‘It could get warm./The warm weather might  
       come.’
- b. /kúʔ/                        ‘to do’  
       kúʔse.                      ‘(I) am doing’  
       kusiʔx.                     ‘we are doing’  
       kosáʔqa.                  ‘I did recently’  
       kosiʔqa.                  ‘we did recently’  
       kótʔaʔ                    ‘I would do’
- c. /-un/                        ‘agentive suffix’  
       ʔimécʔinpun              ‘prophet’  
       hayáytamon              ‘a person who gives a war cry’
- d. /-(n)uʔ/                    ‘future suffix’  
       hiʔpúʔ.                    ‘he will eat’  
       hipeʔpúʔ.                ‘they will eat’  
       hipáynoʔ.                ‘he will come’  
       hipapáynoʔ              ‘they will come’

As (7), (8) and (9) show, harmony is neither root- nor affix-controlled, nor is it unidirectional. The determining factor is vowel quality. If any morpheme contains a dominant vowel, the other vowels harmonize with it. Under the assumption that the harmonizing feature is ATR, this means that [–ATR] vowels are dominant,

and [+ATR] vowels are recessive.

Aoki (1966) provides evidence that *i* can be either dominant or recessive. As shown in (10a), when affixed to the stem /ʔíːc/ ‘mother,’ the first-person possessive and vocative morphemes surface with recessive vowels. This shows that the affixes have recessive vowels underlyingly, and at this point we might say that *i* is simply neutral and doesn’t participate in harmony at all.

- (10) a. neʔíːc                    ‘my mother’  
          ʔíːceʔ                   ‘mother!’  
      b. naʔcíːc                ‘my paternal aunt’  
          cíːcaʔ                ‘paternal aunt!’

But in (10b), the same affixes surface with dominant vowels. Some dominant vowel must appear in these forms to trigger the affixes’ alternations. But the only other vowel in (10b) is the *i* of the stem *cíːc* ‘paternal aunt,’ so we must conclude that this vowel is in the dominant category. If *i* is dominant (i.e. [–ATR]), then why don’t we see [–ATR] harmony in (10a)? The simplest conclusion is that *i* can have membership in either the dominant or recessive classes.

Hall & Hall (1980) argue that the dual membership of *i* reflects a surface neutralization of an underlying ATR distinction. The morpheme meaning ‘mother’ has a [+ATR] vowel, while the morpheme meaning ‘paternal aunt’ has a [–ATR] vowel. I will continue to use Aoki’s transcriptions, but I adopt Hall & Hall’s ATR-based characterization of harmony. Nothing crucial hinges on these choices. If Hall & Hall’s position is correct, it only means that some of the transcriptions used here are either imprecise or reflect the neutralization mentioned above. If

Hall & Hall are incorrect, it is simple enough to replace  $[\pm\text{ATR}]$  with a more appropriate feature.

To summarize, Nez Perce has a dominant/recessive vowel harmony system, with  $[-\text{ATR}]$  (*o, a*) as the dominant feature and  $[\text{+ATR}]$  (*u, e*) as the recessive feature. The vowel *i* can be either dominant or recessive.

Each Nez Perce word is fully harmonic. How are we to produce this in OT? Chapter 2 gives a short overview of attempts to produce harmony in OT, and I arbitrarily select an analysis based on  $\text{AGREE}[-\pm\text{ATR}]$  (Baković 2000, Lombardi 1996, 1999) here:

- (11)  $\text{AGREE}[-\pm\text{ATR}]$ : Vowels in adjacent syllables within a word must have identical ATR specifications.

Nothing crucial hinges on the choice of  $\text{AGREE}$  over  $\text{ALIGN}$ ,  $\text{SPREAD}$ , etc. All that is needed here is something to trigger the word-level harmony that is altered postlexically.

To produce the dominant/recessive character of Nez Perce's harmony,  $\text{IDENT}[\text{ATR}]$  can be decomposed into  $\text{IDENT}[-\text{ATR}]$  and  $\text{IDENT}[\text{+ATR}]$  (Hall 2006, McCarthy & Prince 1995, Pater 1999). With  $\text{IDENT}[-\text{ATR}]$  outranking  $\text{IDENT}[\text{+ATR}]$ , it will always be better to change  $[\text{+ATR}]$  (i.e. recessive) vowels rather than  $[-\text{ATR}]$  (dominant) vowels in case of a mismatch. This is illustrated in (12) for *ca·qát'ayn* 'for a raspberry.'

(12)

/cé·qet-’ayn/	AGREE-[±ATR]	IDENT[-ATR]	IDENT[+ATR]
a. cé·qet’ayn	*!		
☞ b. ca·qát’ayn			**
c. cé·qet’eyn		*!	

The fully faithful candidate (a) fatally violates AGREE because the vowels in the last two syllables do not have the same ATR features. We’re then faced with a choice: Either the two [+ATR] vowels should change (candidate (b)) or the one [-ATR] vowel should change (candidate (c)). The latter violates the higher-ranked IDENT constraint, so it is ruled out, and candidate (b) wins, with the recessive vowels changing to match the dominant vowel.

Of course, if all the vowels in a word match underlyingly, no change is necessary because AGREE is already satisfied. (13) shows this with *neʔméx* ‘my paternal uncle.’

(13)

/neʔ-méq/	AGREE-[±ATR]	IDENT[-ATR]	IDENT[+ATR]
☞ a. neʔméx			
b. naʔmáx			*!*
c. neʔmáx	*!		

(As for the consonant mutation in this form, Aoki (1966) states that *q* appears in onsets and becomes *x* in codas.)

We now have a simple constraint system that produces Nez Perce’s lexical vowel harmony. Since AGREE is the harmony-driving constraint of choice here, the sour-grapes problem (McCarthy 2003, 2004, Padgett 1995) can arise. I will not attempt to resolve this issue since the primary concern of this chapter is

postlexical harmony. A more general solution for vowel harmony that does not encounter the sour-grapes problem and the defects of alternatives to AGREE is the subject of ongoing research in phonology, and whatever that replacement theory turns out to be can replace AGREE without affecting the analysis of postlexical spreading, to which I turn now.

## 5.2.2 Postlexical Harmony

Recall that in fast speech, the last vowel of one word can harmonize with the following word:

- (14) a. ʔitam'yát'as ʔewsí'x.      'They are for sale.'  
           ʔitam'yát'es ʔewsí'x.
- b. míniku'ne pá'kciqa.      'Which one did they see?'  
           míniku'na pá'kciqa.
- c. yoɣma lepúʔ papá'ynoʔ.    'Those two people will come here.'  
           yoɣme lepóʔ papá'ynoʔ.

The analysis is now faced with two tasks: (i) produce the minimal cross-word spreading, and (ii) account for the optionality. The former is accomplished here with the NONFINALITY constraint in (15):

- (15) NONFINALITY-ATR: The head of an ATR domain cannot be in the word-final syllable.

NONFINALITY-ATR discourages placement of ATR domain heads in word-final syllables, just as Prince & Smolensky (1993[2004]) use NONFINALITY to ban prosodic heads from word-final syllables. As is obvious from this constraint, we must assume that ATR domains are headed. Domain headedness is not a novel proposal: Smolensky (1993, 1995, 2006), McCarthy (2004), and Cassimjee & Kisseberth (1998), among others, have proposed this. I follow Smolensky (2006) most closely—except for one point taken up immediately below—because his framework can be implemented without the theoretical apparatuses that accompany Headed Spans and Optimal Domains Theory. The premise is simple: In any consecutive string of [-ATR] vowels (i.e. an ATR domain), one of the vowels is a head. The same goes for a string of [+ATR] vowels. In Nez Perce, the rightmost vowel in the domain is the head.

Why the rightmost vowel? Clearly, if Nez Perce’s harmony were of the right-to-left variety, it would be easy enough to say that the rightmost vowel is the head because it is the trigger. This is exactly the position Smolensky (2006) takes: headedness is correlated with the direction of spreading. Cassimjee & Kisseberth (1998) take the opposite approach and identify heads as the rightmost vowel in a rightward-spreading context and the leftmost vowel in a leftward-spreading context—the head is the last vowel targeted by spreading. But a vowel in any position can be the trigger in Nez Perce, so under the “head = trigger” approach, the head could in principle be any vowel in a domain. This approach also encounters indeterminacy. In a word with all recessive vowels or all dominant vowels, no spreading occurs, so the head would be impossible to identify. Likewise, the suffix /-laykin/ ‘near’ has two dominant vowels (see (7a))—which is the head when the



suffix attaches to a recessive stem? The “head = last target” approach also fails to uniquely identify a head because spreading is bidirectional.

