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HARMONY, DOMINANCE AND CONTROL

by

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ABSTRACT OF THE DISSERTATION

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In this dissertation I argue for a general model of assimilation within Optimality Theory, with vowel harmony processes serving as a specific empirical testing ground. The model centers around agreement constraints. I demonstrate that the interaction among agreement constraints and other well-established constraints (particular members of the general markedness and faithfulness constraint families) is sufficient to account for the various vagaries of vowel harmony, and that representational devices such as crucial underspecification and autosegmental feature-sharing are consequently unnecessary.

Vowel harmony processes can be either stem-controlled or dominant-recessive. Stem-controlled vowel harmony processes are the more familiar kind, where the harmonic feature value of vowels in the stem determines the harmonic feature value of vowels in subsequent affixes. In a language with a dominant-recessive vowel harmony process, on the other hand, one harmonic feature value is 'dominant' and the other is 'recessive' such that any dominant-valued morpheme vowel, stem or affix, determines the harmonic feature value of all other (otherwise recessive-valued) morpheme vowels.

I offer a novel analysis of the distinction between stem-controlled and dominant-recessive vowel harmony processes. I argue that the phenomenon of stem control is due to the relatively higher rank of faithfulness constraints on the correspondence relation between stems and their affixed forms; i.e., that stem-controlled vowel harmony is a cy-

elic process. Dominance, on the other hand, is due to the relatively higher rank of a constraint that specifically prevents dominant-valued (here understood as 'unmarked') segments from becoming recessive-valued ('marked'). I argue that this type of constraint, a local conjunction of markedness and faithfulness, is independently required in order to explain the fact that a larger number of segments with a particular value of the harmonic feature do not ever 'gang up' on a smaller number of segments with the opposite value, a universal fact that has otherwise proven to be difficult to guarantee as a general result.

The factorial typology of the constraints relevant to the proposed model is thoroughly investigated, and several challenging examples (Yoruba, Maasai, Turkana and Nez Perce) are given detailed attention and analysis. Taken together, these components of the dissertation confirm the descriptive and explanatory adequacy of the proposed model.

PREFACE

When it comes to the transcription of vowels I try to be as exact as possible throughout this dissertation, bounded only by the relative exactness of my sources for each language.¹ To this end, I have adopted a unique set of symbols to transcribe vowels in all of the languages I make reference to, regardless of the symbols used in my sources. The symbols are those of the International Phonetic Alphabet, as revised to 1993 (see the charts on the last page of Ladefoged & Maddieson 1996); the values for the distinctive features [high] ([HI]), [low] ([LO]), [back] ([BK]), [round] ([RD]), and [advanced tongue root] ([ATR]) that I assume these symbols to have can be read from the following two charts. (Shaded cells in the first chart are feature combinations for which there is no symbol.)

		[-BK]		[+BK]		
[+HI]	[+ATR]	ɪ	ʏ	ɯ	u	
	[-ATR]	ɪ	ʏ		u	
[-HI]	[+ATR]	e	ø	ɤ	o	[-LO]
	[-ATR]	ɛ	œ	ʌ	ɔ	
	[+ATR]	æ		ɐ		[+LO]
	[-ATR]	a	æ	ɑ	ɒ	
		[-RD]	[+RD]	[-RD]	[+RD]	

	ɪ	ɪ	e	ɛ	æ	a	y	ʏ	ø	œ	ɛ	ɯ	ɤ	ʌ	ɐ	ɑ	u	u	o	ɔ	ɒ
[HI]	+	+	-	-	-	-	+	+	-	-	-	+	-	-	-	-	+	+	-	-	-
[LO]	-	-	-	-	+	+	-	-	-	-	+	-	-	-	+	+	-	-	-	-	+
[BK]	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
[RD]	-	-	-	-	-	-	+	+	+	+	+	-	-	-	-	-	+	+	+	+	+
[ATR]	+	+	-	+	-	+	-	+	-	-	-	+	+	-	+	-	+	-	+	-	-

Individual charts tailored to particular languages are provided as the need arises. These language-particular charts are always consistent with the more inclusive charts above.

¹ I am fairly lax in my transcription of consonants, following my sources unless otherwise noted.

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There's a pattern here to see, and the point will soon be clear to me.
Stewart Copeland — The Rhythmist

Nobody (except, one would hope, myself) is more responsible than Alan Prince for anything noteworthy to be found in these pages, not to mention the pages of any other work that I've done since coming to Rutgers or even probably that I will do in the foreseeable future. Akin Akinlabi challenged me to look at Yoruba and provided much assistance when I took him up on it. Hubert Truckenbrodt made sense of my once rather lame thoughts on dominant-recessive harmony, and I can't thank him enough for that. John McCarthy contributed substantially to my thoughts and to their transference to paper, offering ideas and suggestions above and beyond the call of duty. Thanks to all four of you.

I discussed (the many incarnations of) this dissertation with too many other people than I could possibly enumerate. You all know who you are — thanks. Thanks also to folks at Tübingen, Cornell, JHU, UMD, MIT, Harvard, SUNY Stony Brook, PSU, UMass, and Penn, who endured presentations of this work in various stages of disrepair.

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This dissertation is certified Y2K-compliant. Down with Microsoft.

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CHAPTER ONE
ASSIMILATION AS AGREEMENT

1. Introduction

1.1 Vowel harmony and conflicting conditions

Vowel harmony is the phenomenon observed in some languages by which all the vowels in a word (or other morpho-phonological unit) must bear the same value of some vocalic feature. There are very few if any languages for which this definition is absolutely true, but clearly, some languages evidence strong pressure toward having all the vowels in a word assimilate. Other, conflicting conditions simply get in the way and often prevent this fact from being superficially true in many of those languages.

Take the well-known example of Turkish (Lyons 1962, Lightner 1965, 1972, Zimmer 1967, 1969, Haiman 1972, Underhill 1976, Clements & Sezer 1982, Kirchner 1993, Kaun 1995, Padgett 1995ab), the vowel inventory of which is given in (1).

(1) Turkish vowel inventory

	[-BK]		[+BK]	
[+HI]	i	y	ɯ	u
[-HI]	e	ø	ɑ	o
	[-RD]	[+RD]	[-RD]	[+RD]

Vowel harmony in Turkish is such that all the vowels in a word must bear the same values of the features [BK] and [RD]. A conflicting condition, which I will refer to simply as Condition C, requires that all non-initial [-HI] vowels be [-RD]; that is, [o] and [ø] do not occur non-initially. Condition C systematically overrides vowel harmony, and therefore a non-initial [-HI] vowel does not have the same value of [RD] as a [+RD] vowel in the same word.

The following data exemplifies the situation. The accusative suffix in Turkish is minimally a [+HI] vowel, and its values for [BK] and [RD] are determined by the values of these features in the vowel of the preceding noun root. This is shown in (2).

- (2) Turkish accusative suffix (adapted from Underhill 1976:23)¹
- a. √el • i 'hand (accusative)'
 - b. √kul • u 'slave (accusative)'

The dative suffix in Turkish, on the other hand, is minimally a [-HI] vowel, and so while its value for [BK] is determined by the vowel in the preceding noun root, its value for [RD] must be [-RD] due to Condition C. This is shown in (3).

- (3) Turkish dative suffix (adapted from Underhill 1976:23)
- a. √el • e 'hand (dative)'
 - b. √kul • a 'slave (dative)'

This pattern of interaction between vowel harmony and Condition C in Turkish holds for the entire language, save for some recent loanwords and a handful of unsystematic exceptions (Clements & Sezer 1982). In language after language, vowel harmony and other conditions interact with one another in utterly systematic ways such as this, and research in the empirical domain of vowel harmony has emphasized the importance of making sense of this interaction.

Optimality Theory (OT; Prince & Smolensky 1993) is thoroughly in the business of making sense of systematic interactions among conflicting conditions. At the heart of OT is the premise that the grammar of a language is defined by a particular ranking of a universal set of violable constraints in a strict dominance hierarchy; a conflict between any two constraints over the selection of a given input-output pairing is resolved in favor of the higher-ranked of the two. The constraints themselves express very general desirable outcomes or conditions. OT is thus a very appropriate framework in which to couch a theory of vowel harmony.

¹ Here and throughout this dissertation, a bullet '•' denotes a morpheme boundary and the radical symbol '√' denotes that the following morpheme is the root.

And, indeed, vowel harmony has received a considerable amount of attention in the relatively young OT literature.² But almost all of these works maintain, in some form or another and to some extent or another, representational vestiges of the autosegmental model of assimilation.³ This is curious, since the devices of the autosegmental model were originally designed to explain the conflict of conditions apparent in assimilation, but this explanatory burden should now be shifted entirely to the shoulders of violable constraint interaction in OT.

The model of assimilation defended in this dissertation rests on this imperative. The conflict of conditions apparent in vowel harmony (and in assimilation more generally) is attributed entirely to the well-motivated interaction of violable constraints in OT. These constraints are ingeniously designed not to rely on quirks of autosegmental representation and underspecification, rendering these and other complex representational devices entirely (and desirably) superfluous. I argue throughout the dissertation that this reductionist stance succeeds in achieving both wide empirical coverage and explanatory depth with nothing other than the interaction of constraints. These constraints are grouped together into three general families — agreement, faithfulness, and markedness — and are introduced as such in the remainder of this section.

² A list of OT work in which harmony processes are addressed to some significant extent includes Akinlabi 1994, 1997, in progress, Albert 1995, Archangeli & Pulleyblank 1993, Archangeli & Suzuki 1997, Beckman 1995, 1997, 1998, Benua 1996, Cole & Kisseberth 1994abc, 1995, Gafos 1996, 1998, Hyman 1998, Kaun 1995, Kirchner 1993, Klein 1995, Krämer 1999, Li 1996, McCarthy 1997a, Ni Chiosáin & Padgett 1997, Padgett 1995ab, Parkinson 1996, Polgárdi 1998, Pulleyblank 1993, 1996, 1997, Ringen & Heinämäki 1999, Ringen & Vago 1995, 1997, Smolensky 1993, 1997, Walker 1997, 1998ab, 1999, and certainly much more work that I am unfortunately and ignorantly unaware of. (For a recent review of theoretical issues pertaining to vowel harmony, see van der Hulst & van de Weijer 1995.)

³ A notable exception is Krämer 1999. The autosegmental model of assimilation as applied to vowel harmony is exemplified by the work of Clements (1976a) and most work since. This model finds its roots in both the “suprasegmental” and “prosodic” models of vowel harmony, exemplified by such works as Harris 1944, Lyons 1962, and Lightner 1965.

1.2 Agreement constraints

1.2.1 Introduction

I assume that assimilation between adjacent segments is driven by the family of agreement constraints (Lombardi 1996ab, 1999; see also Beckman 1998, Butska 1998) defined in (4).⁴

(4) AGREE[F]

Adjacent segments must have the same value of the feature [F].

I assume that an agreement constraint is violated once for each transition from one value of the relevant feature to the other; thus, AGREE[VOI] is violated twice by an obstruent cluster like [btg] or [pdk], in which there are two transitions in voicing (+ – + and – + –, respectively), and only once by an obstruent cluster like [btk] or [pdg], in which there is only one such transition. Violation of agreement constraints is minimized to the extent allowed by the relative ranking of conflicting constraints, as is usual in OT.⁵

Whether the concept “feature value” in the preceding means binary ‘+’ vs. ‘–’ or unary presence vs. absence is absolutely irrelevant. An agreement constraint compares adjacent segments and assesses a violation if and only if they differ in terms of the feature in question. Assuming that the feature [VOI] is binary, AGREE[VOI] is violated by a [+VOI] obstruent adjacent to a [–VOI] obstruent, in either order, and is satisfied otherwise. Assuming that [VOI] is unary, AGREE[VOI] is violated by an obstruent specified for [VOI] adjacent to an obstruent without such a specification, in either order, and is satisfied otherwise. For concreteness and simplicity, I will assume throughout this dissertation that all

⁴ Gnanadesikan’s (1997) ASSIM and Krämer’s (1999) SS-IDENT constraints are identical to the agreement family in most respects, as is the basic spirit of Pulleyblank’s (1997) IDENTICAL CLUSTER constraints. On the formally distinct notion of “featural alignment”, see Chapter 4.

⁵ An interesting possibility that I do not investigate here is that agreement is more monolithic, demanding that adjacent segments agree in terms of a *feature class* (à la Padgett 1995ab) or in terms of *all features* (cf. Kirchner 1993). Under either approach, better satisfaction of agreement is gained gradually for each agreeing feature, and an agreement constraint is often forced to be (minimally) violated by higher-ranked constraints of various kinds.

features are binary; this innocuous assumption should in no way affect any of the claims made herein.⁶

An AGREE[F] constraint, where [F] is a vocalic feature such as [BK], [RD], or [ATR], directly expresses what we call vowel harmony. The fact that vowel harmony is usually not an absolute in languages said to have it is of course due to the violability of agreement constraints and the inherent conflict between agreement constraints and other constraints that directly express other conditions (more on these shortly below). Whether or not and the extent to which a given language exhibits vowel harmony depends on how all of these constraints are ranked with respect to each other in the language-particular constraint hierarchy that defines that language's grammar.

An assumption that I make in passing here is that assimilation — and thus the sense of 'segmental adjacency' necessary for the definition of agreement constraints — is strictly local (see Archangeli & Pulleyblank 1994, Pulleyblank 1996, Gafos 1996, 1998, Ni Chiosáin & Padgett 1997, Walker 1998a, 1999, and references therein). The vowels in a VCV sequence share some vocalic feature only if the intervening consonant also does (on which see Öhman 1966), and the consonants in a CVC sequence share some consonantal feature only if the intervening vowel also does. The basic asymmetry between vowels and consonants that accounts for the prevalence of vowel harmony across consonants and for the relative absence of "consonant harmony" across vowels is because vocalic features are compatible with consonants in a way that consonantal features are not compatible with vowels, a phonological fact rooted in physiology.⁷ In short, adding a vocalic feature to a consonant does not rob the consonant of its consonantality, but adding a consonantal feature to a vowel *does* rob the vowel of its vowelhood (see the references

⁶ This is not to deny the possibility that there may be independent evidence that distinguishes binary and unary feature theories. For instance, Lombardi (1991 *et seq.*) claims that the feature [VOI] must be unary for reasons that are not necessarily germane in the current context.

⁷ Implications for certain cases of consonant harmony across vowels are addressed by Gafos (1996, 1998). On vowel transparency within a strictly local model of assimilation, see Chapter 5.

cited for details). Although I hereby assume that consonants fully participate in vowel harmony (as they clearly do in Turkish, for example; see Clements & Sezer 1982), I henceforth ignore consonants altogether and focus on vowels, which for all intents and purposes are adjacent across intervening consonants.

1.2.2 Directionality?

Of particular interest in this investigation is the assumption that agreement constraints are *left-right symmetrical*. What this means is that there are always at least two output candidates for any input that best satisfy a given AGREE[F] constraint, one in which adjacent segments are all [+F] and one in which they are all [-F], regardless of these segments' values of [F] in the input.

Consider the following simplified example. Take two adjacent output segments *x* and *y*. If *x* and *y* have the same value of [F], as in (5a,b), then AGREE[F] is satisfied. If *x* and *y* have different values of [F] in the output, as in (5c,d), then AGREE[F] is violated.

(5) Satisfy AGREE[F]	Violate AGREE[F]
a. $\begin{matrix} x & y \\ [-F] & [-F] \end{matrix}$	c. $\begin{matrix} x & y \\ [-F] & [+F] \end{matrix}$
b. $\begin{matrix} x & y \\ [+F] & [+F] \end{matrix}$	d. $\begin{matrix} x & y \\ [+F] & [-F] \end{matrix}$

So, given an input in which a pair of adjacent segments have different values for the feature [F], either the first segment of the pair may assimilate to the second or the second to the first. As far as AGREE[F] itself is concerned, these candidate outputs are equally good; the choice between them must be made by other constraints. I argue throughout this dissertation that these other constraints are nothing other than particular members of the well-established markedness and faithfulness constraint families of OT, and that the relations and interactions among the members of these three general families of constraints are sufficient to account for the major properties of vowel harmony — including the ap-

parent asymmetrical effect of ‘directionality’ so often noted in the current literature about vowel harmony systems.

The majority of languages with vowel harmony with which I would say most linguists are familiar (Uralic and Altaic languages like Turkish, Hungarian, Finnish, etc.) have strictly suffixing morphology, and the vowel harmony processes in most of these languages are *stem-controlled*, meaning that a vowel in the stem of affixation (ultimately, the root) determines the value of the harmonic feature for an adjacent suffix vowel (ultimately, the whole word). Vowel harmony thus appears to be unidirectional in these languages: root to suffix = left to right. But despite these appearances, there is ample evidence that the ‘direction’ of vowel harmony is entirely dependent on the morphological structure of the language. First, in languages with strictly prefixing morphology (e.g., Yoruba; see Chapter 3 for details), harmony reliably propagates from root to prefix (= right to left). Second, in languages with both prefixes and suffixes, vowel harmony propagates outward from the root, both leftward toward prefixes and rightward toward suffixes (see e.g. Clements 1976a, 1977, 1981 on Akan and Ringen 1975, Zsiga 1997 on Igbo). An interesting example in this context is a (not terribly productive) prefix in Finnish — an otherwise strictly suffixing language, as mentioned earlier — that alternates harmonically in the expected stem-dependent fashion, from right to left.

- (6) Finnish root-to-prefix (right-to-left) [BK] harmony (Heli Harrikari, p.c.)
- | | | |
|----|--------------|-------------|
| a. | ypø • √yksin | ‘all alone’ |
| b. | upo • √uusi | ‘brand new’ |

For these reasons and others like them, Beckman (1995, 1996, 1998) and Lombardi (1996ab, 1999) have argued against directionality as an independent parameter of assimilation (see also Padgett 1995ab and Steriade 1995 for similar arguments).

If directionality were an independent assimilation parameter along which languages could arbitrarily differ, then one would expect to find at least the following two un-

attested vowel harmony patterns. The first is a left-to-right pattern from the initial syllable, root or prefix; the other is a right-to-left pattern from the final syllable, root or suffix — logically independent considerations such as morphological impoverishment aside (e.g., a lack of prefixes, as in Turkish, or a lack of suffixes, as in Yoruba). A theory of assimilation with directionality as a theoretical primitive directly predicts the possibility of these kinds of unattested patterns.

Another compelling argument against directionality as an independent parameter of assimilation comes from so-called *dominant-recessive* vowel harmony. In languages with dominant-recessive harmony, the value of the harmonic feature for a given word is determined in some cases by a vowel in the stem of affixation and in other cases by an affix vowel; determinants of harmony are called ‘dominant’ vowels and non-determinants are called ‘recessive’ vowels. What is relevant to the present discussion is that recessive vowels both preceding and following a dominant vowel are affected by harmony; that is, harmony is bidirectional. If dominant-recessive harmony could in principle be unidirectional, then we would expect to find a language in which the recessive vowels on one side of a dominant vowel are affected by harmony, while those on the other side remain unaffected. Such a pattern is entirely unattested.⁸

Much of the remainder of this dissertation is devoted to demonstrating that the simpler, bidirectional interpretation of agreement constraints, which I take to be the null hypothesis, is fundamental to an explanatorily and descriptively better analysis of the full typology of vowel harmony observed in the world’s languages. The essential arguments are outlined in §3 below, with further elaboration in Chapter 2. Before that, I introduce in the rest of this section the markedness and faithfulness constraint families that I assume to play a critical role in vowel harmony, and in §2, their basic interaction.

⁸ See §3.4 below for more on dominant-recessive vowel harmony.

1.3 Faithfulness

A single general family of faithfulness constraints is of concern in this dissertation: the IDENT[F] family of featural faithfulness constraints familiar from the Correspondence theory of faithfulness developed in McCarthy & Prince 1995, 1999 and in most OT work since.

- (7) Featural faithfulness in Correspondence theory
- a. IDENT[F]
Correspondent segments must have the same value of the feature [F].
 - b. *Correspondence*: Given two strings S_1 and S_2 , **correspondence** is a relation \mathfrak{R} from the elements of S_1 to those of S_2 . Elements $\alpha \in S_1$ and $\beta \in S_2$ are referred to as **correspondents** of one another when $\alpha \mathfrak{R} \beta$.

The IDENT[F] family of faithfulness constraints is not only subdivided by feature but also by the correspondent strings a given member of the family evaluates. For instance, as McCarthy & Prince (1995, 1999) argue, the relation between a reduplicative morpheme and the base of reduplication is regulated by one set of IDENT[F] constraints; these are referred to as BR-IDENT[F] constraints, ‘B’ for ‘base’ and ‘R’ for ‘reduplicant’. The relation between the underlying representation (the ‘input’) and the surface representation (the ‘output’) is regulated by another set of IDENT[F] constraints; these are referred to as IO-IDENT[F] constraints. Another set of IDENT[F] constraints regulating the correspondence between an affixed form and its stem of affixation, responsible for cyclicity effects and introduced in §3.2 below, play a critical role in the proposed model of assimilation — as do IO-IDENT[F] constraints.⁹ Faithfulness constraints may also be relativized to particular morphological categories or prosodic positions. For instance, a contrast in the values of a feature may be preserved in a root morpheme or stressed syllable but neutralized elsewhere. Positional neutralizations of this sort have been fruitfully analyzed as the result of faithfulness constraints specific to these ‘prominent’ morphological categories and prosodic positions (see Beckman 1998 for significant elaboration of this idea). Vowel har-

⁹ The base-reduplicant relation is irrelevant here and thus BR-IDENT[F] constraints make no appearance at all in this dissertation; neither do constraints governing segmental as opposed to featural faithfulness (MAX, DEP, etc.).

mony processes are, descriptively speaking, instances of positional neutralization, but positional faithfulness constraints play only a minor role in this dissertation. I discuss the reason for this more fully in Chapter 2.

Note the parallel between the definition of featural faithfulness constraints in (7) and that of agreement constraints in (4): in each case, two segments in a particular relation to one another (correspondence, adjacency) are required to have the same value of the feature [F]. Agreement constraints are thus in a way part of the greater faithfulness family.¹⁰ Rather than being an addition to the theory, agreement is just another ‘extension of faithfulness’ (McCarthy 1995). I do not dwell on this parallel further here, though I believe that it is of some interest that faithfulness, a formal notion necessary and unique to OT, can be extended to subsume such diverse phenomena as reduplication, cyclicity, and harmony.¹¹

1.4 Markedness constraints

The two sub-families of markedness constraints in (8) are the most relevant ones in this dissertation (where α , β , and γ are potentially different values of the distinct features [F], [G], and [H]). Individual members of these constraint sub-families assert the markedness of a particular feature (8a) or feature combination (8b); their relative ranking in an OT constraint hierarchy, which may be determined either universally or language-particularly, expresses the relative markedness of those particular features and feature combinations.¹²

¹⁰ See Krämer 1999 for an explicit proposal along these lines. A similar (though not identical) parallel between the elements of Correspondence theory and the principles of autosegmental phonology is noted explicitly by McCarthy & Prince (1995:266, 1999:228).

¹¹ And more. For further extensions of faithfulness, see e.g. McCarthy 1997b (on prosodic circumscription effects), McCarthy 1998a (on process opacity), and McCarthy 1998b (on morpheme structure conditions).

¹² Markedness constraints of the type in (8b) should be most familiar to the reader; they correspond in varying degrees to ‘marking conditions’ (Chomsky & Halle 1968), ‘segment-structure rules’ (Stanley 1967), ‘redundancy rules’ (Archangeli 1984), ‘filters’ (Calabrese 1988), ‘persistent rules’ (Myers 1991a), and ‘Grounding Conditions’ (Archangeli & Pulleyblank 1994), among other related concept terms (e.g., ‘feature co-occurrence restrictions’).

(8) Markedness constraint sub-families

- a. * $[\alpha F]$
An output segment must not be specified as $[\alpha F]$.
- b. * $[\alpha F, \beta G, \gamma H \dots]$
An output segment must not be specified as $[\alpha F, \beta G, \gamma H \dots]$.

I assume that violation of these constraints is assessed by segment rather than by feature, such that there is no distinction between two segments that bear independent instances of a feature value (9a) and two segments that autosegmentally share that feature value (9b) — both of these representations violate the markedness constraint * $[+F]$ twice.

(9) Indistinguishable candidates

- | | | | | | |
|----|------|------|----|------|---|
| a. | x | y | b. | x | y |
| | ↓ | ↓ | | y | t |
| | [+F] | [+F] | | [+F] | |

This differs from the “feature-driven markedness” approach adopted by Beckman (1995, 1997, 1998), in which autosegmental feature sharing minimizes markedness violation because such violation is assessed by feature rather than by segment (see also McCarthy & Prince 1994a, Itô & Mester 1994, Padgett 1995ab, Walker 1998b, and Alderete et al. 1999, among others). I discuss this difference in approach to markedness in Chapter 6. I should note that autosegmental spreading representations are not at all incompatible with the model of assimilation proposed here. A pair of adjacent segments in principle satisfies an AGREE[F] constraint either by bearing separate instances of the same value of [F] as in (9a) or by autosegmentally sharing a single value of [F] as in (9b) (as noted by Beckman (1998:41, fn. 29)). The point that I would like to stress is that *no* constraint needs to distinguish between these two representations to account for the various vagaries of vowel harmony.

The reason I keep the two markedness sub-families in (8) separate is to make clear an important distinction between them. The sub-family of constraints in (8b) is in a sense more context-sensitive than that in (8a) due to the specification of more than one feature — each feature provides a context of markedness for the other(s). A member of the sin-

gle-feature sub-family in (8a) is violated by the mere presence of the mentioned feature value; or, equivalently, it can only be satisfied by the absence of the mentioned feature value. For instance, a constraint like * $[+RD]$ can only be satisfied by a $[-RD]$ segment. A member of the multiple-feature sub-family in (8b), on the other hand, can be satisfied by the absence of *any* of the two or more mentioned feature values. For example, a constraint like * $[-HI, +RD]$ can be satisfied *either* by a $[+HI]$ segment *or* by a $[-RD]$ segment. The choice among the multiple options available for satisfying such a markedness constraint (given an input whose faithful realization would violate the constraint) depends on the relative ranking of markedness and faithfulness constraints, as discussed in some detail in the following section.

2. Markedness, Faithfulness, and Segmental Inventories

2.1 Introduction

Markedness constraints and faithfulness constraints interact with each other in the most basic of ways, and their interaction typically determines whether a particular segment or class of segments is in the *inventory* of a language (if faithfulness dominates markedness) or not (if markedness dominates faithfulness). This fundamental approach to segmental inventories in OT (following the lead of Prince & Smolensky 1993:§9 and much work since) differs somewhat from more traditional, and perhaps more familiar, approaches; this section provides a brief overview of the approach that readers familiar with OT may safely skip.

2.2 Preliminaries

Consider a universe of possible inputs consisting of the segments /u,o,a/.¹³ Suppose that /u/ is $[+HI, +RD]$, /o/ is $[-HI, +RD]$, and /a/ is $[-HI, -RD]$ — all other featural distinctions are suppressed and ignored. Accordingly, there are some markedness constraints against some

¹³ Though I am limiting the discussion here to a hypothetical language, this set of segments and the constraints in (10) and (11) below are not entirely arbitrary. See in particular Chapter 2, §2, where they pop up again.

values or combinations of values of the features [HI] and [RD], as given in (10) below, and faithfulness constraints for the preservation of their specified input values, as given in (11).

- (10) Some markedness constraints on /u,o,a/
- *[+HI]
Violated by a segment specified as [+HI] (i.e., [u]).
 - *[-RD]
Violated by a segment specified as [-RD] (i.e., [a]).
 - *[-HI, +RD]
Violated by a segment specified as [-HI, +RD] (i.e., [o]).
- (11) Faithfulness constraints on /u,o,a/
- IO-IDENT[HI]
Violated by a change from [α HI] to [$-\alpha$ HI] (i.e., /u/ → [o] and /o/ → [u]).
 - IO-IDENT[RD]
Violated by a change from [α RD] to [$-\alpha$ RD] (i.e., /o/ → [a] and /a/ → [o]).

When a faithfulness constraint dominates all of the markedness constraints that it potentially conflicts with, the result is a faithful mapping from input to output in terms of the relevant feature. For instance, the faithfulness constraint IO-IDENT[HI] (11a) conflicts with both *[+HI] (10a) and *[-HI, +RD] (10c); if IO-IDENT[HI] dominates both of these markedness constraints, then the underlying contrast between the two values of the feature [HI] is preserved in the mapping from the [+HI, +RD] input /u/ and the minimally distinct [-HI, +RD] input /o/ to their respective outputs, [u] and [o]. This is shown by the following two tableaux.

(12) Input: /u/

Candidates	IO-IDENT[HI]	*[+HI]	*[-HI, +RD]
a. ^{ESP} [u]		*	
b. [o]	* !		*

(13) Input: /o/

Candidates	IO-IDENT[HI]	*[+HI]	*[-HI, +RD]
a. [u]	* !	*	
b. ^{ESP} [o]			*

Likewise, the faithfulness constraint IO-IDENT[RD] (11b) conflicts with both *[-RD] (10b) and *[+HI, -RD] (10c); if IO-IDENT[RD] dominates both of these markedness constraints, then the underlying contrast between the two values of the feature [RD] is preserved in the mapping from the [-HI, +RD] input /o/ and the minimally distinct [-HI, -RD] input /a/ to their respective outputs [o] and [a]. This is shown by the next two tableaux.

(14) Input: /o/

Candidates	IO-IDENT[RD]	*[-RD]	*[-HI, +RD]
a. ^{ESP} [o]			*
b. [a]	* !	*	

(15) Input: /a/

Candidates	IO-IDENT[RD]	*[-RD]	*[-HI, +RD]
a. [o]	* !		*
b. ^{ESP} [a]		*	

Unfaithful mappings result when some markedness constraint dominates a conflicting faithfulness constraint. In the next two sub-sections I show how two different languages, each consisting of a different subset of the outputs [u,o,a], result from different rankings of the constraints in (10) and (11) by the *neutralization* of potential feature contrasts.

2.3 Neutralization I

Suppose we would like to describe a language with only [o,a] as surface vowels — that is, a proper subset of the set of inputs, not including [u]. According to the *Richness of the*

Base hypothesis (Prince & Smolensky 1993; see also Itô, Mester, and Padgett 1993, 1995, Kirchner 1995, 1997, Smolensky 1996, among many others), stated in (16) below, the set of possible outputs of a language is determined by a grammar consisting of a particular ranking of universal constraints applied to a universal set of inputs. Any language-particular restrictions on possible inputs are thus disallowed under this hypothesis.

(16) The Richness of the Base hypothesis (from Smolensky 1996:3)

The source of all systematic cross-linguistic variation is constraint reranking. In particular, the set of *inputs* to the grammars of all languages is the same. The grammatical inventories of a language are the *outputs* which emerge from the grammar when it is fed the universal set of all possible inputs.

According to the Richness of the Base hypothesis, every possible input must be contended with in every language, including ones that do not surface faithfully. The faithful mapping from /u/ to [u] must thus be avoided in order to describe the language with only [o,ɑ] in its surface inventory. To avoid this faithful mapping, it must be the case that the markedness constraint against [u], *[+HI], crucially dominates all of the conflicting constraints violated by at least one of the other, unfaithful candidate outputs of the input /u/.

The unfaithful candidate mapping from /u/ to [o] violates IO-IDENT[HI] and *[-HI, +RD]. These two constraints conflict with *[+HI], the constraint violated by the faithful candidate we intend to avoid. Therefore, in order for this unfaithful mapping to be better than the faithful mapping, *[+HI] must dominate both IO-IDENT[HI] and *[-HI, +RD]. Likewise, the unfaithful candidate mapping from /u/ to [ɑ] violates IO-IDENT[HI], *[-RD] and IO-IDENT[RD]. All three of these constraints conflict with *[+HI], so in order for this mapping to win out over the faithful mapping, *[+HI] must dominate all three of the constraints IO-IDENT[HI], *[-RD] and IO-IDENT[RD].

The choice between the two unfaithful candidate mappings comes down to the specification of a couple of additional rankings. For the mapping from /u/ to [o] to be optimal, either IO-IDENT[RD] or *[-RD] must dominate *[-HI, +RD]. This is shown in (17).

(17) Input: /u/

Candidates	*[+HI]	IO-ID[HI]	IO-ID[RD]	*[-RD]	*[-HI, +RD]
a. [u]	* !				
b. [o]		*			*
c. [ɑ]		*	* !	* !	

If *[-HI, +RD] dominates both IO-IDENT[RD] and *[-RD], on the other hand, the winning candidate is instead the individual mapping from /u/ to [ɑ]. However, this also results in the optimality of the mapping from /o/ to [ɑ], meaning that the language corresponding to this ranking consists of just [ɑ] and not [o,ɑ], as we had set out to describe. This situation is demonstrated by the tableaux in (18) and (19) for the inputs /u/ and /o/, respectively.

(18) Input: /u/

Candidates	*[+HI]	IO-ID[HI]	*[-HI, +RD]	IO-ID[RD]	*[-RD]
a. [u]	* !				
b. [o]		*	* !		
c. [ɑ]		*		*	*

(19) Input: /o/

Candidates	*[+HI]	IO-ID[HI]	*[-HI, +RD]	IO-ID[RD]	*[-RD]
a. [u]	* !	*			
b. [o]			* !		
c. [ɑ]				*	*

The conclusion here is that the only way to end up with a language with the surface inventory [o,ɑ] and without [u] is to have the ranking of assumed constraints shown in (17), which disposes of /u/ by mapping it onto [o], thereby neutralizing the potential distinction between /u/ and /o/ (as demanded by the Richness of the Base hypothesis).

It should be noted that the details of this result can be disrupted if we choose to assume the existence of any other constraints that might distinguish the candidate mappings under discussion. For instance, there could be a markedness constraint violated by [-HI,

+RD] vowels in non-initial syllables.¹⁴ If such a constraint existed and were higher-ranked than IO-IDENT[RD] and *[-RD] in the otherwise unchanged hierarchy in (17), the result would be that the mappings from /u/ and /o/ to [o] would be optimal in initial syllables while mappings from /u/ and /o/ to [a] would be optimal in non-initial ones. This situation is summarized by the following combined tableaux. (Mappings onto [u] and the sub-ranking that guarantees their utter failure, *[+HI] » IO-IDENT[HI], are left out of these tableaux for reasons of space.)

(20) Input: initial (# __) /u,o/

Candidates	*[-HI, +RD] / σ __	IO-ID[RD]	*[-RD]	*[-HI, +RD]
a. ^{SP} [o]				*
b. [a]		* !	* !	

(21) Input: non-initial (σ __) /u,o/

Candidates	*[-HI, +RD] / σ __	IO-ID[RD]	*[-RD]	*[-HI, +RD]
a. [o]	* !			*
b. ^{SP} [a]		*	*	

Similar considerations could even conspire to allow surface [u] in certain contexts; this is of course desirable and necessary, in order to describe situations of allophonic alternation (complementary distribution). Strictly speaking, then, a segmental ‘inventory’ in the sense under discussion in this section is not the underlying inventory,¹⁵ by the Richness of the Base hypothesis, nor is it the entire surface inventory, due to potential positional or otherwise contextually marked distinctions. An inventory is instead understood to be the set of optimal mappings in a given position or context. Thus, the language just considered has two segmental inventories, an initial syllable inventory (19) and a non-initial syllable inventory (20). The two inventories have the same surface segments [o,a]; the

¹⁴ See Chapter 2, §2.3.4 for the more intricate faithfulness account of such positional distinctions that I assume to be the correct one; for the purposes of the present simple point I appropriate this simpler markedness account.

¹⁵ Also known as the phonemic inventory or ‘phonological alphabet’ (Calabrese 1988).

initial inventory optimally maps /u/ to [o] while the non-initial inventory optimally maps /u/ to [a] instead.

2.4 Neutralization II

Now suppose we would like to describe a language with only [u,a] as surface vowels; another proper subset of the set of inputs, this time not including [o]. This case is somewhat different than the previous one because there are two possible surface manifestations for the possible input /o/. The faithful candidate mapping from /o/ to [o] that must be avoided violates *[-HI, +RD]; ranking both this constraint and one of two conflicting faithfulness constraints (IO-IDENT[HI] or IO-IDENT[RD]) above the other results in a mapping from /o/ to [a], if IO-IDENT[RD] is lowest-ranked, as in (22), or a mapping from /o/ to [u], if IO-IDENT[HI] is lowest-ranked, as in (23).

(22) Input: /o/

Candidates	*[-HI, +RD]	IO-IDENT[HI]	IO-IDENT[RD]
a. [u]		* !	
b. [o]	* !		
c. ^{SP} [a]			*

(23) Input: /o/

Candidates	*[-HI, +RD]	IO-IDENT[RD]	IO-IDENT[HI]
a. ^{SP} [u]			*
b. [o]	* !		
c. [a]		* !	

To complete the description of a language with only [u,a] and not [o], the constraint hierarchy in (22) must be prevented from incorrectly selecting a mapping from /u/ to [a] as optimal. This is done by ranking IO-IDENT[HI] above *[-RD], as shown in (24) below.

(24) Input: /u/

Candidates	*[-HI, +RD]	IO-IDENT[HI]	IO-IDENT[RD]	*[-RD]
a. ^{EXP} [u]				
b. [o]	* !	* !		
c. [a]		* !	*	*

The hierarchy in (23) must likewise be prevented from incorrectly selecting a mapping from /a/ to [u] as optimal. This time, this is achieved by ranking IO-IDENT[RD] above *[+HI].

(25) Input: /a/

Candidates	*[-HI, +RD]	IO-IDENT[RD]	IO-IDENT[HI]	*[+HI]
a. [u]		* !	*	*
b. [o]	* !	* !		
c. ^{EXP} [a]				

The language with [u,a] and without [o] can thus also be described in two ways; either /o/ neutralizes with /a/ as in (22)/(24), or it neutralizes with /u/ as in (23)/(25).

2.5 Summary

In this section I have outlined the essential components of the interaction of markedness and faithfulness in OT. Featural contrasts, underlyingly free under the Richness of the Base hypothesis, are preserved on the surface if faithfulness dominates markedness, and neutralized if markedness dominates faithfulness. Different interactions among several of these mini-hierarchies of markedness and faithfulness result in different segmental inventories.

In the real world of natural language phonology, of course, featural contrasts exist along many more dimensions than just [HI] and [RD], and so the number and type of ranking statements required to make a given mapping optimal depends in large part on the contrasts that intersect with that mapping. In addition, different mappings may be opti-

mal in different contexts, as noted in §2.3, adding yet another set of distinctive dimensions to the mix.

Regardless of the consequential details of these perhaps over-simplified idealizations (all made here for expository reasons), the basic necessary condition for optimality is always the same: some constraint violated more by any suboptimal mapping must be higher-ranked than all constraints violated more by the optimal mapping, a condition that holds regardless of what the universal set of constraints is (in fact, regardless of whether the set of constraints is universal).

This necessarily brief introduction to the basic interaction between markedness and faithfulness may leave more questions asked than answered. More extensive discussion can be found in Prince & Smolensky 1993 (especially §9), McCarthy & Prince 1995, 1999, and in a large selection of other OT works (the collection including McCarthy & Prince 1995 is a good start for those unfamiliar with OT), since this is such a fundamental part of the theory.

I should note in closing that among the input restrictions disallowed by the Richness of the Base hypothesis is the crucial use of input underspecification, a mainstay of the more recent literature on vowel harmony. Because I adopt the Richness of the Base hypothesis in this dissertation, the familiar trappings of underspecification — such as archisegmental representations — are not to be found here. See Chapter 6 for detailed discussion of why underspecification is not only unnecessary but undesirable in the analysis of vowel harmony.

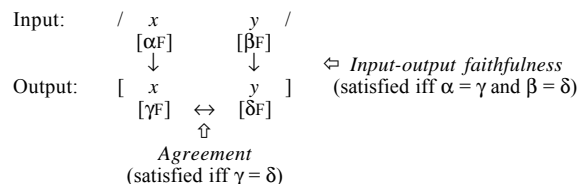
3. Interaction with Agreement

3.1 To agree or not to agree

Agreement constraints and input-output faithfulness constraints often conflict. IO-IDENT[F] is best satisfied by maintaining input values of [F] in the output, but if adjacent

segments happen to differ in terms of [F] in the input, then AGREE[F] will not be satisfied by an [F]-faithful output candidate. Consider the diagram in (26) below.

(26) Input-output faithfulness vs. agreement



Suppose that x and y in the input here have the same value of the feature [F] — e.g., they are both [+F]. A faithful output candidate for this input would be one in which x and y are both also [+F] in the output. Note that this candidate satisfies agreement rather trivially, since x and y happen to have the same value of the feature [F] in the input. So, when the input coefficient variables α and β in the diagram are equal in value, input-output faithfulness and agreement are not in conflict. Now suppose that x and y in the input have different values of the feature [F]; that is, $\alpha \neq \beta$. The faithful output candidate in this case is inevitably one in which $\gamma \neq \delta$. Although this candidate satisfies input-output faithfulness, it does not satisfy agreement. So, when the input coefficient variables α and β are unequal in value, input-output faithfulness and agreement are in conflict. This is all summarized in (27) below.

(27) Conflict of input-output faithfulness and agreement

- a. **Given:**
- i. a pair of input segments x and y ,
 - ii. x is $[\alpha F]$ and y is $[\beta F]$, and
 - iii. the output correspondents of x and y are adjacent, **then:**
- b. IO-IDENT[F] and AGREE[F] conflict if $\alpha \neq \beta$, **else**
 - c. IO-IDENT[F] and AGREE[F] are not in conflict.

The interaction between agreement and input-output faithfulness constraints is thus the most basic to assimilation; the relative ranking of conflicting members of these families pretty much determines whether a language has some assimilation or not. A language in

which AGREE[F] dominates IO-IDENT[F] has assimilation in terms of [F], since agreement will demand that adjacent output segments have the same value of [F] regardless of those segments' independent input values of [F]. Conversely, a language in which IO-IDENT[F] dominates AGREE[F] has *no* assimilation in terms of [F], since faithfulness will demand that output segments surface with their input value of [F] regardless of whether adjacent output segments disagree in terms of [F] as a result.

To further facilitate the understanding of this basic constraint interaction, consider an input consisting of two vowels that do not have the same value of some feature [F]; the first vowel has one value of [F], $[\alpha F]$, and the second has the opposite value, $[-\alpha F]$. There are three candidate outputs of this input that are of interest here: one that is identical to the input, one in which both vowels are $[\alpha F]$, and one in which both vowels are $[-\alpha F]$. Now consider a grammar in which IO-IDENT[F] dominates AGREE[F]. As the tableau in (28) shows, the optimal output candidate for this input in a language with this constraint ranking is the one in (28a) because this candidate satisfies IO-IDENT[F], albeit at the expense of AGREE[F].

(28) Input: $[\alpha F] [-\alpha F]$

Candidates	IO-IDENT[F]	AGREE[F]
a. $[\alpha F] [-\alpha F]$		*
b. $[\alpha F] [\alpha F]$	* !	
c. $[-\alpha F] [-\alpha F]$	* !	

Now consider what happens with this same input in a language with a grammar in which AGREE[F] dominates IO-IDENT[F]. As shown by the tableau in (29), AGREE[F] is fatally violated by the faithful output candidate in (29a); one of the remaining two output candidates emerges victorious, despite the fact that they both violate IO-IDENT[F].

(29) Input: $[\alpha F]$ $[-\alpha F]$

Candidates	AGREE[F]	IO-IDENT[F]
a. $[\alpha F]$ $[-\alpha F]$	* !	
b. $[\alpha F]$ $[\alpha F]$		*
c. $[-\alpha F]$ $[-\alpha F]$		*

3.2 Stem control

The ultimate decision between these two candidates is often made in favor of the one most faithful to the harmonic feature value of the stem of affixation. In other words, the harmonic feature value of a stem + affix combination is determined by the harmonic feature value of a vowel in the stem of affixation, as opposed to that of a vowel in the affix. Such a vowel harmony process is thus called *stem-controlled*.¹⁶

What is needed to derive stem-controlled vowel harmony is a special kind of faithfulness constraint preferring that the feature values of the stem of affixation remain unchanged; in particular, the harmonic feature value of the stem of affixation. This idea is here implemented within Transderivational Correspondence Theory (TCT; see Benua 1995, 1997ab for development of this theory and for references to related work).

In TCT, there is a correspondence relation between affixed forms and their stems of affixation. Featural faithfulness constraints on this correspondence relation, here called SA-IDENT[F] constraints ('S' for 'stem', 'A' for 'affixed form'), demand that correspondent segments in such morphologically-related forms have the same value of the feature [F].¹⁷

(30) SA-IDENT[F]

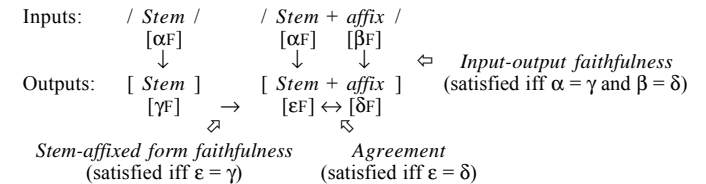
A segment in an affixed form [*Stem + affix*] must have the same value of the feature [F] as its correspondent in the stem of affixation [*Stem*].

¹⁶ The term *root control* is also often used in reference to such vowel harmony processes. I discuss in Chapter 2, §2.3 why *stem control* is a more accurate term, following Kirchner's (1993) take on an often-made observation.

¹⁷ The linear order of *Stem* and *affix* in the definition in (30) is irrelevant; *affix* can be either a prefix or a suffix.

The way that stem-affixed form faithfulness fits within the model together with input-output faithfulness and agreement is schematized in the diagram in (31) below.

(31) Transderivational Correspondence Theory



As indicated by the unidirectional arrow '→' in this diagram that denotes the stem-affixed form correspondence relation, this relation is *asymmetrical* in that an affixed form may be forced to mimic its stem but not vice-versa. This is technically achieved in TCT by evaluating each stem of affixation by a higher-ranked recursion of the entire constraint hierarchy (see Benua 1997a for the details of this proposal). For present purposes, I simply stipulate that an affixed form has access to the output form of its stem but not vice-versa for the purposes of evaluation by SA-IDENT[F] constraints, and the output form of the stem of affixation is shown above tableaux alongside the input for ease of verification.

For purposes of illustration, suppose that the first vowel in the input considered in (29) above is a root vowel and the second is an adjacent affix vowel.¹⁸ Regardless of where it is ranked with respect to AGREE[F] and IO-IDENT[F], SA-IDENT[F] prefers the candidate in which the affix vowel assimilates to the root vowel rather than the candidate in which the root vowel assimilates to the affix vowel. This is shown by the tableau in (32).

(32) Input: $\sqrt{[\alpha F]} \cdot [-\alpha F]$ Stem: $\sqrt{[\alpha F]}$

Candidates	AGREE[F]	IO-IDENT[F]	SA-IDENT[F]
a. $\sqrt{[\alpha F]} \cdot [-\alpha F]$	* !		
b. $\sqrt{[\alpha F]} \cdot [\alpha F]$		*	
c. $\sqrt{[-\alpha F]} \cdot [-\alpha F]$		*	* !

¹⁸ The necessarily-imposed linear order of these vowels suggests that the affix is a suffix as opposed to a prefix. The point being made here trivially holds for the mirror image situation with an adjacent prefix.

In (32a) we again have the completely faithful candidate, which fatally violates the undominated AGREE[F] constraint. The candidates in (32b) and (32c) represent the two possible avoidances of that fatal violation, each incurring an equal violation of IO-IDENT[F]. Of these two, however, only (32b) satisfies SA-IDENT[F]. The stem of affixation for this affixed form, as indicated above the tableau, is specified as $[\alpha F]$; the corresponding vowel is also specified as $[\alpha F]$ in (32b), while it is counterspecified as $[-\alpha F]$ in (32c).

It would seem, then, that simply introducing stem-affixed form faithfulness achieves the desired result for stem control. We are lulled, however, by the simplicity of the input considered in (32): if there are more than two vowels in the input, then a potential problem arises depending on what the harmonic feature values of those vowels are in the input.

3.3 'Majority rule'

3.3.1 The problem

Suppose that another suffix with a $[-\alpha F]$ vowel is attached to the stem derived in (32). The ranking between SA-IDENT[F] and IO-IDENT[F] now makes a significant difference. One ranking returns the desired result, while the other makes a faulty prediction of pathological proportions. If SA-IDENT[F] dominates IO-IDENT[F], then the expected result — that the suffix vowel becomes $[-F]$ to agree with the stem vowels — is optimal, as shown in (33).

(33) Input: $\sqrt{[\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$ Stem: $\sqrt{[\alpha F] \cdot [\alpha F]}$

Candidates	AGREE[F]	SA-IDENT[F]	IO-IDENT[F]
a. $\sqrt{[\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$	* !	* !	
b. $\sqrt{[\alpha F] \cdot [\alpha F] \cdot [-\alpha F]}$	* !		*
c. $\sqrt{[\alpha F] \cdot [\alpha F] \cdot [\alpha F]}$			**
d. $\sqrt{[-\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$		** !	*

But if IO-IDENT[F] dominates SA-IDENT[F] instead, then there is an unexpected and in fact absolutely wrong result: the stem vowels become $[-\alpha F]$ to agree with the suffix vowel, as shown in (34) (the intended but failed candidate is indicated with a skull-and-crossbones).

(34) Input: $\sqrt{[\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$ Stem: $\sqrt{[\alpha F] \cdot [\alpha F]}$

Candidates	AGREE[F]	IO-IDENT[F]	SA-IDENT[F]
a. $\sqrt{[\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$	* !		*
b. $\sqrt{[\alpha F] \cdot [\alpha F] \cdot [-\alpha F]}$	* !	*	
c. $\sqrt{[\alpha F] \cdot [\alpha F] \cdot [\alpha F]}$		** !	
d. $\sqrt{[-\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$		*	**

The reason for the erroneous prediction in (34) is clear, as originally noted by Lombardi (1996a, 1999): IO-IDENT[F], symmetrically violated by every change from one value of [F] to the other, prefers less change from input to output. When AGREE[F] is dominant, it winnows the candidate set down to basically two candidates, one with all $[\alpha F]$ segments and the other with all $[-\alpha F]$ segments. If IO-IDENT[F] gets the next crack at the evaluation process, it will choose the one of these candidates that is least deviant from the input, regardless of the stem/affix or +/- distinctions. In other words, what ends up mattering is the *relative percentages* of $[\alpha F]$ and $[-\alpha F]$ vowels in the input: the underlyingly greater number of $[-\alpha F]$ vowels in (34) gangs up on the lesser number of $[\alpha F]$ vowels, yielding the problematic effect that I call 'majority rule'.

This problem only arises if IO-IDENT[F] is allowed to dominate SA-IDENT[F]. This might lead one to believe that the solution to the problem is to not allow this ranking. Aside from the negative typological consequences that this move might have, among them the loss of some of McCarthy's (1998b) interesting results derived from the free interaction of these constraint types, this ad hoc move turns out not to be desirable in any case. This is because the problem is not confined to the interaction of SA-IDENT[F] and IO-IDENT[F]: it arises whenever a positionally-sensitive faithfulness constraint like SA-IDENT[F] is not active in the decision between two assimilated candidates (Lombardi

1996a, 1999; see also §3.3.8). So, the trick is to not let the decision ever fall to IO-IDENT[F], and there are a number of ways to skin this particular cat.¹⁹

In §§3.3.2–3.3.7 below, I argue for a particularly successful and independently-motivated method for ensuring the necessary result: the local conjunction (Smolensky 1993, 1995, 1997) of markedness and faithfulness (Lubowicz 1998). This solution is contrasted with two other potential but failed solutions in §3.3.8. The local conjunction solution to the majority rule problem is crucial to the analysis of dominant-recessive vowel harmony, the topic of §3.4 further below.

3.3.2 Local conjunction

Smolensky (1993, 1995, 1997) proposes that two constraints A and B may be *locally conjoined*, creating a third constraint A &_lB that is violated whenever both A and B are simultaneously violated in some local domain *l*.²⁰ Local conjunctions are in general motivated by situations in which it appears that A and B are individually violable in order to satisfy some conflicting constraint C, but when satisfaction of *both* A and B within some local domain is at stake, C is forced to be violated instead. Such an interaction of constraints is simply not possible under strict domination. If C dominates A and B, then either A or B or both are violated as many times as necessary to satisfy C. In order for the coincidental violation of both A and B to ‘gang up’ on C, a local conjunction A &_lB that in turn outranks C is necessary.

The elements of the theory of local conjunction that I assume are as in (35) (adapted from Itô & Mester 1998:11). Note in particular the universal ranking that is assumed to hold between local conjunctions and their conjuncts, stated in (35c), to the ef-

¹⁹ One obvious way is to appeal to underspecification, an utterly typical invocation in the analysis of vowel harmony. Aside from its general incompatibility with the Richness of the Base hypothesis (16), there are some non-trivial problems with underspecification that I address separately in Chapter 6.

²⁰ See Hewitt & Crowhurst 1996 and Crowhurst & Hewitt 1997 for a somewhat different view of how constraints can be co-ordinated using various Boolean connectives. NB: In the terminology adopted by Crowhurst & Hewitt, making more transparent the connection with classical propositional logic (on which their theory of constraint co-ordination is founded), a local “conjunction” corresponds to a logical *disjunction* of constraints.

fect that it is universally worse to violate a local conjunction than it is to violate either of its conjuncts. This component of the theory plays a crucial part in my proposal, as I make clear below.

(35) Local conjunction theory (adapted from Itô & Mester 1998:11)

- a. Definition: If A and B are non-conjoined members of the universal constraint set *Con*, then their local conjunction A &_lB is also a member of *Con*.
- b. Interpretation: A &_lB is violated if and only if both its conjuncts A and B are violated in the smallest domain evaluable by A and B.
- c. Ranking (universal): A &_lB » { A, B }

A considerable amount of attention is paid in the literature on local conjunction to the question whether any two constraints are conjoinable (see e.g. Miglio & Fukazawa 1997, Itô & Mester 1998, Lubowicz 1998; see also Crowhurst & Hewitt 1997). The consensus seems to be that *not* any two constraints should be conjoinable, and there are thus various proposals for properly restricting the definition of local conjunction, and I adopt a couple here.²¹

First of all, the definition in (35a) differs from Itô & Mester’s in that it is stipulated that two conjoinable constraints A and B must not themselves be locally conjoined, making the definition non-recursive.²² As pointed out by Alan Prince (p.c.), a recursive definition of local conjunction entails an infinite number of constraints in *Con*, meaning that a grammar cannot consist of all the constraints in *Con* — a fundamental modification of a basic OT premise. If local conjunctions are not universal but rather are formed on a language-particular basis, as explicitly assumed in Smolensky 1997, then this is a non-issue. But in order for local conjunction to provide a workable solution to the majority rule problem, I must assume that local conjunctions are universal and that only their ranking, modulo (35c), is determinable on a language-particular basis.

²¹ See the references cited for more discussion. See also §3.3.6 below.

²² This restriction thus rules out the possibility of ‘power hierarchies’ as proposed by e.g. Smolensky (1995), Legendre et al. (1995) and Legendre, Smolensky & Wilson (1998). See also footnote 23 immediately below.

Secondly, I follow Lubowicz (1998) in assuming that the local domain l of a local conjunction is always the smallest domain evaluable by its conjuncts, as noted in (35b). This restriction prevents some of the potential proliferation of local conjunctions, because two local conjunctions cannot differ solely by their domain of application.²³

3.3.3 Markedness and faithfulness

Various types of constraints may be locally conjoined. For instance, Kirchner (1996) argues that the proper analysis of synchronic chain shifts involves the local conjunction of faithfulness constraints, Itô & Mester (1998) show how positional markedness effects can be analyzed with the local conjunction of markedness constraints, and Lubowicz (1998) proposes to account for derived environment effects with the local conjunction of markedness and faithfulness.²⁴ I adopt Lubowicz's proposal here, and assume that markedness constraints like those in (8) can be locally conjoined with IO-IDENT[F] constraints, resulting in local conjunctions of the form in (36).²⁵

(36) Local conjunction of markedness and faithfulness

- a. $*[\alpha F] \&_l \text{IO-IDENT}[F]$
An output segment must not be specified as $[\alpha F]$, if its input correspondent is not also specified as $[\alpha F]$.
- b. $*[\alpha F, \beta G(\gamma H \dots)] \&_l \text{IO-IDENT}[F]$
An output segment must not be specified as $[\alpha F, \beta G(\gamma H \dots)]$, if its input correspondent is not also specified as $[\alpha F]$.

²³ This restriction also appears to render ineffectual the local conjunction of a constraint with itself ('local self-conjunction'; see Smolensky 1995, Alderete 1997, Itô & Mester 1996, 1998, Spaelti 1997; see also Crowhurst & Hewitt 1997), because the effect of $A \&_l A$ would be the same as the effect of A alone. But this depends on the flexibility of the 'domain' evaluated by A ; if its size can vary, like the 'chain link' domain in Legendre et al. 1995 and Legendre, Smolensky & Wilson 1998, then $A \&_l A$ could potentially be distinguished from A in some circumstances.

²⁴ Ania Lubowicz (p.c.) has explained to me how the local conjunction of markedness and faithfulness can also be used to account for synchronic chain shifts, an approach to be compared with Kirchner's (1996) approach employing the local conjunction of faithfulness constraints alone.

²⁵ Itô & Mester (1998) and others have also conjectured that multiple-feature markedness constraints (8b) are themselves local conjunctions of the 'more basic' single-feature markedness constraints (8a). Note that this predicts that multiple-feature markedness constraints should be universally higher-ranked, by (29c), than the single-feature markedness constraints that constitute their conjuncts — a non-trivial prediction that remains to be thoroughly investigated. Note also that, because the definition of local conjunction I assume in (29a) is non-recursive, the idea that multiple-feature markedness constraints are local conjunctions entails that they cannot be further conjoined with other constraints. Since I assume that multiple-feature markedness constraints *can* be conjoined with other constraints, as in (30b), I am led to the necessary conclusion that they cannot themselves be local conjunctions.

The net effect of these local conjunctions is that they specifically prohibit the unfaithful introduction in the output of a marked segment. For instance, $*[+RD] \&_l \text{IO-IDENT}[RD]$ is not violated by just any $[+RD]$ vowel in the output; it is violated only if such an output vowel is in correspondence with a $[-RD]$ vowel in the input — in other words, only if the output vowel is *unfaithfully* $[+RD]$; only if it is $[+RD]$ by virtue of its unfaithfulness to the input value of $[RD]$. Removing the relevant IO-IDENT $[RD]$ violation from a candidate that violates $*[+RD] \&_l \text{IO-IDENT}[RD]$ guarantees the satisfaction of $*[+RD]$, since the result is a $[-RD]$ vowel. Similarly, $*[-HI, +RD] \&_l \text{IO-IDENT}[RD]$ is not violated by just any $[-HI, +RD]$ vowel; it is violated only if such an output vowel corresponds to a $[-RD]$ vowel in the input.

Note that an input $[+HI, +RD]$ vowel in correspondence with an output $[-HI, +RD]$ vowel would not violate $*[-HI, +RD] \&_l \text{IO-IDENT}[RD]$, even though such a mapping is unfaithful and violates $*[-HI, +RD]$. This is because the mapping is unfaithful in terms of the feature $[HI]$, but the faithfulness conjunct of this particular local conjunction mentions the feature $[RD]$. This mapping does however violate another local conjunction, $*[-HI, +RD] \&_l \text{IO-IDENT}[HI]$, which is in turn not violated by the unfaithful mapping from a $[-HI, -RD]$ vowel to a $[-HI, +RD]$ vowel.

3.3.4 No more majority rule

A local conjunction like $*[-\alpha F] \&_l \text{IO-IDENT}[F]$ is violated by a $[-\alpha F]$ segment in the output that is in correspondence with an $[\alpha F]$ segment in the input, and is universally higher-ranked than each of its conjuncts $*[-\alpha F]$ and IO-IDENT $[F]$ according to the universal ranking element (35c) of the theory of local conjunction. What this means is that this asymmetrical local conjunction $*[-\alpha F] \&_l \text{IO-IDENT}[F]$ will always get evaluative priority over its symmetrical faithfulness conjunct IO-IDENT $[F]$, thus eliminating the majority rule problem.

This is shown in (37), where the input is the same as the one considered in (33) and (34). The input-faithful candidate in (37a) and the stem-faithful candidate in (37b) are, as usual, ruled out by their fatal violations of AGREE[F]. The majority rule candidate in (37d) correctly loses to the desired stem-controlled candidate in (37c), because the former fatally violates the universally higher-ranked local conjunction $*[-\alpha F] \&_l$ IO-IDENT[F] while the latter only violates the lower-ranked symmetrical faithfulness conjunct IO-IDENT[F].

(37) Input: $\sqrt{[\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$ Stem: $\sqrt{[\alpha F] \cdot [\alpha F]}$

Candidates	AGR[F]	$*[-\alpha F]$ & _l IO-ID[F]	IO-ID[F]	SA-ID[F]
a. $\sqrt{[\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$	* !			*
b. $\sqrt{[\alpha F] \cdot [\alpha F] \cdot [-\alpha F]}$	* !		*	
c. $\sqrt{[\alpha F] \cdot [\alpha F] \cdot [\alpha F]}$			**	
d. $\sqrt{[-\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$		* !	*	**

3.3.5 Assimilation to the unmarked

Note that the relative ranking between IO-IDENT[F] and SA-IDENT[F] is technically not relevant in (37), as indicated by the dotted line between them. This is because the higher-ranked constraints AGREE[F] and $*[-\alpha F] \&_l$ IO-IDENT[F] narrow down the relevant field of candidates enough on their own to select the optimal candidate in (37c). This fact partly disguises a significant coincidence: the optimal candidate in (37c) is indeed the desired stem-controlled candidate, but SA-IDENT[F], the constraint argued here to be responsible for stem control, is completely irrelevant to this decision due to its low rank.

To appreciate this coincidence, consider the case shown in (38) below. The input here consists of a $[-\alpha F]$ root vowel followed by an $[\alpha F]$ affix vowel, the polar opposite of the initial root and affix combination shown in (37) above.

(38) Input: $\sqrt{[-\alpha F] \cdot [\alpha F]}$ Stem: $\sqrt{[-\alpha F]}$

Candidates	AGREE[F]	$*[-\alpha F]$ & _l IO-ID[F]	IO-ID[F]	SA-ID[F]
a. $\sqrt{[-\alpha F] \cdot [\alpha F]}$	* !			
b. $\sqrt{[-\alpha F] \cdot [-\alpha F]}$		* !	*	
c. $\sqrt{[\alpha F] \cdot [\alpha F]}$			*	*

The assimilated candidate in (38c), despite its lack of stem control, is optimal. This is because the candidate with stem control in (38b) violates the local conjunction due to the unfaithful instance of $[-\alpha F]$ in the affix vowel, while the optimal candidate has no instances of $[-\alpha F]$ at all, escaping the local conjunction and emerging victorious. If the ranking of SA-IDENT[F] and $*[-\alpha F] \&_l$ IO-IDENT[F] were reversed, the candidates with stem control in both (37c) and (38b) would of course win. Under the given ranking, however, stem control is either accidental (as in (37)) or absent (as in (38)) — assimilation is always to $[\alpha F]$.