Because of these questions, if the research cited above is right and harmonic domains are headed, we cannot derive the location of the head from properties of the harmonic system itself, at least as far as Nez Perce is concerned.<sup>3</sup> We can, however, turn to headedness in other domains, such as foot- and word-level prominence. Binary feet can be left- or right-headed, as can words (i.e. primary stress can fall on the first or last foot). In these domains, although headedness can be correlated with other factors such as moraic vs. syllabic binarity (see Hayes 1995), it is essentially arbitrarily stipulated, either via a parameter setting or a constraint requiring prominence at one end of the domain or the other.

We can do the same for vowel harmony domains. An Alignment constraint requiring the head to be at the right edge of an ATR domain will, when undominated, effectively produce “iambic” ATR domains. I assume such a constraint here, and to streamline the discussion I will neither show the constraint in Tableaux nor consider candidates that violate it.

Harmonic domains may plausibly show a universal tendency for right-headedness. Hyman (to appear) identifies a crosslinguistic bias for right-to-left harmony, and it would not be surprising if headedness reflected this bias. (Or perhaps the directionality bias reflects a headedness universal.) Thus the claim that Nez Perce has right-headed domains may be the equivalent of claiming it has default

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<sup>3</sup>Stress seems to be of no help either. Aoki (1970) lists stress as a phoneme, implying that its placement is unpredictable. His description of where stress appears in various morphological contexts, along with an inspection of his data, suggest that while perhaps not wholly unpredictable, stress does not consistently appear in any particular position in the language. A “head = stressed” approach would identify a unique head in each word, but the location of the head would vary across words.

headedness.

Despite the terminological distinction between lexical and postlexical harmony, it is not necessary to adopt Stratal OT (Kiparsky 2000, Rubach 1997, among others)—as was done in the analysis of Chamorro in Chapter 3—to account for (14). NONFINALITY-ATR can be added to the top of the existing constraint ranking to produce the correct result. Nonetheless, certain aspects of the analysis become simpler under Stratal OT, so I adopt that approach here. The constraint ranking from the previous section holds for the lexical stratum, and the addition (or promotion) of NONFINALITY happens postlexically. See Chapter 3 for more discussion of Stratal OT.

How does NONFINALITY-ATR produce Nez Perce's postlexical spreading? Consider  $\{?itam'yá't'as\} \{?ewsi'x.\}$  'They are for sale.' Each word forms its own harmonic domain, indicated with curly braces. Since domains are right-headed, the final vowel in each word is the head of that word's domain, and NONFINALITY-ATR is therefore violated twice. But readjusting the domain boundaries to produce  $\{?itam'yá'\} \{t'es ?ewsi'x.\}$  eliminates one of these violations. The rightmost vowel in the first harmonic domain—the head—is no longer the word-final vowel. At a cost of minimal disharmony, NONFINALITY-ATR is better satisfied. The Tableau in (16) illustrates the point.<sup>4</sup>

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<sup>4</sup>I assume that AGREE remains concerned with word-level harmony even at the postlexical stage. As far as I can tell, the analysis would still hold up even if AGREE penalized all disharmonic adjacent vowels regardless of word boundaries. Vowel harmony systems with harmonic domains that are larger than words are rare, so it seems likely that whatever drives harmony cares solely about word-level harmony.

(16)

	NONFIN	AGREE	ID[-ATR]	ID[+ATR]
/ʔitam'yá't'as ʔewsí'x./				
a. {ʔitam'yá't'as} {ʔewsí'x.}	**!			
b. {ʔitam'yá'} {t'es ʔewsí'x.}	*	*	*	
c. {ʔitam'} {yé't'es ʔewsí'x.}	*	*	**!	
d. {ʔitam'yá'} {t'es ʔew} {sí'x.}	*	**!	*	*

Aoki (1966) does not give underlying representations for these words, but that is not problematic here because the input for (16)—a postlexical Tableau—is the output of the lexical evaluation, where each word is fully harmonic.

Candidate (a) maintains full word-level harmony and therefore incurs two violations of NONFINALITY. Candidate (b) eliminates one of these violations by spreading the [+ATR] feature of the second word onto the last vowel of the first word. Since the last vowel of the second word is still the head of a harmonic domain, NONFINALITY is still violated once.

Candidate (c) shows that spreading beyond the last vowel of the first word is unmotivated. This doesn't eliminate violations of either NONFINALITY or AGREE, and it incurs an unnecessary violation of IDENT. As with the analyses of Lango and Chamorro from preceding chapters, spreading by one syllable is optimal because it satisfies the constraint that motivates spreading while minimally violating faithfulness.

Candidate (d) shows that this one violation of NONFINALITY is unavoidable. This candidate removes the final vowel from the second word's harmonic domain. Now the [+ATR] domain's head is not word-final. But the word-final vowel must

be specified for  $[\pm\text{ATR}]$ ,<sup>5</sup> so its new  $[-\text{ATR}]$  domain incurs a violation of NONFINALITY. Simply put, one violation of NONFINALITY is inevitable because the last vowel of the last word must be in an ATR domain, and it will be the head of that domain. With respect to NONFINALITY, candidate (d) ties with candidate (b), but the former's new ATR domain incurs an extra violation of AGREE, so the latter wins.

There are other candidates worth considering. For example, rather than spreading leftward, we could spread rightward and avoid a violation of NONFINALITY equally satisfactorily:  $*\{\text{?itam}'y\acute{a}t'as \text{?aw}\}\{\text{s}\acute{i}'x.\}$ . We could also spread leftward all the way to the beginning of the first word and eliminate the AGREE violation:  $*\{\text{?item}'y\acute{e}t'es \text{?ews}\acute{i}'x.\}$ . How do we rule out these candidates?

This is the point at which Stratal OT becomes helpful. The first candidate from the previous paragraph is ruled out because it alters the ATR specification of a word-initial vowel. Although initial vowels can undergo lexical harmony, as many of the examples above show, they never change after leaving the lexical stratum. Therefore, we can adopt the Positional Faithfulness (Beckman 1999) constraint in (17). (Word-initial vowels are singled out for their prominence, just as NONFINALITY singles out final syllables for their non-prominence.)

- (17) IDENT[ATR]-[ $\text{W}_d\sigma$ ]: Corresponding vowels in word-initial syllables have identical ATR specifications.<sup>6</sup>

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<sup>5</sup>Underspecification seems untenable since both  $[\text{+ATR}]$  and  $[-\text{ATR}]$  are active postlexically.

<sup>6</sup>Decomposing this constraint into IDENT $[-\text{ATR}]$ -[ $\text{W}_d\sigma$ ] and IDENT $[\text{+ATR}]$ -[ $\text{W}_d\sigma$ ] is a possibility, but since no ranking between the “atomic” constraints can be determined, I will not make that move here.

The Positional Faithfulness constraint can also rule out  $*\{\text{?item'yé't'es ?ewsí'x.}\}$ —despite the same  $i$  appearing in the transcription of the initial syllable, we've changed the ATR specification of this vowel. But what if we stop short of the initial vowel, as in  $*\{\text{?i}\}\{\text{tem'yé't'es ?ewsí'x.}\}$ ? The general Faithfulness constraints that are already part of the analysis rule this candidate out, just as they eliminated candidate (c) from (16).

With the new Positional Faithfulness constraint, these alternative candidates are now accounted for:

(18)

	IDENT[ <sub>Wd</sub> σ]	NONFIN	AGREE	IDENT[-ATR]	IDENT[+ATR]
/?itam'yá't'as ?ewsí'x./					
a. {?itam'yá't'as} {?ewsí'x.}		**!			
b. {?itam'yá'}{t'es ?ewsí'x.}		*	*	*	
c. {?itam'yá'}{t'es ?ew}{sí'x.}		*	**!	*	*
d. {?itam'yá't'as ?aw}{sí'x.}	*!	*	*		*
e. {?item'yé't'es ?ewsí'x.}	*!	*		****	
f. {?i}{tem'yé't'es ?ewsí'x.}		*	*	**!*	

Candidate (a)—the fully faithful candidate—is eliminated by NONFINALITY as before, and candidate (c) has the same fatal AGREE violation that we saw in (16). Candidate (d) is the rightward-spreading candidate, and it fatally violates IDENT[ATR]-[<sub>Wd</sub>σ]. Candidate (e), which posits a single domain for the entire construction, loses for the same reason. Candidate (f) avoids violating the Positional Faithfulness constraint by placing the initial syllable in its own domain and assigning the rest of the form to a second domain. Because the second do-

main does not include the initial vowel, this candidate incurs the same AGREE violation that the winning candidate incurs, and the decision is passed on to the IDENT constraints. Since candidate (b) changes just one ATR specification, it fares better in terms of faithfulness than candidate (f).