This pattern of assimilation is in fact attested: it corresponds to what is known as dominant-recessive vowel harmony. The primary characteristic of this pattern of vowel harmony is that all vowels are forced to agree with whichever vowel happens to bear a particular value of the harmonic feature (if any) — no matter what the morphological status of that vowel is, root or affix. Details and examples are left until §3.4; what is immediately relevant in this context is that the “particular value” of the harmonic feature that controls the assimilation in dominant-recessive systems is claimed here to be the value that is *unmarked* with respect to the other, given the structure of the vowel inventory of the language. In other words, when there isn’t stem control, there is *assimilation to the unmarked*.

The local conjunction solution to the majority rule problem correctly predicts the assimilation-to-the-unmarked result. Suppose for the sake of argument that $[-\alpha F]$ is the universally marked value of the feature [F], and that $*[-\alpha F]$ — the markedness conjunct

of the local conjunction $*[-\alpha F] \&_l \text{IO-IDENT}[F]$ — reflects the markedness of this feature value. If a corresponding (anti-)markedness constraint $*[\alpha F]$ is presumed to exist, then it must be universally lower-ranked than $*[-\alpha F]$; this much follows from reasonable and well-accepted assumptions about the theory of markedness within OT (Prince & Smolensky 1993, Chapter 9). Following Spaelti (1997), Itô & Mester (1998), Aissen (1998b), and Artstein (1998), I assume that such universal ranking relations are preserved under local conjunction.²⁶

(39) Ranking preservation (adapted from Aissen 1998:28)

The local conjunction of a constraint C with a subhierarchy $\{A \gg B \gg \dots \gg Z\}$ yields the subhierarchy $\{A \&_l C \gg B \&_l C \gg \dots \gg Z \&_l C\}$.

The proposed principle of ranking preservation, independently well-motivated within both phonology (Spaelti 1997, Itô & Mester 1998) and morpho-syntax (Aissen 1998, Artstein 1998b), captures the desired result that $*[-\alpha F] \&_l \text{IO-IDENT}[F]$ is universally ranked higher than $*[\alpha F] \&_l \text{IO-IDENT}[F]$. The tableau in (40), with the same input as in (38), shows how this guarantees the correct result that there is assimilation to the unmarked.

(40) Input: $\sqrt{[-\alpha F] \cdot [\alpha F]}$

Candidates	AGR [F]	$*[-\alpha F] \&_l$ IO-ID[F]	$*[\alpha F] \&_l$ IO-ID[F]	IO- ID[F]	$*[-\alpha F]$	$*[\alpha F]$
a. $\sqrt{[-\alpha F] \cdot [\alpha F]}$	* !				*	*
b. $\sqrt{[-\alpha F] \cdot [-\alpha F]}$		* !		*	**	
c. $\sqrt{[\alpha F] \cdot [\alpha F]}$			*	*		**

It should be noted that the same result, perhaps with somewhat distinct consequences, can be achieved by asserting that the constraint against the unmarked $[\alpha F]$ simply does not exist, and that the relevant local conjunction ($*[\alpha F] \&_l \text{IO-IDENT}[F]$) is thereby also non-

²⁶ The term ‘subhierarchy’ in the following definition refers to any set of universally ranked constraints and their relative ranking; thus, $\{*[-\alpha F] \gg *[\alpha F]\}$ is the subhierarchy under discussion in the text.

existent. The evidence for fixed markedness subhierarchies when the difference between just two complementary sets of elements is called for is, after all, somewhat lacking.²⁷

3.3.6 Co-relevance

Itô & Mester (1998:§2.2) make a case against the local conjunction of markedness and faithfulness constraints. As these authors show, there are some undesirable consequences that result when certain markedness and faithfulness constraints are locally conjoined with each other. Their example is the local conjunction of the markedness constraint NOCODA (violated by closed syllables) and the faithfulness constraint IO-IDENT[VOI]. When ranked with respect to other constraints as in (41), this local conjunction can be responsible for the generation of a language in which obstruents may be voiced *only in the coda of a syllable*, more or less the reverse of what is typically found in the world’s languages.

(41) Syllable-initial devoicing? (Itô & Mester 1998:14-15)

NOCODA $\&_l$ IO-IDENT[VOI] \gg $*[+VOI] \gg$ IO-IDENT[VOI]

Itô & Mester’s argument proceeds as follows. Voiced obstruents are in general devoiced due to the ranking of $*[+VOI]$ over IO-IDENT[VOI] — except in codas, because codas violate NOCODA and therefore devoicing (more generally, any change in voicing) in the coda violates the top-ranked local conjunction NOCODA $\&_l$ IO-IDENT[VOI]. The result is a voicing contrast only in the coda or, more or less equivalently, voicing neutralization only in the onset. (This argument presupposes that codas aren’t otherwise dealt with in the language by, e.g., deletion or epenthesis; see Itô & Mester’s original argument for more details.)²⁸

As Alan Prince and Ania Lubowicz (p.c.) have pointed out to me, the problem with local conjunctions like Itô & Mester’s NOCODA $\&_l$ IO-IDENT[VOI] is that its conjuncts

²⁷ In fact, this reasoning also applies to the lowest-ranked constraint of any fixed markedness subhierarchy of n constraints (where $n \geq 2$), as John McCarthy and Alan Prince (p.c.) have independently pointed out to me.

²⁸ There is an additional non-trivial problem that is being glossed over here: if the domain that NOCODA evaluates is the entire syllable, then the language generated is more accurately one in which there is a voicing contrast both in the onset and coda, but *in closed syllables only*. Either way, we are talking about unattested patterns; for present purposes I assume that the domain that NOCODA evaluates is co-extensive with the understood sub-syllabic category ‘coda’.

are in an important sense not *relevant* to each other, in the way that the conjuncts of the local conjunctions schematized in (36) — repeated in (42) below — are.

- (42) Local conjunction of markedness and faithfulness
- a. * $[\alpha_F]$ &_{*l*} IO-IDENT[F]
An output segment must not be specified as $[\alpha_F]$, if its input correspondent is not also specified as $[\alpha_F]$.
 - b. * $[\alpha_F, \beta_G(\gamma_H \dots)]$ &_{*l*} IO-IDENT[F]
An output segment must not be specified as $[\alpha_F, \beta_G(\gamma_H \dots)]$, if its input correspondent is not also specified as $[\alpha_F]$.

The conjuncts of the local conjunctions in (42) are relevant to each other in the sense that each conjunct mentions a particular feature, [F], also mentioned by the other conjunct. I dub this potential connection between markedness and faithfulness constraints *co-relevance* and define it more formally in (43) below.

- (43) Co-relevance
- A markedness constraint μ and a faithfulness constraint ϕ are *co-relevant* iff
- a. satisfaction of μ depends in part on the output not containing a particular value of a feature [F], and
 - b. satisfaction of ϕ depends on the value of the same feature [F] not having changed in the mapping from input to output.

Co-relevance is what establishes the causal link between the conjuncts of the local conjunctions schematized in (42). As discussed at the end of §3.3.4, the faithfulness violation is *responsible* for the markedness violation in the case of these local conjunctions. This is not the case for local conjunctions like NOCODA &_{*l*} IO-IDENT[VOI], Itô & Mester's (1998) strawman case. Violation of the faithfulness conjunct IO-IDENT[VOI] does not in any way aid and abet in the violation of the markedness conjunct NOCODA. In other words, simply removing the relevant IO-IDENT[VOI] violation from a candidate that violates NOCODA &_{*l*} IO-IDENT[VOI] will not thereby result in the satisfaction of NOCODA; a coda remains, whether it's voiced or voiceless. In order to avoid the pathological situation portrayed by Itô & Mester's (1998) case of NOCODA &_{*l*} IO-IDENT[VOI] while retaining the results neces-

sary here, then, it must be stipulated that the conjuncts of local conjunctions of markedness and faithfulness are required to be co-relevant.²⁹

Crowhurst & Hewitt (1997) (see also Hewitt & Crowhurst 1996, Lubowicz 1998) propose to limit co-ordination (of which local conjunction — their constraint disjunction — is a sub-case; see footnote 20) to constraints that share a “primary argument”, “the linguistic object or domain for which violations are assessed when a candidate fails to satisfy the condition specified by the constraint” (Crowhurst & Hewitt 1997:10). This proposal is very similar in spirit to the current co-relevance proposal. However, Crowhurst & Hewitt (1997:56, fn. 42) specifically allow for the *segment* to be a primary argument, making local conjunctions such as * $[+RD]$ &_{*l*} IO-IDENT[HI] — the conjuncts of which are both arguably violated by segments bearing the mentioned features, not necessarily by the features themselves — permissible. But these conjuncts are not co-relevant as required by (43); they do not mention the same feature.

In closing, I should note that the definition of co-relevance might conceivably be extended to cover objects other than features (e.g., units of prosody), or to apply to local conjunctions other than those whose conjuncts are a markedness constraint and a faithfulness constraint. Both of these issues are however beyond the scope of the current investigation.

3.3.7 Summary

In §3.3.1, I described a potential problem with the adopted agreement model of assimilation. When a stem-affixed form faithfulness constraint SA-IDENT[F] is ranked below its input-output faithfulness correlate IO-IDENT[F] which is itself ranked below its agreement counterpart AGREE[F], the left-right symmetry of AGREE[F] and the vertical symmetry of

²⁹ In a more recent paper, Itô & Mester (1999) argue that local conjunctions of markedness and faithfulness can be used to account for certain types of opaque process interaction. The particular local conjunctions that these authors propose are distinctly not co-relevant in the sense defined here, as they themselves explicitly note. How to reconcile these authors' very interesting results with those elaborated here is unfortunately a matter for future research in this area to decide. (I thank Armin Mester for fruitful discussion of this issue.)

IO-IDENT[F] results in a pathological ‘majority rule’ effect. This is repeated from (34) above in (44) below.

(44) Input: $\sqrt{[\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$ Stem: $\sqrt{[\alpha F] \cdot [\alpha F]}$

Candidates	AGREE[F]	IO-IDENT[F]	SA-IDENT[F]
a. $\sqrt{[\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$	* !		*
b. $\sqrt{[\alpha F] \cdot [\alpha F] \cdot [-\alpha F]}$	* !	*	
c. $\sqrt{[\alpha F] \cdot [\alpha F] \cdot [\alpha F]}$		** !	
d. $\sqrt{[-\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$		*	**

The problem is proposed here to be solvable by the theory of local conjunction. Specifically, the local conjunction of co-relevant markedness and faithfulness constraints is guaranteed to correctly circumvent the problematic majority rule effect, as shown in (45).

(45) Input: $\sqrt{[\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$ Stem: $\sqrt{[\alpha F] \cdot [\alpha F]}$

Candidates	AGR[F]	*[- αF] & _I IO-ID[F]	IO-ID[F]	SA-ID[F]
a. $\sqrt{[\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$	* !			*
b. $\sqrt{[\alpha F] \cdot [\alpha F] \cdot [-\alpha F]}$	* !		*	
c. $\sqrt{[\alpha F] \cdot [\alpha F] \cdot [\alpha F]}$			**	
d. $\sqrt{[-\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$		* !	*	**

As discussed in §3.3.5, the choice of $[\alpha F]$ as the unmarked value of the harmonic feature and coincidentally as its underlying value in the root vowel is slightly misleading here, since the optimal candidate appears to be optimal due to stem control. Consider instead a $[-\alpha F]$ root vowel followed by an $[\alpha F]$ affix vowel; an anti-stem-control candidate is optimal, as shown in (46).

(46) Input: $\sqrt{[-\alpha F] \cdot [\alpha F]}$ Stem: $\sqrt{[-\alpha F]}$

Candidates	AGR[F]	*[- αF] & _I IO-ID[F]	IO-ID[F]	SA-ID[F]
a. $\sqrt{[-\alpha F] \cdot [\alpha F]}$	* !			
b. $\sqrt{[-\alpha F] \cdot [-\alpha F]}$		* !	*	
c. $\sqrt{[\alpha F] \cdot [\alpha F]}$			*	*

This result is due to the fact that the local conjunction solution to the majority rule problem predicts assimilation to the unmarked in the absence of stem control. Stem control is absent under this ranking because SA-IDENT[F] is ranked below the pertinent local conjunction; since $[\alpha F]$ is the unmarked value of [F] by hypothesis, the result is assimilation to this unmarked value. This result holds regardless of the relative percentages of marked and unmarked values of [F] in the input, as shown in (47).

(47) Input: $\sqrt{[-\alpha F] \cdot [\alpha F] \cdot [-\alpha F]}$ Stem: $\sqrt{[\alpha F] \cdot [\alpha F]}$

Candidates	AGR[F]	*[- αF] & _I IO-ID[F]	IO-ID[F]	SA-ID[F]
a. $\sqrt{[-\alpha F] \cdot [\alpha F] \cdot [-\alpha F]}$	** !			*
b. $\sqrt{[\alpha F] \cdot [\alpha F] \cdot [-\alpha F]}$	* !		*	
c. $\sqrt{[\alpha F] \cdot [\alpha F] \cdot [\alpha F]}$			**	
d. $\sqrt{[-\alpha F] \cdot [-\alpha F] \cdot [-\alpha F]}$		* !	*	**

In §3.4 further below I argue that dominant-recessive vowel harmony is an instance of precisely this assimilation-to-the-unmarked result.

The following is a summary breakdown of the theory of local conjunction, forged during the course of this discussion (cf. (35), page 28).

(48) Local conjunction theory

- a. **Definition:** If A and B are non-conjoined members of the universal constraint set *Con*, then their local conjunction $A \&_I B$ is also a member of *Con*.
 - If $A \in$ markedness and $B \in$ faithfulness, then A and B must be co-relevant. (A markedness constraint μ and a faithfulness constraint ϕ are *co-relevant* iff satisfaction of μ depends in part on the output not containing a particular value of a feature [F], and satisfaction of ϕ depends on the value of the same feature [F] not having changed in the mapping from input to output.)
- b. **Interpretation:** $A \&_I B$ is violated if and only if both its conjuncts A and B are violated in the smallest domain evaluable by A and B.
- c. **Ranking (universal):** $A \&_I B \gg \{A, B\}$.
 - Preservation: The local conjunction of a constraint C with a subhierarchy $\{A \gg B \gg \dots \gg Z\}$ yields the subhierarchy $\{A \&_I C \gg B \&_I C \gg \dots \gg Z \&_I C\}$.

3.3.8 Two alternative solutions

3.3.8.1 Preamble

Lombardi (1996a, 1999) notes the same majority rule problem with respect to a parallel situation in her analysis of voicing assimilation in obstruent clusters, and proposes her own solution to it. In what follows I review the relevant case Lombardi discusses and her solution to the majority rule problem, as well as another possible solution that emerges from other work on the question of featural faithfulness. These two solutions to the majority rule problem are rejected based on their inadequacy relative to the local conjunction solution with which they are contrasted.

3.3.8.2 Voicing assimilation in Yiddish

Voicing assimilation is typically controlled by an obstruent that is tautosyllabically released into a sonorant (Lombardi 1991, 1995a).³⁰ I follow Lombardi in referring to this position as an *onset*, to be contrasted with a *coda*. (These positions are not to be confused with the more familiar sub-syllabic category namesakes with which they do not necessarily coincide). For instance, in Yiddish (Katz 1987, Lombardi 1996ab, 1999), word-final obstruents contrast in voicing, but adopt a following word-initial obstruent's value of this feature in compounds.³¹

(49) Obstruent clusters in Yiddish (Katz 1987:29-30)

- a. [+VOI]_{Coda} [-VOI]_{Onset} → [-VOI]_{Coda} [-VOI]_{Onset}
- | | | | |
|----------|-------------|--------------|------------------------|
| [vɔg] | 'weight' | [vɔkʃɔl] | 'scale' |
| [briv] | 'letter' | [brifʃregər] | 'mailman' |
| [ajz] | 'ice' | [ajskastn] | 'icebox' |
| [ʃantaʃ] | 'blackmail' | [ʃantaʃʃrik] | 'blackmailing tactics' |
- b. [-VOI]_{Coda} [+VOI]_{Onset} → [+VOI]_{Coda} [+VOI]_{Onset}
- | | | | |
|--------|---------|---------------|------------------|
| [bak] | 'cheek' | [bagbejn] | 'cheekbone' |
| [bux] | 'book' | [buygəʃeft] | 'bookstore' |
| [zis] | 'sweet' | [zizvarg] | 'candy products' |
| [kɔp] | 'head' | [kɔbvejtik] | 'headache' |
| [vajʃ] | 'far' | [vajdzeəvdik] | 'farsighted' |

³⁰ See Steriade 1997 for an alternative view and method of analysis.

³¹ Lombardi (1996ab, 1999) specifically demonstrates that voicing assimilation is independent of word- or syllable-final neutralization of voicing (cf. Mester & Itô 1989, Cho 1990, Lombardi 1991, 1995a).

Following Lombardi (1996ab, 1999), I assume that the constraint responsible for onset control in voicing assimilation is an onset-specific faithfulness constraint that I will refer to here as ONS-IDENT[VOI], defined in (50) below. ONS-IDENT[VOI] is in relevant respects analogous to the stem-affixed form faithfulness constraints I assume to be responsible for stem control.³² When sufficiently high-ranked, ONS-IDENT[VOI] is responsible for onset-controlled voicing assimilation, just as SA-IDENT[F] is responsible for stem-controlled vowel harmony.

(50) ONS-IDENT[VOI]

An onset segment in the output must have the same value of the feature [VOI] as its input correspondent.

The constraint AGREE[VOI] enforces voicing assimilation due to its rank above IO-IDENT[VOI]; no matter where the onset-specific faithfulness constraint ONS-IDENT[VOI] is ranked with respect to these two, it decides in favor of assimilation to the onset.

(51) Input: [-VOI] [+VOI]

Candidates	AGREE[VOI]	IO-ID[VOI]	ONS-ID[VOI]
a. [-VOI] _{Cod} [+VOI] _{Ons}	* !		
b. [+VOI] _{Cod} [+VOI] _{Ons}		*	
c. [-VOI] _{Cod} [-VOI] _{Ons}		*	* !

There are obstruent clusters, however, in which neither obstruent is an onset and thus to which ONS-IDENT[VOI] is technically inapplicable. Take, for instance, final clusters created by affixation of a suffix consisting of a single obstruent to an obstruent-final root. If either of the obstruents is underlyingly voiceless, the cluster surfaces as voiceless.³³

³² Beckman (1995, 1997, 1998), following suggestions originally made by McCarthy & Prince (1994ab, 1995) and Selkirk (1994, 1995), proposes that stem control is due to more homologous *root-specific* faithfulness constraints as opposed to the merely analogous stem-affixed form faithfulness constraints that I am assuming here. There is an important empirical reason to reject Beckman's analysis of stem control; see Chapter 2, §2.4 for detailed discussion.

³³ There are unfortunately no examples in Yiddish of a voiced obstruent suffix. Lombardi (1999:294-295) claims that this gap is "more or less expected [...] [s]ince such suffixes would always devoice" — but this is clearly not the case. Such a suffix is expected to devoice *only* when attached to a root with a final voiceless obstruent; since word-final voicing is otherwise contrastive in Yiddish (see (49)), it is expected to faithfully surface voiced in all other contexts. There also seem to be no examples of final voiced clusters, polymorphemic or otherwise, but Lombardi provides one from Serbo-Croatian, which is otherwise parallel to Yiddish: [grozd] 'bunch of grapes'.

(52) Final obstruent clusters in Yiddish (Katz 1987:127-131)³⁴

[+VOI] [-VOI] → [-VOI] [-VOI]
 [zɔg] ‘say! (familiar)’ [zɔkt] ‘say! (formal)’ [gəzɔkt] ‘said’

Since ONS-IDENT[VOI] is irrelevant in final clusters, it cannot be the constraint that breaks the tie between the two potential AGREE[VOI]-satisfying candidates. Lombardi instead attributes assimilation to voicelessness to an independently-motivated markedness constraint against voiced obstruents, *[+VOI].³⁵ This is depicted in (53).

(53) Input: [+VOI] [-VOI]

Candidates	AGR[VOI]	IO-ID[VOI]	ONS-ID[VOI]	*[+VOI]
a. [-VOI] [+VOI]	* !			*
b. [+VOI] [+VOI]		*		** !
c. [-VOI] [-VOI]		*		

*[+VOI] cannot be ranked just anywhere; it must be crucially ranked with respect to both of the faithfulness constraints. For example, ONS-IDENT[VOI] must dominate *[+VOI] to account for assimilation of a voiceless coda to a voiced onset, as shown in (54) (cf. (51)).

(54) Input: [-VOI] [+VOI]

Candidates	AGR[VOI]	IO-ID[VOI]	ONS-ID[VOI]	*[+VOI]
a. [-VOI] _{Cod} [+VOI] _{Ons}	* !			*
b. [+VOI] _{Cod} [+VOI] _{Ons}		*		**
c. [-VOI] _{Cod} [-VOI] _{Ons}		*	* !	

IO-IDENT[VOI] must also dominate *[+VOI] in order to account for the fact that single voiced obstruents (i.e., not in clusters) are generally contrastive, as shown in (55). (The fact that ONS-IDENT[VOI] dominates *[+VOI] is not sufficient to account for this fact, since the voicing contrast obtains in codas as well as onsets. The potentially extraneous violation of ONS-IDENT[VOI] is therefore indicated in the tableau by a parenthesized asterisk.)

³⁴ The first example here could also be glossed as ‘I say’ and the second example could also be glossed as ‘you say (singular formal)’, ‘s/he says’, or ‘you say (plural)’. I chose the imperative glosses arbitrarily.

³⁵ Lombardi’s constraint is called ‘*Lar’, amounting to the same thing in this particular circumstance. I ignore the distinction between obstruent and sonorant voicing here; hence *[+VOI] instead of, e.g., *[-SON, +VOI].

(55) Input: [+VOI]

Candidates	AGR[VOI]	IO-ID[VOI]	ONS-ID[VOI]	*[+VOI]
a. [+VOI]				*
b. [-VOI]		* !	(*)	

The significant insight behind this proposal is that it is *markedness* that decides between two AGREE[VOI]-satisfying candidates when ONS-IDENT[VOI] is irrelevant. In other words, in the absence of onset-control, there is assimilation to the unmarked — assimilation to voicelessness (recall §3.3.5 above; see also §3.4.3 below). This seems to be the correct result in general: there is never assimilation to the marked voicing value [+VOI] when ONS-IDENT[VOI] is irrelevant.

Nevertheless, the ranking in (55) predicts that in a string of three or more obstruents in final position (that is, when ONS-IDENT[VOI] is irrelevant) what will emerge will not depend on markedness, but rather on the relative percentages of [+VOI] and [-VOI] in the input. Take an input with three final obstruents, as in (56), two of which are voiced (the first two here, but this detail is technically irrelevant). A faithful rendition of this input fatally violates AGREE[VOI], as shown by (56a); the two remaining candidates are left to be compared by IO-IDENT[VOI], which prefers one change from the unmarked [-VOI] to the marked [+VOI] (56b) than two changes from the marked [+VOI] to the unmarked [-VOI] (56c).

(56) Input: [+VOI] [+VOI] [-VOI]

Candidates	AGR[VOI]	IO-ID[VOI]	ONS-ID[VOI]	*[+VOI]
a. [+VOI] [+VOI] [-VOI]	* !			**
b. [+VOI] [+VOI] [+VOI]		*		***
c. [-VOI] [-VOI] [-VOI]		** !		

This is of course the same majority rule problem noted for vowel harmony. The only significant difference is that a positional faithfulness constraint like ONS-IDENT[VOI] can simply be irrelevant in contexts where a phonological alternation is visible (e.g., word-

finally with consonantal suffixation) whereas a stem-affixed form faithfulness constraint can only be made inactive by low ranking (because of its morphological derivation-dependent definition).

As Lombardi (1996a, 1999) notes, no phonological process is known to work in this way, caring one way or the other about the relative percentages of feature values in the input. Lombardi proposes to avoid this erroneous prediction by redefining featural faithfulness constraints. Any such redefinition has consequences beyond the case at hand, of course, and in what follows I review two potential candidates for the redefinition of featural faithfulness constraints and reject them based on their respective adverse consequences compared to the proposed local conjunction solution to the majority rule problem.

3.3.8.3 Forcing the tie

The logic of Lombardi's own proposal runs as follows: it is the lack of a tie on IO-IDENT[VOI] that yields the wrong result in (56); therefore, this constraint — or, more generally, all featural faithfulness constraints — must be redefined such that there *is* a tie in this case. To this end, Lombardi (1999:296) proposes that violations of featural faithfulness constraints should be calculated such that “any change in feature association returns a single violation mark”, assuming that the voicing of obstruent clusters is autosegmentally represented as shown in (57).³⁶

(57) Featural faithfulness violation (adapted from Lombardi 1999:296)

Input: One IO-IDENT[VOI] violation each for these candidate outputs:
 / g d s / g t s k d s k t s g d z
 \ / | | | \ | /
 [+VOI] [+VOI] [+VOI] [+VOI] [+VOI]

The basic idea, as Lombardi (1999:296) writes, is that “any change in the underlying associations of the [voice] autosegment constitutes a violation” of IO-IDENT[VOI]. Losing an

³⁶ To avoid cluttering the representations, I represent voiced obstruents as linked to a [+VOI] autosegment and voiceless ones as unlinked. Lombardi assumes that [voice] is necessarily privative in just this way, but for independent reasons that do not fundamentally affect the point under discussion.

association, as in the first two candidate outputs, losing them both, as in the third, and adding one (or more), as in the fourth, all constitute a single change in the eyes of this faithfulness constraint. The result, as desired, is for the candidate comparison in (56) to be corrected as shown in (58).

(58) Input:

/ g d s /
 \ /
 [+VOI]

Candidates	AGR[VOI]	IO-ID[VOI]	ONS-ID[VOI]	*[+VOI]
a. g d s \ / [+VOI]	* !			**
b. g d z \ / [+VOI]		*		*** !
c. g k t s [+VOI]		*		

The intended result in this particular case is clear, but there is at least one unintended consequence of this proposal that must be addressed. If it really is the case that IO-IDENT[VOI] is violated exactly once by any number of changes in voicing in a cluster, then a bizarre situation is predicted. Consider a hypothetical language with no post-consonantal [g], with alternations showing that potential sequences of C[g] are neutralized to C[k]. Underlying C/g/ is thus dealt with by devoicing, due to the ranking of a hypothetical markedness constraint *C[g] above both of the faithfulness constraints to voicing, ONS-IDENT[VOI] and IO-IDENT[VOI].

On the other hand, IO-IDENT[VOI] dominates *[+VOI], ensuring a voicing contrast otherwise. In this language, then, [k] and [g] contrast post-vocally (or initially), but this contrast is neutralized in favor of [k] post-consonantly. This is shown by the following tableaux.

(59) Input: / pa • ka /

Candidates	*C[g]	IO-ID[VOI]	ONS-ID[VOI]	*[+VOI]
a. ^{ESP} pa • ka				
b. pa • ga		* !	* !	*

Input: / pa • ga /

Candidates	*C[g]	IO-ID[VOI]	ONS-ID[VOI]	*[+VOI]
c. pa • ka		* !	* !	
d. ^{ESP} pa • ga				*

When *C[g] is irrelevant — that is, in the post-vocalic context — the faithfulness constraints ensure a contrast between hypothetical morpheme-initial /k/ and /g/, as shown above. In the post-consonantal environment, *C[g] kicks in and neutralizes this contrast, as shown below.

(60) Input: / pat • ka /

Candidates	*C[g]	IO-ID[VOI]	ONS-ID[VOI]	*[+VOI]
a. ^{ESP} pat • ka				
b. pat • ga	* !	*	*	*

Input: / pat • ga /

Candidates	*C[g]	IO-ID[VOI]	ONS-ID[VOI]	*[+VOI]
c. pat • ka		*	*	
d. ^{ESP} pat • ga	* !			*

The bizarre case comes about in forms with an obstruent cluster, one member of which is underlyingly /g/ and the other member of which is also voiced (note that the other member of the clusters considered in (60) is voiceless). The expected outcome is devoicing of the /g/ and faithful emergence of the other member of the cluster. But this is not the result under Lombardi's proposal. Since any number of changes in voicing in the cluster receive only one violation of IO-IDENT[VOI], what is predicted is devoicing of the entire cluster! This is shown in (61) below.

(61) Input:

/ p a d • g a /
 |
 [+VOI]

Candidates	*C[g]	IO-ID[VOI]	ONS-ID[VOI]	*[+VOI]
a. p a d • g a [+VOI]	* !			**
b. ^{ESP} p a d • k a [+VOI]		*	*	* !
c. ^{ESP} p a t • k a [+VOI]		*	*	

A faithful rendition of the cluster fatally violates *C[g], as shown by the candidate in (61a); the /g/ must devoice. Given this, there are two relevant candidates left to consider: what should be the actual output in (61b), in which the other obstruent remains voiced, and the output in (61c), in which the both obstruents are devoiced. Both of these latter two candidates involve a change in voicing; the first involves a change in one segment, the second involves a change in two. But under Lombardi's proposal in (57), this integral distinction is as irrelevant in this case as it needs to be in (58); therefore, (61c) is expected to win — contrary to expectations — because it has no voiced obstruents and therefore escapes an unnecessary violation of *[+VOI].

The situation concocted above is hypothetical, but what is at stake here is not a specific empirical weakness of Lombardi's proposal in (57); rather, it is the broader implications of the kinds of typological predictions that the proposal makes. A featural contrast in one segment should not depend at all on the neutralization of that same contrast in another segment — unless, of course, there is assimilation for that feature generally in the language. This 'contrast dependency' problem is at least as significant as the majority rule problem that the proposal in (57) is designed to solve.³⁷ Unless the proposal can

³⁷ The contrast dependency problem might be called a 'parasitic emergence of the unmarked' effect, a bizarre subcase of McCarthy & Prince's (1994a) more general 'emergence of the unmarked' effects.

somehow be purged of this unintended consequence while retaining the desired result in (58), it must be rejected for this reason.

3.3.8.4 Feature value faithfulness

In the context of the proposal just reviewed, Lombardi (1996a, 1999) alludes to so-called MAX[F] constraints, on which see Lombardi 1995b, 1998ab, Causley 1997, Myers 1997 and Walker 1997, among others.³⁸ In the Correspondence theory of faithfulness, MAX is a constraint that requires input elements to have output correspondents; MAX[F] would thus be a constraint that requires an underlying instance of [F] to be preserved in the output. MAX[F] constraints must of course require *feature value identity*, not just featural preservation.³⁹ One way to achieve this is to assume that (some) features are privative, such that binary distinctions like “voiced” vs. “voiceless” are captured by the presence vs. absence, respectively, of some monovalent feature [VOI] (see Lombardi 1991 *et seq.* and references therein on the privativity of [VOI]).⁴⁰ Thus, MAX[VOI] would require preservation of voicing, while the counterpart constraint DEP[VOI] would require preservation of voicelessness by penalizing output instances of [VOI] with no underlying correspondents.

This is the second candidate for the redefinition of featural faithfulness constraints to consider: one which distinguishes between, e.g., voiced-to-voiceless and voiceless-to-voiced input-output mappings. To avoid various technical problems with the specifics of the MAX[F]/DEP[F] approach (for instance, the fact that additional constraints

³⁸ See also Archangeli & Pulleyblank 1993, Itô, Mester, & Padgett 1993, 1995, Kirchner 1993, Myers 1994, Pulleyblank 1993, 1996 and many others on the analogous PARSE[F] constraints of pre-Correspondence OT.

Linda Lombardi (p.c.) informs me that an earlier-circulated version of Lombardi 1996a has more explicit discussion of how her forced-tie proposal can be implemented with MAX[F] constraints.

³⁹ This is because imperfect correspondence — e.g., between [αF] and [-αF], or even between [αF] and [βG] — is still, strictly speaking, correspondence. (See Baković 1999 and numerous references therein on imperfect correspondences with respect to segments.) This is of course not the intent of anyone who adopts MAX[F] constraints, but it is an indication that there are some fundamental differences between segmental faithfulness and featural faithfulness regardless of the intended parallelism of the constraints adopted to account for them.

⁴⁰ Lombardi (1998a:21) notes a positive consequence of the MAX[F] approach to laryngeal phonology: faithfulness to voicelessness (an instance of what is noted in the voicing privativity literature as “reference to [-voice]”) cannot be achieved, since MAX[VOI] “would not be violated by voicing an underlying voiceless consonant.” This is of course true, but DEP[VOI] (see immediately below) can be used to regulate faithfulness to voicelessness, as Lombardi does in the very next paper in the same volume (Lombardi 1998b).

are needed to prevent features from freely floating around, on which see Itô, Mester, & Padgett 1993, 1995, Myers 1994, 1999, among others), I consider instead the proposal found in Pater 1999, McCarthy & Prince 1995, 1999, and Butska 1998, among others — equivalent in presently relevant respects to the MAX[F]/DEP[F] approach — in which the featural faithfulness constraints that have so far become familiar are redefined as in (62a) (cf. (7a); the definition of Correspondence in (62b) remains the same as in (7b)).

(62) Feature value faithfulness in Correspondence theory

- a. IDENT[αF]
If a segment in S₁ is [αF], then its correspondent in S₂ is also [αF].
- b. *Correspondence*: Given two strings S₁ and S₂, **correspondence** is a relation \mathfrak{R} from the elements of S₁ to those of S₂. Elements α ∈ S₁ and β ∈ S₂ are referred to as **correspondents** of one another when α \mathfrak{R} β.

For every feature [F] there are two IDENT[αF] constraints, IDENT[+F] and IDENT[-F], the former penalizing any change from [+F] to [-F] and the latter penalizing any change in the opposite direction, from [-F] to [+F].⁴¹ The majority rule problem is avoided under this proposal by taking the symmetry out of featural faithfulness. When positional and/or stem-affixed form faithfulness is not at stake, the ‘trigger’ of assimilation is determined by the relative ranking of IO-IDENT[+F] and IO-IDENT[-F]. If IO-IDENT[+F] dominates IO-IDENT[-F], then it is preferable to maintain any underlying [+F] specifications on the surface, regardless of how many [-F] specifications need to be changed in order to ensure agreement. If IO-IDENT[-F] dominates IO-IDENT[+F], on the other hand, it is preferable to maintain any [-F] specifications and any number of [+F] specifications may be sacrificed in order to achieve assimilation. This is shown in (63) for the case of voicing assimilation in obstruent clusters.⁴²

⁴¹ Butska (1998) specifically argues for the necessity of this distinction with respect to voicing assimilation, though not for any of the reasons under discussion here.

⁴² As indicated by the dotted line between them, AGREE[VOI] and IO-IDENT[-VOI] cannot be definitively ranked with respect to each other, since there is no evidence in the facts under consideration that crucially depends on this ranking.

(63) Input: [+VOI] [+VOI] [-VOI]

Candidates	AGR[VOI]	IO-ID[-VOI]	IO-ID[+VOI]	*[+VOI]
a. [+VOI] [+VOI] [-VOI]	* !			**
b. [+VOI] [+VOI] [+VOI]		* !		***
c. \varnothing [-VOI] [-VOI] [-VOI]			**	

The input considered here is the same as the one considered in (58), with two voiced obstruents and a voiceless one. The faithful candidate in (63a) violates top-ranked AGREE[VOI] and is thus ruled out. This leaves the usual two assimilated candidates, (63b) and (63c), the former being the majority rule, assimilation-to-the-marked candidate and the latter being the desired assimilation-to-the-unmarked candidate. The former correctly loses to the latter, due to the former's single but fatal violation of higher-ranked IO-IDENT[-VOI] compared to the latter's double but irrelevant violation of lower-ranked IO-IDENT[+VOI].

This is the correct result, but it is bought at a serious price. As mentioned earlier, the fundamental insight behind Lombardi's analysis is that when positional considerations are not at stake, there is predicted to be assimilation to the unmarked. This prediction can at best only be stipulated assuming feature value faithfulness. For instance, in this particular case it must be stipulated that IO-IDENT[-VOI] universally dominates IO-IDENT[+VOI] in order to avoid generating the unattested pattern of assimilation to the marked [+VOI] when onset faithfulness is irrelevant. Such a universal ranking stipulation would in effect duplicate the independently necessary role of markedness, with significant explanatory loss.⁴³

3.3.8.5 Local conjunction

Under the local conjunction solution to the majority rule problem proposed further above, the local conjunction necessary in the case of Yiddish is *[+VOI] & IO-IDENT[VOI], result-

⁴³ See Beckman 1995, 1996 for a similar argument regarding the relative ranking of featural alignment constraints.

ing in the candidate comparison and evaluation shown in (64) below (cf. (58) and (63) above).

(64) Input: [+VOI] [+VOI] [-VOI]

Candidates	AGR[VOI]	*[+VOI] & _L IO-ID[VOI]	IO-ID[VOI]	*[+VOI]
a. [+VOI] [+VOI] [-VOI]	* !			**
b. [+VOI] [+VOI] [+VOI]		* !	*	***
c. \varnothing [-VOI] [-VOI] [-VOI]			**	

The local conjunction solution incorporates all of the benefits and none of the drawbacks of the other two solutions just reviewed.

Like the forced tie approach, the local conjunction solution correctly predicts assimilation to the unmarked when ONS-IDENT[VOI] (or SA-IDENT[F], in the case of vowel harmony) is irrelevant (or low-ranked). But because the local conjunction solution does not rely on the essentially representational device of the forced tie approach (57), there is no contrast dependency between the members of an obstruent cluster (or a word, in the case of vowel harmony) that would give rise to anything like the bizarre 'parasitic emergence of the unmarked' pattern noted in §3.3.8.3.

Like the feature value faithfulness approach, the result of the local conjunction solution is that the choice between the two possible candidates that survive AGREE[F] never actually falls to the problematically symmetrical IO-IDENT[F]. However, the independently-motivated ranking preservation component of the theory of local conjunction (48c) automatically predicts the necessary assimilation to the unmarked result without having to resort to the universal ranking stipulation that is necessary in the case of the feature value faithfulness approach, as noted in §3.3.8.4.

In sum, the local conjunction solution to the majority rule problem is clearly to be preferred to either of the other two solutions reviewed above.

3.4 Dominance

3.4.1 Examples

Stem-controlled vowel harmony systems are by far the better-known examples of vowel harmony. In such systems, the harmonic feature value of a word is systematically determined by a vowel in the stem of affixation. In the less well-known examples of dominant-recessive vowel harmony systems, the harmonic feature value of a word seems to be determined not by a particular morpheme or class of morphemes but rather by the underlying presence of a vowel in any morpheme with a particular value of the harmonic feature. Thus, in a dominant-recessive vowel harmony system, vowels in the stem of affixation may in some cases change to agree with an affix vowel in an anti-stem-controlled, or anti-cyclic, manner.

One example of a dominant-recessive vowel harmony system comes from Kalenjin (Tucker 1964, Hall et al. 1974, Clements 1976a, Halle & Vergnaud 1981, Lieber 1987, Ringen 1988a, Archangeli & Pulleyblank 1994, Lodge 1995, Local & Lodge 1996). The vowel inventory of Kalenjin is given in (65).

(65) Kalenjin vowel inventory

	[+ATR]		[-ATR]	
[+HI, -LO]	i	u	ɪ	ʊ
[-HI, -LO]	e	o	ɛ	ɔ
[-HI, +LO]		ɐ		ɑ
	[-BK]	[+BK]	[-BK]	[+BK]

In general, Kalenjin words consist exclusively of [+ATR] vowels or of [-ATR] vowels. The presence of a [+ATR] ‘dominant’ vowel anywhere in the word requires all other vowels in the word to be [+ATR]; otherwise, all vowels surface with their underlying ‘recessive’ value of [-ATR]. Examples are given in (66) below.

(66) Kalenjin dominant-recessive harmony (adapted from Hall et al. 1974:247)

a.	/ kɪ • ɑ • √ker /	→	kɪager
	DIST. PAST • 1SG • shut		‘I shut it’
b.	/ kɪ • ɑ • √ker • in /	→	kɪegerin
	DIST. PAST • 1SG • see • 2SG		‘I saw you (sg.)’
c.	/ kɪ • ɑ • √ker • e /	→	kɪegere
	DIST. PAST • 1SG • shut • NONCOMPL.		‘I was shutting it’

The example in (66a) is a word with all [-ATR] vowels underlyingly, and it surfaces as such. The [-ATR] recessive root /√ker/ ‘shut’ is replaced with the [+ATR] dominant root /√ker/ ‘see’ in (66b), causing all the other vowels in the word to shift to [+ATR]. The same is shown in (66c); here, it is the [+ATR] dominant noncompletive suffix /e/, affixed to the all-recessive stem in (66a), that causes the shift of all vowels — including the root vowel — to [+ATR].

Another example comes from Diola Fogy (Sapir 1965, Ringen 1975). In this language, words also generally consist exclusively of [+ATR] vowels or of [-ATR] vowels. The vowel inventory of Diola Fogy is identical to that of Kalenjin, except that instead of having [ɐ] as the [+ATR] counterpart of the [-ATR] low vowel [ɑ], Diola Fogy has [ɤ], which Sapir (1965:6) transcribes as [ə] and describes as “a tense unrounded high-mid central vowel [under stress]; otherwise [i.e., when unstressed—EB] it takes a slightly lower position which is similar to the English schwa.” Just as in Kalenjin, the presence of a [+ATR] vowel anywhere in the word requires all other vowels in the word to be [+ATR]; otherwise, all vowels surface with their underlying value of [-ATR]. This is shown by the following examples.

(67) Diola Fogy dominant-recessive harmony (adapted from Sapir 1965:12)

a.	/ ni • √baj • en • ʊ /	→	nɪbajenu
	1SG • have • CAUS • 2PL		‘I have caused you to have’
b.	/ ni • √jitum • en • ʊ /	→	nɪjitumenu
	1SG • lead away • CAUS • 2PL		‘I have caused you to be lead away’
c.	/ ni • √baj • ul • ʊ /	→	nɪɤjulu
	1SG • have • from • 2PL		‘I have from you’

The example in (67a) is a word with all [-ATR] vowels underlyingly, and thus it surfaces faithfully. The [-ATR] recessive root / $\sqrt{\text{bqj}}$ / ‘have’ is replaced with the [+ATR] dominant root / $\sqrt{\text{jitum}}$ / ‘lead away’ in (67b), causing all the other vowels in the word to shift to [+ATR]. The same is shown in (67c); here, it is the [+ATR] dominant ‘towards the speaker’ suffix /ul/ (abbreviated to ‘from’ in the interlinear gloss), replacing the recessive causative suffix / ϵn / in (67a), that causes the shift of all vowels — again, including the root vowel — to [+ATR].

3.4.2 Dominance as assimilation to the unmarked

The essence of the dominant-recessive pattern of vowel harmony is the fact that the assimilation is to a particular value of the harmonic feature. Recall from §3.3.5 that well-established assumptions about the theory of markedness within OT coupled with the ranking preservation component of the theory of local conjunction (see (48c) above) together make the strong prediction that this ‘particular value’ of the harmonic feature is the *unmarked* value. So, for the dominant-recessive harmony systems of Kalenjin and Diola Fogy to be properly analyzed as assimilations to the unmarked, the ‘dominant’ [+ATR] value of the harmonic feature [ATR] must be the unmarked one.

As discussed in §3.3.5, the assimilation-to-the-unmarked pattern results from the low rank of the relevant input-output and stem-affixed form faithfulness constraints (in the case of Kalenjin and Diola Fogy, IO-IDENT[ATR] and SA-IDENT[ATR]). The pertinent agreement constraint (AGREE[ATR]) and an appropriate local conjunction of markedness and faithfulness conspire to always prefer the candidate with assimilation to [+ATR] when assimilation is necessary — that is, when the vowels of a word underlyingly disagree in terms of [ATR]. Otherwise, faithfulness to both values of [ATR] prevails. The one remaining question is the identity of the ‘appropriate’ local conjunction of markedness and faithfulness that selects assimilation to [+ATR], given the usual choice granted by the left-right symmetry of AGREE[ATR].

What is needed is a local conjunction with the effect of *[-ATR] &_l IO-IDENT[ATR], violated by an input-output mapping from [+ATR] (unmarked) to [-ATR] (marked). The intended effect is shown by the evaluation in (68) of a simple bimorphic form with a [-ATR] recessive root and a [+ATR] dominant suffix. The faithful realization of this input, shown in (68a), is summarily disposed of by undominated AGREE[ATR]. The candidate in (68b), with assimilation to the marked [-ATR] value of the stem, is ruled out by the equally undominated local conjunction, *[-ATR] &_l IO-IDENT[ATR]. This leaves the candidate in (68c), with assimilation to the unmarked, as the winner — despite its violation of SA-IDENT[ATR].

(68) Input: $\sqrt{[-ATR]} \bullet [+ATR]$ Stem: $\sqrt{[-ATR]}$

Candidates	AGR[ATR]	*[-ATR] & _l IO-ID[ATR]	IO- ID[ATR]	SA- ID[ATR]
a. $\sqrt{[-ATR]} \bullet [+ATR]$	* !			
b. $\sqrt{[-ATR]} \bullet [-ATR]$		* !	*	
c. $\sqrt{+ATR]} \bullet [+ATR]$			*	*

This ranking thus properly defines dominant-recessive harmony systems like those of Kalenjin and Diola Fogy, in which all vowels in a word assimilate to any vowel of the word that bears the dominant — understood here as unmarked — value of the harmonic feature.

It is important to note, however, that one cannot necessarily make a claim about the markedness of the values of the feature [ATR] in isolation; in general, there is very little in the way of evidence for the relative markedness of individual feature values.⁴⁴ Nevertheless, it is striking that the class of dominant vowels in dominant-recessive harmony systems is almost always characterized by one value of the harmonic feature; namely, [+ATR].⁴⁵ I propose to make sense of this fact by claiming that the class of dominant

⁴⁴ Recall from footnote 35 that the markedness of the apparently individual feature value [+VOI] has been claimed to hold for obstruents only; that is, *[+VOI] is really just an abbreviation of something more like *[-SON, +VOI].

⁴⁵ A systematic exception to this generalization, Nez Perce, is confronted in Chapter 5.

vowels in a given language is characterized by its relative unmarkedness within the entire vowel system of the language. As is well known and understood (see in particular Archangeli & Pulleyblank 1994:172ff), the values of [ATR] are typically marked or unmarked in combination with particular values of other features. For instance, non-high [+ATR] and non-low [-ATR] vowels tend to be marked by virtue of the combination of articulatorily antagonistic feature values. As Hall & Hall (1980:207) note:⁴⁶

“[A]s the tongue root is moved forward [in the implementation of [+ATR] — EB], the tongue body is compressed and therefore raised. Conversely, as the tongue root is retracted [in the implementation of [-ATR] — EB], the tongue body is pulled down and therefore lowered.”

Given these considerations, I propose that the local conjunction responsible for the dominance of [+ATR] vowels in so many dominant-recessive vowel harmony systems is *not* *[-ATR] &_t IO-IDENT[ATR], with a single-feature markedness conjunct violated by [-ATR] vowels in general. Rather, I claim that the constraint is *[-LO, -ATR] &_t IO-IDENT[ATR], with a multiple-feature markedness conjunct violated only by antagonistically-specified [-LO, -ATR] vowels. The empirical impact of this choice is subtle but significant. Unlike the more general *[-ATR], the more specific *[-LO, -ATR] is not violated by a [+LO, -ATR] vowel, regardless of its (un)faithfulness. This means that the local conjunction *[-LO, -ATR] &_t IO-IDENT[ATR] is not violated by a change from a [+LO, +ATR] vowel [ɐ] to a [+LO, -ATR] vowel [ɑ]. The net result is that a [+LO, +ATR] vowel is predicted never to be dominant, as shown by the tableau in (69).

The typological fact that dominant-recessive harmony always seems to involve [ATR] as opposed to any other vowel feature is to my knowledge not explained, nor explainable, by any theory of assimilation. I will not make any vain attempts to make sense of this fact here; but see §3.4.3 below. I thank the respondents to an electronic query I posted on the Optimal List and the LINGUIST List — Roderic Casali in particular — for their help in cataloging a representative set of examples of dominant-recessive harmony (the results of the query are summarized at <http://linguistlist.org/issues/9/9-776.html>).

⁴⁶ This passage is also cited by Archangeli & Pulleyblank (1994:175).

(69) Input: $\sqrt{[-ATR]} \bullet [+LO, +ATR]$ Stem: $\sqrt{[-ATR]}$

Candidates	AGR [ATR]	*[-LO, -ATR] & _t IO-ID[ATR]	IO- ID[ATR]	SA- ID[ATR]
a. $\sqrt{[-ATR]} \bullet [+LO, +ATR]$	* !			
b. $\sqrt{[-ATR]} \bullet [+LO, -ATR]$			*	
c. $\sqrt{[+ATR]} \bullet [+LO, +ATR]$			*	* !

This tableau is identical to the one in (68) above except that the local conjunction is now the proposed *[-LO, -ATR] &_t IO-IDENT[ATR] rather than *[-ATR] &_t IO-IDENT[ATR], and the [+ATR] suffix vowel is now more specifically specified as [+LO, +ATR] underlyingly. These changes have a significant effect: since the new local conjunction is not violated by the change from [+LO, +ATR] to [+LO, -ATR] in candidate (69b), this stem-controlled candidate emerges as the winner in this case. Compare this with the result given a [-LO, +ATR] affix vowel, as shown in (70) below. Now the assimilation-to-the-unmarked candidate in (70c) is optimal, just as in (68) above, due to the relevance of the local conjunction to the stem-controlled candidate in (70b).

(70) Input: $\sqrt{[-ATR]} \bullet [-LO, +ATR]$ Stem: $\sqrt{[-ATR]}$

Candidates	AGR [ATR]	*[-LO, -ATR] & _t IO-ID[ATR]	IO- ID[ATR]	SA- ID[ATR]
a. $\sqrt{[-ATR]} \bullet [-LO, +ATR]$	* !			
b. $\sqrt{[-ATR]} \bullet [-LO, -ATR]$		* !	*	
c. $\sqrt{[+ATR]} \bullet [-LO, +ATR]$			*	*

As it happens, many languages with dominant-recessive harmony, like Diola Fogy, have no [+LO, +ATR] vowel in their inventory (due to an undominated *[-LO, +ATR] constraint, on which see Chapters 3, 4, and 5), making this distinction irrelevant in those cases. (Recall that the [-ATR] low vowel [ɑ] alternates with a [+ATR] *mid* vowel [ɤ] in Diola Fogy.) Kalenjin has [+LO, +ATR] vowels, but only as a result of assimilation to a [+ATR] (dominant) vowel; in other words, it is a fact of Kalenjin that there are no dominant low vowels. Whether this is also true of other languages with [+LO, +ATR] vowels and dominant-recessive harmony remains to be thoroughly investigated; the one example I am aware of

at this time, Lango (Woock & Noonan 1979, Noonan 1992, Archangeli & Pulleyblank 1994, Smolensky 1997, Nowak 1999), appears to be just like Kalenjin in this regard. I take this fact to be significantly non-accidental and therefore maintain that the relevant local conjunction for languages with [+ATR] dominant vowels is indeed the one with the multiple-feature markedness conjunct, *[-LO, -ATR] &, IO-IDENT[ATR].⁴⁷

This attack on the problem of the indeterminable relative markedness of the individual values of [ATR] is further supported by the fact that one of the (very few) languages with [-ATR] dominance, Nez Perce (see Chapter 5), independently requires *[-LO, -ATR] &, IO-IDENT[ATR] to be low ranked in order to account for its relatively impoverished vowel inventory.

3.4.3 Other features?

As noted in footnote 45, it is a typological fact that dominant-recessive vowel harmony always seems to involve [ATR] as opposed to any other vowel feature. However, the assimilation-to-the-unmarked pattern, of which dominant-recessive vowel harmony is but a sub-case, is not limited to vowel harmony. As discussed in §3.3.8, it is also apparent in the voicing assimilation pattern found in Yiddish word-final obstruent clusters, where ONS-IDENT[VOI] is irrelevant. A more robust example is the general voicing assimilation pattern found in Swedish (Sigurd 1965, Hellberg 1974), referred to by Lombardi (1996a, 1999) as ‘bidirectional devoicing’ (see also Butska 1998).

Because it is often onset-controlled (see §3.3.8), voicing assimilation is typically regressive in intervocalic obstruent clusters. But in the case of Swedish, as Hellberg (1974:144) puts it, “voicing assimilation functions in the fashion of a so-called mirror-image rule, i.e., a voiced obstruent is devoiced by an adjacent voiceless obstruent, regardless of whether the latter precedes or follows the former.” Examples are given in (71).

⁴⁷ See Chapter 2, §3.2 for further discussion of (the implications of) this claim.

(71) Swedish bidirectional devoicing (adapted from Lombardi 1999:285)

- a. Regressive assimilation to voicelessness
- | | | | | |
|-------------------|------------|---|------------------------------------|---------------------|
| <i>hö</i> g [g] | ‘high’ | ~ | <i>hö</i> gtid [kt] | ‘festival’ |
| <i>vi</i> ga [g] | ‘to marry’ | ~ | <i>vi</i> gsel [ks] | ‘marriage’ |
| <i>klä</i> da [d] | ‘to dress’ | ~ | <i>klä</i> d ^h sel [ts] | ‘dressing’ |
| <i>sko</i> g [g] | ‘forest’ | ~ | <i>sko</i> g ^h s [ks] | ‘forest (genitive)’ |
- b. Progressive assimilation to voicelessness
- | | | | | |
|--------------------|-------------|---|---|---------------|
| <i>br</i> and [b] | ‘fire’ | ~ | <i>sko</i> g ^h br ^h and [ksp] | ‘forest fire’ |
| <i>da</i> g [d] | ‘day’ | ~ | <i>ti</i> sda ^h g [st] | ‘Tuesday’ |
| <i>-de</i> [d] | (preterite) | ~ | <i>sy</i> lde [d] | ‘covered’ |
| <i>lä</i> ste [st] | ‘read’ | ~ | <i>ste</i> kte [kt] | ‘fried’ |
- c. Voiced clusters: no change
- | | | | | |
|------------------|------------|---|--------------------|----------|
| <i>ä</i> ga [g] | ‘to own’ | ~ | <i>ä</i> gde [gd] | ‘owned’ |
| <i>vä</i> ve [v] | ‘to weave’ | ~ | <i>vä</i> vde [vd] | ‘weaved’ |

The first three examples in (71a) are what one usually finds in languages with voicing assimilation: regressive assimilation to the onset obstruent. The last example in (71a) also shows regressive assimilation, but neither obstruent in this cluster is an onset, so assimilation must be to the voicelessness of the final obstruent (as in Yiddish; see (52)). This is confirmed by the examples in (71b), where there is clearly progressive assimilation of voiced onset obstruents to the voicelessness of the other member(s) of the cluster. The examples in (71c) show that this is in fact assimilation and not a general restriction on the voicing of obstruent clusters; if both members of the cluster are underlyingly voiced, then the cluster emerges voiced in the output.

Because voicing assimilation is not necessarily onset-controlled in Swedish, ONS-IDENT[VOI] (the onset-specific faithfulness constraint responsible for onset control in voicing assimilation; see (50)) must be properly subordinated, exactly like SA-IDENT[ATR] must be subordinated in Kalenjin and Diola Fogy. The constraint that ONS-IDENT[VOI] must crucially be outranked by is the local conjunction *[+VOI] &, IO-IDENT[VOI], as shown in (72) below.

(72) Input: [-VOI] [+VOI]

Candidates	AGR[VOI]	*[+VOI] & _l IO-Id[VOI]	IO- Id[VOI]	ONS- Id[VOI]
a. [-VOI] _{Cod} [+VOI] _{Ons}	* !			
b. [+VOI] _{Cod} [+VOI] _{Ons}		* !	*	
c. [-VOI] _{Cod} [-VOI] _{Ons}			*	*

The input in (72) is an obstruent cluster, a voiceless obstruent followed by a voiced obstruent, and it is assumed that the second member is to be an onset in the output. The three candidates are a faithful rendition of the input in (72a), an onset-controlled candidate with assimilation of the voiceless coda to the voicing of the onset in (72b), and an assimilation-to-the-unmarked candidate with assimilation of the voiced onset to the voicelessness of the coda in (72c). The faithful candidate fatally violates the undominated AGREE[VOI] constraint, and the onset-controlled candidate fatally violates the undominated local conjunction *[+VOI] &_l IO-IDENT[VOI]. This leaves the assimilation-to-the-unmarked candidate, as desired.

What this example shows is that not only can the onset-specific faithfulness constraint ONS-IDENT[VOI] be inherently irrelevant, as in the final clusters of Yiddish discussed in §3.3.8, it can also be so low ranked that it is made irrelevant to the evaluation of intervocalic clusters, as in Swedish. Furthermore, the ‘bidirectional devoicing’ pattern of Swedish proves to be nothing other than the voicing-assimilation equivalent of the dominant-recessive vowel harmony pattern.

3.5 Summary

In the more familiar examples of vowel harmony, a vowel in an affix changes to agree in terms of the harmonic feature with an adjacent vowel in the stem to which the affix is attached. Such examples of vowel harmony are known as stem-controlled, and I propose here to analyze stem-controlled vowel harmony in terms of stem-affixed form faithfulness constraints. Given a choice between stem-to-affix and affix-to-stem assimilation

candidates, both satisfying left-right symmetrical agreement, stem-affixed form faithfulness decides in favor of stem-to-affix assimilation.

An apparent problem with the proposed account of stem-controlled vowel harmony arises when one considers input forms with uneven ratios of the harmonic feature values. If stem-affixed form faithfulness is lower ranked than input-output faithfulness, then an effect dubbed ‘majority rule’ emerges. Majority rule is a pathological consequence of the vertical symmetry of input-output faithfulness, whereby an arbitrarily better-represented harmonic feature value overrules the other value, resulting in assimilation of the latter to the former rather than vice-versa. If a stem vowel happens to be specified with the under-represented value, then stem control is subverted in favor of majority rule — an unattested situation.

I propose to circumvent the majority rule effect by invoking the local conjunction of co-relevant markedness and faithfulness constraints. A local conjunction of this type is asymmetrically violated by a mapping from an unmarked feature value to a marked one, and is universally ranked above its conjuncts — its faithfulness conjunct in particular — thereby heading off the apparent problem induced by the symmetry of faithfulness.

This solution to the majority rule problem yields the successful description of an attested assimilation pattern, assimilation to the unmarked. This pattern corresponds to the less well-known examples of dominant-recessive vowel harmony, in which vowel harmony is controlled not necessarily by the stem of affixation but rather by any vowel, stem or affix, that happens to be specified in the input for the ‘dominant’ value of the harmonic feature. This dominant value is claimed to be the unmarked value of the harmonic feature.

4. Overview of the Dissertation

The following is an overview of the remaining chapters of this dissertation.

Chapter 2: Factorial Typology

¶ In this chapter I demonstrate in detail the specific empirical predictions made by the different possible interactions of the constraints that constitute the core of the agreement model of assimilation. The stem-affixed form faithfulness approach to stem-controlled vowel harmony is elucidated with Turkish serving as the primary example, and the local conjunction approach to dominant-recessive vowel harmony is further examined with more detailed analyses of Kalenjin and Diola Fogny. Another potential account of stem control, root-specific faithfulness (Beckman 1995, 1996, 1998) is also considered, contrasted with the stem-affixed form faithfulness approach, and rejected in this chapter.

Chapter 3: [ATR] Harmony and Stem Control

¶ Yoruba has an [ATR] harmony system that is complicated both by its relatively small seven-vowel inventory and by the scarcity of evidence for complex morphological structure in many words that nevertheless exhibit right-to-left directionality of the harmony process. In this chapter I follow many Yoruba scholars in claiming that apparently monomorphemic words in Yoruba are really polymorphemic and that the morphology is strictly prefixal; the apparent right-to-left directionality of [ATR] harmony is thus a reflection of stem control. This analysis obviates the extraneous underspecification and directionality devices used in most recent analyses of Yoruba harmony (Archangeli & Pulleyblank 1989, 1994).

Chapter 4: [+ATR] Dominance and Residual Stem Control

¶ The dominant-recessive harmony systems of Maasai and Turkana differ from those of Kalenjin and Diola Fogny. Like Diola Fogny, Maasai and Turkana lack a direct [+ATR] counterpart of the [+LO, -ATR] vowel [ɑ], but unlike Diola Fogny the

behavior of this recessive vowel depends on its position relative to a dominant vowel and the root. If the dominant vowel is closer to the root than an underlying /ɑ/, then the /ɑ/ becomes the [+ATR] mid vowel [o]. (This much is similar to Diola Fogny, in which [ɑ] alternates with [ɔ].) If the dominant vowel is further from the root than /ɑ/, on the other hand, then the /ɑ/ remains [-ATR], surfacing as [ɑ] and blocking further propagation of [+ATR] harmony. I argue in this chapter that this ambiguous behavior of /ɑ/ is a case of what I call *residual stem control*: stem-affixed form faithfulness for features other than [ATR] is not subvertible in Maasai and Turkana. The proposed analysis is contrasted with (and shown to be superior to) an analysis in terms of two separate harmony processes, the conditions and directions of application of which arbitrarily differ independently of each other (Archangeli & Pulleyblank 1994, Albert 1995, McCarthy 1997a).

Chapter 5: [-ATR] Dominance and Vowel Transparency

¶ In this chapter I address a couple issues that may at first seem to be recalcitrant under the proposed agreement model: [-ATR] dominance and vowel transparency. A few languages with dominant-recessive harmony have [-ATR] as the dominant value rather than [+ATR]. Nez Perce is one of the better-known examples of such a language. I argue that the dominance of [-ATR] as opposed to [+ATR] in Nez Perce may be due to markedness relations that are needed to define the small five-vowel inventory of the language. Nez Perce also has what is known as a *transparent vowel*: the high [+ATR] vowel [i] freely co-occurs with either [-ATR] or [+ATR] vowels, resulting in a double violation of AGREE[ATR] when this vowel is flanked by [-ATR] vowels. Several other more familiar languages with vowel harmony have vowels of this sort, a phenomenon which seems to attest to the non-local nature of vowel harmony (and assimilation more generally). I offer a novel analysis of vowel transparency in which the doubly-violated constraint

AGREE[ATR] plays an unexpectedly central role in selecting the optimal candidate. This analysis provides further support for the strictly local view of assimilation upheld in this dissertation.

Chapter 6: Concluding Remarks

¶ In this chapter I summarize the theoretical results of the preceding chapters with specific attention paid to those devices of most current theories of assimilation — autosegmental representations and underspecification — that I have found completely dispensible throughout the dissertation. The chapter and the dissertation end with the conclusion that these devices are not only dispensible but should be dispensed with, given that the explanatory burden once believed to be necessarily borne by these devices has been shown here to fall squarely on the shoulders of violable constraint interaction in Optimality Theory.

CHAPTER TWO FACTORIAL TYPOLOGY

1. Introduction

The grammars of two languages are *distinct* if the two sets of input-output mappings defined by each grammar differ from each other in any way. Thus, the two hypothetical languages discussed in Chapter 1, §2 have distinct grammars because one maps the universal set of inputs /u,o,a/ onto the proper subset of outputs [o,a] while the other maps the universal set of inputs onto a different proper subset of outputs, [u,a].¹ The set of distinct grammars predicted by the different possible rankings of some set of constraints is often referred to as the *typology* of predicted grammars; given that the number of different possible rankings of n constraints is $n!$ (*'n-factorial'*), the set of distinct partial rankings of constraints that define a typology is referred to as a *factorial typology*.

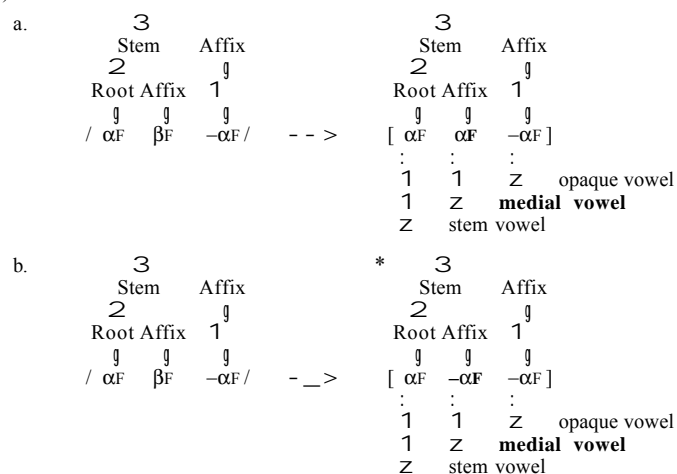
In this chapter I explore the factorial typology defined by the interactions among various members of the constraint families of the agreement model of assimilation; as outlined in Chapter 1, these are agreement, input-output faithfulness, markedness, stem-affixed form faithfulness, and the local conjunction of co-relevant markedness and faithfulness. Each 'slot' in the factorial typology is exemplified here by relevant facts from various languages.

I begin in §2 with the subset of the factorial typology necessary for stem-controlled vowel harmony. The fundamental constraint ranking schema necessary for basic stem control is established first, followed by the introduction and alternative rankings of additional constraints that account for several important variations on the basic stem control theme. I also argue in this section for the stem-affixed form faithfulness account

¹ In fact, the second of these two languages was itself shown in Chapter 1, §2.4 to be definable by two distinct grammars, depending on the fate of the 'missing' faithful input-output mapping /o/ → [o], which could be replaced by either of the unfaithful input-output mappings /o/ → [u] or /o/ → [a].

of stem control as opposed to an account based on root-specific faithfulness (Beckman 1995, 1997, 1998). The main argument is an empirical one, based on a universal fact about stem-controlled vowel harmony systems concerning the behavior of words with necessarily disharmonic vowels, referred to as *opaque* vowels. The fact is that any vowel in an affix between a stem vowel and an opaque affix vowel always harmonizes with the former and never with the latter, a situation schematized in (73).²

(73) Universal behavior of the medial vowel



Note that the vowel under dispute, dubbed the ‘medial vowel’, is not a root vowel, but it *is* a stem vowel with respect to the opaque affix vowel. In §2 I show how the stem-affixed form faithfulness account of stem control correctly predicts that the medial vowel harmonizes with the adjacent stem vowel rather than with the opaque vowel in these situations, while the root-specific faithfulness account is unable to ensure this prediction.

² The fact that the affixes are represented here as suffixes as opposed to prefixes is completely arbitrary. Also, the ‘stem vowel’ here needn’t be a root vowel; it only need be a vowel *closer to the root* than the medial vowel.

I focus on the subset of the factorial typology responsible for the dominant-recessive vowel harmony pattern in §3. In this section I elucidate the essential analytical role played by the local conjunction of co-relevant markedness and faithfulness constraints. The structure of this section mirrors that of §2 fairly closely, in order to facilitate comparison of the parallel results attained in each; one small difference is that a couple of slots in this subset of the factorial typology are here left empirically unfilled until they are directly addressed in Chapter 4.

2. Stem Control is Stem-Affixed Form Faithfulness

2.1 Introduction

In stem-controlled vowel harmony systems, the harmonic feature value of a vowel in a morpheme further from the root — a *more peripheral* morpheme — depends on the harmonic feature value of a vowel in an adjacent morpheme closer to the root — a *less peripheral* morpheme, the least peripheral morpheme possible being the root itself. In this section, I argue that stem-controlled harmony is best accounted for within the proposed model with stem-affixed form faithfulness or SA-IDENT[F] constraints.

2.2 Essentials of stem control

2.2.1 Contrast and its neutralization

A language is not said to have vowel harmony unless the two values of the harmonic feature are somehow distinguished on the surface. Consider for a moment a language in which all vowels are [+F]. Such a language can be said to have vowel harmony in terms of [F] since all vowels do in fact surface with the same value of [F]; to wit, [+F]. But such a statement is of course vacuous, since the fact that the vowels all have the same value of [F] is not due to vowel harmony but to a language-wide neutralization of the potential contrast between the values of [F]. At the heart of any vowel harmony system, then, there must somehow be a surface distinction between the two values of the harmonic feature [F].

Technically, it doesn't matter whether this surface distinction arises contrastively or non-contrastively; we will stick to contrastively arising distinctions here because a contrast between the two values of the harmonic feature is usually necessary (particularly in the case of stem control).³ It is this contrastive distinction that determines which harmonic feature value is propagated from a vowel in a less peripheral morpheme to a vowel in a more peripheral morpheme in a stem-controlled vowel harmony system. Take the accusative suffix in Turkish from Chapter 1, §1.1, repeated in (74) with additional examples.

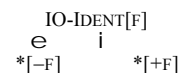
- (74) Turkish accusative suffix
- $\sqrt{\text{el}} \cdot \text{i}$ 'hand (accusative)'
 - $\sqrt{\text{kul}} \cdot \text{u}$ 'slave (accusative)'
 - $\sqrt{\text{jyz}} \cdot \text{y}$ 'face (accusative)'
 - $\sqrt{\text{d3am}} \cdot \text{u}$ 'glass (accusative)'

The two values of each of the harmonic features [BK] and [RD] clearly contrast in Turkish, allowing a four-way contrast among the vowels in the roots of (74) and a resultant four-way alternation in the vowel of the accusative suffix which is dependent on the root contrast.

Recall from Chapter 1, §2 that a contrast between the values of a feature [F] can only arise if the constraint demanding faithfulness to [F] dominates any single-feature markedness constraints against the different values of [F]. Since a contrast between the two values of the harmonic feature underlies stem control, IO-IDENT[F] must outrank both *[-F] and *[+F] in any language with stem-controlled vowel harmony in terms of [F].

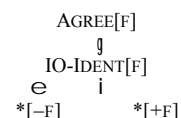
³ An example of a non-contrastive featural distinction that gives rise to vowel harmony comes from Javanese (Dudas 1976, Archangeli 1995, Benua 1996). In Javanese, vowels in closed syllables are [-ATR] while vowels in open syllables are [+ATR]; a [-ATR] vowel in a closed syllable causes a vowel in an adjacent open syllable to become [-ATR], under certain well-defined conditions that differ from dialect to dialect (see the references cited for details). Such cases of non-contrastive vowel harmony involve high ranking *contextual markedness* constraints (in the case of Javanese, a constraint against [+ATR] vowels in closed syllables), which play a central role in the analysis of the complementary distribution situation that defines the very non-contrastiveness of the harmonic feature. The addition of such contextual markedness constraints easily accounts for this class of cases (see Benua 1996); I do not show this here in the interests of maintaining a more manageable factorial typology.

- (75) Basic contrast ranking for [F]



Vowel harmony itself is the neutralization of the basic contrast established by this constraint ranking due to the further ranking of AGREE[F] over IO-IDENT[F], as shown in (76).

- (76) Basic contrast and harmony ranking for [F]



2.2.2 Basic stem control

As discussed at length in Chapter 1, AGREE[F] is equally satisfied by two candidates, one with all [-F] vowels and the other with all [+F] vowels. The choice between these two potentially optimal candidates must somehow consistently be made in favor of the harmonic feature value of the stem of affixation in order to correctly describe stem-controlled vowel harmony.

This seems to be guaranteed so long as SA-IDENT[F], like IO-IDENT[F], dominates both of the markedness constraints *[-F] and *[+F], as shown in (77) below. The input is a root vowel specified as [-F] and an affix vowel counter-specified as [+F]. AGREE[F] is violated by a faithful rendition of this input; to satisfy this constraint, either the root vowel or the affix vowel must assimilate to the other. IO-IDENT[F] is equally violated by these two AGREE[F]-satisfying alternatives; the decision between them then falls to SA-IDENT[F], regardless of its ranking with respect to AGREE[F] and IO-IDENT[F].

- (77) Input: $\sqrt{[-F]} \cdot [+F]$

Candidates	AGR[F]	IO-ID[F]	Stem: $\sqrt{[-F]}$		
			SA-ID[F]	*[-F]	*[+F]
a. $\sqrt{[-F]} \cdot [+F]$	* !			*	*
b. $\sqrt{[-F]} \cdot [-F]$		*		**	
c. $\sqrt{[+F]} \cdot [+F]$		*	* !		**

It would seem, therefore, that simply introducing stem-affixed form faithfulness and ranking it above markedness achieves the desired result for stem control. However, as noted in some detail in Chapter 1, §3.3, a potential problem arises when one considers an input consisting of more than two vowels. The problem, as the reader may recall, is that the harmonic feature value that happens to be better represented in the input will conspire to make all vowels agree with it — if IO-IDENT[F] dominates SA-IDENT[F]. This is shown in (78).

(78) Input: $\sqrt{[-F] \cdot [+F] \cdot [+F]}$ Stem: $\sqrt{[-F] \cdot [-F]}$

Candidates	AGR[F]	IO-ID[F]	SA-ID[F]	*[-F]	*[+F]
a. $\sqrt{[-F] \cdot [+F] \cdot [+F]}$	* !		*	*	**
b. $\sqrt{[-F] \cdot [-F] \cdot [+F]}$	* !	*		**	*
c. $\sqrt{[-F] \cdot [-F] \cdot [-F]}$		** !		***	
d. $\sqrt{[+F] \cdot [+F] \cdot [+F]}$		*	**		***

This apparent problem was argued in Chapter 1, §3.3 to be best dealt with by assuming that there exist local conjunctions of co-relevant markedness and faithfulness constraints, and that these must be universally higher-ranked than their conjuncts — the symmetrical faithfulness conjunct in particular. If either or both of the local conjunctions dominates stem-affixed form faithfulness, then the result is a dominant-recessive vowel harmony system, as demonstrated in Chapter 1, §3.4 and in considerably more detail in §3 further below. In order to maintain stem control, then, the stem-affixed form faithfulness constraint SA-IDENT[F] must also dominate both of the two logically possible local conjunctions, *[-F] & IO-IDENT[F] and *[+F] & IO-IDENT[F]. This is all shown in the following tableau.⁴

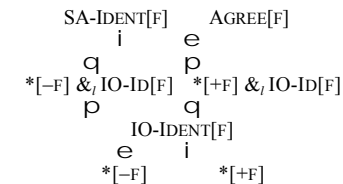
⁴ The lowest-ranked markedness constraints *[-F] and *[+F] are left out of this tableau for reasons of space.

(79) Input: $\sqrt{[-F] \cdot [+F] \cdot [+F]}$ Stem: $\sqrt{[-F] \cdot [-F]}$

Candidates	AGR[F]	SA-ID[F]	*[-F] & IO-ID[F]	*[+F] & IO-ID[F]	IO-ID[F]
a. $\sqrt{[-F] \cdot [+F] \cdot [+F]}$	* !	* !			
b. $\sqrt{[-F] \cdot [-F] \cdot [+F]}$	* !		*		*
c. $\sqrt{[-F] \cdot [-F] \cdot [-F]}$			**		**
d. $\sqrt{[+F] \cdot [+F] \cdot [+F]}$		** !		*	*

AGREE[F] must also dominate both local conjunctions in order to ensure that AGREE[F] will force any vowel, regardless of its underlying specification of [F], to change to the opposite value if such is necessary for the greater agreement-satisfying good.⁵ The minimal schematic ranking necessary for basic stem control is thus as given in (80).

(80) Schematic ranking for basic stem control



As discussed in Chapter 1, §3, these proposed local conjunctions of co-relevant markedness and faithfulness constraints is crucial to the analysis of dominant-recessive vowel harmony, the topic of §3 further below. The role of local conjunctions in the analysis of stem control is thus henceforth generally disregarded in this section, where it is otherwise not so crucial. The frequently and predictably violated, lowest-ranked markedness constraints are also in general ignored to streamline the discussion.

2.2.3 The scope of stem-affixed form faithfulness

2.2.3.1 What is a stem?

I assume that SA-IDENT[F] constraints apply to stem-affixed form pairings in which the stem of affixation may or may not be — and in some cases quite clearly is not — an inde-

⁵ I return to this specific point in §4.2 further below.

pendently occurring surface form of the language in question.⁶ This contrasts with Benua's (1997ab) hypothesis that stem-affixed form correspondence relations only hold between independently occurring surface forms (see also Kenstowicz 1996 and Baković 1998), hence Benua's reference to 'output-output' relations as opposed to the more neutral 'stem-affixed form' relations referred to here. While these two positions seem to be mutually inconsistent, they may yet be reconciled. I cite here references to a couple of independent cases in which the letter of Benua's hypothesis is similarly threatened but with respect to which the spirit of it can still be maintained.

2.2.3.2 Paradigmatic uniformity

It has often been noted that the members of an inflectional paradigm in languages with obligatory inflectional affixation frequently exhibit some non-accidental identity. This 'paradigmatic uniformity' is arguably (and I think quite plausibly) an effect of stem-affixed form faithfulness (see also Kiparsky 1982, Burzio 1996, 1997, Kenstowicz 1996, 1997, Steriade 1996, 1998, 1999, to appear, among others). This seems to pose a serious problem for the strongest form of Benua's hypothesis, since the stem of affixation in such paradigms is not an independently occurring surface form. Nevertheless, Benua (1997:235ff) persuasively argues that it is not necessary to recognize such inflectionally-bound stems as the actual stems of affixation with which other inflected forms are in correspondence. Rather, the members of an inflectional paradigm can be in direct correspondence with one another, and the fact that they surface with distinct inflectional affixes can be attributed to independent morphological considerations. Benua cites a couple of examples that show that this type of 'inter-paradigmatic' correspondence must at least be possible: a member of an inflectional paradigm may exhibit phonological properties that can only be properly attributed to another, inflected member of the paradigm.

⁶ I thank John McCarthy for comments on this general issue.

2.2.3.3 A reversal of expectations

Bobaljik (1997) notes that in the language Itelmen, stem-affixed form correspondence seems to be required to describe a faithfulness relationship between obligatorily inflected verbs and their non-occurring stems of affixation. This much is just the type of case cited above, an example of paradigmatic uniformity. What is different and interesting about Itelmen is that the same faithfulness relationship *fails* to hold between non-obligatorily inflected nouns and *their* stems of affixation, which *do* surface independently. This seems to be a problem for the strong form of Benua's hypothesis because it is the exact opposite of what is naively expected: faithfulness between independently occurring surface forms and the lack thereof otherwise.⁷ But this naive expectation is clearly unnecessary. The observed faithfulness effect in the Itelmen verbal system can be attributed to the relatively high rank of the relevant stem-affixed form faithfulness constraints specific to verbal paradigms — 'inter-paradigmatic' faithfulness constraints of the kind alluded to above — and the lack of faithfulness between noun stems and their derivatives can be attributed to the relatively *low* rank of the relevant stem-affixed form faithfulness constraints specific to the nominal system.⁸ Benua (1997ab) recognizes distinct stem-affixed form correspondence relations of this kind in her account of the differences between Level 1 and Level 2 affixation in English; see Chapter 4 for discussion of another example of this kind.

2.2.3.4 Conclusion

It should be clear from the discussion above that there are ways to allow correspondence to hold between an affixed form and its non-occurring stem of affixation without violating the spirit of Benua's hypothesis that such correspondence relations should not be pos-

⁷ I should note that Bobaljik uses this example to specifically argue against Kenstowicz's (1996) 'Base Identity' theory, which shares with Benua's theory the hypothesis that stem-affixed form correspondence relations hold only between independently occurring surface forms. It is this shared hypothesis that is the crux of Bobaljik's argument, and so I continue the discussion as if any other distinctions between Kenstowicz's and Benua's theories were non-existent.

⁸ These stipulated ranking statements are explanatorily equivalent to Bobaljik's proposed stipulation that the phonology of the Itelmen verbal system is cyclic while that of the nominal system is non-cyclic.

sible. How exactly the results I aim for under my assumption can be held up while still recognizing Benua's results under the opposing hypothesis is a matter somewhat beyond the scope of this dissertation, and must be left for future research in this area.

2.3 Opaque vowels

One must put up barriers to keep oneself intact.
Rush — Limelight

2.3.1 Behavior

An opaque vowel is an obstinately disharmonic vowel, one that for some reason or other cannot bear one of the two values of the harmonic feature. This reason can be either predictably phonological or idiosyncratically morphological. For instance, there is a general condition in Turkish (referred to as 'Condition C' in Chapter 1, §1.1) such that non-initial [-HI] vowels cannot be [+RD]. [-HI] vowels are thus opaque to [RD] harmony, as shown in (81a). This is an example of phonologically predictable opacity. And as shown in (81b), the vowel of the Turkish progressive suffix must be [+BK, +RD] and is hence opaque to both [BK] and [RD] harmony.⁹ This is an example of morphologically idiosyncratic opacity.

(81) Opaque vowels in Turkish

- a. Phonologically predictable: non-initial [-HI] vowels
- i. $\sqrt{\text{el}} \cdot \text{ler}$ 'hand (plural)'
 - ii. $\sqrt{\text{kul}} \cdot \text{lar}$ 'slave (plural)' (* $\sqrt{\text{kul}} \cdot \text{lor}$)
- b. Morphologically idiosyncratic: the progressive suffix
- i. $\sqrt{\text{gel}} \cdot \text{mi} \cdot \text{jor}$ 'come (negative-progressive)' (* $\sqrt{\text{gel}} \cdot \text{mi} \cdot \text{jer}$)
 - ii. $\sqrt{\text{dur}} \cdot \text{mu} \cdot \text{jor}$ 'stand (negative-progressive)'

⁹ The progressive suffix in Turkish surfaces as [jor] after vowel-final stems but with a preceding (and fully harmonic) [+HI] vowel after consonant-final stems (Underhill 1976:111ff). The roots in (81b) are consonant-final, so I add the vowel-final negative suffix to abstract away from this vowel ~ zero alternation. See §2.3.3 for more discussion of this point. Stem-final vowels also raise before the progressive suffix (Underhill 1976:111-112); for instance, the [+HI] vowel of the negative suffix here is usually (i.e., underlyingly) [-HI] (Underhill 1976:57).

Note also that the vowel of the progressive suffix is a non-initial [-HI, +RD] vowel, in violation of the generalization that non-initial [-HI] vowels cannot be [+RD] (i.e., 'Condition C'). I return to this point in §2.3.1.2.

2.3.1.1 Phonologically predictable opacity

The phonologically predictable cases, of which examples abound in vowel harmony systems, are fairly straightforward. Opaque vowels of this kind typically reflect gaps in the language's vowel inventory that are due to multiple-feature markedness constraints. In the case of Turkish, this constraint is the one responsible for the absence of [-HI, +RD] in the non-initial inventory; to wit, *[-HI, +RD].¹⁰ This is shown in (82) below with the example from (81a.ii); the opaque vowel of the plural suffix is perversely assumed to be a [-HI, +RD] vowel to show that it will still not surface as such, in accord with the Richness of the Base hypothesis.

(82) Input: $\sqrt{\text{kul}} \cdot \text{lor}$ 'slave (plural)' Stem: $\sqrt{\text{kul}}$

Candidates	*[-HI, +RD]	AGREE[RD]	IO-IDENT[RD]
a. $\sqrt{\text{kul}} \cdot \text{lor}$	* !		
b. $\sqrt{\text{kul}} \cdot \text{lar}$		*	*

The immediately relevant competition is between candidates (82a) and (82b). The former candidate is [RD]-harmonic (not to mention [RD]-faithful), but critically violates the *[-HI, +RD], which is ranked higher than the conflicting agreement constraint AGREE[RD]. This forces the violation of AGREE[RD] in the disharmonic yet optimal candidate in (82b).

There are two other candidates to consider here that must be properly dispensed with, both of which avoid the *[-HI, +RD] violation of the [RD]-harmonic candidate in (82a) and the AGREE[RD] violation of the disharmonic (and optimal) candidate in (82b). The first such candidate is one in which the would-be opaque vowel's [HI] value is changed, allowing it to agree with the [+RD] vowel of the root. This is because the result is a [+HI,

¹⁰ This constraint was proposed by Kirchner (1993) for Turkish and is further discussed by Kaun (1995) with respect to Turkish and other languages (see also Beckman 1997 on its activity in Shona). Kaun refers to the constraint as *ROLO and attributes its existence to the lesser distinctiveness of lip rounding in non-high vowels (Terbeek 1977, Linker 1982). The 'non-initial' qualification that keeps coming up in this context refers to the fact that [-HI, +RD] vowels [o,ø] are attested in (root-)initial position in Turkish (e.g., [kol] 'arm', [gøz] 'eye'). This regularity is addressed in §2.4 below. (They are also attested in non-initial root syllables of some loanwords (e.g., [pilot] 'pilot'); this irregularity receives no particular attention here.)

+RD] vowel, which obviously does not violate *[-HI, +RD]. To avoid this potential optimum, IO-IDENT[HI] must also dominate AGREE[RD], as shown in (83).

(83) Input: $\sqrt{\text{kul}} \cdot \text{lor}$ ‘slave (plural)’ Stem: $\sqrt{\text{kul}}$

Candidates	*[-HI, +RD]	IO-ID[HI]	AGREE[RD]	IO-ID[RD]
a. $\sqrt{\text{kul}} \cdot \text{lor}$	* !			
b. $\sqrt{\text{kul}} \cdot \text{lar}$			*	*
c. $\sqrt{\text{kul}} \cdot \text{lur}$		* !		

The potentially problematic candidate under discussion is the one in (83c). As shown by the competition between this candidate and the optimal one, a violation of IO-IDENT[HI] is fatal compared to a violation of AGREE[RD]. The candidate in (83c) is representative of a class of candidates that is ubiquitous in vowel harmony systems though usually given short shrift in the literature; I discuss this class of candidates in detail in §2.5 below.

The other way to satisfy both *[-HI, +RD] and AGREE[RD] is to reverse the usual direction of harmony, as it were, and change the [RD] value of the *root* vowel.¹¹ To avoid this potential optimum, SA-IDENT[RD] must also dominate AGREE[RD], as shown in (84).

(84) Input: $\sqrt{\text{kul}} \cdot \text{lor}$ ‘slave (plural)’ Stem: $\sqrt{\text{kul}}$

Candidates	*[-HI, +RD]	SA-ID[RD]	AGREE[RD]	IO-ID[RD]
a. $\sqrt{\text{kul}} \cdot \text{lor}$	* !			
b. $\sqrt{\text{kul}} \cdot \text{lar}$			*	*
c. $\sqrt{\text{ktul}} \cdot \text{lar}$		* !		*

The candidate of interest is the one in (84c), and as shown in the tableau, its violation of SA-IDENT[RD] is fatal compared with the optimal candidate’s violation of AGREE[RD]. This ‘reverse-harmonic’ candidate represents a class of candidates that I discuss in §3, where I review the subset of the factorial typology responsible for dominant-recessive vowel harmony.

¹¹ I thank Hubert Truckenbrodt for originally alerting me to the significance of this class of candidates.

The constraint responsible for the obstinacy of an opaque vowel forces a violation of agreement, but such violation is minimized. A vowel in an affix more peripheral than the opaque vowel affix always agrees with the opaque vowel; significantly, the more peripheral vowel never freely contrasts in terms of the harmonic feature. This is shown in (85).

(85) Turkish opaque vowel agreement

- a. $\sqrt{\text{el}} \cdot \text{ler} \cdot \text{i}$ ‘hand (plural-possessive)’
 b. $\sqrt{\text{kul}} \cdot \text{lar} \cdot \text{tu}$ ‘slave (plural-possessive)’ (* $\sqrt{\text{kul}} \cdot \text{lar} \cdot \text{u}$)

This fact follows from minimal violation of agreement. The opaque vowel of the plural suffix in (85b) necessarily disagrees with the root due to high-ranking *[-HI, +RD], forcing a violation of AGREE[RD] as we have already seen in (82) and (83). However, the [+HI] vowel of the possessive suffix following the plural is not thereby free to also disagree with the adjacent opaque vowel; this would entail an additional, unnecessary, and entirely avoidable violation of AGREE[RD].¹² The crucial comparison is shown in the tableau in (86).

(86) Input: $\sqrt{\text{kul}} \cdot \text{lor} \cdot \text{u}$ ‘slave (plural-poss.)’ Stem: $\sqrt{\text{kul}} \cdot \text{lar}$

Candidates	*[-HI, +RD]	SA-ID[RD]	AGR[RD]	IO-ID[RD]
a. $\sqrt{\text{kul}} \cdot \text{lor} \cdot \text{u}$	* !	* !		
b. $\sqrt{\text{kul}} \cdot \text{lar} \cdot \text{tu}$			*	**
c. $\sqrt{\text{kul}} \cdot \text{lar} \cdot \text{u}$			** !	*

The fully [RD]-harmonic candidate in (86a) is included here merely to emphasize its futility; in this evaluation, it not only violates *[-HI, +RD] but also SA-IDENT[RD], since the [RD] value of the opaque vowel of the plural suffix is fixed as [-RD] in the stem of affixation for the possessive affix. This leaves the two candidates of immediate interest in

¹² So-called transparent vowels are similar to opaque vowels in that they also cannot bear one of the two values of the harmonic feature, but they differ from opaque vowels in that they seem to allow the incompatible value to pass right through them, surfacing with one value while the flanking vowels surface with the opposite value. In such a situation there seem to be two lateral changes in the value of the harmonic feature, one for each transition on either side of the transparent vowel — an apparent affront to strict locality, and an unnecessary additional violation of agreement. Discussion of transparent vowels, which are specially treated here due to their flagrantly non-local appearance, is postponed until Chapter 5.

(86b) and (86c). The former is the optimal candidate, with the possessive suffix vowel in agreement with the opaque plural suffix vowel, thereby violating AGREE[RD] once for the disagreement between the root vowel and the opaque vowel. The latter candidate, with disagreement in both directions, loses due to the second violation of AGREE[RD] that this entails.¹³

In sum, phonologically predictable opaque vowels are the expected result of high-ranking multiple-feature markedness constraints that are independently responsible for gaps in vowel inventories, as originally explicitly proposed by Kiparsky 1981 (see also Seriale 1987, Calabrese 1988, Archangeli & Pulleyblank 1989, 1994, among many, many others). The schematic ranking that accounts for phonologically predictable opacity is given in (87).

(87) Schematic ranking for phonological opacity under stem control



The multiple-feature markedness constraint is represented by * $[\alpha\text{F}, \beta\text{G}]$, which is instantiated in Turkish by * $[-\text{HI}, +\text{RD}]$. The fact that both this constraint and IO-IDENT[G] (in Turkish, IO-IDENT[HI]) outrank AGREE[F] (AGREE[RD]) means that agreement rather than faithfulness will be sacrificed in order not to create a vowel that is not in the language's inventory.

2.3.1.2 Morphologically idiosyncratic opacity

I have nothing too definitive to say about morphologically idiosyncratic opaque vowels; the fact that I refer to them as 'morphologically idiosyncratic' is meant to imply that they defy explanation. A promising possibility is that affixes like the Turkish progressive consistently (and, in this particular case, uniquely) occupy some privileged position in

¹³ Note that this result follows even though the candidates in (86a) and (86c) happen to be faithful to the arbitrarily-specified vowel of the possessive suffix, in accord with the Richness of the Base hypothesis.

morphological or prosodic structure, and that a faithfulness constraint specific to that position (see §2.4 below) is ranked above agreement. This is shown for the Turkish progressive in (88) below.¹⁴

(88) Input: $\sqrt{\text{iste}} \cdot \text{jor}$ 'want (prog.)' Stem: $\sqrt{\text{iste}}$

Candidates	PROG-IDENT[RD]	AGREE[RD]	IO-IDENT[RD]
a. $\sqrt{\text{isti}} \cdot \text{jar}$	* !		*
b. $\sqrt{\text{iste}} \cdot \text{jor}$		*	

The candidate in (88a) is unfaithful to the underlying [RD] value of the progressive morpheme vowel, and consequently violates the postulated positional faithfulness constraint responsible for the disharmonicity of this vowel, a constraint I refer to as PROG-IDENT[RD] (for lack of evidence for the position it might really target). The candidate in (88b) differs in that it is faithful to the underlying [RD] value of the progressive morpheme vowel, but as a consequence violates AGREE[RD]. This comparison reveals that despite its disharmonicity, the latter candidate is the optimal one.

As noted above in the case of phonologically predictable opaque vowels, a vowel in an affix attached more peripherally than a morphologically idiosyncratic opaque vowel affix uniformly agrees with the opaque vowel. As before, this follows from minimal violation of agreement, as shown in the tableau in (89) below.

(89) Input: $\sqrt{\text{iste}} \cdot \text{jor} \cdot \text{im}$ 'want (prog.-1sg.)' Stem: $\sqrt{\text{iste}} \cdot \text{jor}$

Candidates	PROG-ID[RD]	SA-ID[RD]	AGR[RD]	IO-ID[RD]
a. $\sqrt{\text{isti}} \cdot \text{jar} \cdot \text{im}$	* !	* !		*
b. $\sqrt{\text{iste}} \cdot \text{jor} \cdot \text{um}$			*	*
c. $\sqrt{\text{iste}} \cdot \text{jor} \cdot \text{im}$			** !	

¹⁴ I limit the attention to [RD] harmony to minimize expository clutter; what is said for [RD] holds for [BK] here as well. See Odden 1991 and Padgett 1995ab for proposals concerning the unitary behavior of [BK] and [RD].

Recall from fn. 9 that the progressive suffix exhibits syllabically-conditioned allomorphy; I choose a vowel-final root here to maintain focus on the relevant opaque vowel of the suffix. See §2.3.3 below. Note that the final vowel of this root is raised before the progressive, a process noted in fn. 9; other than its honest display in the discrepancy between the input and candidate outputs in (88), I abstract away from this process entirely.

The fully [RD]-harmonic candidate in (89a) is again included here just to highlight its hopelessness, since it not only violates PROG-IDENT[RD] but also SA-IDENT[RD]. This again leaves the two candidates of immediate interest in (89b) and (89c). The former is the optimal candidate, with the first person singular suffix vowel in agreement with the opaque progressive suffix vowel, thereby only violating AGREE[RD] once. The latter candidate, with disagreement both ways, loses due to the second violation of AGREE[RD] that this entails.¹⁵

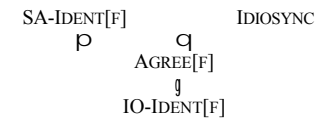
Though perhaps not too terribly enlightening, this analysis of the behavior with respect to vowel harmony of this morphologically idiosyncratic opaque vowel follows from the most plausible analysis of another of its idiosyncrasies. As noted in footnote 9 above, the opaque vowel of this suffix is fairly unique in that it is one of the only non-initial [-HI, +RD] vowels in Turkish. As I show in more detail in §2.4 below, this follows if PROG-IDENT[HI] and PROG-IDENT[RD] dominate *[-HI, +RD] and thus prevent this markedness constraint from incorrectly neutralizing the progressive suffix vowel.¹⁶ Since *[-HI, +RD] in turn dominates AGREE[RD], as shown in §2.3.1.1 above, then PROG-IDENT[RD] also dominates AGREE[RD] by transitivity — the necessary ranking for the desired results just shown in (88) and (89).

The particularities of the Turkish progressive suffix aside, at least the following schematic ranking must hold to account for morphologically idiosyncratic opacity, where IDIOS refers to whatever constraint is responsible for the idiosyncrasy. Any other constraints and their crucial rankings that may come into play depend on the identity of IDIOSYNC.

¹⁵ Note again that this result follows even though the candidates in (89a) and (89c) happen to be faithful to the arbitrarily-specified vowel of the first person singular suffix, in accord with the Richness of the Base hypothesis.

¹⁶ If the more general IO-IDENT[HI] happens to dominate *[-HI, +RD], which is consistent with the rankings otherwise established for these constraints in (83), then the rank of PROG-IDENT[HI] doesn't technically matter.

(90) Schematic ranking for morphological opacity under stem control



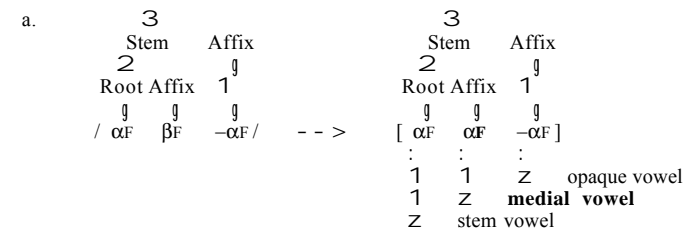
2.3.2 Stem control and the medial vowel

2.3.2.1 Predictable behavior

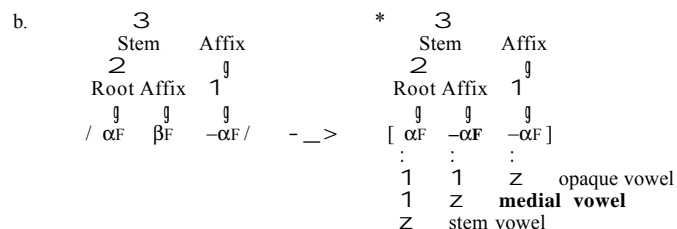
Opaque affix vowels cause agreement violations when the stem of affixation bears the value of the harmonic feature that the opaque vowel cannot bear. In a situation where an affix vowel is caught between an $[\alpha F]$ stem vowel and a $[-\alpha F]$ opaque affix vowel, violation of AGREE[F] seems to be equal whether this medial vowel agrees with the more peripheral opaque vowel or with the less peripheral stem vowel. But not all agreement violations are equal.

The fact is that such medial vowels always agree with the stem vowel and never with the disagreeing opaque vowel, no matter what particular value of the harmonic feature each one bears.¹⁷ This is a universal fact about stem-controlled vowel harmony, and is schematically depicted in (91) below (repeated from (73) above). Agreement is violated in (91a) by the transition from the medial vowel to the opaque vowel; in (91b), the agreement violation is incurred by the transition to the medial vowel from the root vowel (playing the role of the next less peripheral stem vowel, not necessarily the root).

(91) Universal behavior of the medial vowel



¹⁷ The significance of this fact is noted in various different ways by Ringen 1975, Clements 1976a, Anderson 1980, Steriade 1981, and Kirchner 1993, among undoubtedly many others.



As the examples in (92) below show, the conditional suffix in Turkish surfaces as [sej] or [saj]¹⁸ depending on the [BK] value of the vowel in the next less peripheral morpheme (the causative in these examples), but the vowels of both allomorphs of the conditional morpheme are [-RD], as non-initial [-HI] vowels regularly are. The preceding causative morpheme's vowel is thus in principle free to agree either with the [RD] value of the next less peripheral morpheme (here, the root) or with the [RD] value of the following conditional suffix; as (92b,c) show, the latter option is not the case.

(92) Turkish medial vowels with conditional suffix (Gülşat Tosun, p.c.)

- a. √gel • dir • sej • di 'come (caus.-cond.-past)'
- b. √dur • dur • saj • dtu 'stand (caus.-cond.-past)' (*√dur • dur • sej • dtu)
- c. √gyl • dyr • sej • di 'laugh (caus.-cond.-past)' (*√gyl • dir • sej • di)
- d. √atʃ • dtur • saj • dtu 'open (caus.-cond.-past)'

Note that the vowel of the most peripheral past tense morpheme agrees in terms of both harmonic features with the less peripheral opaque vowel of the conditional, as expected.

The same can be shown for the idiosyncratically opaque vowel of the progressive suffix, and in fact already has been in (81b) above; more examples are provided in (93) below. The medial vowel in the negative morpheme is in principle free to agree either with the [BK] and [RD] values of the next less peripheral morpheme (again, the root in these examples) or with the [BK] and [RD] values of the more peripheral progressive suffix (or with one feature value from each, resulting in up to four combinatorial possibilities).

¹⁸ The conditional by itself is just [se] or [sa]; the trailing glide in these examples is specific to the conditional + past combination, which functions as a semantic unit with a counterfactual sense (Underhill 1976:415-416).

As (93a,c,d) show, agreement is with the less peripheral root, not with the more peripheral progressive suffix.

(93) Turkish medial vowels with progressive suffix (adapted from Underhill 1976:27)

- a. √gel • mi • jor • um 'come (neg.-prog.-1sg.)' (*√gel • mu • jor • um)
- b. √dur • mu • jor • um 'stand (neg.-prog.-1sg.)'
- c. √gyl • my • jor • um 'laugh (neg.-prog.-1sg.)' (*√gyl • mu • jor • um)
- d. √atʃ • mu • jor • um 'open (neg.-prog.-1sg.)' (*√atʃ • mu • jor • um)

Note here too that the vowel of the most peripheral first person singular agrees in terms of both harmonic features with the less peripheral opaque vowel of the progressive, as expected.

It should be clear that the universal fate of medial vowels cannot be determined by AGREE[F], since either way this constraint is violated once. On the other hand, the fate of this medial vowel could in principle but should not in fact be determined by input-output faithfulness. If IO-IDENT[F] were to decide, then there would be an emergent contrast predicted in this environment: an underlyingly [αF] affix vowel would surface faithfully, in apparent agreement with the adjacent stem vowel, but an underlying [-αF] affix vowel would also surface faithfully, in apparent agreement with the opaque vowel. Similarly, if one of the local conjunctions of markedness and faithfulness were to decide, then the behavior of the medial vowel would still depend in part on its input specification, which it does not.

It may seem that this problem could be solved by assuming crucial underspecification of affix vowels, with no violation of input-output faithfulness assessed for 'feature-filling' ('structure-building') mappings from input to output. I offer independent arguments against this kind of crucial underspecification in Chapter 6; those arguments aside, however, note that this "solution" merely shifts the problem from faithfulness to markedness: the medial vowel is now expected to agree with whichever adjacent vowel results in the least-marked overall output — another erroneous prediction.

Recall now from (79) above that in order to ensure stem control, SA-IDENT[F] must dominate both of the logically possible co-relevant local conjunctions of markedness with IO-IDENT[F], and that these local conjunctions in turn dominate IO-IDENT[F] by the theory of local conjunction (see Chapter 1, §3.3.7). These independently necessary rankings rule out the possibility of disagreement with a less peripheral adjacent stem vowel in favor of a more peripheral opaque one, correctly predicting that the schematic mapping in (91a), and not the one in (91b), is always optimal in stem-controlled vowel harmony systems.

The reason for this is because of the very claim that stem control is a consequence of stem-affixed form faithfulness. Relative to the more peripheral opaque vowel affix in (91), the next less peripheral medial vowel affix is part of the stem of affixation and is thus subject to stem-affixed form faithfulness. Assume for the sake of argument that the medial vowel is underlyingly specified for the same value of [F] as the opaque vowel, [-αF]. Due to the asymmetry built into the stem-affixed form correspondence relation, the evaluation of the form consisting of the less peripheral root and the medial-vowel affix alone occurs prior to the evaluation of the larger form including the more peripheral opaque-vowel affix. This first evaluation is shown in the tableau in (94).

(94) Input: $\sqrt{[\alpha F]} \cdot [-\alpha F]$ Stem: $\sqrt{[\alpha F]}$

Candidates	AGR[F] !	SA-ID[F]	*[αF] & _r ! IO-ID[F]	*[-αF] & _r ! IO-ID[F]	IO-ID[F]
a. $\sqrt{[\alpha F]} \cdot [-\alpha F]$	* !				
b. $\sqrt{[\alpha F]} \cdot [\alpha F]$			*		*
c. $\sqrt{[-\alpha F]} \cdot [-\alpha F]$		* !		*	*

The high-ranking agreement and stem-affixed form faithfulness constraints conspire to force the affix vowel to agree with the root vowel as in (94b). This optimal output thus

constitutes the stem of affixation for the larger form including the opaque-vowel affix, as shown in (95) below (the opaque vowel affix vowel is indicated with a subscript *o*).¹⁹

(95) Input: $\sqrt{[\alpha F]} \cdot [-\alpha F] \cdot [-\alpha F]_o$ Stem: $\sqrt{[\alpha F]} \cdot [\alpha F]$

Candidates	FIXED	AGREE[F]	SA-ID[F]	IO-ID[F]
a. $\sqrt{[\alpha F]} \cdot [\alpha F] \cdot [\alpha F]_o$	* !			**
b. $\sqrt{[\alpha F]} \cdot [\alpha F] \cdot [-\alpha F]_o$		*		*
c. $\sqrt{[\alpha F]} \cdot [-\alpha F] \cdot [-\alpha F]_o$		*	* !	

The constraint labeled FIXED in this tableau stands for whatever constraint encourages the obstinately inalterable behavior of the opaque vowel (*[-HI, +RD], PROG-IDENT[RD], etc.), which must be ranked above AGREE[F] to force the latter constraint's violation, as already shown in detail in §2.3.1 above. Of the candidates that are left after FIXED has ruled out the harmonic stem-controlled candidate (95a), only candidate (95b), corresponding to (91a) above, is faithful to the values of the harmonic feature in the stem of affixation. Candidate (95c), corresponding to the ungrammatical (91b), is more faithful to the hypothesized input, but input faithfulness is inconsequential to the decision because SA-IDENT[F] dominates IO-IDENT[F]. The independently necessary ranking between stem-affixed form faithfulness and input-output faithfulness thus accounts for the harmonic behavior of vowels in morphemes less peripheral than opaque vowel morphemes.

This ranking does not, however, have anything in particular to say about the harmonic behavior of a medial vowel in the *same* morpheme as an opaque vowel, nor does it say anything about the harmonic behavior of a medial vowel that is epenthesized as a direct result of affixation of a morpheme with an opaque vowel.²⁰ These are discussed in turn below.

¹⁹ Due to space considerations, the local conjunctions of markedness and faithfulness are left out of this tableau; anything noted about input-output faithfulness here also holds for these constraints in this context.

²⁰ I would like to thank everyone at the MIT Phonology Circle on Nov. 2, 1998 for discussion of these cases.

2.3.2.2 Tautomorphemic medial vowels

In the case of a medial vowel in the same morpheme as an opaque vowel, stem-affixed form faithfulness is irrelevant because the medial vowel, being tautomorphemic with the opaque vowel, has no correspondent in this morpheme's stem of affixation. Stem-affixed form faithfulness is silent on the matter, and lower-ranked input-output faithfulness is predicted to emerge with the decision, resulting in an emergent contrast: when caught between two disagreeing vowels, the surface [F]-value of the medial vowel should depend, at least in part, on the value of [F] it is specified for in the input. This is shown in (96).

(96) Input: $\sqrt{[\alpha F]} \bullet [-\alpha F] [-\alpha F]_o$ Stem: $\sqrt{[\alpha F]}$

Candidates	FIXED	AGREE[F]	SA-ID[F]	IO-ID[F]
a. $\sqrt{[\alpha F]} \bullet [\alpha F] [\alpha F]_o$	* !			**
b. $\sqrt{[\alpha F]} \bullet [\alpha F] [-\alpha F]_o$		*		* !
c. $\sqrt{[\alpha F]} \bullet [-\alpha F] [-\alpha F]_o$		*		

This tableau is identical to the one in (95) above with the important exception that the medial vowel and the opaque vowel are tautomorphemic, as indicated by the lack of a bullet '•' between them. This means that the stem of affixation in this case is simply the root vowel, not the root vowel and the medial vowel as it was in (95). This in turn means that the candidate in (96c) — in which the medial vowel is faithful to its input value of [F] (and also happens to agree with the following opaque vowel) — does not violate SA-IDENT[F]. Lower-ranked IO-IDENT[F] thus makes the decision in favor of this candidate as opposed to the candidate in (96b), in which the medial vowel is forced to agree with the root vowel.

2.3.2.3 Epenthetic medial vowels

In the case of an epenthetic medial vowel, both stem-affixed form faithfulness and input-output faithfulness are irrelevant because not only does the medial vowel have no correspondent in the stem of affixation but, being epenthetic, it also has no correspondent in the input. Markedness is predicted to decide in this case, resulting in agreement with

whichever adjacent vowel results in the least-marked overall output. This is shown in (97).

(97) Input: $\sqrt{[\alpha F]} \bullet [-\alpha F]_o$ Stem: $\sqrt{[\alpha F]}$

Candidates	FIXED	AGR[F]	SA-ID[F]	IO-ID[F]	*[αF]
a. $\sqrt{[\alpha F]} \bullet \{ \alpha F \} [\alpha F]_o$	* !			*	***
b. $\sqrt{[\alpha F]} \bullet \{ \alpha F \} [-\alpha F]_o$		*			** !
c. $\sqrt{[\alpha F]} \bullet \{ -\alpha F \} [-\alpha F]_o$		*			*

The medial epenthetic vowel is enclosed within curly braces '{ }' in this tableau. Since this vowel corresponds to nothing in the input nor in the stem of affixation, it violates neither IO-IDENT[F] nor SA-IDENT[F]. The decision between the two candidates in (97b) and (97c) is thus left to the lower-ranked markedness constraint *[αF], which is arbitrarily assumed to be the higher-ranked of *[αF] and *[-αF] to show that the result can in principle be apparent agreement with the following opaque vowel rather than the preceding stem vowel.

2.3.2.4 Conclusions

As shown in §2.3.2.1, the basic prediction of the stem-affixed form faithfulness approach to stem control is borne out in the case of medial vowels that are neither tautomorphemic with an opaque vowel nor epenthetic. Such medial vowels always agree with the vowel of the less peripheral stem of affixation and never with the more peripheral opaque vowel. This systematic behavior follows from the way stem-affixed form faithfulness works: a form with the stem vowel and the medial vowel serves as the stem of affixation for the opaque vowel affix, and the harmonic feature value of the medial vowel is decided solely within that stem of affixation. The harmonic feature value of the opaque vowel is irrelevant to that particular evaluation, and so the opaque vowel is correctly predicted not to have any effect, adverse or otherwise, on the outcome of the medial vowel.

On the other hand, the predictions are fairly clear in both the tautomorphemic and epenthetic cases, but in the unfortunate absence of any clear empirical groundwork in this area, I regrettably leave (dis)confirmation of these predictions for future research. However, one relevant but sadly inconclusive case that I am aware of bears mentioning.

Recall from footnotes 9 and 14 that the progressive suffix in Turkish exhibits syllabically-conditioned allomorphy. After vowel-final stems, it surfaces as [jor]; after consonant-final stems, it also surfaces as [jor] but is preceded by a [+HI] vowel. Underhill (1976:111ff) analyzes the suffix as underlyingly bi-vocalic, accounting for the allomorphy via deletion, but it could well be a mono-vocalic input with epenthesis. If Underhill's deletion analysis is correct, then this is a case of a medial vowel in the same morpheme as an opaque vowel; on the other hand, if the epenthesis analysis is correct, then this is a case of a medial vowel epenthesized as a direct result of affixation of a morpheme with an opaque vowel.

The important fact is that the [+HI] vowel in question is fully harmonic: it always agrees in terms of [BK] and [RD] with the less peripheral stem vowel and not with the more peripheral opaque vowel, as shown in (98) — unless, of course, the stem vowel and opaque vowel themselves happen to agree, as in (98b).

- (98) Turkish progressive suffix (adapted from Underhill 1976:27)
- | | | | |
|----|-------------|--------------------------|------------------------|
| a. | √gel • ijor | 'come (neg.-prog.-1sg)' | (*√gel • <i>ujor</i>) |
| b. | √dur • ujur | 'stand (neg.-prog.-1sg)' | |
| c. | √gyl • yjor | 'laugh (neg.-prog.-1sg)' | (*√gyl • <i>ujor</i>) |
| d. | √atʃ • ujur | 'open (neg.-prog.-1sg)' | (*√atʃ • <i>ujor</i>) |

In other words, the vowel in question behaves just as any other medial vowel would, as if it were in an independent affix. Under the deletion analysis, this fact would have to be attributed to the (entirely arbitrary and accidental) fact that the underlying form of this vowel is /i/; that is, a [-BK, -RD] vowel, in direct opposition to the [+BK, +RD] specification of the following /o/. That way, it will emerge faithfully with respect to one or both

of these features depending on the less peripheral stem vowel. If that stem vowel is [-BK] or [-RD], then agreement between the stem vowel and the opaque vowel is doomed to fail for one or the other feature, and the medial vowel is predicted to be faithful with respect to that feature. If the stem vowel is [+BK] or [+RD], then agreement on both sides is possible, and the medial vowel is forced to be unfaithful to one or both of these features.

Assuming that the vowel in question is epenthetic, on the other hand, means that the choice is left up to markedness: in cases of unavoidable disagreement, the vowel is predicted to surface with whatever value of the [BK] or [RD] results in a less-marked output. Because the vowel in question does not systematically agree with the opaque [+BK, +RD] vowel, then, it must be because these values of these features are marked relative to their opposite values; the vowel in question surfaces as [-BK] or [-RD] when it can, and as [+BK] or [+RD] otherwise.

While a case could possibly be made for the markedness of [+RD] relative to [-RD], I doubt that the same could be done for the markedness of [+BK] relative to [-BK]. However, this is not because the opposite is the case — [-BK] is also not demonstrably marked relative to [+BK] — so this analysis might yet survive this particular criticism. The real problem, of course, is that the values of [BK] and [RD] are usually marked *in certain combinations*; to wit, [+BK, -RD] and [-BK, +RD] (non-low) vowels are typically marked relative to [+BK, +RD] and [-BK, -RD] (again, non-low) vowels. Given the vowel inventory of Turkish, which includes all four of these feature combinations, this problem can be sidelined simply by ranking the multiple-feature markedness constraint(s) responsible for these (more usual) markedness relations — for present purposes, collapsed into the unitary constraint *[-LO, αBK, αRD] — below the conflicting single-feature markedness constraints *[+BK] and *[+RD].

As noted, both analyses have their relative benefits and drawbacks. On the down side for both analyses, they both treat it as an accidental fact that the vowel in question

behaves just like any other medial vowel. The deletion analysis does so by arbitrarily stipulating that the vowel is underlyingly [-BK, -RD], diametrically opposed to the [+BK, +RD] specification of the following opaque vowel, thus guaranteeing its preference to agree with the preceding stem vowel. The epenthesis analysis does so by relying on the admittedly tenuous conjecture that the individual feature values [+BK] and [+RD] of the following opaque vowel are marked, ensuring agreement with the preceding stem vowel's potentially less-marked feature values.

Though the case must unfortunately remain unresolved here, I hope to have at least shown that the predictions made by the proposed model in this empirical gray area are clear and testable in principle. I also hope to have shown that if these predictions are in fact correct, then a more thorough investigation into the phonology of Turkish than is possible or even appropriate here may well help decide whether the allomorphy of the progressive suffix is due to deletion or epenthesis — a very satisfying situation to have engendered.²¹

2.4 Root-specific faithfulness?

2.4.1 Preamble

We are now in a position to compare the stem-affixed form faithfulness account of stem control with an account that has received considerable attention in the OT literature, one involving *root-specific* faithfulness instead (see Beckman 1995, 1997, 1998, following up on suggestions originally made in McCarthy & Prince 1994ab, 1995 and Selkirk 1994, 1995).

The essentials of positional faithfulness theory should be somewhat familiar from the discussion in Chapter 1 of the role of onset-specific faithfulness in Lombardi's

²¹ One avenue worth pursuing concerns the PROG-IDENT[F] constraints postulated in §2.3.1.2 above (see also §2.4 immediately below). Note that if the as-of-yet-undetermined position to which these constraints refer is morphological and thereby includes the entire suffix, then the [+HI] vowel of the post-consonantal allomorph must be epenthetic, since it is fully [RD]- and [BK]-harmonic. The tentative nature of both of these analytical strands precludes any further speculation on this point, which even more tentatively brings them together.

(1996ab, 1999) analysis of voicing assimilation. The main idea is that perceptually or psycholinguistically prominent positions such as roots, root-initial syllables, stressed syllables, and onsets are phonologically privileged in the precise sense that there exist faithfulness constraints keyed to these positions: root-specific faithfulness, onset-specific faithfulness, etc.²² Positional faithfulness constraints are specifically designed to make sense of what is known as *positional neutralization*: the common fact that certain featural contrasts often exist only in roots, not in affixes, or only in onsets, not in codas, and so on.²³

2.4.2 A by now familiar example

For example, as I have mentioned more than a few times already, non-initial [-HI] vowels in Turkish are uniformly [-RD]; initial [-HI] vowels (and all [+HI] vowels), on the other hand, come in both [+RD] and [-RD] flavors. In other words, the values of the feature [RD] are not contrastive in non-initial [-HI] vowels; the potential distinction between [+RD] and [-RD] in non-initial [-HI] vowels is positionally neutralized in the direction of [-RD]. What this means is that the markedness constraint against [-HI, +RD] vowels, *[-HI, +RD], actively delimits the non-initial inventory of Turkish but not its initial inventory.

Since Turkish is a strictly suffixing language, the relevant prominent position in Turkish is the root-initial syllable. Faithfulness constraints specific to the root-initial syllable, RT₁-IDENT[HI] and RT₁-IDENT[RD],²⁴ must both dominate *[-HI, +RD] in order to correctly prevent the values of [HI] and [RD] from being altered in this position. *[-HI, +RD] must in turn dominate the lower-ranked of the two non-positional faithfulness constraints IO-IDENT[HI] and IO-IDENT[RD] in order to enable the neutralization non-initially. Since the lower-ranked of the two is IO-IDENT[RD], as established in (83) above, potential

²² The full range and precise identity of these prominent positions is not at issue here. See Beckman 1998.

²³ For different approaches to positional neutralization, see e.g. Steriade 1993, 1997 and Zoll 1996, 1998a.

²⁴ 'RT₁' refers to the root-initial syllable, of course; Beckman uses 'σ₁' in her work with the same effect intended.

instances of non-initial [-HI, +RD] vowels are predicted to be delabialized to [-RD]. (As noted in footnote 16 above, it could be that the general faithfulness constraint IO-IDENT[HI] in fact dominates *[-HI, +RD]; to simplify matters, I assume that this is so and henceforth disregard the more specific and therefore redundant positional faithfulness constraint RT₁-IDENT[HI].)

The situation is depicted in tableau form below. Initial [-HI, +RD] vowel inputs, like the disembodied /o/ in (99), surface faithfully, despite their violation of *[-HI, +RD], due to the guaranteed failure with respect to the undominated faithfulness constraints faced by any changes in [HI] or [RD] in initial position. (I suppress all other featural distinctions here; in particular, the obvious difference between [o] and [a] in terms of [LO]. See §2.5 below.)

(99) Input: initial /o/

Candidates	RT ₁ -ID[RD]	IO-ID[HI]	*[-HI, +RD]	IO-ID[RD]
a. [u]		* !		
b. ^{ESP} [o]			*	
c. [a]	* !			*

Non-initial [-HI, +RD] vowel inputs like the /o/ in (100), on the other hand, suffer a different fate: positional faithfulness is irrelevant non-initially, and so *[-HI, +RD] emerges to knock out the faithful mapping from /o/ to [o]. This leaves the two unfaithful outputs [u] and [a]; the decision between these two, as mentioned above, is made by the relative ranking of the non-positional faithfulness constraints IO-IDENT[HI] and IO-IDENT[RD].

(100) Input: non-initial /o/

Candidates	RT ₁ -ID[RD]	IO-ID[HI]	*[-HI, +RD]	IO-ID[RD]
a. [u]		* !		
b. [o]			* !	
c. ^{ESP} [a]				*

This analysis of the distribution of [-HI, +RD] vowels in Turkish is an instance of what McCarthy & Prince (1994a) dub *the emergence of the unmarked* (TETU): [-HI, +RD] vowels are marked (see footnote 10) and this fact is reflected by their absence from the non-initial inventory of Turkish, even though they are present in the root-initial inventory — as well as in the progressive suffix and in a few other exceptional positions, all of which should presumably receive a parallel analysis (as granted explicitly to the progressive in §2.3.1.2).

2.4.3 The problem

Given positional faithfulness constraints, it might seem that stem-affixed form faithfulness constraints are in general redundant or at the very least unnecessary for the analysis of stem-controlled vowel harmony. Just like stem-affixed form faithfulness, root-specific faithfulness correctly selects a candidate with assimilation of an affix vowel to a root vowel as opposed to the candidate with assimilation of the root vowel to the affix vowel, as shown in (101).²⁵

(101) Input: $\sqrt{[\alpha F]} \bullet [-\alpha F]$

Candidates	AGREE[F]	IO-IDENT[F]	RT-IDENT[F]
a. $\sqrt{[\alpha F]} \bullet [-\alpha F]$	* !		
b. ^{ESP} $\sqrt{[\alpha F]} \bullet [\alpha F]$		*	
c. $\sqrt{[-\alpha F]} \bullet [-\alpha F]$		*	* !

With all of the necessary adjustments to prevent the majority rule problem (see Chapter 1, §3.3, as well as §2.2.2 above), root-specific faithfulness and stem-affixed form faithfulness seem to do an equally good job of accounting for stem control.

²⁵ The even more specific root-initial faithfulness constraint RT₁-IDENT[F] would function identically in this case. The distinction between these two kinds of positional faithfulness might be made in particular cases on the basis of unsystematically disharmonic roots: if none exist, then root-initial faithfulness is almost certainly to blame; if some do, then root faithfulness in general is perhaps more appropriate. To my knowledge, disharmonic roots in languages that have them (e.g., Turkish; see Clements & Sezer 1982, Kirchner 1993) never quite exhibit the full and complete range of contrasts that root (as opposed to root-initial) faithfulness would bluntly predict; this interesting issue must be left unresolved here, as it is far beyond the scope of the present study.

The crucial difference arises when one considers the issue of medial vowels — the fact that a vowel between a stem vowel and an opaque vowel always agrees with the former and never with the latter. As shown in §2.3.2 above, stem-affixed form faithfulness correctly distinguishes between the candidates at issue. Recall that the crucial element of the stem-affixed form faithfulness account of the medial vowel generalization is that the medial vowel is a stem vowel with respect to the opaque vowel affix. The harmonic feature value of the medial vowel *qua* stem vowel is decided prior to the affixation of the opaque vowel affix and the ranking of SA-IDENT[F] over IO-IDENT[F] prevents any change in that decision.

Root-specific faithfulness, on the other hand, cannot correctly distinguish the relevant candidates. The reason for this is simple: being a root vowel is an all-or-nothing deal; a root vowel is a root vowel and an affix vowel is an affix vowel, end of story. The medial vowel is surely not a root vowel, with respect to the opaque vowel affix or anything else. The medial vowel is thus free to agree with either the adjacent stem vowel or the opaque vowel: AGREE[F] is indifferent, as is RT-IDENT[F]. The decision is thus expected to fall to IO-IDENT[F], resulting in ‘emergence of the faithful’ in the medial vowel.²⁶

(102) Input: $\sqrt{[\alpha F]} \bullet [-\alpha F] \bullet [-\alpha F]$

Candidates	FIXED	AGREE[F]	RT-ID[F]	IO-ID[F]
a. $\sqrt{[\alpha F]} \bullet [\alpha F] \bullet [\alpha F]$	* !			**
b. $\sqrt{[\alpha F]} \bullet [\alpha F] \bullet [-\alpha F]$		*		* !
c. $\sqrt{[\alpha F]} \bullet [-\alpha F] \bullet [-\alpha F]$		*		

There is an additional point distinguishing Beckman’s theory from what I have presented thus far, and that is that Beckman assumes that a markedness constraint is in general better satisfied by autosegmental multiple linking of the relevant feature(s).²⁷ This obviates

²⁶ Technically, the decision is predicted to fall to one of the relevant local conjunctions of markedness and faithfulness, with a similar input-dependent result. I ignore this detail here in the interests of clarity.

²⁷ See Chapter 6 for more detailed arguments against this ‘feature-driven’ view of markedness.

the need for any additional constraints that specifically demand assimilation (like agreement); this point aside, Beckman argues that harmony is in part due to the fact that markedness constraints on the values of a harmonic feature [F] are ranked *between* positional faithfulness and general input-output faithfulness to [F]. What this means is that the decision in (102) above falls not to IO-IDENT[F] but rather to the higher-ranked of the two markedness constraints, *[-F] or *[+F]. But as noted in §2.3.2, this is still not the correct result: the harmonic feature value of a medial vowel depends not on its possible input specification nor on markedness, but rather on the harmonic feature value of the vowel in the next less peripheral morpheme, the adjacent vowel in the stem of affixation.

To my knowledge, Kirchner (1993:17) is the first to observe that the medial vowel generalization is part of the reason why ‘root control’ would be more accurately called ‘stem control,’ at least in Turkish.²⁸ The present conclusion concurs with Kirchner’s observation. Specifically, it is clear that the apparent root-outward (bi)directionality of stem-controlled vowel harmony must proceed cyclically, to each affix from its stem of affixation, and not simply from root to affix. The special fact about the root is not that there are faithfulness constraints specific to it, but that it is the ultimate and supreme stem of affixation.

2.4.4 Conclusion

The conclusion arrived at in this section is that root-specific faithfulness is not good enough for stem-controlled vowel harmony. Specifically, it is not able to account for the universal behavior of medial vowels, and stem-affixed form faithfulness is necessary for that.

This conclusion does not in any way deny the existence of positional faithfulness, of course. Indeed, I assume that positional neutralization involves positional faithfulness,

²⁸ Similarly, Anderson (1980:21ff) makes use of the medial vowel generalization in Turkish as part of his argument that vowel harmony is left-to-right directional as opposed to root-controlled (cf. Steriade 1981).

as in the case of the root-initial vs. non-initial inventory discrepancy in Turkish analyzed above. Under that analysis, the same constraint responsible for the disharmonic behavior of [-HI] vowels with respect to [RD] harmony in Turkish, *[-HI, +RD], also divides the root-initial inventory from the non-initial inventory (modulo the exceptions noted at the end of §2.4.2).

Despite this common analytical anchor, these two facts are not unified under the proposed account. They depend on some of the same rankings, but each requires a couple of different — though not mutually incompatible — crucial rankings. This may at first appear to be problematic, since the two facts seem so clearly to be two sides of the same coin: non-initial [-HI, +RD] vowels are not allowed, and [RD] harmony does not create non-initial — you guessed it! — [-HI, +RD] vowels. (And where else would [RD] harmony create *anything*, since Turkish is strictly suffixing and harmony clearly propagates from root to suffix?)

Much of the above argument is based on an intuition about the relatedness of the two facts in question that is really an illusion. The fact that a harmony process does not create a class of vowels that are not found in positions affected by the harmony process is actually the result of two partially autonomous variables, as can be shown by the fact that they are found independently of each other in languages other than Turkish.

In Standard Yoruba, for instance (see Chapter 3), [+HI] vowels are opaque to the propagation of [-ATR], and there are no [+HI, -ATR] vowels in the entire language, not just in those positions affected by [ATR] harmony. Thus, a constraint responsible for the class of opaque vowels can be one that is violated by vowels that are absent from the language *entirely*, not just in positions otherwise affected by harmony, as in Turkish. A distinction between root-initial and non-initial inventories can also be distinguished in the absence of any harmony process. In Tamil, for example (Christdas 1988, Beckman 1998), non-initial vowels cannot be [-HI, -LO]; such vowels are found only in root-initial syllables, and

there is no harmony. Turkish just happens to be a case in which both variables are found together.