The upshot is this: Minimal violations of AGREE and IDENT are tolerated if it means avoiding word-final domain heads. Directionality is determined by Positional Faithfulness. The apparent noniterativity results from the markedness constraint that motivates spreading being satisfied after the first “iteration.” Faithfulness preventing subsequent spreading.

One might be concerned by the ranking  $\text{IDENT}[-\text{ATR}] \gg \text{IDENT}[\text{+ATR}]$ : Doesn't this mean that it's always better to spread  $[-\text{ATR}]$  postlexically, as was the case lexically? No: The Positional Faithfulness constraint determines the direction of spreading, so the only way to satisfy NONFINALITY is to spread leftward, even if—as we saw in (18)—that means spreading  $[\text{+ATR}]$ .

A few issues remain. First as I understand the facts, words always appear fully harmonic in isolation. Since words in isolation must pass through the postlexical grammar, NONFINALITY might be expected to disrupt this harmony. (19), which takes up the form from (13) again, shows that this is not the case.

(19)

	ID- $[\text{w}_d\sigma]$	NONFIN	AGREE	ID $[-\text{ATR}]$	ID $[\text{+ATR}]$
/neʔmɛx/ ‘my paternal uncle’					
☞ a. {neʔmɛx}		*			
b. {neʔ}{mɛx}		*	*.		*

The input is the output of the lexical Tableau. This form, as candidate (a) shows, violates NONFINALITY. But just as we saw above, positing a new ATR domain on the word-final syllable is no help. This new domain incurs a violation of NONFINALITY plus a new violation of AGREE. NONFINALITY only produces a disharmonic word when there's a following word that can contribute an ATR feature.

Second, postlexical harmony is optional. To derive this property, it is necessary to impose a non-crucial ranking between NONFINALITY and AGREE (Anttila 2006, 2007). As with the non-crucial ranking used to produce Chamorro umlaut in Chapter 3, I assume that a crucial ranking between these constraints is chosen for each evaluation. When NONFINALITY outranks AGREE, postlexical spreading occurs, as we saw above. Under the opposite ranking, the words surface with their lexical harmonic patterns:

(20)

	Id <sub>[-w<sub>d</sub>σ]</sub>	AGREE	NONFIN	Id <sub>[-ATR]</sub>	Id <sub>[+ATR]</sub>
/ʔitam'yá't'as ʔewsí'x./					
☞ a. {ʔitam'yá't'as} {ʔewsí'x.}			**		
b. {ʔitam'yá'} {t'es ʔewsí'x.}		*!	*	*	
c. {ʔitam'yá'} {t'es ʔew} {sí'x.}		*!*	*	*	*
d. {ʔitam'yá't'as ʔaw} {sí'x.}	*!	*!	*		*
e. {ʔitem'yé't'es ʔewsí'x.}	*!		*	****	
f. {ʔi} {tem'yé't'es ʔewsí'x.}		*!	*	***	

Finally, postlexical spreading happens only under fast speech, so NONFINALITY must hold only in this condition. A similar move was made in the analysis of

Lango in Chapter 2, where it was suggested that under fast speech, ATR features must be linked to stressed vowels.

From the point of view of the analysis presented here, the apparent noniterativity of Nez Perce's postlexical harmony is driven by the need to displace the head of a harmonic domain from the last syllable of the word. This only requires minimal displacement, so spreading by more than one syllable is unwarranted. No mention of noniterativity is needed.

The NONFINALITY-based analysis reveals a principled justification for what looks like an arbitrary postlexical process that serves only to disrupt the language's otherwise systematic, whole-word harmony. This disruption turns out to be motivated by pressure against placing domain heads in non-prominent positions, not by an "extra" spreading rule.

The NONFINALITY analysis uses nothing more than pieces of existing proposals. Lexical harmony is driven by AGREE, but any analysis of dominant/recessive harmony will do. NONFINALITY effects are attested in many languages. To pick one example, as discussed in Chapter 4, phrase-final high tones in Chichewa are displaced to the penultimate mora. Splitting IDENT constraints into plus- and minus-specific constraints has been suggested by researchers such as McCarthy & Prince (1995), Pater (1999), and Hall (2006), and the use of faithfulness constraints to keep spreading at a minimum comes from the analyses of Lango and Chamorro elsewhere in this dissertation. Similarly, Stratal OT is found in the analysis of Chamorro in Chapter 3 and has been argued to be necessary by Rubach (1997) and Kiparsky (2000). Moreover, the postlexical ranking adopted here is remarkably similar to the lexical ranking, requiring only two additional constraints



and no reranking of the lexically relevant constraints. The use of non-crucial rankings (which is just the multiple-grammars theory of variation) also comes from the Chamorro analysis with predecessors in Anttila (2006, 2007). Postlexical harmony in Nez Perce simply results from the confluence of these well-substantiated factors.

The following sections discuss other cases of postlexical spreading.

### 5.3 Other Postlexical Harmony Phenomena

Nez Perce is far from alone in the way its harmony system behaves postlexically. This section discusses three languages with similar processes, Somali, Vata, and Akan.

#### 5.3.1 Iterative Postlexical Harmony in Somali

Somali also has a dominant/recessive vowel harmony system that Saeed (1999) characterizes as ATR harmony with [+ATR] dominance. Note that this is the opposite of Nez Perce. The vowel inventory is shown in (21).

(21)	a.	<i>[+ATR] Vowels</i>	b.	<i>[-ATR] Vowels</i>
		i      ɯ		ɪ      u
		e      ö		ɛ      ɔ
		æ		ɑ

Word-internally, “[i]ndividual members of the major lexical categories, for example nouns, verbs, and adjectives,” (Saeed 1999:12) exhibit harmony:

- (22)    *ɪdɑn*            ‘permission’  
           *idæn*            ‘incense burner’  
           *bɑ:ɾɔ*            ‘inspect’  
           *bæɾö*            ‘writhe, roll about’  
           *dɪjɑ:ɾsɔ*        ‘prepare for oneself’  
           *köfɪjæd*        ‘hat’

Transcriptions follow Saeed (1999). Postlexical harmony occurs, too, but in this language it is iterative. As (23b) shows, a word with dominant vowels triggers harmony in the preceding words. (Cf. (23a), which shows that the first two words have recessive vowels underlyingly.)

- (23)    a.    *wa:ʔ sɑ:n fɑ:ɾs*  
           DM hide horse.GEN  
           ‘It is a horse’s hide.’
- b.    *wæ: sæ:n dɪbɪ*  
           DM hide bull.GEN  
           ‘It is a bull’s hide.’

It is unclear from these examples whether the postlexical spreading must cross a morpheme or word boundary along the lines of Shona’s tone spread illustrated in (58) from Chapter 4 above. But what (23) shows clearly is that postlexical harmony is iterative—this is the kind of data that was pointed out as missing for Nez Perce in §5.2.1. Were Somali’s harmony noniterative, we would expect to find \**wa: sæ:n dɪbɪ*. In fact, it seems likely that Somali’s postlexical harmony is driven

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<sup>7</sup>Saeed (1999:11) gives [ɑ] rather than [a] in the language’s vowel inventory, and it is not clear whether this instance of [ɑ] is a typographical error.

by the same mechanisms that produce its lexical harmony, whereas I argued above that this cannot be true of Nez Perce. Evidence for this position comes from the fact that in Somali, postlexical spreading obeys the dominant/recessive nature of the harmonic system, but in Nez Perce's postlexical harmony, both the dominant and the recessive features can spread.

Crucial data are missing for both Nez Perce and Somali. For the former, we have no examples where the target of postlexical spreading is a monosyllabic word. As noted above, this means we can't tell whether the truly noniterative rule in (4) is viable. For Somali, we have no cases where the target is polysyllabic. We know that the rule for Somali's postlexical harmony must be iterative, but we can't tell whether or not the rule must mention a word boundary. Somali presents an interesting contrast to Nez Perce's harmony, but its iterativity means that it has no bearing on the Emergent Noniterativity Hypothesis.

### 5.3.2 Vata: Markedness Suppression

#### 5.3.2.1 Harmony in Vata

Kiparsky (1985) discusses vowel harmony patterns from two languages that merit discussion here. The first language is Vata, which has an ATR harmony system that is very similar to Somali's, although the specific vowels in question are slightly different. (Kiparsky cites Kaye (1982), but I have been unable to locate that source, so I follow Kiparsky's description and data.) The vowel inventory is given in (24).<sup>8</sup> [+ATR] is dominant. Words are fully harmonic.

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<sup>8</sup>Kiparsky lists  $\text{ə}$  as the recessive counterpart of  $\text{ʌ}$ , but his data include  $\text{a}$  instead.

- (24) a. *[+ATR] Vowels*  
           i        u  
           e    ʌ    o
- b. *[-ATR] Vowels*  
               ɪ        ɔ  
               ɛ        ɔ  
                       ə/a

Postlexically, [+ATR] optionally spreads leftward across a word boundary:

- (25) a. ɔ̌ nɪ sáká pí̌ ‘he didn’t cook rice’  
       b. ɔ̌ nɪ sákʌ pí̌  
       c. \*ɔ̌ nɪ sʌkʌ pí̌

As in Somali, only the dominant feature spreads. As (25c) shows, only the last vowel of a word can be targeted, but despite that restriction, there is clear evidence that this is an iterative process: “[I]n a sequence of monosyllabic [-ATR] words the assimilation may propagate arbitrarily far to the left” (Kiparsky 1985:116). This is again similar to Somali, and it is illustrated in (26).<sup>9</sup>

- (26) a. ɔ̌ ká zā pí̌ ‘he will cook food’  
       b. ɔ̌ ká zʌ pí̌  
       c. ɔ̌ kʌ zʌ pí̌  
       d. ɔ̌ kʌ zʌ pí̌

Kiparsky suggests two different rules to account for this. The first is essentially a [+ATR]-specific and iterative version of (5): The postlexical rule spreads [+ATR] but is limited to application across a word boundary.

The second rule, which Kiparsky favors, involves extraprosodicity. Only

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<sup>9</sup>For the sake of completeness, I should note that according to Kiparsky, postlexical harmony cannot spread [+ATR] from nonhigh vowels to high vowels. This is reminiscent of the restrictions on Lango’s harmony (see Chapter 2) and can probably be produced with constraints, from Smolensky (2006), of the sort that were used in that chapter.

[+ATR] is specified lexically, and [-ATR] is filled in by a default rule at the end of the lexical cycle. Word-final vowels are marked as extraprosodic before this rule applies, so they cannot receive [-ATR] by the default rule. Postlexically, extraprosodicity is removed, and the same rule that produced lexical harmony applies again. But now the only available (i.e. unspecified) targets are the formerly extraprosodic word-final vowels. Thus, except for the cases of consecutive monosyllabic words, the harmony rule targets just a single vowel. Optionality is produced by declaring either extraprosodicity or the rule removing it postlexically to be optional.

It should be clear that the NONFINALITY-based analysis developed above for Nez Perce is applicable here, too. In fact, Kiparsky's extraprosodic analysis foreshadows the NONFINALITY approach. However, the data in (26) are problematic for OT. In the multiple-grammars theory of variation (Anttila 2006, 2007), ranking NONFINALITY over IDENT[ATR]-[Wd] $\sigma$ , (26d) can be produced (this form minimizes the number of vowels that are domain-final and word-final). The opposite ranking generates (26a) (the lexical outputs are preserved). But it is not at all clear how to produce the other two possibilities. Vaux (2003b) points out that this "iterative optionality" is very problematic for OT in general. (Cf. vowel reduction in Shimakonde, where stem vowels to the left of the antepenultimate syllable optionally reduce: *kú-pélévélélélá* ~ *kú-pálevélélélá* ~ *kú-pálpávéélélélá* ~ *kú-pálpávávéélélá* ~ *kú-pálpávávéálélélá* 'to not reach a full size for' Liphola (2001:170). Reduction cannot target a vowel to the right of an unreduced vowel: \**kú-pélévéláélélá*.) Other typical approaches to optionality in OT have the same problem as the multiple-grammars theory. I turn now to possible

solutions to the problem presented by (26).

### 5.3.2.2 Iterative Optionality and Markedness Suppression

The question of how to produce all the forms in (26) is a serious one. There are two extensions of OT that are designed to accommodate iterative optionality. The first is Markedness Suppression, which is currently under development (Kaplan in prep). The idea is that markedness constraints may be tagged as optional on a language-particular basis. A candidate that violates a tagged constraint may not actually receive a violation mark, and may thus emerge as optimal in a ranking that would normally rule it out. For example, in Vata, NONFINALITY outranks IDENT, so the evaluation of the form in (26) would normally proceed as in (27).

(27)

	/ó <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub> /	NONFIN	IDENT
a.	ó <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub>	*!***	
b.	ó <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub>	*!**	*
c.	ó <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub>	*!*	**
☞ d.	ó <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub>	*	***

But under Markedness Suppression, NONFINALITY is tagged as optional (as indicated by ‘⊙NONFINALITY’), and some of the violations it assigns may be omitted (as indicated by ‘o’). (27) is still a possible evaluation—it’s the one in which none of ⊙NONFINALITY’s violations are suppressed. Another possible evaluation is given in (28).

(28)

	/ɔ̌ <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub> /	⊙NONFIN	IDENT
a.	ɔ̌ <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub>	*!***	
b.	ɔ̌ <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub>	*!***	*
☞ c.	ɔ̌ <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub>	* <sub>o</sub>	**
d.	ɔ̌ <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub>	*	***!

This time, a violation mark for candidate (c) has been omitted. This means that as far as this Tableau is concerned, candidate (c) violates NONFINALITY just once. It ties with candidate (d) on this constraint now, and it wins because it incurs fewer violations of IDENT than candidate (d).

Yet another possible evaluation is shown in (29).

(29)

	/ɔ̌ <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub> /	⊙NONFIN	IDENT
a.	ɔ̌ <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub>	*! <sub>o</sub> <sub>o</sub> <sub>o</sub>	
☞ b.	ɔ̌ <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub>	<sub>o</sub> <sub>o</sub> <sub>o</sub>	*
c.	ɔ̌ <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub>	<sub>o</sub> <sub>o</sub>	**!
d.	ɔ̌ <sub>1</sub> ká <sub>2</sub> zā <sub>3</sub> pī <sub>4</sub>	<sub>o</sub>	***!

Now all violations of NONFINALITY are suppressed except for one of candidate (a)'s violations. In effect, candidates (b), (c), and (d) do not violate NONFINALITY, and candidate (a) violates it just once. That remaining violation eliminates candidate (a), and candidate (b) wins because it fares better with respect to IDENT than the other remaining candidates.

To complete the analysis it is necessary to rule out [-ATR] spreading (\*ɔ̌ ká zā pī). This can be done by placing \*[-ATR] below IDENT: Underlying [-ATR] specifications can be retained (within the requirements of NONFINALITY), but

new ones are prohibited.

The advantage of Markedness Suppression is its simplicity. Optionality is generated within one grammar, and the theory differs from standard OT only in that any number of violations assessed by a particular constraint can be “erased.” In this way an evaluation can yield candidates (like candidates (b) and (c) above) that are otherwise harmonically bounded.

Vaux (2003b) argues on the basis of phenomena like Vata’s postlexical harmony that phonological grammars must be rule-based because standard OT cannot output candidates that are harmonically bounded, but iterative optionality produces just this kind of form. Rules, on the other hand, can be marked as optional. If Vata’s postlexical harmony rule applies once, we get  $\acute{o} k\acute{a} z\bar{a} p\bar{i}$ . If it applies twice, we get  $\acute{o} k\acute{a} z\bar{a} p\bar{i}$ , etc. Markedness Suppression duplicates rule-based phonology’s ease of analysis by rendering certain markedness constraints impotent to a variable degree. This means that the repair strategies that markedness constraints motivate—such as feature spreading—may apply to variable extents, just like in rule-based phonology.

Riggle & Wilson (2005:9) argue against Markedness Suppression on the grounds that it invites “gratuitous violations of the optional constraint.” This is only true if faithfulness constraints can be tagged as optional. For example, an optional DEP would allow epenthesis of an arbitrary number of segments. But by limiting optionality to markedness constraints, Markedness Suppression, as proposed here and in Kaplan (in prep), answers Riggle & Wilson’s concern. Removing violations assessed by a markedness constraint essentially gives the upper hand to faithfulness temporarily, which is the equivalent of a rule failing to ap-



ply. Markedness Suppression therefore only allows variability in the direction of less change, and the out-of-control deviations that Riggle & Wilson (rightfully) object to are not an issue. Markedness constraints motivate processes, and an optional markedness constraint, like an optional rule, simply doesn't always invite a process to apply.