I also assume that the onset/coda asymmetry in voicing assimilation is the result of positional faithfulness, as discussed in Chapter 1. This case is particularly interesting in the present context: voicing assimilation is predicted to differ from vowel harmony in specific ways, given that it involves positional faithfulness rather than something like stem-affixed form faithfulness. In particular, ‘medial obstruents’ are predicted to surface faithfully in precisely the way that medial vowels do not. Due to the clustering limitations inherent to voicing assimilation compared to vowel harmony, however, the complicated circumstances under which such a prediction can be tested are not likely to serendipitously grace the analyst with their surface convergence.²⁹ This is undoubtedly why vowel harmony — especially in heavily agglutinative languages like Turkish — serves as the usual testing ground for theories of assimilation. This dissertation is no exception to this opportunistic bias.

2.5 *Re-pairing*

2.5.1 *You can get there from here*

It is simply a fact of vowel harmony that not every [αF] vowel in a language with [F] harmony will necessarily have a perfectly direct [-αF] counterpart with which to alternate. Recall the vowel inventory of Turkish from Chapter 1, repeated below in (103).

²⁹ A more-or-less ideal scenario would be something like the following. First, there must be an obstruent that is immune (i.e., opaque) to voicing assimilation; e.g., [k] (or [b]), due to the well-documented (though not terribly pronounced) markedness of velar voicing / labial voicelessness (see Ohala 1983, Westbury & Keating 1986, Hayes 1996, and references therein). Second, there must be a morphological process that brings together three heteromorphic consonants; say, a compounding process with a linking morpheme that consists of [t] (or [d]). Third, there must be a high tolerance for complex obstruent clusters. With this laundry list of requirements in place, all that remains to be done is to make compounds consisting of words that end in [k] (or [b]) followed by words that begin with voiced (or voiceless) obstruents. If the linking morpheme consistently surfaces faithfully, the prediction is borne out; if it consistently agrees with the following obstruent, it is falsified.

(103) Turkish vowel inventory

	[-BK]		[+BK]	
[+HI]	i	y	ɯ	u
[-HI]	e	ø	ɑ	o
	[-RD]	[+RD]	[-RD]	[+RD]

A more accurate representation of this inventory, reflecting a little more than just the phonologically necessary featural contrasts in [HI], [BK] and [RD], would be as shown in (104).

(104) Turkish vowel inventory (revised)

	[-BK]		[+BK]	
[+HI, -LO]	i	y	ɯ	u
[-HI, -LO]	e	ø		o
[-HI, +LO]			ɑ	
	[-RD]	[+RD]	[-RD]	[+RD]

From (104) it is clear that the mid [-BK] vowel [e] does not have a direct, mid [+BK] counterpart in the inventory (i.e., [ɤ]); rather, [e] is paired with the *low* [+BK] vowel [ɑ]. Conversely, it is clear that the low [+BK] vowel [ɑ] does not have a direct, low [-BK] counterpart in the inventory (i.e., [æ]); rather, [ɑ] is paired with the *mid* [-BK] vowel [e].³⁰

This is what is meant by ‘re-pairing’ in the title of this section — potential instances of the vowels [æ,ɤ] due to [BK] harmony are ‘re-paired’ by an additional change in [LO], indirectly pairing mid [-LO, -BK] vowel [e] with [+LO, +BK] vowel [ɑ].

Examples of re-pairing abound in vowel harmony systems, but they are more often than not simply cast aside as irrelevant, superficial by-products of the phonology.³¹

³⁰ Underhill (1976:13ff) notes that the vowels [i,y,e,ø] are in general somewhat lower than the cardinal positions implied by the IPA symbols employed here, except the long versions of [e,i] and these vowels before lenited /g/ (*‘yumuşak ge’*; see Underhill 1976:10-12). Underhill also notes that the vowels [u,o] are lowered in closed syllables, and that the vowel [e] is also lowered in syllables closed by a sonorant “in some dialects, especially in the speech of Istanbul, and more commonly in the speech of women than of men” (Underhill 1976:14). Since [e] is in general already relatively low, this lowering results in a vowel “similar to, but somewhat higher than” the low vowel [æ]. Whether this dialectal variant is in fact a [+LO] vowel does not affect the point under discussion.

³¹ Notable exception include van der Hulst, Mous and Smith 1986 and Calabrese 1988.

For instance, the [±LO] distinction plays no discernible role in the phonology of Turkish, and so the pair of alternants [e,ɑ] are often referred to simply as [-HI] vowels — just as I have been doing until now. Examples of re-pairing have also been fruitfully analyzed as the result of (otherwise often largely inconsequential) ‘fix-up’ or ‘repair’ rules. An analysis of Turkish along these lines would go as follows. At the point in the derivation when [BK] harmony applies, the vowels [æ,ɤ] are created. These non-surface vowels are then targeted by a rule which changes their value of [LO], resulting in the actual surface vowels [e,ɑ].

In the proposed model, re-pairing follows from a simple re-ranking of constraints that we have seen thus far. Take the Turkish example. In order to account for [BK] harmony, AGREE[BK] must dominate IO-IDENT[BK]. In order to account for the absence of the vowels [æ,ɤ] from the Turkish inventory, a markedness constraint (or, quite likely, two separate markedness constraints) against them, call it *[æ,ɤ] for perspicuity, must dominate a conflicting faithfulness constraint. Since we know that potential instances of these vowels due to [BK] harmony are realized as their non-low counterparts [e,ɑ], this faithfulness constraint must be IO-IDENT[LO]. Furthermore, since we know that this change in [LO] is in fact due to [BK] harmony, AGREE[BK] must also dominate IO-IDENT[LO]. This is all shown in the two tableaux below. In (105), the vowel of the plural suffix is assumed to be [-BK] in the input, while in (106), it is assumed to be [+BK], emphasizing the irrelevance of this choice.

(105) Input: √kul • ler ‘slave (plural)’

Candidates	*[æ,ɤ]	AGREE[BK]	IO-IDENT[LO]	IO-IDENT[BK]
a. √kul • ler		* !		
b. √kul • lɤr	* !			*
c. ^{SP} √kul • lar			*	*

(106) Input: $\sqrt{el} \cdot lar$ ‘hand (plural)’

Candidates	*[æ,ɹ]	AGREE[BK]	IO-IDENT[LO]	IO-IDENT[BK]
a. $\sqrt{el} \cdot lar$		* !		
b. $\sqrt{el} \cdot lær$	* !			*
c. $\sqrt{el} \cdot ler$			*	*

As these tableaux show, it is not enough for the [-HI] vowels [e,a] to simply change their [BK] value in order to satisfy AGREE[BK]. This minimal move runs afoul of the undominated markedness constraint *[æ,ɹ], leading to a necessary further change in the value of [LO]. Thus, the vowels [e] and [a] are correctly (re-)paired with each other.

Many languages with vowel harmony exhibit re-pairing alternations that are more often than not de-emphasized, as I mentioned earlier. One more-or-less familiar case is that of the Yowulmne dialect of Yokuts.³² Yowulmne has [RD] harmony, but at least one of the two pairs of vowels that participate in the harmonic alternation has involves re-pairing: the [+BK, +RD] vowel [u] alternates with the [-BK, -RD] vowel [i] — a change in both [RD] and [BK].³³ Likewise, and as we’ll see in further detail in §3.5 below, the [+LO, -ATR] vowel [a] of Diola Fogny is re-paired with the [-LO, +ATR] vowel [ɹ]. Re-pairing will also be encountered again in the analyses of Maasai and Turkana in Chapter 4.

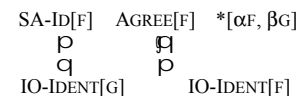
At this point, we can summarize this discussion with the schematic ranking necessary to describe re-pairing. Note that the relative ranking of the two lowest-ranked input-output faithfulness constraints is generally irrelevant. It only further tells us how [αF, βG] vowels are dealt with in the absence of [F]-harmonic considerations; for example, in monosyllabic words. If IO-IDENT[F] dominates IO-IDENT[G], then potential [αF, βG] vow-

³² On Yowulmne (a.k.a. Yawelmani) vowel harmony, see Newman 1944, Kuroda 1967, Kisseberth 1969, Steriade 1981, Archangeli 1984, 1985, Cole & Trigo 1988, Mester 1986, 1988, Cole & Kisseberth 1995, Kaun 1995, Archangeli & Suzuki 1997, Sprouse 1997, McCarthy 1998a, Hansson 1999, Hansson & Sprouse 1999, among others.

³³ The other pair of alternating vowels may or may not involve re-pairing. Newman (1944:19) notes that “the back mid [vowel [ɔ] is] always open, as in German *voll* and English *law*” (italics mine). This vowel alternates with [a], a change in both [RD] and [LO] if [ɔ] is [-LO] (Newman’s “mid”), or a simple change in [RD] if [ɔ] (rather, [ɔ]) is [+LO] (Newman’s “open”). (Thanks to Alan Prince for bringing this issue to my attention.)

els in monosyllables are dealt with by changing them to [αF, -βG]; if IO-IDENT[G] instead dominates IO-IDENT[F], then they are instead changed to [-αF, βG].

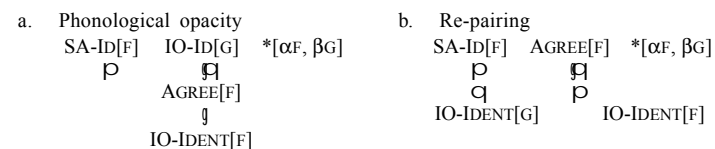
(107) Schematic ranking for re-pairing under stem control



2.5.2 Incompatibility with opacity

Comparing this schematic ranking with the one responsible for phonologically predictable opacity (87), it is clear that the critical difference lies in the relative ranking of the input-output faithfulness constraint violated by a change in the non-harmonic feature [G] mentioned by the undominated multiple-feature markedness constraint. The two schematic rankings are repeated together in (108) below for ease of comparison.

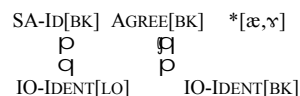
(108) Schematic rankings compared



This difference between opacity and re-pairing betrays a subtle but significant prediction: opacity and re-pairing are partially incompatible. I say only partially because, of course, a language can have both opacity and re-pairing. Turkish is such a language: [-HI] vowels are opaque to [RD] harmony, and [-HI] vowels are re-paired in [+BK] harmony. In this case the two phenomena are not in conflict, however; the harmonic feature in each case is different.

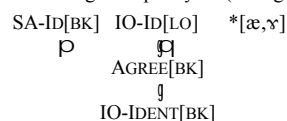
The situation that is predicted not to be possible is something like the following. Take a language just like Turkish, with a re-pairing alternation between [e] and [a]. Following the schema in (107)/(108b), this language must have the following ranking:

(109) Re-pairing in (a language like) Turkish



Now suppose that in this language, this re-pairing is only in evidence if the vowel in question is underlyingly [-BK] (e.g., /e/); if it is [+BK] (e.g., /a/), then there is opacity. Following the schema in (109a), this language must have the following ranking:

(110) Phonological opacity in (a language like) Turkish



What we end up with here, of course, is a contradiction or a *ranking paradox*: the re-pairing alternation between [e] and [a] requires that AGREE[BK] dominate IO-IDENT[LO], and the opacity of [a] requires that IO-IDENT[LO] dominate AGREE[BK].

Now compare this prediction with a rule-based analysis of this fictitious language. The fact that /e/ alternates between [e] and [a] is due to either of two things, depending on one's theoretical proclivities. The first is that /e/ is unspecified for the feature [LO], the correct value of which is supplied by a rule or rules applying sometime after [BK] harmony — [-LO] if the vowel remains [-BK] and [+LO] if the vowel becomes [+BK]. The second is that /e/ is specified as [-LO] but that this value changes to [+LO] by a repair rule (again, applying sometime after [BK] harmony) if the vowel becomes [+BK]. Regardless of this choice, the fact that /a/ is opaque to [BK] harmony can be accounted for in a variety of specific ways; the general idea is that something blocks [-BK] from associating with this low [+BK] vowel (a pre-specified [+BK] feature, a constraint against [+LO, -BK], or what have you). The point is, nothing in this kind of theory explains why this fictitious pattern is entirely unattested, whereas its unattestedness follows directly from the constraint-based agreement model.

2.6 Anti-structure preservation

Conform or be cast out.
Rush — Subdivisions

2.6.1 'Phonemic inventories' sometimes get no respect

A phonological process is said to be *structure preserving* if the set of segments delivered as output of the process is a (not necessarily proper) subset of the independently-defined underlying segmental (or 'phonemic') inventory. This much is merely observational; a process either is or is not structure preserving, depending on the phonemic inventory and on the mappings performed by the process. But some processes are observed to be structure preserving despite the fact that they could, in principle, create segments other than those in the phonemic inventory of the language — vowel harmony processes being cases in point.

Opacity and re-pairing, both common properties of vowel harmony systems, are both responses to undominated multiple-feature markedness constraints that delimit the phonemic vowel inventory of the language (or of some positional subset thereof; see §2.4 above). The tendency for vowel harmony processes to respect inventory limits in this way leads Kiparsky (1981) to the interesting claim that vowel harmony is *universally* structure preserving.³⁴

In a stem-controlled harmony system, the set of vowels that appear contrastively in the root is, for all intents and purposes, the phonemic vowel inventory of the language. The claim that a stem-controlled vowel harmony process is structure preserving thus amounts to the claim that the process does not create vowels that are not independently contrastive in the root. But despite the fact that vowel harmony processes are frequently

³⁴ In later work, Kiparsky (1982, 1985) claims that structure preservation holds of all lexical-phonological processes — vowel harmony processes being a sub-class of these, since they typically take the word as their domain. This claim about structure preservation has interesting consequences that go far beyond the scope of what is immediately at issue here. I refer the interested reader to Kiparsky's work cited here, to Harris 1987, Calabrese 1988, Myers 1991b, and to the very relevant discussion of German fricative assimilation found in Hall 1989, Macfarland & Pierrehumbert 1991, Iverson & Salmons 1992, and Klein 1993 (see also Buck-Gengler 1994 and Merchant 1996).

and perhaps even typically structure preserving, they are not universally so, contrary to Kiparsky's claim.³⁵

In the Ijesa dialect of Yoruba (Awobuluyi 1967, Fresco 1970, Akinlabi, in progress), for instance, a [+HI] oral vowel in the root must be [+ATR]; however, the process of [ATR] harmony creates these otherwise disallowed [+HI, –ATR] oral vowels. The data in (111) below exemplify the situation. As shown, an initial [+HI] prefix vowel must have the same [ATR] value as the final root vowel (see Chapter 3 on the morphological structure of Yoruba).

(111) Anti-structure preservation in Ijesa

a.	i • √ré	'play'	u • √lé	'house'	* _I • √ré, * _U • √lé
b.	ĩ • √jé	'feather'	u • √jε	'work'	* _I • √jé, * _U • √jε
c.	i • √lá	'okra'	u • √gbá	'calabash'	* _I • √lá, * _U • √gbá

The potential failure of stem-controlled vowel harmony to be structure preserving is the expected result of the undominated ranking of three constraints: AGREE[F], SA-IDENT[F], and IO-IDENT[G] (where [F] = [ATR] and [G] = [HI] in Ijesa). AGREE[F] enforces agreement no matter what the cost, SA-IDENT[F] prevents 'harmonic reversal' (on which see §3), and IO-IDENT[G] prevents re-pairing (see §2.5). With all three of these constraints ranked above the inventory-delimiting markedness constraint *[αF, βG] (*[+HI, –ATR] in Ijesa) — which must itself be ranked above IO-IDENT[F] in order to in fact delimit the inventory — a more peripheral affix vowel (of the prefix) is made to agree with the vowel of a less peripheral morpheme (the root), even if this creates a vowel not otherwise in the inventory.

This is shown with an Ijesa example in (112). The input consists of one of the roots in (111) above with a [–HI, –ATR] vowel, preceded by a prefix with a [+HI] vowel. This prefix vowel is arbitrarily assumed to be underlyingly [+ATR]. The failed candidates

³⁵ In earlier work (Baković 1997), I accepted and attempted to derive Kiparsky's universal claim within a model quite different from the one advanced here. I thank Akin Akinlabi for having convinced me that the claim itself is erroneous, and especially for extensive discussion of the Ijesa example discussed immediately below. See also §3.6 for discussion and analysis of a similar anti-structure preservation situation in Kalenjin; for more examples, see Harris 1987.

are the faithful realization of the input in (112a), which loses due to its violation of AGREE[ATR], the 'reverse-harmonic' candidate in (112c), with its fatal violation of SA-IDENT[ATR], and the re-pairing candidate in (112d), critically violating IO-IDENT[HI]. This leaves the anti-structure-preserving candidate in (112b) as optimal, with its now irrelevant violation of *[+HI, –ATR].

(112) Input: u • √jε 'work' Stem: √jε

Candidates	AGR[ATR]	SA- ID[ATR]	IO- ID[HI]	*[+HI, –ATR]	IO- ID[ATR]
a. u • √jε	*!				
b. ^{εε} u • √jε				*	*
c. u • √jε		*!			*
d. ɔ • √jε			*!		*

Because *[+HI, –ATR] is ranked above IO-IDENT[ATR], [+HI, –ATR] vowels are generally expected not to surface in the language: as discussed in detail in Chapter 1, §2, this is a recipe for absence from the inventory.³⁶ But because *[+HI, –ATR] is in turn dominated by the three constraints that are violated by alternative harmonic candidates, it is forced to be violated in harmonic circumstances like in (112), sneaking [+HI, –ATR] vowels into the surface inventory.

The schematic ranking responsible for a vowel harmony process that is anti-structure preserving is thus as in (113). The critical difference between it and the schematic rankings responsible for opacity and re-pairing lies in the relatively lower rank of the inventory-delimiting multiple-feature markedness constraint, *[αF, βG].

(113) Schematic ranking for anti-structure preservation under stem control

SA-ID[F]	AGREE[F]	IO-ID[G]
ρ	⊔	
	*[αF, βG]	
	⊔	
	IO-IDENT[F]	

³⁶ Relevant positional faithfulness constraints — root-specific faithfulness in particular — must of course also be ranked below *[+HI, –ATR]; I abstract away from this detail here in the interests of expository clarity.

2.6.2 More on Ijesa

A final comment is in order here, concerning the particular example of Ijesa. As John McCarthy (p.c.) points out, the basic set of contrasts in Ijesa seems odd in that an [ATR] contrast exists in the root for the [+HI] nasal vowels, but not for their oral counterparts. The data in (114) show that there is an [ATR] contrast in the root for [+HI] nasal vowels, with [ATR] harmony happening as otherwise expected.

(114) Final [+HI] nasal vowels

a.	u • √gū	‘edge’	u • √gū̃	‘vulture’	*u • √gū̃, *u • √gū̄
b.	ɪ • √nĩ	‘one’	ɪ • √jĩ	‘excreta’	*ɪ • √nĩ̃, *ɪ • √jĩ̃
c.	ɛ • √dō	‘baboon’	e • √fū	‘chalk’	*e • √dō̃, *ɛ • √fū̃
d.	ɔ • √tĩ	‘wine’	ò • √fĩ	‘law’	*o • √tĩ̃, *ò • √fĩ̃

Indeed, a language’s nasal vowel inventory is usually a (proper) subset of its oral vowel inventory. But the situation in Ijesa is perhaps not so odd in light of Beddor 1983, a comprehensive study of nasalization and its effects on vowel height perception and articulation. Beddor (1983:168) comments on the fact that many of the languages in her study “involve tongue position differences between oral and nasal vowels” — in particular, high nasal vowels tend to be lower relative than their oral counterparts.

One might conclude from this observation that vowel nasalization causes the partial neutralization of potential height contrasts (where by ‘height’ I mean not only tongue body height but also tongue root advancement/retraction), such that high nasal vowels are lowered from the ‘normal’ height of their oral counterparts. But what Beddor notes is only that there is a *correlation* between height contrasts and nasalization contrasts. One could also conclude that the *lack* of nasalization causes height neutralization, in the opposite direction: high oral vowels are *raised* from the ‘normal’ height of their nasal counterparts.

This might be the conclusion necessary for Ijesa: there is a basic [ATR] contrast in the set of [+HI] vowels that is neutralized in the oral subset, but not the nasal subset, in favor of the relatively raised end of the contrast, [+ATR]. If this is the case, then the rele-

vant multiple-feature markedness constraint in Ijesa is not *[+HI, –ATR] but rather a member of the markedness constraint sub-family that is responsible for Beddor’s observed correlation between vowel height and nasalization contrasts. Exactly what this constraint might be is not germane here; it may simply be the more specific *[-NAS, +HI, –ATR]. I must leave it to future research in this interesting area of phonology to enlighten us.

2.7 Summary

I have reviewed in this section the subset of the factorial typology of proposed constraints consistent with the schematic ranking necessary to describe stem-controlled vowel harmony. This basic ranking is repeated in (115). Input-output faithfulness must dominate markedness in order to guarantee a basic contrast between the values of the harmonic feature. Agreement must in turn dominate input-output faithfulness in order to ensure harmony, and stem-affixed form faithfulness must also dominate input-output faithfulness in order to ensure stem control and to account for the universal behavior of medial vowels (see §2.3.2).

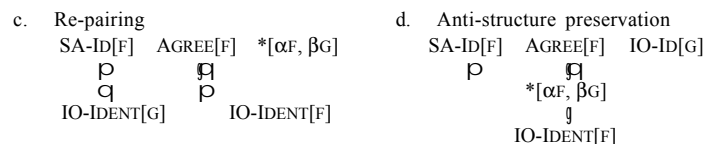
(115) Schematic ranking for basic stem control

SA-IDENT[F]	AGREE[F]
i	e
IO-IDENT[F]	
e	i
*[-F]	*[+F]

Four variations on the basic stem control theme were also discussed in detail in this section, the schematic rankings for which are repeated in (116) below.

(116) Variations on the basic stem control theme

a. Phonological opacity	b. Morphological opacity			
SA-ID[F]	IO-ID[G]	*[αF, βG]	SA-IDENT[F]	IDIOSYNC
ρ	q		ρ	q
	AGREE[F]			AGREE[F]
	g			g
	IO-IDENT[F]			IO-IDENT[F]



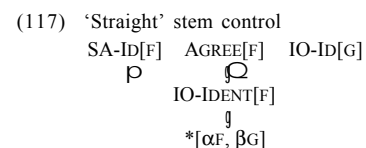
I include morphological opacity (116b) here for completeness; it is for all intents and purposes identical to phonological opacity (116a) except that the more abstract constraint IDIOSYNC replaces * $[\alpha_F, \beta_G]$, which in turn obviates any necessary ranking for IO-IDENT[G]. Given these considerations, I ignore morphological opacity in the discussion that follows.

The variations in (116) consist of alternative rankings centered around the basic stem control ranking in (115), with the addition of two other constraints: the multiple-feature markedness constraint * $[\alpha_F, \beta_G]$, violated by the combination of a particular value of the harmonic feature [F] with a particular value of some other feature [G], and an input-output faithfulness constraint IO-IDENT[G], violated by a change in that other feature. The variations essentially differ in terms of which of the constraints AGREE[F], * $[\alpha_F, \beta_G]$ or IO-IDENT[G] is ranked lowest of the three:

- ¶ Opacity (116a) requires that AGREE[F] be lowest ranked, since it violates agreement. The non-initial [-HI] vowels of Turkish, which are opaque to [RD] harmony, were shown in §2.3.1 to be the by-products of a particular instance of this schematic ranking.
- ¶ Re-pairing (116c) demands that IO-IDENT[G] be lowest ranked. In §2.5.1 I showed how an instance of this schematic ranking accounts for the fact that the [-LO] vowel [e] and [+LO] vowel [a] of Turkish indirectly alternate with each other in [BK] harmony.
- ¶ Anti-structure preservation (116d) entails violation of * $[\alpha_F, \beta_G]$, which must therefore be the lowest-ranked constraint of the three. I demonstrated in §2.6.1

that the creation by [ATR] harmony of otherwise non-contrastive [+HI, -ATR] oral vowels in Ijesa is due to an instance of this schematic ranking.

Any total linearization of the four partial rankings in (116) is consistent with this typological breakdown. The only other crucial rankings noted in all four of the ranking diagrams, AGREE[F] » IO-IDENT[F] and SA-IDENT[F] » IO-IDENT[F], are just the basic ones necessary for stem control (115) in the first place — except for one; namely, the ranking of * $[\alpha_F, \beta_G]$ above IO-IDENT[F] in the case of anti-structure preservation (116d). The opposite ranking between these constraints actually fills a fifth and final typological slot: a ‘straight’ stem-controlled harmony system, with none of the accouterments in (116). This ranking is given in (117).³⁷



Such a pattern is not particularly rare, but it escapes the attention of the vowel harmonist since it is so boringly unencumbered. As van der Hulst, Mous and Smith (1986:105) write, “the treatment of full harmony systems [\approx (117) — EB] is trivial and not very interesting.”

Thus concludes our expedition across the familiar plains of stem control, and so must our foray into the relatively unfamiliar forest of dominance begin. The structure of the following section mirrors that of the section now ending fairly closely, in order to facilitate the comparison of parallel results attained in each, though in all but the summary section (§3.7) I have attempted to minimize repetition and redundancy as much as possible.

³⁷ The relative ranking of IO-IDENT[G] and IO-IDENT[F] is rendered irrelevant by the lowest rank of * $[\alpha_F, \beta_G]$, as indicated by the dotted line between the faithfulness constraints in (117).

3. Dominance is Local Conjunction

3.1 'Harmonic reversal'

A vowel or class of vowels may for some reason or another be obliged to always surface with only one of the two values of the harmonic feature [F], due to some undominated constraint that I refer to abstractly as *FIXED*. As just discussed in the previous section, what happens with words with such a vowel depends on the relative ranking of other constraints. For instance, if the lowest-ranked constraint is *AGREE*[F], the result is opacity, as shown in (118).

(118) Input: $\sqrt{[\alpha F] \cdot [-\alpha F]}$

Stem: $\sqrt{[\alpha F]}$

Candidates	<i>FIXED</i>	<i>SA-ID</i> [F]	<i>AGREE</i> [F]	<i>IO-ID</i> [F]
a. $\sqrt{[\alpha F] \cdot [\alpha F]}$	* !			*
b. $\sqrt{[\alpha F] \cdot [-\alpha F]}$			*	
c. $\sqrt{[-\alpha F] \cdot [-\alpha F]}$		* !		*

But suppose that *AGREE*[F] dominates *SA-IDENT*[F]. The result is something I dub *harmonic reversal*. The obstinate vowel itself triggers harmony, forcing vowels in less peripheral morphemes, even in the root, to agree with it. This is shown in (119).

(119) Input: $\sqrt{[\alpha F] \cdot [-\alpha F]}$

Stem: $\sqrt{[\alpha F]}$

Candidates	<i>FIXED</i>	<i>AGREE</i> [F]	<i>SA-ID</i> [F]	<i>IO-ID</i> [F]
a. $\sqrt{[\alpha F] \cdot [\alpha F]}$	* !			*
b. $\sqrt{[\alpha F] \cdot [-\alpha F]}$		* !		
c. $\sqrt{[-\alpha F] \cdot [-\alpha F]}$			*	*

The class of vowels that behaves in a reverse-harmonic manner depends entirely on the identity of the abstract constraint *FIXED*. Suppose, for instance, that *FIXED* is responsible for phonologically predictable opacity; that is, it is $*[\alpha F, \beta G]$. Suppose also that *IO-IDENT*[G] dominates *SA-IDENT*[F], in order to rule out the re-pairing method of satisfying $*[\alpha F, \beta G]$. Under this ranking, $[\beta G]$ vowels are the ones expected to behave in a reverse-harmonic manner, as shown in (120), while $[-\beta G]$ vowels are expected to harmonize normally with the stem, as shown in (121). Note that these expectations hold regardless of

the underlying value of [F] borne by the vowels in question; since *IO-IDENT*[F] is lowest-ranked, any change in the value of this feature is superfluous. I therefore omit *IO-IDENT*[F] from these tableaux.

(120) Input: $\sqrt{[\alpha F] \cdot [\beta G]}$

Stem: $\sqrt{[\alpha F]}$

Candidates	$*[\alpha F, \beta G]$	<i>AGREE</i> [F]	<i>IO-ID</i> [G]	<i>SA-ID</i> [F]
a. $\sqrt{[\alpha F] \cdot [\alpha F, \beta G]}$	* !			
b. $\sqrt{[\alpha F] \cdot [-\alpha F, \beta G]}$		* !		
c. $\sqrt{[\alpha F] \cdot [-\alpha F, -\beta G]}$				*
d. $\sqrt{[-\alpha F] \cdot [\alpha F, -\beta G]}$			* !	*

(121) Input: $\sqrt{[\alpha F] \cdot [-\beta G]}$

Stem: $\sqrt{[\alpha F]}$

Candidates	$*[\alpha F, \beta G]$	<i>AGREE</i> [F]	<i>IO-ID</i> [G]	<i>SA-ID</i> [F]
a. $\sqrt{[\alpha F] \cdot [\alpha F, -\beta G]}$				
b. $\sqrt{[\alpha F] \cdot [-\alpha F, -\beta G]}$		* !		
c. $\sqrt{[-\alpha F] \cdot [-\alpha F, -\beta G]}$				* !
d. $\sqrt{[\alpha F] \cdot [\alpha F, \beta G]}$	* !		* !	

Now recall that the theory of local conjunction — the components of which are repeated below in (122), reflecting their development in Chapter 1, §3.3 — requires that a local conjunction universally dominate both of its conjuncts.

(122) Local conjunction theory

- a. **Definition:** If A and B are non-conjoined members of the universal constraint set *Con*, then their local conjunction $A \&_l B$ is also a member of *Con*.
 - If $A \in$ markedness and $B \in$ faithfulness, then A and B must be *co-relevant* (A markedness constraint μ and a faithfulness constraint ϕ are *co-relevant* iff satisfaction of μ depends in part on the output not containing a particular value of a feature [F], and satisfaction of ϕ depends on the value of the same feature [F] not having changed in the mapping from input to output.)
- b. **Interpretation:** $A \&_l B$ is violated if and only if both its conjuncts A and B are violated in the smallest domain evaluable by A and B.
- c. **Ranking (universal):** $A \&_l B \gg \{A, B\}$.
 - **Preservation:** The local conjunction of a constraint C with a subhierarchy $\{A \gg B \gg \dots \gg Z\}$ yields the subhierarchy $\{A \&_l C \gg B \&_l C \gg \dots \gg Z \&_l C\}$.

Thus, the local conjunction $*[\alpha F, \beta G] \&_l \text{IO-IDENT}[F]$ must universally dominate its markedness conjunct $*[\alpha F, \beta G]$, which entails — by the power of transitivity of the domination

relation — that $*[\alpha F, \beta G] \&$, IO-IDENT[F] also dominates SA-IDENT[F] in (120) and (121). As noted in §2.2.2 above, this species of ranking is the foundation of a dominant-recessive vowel harmony system; in this particular case, one in which underlying $[-\alpha F, \beta G]$ vowels are dominant and all others recessive. In what follows I pick up where I left off in Chapter 1, §3.4 and show that the local conjunction of co-relevant markedness and faithfulness constraints is both necessary and sufficient to replace FIXED in (119) and thereby account for dominant-recessive vowel harmony.

3.2 Essentials of dominance

3.2.1 Local conjunction and multiple-feature markedness

Recall that the presence of a [+ATR] (dominant) vowel anywhere in a Kalenjin word causes all vowels to be [+ATR]; otherwise, all vowels surface faithfully as [-ATR] (recessive). The Kalenjin vowel inventory and some examples of harmony are repeated in (123) and (124).

(123) Kalenjin vowel inventory

	[+ATR]		[-ATR]	
[+HI, -LO]	i	u	ɪ	ʊ
[-HI, -LO]	e	o	ɛ	ɔ
[-HI, +LO]		ɐ		ɑ
	[-BK]	[+BK]	[-BK]	[+BK]

(124) Kalenjin dominant-recessive harmony (adapted from Hall et al. 1974:247)

- | | | | |
|----|-------------------------------------|---|---------------------|
| a. | / kɪ • ɑ • √ker / | → | kɪrager |
| | DIST. PAST • 1SG • shut | | 'I shut it' |
| b. | / kɪ • ɑ • √ker • m / | → | kɪrɛ:rin |
| | DIST. PAST • 1SG • see • 2SG | | 'I saw you (sg.)' |
| c. | / kɪ • ɑ • √ker • e / | → | kɪrɛgere |
| | DIST. PAST • 1SG • shut • NONCOMPL. | | 'I was shutting it' |

The first thing to note about these examples is that the dominance of the [+ATR] mid vowel [e] in each of the examples in (124b,c) cannot be attributed to the markedness of its [-ATR] counterpart [ɛ] in the same way that the opacity of the [-HI, -RD] vowels [ɑ,e] in Turkish, for instance, can be attributed to the markedness of their [+RD] counterparts

[ɑ,ø]. This is because the vowel [ɛ] does in fact regularly surface in Kalenjin; it surfaces when all the vowels in the word are [-ATR] — that is, when they are all recessive — as in the example in (124a).

The constraint responsible for the dominance sub-case of harmonic reversal therefore cannot simply be a markedness constraint; it must be a constraint that prevents dominant vowels from unfaithfully adopting the recessive value of the harmonic feature. Specifically, it must be a local conjunction of co-relevant markedness and faithfulness constraints. In the case of Kalenjin, the faithfulness conjunct is IO-IDENT[ATR] and the markedness conjunct is one that is violated by the recessive value of the harmonic feature, [-ATR].

Recall from Chapter 1, §3.4.2 that the markedness conjunct of this local conjunction is claimed to be $*[-LO, -ATR]$ rather than the single-feature markedness constraint $*[-ATR]$. There are three reasons to make this claim. The first is that the former, multiple-feature markedness constraint is distinguished from the latter by its reliance on an independently-motivated feature co-occurrence restriction (Hall & Hall 1980, Archangeli & Pulleyblank 1994) that provides a context for the relative markedness of the recessive feature value [-ATR]. The second reason is that $*[-LO, -ATR]$ is not violated by low vowels, which explains why there seem to be no dominant low vowels in Kalenjin (or Lango, the only other language I am aware of with a [+LO, +ATR] vowel and dominance of [+ATR]).

Finally, the third reason for adopting a multiple-feature markedness conjunct as opposed to a single-feature one is that there do exist a few languages in which [-ATR] is the dominant feature value. Arbitrarily dictating the isolated markedness of one or another of the feature values of [ATR] will cause problems either for those languages with [-ATR] dominance or for those with [+ATR] dominance, and simply claiming that the markedness of individual [ATR] values is somehow a variable, language-particular matter

does not seem at all adequate, especially given that [-ATR] dominance in languages like Nez Perce is largely predictable from their severely reduced vowel inventories (the relevant facts of Nez Perce are discussed and analyzed in detail in Chapter 5).

The implication of these considerations seems to be that single-feature markedness conjuncts should not be possible even in principle, since it ought to be no accident that *[-LO, -ATR] as opposed to simply *[-ATR] is used as the markedness conjunct in Kalenjin, Lango, and other languages with [+ATR] dominance. In order to ensure this result, I propose that single-feature markedness constraints in general do not exist, and that there are only multiple-feature markedness constraints — or, more generally, only markedness constraints against features *in some context*, whether featural or non-featural.

3.2.2 Basic dominance

The proposed local conjunction *[-LO, -ATR] &_l IO-IDENT[ATR] naturally takes the place of FIXED in the tableau in (119) above, *mutatis mutandis*, as shown in (125) below.³⁸

(125) Input: $\sqrt{[-ATR]} \bullet [-LO, +ATR]$ Stem: $\sqrt{[-ATR]}$

Candidates	*[-LO, -ATR] & _l IO-ID[ATR]	AGR[ATR]	IO-ID[ATR]	SA-ID[ATR]
a. $\sqrt{[-ATR]} \bullet [-L, +A]$		* !		
b. $\sqrt{[-ATR]} \bullet [-L, -A]$	* !		*	
c. $\sqrt{[+ATR]} \bullet [-L, +A]$			*	*

The higher rank of *[-LO, -ATR] &_l IO-IDENT[ATR] and AGREE[ATR] in languages like Kalenjin thus narrows the field of relevant candidates down to the reverse-harmonic candidate, which only violates the lower-ranked faithfulness constraints SA-IDENT[ATR] and IO-IDENT[ATR]. This is the essence of dominance, the schematic ranking for which is given in (126). (Although I assume the markedness conjunct of the local conjunction to be a multiple-feature markedness constraint, I schematically abbreviate it here as simply *[-αF].)

³⁸ Note that since *[-LO, -ATR] &_l IO-IDENT[ATR] crucially dominates SA-IDENT[ATR], the ranking between SA-IDENT[ATR] and IO-IDENT[ATR] is rendered irrelevant (but see §3.2.2 below), as indicated by the dotted line between them in the tableau and further highlighted by the frivolous reversal of their linear order relative to (119).

(126) Schematic ranking for basic dominance

*[-αF] & _l		
IO-IDENT[F]		AGREE[F]
ρ	q	
q	ρ	IO-IDENT[F]
SA-IDENT[F]		

Just as local conjunctions were ignored in the case of stem control, where they are mostly irrelevant, I henceforth generally disregard stem-affixed form faithfulness in this section on dominance, since SA-IDENT[F] is typically irrelevant here (but see §3.4).

3.3 Dominance meets opacity

3.3.1 Inalterably recessive vowels

Kalenjin has a small number of recessive affix vowels that are idiosyncratically opaque to harmony from a dominant vowel. These are the vowels of the reflexive suffix /ke:/ in (127a), of the negative prefix /ma/ in (127b), and of the perfectivizer prefix /ka/ in (127c).

(127) Kalenjin opacity (adapted from Hall et al. 1974:247)

a. /kɪ • a • √un • ke:/	→	kiɛunge:
DIST. PAST • 1SG • wash • REFL.		'I washed myself'
b. /ka • ma • a • √keɾ • ak/	→	kamaɛge:ɾək
REC. PAST • NEG • 1SG • see • 2PL		'I didn't see you (pl.)'
c. /ka • ma • ka • kə • √ke:ɾ • a/	→	kamagagoge:ɾə
REC. PAST • NEG • PERF • 3SG • SEE • 1SG		'and he hadn't seen me'

These opaque vowels consistently surface with the recessive [-ATR] value of the harmonic feature. Note also that vowels on the side opposite the [+ATR] dominant vowel also surface as [-ATR], as shown in (127b,c) by the surface [-ATR] value of the recent past prefix /ka/ which otherwise usually harmonizes with a following dominant [+ATR] vowel.

Like dominant vowels, the vowel of each of these morphemes must be targetted — albeit idiosyncratically — by some constraint demanding that the vowel surface as [-ATR]. I adopt the same general type of analysis for this case as I did for the idiosyncratic opacity of the Turkish progressive suffix vowel in §2.3.1.2 above: I claim that the three inalterably recessive vowels of Kalenjin are underlyingly [-ATR] and are somehow

subject to a positional faithfulness constraint, which I refer to as REC-IDENT[ATR] and which prevents changing these vowels to [+ATR].³⁹ Since the end result is opacity (i.e., disharmony), both REC-IDENT[ATR] and *[-LO, -ATR] & IO-IDENT[ATR] must dominate AGREE[ATR]. This is shown in (128).⁴⁰

(128) Input: [-LO, +ATR] • [-ATR]_o

Candidates	*[-LO, -ATR] & IO-ID[ATR]	REC-ID[ATR]	AGREE[ATR]	IO-ID[ATR]
a. ^σ [-L, +A] • [-ATR] _o			*	
b. [-L, +A] • [+ATR] _o		* !		*
c. [-L, -A] • [-ATR] _o	* !			*

The disharmonic candidate in (128a) is optimal because AGREE[ATR] is lower ranked than the constraints violated by the other two candidates. The candidate in (128b) is one in which the opaque vowel is changed to agree with the dominant vowel; this candidate fatally violates REC-IDENT[ATR]. The candidate in (128c) is one in which the dominant vowel is changed to agree with the opaque vowel, critically violating *[-LO, -ATR] & IO-IDENT[ATR].

Violation of agreement, though forced by the constraint responsible for opacity, is minimized in dominant-recessive systems just as it is in stem-controlled systems. In a stem-controlled system like Turkish, vowels on the side opposite the root vowel necessarily agree with the opaque vowel. As noted above in reference to the Kalenjin examples in (127b,c), a vowel on the side opposite the *dominant* vowel also necessarily agrees with the opaque vowel. In both cases, this is due to minimal violation: there is no reason to violate agreement more than necessary, as shown in (129) for the dominance case (cf. (86) and (89) for the stem control cases).

³⁹ Hall et al. (1974:248) note that the three inalterably recessive affixes in question are all enclitic and state that “explanations for [their failure] to enter into the harmonic series might be found in their syntax.” The position targeted by REC-IDENT[ATR] might be some (morpho-)syntactic enclitic position under Hall et al.’s hypothesis.

⁴⁰ Recall that the subscript ‘o’ flags the opaque vowel for perspicuity. Since stem-affixed form faithfulness is irrelevant here, information about which of the vowels is a stem vowel relative to the other is not indicated.

(129) Input: [-ATR] • [-ATR]_o • [-LO, +ATR]

Candidates	*[-LO, -ATR] & IO-ID[ATR]	REC-ID[ATR]	AGR[ATR]	IO-ID[ATR]
a. ^σ [-ATR] • [-ATR] _o • [-L, +A]			*	
b. [+ATR] • [+ATR] _o • [-L, +A]		* !		**
c. [+ATR] • [-ATR] _o • [-L, +A]			** !	*
d. [-ATR] • [-ATR] _o • [-L, -A]	* !			*

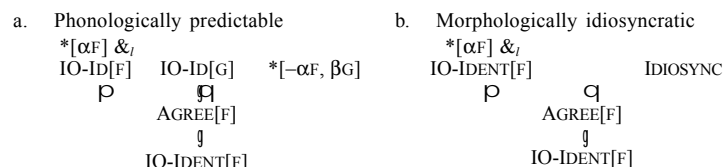
As I hope to have made clear in this section, dominance and opacity are by no means incompatible, as may have been mistakenly inferred from the contrast highlighted between opacity and harmonic reversal in §3.1. Opacity is simply the result of a high-ranked constraint that forces minimal violation of agreement, and this can happen under dominance as well as stem control. And, like stem-controlled systems, a dominant-recessive vowel harmony system may have either morphologically idiosyncratic opaque vowels, like the Kalenjin case just discussed, or phonologically predictable opaque vowels, as in the cases of Maasai and Turkana discussed and analyzed in Chapter 4.

Note however that in the case of phonologically predictable opacity, the multiple-feature markedness constraint responsible for it must mention the *opposite* value of the harmonic feature that is mentioned by the markedness conjunct of the local conjunction responsible for dominance. This is because opaque vowels in dominant-recessive vowel harmony systems are inalterably recessive (or else they’d be dominant!), meaning that the markedness constraint prevents them from adopting the dominant value of the harmonic feature. If the dominant feature value is [-αF], then the markedness conjunct is *[αF] and the multiple-feature markedness constraint responsible for opacity must thus be *[-αF, βG].

The schematic rankings necessary for opacity under dominance are given in (130). The phonologically predictable case has not been examined in detail here, but the additional ranking of IO-IDENT[G] above AGREE[F] that it requires can be easily deduced

from the extensive discussion of phonologically predictable opacity in stem control in §2.3.1.1 above: since it is AGREE[F] that is violated by opacity, IO-IDENT[G] must be higher ranked.

(130) Schematic ranking for opacity under dominance



3.3.2 Dominance and the medial vowel

Note that in both of the latter two examples in (127), repeated below in (131), there is a vowel (underlined here) between the dominant vowel and the idiosyncratically opaque vowel — a medial vowel on a par with those discussed in §2.3.2 above.

(131) Kalenjin medial vowels (adapted from Hall et al. 1974:247)

- | | | |
|---|---|---|
| a. / ka • ma • <u>a</u> • √ke:r • ak / | → | kamagge:rek
'I didn't see you (pl.)' |
| REC. PAST • NEG • 1SG • see • 2PL | | |
| b. / ka • ma • ka • <u>kɔ</u> • √ke:r • a / | → | kamagagge:re
'and he hadn't seen me' |
| REC. PAST • NEG • PERF • 3SG • SEE • 1SG | | |

In (131a) the medial vowel is that of the first person singular subject prefix /a/ and in (131b) it is the vowel of the third person singular subject prefix /kɔ/.⁴¹ Both of these medial vowels emerge as [+ATR] ([ɐ] and [o], respectively), changing their underlying [-ATR] specifications to agree with the dominant vowel of the root. But note that they could have in principle remained [-ATR], agreeing with the opaque vowel on the other side; input-output faithfulness would be better satisfied, and AGREE[ATR] is violated equally either way.

The reason that these medial vowels surface in agreement with the dominant root vowel rather than with the opaque prefix vowel must be due to stem-affixed form faith-

⁴¹ More specifically, /kɔ/ is a “sequential definite 3rd subject” (Hall et al. 1974:247), hence the ‘and’ in the gloss.

fulness. The stem of affixation for the opaque vowel prefix is the combination of the dominant vowel root and medial vowel prefix (and perhaps also the suffix in these examples, depending on the exact morphology of Kalenjin). There being no opaque vowel in this stem of affixation, the prefix vowel has no choice but to agree with the dominant vowel of the root, because AGREE[ATR] and * $[-LO, -ATR]$ &_I IO-IDENT[ATR] both dominate IO-IDENT[ATR]. Once the opaque vowel affix is added, however, there is guaranteed to be disagreement, and so the medial vowel must choose whether to be faithful to its underlying value or to its opposite value in the stem of affixation. Since the latter option is the apparent choice in Kalenjin, it must be the case that SA-IDENT[ATR] dominates IO-IDENT[ATR] in this language.⁴²

(132) Input: $[-ATR]_o \bullet [-ATR] \bullet \sqrt{[-LO, +ATR]}$ Stem: $[+ATR] \bullet \sqrt{[-LO, +ATR]}$

Candidates	REC- ID[ATR]	AGR [ATR]	SA- ID[ATR]	IO- ID[ATR]
a. $[-ATR]_o \bullet [-ATR] \bullet \sqrt{[-L, +A]}$		*	* !	
b. $[-ATR]_o \bullet [+ATR] \bullet \sqrt{[-L, +A]}$		*		*
c. $[+ATR]_o \bullet [+ATR] \bullet \sqrt{[-L, +A]}$	* !			**

The interest of this point derives from the *choice* just alluded to: if the ranking between IO-IDENT[ATR] and SA-IDENT[ATR] were reversed, then the medial vowel would surface faithfully to its input [ATR] value, resulting in (apparent) agreement with the opaque vowel. This is to be distinguished from the behavior of medial vowels in stem-controlled harmony systems; as discussed at significant length in §2.3.2 above, medial vowels in stem-controlled vowel harmony systems never have a choice but to agree with the adjacent stem vowel.

The upshot is that the behavior of medial vowels in dominant-recessive vowel harmony systems differs in principle from that of stem-controlled vowel harmony sys-

⁴² The undominated local conjunction * $[-LO, -ATR]$ &_I IO-IDENT[ATR] and any candidate that foolishly violates it are left out of this tableau due to considerations of space and immediate relevance.

tems.⁴³ As of this writing I do not know of any examples that necessitate the reverse of the Kalenjin ranking just discussed; that is, examples in which medial vowels surface faithfully and in apparent agreement with the opaque vowel rather than with the dominant vowel. This is partly due to the paucity of examples even in those dominant-recessive languages for which there is sufficient data to determine many other things about their vowel harmony systems.

In Maasai and Turkana, for instance, there is simply a general lack of examples with sufficient affixation to see what happens in sequences of the necessary type, which is more peripheral opaque vowel • medial vowel • less peripheral dominant vowel (when the opaque vowel and the medial vowel are both prefixal, as in the Kalenjin example) or less peripheral dominant vowel • medial vowel • more peripheral opaque vowel (when the medial vowel and the opaque vowel are both suffixal). On the other hand, sequences of the type less peripheral opaque vowel • medial vowel • more peripheral dominant vowel, which are not found in Kalenjin, *are* found in both Maasai and Turkana, and their analysis is non-trivial. I postpone discussion and analysis of these cases until these two languages are confronted in Chapter 4.

3.4 Dominance reversal

Before turning to the analysis of cases of re-pairing and anti-structure preservation in dominant-recessive vowel harmony systems, there is one more aspect of the preceding analysis of opacity under dominance that deserves some attention. The tableau in (128) above is repeated in (133) below; I ask that you focus your attention on the final candidate, (133c).

⁴³ Medial vowels that are epenthetic or tautomorphic with the opaque vowel (see §§2.3.2.2–2.3.2.3) are predicted to behave identically in either type of system, a simple *Gedankenexperiment* I leave to the reader.

(133) Input: [-LO, +ATR] • [-ATR]_o

Candidates	*[-LO, -ATR] & _I IO-ID[ATR]	REC-ID[ATR]	AGREE[ATR]	IO-ID[ATR]
a. ɛɔ [-L, +A] • [-ATR] _o			*	
b. [-L, +A] • [+ATR] _o		* !		*
c. [-L, -A] • [-ATR] _o	* !			*

In this candidate, the dominant vowel becomes [-ATR] in violation of the undominated local conjunction *[-LO, -ATR] &_I IO-IDENT[ATR]. (The same is true of the final candidate in (129) above.) Note that this is essentially a reverse-dominance candidate, since a dominant vowel succumbs to a recessive one. If *[-LO, -ATR] &_I IO-IDENT[ATR] were instead ranked below both AGREE[ATR] and REC-IDENT[ATR], then the candidate in (133c) would be the optimal one, as shown below in (134).

(134) Input: [-LO, +ATR] • [-ATR]_o

Candidates	REC-ID[ATR]	AGREE[ATR]	*[-LO, -ATR] & _I IO-ID[ATR]	IO-ID[ATR]
a. [-L, +A] • [-ATR] _o		* !		
b. [-L, +A] • [+ATR] _o	* !			*
c. ɛɔ [-L, -A] • [-ATR] _o			*	*

Like opacity, dominance reversal can come in two flavors: phonologically predictable and morphologically idiosyncratic. The two schematic rankings for these, corresponding to those for opacity in (130), are as given in (135).

(135) Schematic ranking for dominance reversal

a. Phonologically predictable	b. Morphologically idiosyncratic
AGREE[F] IO-ID[G] *[-αF, βG]	AGREE[F] IDIOSYNC
ρ ϑ	ρ ϑ
*[αF] & _I IO-IDENT[F]	*[αF] & _I IO-IDENT[F]
‡	‡
IO-IDENT[F]	IO-IDENT[F]

I am not at this time aware of any phonologically predictable dominance reversals, but I do know of a morphologically idiosyncratic case. This is the case of Turkana, and it is discussed and analyzed at length in Chapter 4.

3.5 Dominance and re-pairing

Recall from Chapter 1, §3.4 that the vowel inventory of Diola Fogny lacks a direct [+ATR] counterpart of the low [-ATR] vowel [a], and that this low vowel alternates instead with the mid [+ATR] vowel [ɤ]. Examples demonstrating this alternation are repeated in (136).

(136) Diola Fogny dominant-recessive harmony (adapted from Sapir 1965:12)

- a. / ni • √baj • ɛn • u / → nibajɛnu
 1SG • have • CAUS • 2PL 'I have caused you to have'
- b. / ni • √baj • ul • u / → nibɤjulu
 1SG • have • from • 2PL 'I have from you'

In the first example (136a), the vowels are all [-ATR] (recessive) and thus surface as such, including the vowel of interest in the root /√baj/. The causative suffix /ɛn/ of this form is replaced in the second example (136b) by the [+ATR] (dominant) 'towards the speaker' suffix /ul/ (abbreviated to 'from' in the interlinear gloss). This causes all the other vowels to shift to [+ATR], including the root vowel, which surfaces as [ɤ].

This indirect alternation is clearly just another instance of re-pairing. Not only IO-IDENT[ATR] but also IO-IDENT[LO] must be sacrificed in Diola Fogny in order to satisfy agreement as well as to not create a [+LO, +ATR] vowel. This is shown in the tableau in (137).

(137) Input: [+LO, -ATR] • [-LO, +ATR]

Candidates	*[-LO, -ATR] & IO-ID[ATR]	AGR [ATR]	*[+LO, +ATR]	IO-ID[ATR]	IO-ID[LO]
a. [+L, -A] • [-L, +A]		* !			
b. [+L, +A] • [-L, +A]			* !	*	
c. [+L, -A] • [-L, -A]	* !			*	
d. ^{ɛɸ} [-L, +A] • [-L, +A]				*	*

The input in this tableau consists of a [+LO, -ATR] vowel and a [-LO, +ATR] (dominant) vowel. The faithful realization of this input in (137a) fatally violates AGREE[ATR], while the simple [-ATR]-to-[+ATR] change in (137b), which is usually optimal in Diola Fogny as

it is in Kalenjin, is ruled out by the markedness constraint against low [+ATR] vowels, *[+LO, +ATR]. Finally, the dominance reversal candidate in (137c), in which the dominant vowel itself changes to [-ATR], violates the undominated local conjunction *[-LO, -ATR] & IO-IDENT[ATR]. This leaves the re-paired candidate in (137d), with its changes in both [ATR] and [LO], as the winner.

The following schematic ranking thus accounts for re-pairing under dominance. Note again that the multiple-feature markedness constraint responsible for re-pairing must mention the opposite value of the harmonic feature that is mentioned by the markedness conjunct of the local conjunction responsible for dominance, for essentially the same reasons noted in §3.3.1 above for the case of phonologically predictable opacity.

(138) Schematic ranking for re-pairing under dominance

$$\begin{array}{c}
 *[\alpha F] \ \&_t \\
 \text{IO-ID}[F] \ \text{AGREE}[F] \ *[-\alpha F, \beta G] \\
 \begin{array}{cc}
 \rho & \rho \\
 \text{q} & \text{p}
 \end{array} \\
 \text{IO-IDENT}[G] \ \text{IO-IDENT}[F]
 \end{array}$$

Unlike re-pairing under stem control (see the end of §2.5), the relative ranking of the two lowest-ranked faithfulness constraints in (138) makes no absolutely no difference, even in monosyllabic words (where [F]-agreement is irrelevant). If IO-IDENT[F] dominates IO-IDENT[G], then potential [-αF, βG] vowels are dealt with by changing them to [-αF, -βG]; if IO-IDENT[G] instead dominates IO-IDENT[F], then they are still changed to [-αF, -βG], because changing them to [αF, βG] violates undominated *[\alpha F] & IO-IDENT[F].

Kalenjin may in fact also involve a case of re-pairing, though the case is very much less clear than it is in Diola Fogny. The low [-ATR] vowel that I have chosen to transcribe as [a] here “is pronounced very slightly fronted” (Hall et al. 1974:244),⁴⁴ while its low [+ATR] counterpart [ɐ] “is quite markedly back” (Hall et al. 1974:244). If this ob-

⁴⁴ Tucker (1964:451) writes that this vowel “has a value mid-way between Cardinal 4 [a] and Cardinal 5 [ɑ]”.

servation entails a difference in the feature [BK], then a re-pairing analysis is called for in the case of Kalenjin.

3.6 Dominance and anti-structure preservation

What Kalenjin does have is a clear case of anti-structure preservation. As discussed in §3.2.1 above, the choice of *[-LO, -ATR] as the markedness conjunct of the local conjunction responsible for [+ATR] dominance is supported in part by the fact that no language seems to have dominant [+LO, +ATR] vowels. Kalenjin has no examples of a dominant low vowel, while examples in Diola Fogany of dominant [ɣ] — the mid [+ATR] counterpart of the low [-ATR] vowel [a] — are quite thick on the ground, as the following examples show.

(139) Diola Fogany dominant /ɣ/ (Sapir 1965:12)

- | | | | | |
|----|---------------------|---|----------|-------------------------|
| a. | / i • √kɣɣɣ / | → | ikɣɣɣ | 'I am big' |
| b. | / ε • √mɣp • ey / | → | emɣpey | 'the ground squirrel' |
| c. | / a • √fɣnɣ • aw / | → | fɣnɣ:w | 'the joker' |
| d. | / na • √fɣl • ulɔ / | → | nɣfɣlulo | 'he went out from' |
| e. | / u • √tɣs • ut / | → | utɣsut | 'you (sg.) don't cross' |

Examples like these for Kalenjin [ɐ] simply do not exist. Because this vowel is never dominant, it cannot be a part of this language's phonemic inventory in the sense defined in §2.6. The [+LO, +ATR] vowel [ɐ] only surfaces in Kalenjin as a consequence of [ATR] harmony, meaning that Kalenjin [ATR] harmony is not structure preserving.

This can of course be accounted for by lowering the rank of *[+LO, +ATR] relative to the primary conflicting constraints AGREE[ATR] and IO-IDENT[LO], as shown in (140).

(140) Input: [+LO, -ATR] • [-LO, +ATR]

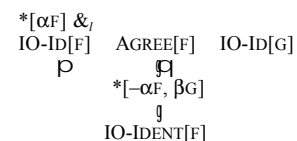
Candidates	*[-LO, -ATR] & IO-ID[ATR]	AGR [ATR]	IO-ID[LO]	IO-ID[ATR]	*[+LO, +ATR]
a. [L, -A] • [-L, +A]		* !			
b. [L, +A] • [-L, +A]				*	*
c. [L, -A] • [-L, -A]	* !			*	
d. [-L, +A] • [-L, +A]			* !	*	

As in (137) further above, the input in this tableau is a [+LO, -ATR] vowel and a [-LO, +ATR] (dominant) vowel. The faithful realization of this input in (140a) fatally violates AGREE[ATR], the dominance reversal candidate in (137c) is mortally wounded by a violation of the local conjunction *[-LO, -ATR] & IO-IDENT[ATR], and the re-paired candidate in (137d), with its changes in both [ATR] and [LO], suffers a lethal violation of IO-IDENT[LO]. This leaves the simple [-ATR]-to-[+ATR] change in (137b), which only violates low-ranked *[+LO, +ATR].

Note that *[+LO, +ATR] does not necessarily dominate IO-IDENT[ATR] here. This is because the absence of the [+LO, +ATR] vowel [ɐ] from the phonemic inventory (i.e., the set of dominant vowels) of Kalenjin is already accounted for by the fact that the markedness conjunct of the undominated local conjunction is *[-LO, -ATR].

The schematic ranking for anti-structure preservation under dominance is thus as given in (141). Once again and for the same reasons as before, the multiple-feature markedness constraint must mention the opposite value of the harmonic feature that is mentioned by the markedness conjunct of the local conjunction responsible for dominance.

(141) Schematic ranking for anti-structure preservation under dominance



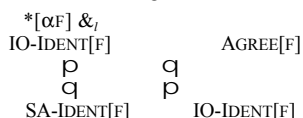
3.7 Summary

Dominance is a species of harmonic reversal, the result of the relative markedness of the recessive value of the harmonic feature. It is driven by a local conjunction of co-relevant markedness and faithfulness constraints, one that militates against a change from the unmarked (dominant) value to the marked (recessive) value. This local conjunction enables dominance if both it and agreement dominate stem-affixed form faithfulness.

The markedness conjunct of this local conjunction is argued not to arbitrarily dictate the relative markedness of the individual values of the harmonic feature [ATR], but instead to be a well-motivated multiple-feature markedness constraint reflecting the markedness of the different values of [ATR] in combination with antagonistic values of the vowel height features [HI] and [LO]. For instance, the relevant multiple-feature markedness constraint in [+ATR]-dominant languages like Kalenjin and Diola Fogny is *[-LO, -ATR].

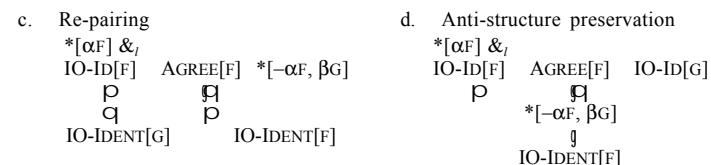
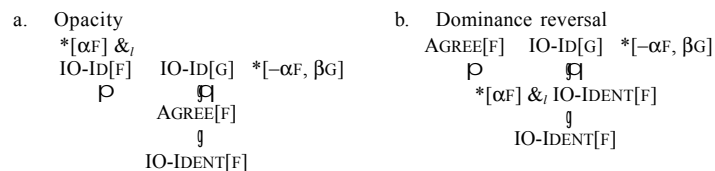
I have reviewed in this section the subset of the factorial typology of proposed constraints consistent with the schematic ranking necessary to describe dominant-recessive vowel harmony. This basic ranking is repeated in (142). Agreement must dominate input-output faithfulness in order to ensure harmony, and it must also dominate stem-affixed form faithfulness together with the local conjunction in order to ensure dominance (as a sub-case of harmonic reversal).

(142) Schematic ranking for basic dominance



Four variations on the basic dominance theme were also discussed in detail in this section, the schematic rankings for which are repeated in (143) below. (I omit the morphologically idiosyncratic types of opacity and dominance reversal; see §3.3.1 and §3.4.)

(143) Variations on the basic dominance theme



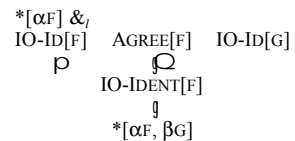
These four variations consist of alternative rankings centered around the basic dominance ranking in (142), with the addition of two other constraints: the multiple-feature markedness constraint *[-αF, βG], violated by the combination of the dominant value of the harmonic feature [F] with a particular value of some other feature [G], and an input-output faithfulness constraint IO-IDENT[G], violated by a change in that other feature. These ranking variations basically differ from each other in terms of which of the four constraints AGREE[F], *[αF] &_I IO-IDENT[F], *[-αF, βG] or IO-IDENT[G] is ranked lowest:

- ¶ Opacity requires that AGREE[F] be lowest ranked, since it violates agreement. The inalterably recessive vowels of Kalenjin, which are opaque to [ATR] harmony, were shown in §3.3.1 to be the result of a particular instance of the morphologically idiosyncratic version (130b) of this schematic ranking. The phonologically predictable cases of Maasai and Turkana will be discussed and analyzed in Chapter 4.
- ¶ Dominance reversal violates *[αF] &_I IO-IDENT[F], which must be lowest ranked in order to account for it. As noted in §3.4, the typological slot defined by the morphologically idiosyncratic version (135b) of this ranking is filled by Turkana, a case to be discussed and analyzed in some detail in Chapter 4.
- ¶ Re-pairing demands that IO-IDENT[G] be lowest ranked. In §3.5 I showed how an instance of this schematic ranking accounts for the fact that the [-LO] vowel [ɣ] and [+LO] vowel [a] of Diola Fogny alternate with each other in [ATR] harmony.
- ¶ Anti-structure preservation entails violation of *[αF, βG], which must therefore be the lowest-ranked constraint of the four. I demonstrated in §3.6 that the creation

by [ATR] harmony of otherwise non-contrastive (i.e., non-dominant) [+LO, +ATR] vowels in Kalenjin is due to an instance of this schematic ranking.