Of course, certain details of Markedness Suppression need to be worked out. Perhaps the most pressing is how the framework accounts for directionality facts in languages like Shimakonde. Recall that vowel reduction in Shimakonde starts at the left edge and proceeds rightward up to the penultimate vowel so that any number of vowels at the left edge of a word may be reduced. If a vowel is not reduced, no vowels to its right may be reduced. Perhaps this can be produced with Alignment constraints (a feature domain must be right-aligned in a word) or \*STRUC (a contiguous string of reduced vowels needs just one set of multiply linked features, but discontinuous strings would need multiple sets of features). More work is needed on this issue.

Also, while applying Markedness Suppression to NONFINALITY gets the correct result above, it may turn out that applying it to other constraints leads to bad predictions. Limiting Markedness Suppression to markedness constraints eliminates some undesirable predictions as described above, but letting Markedness Suppression to apply to any markedness constraint may still be too permissive. The consequences of eliminating other markedness constraints' violations needs further exploration.

Riggle & Wilson (2005) have their own theory of iterative optionality in which constraints evaluate candidates on a position-specific basis. For example,

rather than adopting NONFINALITY and IDENT as global constraints, we atomize them, creating one NONFINALITY and one IDENT for each position in a form. NONFINALITY@ $i$  (indices are the same ones used to track input-output correspondence relationships) assesses violations of NONFINALITY incurred only at position  $i$ . By interleaving the NONFINALITY@ $i$  and IDENT@ $i$  constraints, we can permit spreading in some locations but block it in others. If NONFINALITY@ $j$  outranks IDENT@ $j$  but IDENT@ $k$  outranks NONFINALITY@ $k$ , spreading to position  $j$  but not to position  $k$  is permitted.

For a concrete example, consider (30). In this ranking, the NONFINALITY constraints for positions 2 and 3 outrank the IDENT constraints for those positions. This means that spreading to those vowels is required, and candidates (a) and (b) are eliminated. But IDENT@1 outranks NONFINALITY@1, so the first vowel is not a valid target. Candidate (d), which spreads to this vowel, consequently loses. Candidate (c) wins. This form's spreading targets just the vowels whose NONFINALITY constraints are undominated. The other variants in (26) are produced with other permutations of the constraints.

(30)

$/\acute{o}_1 \acute{k}\acute{a}_2 \acute{z}\acute{a}_3 \acute{p}\acute{i}_4/$	Id@1	NF@2	NF@3	NF@1	Id@2	Id@3
a. $\acute{o}_1 \acute{k}\acute{a}_2 \acute{z}\acute{a}_3 \acute{p}\acute{i}_4$		*!	*!	*		
b. $\acute{o}_1 \acute{k}\acute{a}_2 \acute{z}\bar{\lambda}_3 \acute{p}\bar{i}_4$		*!		*		*
☞ c. $\acute{o}_1 \acute{k}\acute{\lambda}_2 \acute{z}\bar{\lambda}_3 \acute{p}\bar{i}_4$				*	*	*
d. $\acute{o}_1 \acute{k}\acute{\lambda}_2 \acute{z}\bar{\lambda}_3 \acute{p}\bar{i}_4$	*!				*	*

Position-specific evaluation is designed to account for phenomena such as French schwa deletion (Dell 1973), where any combination of schwas may be

deleted as long as illicit consonant clusters are avoided. Like Markedness Suppression, it therefore needs an additional account of the directionality facts in Shimakonde.

Riggle & Wilson recognize the need to pin down the mechanisms behind indexation. Epenthetic segments pose an interesting problem, and Riggle & Wilson provisionally suggest that such a segment is given two indices, one that matches the index for the segment to its left and the other that matches the index for the segment to its right. A related question that they do not address is whether epenthetic segments in different candidates should receive the same index. Similarly, Riggle & Wilson note that a markedness constraint  $M$  may refer to multiple segments ( $S_i$  and  $S_j$ , for example), in which case it is not clear whether a violation of  $M$  is recorded by  $M@i$  or  $M@j$ .

It is also not clear how the position-specific constraints are projected: Does the set  $\text{NONFINALITY}@1, \dots, \text{NONFINALITY}@n$  exist universally, for an arbitrary value of  $n$ ? In this case, are  $\text{NONFINALITY}@i$  and  $\text{NONFINALITY}@j$  independently rankable across languages? If so, the resulting factorial typology surely massively overgenerates. Or are constraints decomposed on the fly for each evaluation, in which case the number of  $\text{NONFINALITY}$  constraints is contingent upon the length of the input? Under this option the mechanism for decomposing constraints needs further elaboration.

To summarize, Vata vowel harmony has no impact on the Emergent Non-iterativity Hypothesis because it is iterative, but its optionality presents an interesting challenge for OT. Both Markedness Suppression and position-specific evaluation can account for this optionality, and thus Vaux (2003b) is wrong to

claim that rule-based phonology corners the marked on iterative optionality. The simplicity of Markedness Suppression compared to the enormous complexity of position-specific evaluation argues in favor of the former. It remains to be seen if Markedness Suppression can account for all cases of optionality in phonology.

### 5.3.3 Phonetic Effects in Akan

Kiparsky (1985) also discusses in Akan (Clements 1981). Of interest here is a vowel-raising process in the language, but a discussion of that phenomenon must begin with Akan's ATR harmony. The vowel inventory is given in (31).

(31)	a.	<i>[+ATR] Vowels</i>	b.	<i>[-ATR] Vowels</i>
		i      u		ɪ      ʊ
		e      o		ɛ      ɔ
				a

The vowel *a* is opaque, but it can initiate [-ATR] harmony. Words without *a* are either entirely [+ATR] or entirely [-ATR] (32a), but mismatched vowels can appear in a word as long as *a* intervenes (32b). There are also a few exceptionally disharmonic roots.

(32)	a.	e-bu-o	‘nest’
		ɛ-bʊ-ɔ	‘stone’
		o-kusi-e	‘rat’
		ɔ-kɔɖɪ-ɛ	‘eagle’
		o-be-tu-i	‘he came and dug (it)’
		ɔ-be-tʊ-ɪ	‘he came and threw (it)’

- b. fɔɲanɪ            ‘to search’  
       pɪɾako           ‘pig’

Harmony is root-controlled, so as Kiparsky notes, this harmony system is much like Vata’s except for the opacity of *a*. In the case of mismatched roots, affixes harmonize with the nearest root vowel:<sup>10</sup> *o-bisa-I* ‘he asked (if).’ Harmony is complete (i.e. iterative) and doesn’t occur postlexically, so I will not analyze it here. See Clements (1981) and Kiparsky (1985) for analyses.

Turning to vowel raising, Clements (1981:154) notes that “/ɪ ʊ ɛ ɔ a/ have raised variants [ɪ̣ ʊ̣ ɛ̣ ɔ̣ ạ] when the first syllable of the next word begins with a [+high, +advanced] [i.e. [+high, +ATR]—AFK] vowel.” Clements gives the following examples.

- (33) a. bayɪɛ                    ‘yam’  
       bayɪɛ nʊ                ‘the yam’  
       bayɪɛ bi                ‘a yam’
- b.    ɔwɔ                      ‘snake’  
       ɔwɔ nʊ                ‘the snake’  
       ɔwɔ bi                ‘a snake’
- c.    kofi bisa sɪkɔɲ        ‘Kofi asks for a knife’  
       kofi bisa sika        ‘Kofi asks for money’

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<sup>10</sup>This same example shows that *a*, though invariant, can initiate its own harmony domain. Root-initial consonants can interact with harmony and vowel raising, but this complication is irrelevant for present purposes.

Raising is not strictly postlexical. It occurs word-internally, too, where it is only visible with *a*. Because of vowel harmony, the other [-ATR] vowels cannot precede a [+ATR] vowel within a word. Examples of word-internal raising are given in (34).

- (34)    *kari*            ‘to weigh’  
           *ɔ-furuma*       ‘navel’  
           *wɔ-tu*           ‘he has dug it’  
           *pɔtiri*           ‘to slip’  
           *yɔfunu*          ‘belly’

Within nouns, raising is also triggered by non-high vowels: *pirɔko* ‘pig.’

Vowel raising “is not local to the syllable immediately preceding the conditioning syllable but influences the articulation of preceding syllables as well” (Clements 1981:157), but this influence is gradient.<sup>11</sup> Clements describes it as a “crescendo” whereby vowels become increasingly raised as the triggering [+ATR] vowel is approached. Both Clements and Kiparsky suggest on the basis of this fact that vowel raising is a phonetic rule that does not have a place in the phonological grammar of Akan.