Any total linearization of the four partial rankings in (143) is consistent with this typological breakdown. The only other crucial rankings noted in all four of the ranking diagrams, AGREE[F] » IO-IDENT[F] and * $[\alpha F]$ &_I IO-IDENT[F] » IO-IDENT[F], are just the basic ones necessary for dominance (142) in the first place — except for one; namely, the ranking of the * $[-\alpha F, \beta G]$ above IO-IDENT[F] in the case of anti-structure preservation (143d). Just as in the case of stem control (see §2.7), the opposite ranking between * $[-\alpha F, \beta G]$ and IO-IDENT[F] in (143d) fills a fifth and final typological slot: a dominant-recessive vowel harmony system with none of the accouterments in (143).⁴⁵

(144) ‘Straight’ dominance



I am not aware of any examples of ‘straight’ dominance in [ATR] harmony, but the case of Swedish bidirectional devoicing discussed in Chapter 1, §3.4.3 seems to fit the bill. Every voiced (recessive) obstruent has a voiceless (dominant) counterpart, and there seems to be no opacity (i.e., no stubbornly voiced obstruents), no re-pairing (e.g., no indirect pairing between a voiceless stop and a voiced fricative), and no anti-structure preservation (i.e., any voiceless obstruent may be the dominant member of a cluster).⁴⁶

⁴⁵ The relative ranking of IO-IDENT[G] and IO-IDENT[F] is technically rendered totally irrelevant by this re-ranking, as indicated by the dotted line between them in (144).

⁴⁶ Things are not necessarily always as they seem, however, and more investigation into the case of Swedish is in order. In particular, there is an accompanying tense/lax obstruent distinction described by Hellberg (1974).

And thus concludes our foray into the relatively unfamiliar forest of dominance, not to mention our investigation of the factorial typology germane to this dissertation.

CHAPTER THREE
[ATR] HARMONY AND STEM CONTROL

1. Introduction

In this chapter I offer a complete analysis of the [ATR] harmony facts of (Standard) Yoruba within the agreement model.¹ Under the proposed analysis, any combination of vowels in the input is shown to result in a licit output combination; no crucial assumptions about the phonological structure of underlying representations are made, thereby demonstrating that an analysis in accord with the Richness of the Base hypothesis is not only possible but also desirable. This is in stark contrast with most recent analyses of the Yoruba facts (see especially Archangeli & Pulleyblank 1989, 1994, Pulleyblank 1993, 1996; though cf. Mohanan 1991, Artstein 1998a) which uphold crucially underspecified representations and the claim that only one value of the harmonic feature is ‘active’ in Yoruba; [-ATR].

Vowel harmony in Yoruba words is controlled by the final vowel, which seems to indicate that it is a unidirectional, right-to-left process. I follow many Yoruba scholars (see e.g. Adetugbo 1967, Fresco 1970, Awoyale 1974, Akinkugbe 1978) in claiming that final vowels are in fact root vowels, despite the apparent paucity of independent synchronic evidence for such morphological structure in some cases, and that Yoruba vowel harmony is thus an instance of stem control. An important fact follows from this as-

¹ Previous analyses of Yoruba vowel harmony include Awobuluyi 1967, Awobuluyi & Bamgbose 1967, Bamgbose 1966, 1967, Oyelaran 1971, Folarin 1987, Archangeli & Pulleyblank 1989, 1994, Pulleyblank 1993, 1996. Unless otherwise specified, the Yoruba data cited in this chapter were obtained from personal communications with Akin Akinlabi and/or from his phonological grammar of Yoruba, in progress. I thank Akin for comments, suggestions, and discussion, as well as for his generous and invaluable help with the data, not to mention access to his work in progress. Any remaining errors of fact and/or interpretation are of course mine alone.

Readers familiar with Yoruba orthography will notice that I transcribe the non-low [-ATR] vowels as [i, u, e, o] rather than ‘i, u, e, o’, the palatal glide as [j] rather than ‘y’, the palatal affricate with [dʒ] rather than ‘j’, and the labiovelar stops as [kp] and [gb] rather than ‘p’ and ‘gb’. Also, nasal vowels are transcribed with a diacritic for nasality (e.g., [ū]) rather than with a following nasal consonant (e.g., ‘un’). Finally, tones are transcribed but are otherwise ignored; ́ = high toned vowel, ̀ = low toned vowel, v (lack of tone marking) = mid toned vowel.

sumption: the fact that a vowel between the final vowel and an opaque vowel — a medial vowel, as such vowels were dubbed in Chapter 2 — consistently agrees with the final (root) vowel and never with the opaque vowel in Yoruba. (The fact itself is discussed in some detail in §4 of this chapter.)

There are two classes of phonologically-predictable opaque vowels in Yoruba: the [+HI] class, the two members of which are always [+ATR], and the [+LO] class, the single member of which is always [-ATR]. The opacity of these two vowel classes follows from the high rank of two multiple-feature markedness constraints *[+HI, -ATR] and *[+LO, +ATR], which respectively prevent [+HI] and [+LO] vowels from bearing an antagonistic value of the harmonic feature [ATR]. Disagreement between a [+HI] or [+LO] vowel with an adjacent stem vowel may thus be tolerated, but a vowel on the side opposite the root must agree with the markedness-bound opaque vowel in order to minimize violation of agreement. This applies equally to [+HI] vowels and [+LO] vowels under the proposed analysis, as schematized in (145).

(145) Opacity in Yoruba

- a. $[-\underset{\text{HI}}{\text{HI}}, +\text{ATR}] \cdot [+_{\text{HI}}, +\text{ATR}] \cdot \sqrt{[-\underset{\text{HI}}{\text{HI}}, -\text{ATR}]}$
- | | | | |
|---|---|---|---|
| 1 | 1 | Z | [-HI] root vowel arbitrarily specified [-ATR] |
| 1 | Z | | [+HI] vowel must be [+ATR], forcing disagreement with root vowel |
| Z | | | [-HI] vowel must be [+ATR] to agree with adjacent [+HI, +ATR] vowel |
- b. $[-\underset{\text{LO}}{\text{LO}}, -\text{ATR}] \cdot [+_{\text{LO}}, -\text{ATR}] \cdot \sqrt{[-\underset{\text{LO}}{\text{LO}}, +\text{ATR}]}$
- | | | | |
|---|---|---|---|
| 1 | 1 | Z | [-LO] root vowel arbitrarily specified [+ATR] |
| 1 | Z | | [+LO] vowel must be [-ATR], forcing disagreement with root vowel |
| Z | | | [-LO] vowel must be [-ATR] to agree with adjacent [+LO, -ATR] vowel |

The invocation of markedness constraints such as these closely follows recent work on Yoruba vowel harmony (Archangeli & Pulleyblank 1989, 1994, Pulleyblank 1993, 1996), but a critical difference lies in the uniform effects of these two markedness constraints in the proposed analysis compared with their disparate effects in these other analyses. In a

nutshell, the result under these other analyses is that [+HI] vowels block [-ATR] spreading while [+LO] vowels trigger it. This difference is a focus of critique in §4 of this chapter.

Another interesting fact about Yoruba vowel harmony is that [+HI] root vowels, although consistently [+ATR] themselves, in some cases behave as if they were [-ATR] in that they require preceding prefix vowels to be [-ATR]. This ambiguous behavior of [+HI] root vowels is analyzed here as the derivationally opaque interaction (Kiparsky 1971, 1973) between vowel harmony and [ATR] neutralization in [+HI] vowels, an analysis couched within McCarthy's (1998a) Sympathy Theory. Under this analysis, a designated faithfulness constraint ensures that [+HI, -ATR] root vowels emerge faithfully in an [ATR]-harmonic candidate that does not itself surface. In the eventual, disharmonic surface form, the prefix vowel's derived [-ATR] value is preserved by faithfulness to the non-surfacing harmonic candidate but the [+HI] root vowel's [-ATR] value is lost due to [ATR] neutralization.

The proposed analysis of Yoruba [ATR] harmony is presented in this chapter as an alternative to other recent analyses, for which I use Archangeli & Pulleyblank's (1989) seminal analysis as a representative. However, it is worth bearing in mind that it is the representational devices *behind* these other analysis (e.g., directionality, underspecification) that are at issue in this dissertation. These devices either already have been or eventually will be argued against on independent grounds in other chapters. Insofar as the proposed analysis is successful, then, the overall argument that such devices are unnecessary is supported.

2. Yoruba Vowel Inventory

2.1 The contrast in mid vowels

At the core of almost any vowel harmony system lies the fact that two sets of vowels *contrast* in the language, one set for each value of the harmonic feature. This does not

mean, however, that every vowel must *minimally* contrast with some other vowel solely in terms of the harmonic feature; the fact that this is often *not* the case in fact accounts for a great deal of what is interesting about vowel harmony from both a descriptive and a theoretical perspective. The vowel inventory of Yoruba is particularly interesting in this regard.²

(146) Yoruba vowel inventory

	[+ATR]		[-ATR]	
[+HI, -LO]	i	u		
[-HI, -LO]	e	o	ɛ	ɔ
[-HI, +LO]			a	
	[-BK]	[+BK]	[-BK]	[+BK]

As shown in (146), only the mid vowels [e,o,ɛ,ɔ] contrast in terms of the harmonic feature [ATR]; the high vowels [i,u] lack [-ATR] counterparts and the low vowel [a] lacks a [+ATR] counterpart. These two static facts are dynamically reflected in the different behaviors of these vowels with respect to [ATR] harmony, as we will see in §§3–4 below.

To describe the basic contrast that exists between the two values of the feature [ATR] in mid vowels, any and all markedness constraints against the two values of this feature in mid vowels — abbreviated here simply as *[+ATR] and *[-ATR] — must be dominated by the input-output faithfulness constraint IO-IDENT[ATR] to ensure the preservation of both values of [ATR] in the grammatical mapping from input mid vowels to output mid vowels.³

(147) [ATR] contrast ranking

IO-IDENT[ATR] » { *[+ATR], *[-ATR] }

² According to Akin Akinlabi (p.c.), the low vowel in Yoruba is central as opposed to back (cf. Archangeli & Pulleyblank 1989:174). I indicate this distinction by using the symbol [a] for a [-BK] low vowel as opposed to [ɑ] for a [+BK] low vowel. This symbolic choice is of no other significant consequence.

There are also three nasal vowels [ĩ,õ,ũ]; I mostly ignore this small contrast in nasality as it has no particular bearing on the [ATR] harmony facts of Standard Yoruba (cf. the Ijesa dialect, discussed in Chapter 2, §2.6).

³ No ranking between the two markedness constraints can be established, as I indicate by enclosing them in curly braces and separating them with a comma (equivalent to a dotted line as opposed to a solid line in tableaux).

If the very basic [ATR] contrast ranking in (147) did not hold in Yoruba, then either the [-ATR] set or the [+ATR] set of mid vowels would be predicted to *neutralize* with the other set, depending on the relative ranking of the two markedness constraints. If *[-ATR] were to dominate both IO-IDENT[ATR] and *[+ATR], for instance, then it would be best to change an input [-ATR] mid vowel to its [+ATR] counterpart, violating *[+ATR] and IO-IDENT[ATR] but sparing a violation of the hypothetically top-ranked *[-ATR]. The incorrectness of this ranking is shown by the tableaux in (148) below, in which a [-ATR] mid vowel in the input is shown to surface incorrectly as a [+ATR] mid vowel in the output.⁴

(148) Input: /ɛ/ (NB: *incorrect ranking for Yoruba*)

Candidates	*[-ATR]	IO-IDENT[ATR]	*[+ATR]
a. e	* !		
b. ^{ɛ̄} e		*	*

By the same logic, if *[+ATR] were to dominate both IO-IDENT[ATR] and *[-ATR], then it would be best to change an input [+ATR] mid vowel to its [-ATR] counterpart. The incorrectness of this ranking is shown by the tableaux in (149) below, in which a [+ATR] mid vowel in the input is shown to surface incorrectly as a [-ATR] mid vowel in the output.

(149) Input: /e/ (NB: *incorrect ranking for Yoruba*)

Candidates	*[+ATR]	IO-IDENT[ATR]	*[-ATR]
a. e	* !		
b. ^{ɛ̄} e		*	*

Since neither of these situations is the case in Yoruba, then it must be the case that the ranking in (147) holds, allowing the feature [ATR] to contrast. This is shown by the two tableaux in (150) and (151) below, in which [-ATR] and [+ATR] mid vowels in the input are respectively shown to correctly surface unchanged.

⁴ Unless an actual Yoruba word is being cited as an example, I consistently use front vowel symbols to represent both the front and back non-low vowels; thus, e = {e,o}, ɛ = {ɛ,ɔ}, and i = {i,u}.

(150) Input: /ɛ/

Candidates	IO-IDENT[ATR]	*[+ATR]	*[-ATR]
a. e	* !	*	
b. ^{ɛ̄} e			*

(151) Input: /e/

Candidates	IO-IDENT[ATR]	*[+ATR]	*[-ATR]
a. ɛ	* !		*
b. ^{ɛ̄} e		*	

2.2 Neutralization in non-mid vowels

2.2.1 Preamble

Since the values of [ATR] must contrast in Yoruba mid vowels, the lack of the [-ATR] high vowels [i,u] and of the [+ATR] low vowel [æ] must be due to markedness constraints militating against the *combination* of particular values of [ATR] with particular values of the features [HI] and [LO] — the features that distinguish these from the mid vowels. These multiple-feature markedness constraints are *[+HI, -ATR] and *[+LO, +ATR], motivated by the articulatory antagonism between a raised tongue body and a retracted tongue root in the former case and between a lowered tongue body and an advanced tongue root in the latter (see Hall & Hall 1980, Archangeli & Pulleyblank 1989, 1994, and references therein).

*[+HI, -ATR] and *[+LO, +ATR] are each active in delimiting the vowel inventory of Yoruba by virtue of being crucially higher-ranked than some conflicting faithfulness constraint which otherwise requires these potential contrasts in the input to be maintained in the output, in accordance with the Richness of the Base hypothesis (see Chapter 1, §2). However, *[+HI, -ATR] and *[+LO, +ATR] can be satisfied by a change in *either* of the two features specified by each constraint, and so the particular conflicting faithfulness constraint that is crucially dominated by each of them must be decided based on the available evidence.

2.2.2 High vowels

In order to satisfy *[+HI, -ATR], for instance, a [-ATR] high vowel /i/ in the input may change its [ATR] value or its [HI] value, surfacing in the output either as a [+ATR] high vowel [i] or as a [-ATR] mid vowel [ɛ]. The former result violates IO-IDENT[ATR] and the latter result IO-IDENT[HI]; to be active in Yoruba, *[+HI, -ATR] must dominate one of these two faithfulness constraints, and if it dominates both, then the lower-ranked of the two is the one that is violated in order to satisfy *[+HI, -ATR] in the optimal mapping. The two different results are shown by the tableaux in (152) and (153) below.

(152) Input: /i/

Candidates	*[+HI, -ATR]	IO-Id[HI]	IO-Id[ATR]	*[+ATR]	*[-ATR]
a. I	* !				*
b. ^{ɛɔ} i			*	*	
c. ɛ		* !			*
d. e		* !	*	*	

(153) Input: /i/

Candidates	*[+HI, -ATR]	IO-Id[ATR]	IO-Id[HI]	*[+ATR]	*[-ATR]
a. I	* !				*
b. i		* !		*	
c. ^{ɛɔ} ɛ			*		*
d. e		* !	*	*	

The tableau in (152) shows that a change in [ATR] is optimal, due to the relatively low rank of IO-IDENT[ATR]. The tableau in (153), on the other hand, shows that a change in [HI] is best because IO-IDENT[HI] is the lower-ranked of the relevant constraints.

Supposing that this latter ranking holds and that an input [+HI, -ATR] vowel surfaces as [-HI, -ATR] rather than as [+HI, +ATR], the existence of the [+HI, +ATR] vowels in the vowel inventory is still predicted. These simply emerge faithfully from input [+HI, +ATR] vowels, as shown in (154) below.

(154) Input: /i/

Candidates	*[+HI, -ATR]	IO-Id[ATR]	IO-Id[HI]	*[+ATR]	*[-ATR]
a. I	* !	* !			*
b. ^{ɛɔ} i				*	
c. ɛ		* !	*		*
d. e			* !	*	

2.2.3 Low vowels

In the same fashion, *[+LO, +ATR] may be satisfied given a [+ATR] low vowel /æ/ in the input either by changing its [ATR] value or by changing its [LO] value, so that it surfaces either as a [-ATR] low vowel [a] or as a [+ATR] mid vowel [e]. The former result violates IO-IDENT[ATR] and the latter result IO-IDENT[LO]; to be active in Yoruba, *[+LO, +ATR] must dominate one of these two faithfulness constraints, and if it dominates both, then the lower-ranked of the two is the one that is violated in order to satisfy *[+LO, +ATR] in the optimal mapping. The two possibilities are shown in (155) and (156) below.

(155) Input: /æ/

Candidates	*[+LO, +ATR]	IO-Id[LO]	IO-Id[ATR]	*[+ATR]	*[-ATR]
a. æ	* !			*	
b. ^{ɛɔ} a			*		*
c. e		* !		*	
d. ɛ		* !	*		*

(156) Input: /æ/

Candidates	*[+LO, +ATR]	IO-Id[ATR]	IO-Id[LO]	*[+ATR]	*[-ATR]
a. æ	* !			*	
b. a		* !			*
c. ^{ɛɔ} e			*	*	
d. ɛ		* !	*		*

The tableau in (155) shows that a change in [ATR] is optimal, due to the relatively low rank of IO-IDENT[ATR]. The tableau in (156), on the other hand, shows that a change in [HI] is best because IO-IDENT[HI] is the lower-ranked of the relevant constraints.

Again, supposing that this latter ranking holds and that input /æ/ surfaces as [e] rather than as [a], the existence of the [+LO, -ATR] low vowel [a] in the vowel inventory is still predicted. It simply emerges faithfully from input /a/, as shown in (157) below.

(157) Input: /a/

Candidates	*[+LO, +ATR]	IO-ID[ATR]	IO-ID[LO]	*[+ATR]	*[-ATR]
a. æ	* !	* !		*	
b. ^{ESP} a					*
c. e		* !	*	*	
d. ε			* !		*

2.2.4 Summary

In order to exclude the [+HI, -ATR] vowels [i, u] and the [+LO, +ATR] vowel [æ] from the Yoruba vowel inventory while maintaining the otherwise basic contrast between the values of [ATR] in mid vowels, the markedness constraints *[+HI, -ATR] and *[+LO, +ATR] must each crucially dominate one of two faithfulness constraints in order to effect one of two possible changes: a change in relative tongue root height (i.e., [HI] or [LO]) or a change in relative tongue root advancement (i.e., [ATR]). Which change is made in each of these cases cannot be determined on the basis of the static inventory alone; either of the two mappings in each case above is equally plausible. The choice is made definitively by the behavior of the high and low vowels with respect to [ATR] harmony, as discussed in detail in the following section.

3. [ATR] Harmony in Disyllables

3.1 Introduction

The facts of Yoruba [ATR] harmony are by and large based on the patterns found in two sets of data, disyllabic nouns and trisyllabic nouns. In this section I review and analyze the harmonic distribution of vowels in disyllables; the trisyllabic forms are put aside until §4.

Disyllabic nouns come in two flavors: monomorphemic nouns of the form VCV and deverbal nouns of the form V • √CV, where √CV is a verbal root. The final CV portion of VCV forms does not seem to correspond synchronically to any independently-justified root to which the initial V portion could be said to be attached as a prefix. However, Adetugbo (1967), Fresco (1970), Awoyale (1974), and Akinkugbe (1978) have proposed to analyze all noun-initial vowels in Yoruba as prefixes (cf. Oyelaran 1971) to a CV root, such that both sets of disyllabic forms are actually bimorphemic V • √CV.

There are at least two converging forms of evidence for the correctness of this proposal. The first form of evidence is what is of central importance here: [ATR] harmony is systematically controlled by the final vowel in Yoruba. This fact indicates that the final vowel is positionally privileged in some sense; that there is a high-ranking, special [ATR] faithfulness constraint that prevents its alteration. As I show in §4, the behavior of vowels between the final vowel and an initial opaque vowel (medial vowels; see Chapter 2, §2.3.2) reveals the true identity of this faithfulness constraint as SA-IDENT[ATR], meaning that the final vowel is the vowel of the ultimate stem of affixation, otherwise known as the root.

The second form of evidence has to do with a curious distributional restriction: nasal vowels and the vowel [u] are systematically absent from the initial syllable in Standard Yoruba. This fact points to a fundamental distinction between initial and final syllables; namely, that the final syllable hosts a wider range of contrasts than the initial syllable does. In the absence of cross-linguistic evidence for the positional privilege of final syllables *qua* final syllables, one can only conclude that the final syllable in Yoruba is privileged for some other reason. This reason must be morphological: the final syllable is part of the root while the initial syllable is part of an affix. Root-specific faithfulness (see Chapter 2, §2.4) outranks the markedness of nasal vowels and [u], which in turn outranks

general faithfulness. This schematic ranking delimits the inventory of the initial (prefix) syllable while allowing a wider range of contrasts in the final (root) syllable.⁵

I therefore adopt the proposal that all disyllabic nouns are bimorphemic $V \cdot \sqrt{CV}$ and refer to “initial prefix” and “final root” vowels throughout this chapter. That said, however, the reader should note that I will be using the simpler representation VCV for all of these forms in examples and tableaux. This choice is merely to avoid clutter; the final vowel is always the root and the initial one is always the prefix, so there should be no confusion.

3.2 Harmonic restrictions

The vocalic distributional restrictions indicative of [ATR] harmony in disyllables can be summarized as follows. In forms with mid vowels only, the two vowels must agree in their value for [ATR]; thus, the sequences [eCe] and [eCε] are allowed while *[εCe] and *[eCε] are disallowed. If the final root vowel is the [-ATR] low vowel [a], then the initial prefix vowel, if mid, must be [-ATR]; this rules out the sequence *[eCa] while allowing the sequence [εCa]. Any other combinations of low and mid vowels ([aCe], [aCε]) and any combination of high and mid vowels ([iCe], [iCε], [eCi], [εCi]) and of low and/or high vowels ([iCa], [aCi], [iCi], [aCa]) are permitted. Examples of the attested vowel combinations are given in (158).⁶

⁵ Since these particular distributional facts are not directly relevant to [ATR] harmony, I do not offer the details of the analysis in this chapter. Note, however, that it is essentially an instance of an *emergence of the unmarked* ranking, just like the one offered in Chapter 2, §2.4.2 for the distribution of [-HI, +RD] vowels in Turkish.

⁶ All of the examples in (158) are of the supposed monomorphemic VCV type. For reasons that can only be presumed to be accidental, there are no clearly non-deverbal words of the form [ɔCu] unless the final vowel is nasalized, hence the necessary choice of the last form in (158c.iv) with the only nasal vowel in these examples.

(158) Examples of Yoruba attested vowel combinations in VCV forms

- a. Mid vowels
 - i. [eCe] — [ɛ̀wè] ‘lip’, [olè] ‘thief’, [èrò] ‘crowd’, [òd̄ò] ‘rain’
 - ii. [εCe] — [ɛ̀gɛ́] ‘cassava’, [ɔsɛ́] ‘soap’, [ɛ̀fɔ́] ‘vegetable’, [ɔwɔ́] ‘hand’
- b. Low and mid vowels
 - i. [eCa] — [ɛ̀ja] ‘fish’, [òd̄á] ‘drought’
 - ii. [aCe] — [aɛ́] ‘world/earth’, [abo] ‘female’
 - iii. [aCε] — [alé] ‘night’, [akɔ́] ‘male’
- c. High and mid vowels
 - i. [iCe] — [ilé] ‘house’, [iḡbó] ‘forest, wood’
 - ii. [iCε] — [ide] ‘brass’, [ikó] ‘cough’
 - iii. [eCi] — [ebi] ‘hunger’, [òrí] ‘shea-butter’, [eku] ‘rat’, [òwú] ‘cotton’
 - iv. [εCi] — [ɛ̀bi] ‘guilt’, [ɔ́tí] ‘wine/beer’, [ɛ̀tu] ‘deer’, [ɔ̀rú] ‘heaven’
- d. Low and high vowels
 - i. [iCa] — [ilá] ‘okra’
 - ii. [aCi] — [àfi] ‘except’, [atú] ‘type of dress’
 - iii. [iCi] — [igi] ‘tree’, [ikú] ‘death’
 - iv. [aCa] — [aja] ‘dog’

The table in (159) below summarizes the facts just reviewed. Initial (prefix) vowels, labelled ‘V₁’, are listed vertically; final (root) vowels, labelled ‘V₂’, are listed horizontally. (The vowel [u] is left out of the vertical column to underscore the fact that its general absence in the initial prefix position is of no harmonic significance; see §3.1 above.) An unshaded cell indicates an attested combination of the respective vowels and a shaded cell indicates an unattested combination; the references in the unshaded cells are to the relevant data in (158).

(159) Vowel combinations in V₁CV₂ forms

$\downarrow V_1 / V_2 \rightarrow$	i	u	e	o	ε	ɔ	a
i	(d.iii)		(c.i)		(c.ii)		(d.i)
e	(c.iii)		(a.i)				
o							
ε	(c.iv)				(a.ii)		(b.i)
ɔ							
a	(d.ii)		(b.ii)		(b.iii)		(d.iv)

Based on the above facts, it appears that the two vowels in VCV forms in Yoruba must agree in terms of [ATR], *except* under any of the following conditions.

(160) Conditions under which vowels in VCV forms *needn't* agree in terms of [ATR]

- a. The initial prefix vowel is the [-ATR] low vowel [a].
- b. The initial prefix vowel is the [+ATR] high vowel [i].⁷
- c. The final root vowel is one of the [+ATR] high vowels [i,u].

The conditions in (160a,b) state that disharmony is tolerated only when the initial prefix vowel is a vowel that has no counterpart with which to alternate along the [ATR] dimension, due to the effect of the inventory-delimiting markedness constraints *[+HI, -ATR] and *[+LO, +ATR]. Since AGREE[F] constraints are completely symmetrical, there must be a reason why the final root vowel, when it is mid and thereby *is* able to alternate, does not give way and agree with the unchangeable initial prefix vowel in such a circumstance. The reason must be that harmony is stem-controlled in Yoruba, as I show in the sub-sections to follow.

The condition in (160c) adds a complicating twist to the picture, and I devote specific attention to it in §3.6. It should be noted here that some dialects of Yoruba other than the standard — for instance, the Ijesa dialect (Awobuluyi 1967, Fresco 1970, Akinlabi, in progress) — do not observe the condition in (160c); that is, a [+ATR] high vowel in the final root position may only be preceded by a [+ATR] initial prefix vowel (unless, of course, the initial prefix vowel is low, in which case the condition in (160a) takes precedence).⁸ [ATR] harmony is also stem-controlled in these dialects, just as it is in the standard; there is clearly something special about the condition in (160c), as I demonstrate in §3.6.

3.3 Low vowels and stem control

3.3.1 Introduction

Consider the fact that the disharmonic form *[eCa] is disallowed but the equally disharmonic form [aCe] (158b.ii), with the same vowels in the reverse order, is perfectly grammatical. A reasonable analysis of these facts is that in an input like /eCa/, which is most

⁷ Or [u], but again this vowel never occurs in the initial prefix position for presumably independent reasons.

⁸ The condition in (160b) is also not observed in the Ijesa dialect; that is, high vowels in the initial prefix position are [-ATR] if the final root vowel is [-ATR] (see Chapter 2, §2.6).

in danger of leading to the ungrammatical output *[eCa], the disagreement between the two vowels is not tolerated and the [ATR] value of the initial prefix vowel is changed to agree with the [ATR] value of the final root vowel. This problematic input thus surfaces as the unexceptional form [eCa] (158b.i). On the other hand, there is nothing to be done with an input like [aCe]; the disagreement in this case must be tolerated. The [ATR] value of the final root vowel cannot be changed because harmony is stem-controlled, and the [ATR] value of the initial prefix vowel also cannot be changed because [+ATR] low vowels are disallowed by *[+LO, +ATR].

3.3.2 Initial mid and final low

In order for the problematic input /eCa/ to surface as [eCa], AGREE[ATR] must be ranked high enough to force the initial prefix vowel to change its [ATR] value to [-ATR]. Thus, AGREE[ATR] must dominate at least both IO-IDENT[ATR] and *[-ATR] — effectively, the [ATR] contrast ranking in (147) — as shown by the tableau in (161) below.

(161) Input: /eCa/

Candidates	AGREE[ATR]	IO-IDENT[ATR]	*[+ATR]	*[-ATR]
a. eCa	* !		*	*
b. ^ɛ eCa		*		**

The more transparent input /ɛCa/ should also surface as [eCa], satisfying AGREE[ATR] at no expense to IO-IDENT[ATR]. This is shown by the tableau in (162) below.

(162) Input: /ɛCa/

Candidates	AGREE[ATR]	IO-IDENT[ATR]	*[+ATR]	*[-ATR]
a. eCa	* !	*	*	*
b. ^ɛ eCa				**



Under this analysis, the underlying [ATR] value of the initial prefix mid vowel cannot be determined since it always alternates to agree with the final root vowel. This has led some analysts to assume that such predictably harmonizing vowels are underlyingly unspecified for the harmonic feature, and that vowel harmony is strictly a feature-filling as opposed

to a feature-changing process (Archangeli & Pulleyblank 1989, 1994, Pulleyblank 1993, 1996, Akinlabi, in progress). See Chapter 6 for empirical and theoretical arguments against the crucial use of underspecification in the analysis of vowel harmony; see also Mohanan 1991 for these arguments with specific reference to the analysis of Yoruba [ATR] harmony.

3.3.3 Initial low and final mid

Now the reason that a disharmonic form like [aCe] (158b.ii) is grammatical is that the initial prefix vowel /a/ of an input /aCe/ cannot change to agree in terms of [ATR] with the final root vowel, because it is a low vowel and does not have a [+ATR] counterpart [æ] to alternate with due to *[+LO, +ATR]. Thus, *[+LO, +ATR] must dominate AGREE[ATR]. But this by itself is not sufficient, since AGREE[ATR] is symmetrical: a change in the value of [ATR] in the final root vowel should be good enough to ensure its satisfaction, as shown in (163) below. The intended output is indicated with a skull and crossbones; the failure of this particularly transparent mapping implies the failure of any mapping to this desired output.⁹

(163) Input: /aCe/

Candidates	*[+LO, +ATR]	AGR[ATR]	IO-ID[ATR]	*[+ATR]	*[-ATR]
a.  aCe		* !		*	*
b. æCe	* !		*	**	
c.  aCε			*		**


This indicates that the constraint responsible for stem-control must be active in selecting candidate (163a) over (163c). This constraint could in principle be the root-specific faithfulness constraint RT-IDENT[ATR], which (163c) clearly violates but (163a) satisfies. However, based on evidence from trisyllabic forms in Yoruba (see §4 below) and on the behavior of vowel harmony in such longer forms in languages generally (see Chapter 2,

⁹ I hesitate to write that this result is *entailed* because of the outside possibility of chain shift mappings. See Kirchner 1996 and Gnanadesikan 1997 on the analysis of chain shifts in OT; see also Moreton 1996 for relevant discussion. (Thanks to John McCarthy for pointing out the relevance of this point in this context.)

§2.3.2), I claim that stem control is instead due to stem-affixed form faithfulness; that is, not faithfulness to the *input* of the root, but rather to the *output* of the stem of affixation.

The fact that a [+ATR] mid vowel in the final root position does not change to agree with an unchangeable [-ATR] low initial prefix vowel, even at the risk of violating AGREE[ATR], indicates that the stem-affixed form faithfulness constraint SA-IDENT[ATR] is also higher-ranked than AGREE[ATR] in Yoruba. This is shown in the tableau in (164).¹⁰

(164) Input: /aCe/ Stem: [Ce]

Candidates	*[+LO, +ATR]	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]
a.  aCe			*	
b. æCe	* !			*
c. aCε		* !		*

Given the basic [ATR] contrast ranking in (147), we know that the final CV root portion of the input, /Ce/, surfaces as [Ce] (see the tableau in (151)); therefore, this is the stem, as shown above the tableau alongside the input. Changing the vowel of this stem to [ε] as in candidate (164c) fatally violates SA-IDENT[ATR], and so lower-ranked AGREE[ATR] is sacrificed instead.

To complete the argument, it must be shown that [ε] cannot be recruited as the indirect [+ATR] alternant for the initial prefix /a/ in order to satisfy AGREE[ATR]. Since such an alternation would involve a change in the feature [LO], IO-IDENT[LO] must also dominate AGREE[ATR], as shown in (165).

¹⁰ The lowest-ranked markedness constraints *[+ATR] and *[-ATR] are here and henceforth left out of tableaux whenever horizontal space is at a premium.

(165) Input: /aCe/ Stem: [Ce]

Candidates	*[+LO, +ATR]	SA-ID[ATR]	IO-ID[LO]	AGR[ATR]	IO-ID[ATR]
a. ^{ɛɛ} aCe				*	
b. æCe	* !				*
c. aCɛ		* !			*
d. eCe			* !		*

By transitivity of constraint domination, IO-IDENT[LO] dominates IO-IDENT[ATR], which means that potential instances of the low [+ATR] vowel /æ/ in the input must be dealt with by forcing violation of IO-IDENT[ATR], yielding [a], rather than IO-IDENT[LO], which would produce [e]. This is shown in the tableau in (166) below (cf. (155) above; see also §3.6 below, where this particular result will be tweaked slightly).

(166) Input: /æ/

Candidates	*[+LO, +ATR]	IO-ID[LO]	IO-ID[ATR]	*[+ATR]	*[-ATR]
a. æ	* !			*	
b. ^{ɛɛ} a			*		*
c. e		* !		*	
d. ɛ		* !	*		*

Before concluding, we must also account for harmonic outputs like [aCɛ] (158b.iii). The grammar as it stands predicts these to surface unchanged from inputs like /aCe/, because any change in the [ATR] value of either of the vowels of this input results in unmotivated and therefore unnecessary violations of either *[+LO, +ATR], SA-IDENT[ATR], AGREE[ATR], and/or IO-IDENT[ATR]. This is shown in the tableau in (167) below.

(167) Input: /aCe/ Stem: [Ce]

Candidates	*[+LO, +ATR]	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]
a. ^{ɛɛ} aCɛ				
b. æCɛ	* !		*	*
c. aCe		* !	*	*

3.3.4 Previous analyses

The facts involving combinations of low and mid vowels have been accounted for quite differently in previous analyses of Yoruba. Ever since Archangeli & Pulleyblank's (1989) seminal analysis, it has almost been taken for granted that the absence of *[eCa] as opposed to other combinations is indicative of the fact that only [-ATR] spreads, and it does so in a unidirectional manner, from right to left. As we have just seen, the apparent directionality of Yoruba [ATR] harmony is amenable to an analysis in terms of stem control; this is desirable for two reasons. First, as argued in Chapter 1, §1.2.2, it is a mistake to separate the apparent directionality of a vowel harmony process from the morphological structure of the language; this leads to the potential generation of many unattested harmony patterns. Second, the stem control analysis of Yoruba vowel harmony better explains the behavior of medial vowels, as demonstrated in §4 below where trisyllabic forms are discussed and analyzed.

3.4 Mid vowels

3.4.1 Potentially disharmonic inputs

Under the analysis presented thus far, it is not surprising that *[eCe] and *[eCɛ] are impossible disharmonic forms and that only the harmonic mid-vowel forms [eCe] (158a.i) and [ɛCɛ] (158a.ii) are possible. An initial prefix [-ATR] vowel /e/ is predicted to change to [+ATR] [e] to agree with a final root [e], and an initial [+ATR] prefix vowel /e/ is predicted to change to [-ATR] [ɛ] to agree with a final root [ɛ]. The two tableaux in (168) and (169) below demonstrate this. (The constraints *[+LO, +ATR] and IO-IDENT[LO] are left out of these tableaux due to their general irrelevance in these cases.)

(168) Input: /ɛCe/

Candidates	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]	*[+ATR]	*[-ATR]
a. eCe		* !		*	*
b. ɛCɛ	* !		*		**
c. ^{ɛɛ} eCe			*	**	

(169) Input: /eCe/ Stem: [Ce]

Candidates	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]	*[+ATR]	*[-ATR]
a. eCe		* !		*	*
b. eCε	* !		*		**
c. eCe			*	**	

3.4.2 Harmonic inputs

Given inputs with mid vowels that already agree in terms of [ATR] the result is an unaltered output in each case, as shown in the tableaux in (170) and (171) below.

(170) Input: /eCe/ Stem: [Ce]

Candidates	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]	*[+ATR]	*[-ATR]
a. eCe		* !		*	*
b. eCε	* !		**		**
c. eCe				**	

(171) Input: /εCe/ Stem: [Ce]

Candidates	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]	*[+ATR]	*[-ATR]
a. εCe		* !		*	*
b. εCε	* !				**
c. εCe			**	**	

Thus the analysis so far achieves the desired result that the [ATR] value of a mid vowel in the initial prefix position depends entirely on the [ATR] value of the final root vowel, mid or low.

3.4.3 Previous analyses

In Archangeli & Pulleyblank's (1989) analysis, the absence of disharmonic forms like *[eCε] is accounted for straightforwardly. Much like the present analysis, the [-ATR] value of the final vowel in an input like /eCe/ spreads from right to left to the initial vowel, rendering the unimpeachable form [εCε].¹¹ The analysis of *[eCε] is a bit more complicated, however. Like [aCe], this form is expected to be possible because only

¹¹ As discussed immediately below, an input like /eCε/ is not possible under Archangeli & Pulleyblank's assumptions. This detail is for all intents and purposes irrelevant to the point just made.

[-ATR] spreads and it only spreads from right to left (see §3.3.4 above). Archangeli & Pulleyblank avoid this expectation by claiming that the input /eCε/ is simply not a possible one in Yoruba.

Specifically, Archangeli & Pulleyblank (1989:180ff) propose that [-ATR] is a floating, 'morpheme-level' feature, such that the only possible disyllabic mid-vowel melody is the [ATR]-unspecified /ECE/, which may or may not be accompanied by a single [-ATR] feature. If the melody is so accompanied, then the [-ATR] feature links and spreads in a right-to-left fashion such that the output is [εCe]. If the melody is not accompanied by [-ATR], then the mid vowels surface with the default [+ATR] specification, rendering [eCe]. (Low vowels are [-ATR] by default, and so [aCe] is generated from the unaccompanied melody /ACE/ while [aCe] is derived from the same melody with an accompanying [-ATR] feature.)

There are two arguments for the superiority of the proposed analysis as opposed to Archangeli & Pulleyblank's. The first reason, a relatively minor one, is the fact that both the initial linking of an accompanying [-ATR] feature and [-ATR] spreading proceed from right to left. There is nothing to prevent the two operations from applying in different directions, yielding a wealth of odd patterns.¹² For instance, if linking applies from left to right while spreading applies from right to left, then [εCe] will be allowed while [eCε] and [eCe] are excluded. If linking applies from right to left while spreading applies from left to right, on the other hand, then [eCε] will be allowed while [εCε] and [εCe] are excluded.

The second, less trivial argument is the fact that it must be stipulated in Archangeli & Pulleyblank's analysis not only that [-ATR] is a morpheme-level feature, but that the only morphemes that may come accompanied by a [-ATR] feature are roots. In

¹² Archangeli & Pulleyblank (1989:181) state that linking "must take place from right to left because it feeds [spreading], a rule already established as applying from right to left." It is not clear how this deduction follows.

clearly bimorphemic forms (i.e., deverbal nouns), a prefix mid vowel alternates to agree with the following root vowel, not the other way around.¹³ If a prefix could come accompanied by its own [-ATR] feature, then we'd expect to find, contrary to fact, some cases of roots alternating to agree with the preceding prefix; namely, when an unaccompanied root is attached to a [-ATR]-accompanied prefix. The floating [-ATR] feature of the prefix would first link to the root vowel and then spread to the prefix vowel, in the expected right-to-left fashion. Even if the initial linkage to the root vowel were claimed to be prevented by the intervening morpheme boundary, it would still not be explained why the [-ATR] feature cannot then link to the prefix vowel, rendering an unattested disharmonic form like *[eCe].

All is explained uniformly under the proposed analysis. The absence of disharmonic mid-vowel forms is entirely due to stem control and the fact that both [-ATR] and [+ATR] mid vowels exist in the inventory (i.e., the fact that markedness constraints against the alternants in question are ranked low). The only crucial assumption in the proposed analysis, which has a number of precedents in the Yoruba literature, is that all disyllabic forms are bimorphemic. Both [-ATR] and [+ATR] enjoy an entirely free distribution in the input, only to be appropriately reined in by the relative ranking of relevant constraints on the output.

3.5 High vowels in the prefix

Forms with a high vowel in the initial prefix position are just like forms with a low vowel in this position, except that the markedness constraint responsible for their disharmonic behavior is *[+HI, -ATR] rather than *[+LO, +ATR]. Ranking the former constraint in the same spot as the latter thus accounts for the existence of disharmonic forms like [iCe] (158c.ii). To complete the argument, [ε] must not be a possible indirect [-ATR] alternant

¹³ Unless the root vowel is [+HI], in which case there is more to the story; see §3.6 below.

for /i/ in order to satisfy AGREE[ATR]; IO-IDENT[HI] must thus also dominate AGREE[ATR]. This is all shown in the tableau in (172) below (cf. (165) above).

(172) Input: /iCe/ Stem: [Ce]

Candidates	*[+HI, -ATR]	SA-ID[ATR]	IO-ID[HI]	AGREE[ATR]	IO-ID[ATR]
a. ^{ɛɛ} iCe				*	
b. iCe	* !				*
c. iCe		* !			*
d. eCe			* !		*

IO-IDENT[HI] in turn dominates IO-IDENT[ATR] by transitivity of constraint domination, meaning that potential instances of [+HI, -ATR] vowels in the input are dealt with by forcing violation of IO-IDENT[ATR], producing [+HI, +ATR] vowels, rather than IO-IDENT[HI], which would yield [-HI, -ATR] vowels. This is shown in the tableau in (173) below (cf. (152) above).

(173) Input: /i/

Candidates	*[+HI, -ATR]	IO-ID[HI]	IO-ID[ATR]	*[+ATR]	*[-ATR]
a. I	* !				*
b. ^{ɛɛ} i			*	*	
c. ε		* !			*
d. e		* !	*	*	

The same ranking of course accounts for the grammaticality of the harmonic form [iCe] (158c.i) from the input /iCe/, as shown in the tableau in (174) below (cf. (167) above).

(174) Input: /iCe/ Stem: [Ce]

Candidates	*[+HI, -ATR]	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]
a. ^{ɛɛ} iCe				
b. iCe	* !		*	*
c. iCe		* !	*	*

The ranking proposed so far also accounts for the fact that high and low vowels freely co-occur in any order; [iCa] (158d.i) and [aCi] (158d.ii). This is because the high-ranking

constraints *[+HI, -ATR] and *[+LO, +ATR] prevent these vowels from changing to either of their [ATR] counterparts in order to agree with the other vowel, as shown by the tableaux in (175) and (176). (The faithfulness constraints IO-IDENT[HI] and IO-IDENT[LO] and the candidates that fatally violate them are not shown here for reasons of space.)

(175) Input: /iCa/ Stem: [Ca]

Candidates	*[+LO, +ATR]	*[+HI, -ATR]	SA-ID[ATR]	AGR [ATR]	IO-ID[ATR]
a. ^{ESP} iCa				*	
b. iCa		* !			*
c. iCæ	* !		* !		*

(176) Input: /aCi/ Stem: [Ci]

Candidates	*[+LO, +ATR]	*[+HI, -ATR]	SA-ID[ATR]	AGR [ATR]	IO-ID[ATR]
a. ^{ESP} aCi				*	
b. æCi	* !				*
c. aCi		* !	* !		*

It naturally follows that high vowels may co-occur with each other and that low vowels may co-occur with each other; [iCi] (158d.iii) and [aCa] (158d.iv). Any change to the potential inputs /iCi/ and /aCa/ would result in unnecessary violations of one or more of the proposed constraints. I leave verification of this to the reader, in the interests of moving on to the least trivial part of the analysis — accounting for condition (160c).

3.6 High vowels in the root

3.6.1 Condition (160c)

Thus far I have accounted for the conditions in (160a,b) under which vowels may disagree in terms of [ATR]. As it stands, the proposed ranking fails to account for the condition in (160c) — the ambiguous behavior of high vowels in the final root position. The specific problem is that disharmonic forms like [eCi] (158c.iv) are grammatical; the initial prefix

vowel in such forms should be able to change its [-ATR] value to agree with the final [+ATR] root vowel.

3.6.2 Consistency in deverbal noun formation

The behavior of clearly bimorphemic V • √CV deverbal nouns indicate the solution to this problem. When a nominalizing V prefix with a mid vowel is attached to a √CV verbal root with a high vowel, the prefix vowel is consistently either [+ATR] or [-ATR], *depending on the identity of the root*. Thus, the verb roots [mu] ‘to drink’ and [rí] ‘to see’ take only [-ATR] mid-vowel prefixes ([ðmu] ‘drinker’, [èrí] ‘evidence’) while the verb roots [kú] ‘to die’ and [rú] ‘to disrupt’ take only [+ATR] prefixes ([òkú] ‘corpse’, [erú] ‘dishonesty’).¹⁴

Some high vowels in roots thus consistently behave as if they were [-ATR]. I propose to account for this fact by claiming that roots like [mu] ‘to drink’ are underlyingly /mú/, with a [+HI, -ATR] vowel. These roots consistently take [-ATR] prefixes because this allows agreement with the root vowel at an opaque level of analysis somewhere along the way to the eventual output. Thus, the [ATR] value of the initial prefix vowel is indeed entirely dependent on the [ATR] value of the final root vowel, as I’ve claimed — just not necessarily the final root vowel’s *surface* [ATR] value. At the surface, the covertly [-ATR] root vowel becomes [+ATR] due to *[+HI, -ATR], but the derived [-ATR] value of the prefix is retained despite the fact that it thereby ends up disagreeing with the root vowel.

Note that the necessary opaque level of analysis cannot simply be the input itself. The tableaux in (177) and (178) below show how only [eCi] is optimal under the proposed ranking, whether the input is /eCi/ (177) or /εCi/ (178). Though this optimal candidate is a grammatical one, the intended output [eCi] (indicated with a skull and crossbones) is

¹⁴ Note in particular the minimal contrast between [rú] ‘to disrupt’ and [rí] ‘to haft’; the former takes [+ATR] prefixes, as just noted, while the latter takes [-ATR] prefixes ([èrí] ‘the haft’; this latter example is noted in Archangeli & Pulleyblank 1989:188, fn. 18).

hereby predicted not to be. (The output of the stem of affixation of these forms is [Ci], not [Ci]; a necessary result, as was already shown in (173) above.)

(177) Input: /eCi/ Stem: [Ci]

Candidates	*[+HI, -ATR]	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]
a. $\{eCi\}$ eCi				*
b. $\{eCi\}$ eCi			* !	**
c. eCi	* !	* !		*

(178) Input: /εCi/ Stem: [Ci]

Candidates	*[+HI, -ATR]	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]
a. $\{eCi\}$ eCi				**
b. $\{eCi\}$ eCi			* !	*
c. eCi	* !	* !		

3.6.3 Sympathy Theory

3.6.3.1 Preamble

What is needed is an opaque level of analysis at which the third candidate in these tableaux, [eCi], is optimal and in a correspondence relation with the surface level of analysis, which retains the [-ATR] value of the initial prefix vowel even while sacrificing that value of the final root vowel and violating AGREE[ATR]. For this purpose I adopt McCarthy's (1998a) Sympathy Theory, by which the output candidates of an input are in correspondence with a designated output candidate. This designated candidate (termed the 'sympathetic' candidate, indicated with a $\{ \}$ in tableaux and enclosed in curly braces '{ }' in the text) may ultimately be non-optimal, in which case the occasion for an opaque interaction presents itself if faithfulness to the sympathetic candidate outweighs other constraints on the optimal output.

In the case of e.g. [ɔ̃mu] 'drinker', the input could be either /ɔ̃mu/ or /ɔ̃mu/ but the sympathetic candidate in both cases is {ɔ̃mu}; the actual output [ɔ̃mu] retains the [ATR] value of the initial prefix vowel in the sympathetic candidate but not that of the fi-

nal root vowel. This is because *[+HI, -ATR] dominates the demand for faithfulness to the sympathetic candidate — 'sympathetic faithfulness' — but sympathetic faithfulness in turn dominates AGREE[ATR], which is the crucial constraint violated by the actual output [ɔ̃mu].

3.6.3.2 Selecting the sympathetic candidate

The sympathetic candidate is selected as follows. All output candidates of a given input are measured up to a designated faithfulness constraint (termed the 'selector').¹⁵ The sympathetic candidate is the one candidate that both satisfies the selector and also best-satisfies the remainder of the constraint hierarchy in the usual fashion.

The selection of the sympathetic candidate is for all intents and purposes equivalent to a separate evaluation in which the selector is promoted to the top of the hierarchy. For expository purposes, I include a separate tableau showing the selection of the sympathetic candidate, with the selector in the top-ranked position and highlighted with a double-lined border. It should be noted, however, that under McCarthy's (1998a) proposal there is no actual promotion of the selector; the sympathetic candidate is selected in parallel with the optimal output (see McCarthy 1998a for details).

In the case at hand, the selector must be a faithfulness constraint that (temporarily) prevents the absolute neutralization of [+HI, -ATR] root vowels, so that e.g. the /u/ of the root /mu/ 'to drink' is preserved in the sympathetic candidate. One obvious constraint for this purpose, IO-IDENT[ATR], will not work as the selector because this constraint would preserve the value of [ATR] in *any* vowel, root or affix, such that the sympathetic candidate for /ɔ̃mu/ would be {ɔ̃mɔ̃} while the one for /ɔ̃mu/ would be {ɔ̃mɔ̃}. In

¹⁵ Selectors are not in principle limited to faithfulness constraints; in fact, markedness constraints have been used as selectors in Sympathy Theory analyses by Itô & Mester (1997), who use an alignment constraint; de Lacy (1998), who uses an exhaustive footing constraint; and Walker (1998a, 1999), who uses a feature-spreading constraint. McCarthy (1998a) notes that allowing markedness constraints to be used as selectors has consequences far beyond those explored in detail in his work, some of which may be conceptually or even empirically undesirable. See also McCarthy 1999 for extensive discussion of this issue; see also Chapter 5.

short, with IO-IDENT[ATR] as the selector, the ambiguous [ATR] value of the prefix is predicted to be maintained regardless of the possibility of AGREE[ATR] violation, whereas the single sympathetic candidate desired from both of these inputs, {ðmʊ}, must satisfy AGREE[ATR].

Using the root-specific faithfulness constraint RT-IDENT[ATR] as the selector avoids this problem by specifically excluding the prefix from its purview. This prevents an input [+HI, -ATR] root vowel from being changed under pressure from *[+HI, -ATR] into a [+ATR] high vowel in the sympathetic candidate, since such a change would violate RT-IDENT[ATR].¹⁶

However, recall that the other way to satisfy *[+HI, -ATR] is to change an input [-ATR] high vowel into a [-ATR] mid vowel, which is only prevented from happening by the ranking of *both* *[+HI, -ATR] and IO-IDENT[HI] above IO-IDENT[ATR] (see the discussion surrounding (173) above). RT-IDENT[ATR] is merely a root-specific version of IO-IDENT[ATR], and so it must also be normally dominated by IO-IDENT[HI] (or at least by RT-IDENT[HI]) in order for this result to hold. But since RT-IDENT[ATR] is the selector, it is effectively undominated for the purposes of selecting the sympathetic candidate. The sympathetic candidate could thus satisfy *[+HI, -ATR] by violating IO-IDENT[HI] instead, resulting in {ɛ} from /i/. To preclude this mapping, then, IO-IDENT[HI] must dominate *[+HI, -ATR].

With this ranking in place, the next two tableaux show how the sympathetic candidate is correctly selected with either /ðmʊ/ (179) or /ðmʊ/ (180) as the input.¹⁷

¹⁶ Such a change would *not* violate SA-IDENT[ATR], because (as noted just above (177)) the stem of affixation of the form in question must be [mu] (that is, [C]). This precludes SA-IDENT[ATR] from being a viable selector.

Note that this distinction between stem-affixed form faithfulness and root-specific faithfulness is yet another example of the fact that one cannot totally dispense with either; recall the discussion in Chapter 2, §2.4.

¹⁷ Note that the necessary linearization of the constraint hierarchy in the tableau makes it look as if IO-IDENT[HI] dominates SA-IDENT[ATR] here, though there is in fact no established ranking between these two constraints.

(179) Input: /ðmʊ/ Stem: [mu]

Candidates	RT-ID[ATR]	IO-ID[HI]	*[+HI, -ATR]	SA-ID[ATR]	AGR [ATR]	IO-ID[ATR]
a. $\text{ðm}\text{ʊ}$			*	*		
b. $\text{ðm}\text{u}$			*	*	* !	*
c. $\text{ðm}\text{ɔ}$		* !		*		
d. $\text{ðm}\text{u}$	* !					**

(180) Input: /ðmʊ/ Stem: [mu]

Candidates	RT-ID[ATR]	IO-ID[HI]	*[+HI, -ATR]	SA-ID[ATR]	AGR [ATR]	IO-ID[ATR]
a. $\text{ðm}\text{ʊ}$			*	*		*
b. $\text{ðm}\text{u}$			*	*	* !	
c. $\text{ðm}\text{ɔ}$		* !		*		*
d. $\text{ðm}\text{u}$	* !					*

Due to the top rank of the selector, the usual mapping of /ʊ/ to [u] in the last candidate of these two tableaux (cf. (173) above) is immediately discarded in this evaluation, leaving only candidates that preserve the [-ATR] value of the root vowel. One of these, candidate (c), has a [-ATR] mid vowel in the root, satisfying *[+HI, -ATR] but fatally violating the higher-ranked constraint IO-IDENT[HI] due to its non-preservation of the [+HI] value of the root vowel. This leaves only two candidates, (a) and (b), both of which violate *[+HI, -ATR] and SA-IDENT[ATR] but only the first of which satisfies the next constraint in the hierarchy, AGREE[ATR]. This candidate, {ðmʊ}, is the sympathetic candidate in both cases, as desired.

3.6.3.3 Sympathetic faithfulness

Now that the correct sympathetic candidate {ðmʊ} has been selected, the correct output candidate [ðmʊ] must be derived from it. This is achieved via a correspondence relation between output candidates and the sympathetic candidate, parallel to other correspondence relations (input-output, stem-affixed form, etc.). Faithfulness constraints on this particular correspondence relation — sympathetic faithfulness or ☉ -IDENT[F] constraints

— are ranked among the rest of the constraints in the hierarchy and, if sufficiently high-ranked, play an integral part in choosing the optimal candidate.

The actual output [ð̥mu], though unfaithful to the [ATR] value of the sympathetic candidate's final root {u}, is faithful to the [ATR] value of its initial prefix {ð̥} despite the violation of AGREE[ATR] that the resulting combination incurs. The unfaithfulness to the {u} is due to the fact that the sympathetic faithfulness constraint IO-IDENT[ATR] is ranked either below IO-IDENT[HI] and *[+HI, -ATR], or else below SA-IDENT[ATR]. Either way, the sympathetically [ATR]-faithful candidates *[ð̥mu] and *[ð̥mɔ] are correctly precluded. But IO-IDENT[ATR] must in turn dominate AGREE[ATR], which prefers *[ð̥mu]. This is all shown in the tableaux below for each of the relevant inputs /ð̥mu/ (181) and /ð̥mu/ (182).¹⁸

(181) Input: /ð̥mu/ Stem: [mu] (see (179) for selection of the sympathetic candidate)

Candidates	IO-ID[HI]	*[+HI, -ATR]	SA-ID[ATR]	IO-IDENT[ATR]	AGR [ATR]	IO-ID[ATR]
a. IO-IDENT[ATR] ð̥mu		* !	* !			
b. ð̥mɔ	* !		* !			
c. IO-IDENT[ATR] ð̥mu				*	*	*
d. ð̥mu				** !		**

(182) Input: /ð̥mu/ Stem: [mu] (see (180) for selection of the sympathetic candidate)

Candidates	IO-ID[HI]	*[+HI, -ATR]	SA-ID[ATR]	IO-IDENT[ATR]	AGR [ATR]	IO-ID[ATR]
a. IO-IDENT[ATR] ð̥mu		* !	* !			*
b. ð̥mɔ	* !		* !			*
c. IO-IDENT[ATR] ð̥mu				*	*	**
d. ð̥mu				** !		*

The evaluation of the actual output thus differs from the evaluation of the sympathetic candidate in that the mapping from /u/ to [u] is now required. The mapping of /u/ to [ɔ]

¹⁸ Note that the erstwhile selector RT-IDENT[ATR], violated by candidates (c) and (d) in these tableaux (the former being the optimal candidate), must be ranked below *[+HI, -ATR] to ensure the optimality of the actual output.

in candidate (b) in these tableaux is ruled out either by IO-IDENT[HI] (as in the selection of the sympathetic candidates in (179) and (180)) or else by SA-IDENT[ATR], and the faithful route from /u/ to [u] in candidate (a) is blocked by either *[+HI, -ATR] or else (again) by SA-IDENT[ATR]. The ultimate choice comes down to the harmonic candidate in (d) and the disharmonic but more sympathetically faithful candidate in (c), and the decision is made in favor of the latter because IO-IDENT[ATR] dominates AGREE[ATR].

3.6.4 Summary

To summarize, the relative ranking of agreement, markedness, input-output faithfulness and stem-affixed form faithfulness alone cannot account for condition (160c). However, the ambiguous behavior of high vowels in the final root position is entirely systematic in a way that calls for an opaque level of analysis, and I have shown here that Sympathy Theory provides just the right tools for this sort of analysis.

Abstract analyses of this sort have a long history in the vowel harmony literature, dating at least as far back as Vago 1973. Sound changes in languages with vowel harmony often leave gaps in the vowel inventory that the vowel harmony process takes its time catching up with. One of Vago's best-known examples is Hungarian, a language with [BK] harmony that has no [+BK] counterparts of the non-low [-BK] vowels [i,e], but some roots with only these vowels nevertheless consistently take [+BK] suffixes.¹⁹

Other examples include Manchu (Vago 1973, Odden 1978, Finer 1981, Li 1996), Yowlunne Yokuts (Newman 1944, Kuroda 1967, Kisseberth 1969, Steriade 1981, Archangeli 1984, 1985, Cole & Trigo 1988, Mester 1986, 1988, Cole & Kisseberth 1995, Kaun 1995, Archangeli & Suzuki 1997, Sprouse 1997, McCarthy 1998a, Hansson 1999, Hansson & Sprouse 1999), and Nez Perce (Rigsby 1965, Aoki 1962, 1966, 1968, 1970,

¹⁹ These Hungarian vowels are also transparent to the vowel harmony process, but this is a partially separate matter. Finnish is practically identical to Hungarian in that [i,e] are transparent to [BK] harmony, but roots with only these vowels always take [-BK] suffixes (with one systematic exception, on which see Kiparsky 1981). On the analysis of vowel transparency within the agreement model, see Chapter 5.

Chomsky & Halle 1968, Jacobsen 1968, Kiparsky 1968, Rigsby & Silverstein 1969, Zwicky 1971, Kim 1978, Hall & Hall 1980, Anderson & Durand 1988). Needless to say, the need for abstract analysis in the domain of vowel harmony is amply justified, as is the evidence for opaque process interactions more generally. The ambiguous behavior of high vowels in Yoruba is simply another example of such evidence.

3.6.5 What about low vowels?

The foregoing analysis encounters a potential but entirely avoidable problem. Given an input like /eCæ/ or /εCæ/ — one with a low [+ATR] final root vowel and a mid initial prefix vowel of any [ATR] specification — the inevitable sympathetic candidate seems to be {eCæ}, which could then lead to either one of two ungrammatical outputs: either *[eCæ] itself, by complete sympathetic faithfulness, or *[eCa], by absolute neutralization of the low [+ATR] vowel and sympathetic faithfulness to the [ATR] specification of the initial prefix vowel.

Since RT-IDENT[ATR] is the selector, the expected mapping from /æ/ to [a] in (166) is blocked in the selection of the sympathetic candidate. But this does not necessarily mean that the sympathetic mapping to {æ} will be the one to survive. Rather than tolerate the violation of *[+LO, +ATR] that {æ} incurs, IO-IDENT[LO] could be violated instead, resulting in {e} from /æ/. To ensure this, *[+LO, +ATR] must dominate IO-IDENT[LO]. Note that this is essentially the opposite of the ranking called for between the corresponding constraints in the case of high vowels: recall that in order to ensure the sympathetic mapping from /i/ to {ɪ}, IO-IDENT[HI] must dominate *[+HI, -ATR], lest /i/ become {ɛ} instead.

In the evaluation of the actual output, the {e} sympathetically derived from /æ/ will surface unchanged as [e] if ⊕-IDENT[ATR] also dominates IO-IDENT[LO]. All of this is shown in the following tableaux. First, the evaluation of the sympathetic candidate for each of the relevant inputs /eCæ/ and /εCæ/ is given in (183) and (184), respectively;

then, the evaluation of the actual output in each case is shown in (185) and (186). The output is predicted to be [eCe] (158a.i) under this ranking, a perfectly harmonic form (cf. (168) and (170) above).

(183) Input: /eCæ/

Candidates	RT-ID[ATR]	*[+LO, +ATR]	IO-ID[LO]	AGR[ATR]	IO-ID[ATR]
a. eCæ		* !			
b. εCæ		* !		*	*
c. ⊕ eCe			*		
d. eCa	* !				*

(184) Input: /εCæ/

Candidates	RT-ID[ATR]	*[+LO, +ATR]	IO-ID[LO]	AGR[ATR]	IO-ID[ATR]
a. eCæ		* !		*	
b. εCæ		* !			*
c. ⊕ eCe			*		*
d. eCa	* !				*

(185) Input: /eCæ/ (see (183) for selection of the sympathetic candidate)

Candidates	*[+LO, +ATR]	⊕-ID[ATR]	IO-ID[LO]	AGR[ATR]	IO-ID[ATR]
a. eCæ	* !				
b. ⊕ eCe			*		
c. eCa		* !		*	*
d. εCa		* !*			**

(186) Input: /εCæ/ (see (184) for selection of the sympathetic candidate)

Candidates	*[+LO, +ATR]	⊕-ID[ATR]	IO-ID[LO]	AGR[ATR]	IO-ID[ATR]
a. eCæ	* !				*
b. ⊕ eCe			*		*
c. eCa		* !		*	**
d. εCa		* !*			*

All that this analytical twist entails is that the claim made in (166) is not entirely correct. An input /æ/ in the root does not surface as [a] but rather as [e], due to the independently necessary use of RT-IDENT[ATR] as the selector in the Sympathy Theory analysis, which

temporarily blocks both the mapping from /æ/ to {a} as well as the mapping from /ɪ/ to {i} in the root. *[+LO, +ATR] ranked above IO-IDENT[LO] makes the sympathetic mapping from /æ/ to {e} optimal while the “opposite” ranking IO-IDENT[HI] over *[+HI, –ATR] makes the sympathetic mapping from /ɪ/ to {i} optimal. In the evaluation of the actual output, the sympathetically faithful /æ/ to ({e} to) [e] mapping is made possible, as was just shown, by the ranking of ⊗-IDENT[ATR] above IO-IDENT[LO]. The parallel case of /ɪ/ to ({i} to) [e] is correctly blocked due to the rank of IO-IDENT[HI] above ⊗-IDENT[ATR] ; thus, /ɪ/ actually surfaces as [i], as was shown earlier, in complete conformity with the claim made in (173).²⁰

Before closing this sub-section, I would like to briefly address a point raised by John McCarthy concerning the foregoing analysis.²¹ The ranking arguments made above between *[+LO, +ATR] and IO-IDENT[LO] on the one hand and between *[+HI, –ATR] and IO-IDENT[HI] on the other are rather delicate; neither involves a sympathetic faithfulness constraint yet both are made internal to the Sympathy Theory analysis — there seems to be no independent evidence for the relative rankings established between the members of these pairs of constraints. I concede that this is true, and there is an important reason why I think that the complexity of these ranking arguments is justified and in fact desirable.

Kiparsky (1973:80) claims that “opacity adds to linguistic complexity” (emphasis in the original) by which he means that “it [is] relatively hard to learn a rule [if there] is a relatively abstract indirect relationship between the form of the rule and the surface forms

²⁰ Note that it is also possible to get the right results in (183) through (186) above if either SA-IDENT[ATR] or RT-IDENT[ATR] rather than ⊗-IDENT[ATR] dominates IO-IDENT[LO]. The reason in the case of SA-IDENT[ATR] is precisely because of the point just made, that an underlying /æ/ in the root is destined to surface as [e]; this makes the stem of the hypothetical forms above [Ce], with a [+ATR] vowel, so the forms that violate ⊗-IDENT[ATR] in (185c,d) and (186c,d) also violate SA-IDENT[ATR]. The reason in the case of RT-IDENT[ATR] is that the underlying root vowel /æ/ is also [+ATR], and so again the forms that violate ⊗-IDENT[ATR] in (185c,d) and (186c,d) also violate RT-IDENT[ATR]. Thus, either SA-IDENT[ATR], RT-IDENT[ATR], or ⊗-IDENT[ATR] must dominate IO-IDENT[LO] to ensure the correct results in (183) through (186) above. Having noted this, I arbitrarily assume that it is in fact ⊗-IDENT[ATR] that crucially dominates IO-IDENT[LO].

²¹ In a recent paper, Itó & Mester (1999) raise the same issue in the context of another Sympathy Theory analysis.

of the language.” This general claim has gone generally unchallenged, correctly in my view. The insight behind this claim is quite clearly reflected in the devices of Sympathy Theory; the choice of an appropriate selector and the proper ranking of sympathetic faithfulness constraints among other constraints together involve relatively complex calculations.

Naturally, additional rankings among other constraints that are motivated primarily by a Sympathy Theory analysis, such as in the case at hand, further add to this complexity. All of this complexity is justified, however, by the very fact that derivational opacity tends to be marginalized and/or lost in the process of language change (see Kiparsky 1971). For instance, some dialects of Yoruba (Ijesa, for example) do not exhibit the opacity found in Standard Yoruba, as pointed out earlier; high root vowels in Ijesa cannot be preceded by [–ATR] mid vowel prefixes. Similarly, there are relatively few Hungarian roots with the [–BK] vowels [i,e] that take [+BK] suffixes (“about fifty”, by Vago’s (1976) count), and modern day Yowlumne has all but lost the infamous opaque interaction between the processes of long high vowel lowering and rounding harmony (Hansson 1999, Hansson & Sprouse 1999).

3.7 Previous analyses

Under Archangeli & Pulleyblank’s (1989) analysis, condition (160c) follows in a manner that may at first glance seem to be more straightforward than the analysis offered here. As discussed in §3.4.3, Archangeli & Pulleyblank assume that [–ATR] is a morpheme-level feature that either does or does not accompany otherwise [ATR]-unspecified melodies. In the case at hand, the underspecified melody would be /ECI/. If unaccompanied, it surfaces by default with [+ATR] vowels; [eCi]. If accompanied, on the other hand, the accompanying [–ATR] feature attempts to link to the underspecified melody in a right-to-left fashion. This linkage is blocked in the case of the final [+HI] vowel due to the *[+HI, –ATR] constraint; the [–ATR] feature simply skips this final vowel and links to the initial

mid vowel, producing the desired [eCi] output. No opaque level of analysis seems to be necessary to derive this result.

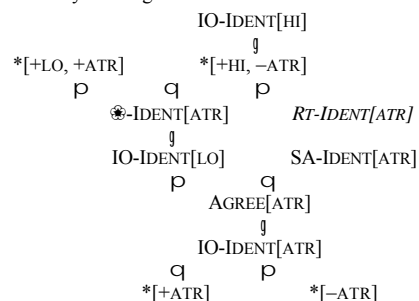
All is not as it seems, however. First of all, the unsuccessful ‘attempt’ on the part of the morpheme-level [-ATR] feature to first link to the [+HI] final vowel in fact results in a derived level of representation distinct from the input, albeit virtually indistinguishable from the input. The difference lies in the fact that this derived representation must somehow encode the derivational piece of information that the [-ATR] feature has already attempted to link to the final vowel, or else this feature would again and again attempt to link to the final vowel to no avail. Secondly, recall also from §3.4.3 that the morpheme-level analysis of [-ATR] in Yoruba is to be regarded with suspicion because it requires further stipulation in order to ensure that only *root* morphemes may come accompanied by [-ATR]. This criticism is particularly relevant to the case at hand since verbal roots with [+HI] vowels systematically select either [+ATR] or [-ATR] mid-vowel prefixes. Finally, note that the analysis of a dialect like Ijesa, in which condition (160c) does not hold, must be complicated by a statement to the effect that the right-to-left linkage of [-ATR] is not allowed to move on to the initial mid vowel after its unsuccessful attempt to link to the final high vowel. The problem here is that the analysis of Ijesa, in which [ATR] harmony holds more uniformly, should certainly not be more complicated than the analysis of the standard dialect, in which more conditions hold.

3.8 Interim summary

In (187) below I give a partial ranking diagram of the proposed constraints and their crucial rankings for the proposed analysis of [ATR] harmony in disyllabic forms in Yoruba (the sympathetic candidate selector *RT-IDENT[ATR]* is italicized for perspicuity). As I’ve shown so far, these rankings of the constraints account for the relevant facts under the assumption that any combination of vowels is possible in the input, in accordance with the Richness of the Base hypothesis. There is no need for underspecification or autosegmen-

tal spreading representations at any level of analysis; the fact that the [ATR] value of an initial prefix mid vowel is completely predictable from the [ATR] value of the final root vowel follows from the fact that harmony is stem-controlled and potentially feature-changing.

(187) Summary ranking



A partial ranking such as this one only makes note of crucial rankings; any total linearization of these constraints that is consistent with these crucial rankings will generate the same set of facts. Some direct ranking arguments made in the analysis above, such as the argument made in (164) that **[+LO, +ATR]* dominates *AGREE[ATR]*, are not directly reflected in the above diagram but are rendered indirect by rankings independently argued to exist between these constraints and those that come between them (**[-IDENT[ATR]*, *IO-IDENT[LO]*).

In the following section, I demonstrate how this same partial ranking of constraints is sufficient to account for the distribution of vowels in trisyllabic forms in Yoruba.

4. [ATR] Harmony in Trisyllables

4.1 The structure of trisyllables

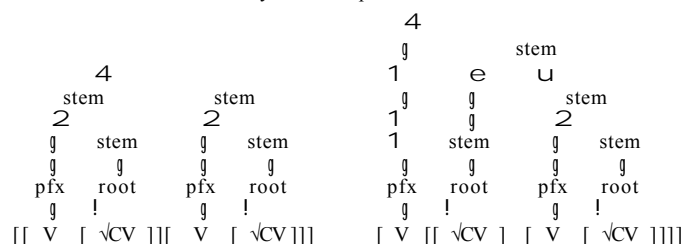
Many trisyllables in Yoruba are nominal compounds of two disyllabic VCV nouns, or verbal compounds of a CV verb and a disyllabic VCV noun which is then nominalized by a V

prefix. In both cases there is hiatal vowel deletion at the juncture between the members of the compound;²² the compounds thus all end up having the trisyllabic form VCVCV.

Some of these compounds exhibit [ATR] harmony between the members of the compound while others do not (Archangeli & Pulleyblank 1989:189-190). Akinlabi (1986) notes that the compounds that do not exhibit harmony are more clearly synchronically compositional than those “compounds” that do exhibit harmony, implying that the difference between the two basic types of trisyllable boils down to a difference in their respective morphological structures.²³ On the basis of this evidence, I propose that there is in fact a morphological structural difference between harmonic and disharmonic trisyllables.

First, those compounds that are more clearly synchronically compositional and that do not exhibit [ATR] harmony. I assume that the morphological structure of these is as shown by either of the two possible stem-compounding structures in (188). (Hiatal vowel deletion must apply in both cases in order to account for the eventual surface VCVCV forms.)

(188) Structures of disharmonic trisyllabic compounds



In each of these types of compound, the first CV sequence is a root and also a stem of affixation. Since harmony is stem-controlled, the vowels of these stems are impervious to

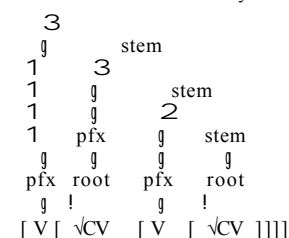
²² On hiatal vowel deletion in Yoruba, see Akinlabi & Oyeade 1987, Bamgbose 1966, Ola 1991, Ola & Pulleyblank 1998, Oyelaran 1971, Pulleyblank 1988ab, 1998, Rosenthal 1994, 1997, and references therein.

²³ See Folarin 1987 for a level-ordering account of this difference.

the demands of agreement; that is, these stem vowels are protected by SA-IDENT[ATR], which was shown in the previous section to dominate AGREE[ATR]. I henceforth ignore trisyllabic compounds of these two types since they do not exhibit [ATR] harmony.

The structure of those less clearly synchronically compositional “compounds” that *do* exhibit [ATR] harmony, on the other hand, is assumed to be as shown in (189). (Again, hiatal vowel deletion must apply in order to account for the resulting surface VCVCV form.)

(189) Structure of harmonic trisyllabic “compounds”



In the type of “compound”, which has a right-branching, prefixation-to-a-stem structure, the first CV sequence is categorially a root but it is not a stem of affixation. As indicated in the structure, it is technically demoted in status to a prefix. This means that the vowel of this root can change under harmonic pressure to agree with the vowel of the following stem to which it is attached. Just as I assume that apparently monomorphemic disyllabic forms have a bimorphemic $V \cdot \sqrt{CV}$ structure, I assume that all [ATR]-harmonic trisyllabic forms that are not readily and undeniably analyzable as polymorphemic do in fact have the structure in (189). As in the case of disyllables, I will be using the simpler representation VCVCV for all of these trisyllabic forms in examples and tableaux in order to minimize clutter.

In the remainder of this section I summarize the empirical generalizations relevant to [ATR] harmony in trisyllabic forms (§4.2) and then demonstrate how these facts

fall out from the constraint ranking already established for the analysis of [ATR] harmony in disyllabic forms (§4.3). I conclude the section and chapter with a brief summary (§4.4).

4.2 Empirical generalizations

4.2.1 High and low vowels

High and low vowels freely co-occur in the trisyllabic forms, just as they do in the disyllabic forms in (158d.i) and (158d.ii). This is shown by the examples in (190).

(190) High and low vowel co-occurrence

- a. [akisa] ‘rag’ (cf. (158d.i) [ilá] ‘okra’)
- b. [ikparí] ‘end’ (cf. (158d.ii) [ãfi] ‘except’)

These examples are entirely expected, since neither high nor low vowels are able to change their [ATR] specification to agree with each other due to *[+HI, –ATR] and *[+LO, +ATR].

4.2.2 All mid vowels

In trisyllabic forms with mid vowels only, all of them must agree in terms of [ATR], just as in the disyllabic forms in (158a). This is exemplified by the minimal contrast in (191).

(191) All mid vowels

- a. [ògèdè] ‘incantation’ (cf. (158a.i) [èwè] ‘lip’)
- b. [ògèdè] ‘banana/plantain’ (cf. (158a.ii) [ègé] ‘cassava’)

The obligatory agreement in these examples is also entirely expected, since no constraint preventing mid vowels from alternating between [+ATR] and [–ATR] dominates AGREE[ATR].

4.2.3 Two mids and a low

In trisyllabic forms with two mid vowels and a final low root vowel, the mid vowels must be [–ATR], just as in the disyllabic forms in (158b.i). This is shown in (192).

(192) Two mid vowels and a final low vowel

- a. [emèwà] ‘chief’s messenger’ (cf. (158b.i) [ɛja] ‘fish’)
- b. [ebɔra] ‘type of egungun’ (cf. (158b.i) [ɔdá] ‘drought’)

Again, the obligatory agreement in these examples is not at all unexpected. The low vowel is necessarily [–ATR] and, being a root vowel, controls harmony. Since AGREE[ATR] is otherwise undominated, both the initial and medial mid vowels are forced to agree with the low vowel.

4.2.4 A low and two mids

Like the other two types of disyllabic form in (158b.ii) and (158b.iii), an initial low vowel may be followed by two mid vowels with any [ATR] specification, but the mid vowels themselves must agree with each other. This is shown by the contrast in (193).

(193) Initial low vowel and two mid vowels

- a. [àjèrè] ‘name of a Yoruba town’ (cf. (158b.ii) [ajé] ‘world/earth’)
- b. [abéré] ‘needle/pin’ (cf. (158b.iii) [alé] ‘night’)

The form in (193a), just like the [aCe] forms in (158b.ii), is necessarily disharmonic due to the fact that neither the final root mid vowel nor the initial prefix low vowel can change to agree with the other, harmony being stem-controlled and low vowels being subject to *[+LO, +ATR]. Note that the medial vowel in this case necessarily agrees with the final root vowel and not with the initial prefix vowel, as expected under the stem-affixed form faithfulness analysis of stem control. We specifically return to this important analytical point in §4.3.4 below.

4.2.5 A high and two mids

An initial high vowel may be followed by mid vowels with any [ATR] specification, though the mid vowels must themselves agree with each other. This is shown in (194).

(194) Initial high vowel and two mid vowels

- a. [ijèrè] ‘a kind of seed’ (cf. (158c.i) [ilé] ‘house’)
- b. [ikéré] ‘name of a Yoruba town’ (cf. (158c.i) [idɛ] ‘brass’)

The form in (194b), just like the [iCe] forms in (158c.ii), is necessarily disharmonic due to the fact that neither the initial prefix high vowel nor the final root mid vowel can change to agree with the other, high vowels being subject to *[+HI, –ATR] and harmony

being stem-controlled. Note again that the medial vowel in this case necessarily agrees with the final root vowel and not with the initial prefix vowel; again, we return to this point in §4.3.4.

4.2.6 Two mids and a high

Trisyllabic forms with a final high vowel behave in the same ambiguous fashion as the disyllabic forms in (158c.iii) and (158c.iv) with a final high vowel: the high vowel may be preceded by two mid vowels with any [ATR] specification, though the mid vowels themselves must agree with each other. This is shown by the examples in (195).

(195) Two mid vowels and a final high vowel

- a. [oʃòdì] ‘name of a ward in Lagos’ (cf. (158c.iii) [òrì] ‘shea-butter’)
 b. [òǵbèrì] ‘uninitiated, ignorant’ (cf. (158c.iv) [èbì] ‘guilt’)

The example in (195b) shows that some high vowels behave as if they were [-ATR] in the final root position of trisyllabic forms, just as they do in the disyllabic forms in (158c.iv).

4.2.7 Medial high and low vowels

High and low vowels in the medial position of trisyllabic forms are expected to co-occur with any vowel in the final root position, just as in disyllabic forms, and this is in fact the case. But the mid vowel in the initial prefix position in such forms necessarily agrees with the medial high or low vowel; that is, both high and low vowels are opaque in Yoruba, in the sense explained in detail in Chapter 2, §2.3. The Yoruba situation is schematized in (196) below.

(196) Opacity in Yoruba

- a. $[-\text{HI}, +\text{ATR}] \cdot [+ \text{HI}, +\text{ATR}] \cdot \sqrt{[-\text{HI}, -\text{ATR}]}$
 1 1 Z [-HI] root vowel arbitrarily specified [-ATR]
 1 Z [+HI] vowel must be [+ATR], forcing disagreement with root vowel
 Z [-HI] vowel must be [+ATR] to agree with adjacent [+HI, +ATR] vowel
- b. $[-\text{LO}, -\text{ATR}] \cdot [+ \text{LO}, -\text{ATR}] \cdot \sqrt{[-\text{LO}, +\text{ATR}]}$
 1 1 Z [-LO] root vowel arbitrarily specified [+ATR]
 1 Z [+LO] vowel must be [-ATR], forcing disagreement with root vowel
 Z [-LO] vowel must be [-ATR] to agree with adjacent [+LO, -ATR] vowel

There is only one example that I am aware of with a medial low vowel and an initial prefix mid vowel: [erákpó] ‘type of plant’. As in the corresponding disyllabic forms in (158b.ii), such a form is necessarily disharmonic due to the fact that neither the final root vowel nor the medial low vowel can change to agree with the other. But the initial prefix mid vowel *must* be [-ATR], in agreement with the low vowel in the middle; doubly disharmonic forms like *[eCaCe] are undeniably not tolerated. (Similar considerations hold for forms like *[eCaCi], of course.) The only doubly disharmonic forms with a medial low vowel that are tolerated have a high vowel in the initial prefix position, since high vowels are likewise unchangeable; thus, [ɪgàkè] ‘tickling’ and [ɪkparí] ‘end’ are both possible forms.²⁴

Forms with a medial high vowel behave in parallel fashion to those with a medial low vowel: a medial high vowel may be followed by a [-ATR] vowel but not preceded by one. Thus, [òkíǵbè] ‘magical drug’ and [èdǵíká] ‘shoulder’ are possible forms; conspicuously absent are doubly disharmonic forms like *[eCiCe] and *[eCiCa]. The only such forms with a medial high vowel that are tolerated have an initial prefix low vowel; thus, [àkùrò] ‘dry-season marshy-farm’ and [akisa] ‘rag’ are both possible forms. High vowels in the medial position are therefore opaque and undeniably [+ATR] (in contrast with high vowels in the final root position which in some cases behave as if they are [-ATR], as shown in (195) above).²⁵

4.2.8 Summary

The following is a brief summary of the relevant generalizations just reviewed concerning the harmonic restrictions on trisyllabic forms in Yoruba. Anticipating the details of the

²⁴ The fact that there seem to be no forms like [eCaCe], with a low vowel harmonically flanked by [-ATR] mid vowels, can only be taken as accidental. Akinlabi (in progress) notes that there are relatively few trisyllabic forms of the type that exhibit [ATR] harmony in any case, and so a random gap in the data is not to be unexpected. Note that alongside this accidental gap, there do exist examples of forms like [eCiCe], with a high vowel harmonically flanked by [+ATR] mid vowels: [òjìbó] ‘any European’, [orúkpò] ‘mudbench serving as a bed’ and [èstúró] ‘Redflanked Duiker’ (Archangeli & Pulleyblank 1989:207, 1994:190).

²⁵ See §4.3.6 below for discussion and analysis of some apparent exceptions to this statement.

analysis to follow in §4.3 below, brief remarks about the analysis of each generalization are also provided. As the analysis itself will make clear, the distribution of vowels in trisyllabic forms is straightforwardly accounted for by the very same constraint ranking already established on the basis of the analysis of the distribution of vowels in disyllabic forms.

To begin, the final VCV portion of trisyllabic VCVCV forms exhibits the exact same distribution of vowels as exhibited by the disyllabic VCV forms analyzed in §3, right down to the ambiguous behavior of high vowels in the final root position. Since the relevant trisyllabic forms are assumed here to have the morphological structure in (189), this fact is to be expected: disyllabic forms are simply the stems of affixation for trisyllabic forms.

The distribution of vowels in the initial VCV portion of trisyllabic VCVCV forms, on the other hand, is more restrictive. An initial prefix mid vowel must agree with a following high vowel and be [+ATR], or with a following low vowel and be [-ATR], regardless of the [ATR] specification of the final root vowel. This opacity of high and low vowels follows from stem control and the locality of agreement: *[+HI, -ATR] prevents high vowels from agreeing with [-ATR] stem vowels and *[+LO, +ATR] prevents low vowels from agreeing with [+ATR] stem vowels, while SA-IDENT[ATR] prevents alternation in the stem itself. A mid vowel adjacent to the opaque high or low vowel on the side opposite the root must agree with the opaque vowel or suffer an additional, unnecessary, and avoidable violation of AGREE[ATR].

Finally, forms with initial prefix high or low vowels may be followed by mid vowels of either [ATR] specification, but the mid vowels themselves must agree with each other. The fact that the medial mid vowel must agree with the final (root) mid vowel rather than with the initial (opaque) prefix vowel is a direct and unavoidable consequence of the stem-affixed form faithfulness analysis of stem control, as was shown in general

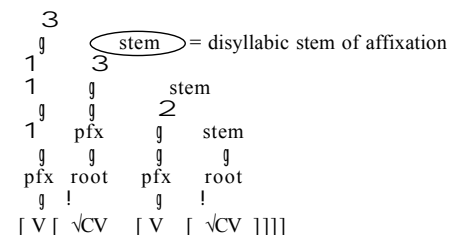
terms in Chapter 2, §2.3.2 and as is to be shown for the particular case of Yoruba in §4.3.4 below.

4.3 Analysis

4.3.1 Preamble

As noted above, the final disyllabic portion of trisyllabic VCVCV forms enjoys the same pattern of distribution as the disyllabic forms analyzed in §3 do. This is analyzed here as a result of the fact that this final disyllabic sequence functions as the stem of affixation for the initial syllable of the larger trisyllabic form, as depicted in (197) (modified from (189) above).

(197) Structure of harmonic trisyllabic “compounds”



Recall that one of the two vowels in hiatus between the demoted prefixal root and the stem to which it is attached is deleted. The claim that disyllables are the stems of affixation for trisyllables is technically true regardless of which of these two vowels deletes. Hiatal vowel deletion presumably occurs in the evaluation of the disyllabic stem with which the trisyllabic affixed form is in stem-affixed form correspondence. No matter which of the two vowels deletes, the remaining vowel is subject to the hierarchy of constraints established in §3. For practical purposes, I put hiatal vowel deletion aside and henceforth assume inputs with the three non-deleted vowels instead of the technically more accurate four vowels.

Since the evaluation of the final disyllabic sequence proceeds exactly as demonstrated for the disyllabic forms in §3, each tableau in this section includes the predicted

form of the disyllabic stem alongside the trisyllabic input and a cross-reference to the corresponding tableau in §3, allowing the reader to conveniently verify the asserted results.

4.3.2 Mid vowels

In trisyllabic forms with all mid vowels, the vowels must be all [-ATR] or all [+ATR], just as in disyllabic forms. As before, the [ATR] value of non-final (initial and medial) mid vowels is determined by the [ATR] value of the final root vowel. In the next two tableaux, I demonstrate how two deviant inputs, /eCeCe/ (198) and /eCeCe/ (199) are brought into conformity with AGREE[ATR] by changing the [ATR] value of both non-final vowels.²⁶ Note that the top-ranked constraint of relevance to these forms, SA-IDENT[ATR], rules out any attempt to subvert stem control, at the added expense of the lower-ranked input-output faithfulness and markedness constraints IO-IDENT[ATR], *[+ATR], and/or *[-ATR].

(198) Input: /eCeCe/ Stem: [CeCe] cf. (168)

Candidates	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]	*[+ATR]	*[-ATR]
a. eCeCe	* !	*		*	**
b. eCeCe	** !		*		***
c. eCeCe		* !	*	**	*
d. eCeCe			**	***	

(199) Input: /eCeCe/ Stem: [CeCe] cf. (169)

Candidates	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]	*[+ATR]	*[-ATR]
a. eCeCe	** !	*		**	*
b. eCeCe	* !		*	***	
c. eCeCe		* !	*	*	**
d. eCeCe			**		***

²⁶ Less deviant inputs such as /eCeCe/, /eCeCe/, /eCeCe/, /eCeCe/, etc., are also predicted to surface harmonically; the resultant mappings simply violate IO-IDENT[ATR] less than those considered here. This merely underscores the point that the [ATR] values of the non-final vowels are predictable from the [ATR] value of the final root vowel.

4.3.3 Low vowels

Trisyllabic forms with a low vowel in the final root position also respect the same pattern as disyllabic forms in that only [-ATR] mid vowels may precede them.²⁷ This also follows from the proposed ranking, as shown in the tableau in (200) for the deviant input /eCeCa/.²⁸

(200) Input: /eCeCa/ Stem: [CeCa] cf. (161)

Candidates	AGREE[ATR]	IO-IDENT[ATR]	*[+ATR]	*[-ATR]
a. eCeCa	* !		**	*
b. eCeCa		**		***

Next, consider forms with a low vowel flanked by mid vowels. If the final root mid vowel is [-ATR], then a [-ATR] initial prefix mid vowel will satisfy AGREE[ATR] perfectly. This is shown in the tableau in (201) below, in which the input is assumed for the sake of argument to have a [+ATR] mid vowel in the initial prefix position. A couple AGREE[ATR]-satisfying candidates that preserve the [ATR] value of the initial mid vowel are thrown in for good measure, to show just how pointless it would be to do anything but change it to [-ATR].

(201) Input: /eCaCe/ Stem: [CaCe] cf. (167)

Candidates	*[+LO, +ATR]	IO-ID[LO]	SA-ID[ATR]	AGR[ATR]	IO-ID[ATR]
a. eCaCe				* !	
b. eCaCe	* !		**		*
c. eCaCe		* !	** !		**
d. eCaCe					*

If the final mid vowel is [+ATR], on the other hand, then there is bound to be a violation of AGREE[ATR] due to the inevitable disagreement between the final mid vowel and the medial low vowel. Still, the initial mid vowel must be [-ATR], in agreement with the adja-

²⁷ The ranking *[+LO, +ATR] » *[-IDENT[ATR]] » IDENT[LO] keeps forms with a low [+ATR] vowel in the final root position in check under the Sympathy Theory analysis of §3.6, as discussed specifically in §3.6.5.

²⁸ As noted in the case of mid vowels in footnote 26 above, less deviant inputs like /eCeCa/ and /eCeCa/ are also predicted to surface as [eCeCe], with only one violation of IO-IDENT[ATR] instead of the two violations in (200).

cent medial low vowel, in order to *better* satisfy AGREE[ATR] than the alternative. This is shown in the tableau in (202) below, where again the initial mid vowel is perversely assumed to be [+ATR]. This accounts for the opacity of the low vowel in the medial position.

(202) Input: /eCaCe/ Stem: [CaCe] *cf.* (165)

Candidates	*[+LO, +ATR]	IO-ID[LO]	SA-ID[ATR]	AGR[ATR]	IO-ID[ATR]
a. eCaCe				** !	
b. eCaCe	* !		*		*
c. eCeCe		* !	* !		*
d. eCaCe			* !		**
e. eCaCe				*	*

I should note here that an input like that in (202) but with a high vowel in the final root position is correctly predicted to behave in exactly the same way, with the only exception being that there are two constraints that prevent the final root vowel from changing to agree with the medial low vowel, *[+HI, -ATR] as well as SA-IDENT[ATR]. The relative high rank of *[+HI, -ATR] and *[+LO, +ATR] straightforwardly explains why high and low vowels are able to co-occur freely in general (see the tableaux in (175) and (176) in §3 above), and I shall therefore have nothing more to say about such forms.

4.3.4 Initial inalterability and stem control

Trisyllabic forms with initial high or low vowels deserve separate mention and analysis, since a significant aspect of their behavior follows from the use of SA-IDENT[ATR] as opposed to RT-IDENT[ATR] as the constraint responsible for stem control (see also Chapter 2, §2.3.2).

Two mid vowels following an initial high or low vowel may be either [-ATR] or [+ATR], depending on the input specification of the mid vowel in the final root position. When this final root vowel has the same value of [ATR] as the initial, inalterable high or low vowel, this fact follows trivially, as shown in the tableaux in (203) and (204) below.

(203) Input: /iCeCe/ Stem: [CeCe] *cf.* (170)

Candidates	IO-ID[HI]	*[+HI, -ATR]	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]
a. iCeCe			* !	**	
b. iCeCe					*
c. iCeCe			** !	*	*
d. iCeCe		* !	** !		**
e. eCeCe	* !		** !		**

(204) Input: /aCeCe/ Stem: [CeCe] *cf.* (171)

Candidates	*[+LO, +ATR]	IO-ID[LO]	SA-ID[ATR]	AGREE[ATR]	IO-ID[ATR]
a. aCeCe			* !	**	
b. aCeCe					*
c. aCeCe			** !	*	*
d. æCeCe	* !		** !		**
e. eCeCe		* !	** !		**

Total satisfaction of AGREE[ATR] in each case is possible simply by changing the [ATR] value of the medial mid vowel (if necessary; the same outputs of course surface faithfully from the inputs /iCeCe/ and /aCeCe/, respectively, in which this vowel already agrees).

But when the final root vowel disagrees with the initial high or low vowel, a medial mid vowel has two seemingly equivalent options: to agree either with the root vowel to the right or with the opaque high or low vowel to the left. Either way, AGREE[ATR] is violated once. The correct choice, to agree with the root vowel, is of course made by SA-IDENT[ATR].

(205) Input: /iCeCe/ Stem: [CeCe] *cf.* (169)

Candidates	SA-IDENT[ATR]	AGREE[ATR]	IO-IDENT[ATR]
a. iCeCe	* !	*	
b. iCeCe		*	*

(206) Input: /aCeCe/ Stem: [CeCe] *cf.* (168)

Candidates	SA-IDENT[ATR]	AGREE[ATR]	IO-IDENT[ATR]
a. aCeCe	* !	*	
b. ^{ɛɛ} aCeCe		*	*

It is thus crucial that SA-IDENT[ATR] and not RT-IDENT[ATR] be responsible for stem-control, as argued in Chapter 2. In the example comparisons in (205) and (206) just above, both candidates satisfy RT-IDENT[ATR], since the final root vowel itself is not changed in either case.²⁹ Since the candidates also tie on AGREE[ATR], the choice between them should fall to IO-IDENT[ATR], which conflicts with SA-IDENT[ATR] in just these cases. A contrast would be predicted to emerge between /aCeCe/ and /aCeCe/ on the one hand and /iCeCe/ and /iCeCe/ on the other, all of which would, counter-factually, surface faithfully.

4.3.5 Opaque high vowels

Consider forms with a high vowel flanked by mid vowels. If the final mid vowel is [+ATR], then the initial mid vowel is trivially [+ATR] as well, since this best satisfies AGREE[ATR]. This is shown in the tableau in (207) below, in which the input is assumed for the sake of argument to have a [-ATR] mid vowel in the initial prefix position. Just as in the parallel medial low vowel example in (201) above, two AGREE[ATR]-satisfying candidates that preserve the [ATR] value of the initial vowel are included just to show that it is useless to do anything but change it to [+ATR].

(207) Input: /ɛCiCe/ Stem: [CiCe] *cf.* (174)

Candidates	IO-ID[HI]	*[+HI, -ATR]	SA-ID[ATR]	AGR[ATR]	IO-ID[ATR]
a. eCiCe				* !	
b. eCiCe		* !	** !		*
c. eCeCe	* !		** !		**
d. ^{ɛɛ} eCiCe					*

²⁹ John McCarthy points out to me that if hiatal vowel deletion applies to the second of the two vowels in hiatus in the structure that I assume for harmonic trisyllables in (197), then the remaining vowel is a root vowel, and thus potentially subject to RT-IDENT[ATR]. Interestingly, it is typically the first of two vowels in hiatus that deletes in Yoruba. In fact, Pulleyblank (1988b) specifically proposes that deletion applies to the first (in this case, root) vowel only and that some apparent cases of second-vowel deletion are the result of a total progressive assimilation process that applies prior to deletion (see §4.3.6 below).

If the final mid vowel is [-ATR], then despite the disagreement between this vowel and the medial high vowel, the initial mid vowel must be [+ATR]. Total satisfaction of AGREE[ATR] is impossible due to stem control and the inalterability of the medial high vowel, but just as in the parallel medial low vowel example in (202) above, violation of AGREE[ATR] can be minimized, accounting for the opacity of high vowels in the medial position.

(208) Input: /ɛCiCe/ Stem: [CiCe] *cf.* (172)

Candidates	IO-ID[HI]	*[+HI, -ATR]	SA-ID[ATR]	AGR[ATR]	IO-ID[ATR]
a. eCiCe				** !	
b. eCiCe		* !	* !		*
c. eCeCe	* !		* !		*
d. eCiCe			** !		**
e. ^{ɛɛ} eCiCe				*	*

4.3.6 Derivationally opaque high vowels

As noted in §4.2.6, examples with a final high root vowel (repeated below in (209)) may be preceded by either [+ATR] or [-ATR] mid vowels, showing that derivational opacity is alive and well in these forms in exactly the same manner as in corresponding disyllabic forms.

(209) Two mid vowels and a final high vowel

- a. [oʃòd̪í] ‘name of a ward in Lagos’ (cf. (158c.iii) [òrí] ‘shea-butter’)
 b. [ɔ̀g̀b̀èr̪í] ‘uninitiated, ignorant’ (cf. (158c.iv) [è̀bi] ‘guilt’)

I forego presentation of the Sympathy Theory analysis as it applies to trisyllabic forms as its application should be self-evident from the detailed discussion and analysis in §3.6.

There is, however, a small class of words that deserve separate mention. These are words with both a medial and a final high vowel and an initial [-ATR] mid vowel.³⁰

³⁰ I thank Akin Akinlabi for drawing my attention to examples of this type.

(210) Initial mid vowel and two high vowels

- a. [ɛ́lírí] ‘type of tiny mouse’
 b. [ewírì] ‘bellows’
 c. [ɛ̀bìù] ‘a trap’
 d. [ɛ̀lukú] ‘type of masquerade’
 e. [ɛ̀kùlù] ‘type of bird’
 f. [ɛ̀bùrú] ‘shortcut’ (Archangeli & Pulleyblank 1989:184, fn. 14)
 g. [ɔ̀mutí] ‘drunkard’ (Archangeli & Pulleyblank 1989:188, fn. 18)

The vocalic distribution in these forms is unexpected: medial high vowels are expected to be opaque; that is, they are expected to require an initial mid vowel to be [+ATR].

The last of these examples (210g) is quite clearly synchronically compositional, and so its odd behavior may be attributable to the fact that it is a true, disharmonic compound with one of the morphological structures in (188). This is not necessarily the case with the other two examples, however, and so the unexpected behavior of these forms demands explanation.

The explanation may in fact be found by delving into the details of the composition of (210g). This example involves the same verb root [mu] ‘to drink’ that was analyzed in §3.6 as having an underlyingly (and thus sympathetically) [–ATR] vowel in order to explain the fact that it consistently takes [–ATR] mid-vowel prefixes (e.g., [ɔ̀mu] ‘drinker’, [ɛ̀mu] ‘palmwine’). In the example at hand, the verb root [mu] is prefixed to, or compounded with, the noun [ɔ̀tí] ‘wine/beer’.³¹ The first vowel of this noun is deleted in hiatus; note that the high root vowel of this noun must also be underlyingly and sympathetically [–ATR] in order to explain the fact that the preceding prefix is a [–ATR] mid vowel.

This form is an example of one of the rare cases when the second rather than the first vowel deletes by hiatal vowel deletion (see footnote 29), meaning that the high vowel that remains in this case is categorially a root vowel. Suppose this is true of all the other examples in (210) as well, and that these undeleted high root vowels are underly-

³¹ Archangeli & Pulleyblank (1989:188, fn. 18) gloss this noun as ‘liquor’.

ingly [–ATR] just as they are (210e). The [–ATR] value of the initial mid vowel can then be derived sympathetically, as follows. The medial high root vowel remains [–ATR] in the sympathetic candidate due to the temporarily undominated rank of the selector RT-IDENT[ATR], and the initial mid vowel must be [–ATR] in the sympathetic candidate, regardless of its input value, due to the rank of AGREE[ATR] over IO-IDENT[ATR]. The mid vowel must be kept [–ATR] in the eventual surface form by the relatively high rank of sympathetic faithfulness, while the medial high root vowel is neutralized to [+ATR] due to higher-ranked *[+HI, –ATR].

This is all shown in the two tableaux below, arbitrarily using (210d) as the example and assuming that the initial prefix vowel of this form is underlyingly [+ATR]. (The final high root vowel is also assumed to be underlyingly [–ATR], just as it is in (210g)). The tableau in (211) shows the selection of the sympathetic candidate, and the tableau in (212) shows the evaluation of the actual output (cf. (180) and (182) above for the parallel disyllabic case).

(211) Input: /ɛ̀lukú/ Stem: [lukú]

Candidates	RT- ID[ATR]	IO- ID[HI]	*[+HI, –ATR]	SA- ID[ATR]	AGR [ATR]	IO- ID[ATR]
a. ☉ ɛ̀lukú			**	**		*
b. ɛ̀lukú			**	**	*!	
c. ɛ̀lɔ̀kɔ̀		**!		**		*
d. ɛ̀lukú	**!					**

(212) Input: /ɛ̀lukú/ Stem: [lukú] (see (211) for selection of the sympathetic candidate)

Candidates	IO- ID[HI]	*[+HI, –ATR]	SA- ID[ATR]	☉- ID[ATR]	AGR [ATR]	IO- ID[ATR]
a. ☉ ɛ̀lukú		**!	**!			*
b. ɛ̀lɔ̀kɔ̀	**!		**!			*
c. ☿ ɛ̀lukú				**	*	***
d. ɛ̀lukú				***!		**

What this analysis cannot in and of itself account for is the fact that the final root vowel in all of these examples is itself high. Substituting a non-high vowel in the root should give the same results *vis-à-vis* the derivationally opaque behavior of the medial high root vowel; this would clearly be a wrong result, however, since medial high vowels are otherwise unequivocally [+ATR], as discussed in §4.2.7 and analyzed in §4.3.5 above.

Interestingly, not only is the final root vowel high in all of the examples in (210); in all but the final example (210g) — which may well be just plain exceptional due to its synchronic compositionality — the final root vowel is identical to the medial root vowel of interest in terms of *all* of its non-tonal features. This additional quirk of the data may provide the key to its explanation. As noted in footnote 29 and echoed above, it is usually the first of two vowels in hiatus — the root vowel, in the cases at hand — that deletes in Yoruba. Under the analysis proposed above, the cases in (210) are clearly exceptions to this generalization.³² I suggest that it is the identity of the resulting pair of root vowels (i.e., the fact that they are at least both [+HI], if not the more striking fact that they also share other feature values) that establishes the preference for deletion of the second vowel in just these cases. Regardless of the generality of this analysis (i.e., whether or not it applies to other pairs of identical root vowels), this would be the only situation in which a [+HI, -ATR] root vowel would survive hiatal vowel deletion, thus accounting for the facts at hand.

4.3.7 Previous analyses

Insofar as the harmonic distribution of vowels in trisyllables mirrors that of disyllables, the criticisms of Archangeli & Pulleyblank's (1989) analysis offered in §3 apply equally well here. The three major differences are the opacity of medial high and low vowels (§4.3.3, §4.3.5), the behavior of medial mid vowels in forms with initial opaque vowels

³² Another apparent exception to this generalization, as analyzed by Pulleyblank (1988b) and noted in footnote 29 above, is when the second vowel is [+HI]. Pulleyblank argues that the first vowel is always the one that deletes, but that a [+HI] second vowel completely assimilates to the first vowel before deletion takes place.

(§4.3.4), and the derivational opacity of medial high root vowels (as just reviewed in §4.3.6). I now consider Archangeli & Pulleyblank's (1989) treatment of each of these differences in turn and briefly contrast them with their respective treatment under the proposed analysis.

First, the opacity of medial high and low vowels. Recall that the relevant facts are as schematized in (196), repeated in (213) below.

(213) Opacity in Yoruba

- a. $[-\text{HI}, +\text{ATR}] \cdot [+ \text{HI}, +\text{ATR}] \cdot \sqrt{[-\text{HI}, -\text{ATR}]}$
 $\begin{array}{ccc} \underset{..}{1} & \underset{..}{1} & \underset{..}{Z} \\ \underset{..}{1} & \underset{..}{Z} & \underset{..}{Z} \\ \underset{..}{Z} & & \end{array}$ [-HI] root vowel arbitrarily specified [-ATR]
 [+HI] vowel must be [+ATR], forcing disagreement with root vowel
 [-HI] vowel must be [+ATR] to agree with adjacent [+HI, +ATR] vowel
- b. $[-\text{LO}, -\text{ATR}] \cdot [+ \text{LO}, -\text{ATR}] \cdot \sqrt{[-\text{LO}, +\text{ATR}]}$
 $\begin{array}{ccc} \underset{..}{1} & \underset{..}{1} & \underset{..}{Z} \\ \underset{..}{1} & \underset{..}{Z} & \underset{..}{Z} \\ \underset{..}{Z} & & \end{array}$ [-LO] root vowel arbitrarily specified [+ATR]
 [+LO] vowel must be [-ATR], forcing disagreement with root vowel
 [-LO] vowel must be [-ATR] to agree with adjacent [+LO, -ATR] vowel

In Archangeli & Pulleyblank's analysis, only [-ATR] is considered to be 'active' in Yoruba, for specific reasons outlined earlier. This means that only [-ATR] is referred to by the vowel harmony process, which spreads this feature value from right to left. In a form like that in (213a), spreading of [-ATR] is blocked by [+HI] vowels due to *[+HI, -ATR], and the vowel on the side opposite the root emerges with the default value of [+ATR], coincidentally agreeing with the adjacent [+HI, +ATR] vowel. In a form like that in (213b), on the other hand, [+ATR] does not spread from the root because only [-ATR] is active. Right-to-left [-ATR] spreading is triggered instead by the [+LO, -ATR] vowel — which must be [-ATR] due to the *[+LO, +ATR] constraint — affecting only the vowel on the side opposite the root. The end result in each case is the same: an opaque vowel with agreement to the left and disagreement to the right. How this result is achieved in each case is different,

however: as noted in §1, [+HI] vowels passively block [-ATR] spreading while [+LO] vowels actively trigger it.³³

Under the proposed analysis, this analytical distinction vanishes. The initial vowel in both cases in (213) agrees with the adjacent opaque vowel because agreement violations are preferably minimized. Both [+ATR] and [-ATR] are ‘active’ under the present analysis in that they are both subject to AGREE[ATR]; the conditions under which agreement is satisfied or (minimally) violated are determined not by an accident of input underspecification but by the systematic interaction of AGREE[ATR] with the other constraints relevant to the analysis.

Next, consider the behavior of medial mid vowels in forms with initial opaque vowels. As discussed in §§4.2.4–4.2.5 and analyzed in §4.3.4, these medial vowels necessarily agree with the final root vowel, even at the expense of disagreement with the initial opaque vowel. Under Archangeli & Pulleyblank’s analysis, this is the result of three analytically separate assumptions: the first is that only [-ATR] is specified, and as a morpheme-level feature; the second is the strictly right-to-left nature of both the linking and spreading of this feature; the third is the fact that the default [ATR] value for non-low vowels is [+ATR].

Take the case of an initial [+HI] vowel followed by two [-ATR] mid vowels, [iCeCe] (194b). The underlying representation of this form would be /ICECE/, [ATR]-unspecified, but accompanied by a morpheme-level [-ATR] feature. This feature first links to the final vowel and then spreads leftward, stopping after a failed attempt to link to the initial [+HI] vowel. This vowel is then specified by default as [+ATR], resulting (correctly) in [iCeCe].

³³ In fact, Archangeli & Pulleyblank (1989) state their constraints in different terms specifically in order to make sense of this analytical disparity; thus *[+HI, -ATR] is stated as “A [-ATR] specification can be linked only to a vowel that is [-high]” (Archangeli & Pulleyblank 1989:175) while *[+LO, +ATR] is stated as the redundancy rule “[+low] → [-ATR]” (Archangeli & Pulleyblank 1989:179). See Mohanan 1991:297ff for discussion.

Now consider the case of an initial [+LO] vowel followed by two [+ATR] mid vowels, [aCeCe] (193a). The underlying representation of this form would be /ACECE/, [ATR]-unspecified and unaccompanied. The initial [+LO] vowel is specified by default as [-ATR]. Since this feature can only spread from right to left, the following two mid vowels must be specified by default as [+ATR], resulting (again, correctly) in [aCeCe].

Under the proposed analysis, the only assumption analogous to any one of these three is the right-to-left directionality of harmony, which boils down to the stem-affixed form faithfulness account of stem control coupled with a precedented assumption about the morphological structure of Yoruba. This assumption turns out to be all that is necessary: a medial vowel must agree with the following root vowel and not with the preceding opaque prefix vowel because that is how stem-controlled vowel harmony works; the opaque prefix vowel, no matter whether its [+HI] or [+LO], cannot force the vowels of its stem of affixation to agree with it because SA-IDENT[ATR] dominates AGREE[ATR].

Finally, consider the derivational opacity of medial high vowels just discussed and analyzed in §4.3.6. Under Archangeli & Pulleyblank’s analysis, these facts are explained without further ado; an [eCiCi] form like those in (210) is simply an /ECICI/ input with an accompanying [-ATR] feature, which fails to link to either of the two high vowels and so eventually settles for the initial mid vowel, correctly deriving [eCiCi] (after [+ATR] is supplied by default to the two high vowels, of course). On the other hand, these facts require considerable gymnastics under the proposed account, as the discussion in §4.3.6 plainly indicates. However, at least a couple of the issues raised for Archangeli & Pulleyblank’s analysis in §3.6.6 above apply equally well here. First, each ‘attempt’ on the part of the [-ATR] feature to link to a high vowel results in a derived representation that coincides with the derived sympathetic candidate necessary to the proposed analysis. Second, the analysis of a dialect like Ijesa, which should be simpler in that it has no derivational opac-

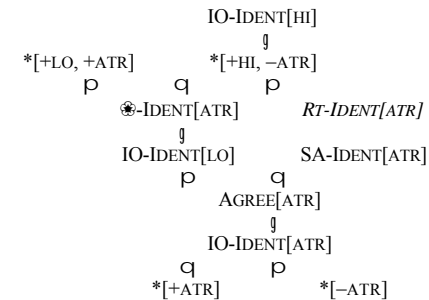
ity, would nevertheless require the additional statement to the effect that the right-to-left linkage of [-ATR] is not allowed to repeat after an unsuccessful first link attempt.

4.4 Final summary

The [ATR] harmony facts of Yoruba, previously believed to require directional spreading and crucial input underspecification, succumb to an analysis without either of these devices under the assumptions of the agreement model. The primary components of this analysis, apart from a member of the proposed family of agreement constraints, consist of various relevant members of constraint families that are all independently motivated within OT: markedness, input-output faithfulness, stem-affixed form faithfulness, root-specific faithfulness, and sympathetic faithfulness. If all it takes to analyze such a reasonably complex vowel harmony system is a particular ranking of these various components — and this seems to be the case, at least for the most part — then the representational devices of the autosegmental model, especially underspecification, are called into serious question. (Given this point and other, comparable points to be made in forthcoming chapters, I return to specifically address the issue of underspecification in Chapter 6.)

The ranking of constraints necessary to account for all of the [ATR] harmony facts of Yoruba in both disyllabic and trisyllabic forms is no more than the ranking in (214) (repeated from (187) above), which was arrived at on the basis of the facts in disyllabic forms alone.

(214) Summary ranking



This convergence of analysis is in no way surprising, and is indeed promising in light of the fact that the difference between the disyllabic and trisyllabic forms is not just another vowel position but the potential for an entire set of vocalic contrasts in that position, given the freedom afforded to the input by the Richness of the Base hypothesis. Despite this near explosion of opportunities for things to go wrong, the proposed ranking for disyllabic forms has turned out to be tight enough to keep things on the right track in trisyllabic forms as well.

- c. i. /√*isuj* • *iʃo* • *re* / → *isujiʃore* (*dominant suffix*)
wash • INTRANS. • APPL. 'wash with something!'
ii. /√*isuj* • *iʃo* / → *isujiʃo* (*all recessive*)
wash • INTRANS. 'wash!/do the washing!'

(219) Turkana dominance (Vago & Leder 1987:384, Albert 1995:13)³

- a. i. /ε • √*lqs* • *i* / → *elosi* (*dominant root*)
3 • go • ASP 's/he will go'
ii. /ε • √*em* • *i* / → *emiri* (*all recessive*)
3 • fear • ASP 's/he will fear'
b. i. /ε • √*koko* • *un* • *i* • *u* / → *ekokounio* (*dominant suffix*)
3 • steal • VEN • ASP • VOI 'they are being stolen'
ii. /ε • *a* • √*koko* • *un* • *i* / → *ekokouuri* (*all recessive*)
3 • TNS • steal • VEN • VOI 'they were stolen'

As in Kalenjin, Diola Fogny, and all other dominant-recessive vowel harmony systems that I am aware of, there are no prefix vowels in Maasai or Turkana that behave in a dominant fashion; only root and suffix vowels may be dominant. Prefix vowels in Maasai and Turkana are exceptional in other significant ways as well; I will ignore them in general for now and return to discussion and analysis of their behavior in §5 further below.

2.2 The low vowel

2.2.1 Re-pairing

As already noted, the [-ATR] low vowel [a] has no direct [+ATR] counterpart in Maasai or Turkana.⁴ If there is a dominant vowel in a less peripheral morpheme than an /a/, then the /a/ surfaces re-paired as [o], as schematized above in (216). This is shown by the examples in (220), which contrast forms with low vowels (*italicized*) preceded by dominant vowels in less peripheral morphemes with near-minimally different forms without any dominant vowels.⁵

³ Certain independent hiatal vowel contractions are ignored in the Turkana data; see Dimmendaal 1983.

⁴ Levergood (1984:34/276) claims that there is a [+ATR] low vowel in Maasai, but that it "is very restricted in its distribution". According to Tucker & Mpaayei (1955:xiv), this centralized vowel is found "[o]nly after 'wu-'. "

⁵ A horizontal line will henceforth divide Turkana examples (below) from Maasai examples (above).

(220) Re-pairing in Maasai (Wallace-Gadsden 1983:26) and Turkana (Albert 1995:7)

- a. i. / *m* • √*muɔŋ* • *a* / → *imudoŋo* (*dominant root*)
FEM.PL • noun • PL 'kinship'
ii. / *m* • √*lipɔŋ* • *a* / → *ilipɔŋa* (*all recessive*)
FEM.PL • noun • PL 'full-grown female'
b. i. / *eŋ* • √*komon* • *a* / → *eŋkomono* (*dominant root*)
FEM.SG • verb • PROD. 'prayer'
ii. / *ɔl* • √*men* • *a* / → *ɔlmena* (*all recessive*)
MASC.SG • verb • PROD. 'contempt'
-
- c. i. / ε • √*pup* • *aan* • *n* • *a* / → *epupooono* (*dominant root*)
3 • obey • HAB • SG • VOI 's/he is obedient'
ii. / ε • √*peg* • *aan* • *n* • *a* / → *epegaaana* (*all recessive*)
3 • argue • HAB • SG • VOI 's/he is argumentative'
iii. / ε • √*ban* • *aan* • *n* • *a* / → *ebanjaana* (*all recessive*)
3 • be stupid • HAB • SG • VOI 's/he is absolutely stupid'

Comparison with the forms in (218c) and (219b) above reveals the neutralization between /ɔ/ and /a/ noted in (216) above. Though they each surface faithfully in words with recessive vowels only, both surface as [o] when there is a dominant vowel in a less peripheral morpheme.

2.2.2 Root opacity

A low vowel /a/ in the root is always opaque, surfacing as [a] even if this entails disagreement with a dominant vowel, as schematized above in (217). In each pair of examples in (221) below, a form with a low root vowel and a following dominant suffix vowel is contrasted with a near-minimally different form with a non-low vowel in the root.⁶

(221) Root opacity in Maasai and Turkana

- a. i. / *i* • √*as* • *iʃo* • *re* / → *iasišore* (*dominant suffix*,
2SG • do • INTRANS. • APPL. 'you work' *opaque root*)
ii. / *i* • √*ɔŋ* • *iʃo* • *re* / → *idunjšore* (*dominant suffix*,
2SG • cut • INTRANS. • APPL. 'you cut w/ s.t.' *dominant root*)
b. i. / *ki* • √*nar* • *je* / → *kinarie* (*dominant suffix*,
1PL • share • APPL. 'we share w/ s.o.' *opaque root*)
ii. / *ki* • √*ɔŋ* • *je* / → *kidunjie* (*dominant suffix*,
1PL • cut • APPL. 'we cut w/ s.t.' *dominant root*)
-
- c. i. / *a* • √*abar* • *u* / → *ababaru* (*dominant suffix*,
GEN • salty • NOM 'saltiness' *opaque root*)
ii. / *a* • √*ilim* • *u* / → *alilimu* (*dominant suffix*,
GEN • cold • NOM 'coldness' *dominant root*)

⁶ Maasai examples from Archangeli & Pulleyblank 1994:306-307, Turkana examples from Albert 1995:15.

There are two possible explanations for the systematic opacity of root vowels. One is that since only roots and suffixes may contain dominant vowels, there can never be a dominant vowel to the left of a low root vowel. The other is that since the root is the least peripheral morpheme possible, there can never be a dominant vowel in a morpheme less peripheral than the root. We will return to a comparison of these two possible analyses in §2.3 below.

2.2.3 Suffixal variability

A low vowel /a/ in a suffix followed by a dominant vowel in a more peripheral morpheme is also opaque, just as it is in the roots shown in (221) — that is, unless the low vowel suffix is also preceded by a dominant vowel in either another, less peripheral suffix or a root, in which case it is re-paired with [o] just as in (220). This is shown by the examples in (222), which contrast forms with dominant vowels both to the left and right of low vowels with near-minimally different forms with dominant vowels only to the right of low vowels.⁷

(222) Suffixal variability in Maasai and Turkana

a.	i.	/ ε • √ <u>ibuk</u> • ar • <u>ie</u> /	→	eibukorie	(re-paired)
		3SG • pour • MA • APPL.		‘s/he poured it away w/ s.t.’	
	ii.	/ ε • ta • √ <u>no</u> k • ar • <u>ie</u> /	→	etunokarie	(opaque)
		3SG • PAST • bury • MA • APPL.		‘s/he buried it w/ s.t.’	
b.	i.	/ α • √ <u>du</u> • akm • <u>ie</u> /	→	aduɟokinie	(re-paired)
		1SG • cut • DATIVE • APPL.		‘I cut for s.o. w/ s.t.’	
	ii.	/ α • √ <u>pu</u> t • akm • <u>ie</u> /	→	aɟutakinie	(opaque)
		1SG • fill • DATIVE • APPL.		‘I fill it for s.o. w/ s.t.’	
c.	i.	/ ε • √ <u>su</u> d • a • rɪ • <u>ie</u> /	→	eisudoriye	(re-paired)
		3SG • hide • MA • N • APPL.		‘s/he will hide him/herself’	
	ii.	/ ε • √ <u>pu</u> t • a • rɪ • <u>ie</u> /	→	eɟputariye	(opaque)
		3SG • fill • MA • N • APPL.		‘it will get filled up’	

⁷ Maasai examples from Archangeli & Pulleyblank 1994:308, Turkana examples from Albert 1995:17. The vowel of the Maasai prefix /ta-/ (glossed ‘PAST’ in (222a.ii)) alternates in a curious yet entirely systematic fashion depending on the vowel of the stem it is attached to. See Wallace-Gadsden 1983 for discussion.

d.	i.	/ α • √ <u>tu</u> r • aan • <u>u</u> /	→	aturoonu	(re-paired)
		GEN • agile • HAB • NOM		‘agility’	
	ii.	/ α • √ <u>pe</u> g • aan • <u>u</u> /	→	aɟegaanu	(opaque)
		GEN • deny • HAB • NOM		‘denial’	
	iii.	/ α • √ <u>da</u> k • aan • <u>u</u> /	→	adakaanu	(opaque)
		GEN • graze • HAB • NOM		‘satiation’	

3. Previous Analyses

3.1 The allure of directionality

The behavior of low vowels in Maasai and Turkana is quite intricate but can be summarized rather simply in terms of directional feature spreading: a low vowel is re-paired by the spreading of [+ATR] from the left and opaque to the spreading of [+ATR] from the right; if [+ATR] can spread to a low vowel from either the left or the right, spreading from the left occurs because spreading from the right cannot, and the low vowel is re-paired. (Note that a low root vowel is correctly expected to always be opaque, as shown in (221); since there are no dominant prefixes, [+ATR] can never spread onto a root vowel from the left.)

This is in fact the gist of the Grounded Phonology analysis of Maasai offered by Archangeli & Pulleyblank (1994), who argue that the behavior of the low vowel is evidence for their more general position that all feature spreading is unidirectional. These authors claim that perceived bidirectionality, as in Maasai and Turkana, is instead often the result of two unidirectional rules, one rightward and one leftward, each of which may be subject to its own conditions on its application.⁸ The foregoing is also the essence of the OT analysis of Turkana proposed by Albert (1995). (The schematic properties of Albert’s type of analysis are independently investigated by McCarthy (1997a) under the broad rubric “process-specific constraints.”) In the rest of this section we consider both of these analyses in turn and reject them based on their explanatory inferiority to the cyclic analysis to be proposed in §4.

⁸ Perceived bidirectional spreading may also arise through a combination of edgemost association and one unidirectional rule in the Grounded Phonology framework (see Archangeli & Pulleyblank 1994:299ff).

3.2 Process-specific markedness

The two rules that Archangeli & Pulleyblank offer for Maasai are shown in (223) below (adapted from Archangeli & Pulleyblank 1994:309-310). The differences between the rules are what is at issue here, and these are highlighted in **boldface**. The significant difference is that right-to-left [+ATR] spreading (223a) is subject the markedness constraint * [+LO, +ATR] whereas left-to-right [+ATR] spreading (223b) has no conditions on its application.⁹

(223) [+ATR] spreading in Maasai (and Turkana)

	a. Right-to-left [+ATR]	b. Left-to-right [+ATR]
Argument		
Parameters	1. Function: INSERT 2. Type: PATH 3. Direction: RIGHT TO LEFT 4. Iteration: ITERATIVE	1. Function: INSERT 2. Type: PATH 3. Direction: LEFT TO RIGHT 4. Iteration: ITERATIVE
Structure requirements	1. Argument structure: NONE 2. Target structure: FREE	1. Argument structure: NONE 2. Target structure: FREE
Other requirements	1. Argument conditions: \emptyset 2. Target conditions: * [+LO, +ATR]	1. Argument conditions: \emptyset 2. Target conditions: \emptyset

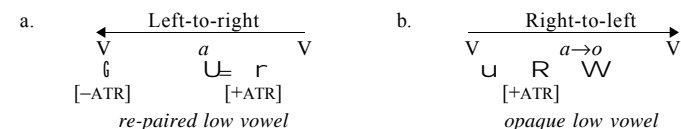
The intended results of these rules are schematized in (224). Since right-to-left [+ATR] spreading (223a) is subject to * [+LO, +ATR], this rule stops at a low vowel, as shown in (224a).¹⁰ This explains the opaque instances of [a] in roots as well as those in suffixes that are not preceded by a dominant vowel. In effect, this rule only targets non-low vowels. Since left-to-right [+ATR] spreading (223b) is *not* subject to * [+LO, +ATR], it targets low and non-low vowels alike and creates an [e] which is then adjusted to [o], as shown in (224b).¹¹

⁹ For readers unfamiliar with the rule notation in Archangeli & Pulleyblank's Grounded Phonology framework, a 'target condition' is a condition that may be imposed on the segment that is structurally changed by the rule and an 'argument condition' is one that may be imposed on the segment that triggers the rule.

¹⁰ The recessive vowel to the left of the low vowel in (224a) likely receives its [-ATR] specification by a default rule under Archangeli & Pulleyblank's analysis, the rules in their framework being strictly feature-filling.

¹¹ "Application of [(223b)] to a low vowel creates a [+ATR, +low] pairing, an antagonistic combination that ultimately results in [o]" (Archangeli & Pulleyblank 1994:311). The footnote referenced after this passage states that "[t]he surface result [o] could be derived either phonetically or phonologically" (*ibid.*, p. 461).

(224) Right-to-left vs. left-to-right [+ATR] spreading



When flanked on both sides by dominant vowels, a low vowel undergoes left-to-right [+ATR] spreading (223b) simply because this is the only rule which can apply to it, the targets of right-to-left [+ATR] spreading (223a) being effectively limited to non-low vowels.

This analysis seems to account fairly simply for the relevant facts. Note, however, that it depends in large part on the idea that left-to-right [+ATR] spreading (223a) is not subject to * [+LO, +ATR], even though a subsequent rule (or component of grammar; see footnote 11) ensures that the eventual output — the [-LO, +ATR] vowel [o] — respects this markedness constraint. A better analysis would be one in which both rules simply respect the constraint in the first place. There must thus be some other target condition that distinguishes the rules from each other. As discussed immediately below, Albert's (1995) OT analysis of the same pattern in Turkana establishes the true identity of the relevant target condition and thus overcomes this particular difficulty with Archangeli & Pulleyblank's analysis of Maasai.

3.3 Process-specific faithfulness

Albert notes that both [+ATR] spreading processes are in fact subject to the markedness constraint * [+LO, +ATR], since the output of each of them crucially (that is, not expectedly) respects this constraint. The true distinction between these processes, Albert argues, is simply that left-to-right spreading is able to effect changes in the values of features other than [ATR] — namely, [LO] and [RD] — in order to create [o], while right-to-left spreading is not able to effect these changes. The actual condition on right-to-left spreading is therefore *faithfulness* to one of these other features; to wit, either IO-IDENT[LO] or IO-IDENT[RD].

To begin, Albert formally differentiates the two spreading processes via the edge parameter of the featural alignment constraint ALIGN[+ATR].¹²

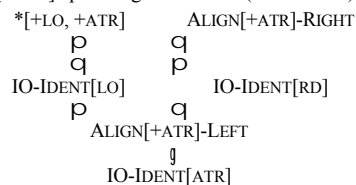
(225) [+ATR] spreading as alignment

- a. ALIGN[+ATR]-LEFT — [+ATR] is aligned with the left edge of the word.
- b. ALIGN[+ATR]-RIGHT — [+ATR] is aligned with the right edge of the word.

For the purposes of harmony, the constraints in (225) must require not only that the feature value [+ATR] coincide with the designated word edge, but also that it remain anchored to its ‘input sponsor’ (i.e., to the output correspondent of the input segment specified with this feature value). In effect, these constraints demand *spreading* of [+ATR] to the designated word edge.¹³ ALIGN[+ATR]-LEFT (225a) thus corresponds to right-to-left [+ATR] spreading (223a) while ALIGN[+ATR]-RIGHT (225b) corresponds to left-to-right [+ATR] spreading (223b).

With these featural alignment constraints in hand, Albert (1995:12ff) argues that the ranking of constraints in (226) below accounts for the relevant Turkana facts.¹⁴

(226) [+ATR] spreading in Turkana (and Maasai)



The undominated rank of * [+LO, +ATR] ensures that neither spreading process creates [ɐ]. But the core of this constraint hierarchy lies in the ranking of the faithfulness constraints

¹² On featural alignment and related proposals, see (among many others) Akinlabi 1994, 1997, Cole & Kisseberth 1994abc, 1995, Kirchner 1993, McCarthy 1997a, Ni Chiosáin & Padgett 1997, Padgett 1995ab, Pulleyblank 1993, 1996, Ringen & Vago 1995, 1997, Smolensky 1993, and Walker 1997, 1998ab, 1999. Featural alignment is couched within the broader context of Generalized Alignment theory (McCarthy & Prince 1993).