As I argued in Chapter 4, being phonetic doesn’t necessarily place a phenomenon outside the grammar. But if Clements and Kiparsky are correct (and there is a principled reason to account for peak delay but not vowel raising in the phonological grammar), they raise an interesting possibility. Kiparsky contrasts Vata’s postlexical harmony with Akan’s vowel raising and concludes that the for-

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<sup>11</sup>It also shows that vowel raising is iterative, so I do not offer an analysis here. Perhaps Markedness Suppression can account for the gradience.



a word is targeted. But, as Willis points out, we're clearly dealing with phonetic gestural overlap rather than the phonological replacement of coronal features with labial or velar features. The coronal gesture is still present, but it is masked by the labial and velaric gestures. If, as Willis argues, this phenomenon is not an automatic product of the physiological implementation of a (non-assimilated) phonological structure, it can be analyzed within a PDT-like framework, and the apparent noniterativity can be captured with a constraint similar to `PEAK DELAY` which promotes extending the domains of the phonetic counterpart of a labial or velar feature.

As this discussion shows, there are a number of ways to frame postlexical phenomena. Kiparsky and Pulleyblank are surely correct to think that some of these phenomena fall squarely within phonology, and in this chapter I have suggested ways to account for this variety. But it is also clear that phonetic postlexical processes exist, and they either are irrelevant to the question of noniterativity's place in phonology or fall within the purview of PDT.

## 5.4 Irish Palatalization

Palatalization in Irish (Bennett 2008, De Bhaldraithe 1975, Ní Chiosáin 1991, 1994, Ó Siadhail 1988, 1989) presents a particularly striking case of an apparently noniterative postlexical process. A word-final consonant palatalizes before a word-initial *i*:<sup>12</sup>

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<sup>12</sup>Note that *s<sup>j</sup>* is equivalent to *f*—I use the former to emphasize that this is a palatalized version of *s*. Data in this section come chiefly from Bennett (2008), but wherever possible I have checked his data against other sources cited in this section. Additional data come from these sources as well, and I am grateful to James McCloskey for his generous guidance in helping me understand the facts better.



- (36) a. ən o:r<sup>j</sup>            ‘the gold (masc. sg. gen. def.)’  
           ən a:his<sup>j</sup>        ‘the joy (masc. sg. gen. def.)’  
           ən<sup>j</sup> i:ntis<sup>j</sup>      ‘the wonder (masc. sg. gen. def.)’  
           ən<sup>j</sup> in<sup>j</sup>il<sup>j</sup>       ‘the machine (masc. sg. gen. def.)’  
       b. bɑ:d            ‘boat’  
           bɑ:d<sup>j</sup> iəskəx   ‘fishing boat’

However, it does not occur morpheme-internally:

- (37) tirsə            ‘tiredness’  
       sir<sup>j</sup>ə           ‘holiday’  
       bid<sup>j</sup>al        ‘bottle’  
       b<sup>j</sup>ali          ‘way (gen.)’  
       gil<sup>j</sup>p<sup>j</sup>in<sup>j</sup>axt   ‘wolfing’

Palatalization can occur across morpheme boundaries. Ní Chiosáin (1991) states that just two suffixes trigger palatalization in this context, the diminutive suffix *-i:n<sup>j</sup>* and the agentive suffix *e:rə*:

- (38) a. bɑ:d            ‘a boat’        bɑ:d<sup>j</sup>i:n<sup>j</sup>        ‘a little boat’  
           en            ‘a bird’        e:n<sup>j</sup>i:n<sup>j</sup>        ‘a little bird’  
       b. sɑ:w          ‘a saw’        sɑ:v<sup>j</sup>e:rə        ‘a sawyer’

Ní Chiosáin (1991) argues that the palatalization in (38) isn’t assimilation, but rather results from a process of “Final Palatalization” in which the palatalization of a root-final consonant marks a morphosyntactic distinction. If this is right, these data are irrelevant to palatalization as assimilation, and I won’t consider

them further.

According to De Bhaldraithe (1975) and Ó Cuív (1975), both *i* and *e* trigger palatalization. I restrict the discussion here to *i*, but the analysis below is easily extendable to (and in fact predicts) palatalization triggered by *e* as well.

Palatalization appears noniterative in that just one segment in each word in (36) palatalizes. But this noniterativity is emergent because only *i* triggers palatalization and therefore, like Nati (see Chapter 1), palatalization cannot proceed from one target to the next. (There is a separate process discussed below by which adjacent consonants harmonize with each other, so the mapping  $CC\#i \rightarrow CC^j\#i \rightarrow C^jC^j\#i$  is expected, but the last step follows from the separate consonant harmony.) Irish palatalization therefore does not challenge the Emergent Noniterativity Hypothesis, but as the phenomenon is amenable to the NONFINALITY-based style of analysis developed in this chapter, it deserves more discussion.

Accounting for these facts is, as we will see below, far from trivial. But first, the data shown above should be placed in their larger context. In the discussion below, I largely follow the analysis of Bennett (2008), although my account of the above facts differs from his significantly.

Palatalization is a contrastive feature for consonants in Irish. Every non-palatalized consonant (except perhaps [h], and [r] in initial position) contrasts with a palatalized but otherwise identical consonant. Some minimal pairs are given in (39).

- (39) a.  $pi:n^j$             ‘not much’  
          $p^j:i:n^j$         ‘a penny’

b.	bo:	‘a cow’
	b <sup>h</sup> o:	‘alive’
c.	mis <sup>h</sup> i	‘indeed’
	m <sup>h</sup> is <sup>h</sup> i	‘me’
d.	ti:	‘hay’
	t <sup>h</sup> i:	‘house’
e.	su:l <sup>h</sup>	‘an eye’
	s <sup>h</sup> u:l	‘walk’
f.	lo:n	‘lunch’
	l <sup>h</sup> o:n	‘a lion’
g.	gin <sup>h</sup>	‘a wound’
	g <sup>h</sup> in <sup>h</sup>	‘conceive’

However, adjacent consonants must agree in palatalization, i.e. [ $\pm$ back]. This, to my knowledge, is a universal generalization that holds within morphemes (both as a static generalization (40a) and in derived clusters (40b)), across morpheme boundaries (41), and across word boundaries (42). I will call this palatalization “C-palatalization.” Bennett abstracts away from some details of C-palatalization (see Ní Chiosáin 1991), and I follow him in this regard, too.

(40)	a.	g <sup>h</sup> l <sup>h</sup> an	‘valley’
		tas <sup>h</sup> m <sup>h</sup> ə	‘accident’
		boxt	‘poor’
		g <sup>h</sup> i:skɑ:n	‘squeaking’

- b. obir<sup>j</sup>            ‘work (nom)’            aib<sup>j</sup>r<sup>i</sup>            ‘work (gen)’  
pobəl            ‘people’            paib<sup>j</sup>l<sup>i</sup>i:            ‘public (adj)’
- (41) a. s<sup>j</sup>æ:n-            ‘old’  
p<sup>j</sup>i:n<sup>j</sup>            ‘penny’            s<sup>j</sup>æ:n<sup>j</sup>-f<sup>j</sup>i:n<sup>j</sup>            ‘old penny’  
potə            ‘pot’            s<sup>j</sup>æ:n-fotə            ‘old pot’  
g<sup>j</sup>æ:tə            ‘gate’            s<sup>j</sup>æ:n<sup>j</sup>-ɣ<sup>j</sup>ætə            ‘old gate’
- b. t<sup>j</sup>ə/tə            (adjectivalizing morpheme)  
klos<sup>j</sup>            ‘(to) hear’            klos<sup>j</sup>-t<sup>j</sup>ə            ‘heard (adj.)’  
sa:wɑ:l<sup>j</sup>            ‘(to) save’            sa:wɑ:l<sup>j</sup>-t<sup>j</sup>ə            ‘saved (adj.)’  
d<sup>j</sup>i:n            ‘(to) make’            d<sup>j</sup>i:n-tə            ‘made (adj.)’
- c. in<sup>j</sup>-            ‘-able’  
klos<sup>j</sup>t<sup>j</sup>ə            ‘heard (adj.)’            in-xloft<sup>j</sup>ə            ‘audible’
- (42) a. pail<sup>j</sup>            ‘pools’  
lɑ:n            ‘full’  
pail lɑ:n            ‘full pools’
- b. kut            ‘cat’  
d<sup>j</sup>æ:s            ‘nice’  
kut<sup>j</sup> d<sup>j</sup>æ:s            ‘nice cat’

It is always the affix that changes to match the stem in the case of morphologically complex words. Across a word boundary, the word-final consonant changes to match the word-initial consonant.