¹³ I set aside the complexities of exactly how this effect is derived; they are not addressed in Albert’s work and they are addressed in various different ways in the works cited in footnote 12.

¹⁴ Regarding the mapping from /a/ to [o], Albert (1995:11-12) limits his attention to the change in [LO], pointing out that the additional change in [RD] effected by left-to-right spreading can be ensured by the undominated rank of a markedness constraint against non-low back unrounded vowels — which, like * [+LO, +ATR], is independently necessary to account for the vowel inventory in (215). Note, however, that this does not exempt ALIGN[+ATR]-RIGHT from the requirement in (226) that it dominate both IO-IDENT[LO] and IO-IDENT[RD]; if either faithfulness constraint were to dominate this alignment constraint, then the mapping from /a/ to [o] would be blocked.

IO-IDENT[LO] and IO-IDENT[RD] relative to the alignment constraints ALIGN[+ATR]-RIGHT and ALIGN[+ATR]-LEFT. The faithfulness constraints are ranked lower than ALIGN[+ATR]-RIGHT, enabling the mapping from /a/ to [o] in the left-to-right spreading direction. On the other hand, the faithfulness constraints are ranked higher than ALIGN[+ATR]-LEFT,¹⁵ blocking this particular mapping in the opposite spreading direction. This is of course precisely the desired result: re-pairing from left to right and opacity from right to left.

Though this analysis avoids the problem introduced by the analysis reviewed in §2.3.2, the two analyses share in common the problem that they do not offer an explanation as to why low vowels are opaque to right-to-left [+ATR] spreading and harmonic (though re-paired) with respect to left-to-right [+ATR] spreading, rather than vice-versa. There is no necessary connection between direction of spreading and subjection to a target condition, be it markedness or faithfulness. The alignment constraints could freely be substituted for one another in (226), and the target condition specifications in (223) could easily be reversed. The result in either case would be a language just like Maasai and Turkana except that /a/ is opaque to left-to-right [+ATR] spreading and harmonic/re-paired with respect to right-to-left [+ATR] spreading. Clearly, neither of these analyses is restrictive enough in this respect, specifically because of their shared, independently parametrizable directionality device.

The cyclic analysis to follow in §4 immediately below achieves this restrictiveness by directly attributing the apparent directionality of harmony in Maasai and Turkana to the independently motivated phenomenon of stem control. Even though [ATR] harmony itself is not stem-controlled in these languages, the potential mapping from /a/ to [o] is: it is allowed if an affix low vowel needs to agree with its [+ATR] stem of affixation, but it is blocked if a [+ATR] affix is attached to a stem with a low vowel. The reversed, counter-

¹⁵ Technically, only one of the two faithfulness constraints must dominate ALIGN[+ATR]-LEFT; the other may be ranked anywhere so long as it is below ALIGN[+ATR]-RIGHT (see the immediately preceding footnote). This minor detail is left out of the text to streamline the exposition.

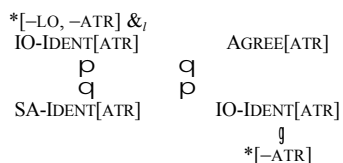
factual situation that was conjured up above is impossible to describe under this analysis, a desirable result.

4. The Cyclic Analysis

4.1 Basic dominance

As in Kalenjin (see Chapter 2, §3.2), the regular pattern of dominant-recessive harmony among non-low vowels in Maasai and Turkana is the result of the ranking in (227) below.

(227) Basic [+ATR] dominance ranking



The markedness constraint *[-ATR], which was put aside in the analysis of Kalenjin, is included here for the sake of completeness. It stands for any markedness constraint that may be violated by a recessive (that is, [-ATR]) vowel that surfaces as such in the output. The fact that IO-IDENT[ATR] dominates *[-ATR] ensures that words with vowels that are all recessive surface faithfully. To streamline the exposition, the opposite markedness constraint *[+ATR] is not considered here, just as it wasn't in the analysis of Kalenjin. However, note that it only need be lower-ranked than the local conjunction *[-LO, -ATR] &_i IO-IDENT[ATR], which makes the necessary distinction between dominant and recessive vowels. Those that are [-LO, +ATR] (dominant) underlyingly are not allowed to surface unfaithfully as [-ATR] by this constraint, and so must surface as [+ATR], in violation of *[+ATR].

Because of the undominated rank of both *[-LO, -ATR] &_i IO-IDENT[ATR] and AGREE[ATR], recessive vowels are forced to change in agreement with dominant vowels, even at the expense of unfaithfulness either to the stem of affixation (because of the

lower rank of SA-IDENT[ATR]) or to the input (because of the even lower rank of IO-IDENT[ATR]).

The following three tableaux demonstrate the correctness of this ranking for the basic pattern of Maasai and Turkana exemplified by the data in (218) and (219). These tableaux consist of the successive cyclic evaluation of the Maasai input / $\sqrt{\text{isuj}} \cdot \text{ĩso} \cdot \text{re}$ / 'wash with something!' in (218c.i) above, which consists of a recessive-vowel root followed by a recessive-vowel suffix, which is in turn followed by a dominant-vowel suffix. The root / $\sqrt{\text{isuj}}$ / 'wash', the ultimate stem of affixation, is evaluated first in (228) below.

(228) Input: / $\sqrt{\text{isuj}}$ /

Candidates	*[-LO, -ATR] & _i IO-ID[ATR]	AGR [ATR]	SA-ID[ATR]	IO-ID[ATR]	*[-ATR]
a. ɪsuj					**
b. isuj		* !		*	*
c. isuj				** !	

There is no stem of affixation for this form, so SA-IDENT[ATR] is irrelevant to the evaluation. There is also no underlying dominant vowel in this all-recessive input form, so *[-LO, -ATR] &_i IO-IDENT[ATR] is also irrelevant. The choice essentially comes down to the interaction between faithfulness and markedness. The faithful, all-recessive candidate in (228a) most violates the markedness constraint *[-ATR], but this proves to be the best choice in this case since the other two candidates are either just unfaithful (228c), violating the higher-ranked faithfulness constraint IO-IDENT[ATR], or both disharmonic and unfaithful (228b), violating both IO-IDENT[ATR] and AGREE[ATR].

The result of the evaluation in (228) serves as the stem of affixation in (229) below; the evaluation of the candidate outputs for / $\sqrt{\text{isuj}} \cdot \text{ĩso}$ / 'wash!/do the washing!' in (218c.ii).

(229) Input: /√isuj • išo /

Stem: isuj

Candidates	*[-LO, -ATR] & IO-ID[ATR]	AGR [ATR]	SA-ID[ATR]	IO-ID[ATR]	*[-ATR]
a. isujišo					****
b. isujišo		* !		**	**
c. isujišo			** !	****	

*[-LO, -ATR] & IO-ID[ATR] is again irrelevant here because again there are no dominant vowels in the input. Since there is a stem of affixation, however, SA-IDENT[ATR] is active in determining the optimal output. Regardless in this case, the faithful all-recessive candidate in (229a) is again optimal, as it was in (228a). Introducing disagreement as in (229b) does nothing but fatally violate AGREE[ATR], and switching to the all-dominant candidate in (229c), while best-satisfying *[-ATR], simply violates both SA-IDENT[ATR] and IO-ID[ATR] due to the unfaithful reproduction of both the stem vowels and of the input vowels.

Now, the result of the evaluation in (229) serves as the stem for the evaluation in (230) of the further affixed input form /√isuj • išo • rē / ‘wash with something!’ in (218c.i).

(230) Input: /√isuj • išo • rē /

Stem: isujišo

Candidates	*[-LO, -ATR] & IO-ID[ATR]	AGR [ATR]	SA-ID[ATR]	IO-ID[ATR]	*[-ATR]
a. isujišore	* !			*	*****
b. isujišore		* !			****
c. isujišore			****	****	

This time there is an underlyingly [+ATR] (dominant) vowel introduced by the newly-attached suffix; *[-LO, -ATR] & IO-ID[ATR] now swings into action, knocking off the all-recessive candidate in (230a). This leaves the faithful but disharmonic candidate in (230b) and the harmonic but unfaithful candidate in (230c). AGREE[ATR] outranks both

SA-IDENT[ATR] and IO-IDENT[ATR], so faithfulness gives way and harmony decides in favor of (230c).

So far, the analysis of basic dominance in Maasai and Turkana is just as it was for Kalenjin in Chapter 2, §3.2. When there are no low vowels to worry about, Maasai and Turkana exhibit a perfectly simple and well-behaved dominant-recessive harmony system. Low vowels add a layer of complexity, yet the overall system remains well-behaved. The facts simply require the identification of a few more constraints and their relative ranking.

4.2 The low vowel

4.2.1 Re-pairing

Recall that there are two patterns of concern in Maasai and Turkana words with low vowels: when [+ATR] approaches a low vowel from a less peripheral morpheme to the left, in which case the low vowel is re-paired with [o] (see (216) above), and when [+ATR] approaches a low vowel from a more peripheral morpheme to the right (and also *not* from a less peripheral one to the left), in which case the low vowel is opaque and remains [a] (see (217) above).

First, it is important to establish what the re-pairing mapping from /a/ to [o] itself consists of, ranking-wise. This mapping involves changes in the features [ATR], [LO] and [RD]. Apart from the additional change in the feature [RD], this re-pairing mapping is the same as the one in Diola Fogny analyzed in Chapter 2, §3.5, in which /a/ is re-paired with the [-RD] mid vowel [ɤ]. The ranking necessary for Diola Fogny is given in (231) below.

(231) Re-pairing under dominance (Diola Fogny)

*[-LO, -ATR]	AGR	
& IO-ID[ATR]	[ATR]	*[+LO, +ATR]
p	q	
q	p	
SA-ID[ATR]	IO-ID[LO]	IO-ID[ATR]
	j	
	*[-ATR]	

anything with the addition of the dominant-vowel suffix to this stem; any change to the vowels of the stem of affixation and/or to the dominant suffix vowel suffers violation(s) of one of the undominated constraints *[v,ɣ], AGREE[ATR] or *[-LO, -ATR] & IO-IDENT[ATR].

(234) Input: /√tur • aan • u/ Stem: [turoon]

Candidates	*[v,ɣ]	AGR [ATR]	*[-LO, -ATR] & IO-ID[ATR]	IO- ID[ATR]	IO- ID[LO]	IO- ID[RD]
a. turaanu		** !				
b. tureenu	** !			**		
c. turɣnu	** !			**	**	
d. turoonu				**	**	**
e. turaanu		* !	* !	*		
f. turaanu			** !	**		

In sum, the undominated rank of markedness constraints against non-low back [-RD] vowels and low [+ATR] vowels in Maasai and Turkana rules out any candidate with either of the vowels [v] or [ɣ] in it, vowels that are otherwise expected as possible [+ATR] alternants of /a/ given the dominant-recessiveness of vowel harmony (cf. Kalenjin and Diola Fogny). The unavailability of these vowels brings other possible candidates into serious competition for optimality, among them a candidate in which /a/, in its attempt to agree with a dominant [+ATR] vowel, surfaces with three featural changes as [o]. The reason that the two additional changes are possible when [+ATR] approaches a low vowel from a less peripheral morpheme but not when it approaches from a more peripheral morpheme is due to an effect that I call residual stem control, which is discussed in the following subsection.

4.2.2 Opacity

Consider the Turkana input /√peg • aan • u/ ‘denial’ in (222d.ii) above (minus the gender prefix /a/; recall footnote 19 above). The least peripheral morpheme of this input — the root /√peg/ ‘deny’ — has a recessive [-ATR] vowel, and it is followed by a suffix with a

low [-ATR] vowel, which is itself followed by a suffix with a dominant [+ATR] vowel. We might naively expect the output of this form to be *[pegoonu], given that harmony is dominant-recessive (that is, potentially anti-cyclic) and that the faithfulness constraints IO-IDENT[ATR], IO-IDENT[LO] and IO-IDENT[RD] are all known to be low enough ranked to be violated.

What is missing in this equation is the fact that the stem of affixation for this form, without the second, dominant-vowel suffix, must be [pegaan] — when there are no dominant vowels, recessive vowels are predicted to surface faithfully. The naively expected output *[pegoonu] thus differs not only from its *input* in terms of [ATR], [LO] and [RD] but also from its *stem of affixation* in terms of these same features. In order for *[pegoonu] to be optimal, then, AGREE[ATR] would have to dominate not only the aforementioned input-output faithfulness constraints but also their stem-affixed form counterparts; to wit, SA-IDENT[ATR], SA-IDENT[LO] and SA-IDENT[RD]. AGREE[ATR] is already known to dominate SA-IDENT[ATR], so in order to ensure the failure of *[pegoonu] in favor of the true (and [ATR]-disharmonic) output [pegaanu], either of the other two stem-affixed form faithfulness constraints, SA-IDENT[LO] or SA-IDENT[RD], must dominate AGREE[ATR]. This is shown in the tableau in (235).

(235) Input: /√peg • aan • u/ Stem: [pegaan]

Candidates	SA- ID[LO]/[RD]	AGR [ATR]	SA- ID[ATR]	IO- ID[ATR]	IO- ID[LO]	IO- ID[RD]
a. pegaanu		*				
b. pegoonu	** !		***	***	**	**

I call this result *residual stem control* because a stem-affixed form faithfulness constraint is responsible for the result, an essentially cyclic effect very much like stem control itself.

Note that the same result as above also holds when the low vowel is in the root itself, as in /√babar • u/ ‘saltiness’, the form in (221c.i) (minus the gender prefix /a/ yet again; see footnote 19). The stem of affixation for this form is simply [babar], and any

attempt to make it agree with the dominant suffix fails for the same reason that these attempts fail in the suffixal low vowel case just examined, as shown in (236).

(236) Input: /√babar • u/ Stem: [babar]

Candidates	SA- ID[LO]/[RD]	AGR [ATR]	SA- ID[ATR]	IO- ID[ATR]	IO- ID[LO]	IO- ID[RD]
a. ^{SP} babaru		*				
b. boboru	** !		**	**	**	**

There is of course another candidate lurking about in both of these cases, one in which the dominant [+ATR] suffix becomes [-ATR] in order to agree with the stubbornly [-ATR] low vowel in the less peripheral suffix or root (compare the candidates in (234e,f) above). This type of candidate was dubbed ‘dominance reversal’ in Chapter 2, §3.4, and like any candidate in which an input [+ATR] vowel surfaces as [-ATR], violates *[-LO, -ATR] & IO-IDENT[ATR]. This constraint must thus also dominate AGREE[ATR], as shown in (237) and (238) below.

(237) Input: /√peg • aan • u/ Stem: [pegaan]

Candidates	*[-LO, -ATR] & IO-ID[ATR]	AGR [ATR]	SA- ID[ATR]	IO- ID[ATR]	IO- ID[LO]	IO- ID[RD]
a. ^{SP} pegaanu		*				
b. pegaanu	* !		***	***	**	**

(238) Input: /√babar • u/ Stem: [babar]

Candidates	*[-LO, -ATR] & IO-ID[ATR]	AGR [ATR]	SA- ID[ATR]	IO- ID[ATR]	IO- ID[LO]	IO- ID[RD]
a. ^{SP} babaru		*				
b. babaru	* !		**	**	**	**

I will have much more to say about dominance reversal in §4.3 below. Before turning to that discussion, let us briefly review the results attained thus far.

4.2.3 Summary

The re-pairing of /a/ to [o] by ‘left-to-right spreading’ and the opacity of /a/ with respect to ‘right-to-left spreading’ in Maasai and Turkana has been analyzed here under the gen-

eral assumptions of the agreement model without reference to any sort of directionality at all. Instead, the apparent effects of directionality are attributed to the correspondence relation that holds between affixed forms and their stems of affixation, a relation independently motivated by the analysis of stem control. This analysis crucially depends on the fact that /a/ is re-paired with [o] when it behaves harmonically; if it weren’t for the additional feature changes this mapping involves, there would be no stem-affixed form faithfulness constraint available to block the mapping from being triggered by right-to-left spreading. Just as crucial, of course, is the fact that the low vowel is harmonic with respect to left-to-right spreading and opaque with respect to right-to-left spreading. If the situation were the reverse, it would be impossible to attribute to residual stem control: the mapping from /a/ to [o] would be strictly anti-cyclic, while stem-affixed form faithfulness predicts strict cyclicity.

Compare these results with those of the directional spreading analyses summarized in §3 above. Directionality is a completely independent parameter of assimilation under these analyses, and therefore no necessary connection can be made between directionality and cyclicity. The fact that the harmonic behavior of /a/ with respect to left-to-right spreading involves an indirect re-pairing mapping to [o] rather than a direct mapping to [e] is also a complete accident under one of these analyses; in fact, it requires special invocation of a later rule that happens to duplicate the phonological condition on right-to-left spreading to the effect that [+LO, +ATR] vowels cannot be created (see footnote 11). The present analysis takes each of these apparent accidents of fact and paints a coherent morpho-phonological picture of the observed systematic behavior of the low vowel in Maasai and Turkana.

4.3 More on dominance reversal

4.3.1 Preamble

Turkana exhibits [+ATR] dominance, but there is also a handful of suffixes whose [-ATR] vowels are also dominant, requiring all vowels in the word to be [-ATR].²⁰ Although these apparently idiosyncratic suffixes present some fairly non-trivial analytical problems, the behavior of low vowels in the presence of these suffixes constitutes fairly conclusive evidence for the cyclic, residual stem control analysis just presented.

4.3.2 Facts

The examples in (239) illustrate the basic behavior of the idiosyncratically dominant [-ATR]-vowel suffixes that exist in Turkana (this suffix is thickly underlined). When attached to an all-recessive stem of affixation as in (239a,b), the vowel of these suffixes appears to be just another [-ATR] recessive vowel, emerging faithfully and having no particular effect on the stem. When attached to a stem of affixation with an otherwise dominant [+ATR] vowel, on the other hand, the vowel of these suffixes stubbornly remains [-ATR] and forces all the other vowels in the word to be [-ATR] — notably including the [+ATR] vowel(s), as shown in (239c).

- (239) An exceptionally dominant [-ATR] suffix (Dimmendaal 1983:284)
- | | | | | |
|----|---------------------------------------|---|-------------|----------------------------|
| a. | / a • √se • un • <u>et</u> / | → | aʒeʊnet | (recessive root) |
| | GEN • choose • VEN • INST-LOC | | 'choice' | |
| b. | / a • √cam • un • <u>et</u> / | → | aʒamʊnet | (recessive root) |
| | GEN • agree • VEN • INST-LOC | | 'agreement' | |
| c. | / a • k • √ido • un • <u>et</u> / | → | akidoʊnet | (otherwise dominant root!) |
| | GEN • K • give birth • VEN • INST-LOC | | 'birth' | |

The real interest of these idiosyncratically dominant [-ATR] vowels is their interaction with low vowels. Consider the data in (240) below. The low vowel of interest here is, as usual, *italicized*.²¹ As can be seen from (240a), there is nothing peculiar about this low

²⁰ Maasai has no morphemes of this type, and neither Maasai nor Turkana seems to have idiosyncratically opaque vowels either (cf. the case of Kalenjin analyzed in Chapter 2, §3.3).

²¹ This vowel is glossed as 'E', for 'epipatetic vowel'. According to Dimmendaal (1983:203-204), the epipatetic vowel no longer serves any grammatical function, but probably once did (similar to the 'moveable k' morpheme, glossed here as 'k'). Though morphosyntactically empty, epipatetic vowels are phonologically regular.

vowel; it remains low and [-ATR] when in recessive company (240a.i) but becomes [o] when preceded by a dominant [+ATR] vowel in a less peripheral morpheme (240a.ii).

- (240) The behavior of the low vowel (Albert 1995:18, Dimmendaal 1983:24-25)
- | | | | | | |
|----|-----|-----------------------------------|---|-----------------------------|------------------|
| a. | i. | / a • k • √ipud • a • km / | → | akipudakm | (recessive root) |
| | | GEN • K • trample • E • DAT | | 'to trample' | |
| | ii. | / a • k • √jbus • a • km / | → | akibusokin | (dominant root) |
| | | GEN • K • drop • E • DAT | | 'to drop' | |
| b. | i. | / ε • √jbus • a • km / | → | eibusokin | (a → o) |
| | | 3 • drop • E • DAT | | 'it has fallen down' | |
| | ii. | / ε • √jbus • a • km • <u>a</u> / | → | eibusokina | (a → ə!) |
| | | 3 • drop • E • DAT • VOI | | 'it has thrown itself down' | |

The form in (240b.i) shows the same thing as the one in (240a.ii), a preceding dominant vowel causing the low vowel to become [o]. Now compare the form in (240b.ii), which has one of the idiosyncratically dominant [-ATR]-vowel suffixes attached to the stem in (240b.i). All of the vowels in the word are forced to be [-ATR], as expected. But note that the low vowel does *not* take advantage of the situation and surface input-faithfully as a [-ATR] low vowel [a], as might be naively expected; instead, it surfaces as the [-ATR] mid round vowel [ɔ].

As originally noted by Dimendaal (1983:23ff), one can make sense of this otherwise strange-looking alternation with cyclicity. The idiosyncratically dominant [-ATR]-vowel suffix is attached to a stem of affixation that has already undergone the re-pairing mapping from /a/ to [o]; the ultimate output [ɔ] ensures better satisfaction of stem-affixed form faithfulness, even though this is at the expense of input-output faithfulness.

4.3.3 Analysis

4.3.3.1 The low vowel

The analysis proposed so far readily accounts for the behavior of low vowels in the presence of these idiosyncratically dominant [-ATR] vowels. Recall that AGREE[ATR] must dominate both IO-IDENT[LO] and IO-IDENT[RD] as well as IO-IDENT[ATR] in order to account for the re-pairing of low vowels when preceded by dominant vowels in less periph-

eral morphemes (see §4.2.1). Recall also that SA-IDENT[LO] and/or SA-IDENT[RD] must dominate AGREE[ATR] in order to account for the opacity of low vowels with respect to dominant vowels in more peripheral morphemes (see §4.2.2). By transitivity of the constraint domination relation, either SA-IDENT[LO] or SA-IDENT[RD] (or both) must dominate IO-IDENT[LO] and IO-IDENT[RD]. What this means is that given the choice, it is better to satisfy stem-affixed form faithfulness to [LO] and/or [RD] than it is to satisfy input-output faithfulness to either of these features. This is of course precisely the desired result.

The following tableau shows a simplified comparison between the two relevant candidate outputs for the input / $\varepsilon \cdot \sqrt{\text{ibus}} \cdot a \cdot \text{kin} \cdot \underline{\text{a}}$ / ‘it has thrown itself down’ in (240b.ii).

(241) Input: / $\varepsilon \cdot \sqrt{\text{ibus}} \cdot a \cdot \text{kin} \cdot \underline{\text{a}}$ / Stem: [eibusokin]

Candidates	SA-ID[LO]/[RD]	AGR [ATR]	SA-ID[ATR]	IO-ID[ATR]	IO-ID[LO]	IO-ID[RD]
a. ε eibusokina			****	**	*	*
b. eibusakina	* !		****	**		

The comparison here is between the actual output candidate in (241a), with the low vowel /a/ emerging as [ɔ], and the contender in (241b), with the same vowel surfacing as [a]. Both candidates are fully harmonic and thus satisfy AGREE[ATR]. Both candidates are also equally unfaithful to the [ATR] values of both the input and the stem; the vowels of both candidates are all [-ATR], while two vowels in the input and four in the stem are [+ATR]. The choice between these candidates thus comes down to the conflict between stem-faithfulness and input-faithfulness to the features [LO] and [RD], since the vowel [ɔ] in (241a) is more faithful to its stem correspondent’s values of these features while the corresponding vowel [a] in (241b) is more faithful to its input correspondent’s values of these features.

4.3.3.2 Inalterable recessiveness

The behavior of low vowels with respect to these idiosyncratically dominant [-ATR] vowels is thus already accounted for by the analysis so far proposed. However, the analysis cannot yet account for the existence or behavior of the idiosyncratically dominant [-ATR]-vowel suffixes themselves. At the very least, it seems that there must be some undominated constraint that requires that these vowels surface as [-ATR]; for present purposes, we can suppose that the vowels are underlyingly [-ATR] and that they are subject to a positional faithfulness constraint that is high enough ranked to ensure that they surface faithfully. These vowels are thus ‘inalterably recessive,’ to re-use a term coined in connection with the similarly idiosyncratic opaque vowels of Kalenjin in Chapter 1, §3.3. In fact, the analysis so far put forth is much like the one proposed for the inalterably recessive vowels of Kalenjin; I will thus refer to the hypothesized positional faithfulness constraint as REC-IDENT[ATR], as I did in the case of Kalenjin.²²

In order for the inalterably recessive vowels of Turkana not only to remain faithfully [-ATR] but also to propagate their [-ATR] value throughout the word, AGREE[ATR] must work in concert with REC-IDENT[ATR] to force otherwise dominant [+ATR] vowels to emerge as [-ATR]. REC-IDENT[ATR] and AGREE[ATR] must thus dominate *[-LO, -ATR] & IO-IDENT[ATR], since this local conjunction usually keeps dominant [+ATR] vowels from becoming [-ATR].

The relevant comparison of candidates for the input / $k \cdot \sqrt{\text{idu}} \cdot \text{un} \cdot \underline{\text{et}}$ / ‘birth’ cited in (239c) above is shown in (242) below. (Again, the gender prefix /a/ is left out due to the distinctive behavior of prefix vowels with respect to harmony, on which see §5 below).

²² This analysis finds a precedent in van der Hulst & Smith 1986:267ff, where it is proposed that the vowels in question are idiosyncratically opaque to the spread of [+ATR] and also regressively spread their [-ATR] value.

(242) Input: / k • √id • un • et / Stem: [kidoun]

Candidates	REC-ID[ATR]	AGR [ATR]	*[-LO, -ATR] & IO-ID[ATR]	SA-ID[ATR]	IO-ID[ATR]
a. kidounet	* !				**
b. ^{ɛɛ} kɪdounet			*	***	**
c. kidounet		* !			*

The relevant difference between Turkana and Kalenjin thus seems to be the relative ranking of AGREE[ATR] and *[-LO, -ATR] & IO-IDENT[ATR], as can be seen by comparing (242) with the tableau in (243) below, evaluating a Kalenjin form with an inalterably recessive vowel.²³

(243) Input: / kɪ • a • √un • ke / Stem: [kiɪun]

Candidates	REC-ID[ATR]	*[-LO, -ATR] & IO-ID[ATR]	AGR [ATR]	SA-ID[ATR]	IO-ID[ATR]
a. kiɪunge:	* !				***
b. kraunge:		* !		***	*
c. ^{ɛɛ} kiɪunge:			*		**

4.3.3.3 A ranking paradox

While this would seem to be the end of the story (save for the substantive identification of the position targeted by REC-IDENT[ATR] in each case), there is in fact a conflict between the ranking shown for Turkana in (242) above and the ranking already shown to be necessary in (237) and (238) further above. These latter two tableaux, the second of which is repeated in (244) below, demonstrate that *[-LO, -ATR] & IO-IDENT[ATR] must dominate AGREE[ATR] in both Turkana and Maasai in order to account for the fact that opaque instances of /a/ are *not* reverse-dominant, in precisely the way that the inalterably recessive vowels *are*.

²³ For the empirically curious, this form is the one cited in Chapter 2, p. 106, (55a); the gloss is DIST. PAST • 1SG • wash • REFL. — ‘I washed myself.’ In keeping with the tradition of typographical cues established in this chapter, the dominant [+ATR] vowel is underlined and the inalterably recessive vowel is thickly underlined.

(244) Input: / √babar • u / Stem: [babar]

Candidates	*[-LO, -ATR] & IO-ID[ATR]	AGR [ATR]	SA-ID[ATR]	IO-ID[ATR]	IO-ID[LO]	IO-ID[RD]
a. ^{ɛɛ} babaru		*				
b. babaru	* !		**	**	**	**

Applying this ranking to the case at hand, we of course get the wrong result — inalterably recessive vowels are predicted to be opaque, just as in Kalenjin. This is shown in (245), with the usual skull-and-crossbones indicating the intended winner.

(245) Input: / k • √id • un • et / Stem: [kidoun]

Candidates	REC-ID[ATR]	*[-LO, -ATR] & IO-ID[ATR]	AGR [ATR]	SA-ID[ATR]	IO-ID[ATR]
a. kidounet	* !				**
b. ^{ɛɛ} kɪdounet		* !		***	**
c. ^{ɛɛ} kidounet			*		*

What we seem to have confronted here is a ranking paradox: *[-LO, -ATR] & IO-IDENT[ATR] must dominate AGREE[ATR] in order to explain the opacity of /a/ in Maasai and Turkana while AGREE[ATR] must dominate *[-LO, -ATR] & IO-IDENT[ATR] in order to explain the reverse-dominance of inalterably recessive vowels in Turkana. There are a number of ways to avoid this ranking paradox, one of which I sketch in outline below.

4.3.3.4 A way out

Suppose that the idiosyncratically dominant [-ATR] vowels under discussion are an indication that dominance is *morphologically* determined in Turkana — unlike Maasai, Kalenjin and Diola Fogy, in which there is only phonologically-determined [+ATR] dominance.²⁴ The claim would be that *[-LO, -ATR] & IO-IDENT[ATR] is not the constraint responsible for the dominance of [+ATR] vowels in Turkana. Instead, dominance is an idiosyncratic property of two classes of morphemes: one class consisting of some morphemes with

²⁴ This is Dimmendaal’s (1983) view of dominance in Turkana (cf. Noske 1990): “[i]n general, there is root-control [= stem-control — EB], except where strong [= dominant — EB] suffixes occur” (Dimmendaal 1983:21).

[+ATR] vowels and the other (comparatively small) class consisting of some morphemes with [-ATR] vowels.

A specialized faithfulness constraint, which I will call DOM-IDENT[ATR], demands that the vowels of both types of dominant morpheme surface [ATR]-faithfully. DOM-IDENT[ATR] would thus take the place of both REC-IDENT[ATR] and *[-LO, -ATR] & IO-IDENT[ATR] at the top of the hierarchy, and the complex (but by now familiar) interaction of agreement, stem-affixed form faithfulness and input-output faithfulness takes care of the (anti-)cyclic [ATR] harmony process and the systematically variable behavior of /a/.

In order for this way out of the ranking paradox to work, only the more peripheral of two (or more) dominant morphemes must be visible to DOM-IDENT[ATR]. To see why this is so, consider the new evaluation of the same form in (242) and (245) above. If, as shown in the tableau in (246) below, DOM-IDENT[ATR] is sensitive both to the dominant affix and to the dominant root of this form, the wrong result is again predicted, just as in (245).

(246) Input: / k • √id • un • gt / Stem: [kidoun]

Candidates	DOM-ID[ATR]	AGR[ATR]	SA-ID[ATR]	IO-ID[ATR]
a. kidounet	* !			**
b. ^ɛ kɪdounet	** !		***	**
c. ^ɛ kidounet		*		*

If, on the other hand, DOM-IDENT[ATR] is only sensitive to the more peripheral dominant affix, then the correct result is obtained, as shown in (247) below (cf. (242) above).

(247) Input: / k • √id • un • gt / Stem: [kidoun]

Candidates	DOM-ID[ATR]	AGR[ATR]	SA-ID[ATR]	IO-ID[ATR]
a. kidounet	* !			**
b. ^ɛ kɪdounet			***	**
c. kidounet		* !		*

This result can be ensured by further stipulating that DOM-IDENT[ATR] is a ‘cyclic’ constraint, in the sense that it can only be sensitive to new material on each cycle. Thus, the root of this form is only subject to DOM-IDENT[ATR] on the very first cycle. When the first suffix is added, its vowel agrees with the two root vowels rather than the other way around because SA-IDENT[ATR], though lower-ranked, breaks the tie between the two AGREE[ATR]-satisfying candidates. Finally, as shown in (247), the tide turns when the dominant affix is added.

This analysis requires one more ranking statement to be made in order to maintain the results arrived at earlier concerning the re-pairing of /a/. Since DOM-IDENT[ATR] must be assumed to be a ‘cyclic’ constraint as just discussed, a dominant [+ATR] vowel in a morpheme less peripheral than an /a/ is not guaranteed to cause the /a/ to be re-paired with [o]. This is because DOM-IDENT[ATR] is not sensitive to the dominant vowel, by hypothesis, and so there are two possible ways to satisfy the next-highest ranked constraint, AGREE[ATR]: by changing /a/ to [o], as desired, or by changing the dominant vowel itself to [-ATR] — another case of dominance reversal. The former, cyclic re-pairing mapping violates IO-IDENT[LO] and IO-IDENT[RD] while the latter, anti-cyclic mapping violates SA-IDENT[ATR]; the stem-affixed form faithfulness constraint must thus dominate both input-output faithfulness constraints.

(248) Input: / √tur • aan / Stem: [tur]

Candidates	DOM-ID[ATR]	AGR[ATR]	SA-ID[ATR]	IO-ID[LO]	IO-ID[RD]
a. turaan		* !			
b. ^ɛ turoon				**	**
c. turaan			* !		

4.3.3.5 Concluding remarks

While the analysis just proposed avoids the ranking paradox pinpointed in §4.3.3.3, it is clearly not an ideal solution. The potential dominance of both [+ATR] and [-ATR] vowels

is desirably unified under the wide umbrella of the idiosyncratic DOM-IDENT[ATR] constraint, but this unification comes at the cost of a novel interpretation of the constraint; namely, that it be ‘cyclic.’ Furthermore, the idiosyncrasy of the relatively few [-ATR] dominant morphemes that exist, compared to the regularity of the many existant [+ATR] dominant morphemes, is not at all captured by this unified analysis. (This distinction may be a matter of historical accident, however; it is not impossible that the [-ATR] dominant morphemes are a relatively recent innovation — compare Maasai, for example, which is closely related to Turkana.)

Regardless of what the ultimately correct analysis of Turkana dominance itself is, the behavior of the low vowel with respect to dominant vowels of either the [+ATR] or [-ATR] varieties is more than satisfactorily explained under the overall residual stem control analysis.

4.4 Opacity vs. dominance: the medial vowel

There is an empirically incorrect prediction that the analysis presented so far seems to make with respect to vowels that lie between an opaque low vowel and a more peripheral dominant vowel, as in the Maasai form / $\varepsilon \cdot \sqrt{\text{put}} \cdot a \cdot \underline{\underline{\text{r}}_1} \cdot \underline{\underline{\text{ie}}} /$ ‘I will get filled up’ in (222c.ii) (the medial vowel of interest is double-underlined). Because the low vowel in the morpheme preceding the double-underlined vowel is opaque and [-ATR] and the vowel in the following morpheme is dominant and [+ATR], the medial vowel has two choices in principle: it can either surface as [-ATR], in agreement with the preceding opaque low vowel but in disagreement with the following dominant vowel, or as [+ATR], in agreement with the following dominant vowel but in disagreement with the preceding opaque low vowel. Either way, AGREE[ATR] has no choice but to be violated, and the decision is erroneously predicted to fall to faithfulness.

(249) Input: / $\varepsilon \cdot \sqrt{\text{put}} \cdot a \cdot \underline{\underline{\text{r}}_1} \cdot \underline{\underline{\text{ie}}} /$ Stem: [ɛɪputari]

Candidates	*[-LO, -ATR] & IO-ID[ATR]	AGR[ATR]	SA-ID[ATR]	IO-ID[ATR]
a. $\varepsilon\text{ɪputariy}\varepsilon$	** !			
b. $\varepsilon\text{ɪputariy}\text{ie}$		*		
c. $\varepsilon\text{ɪputariy}\text{ie}$		*	* !	* !

Since the medial vowel is [-ATR] in both the input and the stem of suffixation for the dominant vowel, the inevitable prediction seems to be that the medial vowel should surface as [-ATR], resulting in *[ɛɪputariyɛ] — contrary to fact; the actual output is [ɛɪputariyie].

Recall from Chapter 2, §3.3.2 that medial vowels in dominant-recessive systems are expected to behave less reliably than those in stem-controlled systems, because the behavior of medial vowels in the latter relies on the high rank of stem-affixed form faithfulness to the harmonic feature [F], which selects agreement with the stem vowel. But because SA-IDENT[F] is crucially low-ranked in dominant-recessive systems, the behavior of the medial vowel in these systems depends on the relative ranking of SA-IDENT[F] with other constraints.

For instance, recall that medial vowels in Kalenjin, which are only found between a dominant root and a more peripheral opaque vowel, seem to always agree with the dominant root. The relevant examples are repeated in (250) below.²⁵

(250) Kalenjin medial vowels (adapted from Hall et al. 1974:247)

- a. / $\text{ka} \cdot \text{ma} \cdot \underline{\underline{\text{g}}} \cdot \sqrt{\text{ker}} \cdot \text{ak} /$ → $\text{kama}\varepsilon\text{ger}\text{ək}$
 REC. PAST • NEG • 1SG • see • 2PL ‘I didn’t see you (pl.)’
- b. / $\text{ka} \cdot \text{ma} \cdot \text{ka} \cdot \underline{\underline{\text{k}}_2} \cdot \sqrt{\text{ker}} \cdot \text{a} /$ → $\text{kamaga}\varepsilon\text{ger}\text{e}$
 REC. PAST • NEG • PERF • 3SG • SEE • 1SG ‘and he hadn’t seen me’

Because the dominant vowel happens to be in a less peripheral morpheme than the opaque vowel in these cases, a simple ranking of SA-IDENT[ATR] above IO-IDENT[ATR] was able to

²⁵ These examples are repeated from Chapter 2, p. 109, (59). Since opacity in Kalenjin is morphologically idiosyncratic, the entire morphemes of interest, rather than just their vowels, are *italicized* here.

account for the medial vowel's agreement with the dominant vowel in Kalenjin. (I will not repeat the analysis here; the reader is invited to refer back to Chapter 2, §3.3.2.)

In the Maasai case at hand, the dominant vowel is in a *more* peripheral morpheme than the opaque vowel. No ranking of SA-IDENT[ATR] and IO-IDENT[ATR] can distinguish the two relevant candidates, as shown in (249); these constraints do not conflict in this case, since they are both violated by the intended optimal form. To solve this problem, a constraint that prefers the optimal form to the suboptimal one in (249) must be invoked and shown to be higher-ranked than both SA-IDENT[ATR] and IO-IDENT[ATR].

I assert that such a constraint in fact already exists: it is the co-relevant local conjunction of markedness and agreement, *[-LO, -ATR] &_l AGREE[ATR]. This constraint is violated by a [-LO, -ATR] vowel that does not agree with at least one of the vowels adjacent to it. Such a vowel is indeed found in the suboptimal candidate in (249) and not in the optimal one: the medial vowel [i] in the suboptimal candidate, a [-LO, -ATR] vowel, disagrees with the adjacent dominant vowel. The medial vowel in the optimal candidate also disagrees with an adjacent vowel; to wit, the opaque one. But crucially, neither of these is [-LO, -ATR]: the medial vowel is [i], which is [+ATR], and the opaque vowel is [ɑ], which is [+LO].

Being a local conjunction, *[-LO, -ATR] &_l AGREE[ATR] must universally outrank its conjuncts, one of which is AGREE[ATR]. Since AGREE[ATR] dominates both SA-IDENT[ATR] and IO-IDENT[ATR], then *[-LO, -ATR] &_l AGREE[ATR] dominates these two constraints by transitivity. The correct result is thus obtained, as shown in (251) below.

(251) Input: / ε • √iput • a • r_l • iε / Stem: [εiputari]

Candidates	*[-LO, -ATR] & _l IO-ID[ATR]	*[-LO, -ATR] & _l AGR[ATR]	AGR [ATR]	SA-ID[ATR]	IO-ID[ATR]
a. εiputariyε	** !				
b. εiputariyie		* !	*		
c. ε ^ɛ iputariyie			*	*	*

This solution is strikingly similar to the one proposed by Levergood (1984:39-41/278-279) in her account of the exact same problem with her analysis of Maasai (see Vago & Leder 1987 for an entirely parallel analysis of Turkana). In brief, Levergood's solution involves a markedness constraint preventing [-ATR] from linking to [-LO] vowels — *[-LO, -ATR]. This constraint holds in the lexical phonology, where vowel harmony takes place; a medial vowel thus agrees with a dominant vowel because it cannot agree with an opaque vowel, lest it violate *[-LO, -ATR]. The constraint is later lifted post-lexically, allowing [-ATR] to link (by default) to [-LO] vowels that are not already linked to [+ATR]; i.e., to recessive vowels.

The analogue of Levergood's distinction between [+ATR] harmony and [-ATR] default in the current analysis is of course the fact that the markedness constraint *[-LO, -ATR] is locally conjoined with the agreement constraint AGREE[ATR]. The markedness constraint asserts itself only when agreement is also at stake, disallowing a [-LO, -ATR] vowel only when such a vowel would cause disagreement. The same [-LO] vowels are [-ATR] by default only when agreement considerations are not at stake; i.e., in a string of recessive vowels.

5. Prefixes

5.1 Introduction

The behavior of prefix low vowels in both Maasai and Turkana presents difficulties for the present residual stem control analysis. Since prefixes must presumably be more peripheral than roots, a dominant vowel in the root is expected to cause re-pairing of a low vowel in a prefix. But the fact is that low prefix vowels are opaque to the propagation of [+ATR]. In §5.2 below, I propose to account for this fact by appealing to prefixal faithfulness, a variety of positional faithfulness that is further motivated by the otherwise unexpected phonological behavior of prefixes with respect to other processes in other languages.

Another fact about prefix vowels, not just in Maasai and Turkana but also in every other dominant-recessive vowel harmony system I am aware of, is that prefixes are never dominant. This fact is a problem for any analysis of dominance; short of stipulating that a prefix vowel is simply never underlyingly specified as [+ATR] — a challenge to the Richness of the Base hypothesis — there seems to be no way to explain this (apparently universal) fact. I propose in §5.3 further below that the lack of dominant prefix vowels is due to a distinction between two stem-affixed form correspondence relations: one holding between stems and suffixed forms, subject to stem-suffixed form faithfulness (SS-IDENT[F]), and the other holding between stems and prefixed forms, subject to stem-prefixed form faithfulness (SP-IDENT[F]). The basic claim is that while [ATR] harmony between stems and suffixes is dominant-recessive due to the relatively lower rank of SS-IDENT[ATR], harmony between stems and prefixes is stem-controlled due to the relatively higher rank of SP-IDENT[ATR].

This analysis not only accounts for the lack of dominant prefixes, but it also predicts a set of facts in Maasai previously analyzed by Levergood (1984) under similar assumptions about the phonology-morphology interface. And while the analysis does not in and of itself *explain* why prefixes and suffixes should be divided amongst themselves in this way, it is supported by Benua's (1997ab) work in this area, in which it is recognized that different affix classes may subcategorize for different stem-affixed form correspondence relations.

5.2 Opacity in prefixes

5.2.1 The problem and its solution

Under the analysis so far presented, a prefix vowel is expected to be more than willing to be re-paired, to change its [LO] value in order to accommodate the faithfulness demands of the stem of affixation. But this is not the case: a low prefix vowel is systematically opaque. For example, the first person singular prefix /a/ in Maasai surfaces as [ɑ] whether

it is attached to a dominant or a recessive stem, as can be seen by comparing the forms in (252) below.²⁶

(252) Prefix opacity in Maasai (Archangeli & Pulleyblank 1994:305)

- | | | | | |
|----|------------------------------------|---|---------|--------------------------|
| a. | <i>/a • √rək • <u>ɪ</u> /</i> | → | aroku | <i>(dominant suffix)</i> |
| | 1SG • black • INCEP. | | | ‘I become black’ |
| b. | <i>/a • ta • √rək • <u>ɑ</u> /</i> | → | atərəkɑ | <i>(all recessive)</i> |
| | 1SG • PAST • black • INCEP. | | | ‘I became black’ |

Note that the low vowel is incorrectly expected to be re-paired in (252a) only if the prefix low vowel is assumed to be more peripheral than the dominant suffix vowel. If the suffix is less peripheral, it is attached first, forcing the [-ATR] root vowel to become [+ATR]. The low vowel prefix is then expected to be re-paired to [o] because not only are its stem vowels [+ATR], they are also [-LO]. Changing the stem vowels to agree with the prefix low vowel would violate both *[-LO, -ATR] &_i IO-IDENT[ATR] and SA-IDENT[ATR], whereas re-pairing the prefix low vowel would only violate lower-ranked IO-IDENT[ATR] and IO-IDENT[LO].

But suppose that the prefix is attached first. Both the root and prefix vowels are [-ATR], so no change is necessary in either. When the dominant suffix is attached, however, a change is necessary. Since *[-LO, -ATR] &_i IO-IDENT[ATR] and AGREE[ATR] both dominate SA-IDENT[ATR], the stem vowels — both the root and prefix vowels, by hypothesis — are expected to change in agreement. However, because either SA-IDENT[LO] or SA-IDENT[RD] is higher ranked than AGREE[ATR] together with *[-LO, -ATR] &_i IO-IDENT[ATR], the prefix vowel is not allowed to be re-paired and the result is instead — correctly — opacity.

Assuming that prefixes are less peripheral than suffixes in Maasai and Turkana thus accounts for the Maasai case in (252a). But other examples of opaque prefix low vowels, such as those found in (222b.i), (221c.ii) and (222d.i) and repeated together in

²⁶ As usual, the low vowel of interest is *italicized* and the dominant vowel in (252a) is underlined. Note that the special behavior of the low vowel of the PAST prefix /ta-/ in (252b) was already noted in footnote 7 above.

(253) below, show that this assumption is not sufficient for either language. In these cases there is also an inarguably less peripheral dominant root, and still the more peripheral prefix low vowel is opaque.

(253) Prefix opacity in Maasai (a) and Turkana (b,c)

a.	/ a • √ <u>duj</u> • akim • <u>je</u> / ISG • cut • DATIVE • APPL.	→	adujokinie 'I cut for s.o. w/ s.t.'	(dominant root)
b.	/ a • √ <u>lijim</u> • <u>u</u> / GEN • cold • NOM	→	alilimu 'coldness'	(dominant root)
c.	/ a • √ <u>tur</u> • aan • <u>u</u> / GEN • agile • HAB • NOM	→	aturoonu 'agility'	(dominant root)


I assume for independent reasons that prefixes are more peripheral than suffixes in both Maasai and Turkana (see §5.3 below), but the examples in (253) demonstrate that this has no bearing on the proper analysis of the opacity of prefixal low vowels.

The opacity of prefixal low vowels is a problem for the present analysis because I claim that (non-cyclic) directionality plays no independent parametric role in the analysis of vowel harmony in general or in the re-pairing mapping of Maasai and Turkana in particular. Under the directional feature spreading analyses proposed by Archangeli & Pulleyblank (1994) and Albert (1995), the reason that re-pairing is blocked in prefixes is the same reason it is blocked in roots and suffixes that are only linearly followed, not preceded, by dominant vowels. The direction of spreading is leftward in all these cases, and low vowels are stipulated to be non-targets to right-to-left [+ATR] spreading (see §3 for details of these analyses).

Despite this apparent disadvantage of the present analysis, I believe that the many arguments in favor of it and against the directional feature spreading analysis far outweigh this one reason for the opposite verdict. So the question is how to account for the opacity of prefix low vowels within the present analysis. What is minimally necessary is a constraint that blocks the re-pairing mapping from /a/ to [o] in prefixes only; that is, a faithfulness constraint specific to the value of either [LO] or [RD] in prefixes, since both

stem-affixed form faithfulness and general input-output faithfulness are unsuited for the job. I propose that there is in fact a prefix-specific correspondence relation, subject to a set of faithfulness constraints that I refer to as PFX-IDENT[F]. Either PFX-IDENT[LO] or PFX-IDENT[RD] must be ranked higher than AGREE[ATR], just like SA-IDENT[LO]/[RD] is in the analysis of low vowel opacity in the stem of affixation. The critical comparison is shown in (254) (cf. (236) above).

(254) Input: / a • √rok • u /

Candidates	Stem: [roku]					
	PFX- ID[LO]/[RD]	AGR [ATR]	SA- ID[ATR]	IO- ID[ATR]	IO- ID[LO]	IO- ID[RD]
a.  aroku		*		*		
b. oroku	* !			**	*	*

The input here is the example in (252a), / a • √rok • u / 'I become black'. For the sake of argument, the first person singular prefix /a/ is assumed to be more peripheral than the dominant suffix /u/; that is, the prefix is attached to a stem that includes both the root and the dominant suffix — a stem with all [+ATR] vowels, [roku]. The two candidates of interest are the optimal one with opacity and the suboptimal one with re-pairing. The opaque form is optimal because either PFX-IDENT[LO] or PFX-IDENT[RD] (or both) rules out the re-pairing candidate due to its rank above AGREE[ATR].²⁷

The disagreement that this opacity entails is tolerated not only because prefixal faithfulness dominates agreement but also because *[-LO, -ATR] & IO-IDENT[ATR] outranks AGREE[ATR], an already-established ranking (see (238) above). The contending candidate being ruled out in (255a) below is one in which the prefixal low vowel is reverse-dominant, forcing the dominant suffix vowel to become [-ATR] in agreement with the low vowel as opposed to vice-versa. Another contending candidate in this case is one in which the inalterability of the prefixal low vowel allows the medial root vowel to surface faith-

²⁷ Note that PFX-IDENT[ATR] must be ranked below AGREE[ATR] in order to account for the fact that non-low prefix vowels alternate in agreement with dominant vowels in the stem. I put this point aside until §5.3.

fully as [-ATR]; this candidate, represented in (255b), is ruled out by *[-LO, -ATR] &_I AGREE[ATR] (cf. (251) above).

(255) Input: / a • √røk • ɯ /

Stem: [roku]

Candidates	*[-LO, -ATR] & _I IO-ID[ATR]	*[-LO, -ATR] & _I AGR[ATR]	AGR [ATR]	SA-ID[ATR]	IO-ID[ATR]
a. arøkɯ	* !				
b. arøkɯ		* !	*		
c. ^{ɛɸ} aroku			*		*

While this analysis predicts that low vowels in Maasai and Turkana prefixes could in principle be re-paired rather than opaque, it does restrict the alternative behavior of a prefixal low vowel to these two choices and no others. For instance, a prefixal low vowel could not, even in principle, be reverse-dominant, because low vowels in a stem are not reverse-dominant. The ranking of *[-LO, -ATR] &_I IO-IDENT[ATR] above AGREE[ATR], albeit language-particular, accounts for both cases simultaneously. In this sense, the opacity of low vowels in general is in fact unified under the present analysis.

5.2.2 A similar case

There is independent motivation for prefix-specific faithfulness, making the adopted solution to the opaque prefixal low vowel problem less of a liability than it may at first seem. In some dialects of Spanish, there is an alternation between [s] and [h] such that [s] appears in syllable onsets while [h] appears in syllable codas. Despite this otherwise purely allophonic alternation, the prefix *des-* surfaces consistently as [deh], in both prevocalic (onset) and preconsonantal (coda) position: *de[h]calzo* ‘barefoot’ *de[h]ayuno* ‘breakfast’.²⁸

Various complicated maneuvers are necessary to derive this form from a presupposed underlying form /des-/ (see Harris 1993, Kenstowicz 1996); but as Benua (1997a) and Hale, Kissonock & Reiss (1997) point out, these analyses are unsuccessful for various

²⁸ *des-* is roughly equivalent to English *un-*: *descalzo* ‘barefoot, unshoed’, *desayuno* ‘breakfast, unfasting’.

reasons and it must simply be admitted that the underlying form of this prefix is exactly what it surfaces as, /deh-/. But unless something further is said, this admission requires that the underlying form of all the segments that *do* alternate between [s] and [h] is /s/ — quite a preponderant lexical accident, since this essentially means that underlying /h/ is limited to exactly the *des-* prefix.

This is where prefix-specific faithfulness comes in. The otherwise allophonic alternation between [s] and [h] is due to the ranking given in (256) below (see Baković 1998; cf. Kenstowicz 1996), where *s]_σ is a context-sensitive markedness constraint against coda [s], *h is a context-free markedness constraint against [h], and IO-IDENT[PL] is a faithfulness constraint against changing the value of (supralaryngeal) consonantal place specification from input to output, the change that is assumed to underlie the [s] ~ [h] alternation.

(256) Allophonic alternation in Spanish
*s]_σ » *h » IO-IDENT[PL]

As shown in Baković 1998, this ranking yields the correct allophonic alternation regardless of whether the input in any given case is [s] or [h], following much work on the subject of complementary distribution rankings in OT. Being subordinate in the ranking, faithfulness is simply irrelevant in the choice between [s] and [h], which is decided by the competition between the two higher-ranked constraints: when the alternating segment is in a coda, *s]_σ reigns supreme, deciding in favor of [h]; in onsets, *s]_σ is irrelevant and the choice falls to *h, which decides in favor of [s]. Now in order for a prevocalic /h/ to surface faithfully in a prefix like *des-*, it would have to somehow escape the fate determined by the ranking of *h above IO-IDENT[PL]. If there were a prefix-specific version of the faithfulness constraint — call it PFX-IDENT[PL] — that dominated *h, an input /h/ would

be allowed (well, forced) to remain distinct in *des-* regardless of its position in syllable structure, as desired.²⁹

(257) Allophonic alternation in Spanish with prefixal faithfulness
 { PFX-IDENT[PL], *s_l } » *h » IO-IDENT[PL]

While a rock-solid case for prefix-specific faithfulness remains to be made, it seems to be a promising area for further research based on the Maasai/Turkana and Spanish cases briefly investigated here. Prefixes often exhibit unexpected phonological behavior that may be accountable for with prefix-specific faithfulness, or at least something akin thereto.

5.3 No dominant prefixes

5.3.1 The problem

Prefix vowels in Maasai and Turkana are never dominant (on this point in Maasai, see Hall et al. 1974:253; on Turkana, see Dimmendaal 1983:21-22). This is not a peculiarity of these two languages. Hall & Hall (1980:227) reflect on the many dominant-recessive vowel harmony systems that they are familiar with and remark: “there seem to be no true cases of Dominant grammatical prefixes which cause harmony to themselves.” The analysis so far presented cannot account for this fact: a [+ATR] vowel in a prefix, just like a [+ATR] vowel in a suffix, is expected to be able to anti-cyclically force the vowels in the stem to which it is attached to become [+ATR]. Note that prefix-specific faithfulness offers no help in this regard: the problem is that prefix vowels cannot be contrastively [+ATR]; their [ATR] value is entirely predictable. Prefix-specific faithfulness is only expected to *encourage* contrasts in prefix vowels, not deter them.

Previous analysts of Maasai and Turkana have been forced to simply assert that there are no [+ATR] vowels in prefixes (see e.g. Archangeli & Pulleyblank 1994:306). This type of assertion of course runs counter to the Richness of the Base hypothesis, re-

²⁹ An analysis along these lines can also be formulated to explain the slightly more intricate behavior of the prefix *sub-* in Catalan (Harris 1993, Merchant 1997). I refrain from doing so here in the interests of brevity.

gardless of the fact that the relevant generalization it aims to explain seems to be a universal one.³⁰ Levergood (1984:36/289) acknowledges the undesirable arbitrariness of an “accidental gap” analysis of just this sort, and in fact argues (1984:45/282ff) that [+ATR] prefix vowels do exist in Maasai — though these vowels are, crucially, not dominant but rather *opaque* in their behavior.

In what follows I offer an analysis that correctly accounts for the generalization but that, perhaps unfortunately, does not explain its universality.³¹ In brief, what I propose is that different affix classes (in the case at hand, prefixes and suffixes) may subcategorize for different stem-affixed form correspondence relations, each of which is subject to a distinct set of stem-affixed form faithfulness constraints. This part of the proposal follows Benua’s (1997ab) account of the parallel and well-known phenomenon of affix class distinctions in languages like English. The fact that there are no dominant prefixes then boils down to the claim that while vowel harmony is dominant-recessive between stems and suffixes because agreement dominates stem-*suffixed* form faithfulness, it is stem-controlled between stems and prefixes because agreement is in turn dominated by stem-*prefixed* form faithfulness.

As an added bonus, it turns out that the behavior of opaque [+ATR] prefix vowels in Maasai, as analyzed by Levergood (1984), is readily accounted for by the proposed analysis.

5.3.2 Preliminaries: morphological analysis

Following Levergood’s (1984) preliminary morphological analysis of Maasai, I assume that a Maasai form like / ε • √ibuk • ar • ie / ‘s/he poured it away with something’ (222a.i) or a Turkana form like / α • √tur • aan • u / ‘agility’ (222d.i) have the morphological

³⁰ Recall that the Richness of the Base hypothesis precludes any language-particular stipulation regarding possible input representations. Any statement to the effect that prefix vowels cannot be [+ATR] must be language-particular, since it is certainly not the case that no language ever has [+ATR] prefix vowels.

³¹ It is actually not clear to me as of this writing that there is anything really to be explained here, at least not any more than there is anything to explain about the fact that the harmonic feature in dominant-recessive vowel harmony systems is always and only [ATR] (and not, say, [BK], [RD], or [HI]).

structure depicted in (258), with prefixes more peripheral than ('attached subsequently to') suffixes.

(258) Morphological structure of Maasai and Turkana

q	p		
g		4	stem
1		stem	
1	3		g
1	stem	g	1
g	g	g	g
pfx	root	sfx	sfx
g	!	g	g
[ε [[[[[√ibuk] ar] ie]]]]			
3SG	pour	MA	APPL. 's/he poured it away w/ s.t.' (Maasai)
[α [[[[[√tur] aən] u]]]]			
GEN	agile	HAB	NOM 'agility' (Turkana)

The key feature of this morphological analysis is that suffixed stems serve as stems of affixation to prefixes, but prefixed stems do *not* serve as stems of affixation to suffixes.

Let us assume for the sake of argument that this morphological analysis is correct for languages with dominant-recessive vowel harmony in general. Given this, the observation that prefixes are never dominant in such languages amounts to the following: prefix vowels alternate in agreement with the vowels of their stems of prefixation and not vice-versa. In other words, even though vowel harmony is not controlled by the stem of *suffixation* in these languages, it *is* controlled by the stem of *prefixation*.

5.3.3 Stem-suffixed form vs. stem-prefixed form faithfulness

Recall that if AGREE[F] dominates SA-IDENT[F], there is dominance (temporarily putting aside the additional necessary high rank of a relevant local conjunction). I have so far proposed that AGREE[ATR] dominates SA-IDENT[ATR] in Maasai and Turkana, establishing the fact that [ATR] harmony in these languages is dominant-recessive. But the lack of dominant prefixes indicates that dominance only obtains between stems and suffixes; it does not obtain between stems and prefixes. What I propose therefore is that there is not one but two distinct stem-affixed form correspondence relations, each with its own set of

faithfulness constraints: a stem-suffixed form relation, regulated by SS-IDENT[F] constraints, and a stem-prefixed form relation, regulated by SP-IDENT[F] constraints. The fact that harmony is dominant-recessive between stems and suffixes means that AGREE[ATR] dominates SS-IDENT[ATR], but because harmony is not dominant-recessive between stems and prefixes, SP-IDENT[ATR] must in turn dominate AGREE[ATR]. This ranking is shown in (259).

(259) Prefixal stem control and suffixal dominance
 SP-IDENT[ATR] » AGREE[ATR] » SS-IDENT[ATR]

The proposal that there is more than one stem-affixed form correspondence relation finds a precedent in Benua's (1997ab) work on cyclicity effects in the lexical phonology of English. Benua proposes that the well-established distinction between so-called 'Level 1' and 'Level 2' affixes boils down to a distinction between two stem-affixed form correspondence relations, one between Level 1-affixed forms and their stems of affixation and the other between Level 2-affixed forms and their stems of affixation. Each of these correspondence relations has a distinct set of constraints regulating faithfulness of affixed forms to their stems of affixation, accounting for systematic differences between the two affix classes.

5.3.4 Exemplification

The proposed ranking between SP-IDENT[ATR] and AGREE[ATR] essentially guarantees that there is stem control between stems and prefixes, thereby explaining the fact that there are no dominant prefixes in languages with dominance. A further ranking statement is necessary, however, to determine exactly what happens with an underlying [+ATR] prefix vowel when it is attached to a recessive stem (i.e., one with [-ATR] vowels). As it stands, such a vowel can either become [-ATR] in agreement with the stem, or it can remain [+ATR] and be opaque, forcing more peripheral prefix vowels to also be [+ATR]. The former situation can be ensured by ranking AGREE[ATR] above *[-LO, -ATR] &_i IO-

IDENT[ATR], forcing [+ATR] prefix vowels to change and surface as recessive (and marked) [-ATR] vowels. This is shown in (260), in which a hypothetical input with a [+ATR] prefix vowel and a [-ATR] stem vowel is evaluated.

(260) Input: [+ATR] • √[-ATR] Stem: √[-ATR]

Candidates	SP- ID[ATR]	AGR[ATR]	*[-LO, -ATR] & _l IO-ID[ATR]	PEX- ID[ATR]
a. ^{SP} [-ATR] • √[-ATR]			*	*
b. [+ATR] • √[-ATR]		* !		
c. [+ATR] • √[+ATR]	* !			

The latter situation can be gotten by the opposite ranking of *[-LO, -ATR] &_l IO-IDENT[ATR] and AGREE[ATR], forcing a minimal violation of AGREE[ATR]. This is shown in (261).

(261) Input: [+ATR] • √[-ATR] Stem: √[-ATR]

Candidates	SP- ID[ATR]	*[-LO, -ATR] & _l IO-ID[ATR]	AGR[ATR]	PEX- ID[ATR]
a. [-ATR] • √[-ATR]		* !		*
b. ^{SP} [+ATR] • √[-ATR]			*	
c. [+ATR] • √[+ATR]	* !			

In fact, the relative ranking of SP-IDENT[ATR] and AGREE[ATR] is not determinable when *[-LO, -ATR] &_l IO-IDENT[ATR] is subordinate to them both, as indicated in (260) by the dotted line between them. The lower rank of the local conjunction ensures its violability in optimal forms, securing the inviolability of both SP-IDENT[ATR] and AGREE[ATR] (unless of course other, higher-ranked constraints like *[+LO, +ATR] and SA-IDENT[LO]/[RD] come into play).

The point of the comparison just made is to show that the proposed distinction between SP-IDENT[ATR] and SS-IDENT[ATR] — and the higher rank of the former versus the lower rank of the latter — has the ultimately desired consequence that there are no dominant prefixes in languages with dominance. However, there is still the question as to what

might happen to a prefix that happens to be underlyingly specified as [+ATR]. As far as I can tell, the right result for Kalenjin and Diola Fogny is the one exemplified by (260): a prefix vowel always alternates to agree with the vowels of the stem to which it is attached. The result exemplified by (261), on the other hand, must be the correct one for Maasai, since it has already been established that *[-LO, -ATR] &_l IO-IDENT[ATR] dominates AGREE[ATR] in this language (see §4.2.2).³² Furthermore, as noted earlier, Levergood (1984) observes that there is at least one inalterably [+ATR] prefix vowel in Maasai which behaves in precisely the manner predicted by the ranking shown in (261). We now turn to the analysis of this case.