The data in (36) and (37) illustrate palatalization triggered by *i*, which only occurs across word boundaries. I will call this “*i*-palatalization.” To further illustrate, the forms in (43) show that palatalization and vowel quality do not interact morpheme-internally.<sup>13</sup>

- (43) a. *Front Vowels*
- |           |                    |
|-----------|--------------------|
| sɪrʲə     | ‘holiday’          |
| ʃɪlʲəmʲ   | ‘I think’          |
| fʲæ:di:lʲ | ‘whistling’        |
| dʲɪrʲəx   | ‘straight, honest’ |
| ti:       | ‘house (gen.)’     |
| tʲi:      | ‘straw’            |
- 
- b. *Back Vowels*
- |        |         |
|--------|---------|
| su:lʲ  | ‘eye’   |
| kʲlʲu: | ‘fame’  |
| dorəs  | ‘door’  |
| dʲox   | ‘drink’ |

Bennett accounts for C-palatalization with AGREE-[±back], which requires adjacent consonants to match in backness:

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<sup>13</sup>This holds only for long vowels. Short vowels are front before palatalized consonants and back before non-palatalized consonants (Ní Chiosáin 1991).

(44)

/gʲlan/	AGREE-[±back]	IDENT[back]
a. gʲlan	*!	
☞ b. gʲlʲan		*

To account for the root-controlled nature of C-palatalization, Bennett adopts  $\text{IDENT}[\text{back}]_{\text{stem}}$ , a Positional Faithfulness constraint that requires faithfulness of stem segments.

(45)

/dʲin-tʲə/	AGREE-[±back]	$\text{IDENT}[\text{back}]_{\text{stem}}$	IDENT[back]
a. dʲin-tʲə	*!		
☞ b. dʲin-tə			*
c. dʲinʲ-tʲə		*!	*

To account for the sandhi facts in which word-final consonants match the backness of the following word-initial consonant, Bennett adopts  $\text{IDENT}[\text{back}]/[\text{stem}\_\_\_\_]$ . This Positional Faithfulness constraint blocks changes in the stem-initial segment's backness feature. To comply with AGREE, the word-final consonant must change:

(46)

/pailʲ lɑ:n/	AGREE	$\text{IDENT}/[\text{stem}\_\_\_\_]$	$\text{IDENT}_{\text{stem}}$	IDENT
a. pailʲ lɑ:n	*!			
☞ b. pail lɑ:n			*	*
c. pailʲ lʲɑ:n		*!	*	*

Bennett adopts Stratal OT, and to resolve a ranking paradox that need not concern us here, he introduces  $\text{IDENT}[\text{back}]/[\text{stem}\_\_\_\_]$  only postlexically.

The postlexical stratum is also where Bennett accounts for *i*-palatalization. Since AGREE only militates against mismatched consonants, another constraint

is needed to motivate palatalization with vowels. Bennett adopts PAL-[i] from Padgett (2003) and Gribanova (2007, 2008) (see also Rubach (2000) and Blumenfeld (2003)):

(47) PAL-[i]: A consonant and a following high vowel agree in backness.

This constraint correctly motivates palatalization across word boundaries, but it also triggers palatalization word-internally. Bennett notes this problem and speculates on some possible avenues for a solution. Ultimately, though, he concludes that this case of strict cyclicity poses a major problem for OT because there is no way to render word-internal Ci sequences invisible to PAL-[i].

A solution reveals itself once we realize that *i*-palatalization can be motivated by NONFINALITY. Just as postlexical harmony in Nez Perce targets word-final syllables, *i*-palatalization targets only word-final consonants. Under the assumption that backness domains in Irish are right-headed, we can use the constraint in (48):

(48) NONFINALITY-[±back]: The head of a backness domain may not be a word-final segment.

Like NONFINALITY-ATR, NONFINALITY-[±back] reflects the weakness of final positions. It motivates palatalization at word boundaries (49) but not morpheme-internally (50). Irrelevant constraints are omitted from these Tableaux.

(49)

/bɑ:d iəskəx/ ‘fishing boat’	NONFIN	ID/[stem___	IDENT
a. bɑ:d iəskəx	**!		
☞ b. bɑ:dʲ iəskəx	*		*
c. bɑ:d uəskəx	*	*!	*
d. bɑ:dʲ iəskəx <sup>14</sup>	*		**!

In (49), the [+back] feature of the word-final *d* violates NONFINALITY if it is left alone. Overwriting this feature with the following vowel’s [–back] feature solves this problem: There is no longer a [–back] domain that ends on the final segment of the first word. Notice that IDENT/[stem\_\_\_, which was already motivated by Bennett’s analysis of C-palatalization, accounts for why [–back] spreads from the vowel to the consonant rather than [+back] spreading in the other direction. The word-final *x* must remain as it is. With no following word, its backness feature will necessarily violate NONFINALITY, and IDENT prefers the faithful candidate.

However, NONFINALITY does not motivate palatalization of a word-internal consonant before *i*:

(50)

/fʲæ:di:lʲ/ ‘whistling’	NONFIN	IDENT/[morph___	IDENT
☞ a. fʲæ:di:lʲ	*		
b. fʲæ:dʲi:lʲ	*		*!

Furthermore, acquiring a backness feature from a segment to the word-final consonant’s left does not solve the NONFINALITY problem. Only right-to-left

<sup>14</sup>In actuality, palatalization of the word-final *x* would be detectable through the presence of a mutation of the *əx* sequence: *igʲ* in southern dialects, *ə* in western dialects, or *i* in northern dialects (James McCloskey p.c.).



spreading occurs:

(51)

	/dʲi:n/ ‘(to) make’	NONFIN	IDENT/[ <sub>morph</sub> ___	IDENT
☞ a.	dʲi:n	*		
b.	dʲi:nʲ	*		*!

Why don't we find depalatalization across word boundaries? For example, *ʲesʲ ə vʲar* 'with the man' does not surface as \**ʲes ə vʲar*. The analysis so far leads us to incorrectly predict spreading from ə in this case. We can fix this by splitting IDENT[back] into IDENT[+back] and IDENT[-back] and ranking the former over NONFINALITY.

(52)

	/ʲesʲ ə vʲar/	ID/[ <sub>morph</sub> ___	ID[+bk]	NONFIN	ID[-bk]
☞ a.	ʲesʲ ə vʲar			**	
b.	ʲes ə vʲar		*!	*	

Furthermore, vowels do not undergo palatalization (i.e. fronting): /...u # i .../ → ...i # i ... . When a short vowel is involved, hiatus is often resolved through vowel deletion or *h*-insertion (Breatnach 1947), so in practice it may not be necessary to prevent vowel fronting. It is not clear to me whether hiatus involving only long vowels is similarly resolved, though. In case it is not, by ranking constraints on vowel faithfulness over NONFINALITY, we can prevent vowel mutations.

When a word-final consonant is followed by another consonant rather than a vowel, spreading is again predicted. But in this case we have C-palatalization, which we have seen to be active regardless of word boundaries.

Finally, only *i* triggers palatalization. Itô & Mester (in press) note that this vowel is crosslinguistically more likely to trigger palatalization than other vowels, and they suggest that this is reflected in a set of constraints that are in a stringency relationship (de Lacy 2002a) specifying acceptable backness domain heads. Smolensky (2006) shows how constraints on domain heads can be used to define possible sources of spreading, and his method can pick out *i* as the only legal palatalization trigger. Recall, however, that De Bhaldraithe (1975) and Ó Cuív (1975) claim that *e* also triggers palatalization. If they are right, this same method can single out both *i* and *e* as legal triggers.

To summarize, Irish palatalization presents another case in which NONFINALITY triggers postlexical spreading. Unlike the other cases examined in this chapter, palatalization is not an extension of a vowel harmony system. NONFINALITY's advantage over PAL-[i] is that it correctly restricts *i*-palatalization to word boundaries and attributes this property of *i*-palatalization to the weakness of word-final elements.

## 5.5 Conclusion

This chapter has examined some potentially truly noniterative postlexical processes. Some of these may exhibit emergent noniterativity from a rule-based point of view, and others are indisputably iterative. I argued that NONFINALITY has a significant role to play in these processes. It motivates minimal postlexical spreading so that domain heads may avoid word-final syllables and segments. Based on the gradient nature of vowel raising in Akan, the possibility of analyz-

ing postlexical phenomena in a way similar to the peak delay approach to tone spread/shift was pointed out.

This chapter has obviously not exhausted the range of postlexical phenomena, and it would not be surprising to find that other specific cases require analyses that are not based on NONFINALITY. Rather, this chapter has shown that apparent noniterativity in the postlexical domain is amenable to analyses that do not invoke noniterativity and are more insightful than a simple noniterative rule. The noniterativity in these phenomena is emergent in that the observed spreading satisfies NONFINALITY and no further spreading is required. Crucially, we do not need to specify postlexical spreading as noniterative; that property comes for free. If the sample discussed here is representative, postlexical phenomena therefore do not challenge the Emergent Noniterativity Hypothesis.

# CONCLUSION

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This dissertation has argued that there are no truly noniterative phenomena in phonological grammars. That is, every seemingly noniterative phenomenon exhibits emergent noniterativity. Even the best examples of noniterativity—Lango’s vowel harmony, Chamorro’s umlaut, tone spread/shift, and postlexical spreading—are analyzable in terms that do not invoke noniterativity. These re-analyses are not merely convenient hacks, either. They reveal deeper insights into the motivations behind ostensibly noniterative phenomena and open new areas of inquiry. For example, it was argued in Chapter 3 that Chamorro umlaut is driven by a desire to place pretonic [–back] features in the root. The analysis is centered on the claim that these pretonic syllables are weak, as evidenced by their inability to host stress. In addition to providing an explanation for Chamorro’s typologically unusual prefix-to-root spreading, the analysis points out the need for theoretical and experimental investigations of both the extent of and reasons for the language’s pretonic weakness. The peak delay approach to tonal noniterativity highlights a gap in our empirical understanding of these phenomena, and only more work like that of Myers (1999, 2003) can determine the viability of Peak Delay Theory.

It is interesting to note that Positional Licensing plays a large role in two of the four kinds of phenomena discussed here. This is most likely a coincidence. Lango

and Chamorro exhibit very similar phenomena, with affixes' features spreading to the root. It is therefore not surprising that they submit to similar analyses. There is no *a priori* reason to expect all cases of emergent noniterativity to comprise a single natural class of related phenomena, so it is not surprising that the list of factors that can produce emergent noniterativity is diverse. Chapter 1 presented a partial list of the factors that can lead to the appearance of noniterativity, with an assortment ranging from positional effects to binarity requirements. Positional Licensing may play a large role in the typology of emergent noniterativity, but it seems more likely that it is just one of many formal mechanisms that can, in the right circumstances, lead to what looks like noniterativity. Evidence that this is so is found in Chapter 4, where it was argued that constraints on phonetic implementation can produce (what seems like) noniterative tone spread and shift, and Chapter 5, where it was argued that NONFINALITY can lead to seemingly noniterative phenomena at the postlexical level. PEAK DELAY, NONFINALITY, and Positional Licensing are formally distinct kinds of constraints, but in the right contexts they can produce similar effects. None has a monopoly on noniterativity.

There is, however, a common theme throughout the cases of of noniterativity discussed in the preceding chapters. Often, the constraint that motivates spreading is satisfied after one iteration of spreading. This was the case in Lango, Chamorro, Nez Perce, and the Optimal Domains Theoretic analysis of tone spread/shift. Once this markedness constraint is satisfied, lower-ranking faithfulness constraints step in to prevent further spreading.

This dissertation has focused on assimilatory phenomena, and it is of course necessary to test the Emergent Noniterativity Hypothesis against other phenom-

ena, such as dissimilation. Foot and stress assignment were mentioned briefly in Chapter 1, where it was pointed out that phonologists generally agree that noniterativity in that domain is attributable to edge alignment, not explicit noniterativity requirements.

The dissertation opened with the observation that OT and rule-based phonology differ markedly in their handling of processes, and therefore in their treatment of noniterativity. While rule-based theories are well equipped to produce true noniterativity (via iterativity parameters and the like), OT cannot produce true noniterativity because markedness constraints are not permitted to access the input. This seems *prima facie* like a problem for OT since natural language is filled with phenomena that occur exactly once per output form. Noniterativity is therefore like opacity<sup>1</sup> (e.g. McCarthy 1999 and many papers in Roca (1997), to name just some of the relevant work) and the too-many-solutions problem (Blumenfeld 2006, Steriade 2001) in that it presents no problems for rule-based phonology<sup>2</sup> but potentially represents a major stumbling block for OT. Opacity and the too-many-solutions problem have been used to argue for radical changes to OT's architecture (e.g. Blumenfeld 2006, McCarthy 1999, Rubach 1997) and even for the abandonment of OT altogether (e.g. Idsardi 1997, Paradis 1997). Noniterativity has the potential to join these other phenomena as a mark against OT.

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<sup>1</sup>In fact, noniterativity can be viewed as just a special kind of derivational opacity. Opacity is problematic for OT because OT lacks the intermediate stages that must be referenced to explain the appearance of a non-surface-true generalization. Similarly, OT bans markedness constraints from making reference to an early derivational stage—namely the input—that is crucial to the evaluation of noniterativity.

<sup>2</sup>But see Baković (2007) for an argument that rule-based theories don't handle opacity as well as is typically thought. McCarthy (2008) also points out that too-many-solutions is just as problematic for rule-based phonology as it is for OT.

But noniterativity is only a problem for OT if it is actually attested in natural languages. The investigations in this dissertation suggest that it is not, and therefore the tables are turned. It is a mark in OT's favor that it cannot produce noniterativity, and doubt is cast on rule-based theories because they overgenerate. Thus noniterativity differs from opacity and the too-many-solutions problem in two ways: (i) the "repair" for OT is simple (let markedness constraints access the input), and (ii) the repair is unnecessary because noniterativity is not actually attested.

To frame the issue in a different way, an investigation of noniterativity probes the status of processes in phonology (cf. Nevins & Vaux 2008b). In rule-based phonology, grammars are composed largely of processes (as encoded in rules), but in OT, processes are epiphenomenal products of constraint interaction. Therefore the former can directly impose formal restrictions such as noniterativity on processes while the latter cannot. Since noniterativity is a property of processes, not constraints or representations, only a theory that includes processes can impose noniterativity. The implication of this dissertation, then, is that since grammars cannot require noniterativity, processes are not formal constructs in phonology. This view favors OT over rule-based phonology.

From an OT perspective, the ENH should not be unexpected. The best OT constraints are those that further an independently justifiable cause, such as maintaining lexical information (faithfulness) or promoting articulatory ease and perceptual salience. But what would justify a constraint that requires noniterative spreading? For (iterative) vowel harmony, we can point to the articulatory simplicity that is achieved when a sequence of vowels shares some property. Or we





asymmetry in the wrong direction.

How can rule-based phonology be adapted to reflect the ENH? A simple solution is possible: Another way to frame the conclusion that there are no truly noniterative phenomena is to say that every process is in principle iterative. Thus we can do away with iterativity parameters and issue a theory-wide proclamation (along the lines of the No Crossing Constraint (Goldsmith 1976)) that every rule applies iteratively. Those that do not appear to do so are consequently instances of emergent noniterativity in the sense of Chapter 1. This move, as far as I can see, would achieve the correct results. But it is just a patch. Whereas the absence of true noniterativity is a direct consequence of OT's output-oriented evaluation system, it comes from an arbitrary stipulation in the rule-based revision suggested in this paragraph. It remains a mystery that the stipulation calls for universal iterativity and not universal noniterativity, or that the stipulation exists at all. Even though rule-based phonology can be amended to account for the absence of true noniterativity, it remains conceptually inferior to OT on this point.

Furthermore, an iterativity parameter doesn't shed light on why some processes are noniterative and others aren't. Examining seemingly noniterative phenomena from the perspective of OT forces us to seek a motivation for noniterativity because we have no recourse to an iterativity parameter. When a process applies just once in OT, it is because some output requirement prevents or does not require further spreading, not because an arbitrary prohibition stops it from applying again.

I wish to close the dissertation with a speculation. In the face of the ENH, we might ask how rule-based theories came to predict true noniterativity if the phe-

nomenon is actually unattested. From my current perspective I see two possible parts to the answer. First, self-feeding rules are easy to write and are desirable in any rule-based system because of their utility in phenomena like vowel harmony. Without major constraints on what a well-formed rule is, then, rule-based theories predict true noniterativity from the start. Moreover, when confronted with iterative phenomena like vowel harmony, rule-based theories must adopt an iterativity parameter or the equivalent so that certain rules can be marked as applying exhaustively to their own outputs. Once this formal accommodation is made, true noniterativity is an unavoidable byproduct. The self-feeding rules that are not flagged as iterative produce true noniterativity. To my knowledge there are no satisfactory theories of what kinds of rules may be iterative and what kinds may be noniterative, although Howard (1973) attempts to build to such a theory and finds varying degrees of success.

Thus the prediction of true noniterativity arose through the natural course of rule-based phonology's evolution. The conclusion that this prediction is wrong does not mean that the linguists who developed rule-based phonology carelessly overlooked an obvious generalization. Rather, the ENH reminds us that while it is important to build new theories on the insights of their predecessors, reevaluating old assumptions from the perspective of our new theories is also a valuable exercise.

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