5.3.5 'Inalterable dominance' in Maasai prefixes

As just noted, the ranking between *[-LO, -ATR] &_l IO-IDENT[ATR] and AGREE[ATR] already arrived at for independent reasons predicts that there should be some opaque [+ATR] prefixes in Maasai. Indeed, this is the case; one of these was precisely the subject of Levergood 1984. The relevant facts are as follows. Tucker & Mpaayei (1955:52) note that Maasai verb roots belong to either one of two morphological classes, Class I or Class II. The basic distinction between these two verb classes is that Class II verbs begin with an otherwise meaningless high front vowel prefix (which I will gloss simply as 'v') while Class I verbs do not.

The two verb classes are also distinguished by the phonological behavior of some of the other prefixes they take. The prefix most relevant to Levergood's concerns (and ours) is the third person singular prefix, which consists of a mid front vowel. With Class I verbs, this prefix vowel alternates between [+ATR] [e] and [-ATR] [ɛ], as shown in (262).

³² Which of the two rankings in (260) and (261) is the right one for Turkana remains to be seen. Recall from §4.3 that the analysis of dominance in Turkana may differ in consequential ways from that of these other languages.

(262) 3SG prefix with Class I verbs (Levergood 1984:46/282)

- a. /E • √tur / → etur (dominant root)
 3SG • dig 's/he digs'
- b. /E • √rañ / → erañ (recessive root)
 3SG • sing 's/he sings'
- c. /E • √rip / → erip (recessive root)
 3SG • sew 's/he sews'

The underlying form for this vowel is temporarily represented here as /E/ because it could in principle be either [+ATR] or [-ATR]. Because I am claiming that harmony between stem and prefix is stem-controlled, the underlying [ATR] specification of this vowel is undeterminable.

With Class II verbs, on the other hand, the third person singular prefix is consistently [+ATR] [e], behaving in an opaque fashion when prefixed to [-ATR] stems, as shown in (263).

(263) 3SG prefix with Class II verbs (Levergood 1984:46-47/282-283)

- a. /e • I • √tj / → eitj (dominant root)
 3SG • V • end 's/he ends'
- b. /e • I • √dip / → erdip (recessive root)
 3SG • V • finish 's/he finishes'
- c. /ne • m • e • I • √rrag / → nemeirrag (recessive root)
 FUT • NEG • 3SG • V • lie down 's/he will not lie down'

In this case, it wouldn't make much sense to say that the prefix vowel is underlyingly [-ATR], since it consistently surfaces as [+ATR]. We are in fact justified in assuming that the third person singular prefix for Class II verbs is underlyingly [+ATR] /e/, just as I have specified it in these examples, which might lead us to conclude that the third person singular prefix for Class I verbs — e.g., those in (262) — is underlyingly the minimally distinct [-ATR] /e/.

In order to ensure that the [+ATR] Class II prefix vowel is opaque as opposed to dominant or alternating, SP-IDENT[ATR] and *[-LO, -ATR] & IO-IDENT[ATR] must both be ranked higher than AGREE[ATR], just as in (261) above. This is shown in (264) below for the form in (263b), /e • I • √dip / 's/he finishes'.

(264) Input: /e • I • √dip /

Stem: [ɪdɪp]

Candidates	SP-ID[ATR]	*[-LO, -ATR] & IO-ID[ATR]	AGR[ATR]	PFX-ID[ATR]
a. εɪdɪp		* !		*
b. eidɪp	* !		*	*
c. eidɪp	** !			*
d. ε eidɪp			*	

As shown by the failure of (264a), *[-LO, -ATR] & IO-IDENT[ATR] prevents the [+ATR] prefix vowel from receding into [-ATR]-hood. This does not mean that this vowel is dominant, however; the undominated stem-prefixed form faithfulness constraint SP-IDENT[ATR] ensures complete stem control between stem and prefix, such that not even just the Class II-defining high front prefix vowel can change to agree with [+ATR] third person singular prefix vowel, as in (264b), not to mention both it and the root vowel, as in (264c). All that there is left to do is to violate AGREE[ATR], correctly predicting opacity as shown in (264d).

There is a bit more that needs to be said about the comparison between the optimal candidate and the suboptimal candidate in (264b), both of which share an agreement violation. Note that the obligatory Class II prefix vowel is a medial vowel between the stem vowel and the opaque vowel. This medial vowel optimally agrees with the stem vowel and crucially not with the opaque vowel. In the case at hand, this follows from the fact that both candidates equally violate *[-LO, -ATR] & IO-IDENT[ATR] (see §4.4 above), since in each case there is a [-LO, -ATR] vowel disagreeingly adjacent to a [+ATR] vowel. No matter where this constraint is ranked, then, SP-IDENT[ATR] decides in favor of the correct optimal candidate, as shown.

Suppose, however, that the stem vowel is a low vowel, as in /ne • m • e • I • √rrag / 's/he will not lie down', the form in (263c). Now the relevant output candidates differ in their performance on *[-LO, -ATR] & IO-IDENT[ATR]: the optimal form, with a [-ATR] me-

dial vowel in agreement with the low stem vowel, violates this constraint because the medial vowel is [-LO, -ATR] and it disagrees with the adjacent opaque vowel. The suboptimal candidate *[nemeirrag], on the other hand, satisfies *[-LO, -ATR] &_I AGREE[ATR] because the medial vowel is [+ATR] and the stem vowel it disagrees with is [+LO]. The agreement violation thus involves no [-LO, -ATR] vowel, in contrast with the desired optimal candidate.

To ensure the optimality of the correct form, then, it must be that SP-IDENT[ATR] dominates *[-LO, -ATR] &_I AGREE[ATR], as shown in (265) below for the relevant substring of the form in question, /e • I • √irrag / 's/he lies down'.

(265) Input: /e • I • √irrag / Stem: [irrag]

Candidates	SP-ID[ATR]	*[-LO, -ATR] & _I AGR[ATR]	AGR[ATR]	PFX-ID[ATR]
a. eirrag	* !		*	*
b. eirrag		*	*	

In sum, the analysis of Maasai proposed in previous sections of this chapter, coupled with the tools needed to account of the lack of dominant prefixes, provides the basis for the analysis of an otherwise peculiar set of facts concerning the third person singular Class II prefix. The only remaining question is the connection between the third person singular prefixes of each verb class. On the one hand, the two seem to be tokens of the same basic prefix, since they are both front mid vowels. On the other hand, the difference in behavior between the Class I case and the Class II case seems to indicate that these are in fact two different prefixes.

Levergood's (1984:45/282ff) own analysis is that these are tokens of the same prefix. The vowel of this prefix is underlyingly [-ATR], as are the vowels of all prefixes, and a morphologically-conditioned rule inserts [+ATR] in the Class II case. But Levergood's choice here is entirely determined by the assumptions behind her analysis: derivation of the [+ATR] Class II prefix vowel by rule rather than by underlying specification

prevents this [+ATR] value from anti-cyclically spreading to the stem of prefixation. This is achieved by ordering the spreading rule before the rule inserting [+ATR]; although the spreading rule is lexical and thus re-applies after every affixation operation, it is subject to the Strict Cycle Condition and therefore spreading can only proceed cyclically, affecting only more peripheral affixes. This is how Levergood accounts for the fact that this prefix vowel is opaque and not dominant.

The account proposed here does not similarly determine the correct analysis of the two third person singular prefixes. The assumption in the foregoing pages has been that the Class II prefix is underlyingly [+ATR], distinct from its [-ATR] Class I counterpart, and subject to the local conjunction *[-LO, -ATR] &_I IO-IDENT[ATR]. This assumption accounts neatly for the behavior of this vowel, specifically because the necessary rankings among the three constraints *[-LO, -ATR] &_I IO-IDENT[ATR], SP-IDENT[ATR] and AGREE[ATR] have already been established on independent grounds. But it could very well be that the two prefixes are tokens of the same basic [-ATR] prefix, as in Levergood's analysis, and that some constraint other than *[-LO, -ATR] &_I IO-IDENT[ATR] forces the Class II token to become [+ATR] — again, much like Levergood's analysis. In the absence of clear evidence one way or the other, I am forced to leave this matter open here. Perhaps further research on Maasai can decide.

5.3.6 Concluding remarks

A lack of dominant prefix vowels has been successfully analyzed here as a possible state of affairs, but not as a universal. A simple re-ranking of the proposed constraints would allow dominant prefixes; specifically, if SP-IDENT[ATR] were ranked at the same point in the hierarchy as SS-IDENT[ATR] in (259) — effectively collapsing them into SA-IDENT[ATR] — then any underlying [+ATR] prefix would simply be dominant, just like an underlying [+ATR] suffix is. Relatedly, substituting SP-IDENT[ATR] and SS-IDENT[ATR] for each other

in (259) would predict an unattested language with dominant prefixes and no dominant suffixes!

While I don't expect to be able to explain the apparent universality of any of this, I do believe that something can be said about the apparent fact that dominant suffixes are the norm while dominant prefixes are the exception. There is an interesting parallel between the situation in these languages and one in English (noted earlier) that is relevant to this point. (The following discussion relies heavily on Benua's (1997ab) work on English.)

The noun *bomb* in English is phonetically [bám], with deletion of the final /b/ due to a constraint against final clusters of the type that [mb] would be. The evidence that this final /b/ is in fact present in the underlying form is not merely orthographic; the Level 1-affixed form *bombard* [bəmbáɹd] allows the /b/ to surface, since the cluster is not final (i.e., it is not entirely in a syllable coda) in this form. The stem [bám] and the Level 1-affixed form [bəmbáɹd] thus differ in terms of this [b]. An anti-epenthesis stem-affixed form faithfulness constraint (SA_{L1}-DEP) that holds between these two forms is violated, due to the higher-ranked force of an input-output faithfulness against deletion (IO-MAX).³³

This same stem-final /b/ does not surface in the Level 2-affixed form *bombing* [bámiŋ], however, because another anti-epenthesis stem-affixed form faithfulness constraint between the stem [bám] and this Level 2-affixed form — SA_{L2}-DEP — is *higher-ranked* than IO-MAX. The complete ranking is given in (266) below (cf. (259) above).

(266) English stem-final deletion, Level 1 vs. Level 2 (Benua 1997ab)
SA_{L2}-DEP » IO-MAX » SA_{L1}-DEP

³³ Stress is also shifted in the affixed form, with concomitant vowel reduction. This difference itself would be good enough to make the same point being made; I put it aside here in favor of the difference under discussion.

Level 1 affixes in English have a number of effects on their stems of affixation while Level 2 affixes do not (see footnote 33 for another effect in the example under discussion). Under Benua's (1997ab) analysis, faithfulness between Level 1-affixed forms and their stems is often violated while faithfulness between Level 2-affixed forms and their stems is not. In fact, Level 2 stem-affixed form faithfulness constraints are consistently ranked above their Level 1 counterparts in Benua's analysis, an interesting fact that correlates with another one: Level 2 affixes are more peripheral than Level 1 affixes when both are present in a form, hence *bombarding* is a possible word of English, but **bombingard* isn't.³⁴

My claim about dominant-recessive languages is similar: prefixes are more peripheral than suffixes (recall the structure in (258)), which correlates with the analytically necessary conclusion that SP-IDENT[ATR] dominates SS-IDENT[ATR]. The correlation itself is in no way explained, however, and the matter certainly requires much further research.³⁵

³⁴ This so-called 'affix-ordering generalization' has some apparent exceptions that have been noted in the literature; see Benua 1997a:207ff for discussion, examples, and references.

³⁵ See Burzio 1997 for a somewhat different and promising-looking approach to the issue at hand.

CHAPTER FIVE

[-ATR] DOMINANCE AND VOWEL TRANSPARENCY

1. Introduction

Unlike Kalenjin, Diola Fogany, Maasai and Turkana, the set of [-ATR] vowels is dominant in Nez Perce, as opposed to the more typical [+ATR] set.¹ That this is typologically remarkable is noted by Hall & Hall (1980:220-221), who state that “[i]n all of the African languages the Dominant class is uniformly [+ATR] whereas in Nez Perce it is [-ATR].”

I attempt to demonstrate in §2 below that the situation in Nez Perce is not the result of some random reversal of the relative markedness of the two values of [ATR], but rather that the unmarkedness of the [-ATR] set of vowels in Nez Perce follows from the structure of the notably impoverished five-vowel inventory of the language, given in (267).²

(267) Nez Perce vowel inventory

	[+ATR]		[-ATR]	
[+HI, -LO]	i	u		
[-HI, -LO]				ɔ
[-HI, +LO]	æ			ɑ
	[-BK]	[+BK]	[-BK]	[+BK]

In a nutshell, what I show is that the ranking of constraints responsible for the sparse vowel inventory in (267) crucially requires that the local conjunction claimed to be responsible for [+ATR] dominance — *[-LO, -ATR] & IO-IDENT[ATR] — be among the low-

¹ The following is a sample of work on Nez Perce, including various analytical struggles with the vowel harmony system: Rigsby 1965, Aoki 1962, 1966, 1968, 1970, Chomsky & Halle 1968, Jacobsen 1968, Kiparsky 1968, Rigsby & Silverstein 1969, Zwicky 1971, Kim 1978, Hall & Hall 1980, Anderson & Durand 1988.

² Many authors working on Nez Perce transcribe the low front vowel [æ] as [e] for typographical (and sometimes analytical) simplicity; I follow Hall & Hall (1980:212ff) in my use of the more accurate transcription.

The idea that the opposition between the two vowel sets of Nez Perce is one of relative tongue root advancement is originally due to Hall & Hall (1980). Although this hypothesis has never been verified phonetically, the analysis to follow strongly supports it. I should note here, however, that Hall & Hall (1980) do not claim that the surface realizations of the vowels of Nez Perce are actually as depicted in (270); in fact, each of the vowels (especially [u]) has a variety of exact surface realizations (see Aoki 1970:18ff, Hall & Hall 1980:212ff).

est-ranked.³ This state of affairs facilitates the argument that the [-ATR] set of vowels of Nez Perce is less marked than the [+ATR] set, a parochial fact that is reflected in the vowel harmony system in the familiar (and universal) assimilation-to-the-unmarked fashion.

Nez Perce presents another challenge to the proposed agreement model, one that is very familiar to anyone acquainted with the vowel harmony systems of Hungarian, Finnish and other languages. The recessive (that is, [+ATR]) high front vowel [i] is *transparent* in Nez Perce, allowing a dominant-vowel induced [-ATR] domain to seemingly pass right through it to a recessive vowel on the other side, as schematized in (268) below.

(268) Nez Perce transparency

/ ... u/æ ... i ... a/ɔ ... /	→	[... ɔ/a ... i ... a/ɔ ...]
[+ATR] [+ATR] [-ATR]		[-ATR] [+ATR] [-ATR]
1 1 Z		dominant vowel two agreement violations
1 Z		transparent vowel
Z		recessive vowel

Vowel transparency is an affront to the strictness of strict locality — the assumption that assimilation only applies between strictly adjacent segments (see Archangeli & Pulleyblank 1994, Pulleyblank 1996, Gafos 1996, 1998, Ni Chiosáin & Padgett 1997, Walker 1998a, 1999, and references therein). Within the proposed agreement model, strict locality is built into the agreement constraints themselves, which of course has the desirable effect of predicting vowel *opacity*: violations of agreement may be enforced by a higher-ranked markedness constraint, but violation of agreement is minimized to just the extent required to satisfy that markedness constraint. Transparency is a double agreement violation where just one (that is, opacity) would otherwise seem to be more than sufficient.

The vowel [i] in Nez Perce is odd in another respect: some instances of this vowel are *dominant*, requiring all other vowels in a word to become [-ATR]. This is of

³ This result and others reported here were double-checked using Bruce Hayes' very useful Optimality Theory Software, available at <http://www.humnet.ucla.edu/humnet/linguistics/people/hayes/otsoft/otsoft.htm>.

course unexpected, given that [i] is [+ATR]. On the face of it, it would seem that the transparency of recessive [i] and the dominance of some instances of [i] represent two sides of the same coin: [i] can behave as if it is both [+ATR] and [-ATR] at some deeper level of analysis. Many previous analyses of Nez Perce have capitalized on this parallelism between the two phenomena, accounting for both with the same derivational opacity device. In §3 I argue that this attempt to unify the two cases is misguided. Instead, I propose that the transparency of [i] is the result of the interaction of agreement with a novel type of markedness constraint called a *targeted* constraint, following recent work by Wilson (1999).

In brief, a targeted constraint is one that imposes a special kind of harmonic ordering on the candidate set, such that some candidates are worse (= less harmonic) with respect to the constraint than some, but not all, others. I define a class of targeted constraints that prefers a transparent-vowel candidate to a minimally different candidate without the transparent vowel — i.e., a fully harmonic candidate — but that is silent on the relative harmonic ordering between either of these candidates and an opaque-vowel candidate. Since agreement itself prefers full harmony to opacity, the opaque-vowel candidate is predicted to be worse than the transparent-vowel candidate by transitivity of the harmonic ordering relation. In this way, strictly local agreement in fact plays an unexpectedly central role in ensuring the optimality of the one candidate of the three that violates it the worst.

2. [-ATR] Dominance

2.1 Preliminaries

The fact the vowel harmony in Nez Perce is of the dominant-recessive kind, as well as the fact that it is the [-ATR] set [ɔ,ɑ] that is dominant, is shown by the examples in (269) below.⁴ (Just as in Chapter 4, dominant vowels are underlined in the examples.)

(269) Nez Perce vowel harmony (Aoki 1966:759-760, Aoki 1970:41)

a.	i.	/ næʔ • √mæq /	→	næʔmæχ	(all recessive)
		1 POSS. • paternal uncle		'my paternal uncle'	
	ii.	/ næʔ • √tɔt /	→	nɔʔtɔt	(dominant root)
		1 POSS. • father		'my father'	
b.	i.	/ √mæq • æʔ /	→	mæqæʔ	(all recessive)
		paternal uncle • VOC		'paternal uncle!'	
	ii.	/ √tɔt • æʔ /	→	tɔtæʔ	(dominant root)
		father • VOC		'father!'	
c.	i.	/ √cæqæt • ʔqjn /	→	cæqætʔqjn	(dominant suffix)
		raspberry • for		'for a raspberry'	
	ii.	/ √tuʔujnu • ʔqjn /	→	tɔʔjnɔʔqjn	(dominant suffix)
		tail • for		'for the tail; crupper'	
d.	i.	/ √sɔj • √æ:pu /	→	sɔjæ:pɔ:	(dominant root, recessive root)
		no gloss • people		'the white people'	
	ii.	/ √tæw • √æ:pu /	→	tæwæ:pɔ:	(recessive root, recessive root)
		no gloss • people		'people of Orofino, Idaho'	

Clearly, *[-LO, -ATR] &_i IO-IDENT[ATR] cannot be responsible for dominance in Nez Perce. While the optimal mapping from /æ/ to [ɑ] in (269a.ii), (269b.ii), (269c.i) and (269d.i) does not violate this local conjunction because the resulting vowel is not even [-LO], the optimal mapping from /u/ to [ɔ] in (269c.ii) and (269d.i) clearly does violate this constraint because the resulting vowel is [-LO, -ATR] and the mapping involves a change in the value of [ATR]. While it is also necessary to explain the optimality of the mapping from /æ/ to [ɑ], of course, it is the optimality of the mapping from /u/ to [ɔ] that presents the true challenge.⁵

In order to account for the optimality of this harmony-induced mapping from /u/ to [ɔ], AGREE[ATR] must dominate *[-LO, -ATR] &_i IO-IDENT[ATR]. AGREE[ATR] must also

⁴ The examples in (269d) are compounds. There are no dominant prefixes in Nez Perce, just as there aren't in any of the other languages with dominant-recessive harmony (see Hall & Hall 1980:227-228, note 2).

⁵ Recall that [i] is independently special in the vowel harmony system of Nez Perce; we will return to it in §3.

dominate the non-conjoined markedness and faithfulness constraints that are also violated by the mapping; to wit, *[-LO, -ATR], IO-IDENT[ATR] and IO-IDENT[HI]. These are of course merely necessary conditions, not sufficient ones: to absolutely block the dominance of /u/, each of the suboptimal mappings from one of the dominant vowels /ɔ,u/ to its respective recessive counterpart [u,æ] must violate at least one other constraint that is ranked higher than all of the constraints violated by the optimal mapping from /u/ to [ɔ]. That way, AGREE[ATR] is guaranteed to be best-satisfied by changing /u/ to [ɔ] when necessary.

The argument is fairly complex — as can surely already be appreciated — and it will proceed as follows. First, I will establish a ranking of relevant markedness and faithfulness constraints that accounts for the sparse vowel inventory of Nez Perce (§2.2). I will then add some relevant local conjunctions of markedness and faithfulness into the mix (§2.3) and show where they must be ranked — including *[-LO, -ATR] & IO-IDENT[ATR], which I will show must be ranked relatively low. This puts us in a position to argue that the relatively low rank of this constraint is a sign of the relative unmarkedness of [ɔ] in Nez Perce, a fact that is indirectly reflected in the vowel harmony system in that the [-ATR] vowels are dominant while the [+ATR] vowels are recessive (§2.4).

2.2 Defining the inventory

The vowel inventory of Nez Perce is repeated in (270) below, with the “missing” vowels indicated in parentheses in their respective table cells. (To simplify matters, I ignore the additional dimension of contrast that would result from consideration of the feature [RD].)

(270) Nez Perce vowel inventory

	[+ATR]		[-ATR]	
[+HI, -LO]	i	u	(ɪ)	(ʊ)
[-HI, -LO]	(e)	(o)	(ɛ)	ɔ
[-HI, +LO]	æ	(ɐ)	(a)	ɑ
	[-BK]	[+BK]	[-BK]	[+BK]

This five-vowel inventory of Nez Perce is clearly the result of the activity of several markedness constraints penalizing different antagonistic combinations of the features [HI], [LO] and/or [BK] with [ATR]. For instance, the lack of the high [-ATR] vowels [ɪ,ʊ] is attributable to the antagonism between a high tongue body and a retracted tongue root. The markedness constraint responsible for this is *[+HI, -ATR], familiar from the analysis of Yoruba in Chapter 3. Since this constraint is never violated in Nez Perce, it must be undominated. One way to avoid violation of this markedness constraint is to change the [ATR] value of either of the potential inputs /ɪ,ʊ/, violating IO-IDENT[ATR] and rendering [i,u] as their respective outputs. This is shown in (271) and (272) below. Note that IO-IDENT[HI], another violable faithfulness constraint relevant in this case, must also be ranked higher than IO-IDENT[ATR] to guarantee the intended result that /ɪ,ʊ/ become [i,u] and not [ɛ,ɔ].

(271) Input: /ɪ/

Candidates	*[+HI, -ATR]	IO-IDENT[HI]	IO-IDENT[ATR]
a. ɪ	* !		
b. ɛ		* !	
c. ^{ɛɪ} i			*

(272) Input: /ʊ/

Candidates	*[+HI, -ATR]	IO-IDENT[HI]	IO-IDENT[ATR]
a. ʊ	* !		
b. ɔ		* !	
c. ^{ɛʊ} u			*

The absence of the vowels [o,e] must be due to the antagonism between a non-high tongue body and an advanced tongue root. The markedness constraint is *[-HI, +ATR], a more stringent version of the constraint *[+LO, +ATR] familiar from the analyses in Chapters 2, 3 and 4 of Kalenjin, Diola Fogni, Yoruba, Maasai and Turkana.⁶

⁶ Stringency_{def.} A constraint C₁ is *more stringent* than a constraint C₂ if C₁ is violated by a strict superset of the set of candidates that violate C₂ (Prince 1997b). *[-HI, +ATR] is more stringent than *[+LO, +ATR] because the latter is violated by low [+ATR] vowels while the former is violated by low and mid [+ATR] vowels.

The evaluation of relevant candidate outputs for /o/ and /ɐ/ are shown in (273) and (274), respectively. (Since the outputs predicted are respectively [ɔ] and [a], it follows that these same outputs are the optimal ones from the less deviant inputs /ɔ/ and /a/ as well.)

(273) Input: /o/

Candidates	*[-HI, +ATR]	IO-IDENT[HI]	IO-IDENT[ATR]
a. o	* !		
b. u		* !	
c. ^{NEP} ɔ			*

(274) Input: /ɐ/

Candidates	*[-HI, +ATR]	IO-IDENT[HI]	IO-IDENT[ATR]
a. ɐ	* !		
b. u		* !	
c. ^{NEP} a			*

This new markedness constraint not only rules out [o,ɐ] but also correctly militates against another non-high [+ATR] vowel absent from the Nez Perce inventory: [ɛ]. However, a simple change in [ATR] to an input /e/ incorrectly leads to [ɛ], another absent vowel. This is shown in (275), where [i] is assumed to be the correct optimal candidate in this case.

(275) Input: /e/

Candidates	*[-HI, +ATR]	IO-IDENT[HI]	IO-IDENT[ATR]
a. e	* !		
b. ^{NEP} i		* !	
c. ^{NEP} ɛ			*

In order to guarantee the mapping from /e/ to [i], both *[-HI, +ATR] and the markedness constraint responsible for the absence of [ɛ] — which I will temporarily refer to here as * ϵ — must dominate IO-IDENT[HI]. (I will return to the true identity of * ϵ momentarily.) This correctly avoids the mapping from /e/ to [ɛ]; to rule out another possible map-

ping from /e/ to [ɔ], IO-IDENT[BK] must also dominate IO-IDENT[HI]. This is shown in (276).

(276) Input: /e/

Candidates	* ϵ	*[-HI, +ATR]	IO-ID[BK]	IO-ID[HI]	IO-ID[ATR]
a. e		* !			
b. ^{NEP} i				*	
c. ɛ	* !				*
d. ɔ			* !		*

The problem that we now face is that *[-HI, +ATR] is in danger of incorrectly ruling out the non-high [+ATR] vowel [æ]. The fact that this vowel does exist in the Nez Perce inventory must be because changes to the input /æ/ in terms of [ATR] and/or [HI] also violate some constraint(s) that are ranked higher than *[-HI, +ATR]. For instance, a change in [HI] yields [i], a mapping that of course is also forced to involve a change in [LO] due to the physical impossibility of simultaneously making both [+HI] and [+LO] gestures (Chomsky & Halle 1968:305). As long as IO-IDENT[LO] is ranked above *[-HI, +ATR], then, the unfaithful mapping from /æ/ to [i] is correctly not tolerated in Nez Perce. This is shown in (277).

(277) Input: /æ/

Candidates	IO-ID[LO]	*[-HI, +ATR]	IO-ID[HI]	IO-ID[ATR]
a. ^{NEP} æ		*		
b. i	* !		*	

A change in [ATR], on the other hand, renders [a], another vowel absent from the inventory of Nez Perce. So, as long as the markedness constraint responsible for the absence of [a], which I will temporarily refer to as * a , also dominates *[-HI, +ATR], then the unfaithful mapping from /æ/ to [a] is also correctly avoided, as shown in (278).

(278) Input: /æ/

Candidates	*[a]	*[-HI, +ATR]	IO-IDENT[HI]	IO-IDENT[ATR]
a. ^{NEP} æ		*		
b. a	* !			*

Finally, a change in both [ATR] and [BK] yields [a], which cannot be ruled out by markedness since it is a vowel that is present in the inventory. The additional change in [BK] must be what rules this candidate out, indicating that IO-IDENT[BK] also dominates *[-HI, +ATR].

(279) Input: /æ/

Candidates	IO-ID[BK]	*[-HI, +ATR]	IO-ID[HI]	IO-ID[ATR]
a. ^{NEP} æ		*		
b. a	* !			*

This brings us to consideration of the true identities of the stand-in markedness constraints *[ε] and *[a]. I claim that the absence of both [ε,a] from the Nez Perce inventory is due to the articulatory conflict between a fronted tongue body and a retracted tongue root. The constraint responsible for this is *[-BK, -ATR], a less familiar but no less genuine multiple-feature markedness constraint (MacKay 1976, Archangeli & Pulleyblank 1994). Given the rankings already established, an input /ε/ is predicted to become [i] and an input /a/ is predicted to surface as [æ], as shown in the tableaux in (280) and (281) below.

(280) Input: /ε/

Candidates	*[-BK, -ATR]	IO-ID[BK]	*[-HI, +ATR]	IO-ID[HI]	IO-ID[ATR]
a. ε	* !				
b. e			* !		*
c. ^{NEP} i				*	*
d. ɔ		* !			

(281) Input: /a/

Candidates	*[-BK, -ATR]	IO-ID[LO]	IO-ID[BK]	*[-HI, +ATR]	IO-ID[ATR]
a. a	* !				
b. ^{NEP} æ				*	*
c. i		* !			*
d. ɑ			* !		

In sum, the major gaps in the vowel inventory of Nez Perce have been accounted for by invoking markedness constraints against articulatorily antagonistic feature combinations and judiciously ranking them with respect to each other and with respect to conflicting faithfulness constraints. A summary of the established constraint rankings is given in (282).

(282) Summary ranking

IO-ID[LO]	*[-BK, -ATR]	IO-ID[BK]
⊥	⊥	⊥
	*[-HI, +ATR]	*[+HI, -ATR]
	⊥	⊥
	IO-ID[HI]	
	⊥	
	IO-ID[ATR]	

2.3 Local conjunctions

2.3.1 [HI], [BK] and [ATR]

Assuming that the foregoing is the correct analysis of the inventory of Nez Perce, then at least the following three markedness constraints have been shown to be necessary.

(283) Necessary markedness constraints

- a. *[+HI, -ATR]
An output segment must not be specified as [+HI, -ATR].
- b. *[-HI, +ATR]
An output segment must not be specified as [-HI, +ATR].
- c. *[-BK, -ATR]
An output segment must not be specified as [-BK, -ATR].

According to the theory of local conjunction expounded in Chapter 1, §3.3, each of these markedness constraints is the markedness conjunct of a co-relevant local conjunction with

the faithfulness constraint IO-IDENT[ATR], and each of these local conjunctions universally dominates both of its conjuncts. The local conjunctions are given in (284) below.

(284) Necessary local conjunctions

- a. *[+HI, -ATR] &_i IO-IDENT[ATR]
An output segment must not be specified as [+HI, -ATR], if its input correspondent is not also specified as [-ATR].
- b. *[-HI, +ATR] &_i IO-IDENT[ATR]
An output segment must not be specified as [-HI, +ATR], if its input correspondent is not also specified as [+ATR].
- c. *[-BK, -ATR] &_i IO-IDENT[ATR]
An output segment must not be specified as [-BK, -ATR], if its input correspondent is not also specified as [-ATR].

Since a few of the optimal mappings established in the previous sub-section involve changes in [ATR], then the relative ranking of each of these local conjunctions within the hierarchy already established in (282) may need to be further specified in order to guarantee the right results. For instance, take the first two optimal mappings established in (271) and (272) above, from /ɪ/ to [i] and from /ʊ/ to [u] respectively. Both of these mappings involve a change in [ATR] and therefore a violation of IO-IDENT[ATR], but since the optimal output in each case is a [+HI, +ATR] vowel, none of the three markedness constraints in (283) is implicated. Therefore, none of the three local conjunctions in (284) is violated in these cases and no further ranking statements can be made on the basis of this evidence.

The optimal mapping established in (273), (274) and (280) also violate none of the three local conjunctions. Even though there is a change in [ATR] in each case and hence a violation of IO-IDENT[ATR], the result in each case ([ɔ], [a] and [i], respectively) is unmarked with respect to the markedness conjuncts of the local conjunctions. No further ranking statements can thus be made on the basis of what happens to these inputs (/o/, /ɐ/ and /ɛ/).

The only other optimal mapping that involves a change in [ATR] is the one in (281), from /a/ to [æ]. This mapping crucially violates the markedness constraint in

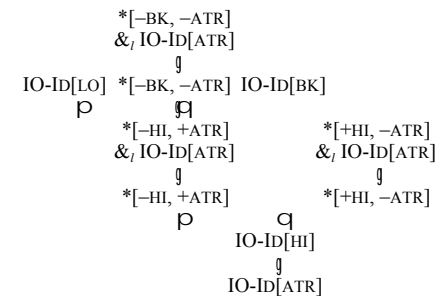
(283b), *[-HI, +ATR], and thus also the local conjunction in (284b), *[-HI, +ATR] &_i IO-IDENT[ATR]. Like its markedness conjunct *[-HI, +ATR], then, *[-HI, +ATR] &_i IO-IDENT[ATR] must be ranked at least below *[-BK, -ATR], IO-IDENT[LO] and IO-IDENT[BK]. This is shown in (285).

(285) Input: /a/ cf. (281)

Candidates	*[-BK, -ATR]	IO-ID[LO]	IO-ID[BK]	*[-HI, +ATR] & _i IO-ID[ATR]	*[-HI, +ATR]	IO-ID[ATR]
a. a	* !					
b. æ				*	*	*
c. i		* !				
d. ɑ			* !			

What we end up with is the revised hierarchy in (286) below, in which the local conjunctions are ranked in their necessary locations. Both *[+HI, -ATR] &_i IO-IDENT[ATR] (284a) and *[-BK, -ATR] &_i IO-IDENT[ATR] (284c) are simply ranked immediately above their highest-ranked conjuncts, a ranking made necessary by local conjunction theory, while the remaining local conjunction *[-HI, +ATR] &_i IO-IDENT[ATR] (284b) is ranked both above its highest-ranked conjunct and below *[-BK, -ATR], IO-IDENT[LO] and IO-IDENT[BK].

(286) Revised hierarchy, including local conjunctions



2.3.2 [LO] and [ATR]

There are at least two more markedness constraints with which we are already familiar that must be taken into consideration in the analysis of Nez Perce. One of these is given in (287a), along with its co-relevant local conjunction with IO-IDENT[ATR] in (287b).

(287) Markedness of [+LO] and [+ATR]

- a. *+[LO, +ATR]
An output segment must not be specified as [+LO, +ATR].
- b. *+[LO, +ATR] &_t IO-IDENT[ATR]
An output segment must not be specified as [+LO, +ATR], if its input correspondent is not also specified as [+ATR].

The markedness constraint in (287a) is, as noted in §2.1 above (see especially footnote 6), a *less stringent* version of *[-HI, +ATR] (283b). The more stringent constraint in this particular case, *[-HI, +ATR], is required in Nez Perce to account for the absence not only of [ɐ] but also of [e,o] from the vowel inventory. This does not mean that the less stringent constraint *+[LO, +ATR] does not exist in Nez Perce; it simply means that the more stringent one is both necessary and sufficient to account for the relevant facts. But since the claim in OT is that languages differ from each other only in the relative ranking of a universal set of constraints (cf. the Richness of the Base hypothesis), then the relative ranking of the otherwise unnecessary constraint *+[LO, +ATR] — and, by extension, that of the local conjunction *+[LO, +ATR] &_t IO-IDENT[ATR] (287b) — must still be established in Nez Perce.

As shown in (288) below, these constraints must both be ranked at least as low as their more stringent counterparts. Specifically, they must be dominated by *[-BK, -ATR], IO-IDENT[LO] and IO-IDENT[BK] in order to still correctly account for the optimal mapping from /a/ to [æ], which violates both *+[LO, +ATR] and *+[LO, +ATR] &_t IO-IDENT[ATR] (as well as their more stringent counterparts *[-HI, -ATR] and *[-HI, +ATR] &_t IO-IDENT[ATR]).

(288) Input: /a/

cf. (281), (285)

Candidates	*[-BK, -ATR]	IO- ID[LO]	IO- ID[BK]	*+[LO, +ATR] & _t IO-ID[ATR]	*+[LO, +ATR]	IO- ID[ATR]
a. a	* !					
b. æ				*	*	*
c. i		* !				*
d. ɑ			* !			

The other markedness constraint that must be taken into account is the more stringent version of *+[HI, -ATR]. This constraint is *[-LO, -ATR], which is perhaps more familiar from its role in the local conjunction *[-LO, -ATR] &_t IO-IDENT[ATR] that was used to account for the dominance of [+ATR] vowels in Kalenjin, Diola Fogany, Maasai and Turkana in Chapters 2 and 4. Both the markedness constraint and the local conjunction are given in (289).

(289) Markedness of [-LO] and [-ATR]

- a. *[-LO, -ATR]
An output segment must not be specified as [-LO, -ATR].
- b. *[-LO, -ATR] &_t IO-IDENT[ATR]
An output segment must not be specified as [-LO, -ATR], if its input correspondent is not also specified as [-ATR].

*[-LO, -ATR] is only optimally violated by [ɔ] in Nez Perce; all other non-low [-ATR] vowels [ɪ,ʊ,ɛ] are missing from the inventory. These vowels are absent not because of this markedness constraint, of course; they are absent due to *+[HI, -ATR] (in the case of [ɪ,ʊ]) and [-BK, -ATR] (in the case of [ɛ]), each of which is only crucially dominated by its co-relevant local conjunction with IO-IDENT[ATR]. If *[-LO, -ATR] were similarly high-ranked, then the presence of [ɔ] in the inventory would be unaccountable for; therefore, this markedness constraint must at least be ranked lower than IO-IDENT[HI], as shown in (290).

(290) Input: /ɔ/

Candidates	*[-HI, +ATR]	IO-IDENT[HI]	*[-LO, -ATR]
a. ɔ	* !		*
b. o			*
c. u		* !	

Another possibility is that *[-LO, -ATR] is ranked below IO-IDENT[ATR], which is violated by both of the suboptimal candidates in (290). Since IO-IDENT[ATR] is already known to be ranked below IO-IDENT[HI], however, the point made in the text just above (290) still stands: *[-LO, -ATR] must *at least* be ranked lower than IO-IDENT[HI].

Recall from (273), however, that /ɔ/ is not the only source for [ɔ] under the proposed ranking. The input /o/ also leads to [ɔ], a mapping that involves both a change in [ATR] and a violation of *[-LO, -ATR]. In other words, this mapping can only be optimal if *[-LO, -ATR] & IO-IDENT[ATR] is also crucially dominated by IO-IDENT[HI], as shown in (291).

(291) Input: /o/ cf. (273)

Candidates	*[-HI, +ATR]	IO-ID[HI]	*[-LO, -ATR] & IO-ID[ATR]	*[-LO, -ATR]
a. o	* !			
b. u		* !		
c. ɔ			*	*

In what follows I attempt to demonstrate how the foregoing analysis of the sparse vowel inventory of Nez Perce helps to account for the apparent markedness reversal necessary to describe the dominant-recessive harmony system of the language.

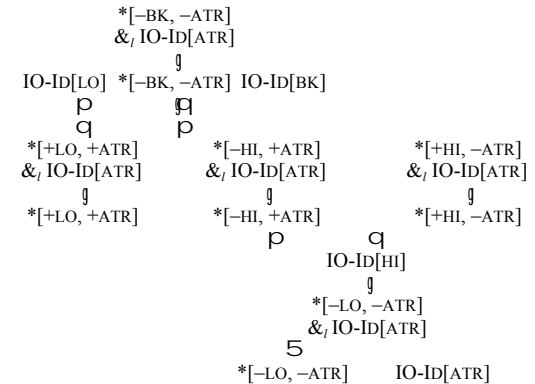
2.4 Interaction with agreement

2.4.1 The low rank of *[-LO, -ATR] & IO-IDENT[ATR]

The long and quite complex chain of deductions in the above has led us to the following important and interesting conclusion: the constraint usually responsible for [+ATR] dominance — *[-LO, -ATR] & IO-IDENT[ATR] — is crucially ranked below most of the other

local conjunctions considered here, as can be gleaned from the pre-final hierarchy given in (292).⁷

(292) Pre-final hierarchy



Most importantly, the set of constraints from IO-IDENT[HI] on down, which of course includes *[-LO, -ATR] & IO-IDENT[ATR], is exactly the set of constraints violated by the optimal (and vexing) mapping from /u/ to [ɔ] that is forced by vowel harmony. Thus, as discussed at the outset of §2.1, AGREE[ATR] must dominate this set of constraints in order to guarantee agreement of /u/ with a dominant vowel. This is shown with the example in (269c.ii), / $\sqrt{\text{tu?ujnu}} \cdot \text{?ajjn}$ / ‘for the tail; crupper’.

(293) Input: / $\sqrt{\text{tu?ujnu}} \cdot \text{?ajjn}$ /

Candidates	AGR [ATR]	IO-ID[HI]	*[-LO, -ATR] & IO-ID[ATR]	*[-LO, -ATR]	IO-ID[ATR]
a. tu?ujnu?ajjn	* !				
b. tɔ?ɔjnɔ?ajjn		***	***	***	***

As also noted earlier, this ranking is a necessary condition but not a sufficient one to guarantee the optimality of the relevant mapping. A mapping from /a/ to [æ] could con-

⁷ The only other local conjunction that could possibly be ranked any lower is *[-LO, +ATR] & IO-IDENT[ATR] (along with its markedness conjunct *[-LO, +ATR]). However, note that any lower ranking of this local conjunction would be empirically insignificant, since it is less stringent than *[-HI, +ATR] & IO-IDENT[ATR].

ceivably be optimal in this particular case. This mapping violates IO-IDENT[ATR], a violation it shares (in part) with the optimal mapping in (293b), but it also violates IO-IDENT[BK]. Of course, it is already known that IO-IDENT[BK] is undominated in the ranking, and so this candidate is easily dispensed with. This is shown in (294).

(294) Input: /√tuʔujnu • ʔɑjn /

Candidates	IO-ID[BK]	IO-ID[HI]	*[-LO, -ATR] & IO-ID[ATR]	*[-LO, -ATR]	IO-ID[ATR]
a. tuʔujnuʔɑjn	* !				*
b. tɑʔɑjnɑʔɑjn		***	***	***	***

2.4.2 Dominant [ɑ]

A more difficult situation is presented by dominant [ɑ]. Take, for example, the compound in (269d.i): /√sɑj • √æ:pu / ‘the white people’. The optimal output is [sɑ:jɑ:pɑ:], in which both /æ/ and /u/ have changed to [ɑ] and [ɑ], respectively. The problem is that changing /ɑ/ to [u] instead should be the better deal: the IO-IDENT[BK] violation incurred by the mapping from /æ/ to [ɑ] is avoided, as well as the *[-LO, -ATR] & IO-IDENT[ATR] and *[-LO, -ATR] violations incurred by the mapping from /u/ to [ɑ]. Only IO-IDENT[HI] and IO-IDENT[ATR] are violated; violations that are (partly) shared with the optimal candidate.

(295) Input: /√sɑj • √æ:pu /

Candidates	IO-ID[BK]	IO-ID[HI]	*[-LO, -ATR] & IO-ID[ATR]	*[-LO, -ATR]	IO-ID[ATR]
a. sɑ:j ɑ:pɑ:	* !	*	*	*	**
b. su:j æ:pu		*			*

There must therefore be a constraint that dominates IO-IDENT[BK] that is violated by the suboptimal mapping from /ɑ/ to [u] and not by either of the two optimal mappings (/æ/ to [ɑ] and /u/ to [ɑ]). We already know that this constraint cannot be either of the two faithfulness constraints violated by the change from /ɑ/ to [u] — IO-IDENT[HI] or IO-IDENT[ATR] — because the change from /u/ to [ɑ] breaches the same two faithfulness con-

straints. It also cannot be any simple markedness constraint against [u]; if any such constraint were to dominate IO-IDENT[BK], it would effectively be undominated and we would expect not to find [u] in the inventory at all! It must therefore be the *combination* of markedness and faithfulness violations that rules out the mapping from /ɑ/ to [u]; that is, the failure of this mapping must be due to a local conjunction of markedness and faithfulness. This makes perfect sense, since this is a mapping from a dominant vowel to a recessive vowel.

None of the markedness constraints that we have been considering until now, repeated together in (296) for convenience, is an appropriate markedness conjunct for such a local conjunction since not one of them is violated by [u].

(296) Markedness constraints so far

- *[+HI, -ATR]
An output segment must not be specified as [+HI, -ATR].
- *[-HI, +ATR]
An output segment must not be specified as [-HI, +ATR].
- *[-BK, -ATR]
An output segment must not be specified as [-BK, -ATR].
- *[+LO, +ATR]
An output segment must not be specified as [+LO, +ATR].
- *[-LO, -ATR]
An output segment must not be specified as [-LO, -ATR].

Note that there are four constraints expressing the antagonism between each of the two values of the tongue body height features [HI] and [LO] and a corresponding value of [ATR]. In general, the higher the tongue body, the more marked [-ATR] is; the lower the tongue body, the more marked [+ATR] is. On the other hand, there is only one constraint that expresses the antagonism of a value of the feature [BK] and a corresponding value of [ATR]: if the tongue body is fronted (that is, [-BK]), then [-ATR] is marked. It is quite plausible that there is a complementary constraint expressing the probably antagonism between a backed tongue body (i.e., [+BK]) and an advanced tongue root (that is, [+ATR]).

This markedness constraint and its co-relevant local conjunction with IO-IDENT[ATR] are stated in (297).

(297) Markedness of [+BK] and [+ATR]

- a. * [+BK, +ATR]
An output segment must not be specified as [+BK, +ATR].
- b. * [+BK, +ATR] & IO-IDENT[ATR]
An output segment must not be specified as [+BK, +ATR], if its input correspondent is not also specified as [+ATR].

The markedness constraint in (297a) is, of course, violated by [u]. Because [u] should not be excluded from the Nez Perce vowel inventory, this constraint must be ranked relatively low. In fact, it must be ranked at least below IO-IDENT[HI], as shown in (298) below.

(298) Input: /u/

Candidates	* [+HI, -ATR]	* [-HI, +ATR]	IO- ID[HI]	* [+BK, +ATR]	IO- ID[ATR]
a. ^{NEP} u				*	
b. u	* !				*
c. o		* !	*	*	
d. ə			* !		*

Since the faithful and necessarily optimal mapping from /u/ to [u] violates * [+BK, +ATR], the alternative unfaithful mappings to [u], [o] and [ə] must be shown to suffer worse fates.⁸ The mappings to [u] or [o] take us out of the vowel inventory, fatally violating the markedness constraints * [+HI, -ATR] and * [-HI, +ATR], respectively.⁹ The final suboptimal mapping to [ə] in (298d) is the key one here: the highest-ranked constraint that this candidate violates is IO-IDENT[HI], and it does not share with the optimal candidate a violation of * [+BK, +ATR]. Therefore, IO-IDENT[HI] must dominate * [+BK, +ATR].

So much for the faithful mapping from /u/ to [u]. *Unfaithful* mappings to [u] are a different story altogether: if the unfaithfulness is to the feature [ATR], then such map-

⁸ Mappings from /u/ to some front and/or low vowel are ruled out by either or both of the undominated faithfulness constraints IO-IDENT[BK] or IO-IDENT[LO], and so are not considered here.

⁹ The mapping to [o] is in fact a rather ridiculous one, since it shares a * [+BK, +ATR] violation with the optimal mapping to [u] and violates * [-HI, +ATR] and IO-IDENT[HI] in addition.

ings will violate the local conjunction in (297b), * [+BK, +ATR] & IO-IDENT[ATR]. This is the case with the unfaithful and suboptimal mapping we are concerned with, the one from /ə/ to [u]. So long as * [+BK, +ATR] & IO-IDENT[ATR] and AGREE[ATR] both dominate IO-IDENT[BK], then, the dominance of [ə] is guaranteed for Nez Perce. This is shown in (299).

(299) Input: /√səj • √æ:pu /

cf. (295)

Candidates	AGR[ATR]	* [+BK, +ATR] & IO- ID[ATR]	IO- ID[BK]	IO- ID[HI]	* [-LO, -ATR] & IO- ID[ATR]
a. səj æ:pu		* !			
a. ^{NEP} səj ə:po			*	*	*
b. suj æ:pu		* !		*	

The only part of the foregoing analysis of the vowel inventory that this move changes is the fate of the one other vowel that was predicted to be [ATR]-unfaithfully mapped to [u]; namely, /u/. The high rank of * [+BK, +ATR] & IO-IDENT[ATR] prevents this particular mapping and /u/ is now predicted to be [HI]-unfaithfully mapped to [ə], as shown in (300).

(300) Input: /u/

cf. (272)

Candidates	* [+BK, +ATR] & IO- ID[ATR]	* [+HI, -ATR]	* [-HI, +ATR]	IO- ID[HI]	IO- ID[ATR]
a. u	* !				*
b. u		* !			
c. o			* !	*	*
d. ^{NEP} ə				*	

This is of course not a problem, given that [ə] is a vowel in the Nez Perce inventory.

2.4.3 Dominant [a]

The dominance of [ə] having been accounted for, we can now return to the explanation of dominant [a]. In a form containing /a/ and either one (or both) of the recessive vowels /u/ or /æ/, these latter vowels respectively change to [a] and [ə] rather than the /a/ changing to its closest [+ATR] counterpart, [æ]. In the case of recessive /u/, as was shown

in (294) above and repeated in (301) below, the undominated rank of IO-IDENT[BK] seems to be sufficient to rule out the mapping from /a/ to [æ].

(301) Input: /√tuʔujnu • ʔɑjn /

Candidates	IO- ID[BK]	IO- ID[HI]	*[-LO, -ATR] & IO-ID[ATR]	*[-LO, -ATR]	IO- ID[ATR]
a. tuʔujnuʔæjn	* !				*
b. ^{ɛʔ} tʔɔjnɔʔɑjn		***	***	***	***

This is of course because the optimal mapping in (301b) from /u/ to [ɔ] simply does not violate IO-IDENT[BK]. When the recessive vowel is /æ/ on the other hand, IO-IDENT[BK] is destined to be violated either way: both the optimal mapping from /æ/ to [a] and the suboptimal mapping from /a/ to [æ] involve a change in the feature [BK]. The choice between these two candidates must thus fall to some other constraint.

The main secret to the dominance of [a] in relation to [æ] is that there are no markedness constraints against [a]; its lowered and backed tongue body make it the quintessential [-ATR] vowel. On the other hand, there are two markedness constraints against [æ] due to its lowered tongue body and advanced tongue root, *[+LO, +ATR] and *[-HI, +ATR]. Thus, either one of these markedness constraints, or either one of the local conjunctions with one of these as the markedness conjunct and IO-IDENT[ATR] as the faithfulness conjunct, is sufficient to rule out the suboptimal mapping from /a/ to [æ].

Unfortunately, this isn't all there is to the story. Consider for a moment the example in (269a.i), /√cæqæt • ʔɑjn / 'for a raspberry'. IO-IDENT[BK] is actually violated *more* by the optimal candidate [caqɑt'ɑjn] than by the relevant suboptimal form *[cæqæt'æjn] — the 'majority rule' problem familiar from Chapter 1 has reared its ugly head. It must be that one of the constraints just mentioned against the suboptimal mapping from /a/ to [æ] dominates IO-IDENT[BK]. It cannot be one of the two markedness constraints, since this would result in the ejection of [æ] from the inventory. It must be

one of the local conjunctions, then, and I arbitrarily select *[+LO, +ATR] & IO-IDENT[ATR] to show this in (302).

(302) Input: /√cæqæt • ʔɑjn /

Candidates	AGR [ATR]	*[+LO, +ATR] & IO-ID[ATR]	IO- ID[BK]	*[+LO, +ATR]	IO- ID[ATR]
a. cæqæt'ɑjn	* !			**	
b. cæqæt'æjn		* !	*	***	*
c. ^{ɛʔ} caqɑt'ɑjn			**		**

Unlike the simpler cases examined in Chapter 1, in which changes only in the harmonic feature were considered, the majority rule problem seemed to have been completely expunged from the system by the theory of local conjunction: since local conjunctions of markedness and faithfulness universally dominate their faithfulness conjuncts, faithfulness doesn't get a crack at selecting a candidate whenever markedness is also implicated. But the theory of local conjunction has no jurisdiction over this particular case, where there is a change not only in the harmonic feature but also in another. Since the problematic faithfulness constraint is IO-IDENT[BK] and the necessary local conjunction has IO-IDENT[ATR] as its faithfulness conjunct, there is no intrinsic ranking between the two constraints and the majority rule pattern is in principle free to arise in such a case.

My suspicion is that this is not the correct result, and that the solution to the majority rule problem proposed in Chapter 1 still needs some work. I am confident that local conjunction is at least a step in the right direction; how it can be amended to properly address this thorny aspect of the problem remains to be seen in future work.

Before closing this sub-section, I must note that the higher rank of *[+LO, +ATR] & IO-IDENT[ATR] just argued to be necessary has a consequence for the definition of the inventory, just as the higher rank of *[-BK, +ATR] & IO-IDENT[ATR] argued to be necessary in §2.3 did. The [-ATR] vowel /a/ had heretofore been assumed to optimally surface as [æ]; since this [ATR]-unfaithful mapping entails a violation of *[+LO, +ATR] & IO-

IDENT[ATR] and this local conjunction is now known to dominate IO-IDENT[BK], the optimal result could now be any one of the following three other plausible candidates: [a] (the faithful candidate), [i] (changing [LO], [HI], and [ATR]) and [ɑ] (changing [BK] and [ATR]).

The faithful candidate is one we are trying to exclude from the inventory; since it is a [-BK, -ATR] vowel while the other two candidates are not, it must be that *[-BK, -ATR] dominates either IO-IDENT[LO] or IO-IDENT[BK] (or both). The choice narrows down to [i] and [ɑ], either of which is an inventory vowel. The choice between them being arbitrary, I arbitrarily decree that it is [ɑ] that surfaces. To ensure this, IO-IDENT[LO] must dominate IO-IDENT[BK]. This is all shown in the following tableau.

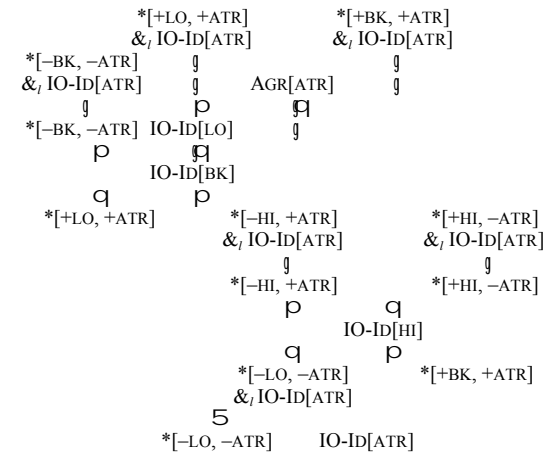
(303) Input: /a/ cf. (281), (285), (288)

Candidates	*[-BK, -ATR]	*[+LO, +ATR] & IO-Id[ATR]	IO-Id[LO]	IO-Id[BK]	*[+LO, +ATR]	IO-Id[ATR]
a. a	* !					
b. æ		* !			*	*
c. i			* !			*
d. ɑ				*		

2.5 Summary and concluding remarks

I have attempted to show in this section that the relatively sparse inventory of Nez Perce is to be blamed for the unexpected dominance of [-ATR] vowels in this language. Through a complex series of ranking arguments we have finally arrived at the very elaborate hierarchy in (304), which seems to account for both the inventory and the harmony pattern.

(304) Final hierarchy



The main ingredient of this hierarchy is the low rank of *[-LO, -ATR] & IO-IDENT[ATR], the constraint usually responsible for [+ATR] dominance. As demonstrated in §2.3, this constraint must be as low ranked as it is in order to properly define the Nez Perce vowel inventory. However, this by itself did not automatically predict the dominance of [-ATR] vowels: the relatively high ranking of two other local conjunctions, *[+LO, +ATR] & IO-IDENT[ATR] and *[+BK, +ATR] & IO-IDENT[ATR], needed to be independently established in §2.4 in order to account completely for the dominance of the [-ATR] vowels of Nez Perce.

Though the analysis is perhaps not as satisfying as one may have wished, I believe that the relationship between the sparseness of the Nez Perce vowel inventory and the dominance of [-ATR], indirect though it may be, is highly significant and reason enough to have pursued an analysis along these lines. The only other languages reported to have [-ATR] dominance — the Paleosiberian languages Chukchee, Koryak and Gilyak — have similarly sparse inventories (Hall & Hall 1980:231, note 18; see also Jakobson 1942, Colarusso 1974, Kenstowicz 1979, Calabrese 1988, Archangeli & Pulleyblank 1994, and ref-

erences cited therein), while the wealth of languages with [+ATR] dominance seem to all have relatively full vowel inventories, with relevant gaps typically found only among the low vowels. While a thorough explanation of this correlation has not yet been reached, the initial results reported here are, I think, quite encouraging.

3. Vowel Transparency

3.1 Dominant vs. recessive [i] in Nez Perce

The high front vowel [i] in Nez Perce belongs to both harmonic sets, in the sense that it freely co-occurs with both the dominant [-ATR] set and the recessive [+ATR] set. More precisely, some instances of [i] are dominant while others are recessive; that is, some morphemes with [i] consistently require all other vowels in the word to be [-ATR] while others do not. Examples of this contrast between dominant and recessive [i] are given in (305).

(305) Dominant vs. recessive [i] (Aoki 1966:762-763)

a. i.	/ næʔ • √cɪc / 1 POSS. • paternal aunt	→	næʔcɪc	(dominant root)
			'my paternal aunt'	
ii.	/ √cɪc • æʔ / paternal aunt • VOC	→	cɪ:cæʔ	(dominant root)
			'paternal aunt!'	
iii.	/ √tulæ: • √cɪk'ɪl • s • æ / foot • destroy • 1 • SG	→	tɔlæ:ck'ɪlksa	(dominant root)
			'I'm destroying with my foot'	
b. i.	/ næʔ • √ʔi:c / 1 POSS. • mother	→	næʔi:c	(all recessive)
			'my mother'	
ii.	/ √ʔi:c • æʔ / mother • VOC	→	ʔi:cæʔ	(all recessive)
			'mother!'	
iii.	/ √tulæ: • √qitti • s • æ / foot • place firmly • 1 • SG	→	tulæ:qittisæ	(all recessive)
			'I'm putting my foot down firmly'	

Curiously, I have found no clear instances of dominant [i] in affixes in Aoki's (1970) grammar; all clear instances of dominant [i] are to be found in roots, where by a "clear instance" I mean a dominant morpheme whose only vowel(s) is/are [i], so that the dominance of the morpheme can only be attributed to [i] and not to another vowel. It is unclear what to make of this discovery (not previously noted, to the best of my knowledge), and this lack of clarity is exacerbated by the fact that Aoki is inconsistent in his morpho-

phonemic transcriptions of dominant morphemes with an [i] and some other vowel in them.¹⁰ Some, like /laykin/ 'in the vicinity of', are transcribed with a dominant /a/ and a recessive /i/ (Aoki 1970:77), while others, like /apik/ 'deprive of something', are transcribed with both a dominant /a/ and a dominant /i/ (Aoki 1970:97). There is no apparent difference in harmonic behavior between these two affixes and so the /i/ cannot be claimed to be truly dominant in either case, since the dominance of each affix could be attributed to the /a/.

The analysis of dominant [i] is not of immediate interest here, and I simply assume that something like the analysis proposed for the similar set of facts in Yoruba (see Chapter 3) is appropriate. In brief, a [-ATR] input source for surface [i] (either /i/ or /e/ in the analysis of the vowel inventory in §2) survives intact in a sympathetic candidate, forcing all other vowels to become [-ATR] in agreement with it before finally emerging as [i] in the ultimate surface form. The details of this analysis are by no means trivial, but I put them aside here in the interests of moving on to the real topic of the present section.¹¹

3.2 Transparent [i]

Recessive instances of [i] are also *transparent* to vowel harmony in Nez Perce: if a dominant [-ATR] vowel occurs in a word with an [i], then all of the other vowels in the word, on either side of the [i], must also be [-ATR] despite the fact that the [i] itself remains [+ATR].

¹⁰ Aoki's transcriptions differ considerably from the symbols employed here; to avoid confusion, I continue to use my adopted symbols even when citing Aoki's work. Interested readers who may consult Aoki 1970 will note that dominant vowels are transcribed as underlined versions of the more basic recessive vowels, such that dominant and recessive [i] are morphophonemically distinguishable though phonemically identical.

¹¹ The apparent fact that dominant [i] is only found in roots indicates that root-specific faithfulness is at play, just as it is in Yoruba. But since harmony is not stem-controlled in Nez Perce, simply using RT-IDENT[ATR] as the selector predicts that recessive root vowels will remain [+ATR] in sympathetic candidates even in the presence of dominant affix vowels, and further rankings must ensure that agreement is achieved at the surface.

(306) Transparent recessive [i] (Aoki 1966:760)

- | | | | |
|-------|---|---|-----------------------------|
| a. i. | /√wæyæ • √wæ:yik • s • æ / | → | wæyæwæ:yiksæ |
| | hurry • go across • 1 • SG | | 'I am hurrying across' |
| ii. | /√wæt • √wæ:yik • s • æ / | → | watwæ:yiksa |
| | wade • go across • 1 • SG | | 'I am wading across' |
| b. i. | /√wæyæ • √wæ:yik • s • æ • næ / | → | wæyæwæ:yiksænæ |
| | hurry • go across • 1 • SG • DIST. PAST | | 'I hurried across long ago' |
| ii. | /√wæt • √wæ:yik • s • æ • næ / | → | watwæ:yiksana |
| | wade • go across • 1 • SG • DIST. PAST | | 'I waded across long ago' |
| c. i. | /√wæyæ • √wæ:yik • s • æ • qɑ / | → | wayawæ:yiksaqa |
| | hurry • go across • 1 • SG • REC. PAST | | 'I hurried across recently' |
| ii. | /√wæt • √wæ:yik • s • æ • qɑ / | → | watwæ:yiksaqa |
| | wade • go across • 1 • SG • REC. PAST | | 'I waded across recently' |

Vowel transparency is of course not unique to Nez Perce; some better-known examples include Hungarian (Vago 1973, 1976, Ringen 1975, 1980, 1988, Clements 1976b, Booij 1984, Goldsmith 1985, van der Hulst 1985, Demirdache 1988, Ringen & Vago 1995, 1997, Polgárdi 1998) and Finnish (Fudge 1967, Ringen 1975, Kiparsky 1981, Goldsmith 1985, Smolensky 1993, Ringen & Heinämäki 1999, Polgárdi 1998).¹² For present purposes I stick to Nez Perce, in the interests of going with the current flow.

The curious thing about transparent vowels is that they seem to allow the opposite value of the harmonic feature to pass right through them, incurring a double violation of agreement — if the transparent vowel happens not to be the first or last vowel in the word (as in the examples above). This is shown schematically in (307) below (repeated from (268)).

(307) Nez Perce transparency

/ ... u/æ ... i ... a/ɔ ... /	→	[... ə/a ... i ... a/ɔ ...]
[₁ +ATR] [₁ +ATR] [_Z -ATR]		[₁ -ATR] [₁ +ATR] [_Z -ATR]
1 1 Z dominant vowel		two agreement violations
1 Z transparent vowel		
Z recessive vowel		

¹² Other relatively well-known cases are Pasiago (Penny 1969ab, 1970, McCarthy 1984, Spencer 1986, Demirdache 1988, Vago 1988, Hualde 1989, Flemming 1993, Ni Choisain & Padgett 1997, Polgárdi 1998) and Wolof (Ka 1988, Archangeli & Pulleyblank 1994, Pulleyblank 1996). On transparency in nasal harmony, see Walker 1998a, 1999 and references therein.

As noted in the introduction to this chapter, vowel transparency flies in the face of the assumption maintained in this dissertation that assimilation only applies between strictly adjacent segments (see Archangeli & Pulleyblank 1994, Pulleyblank 1996, Gafos 1996, 1998, Ni Choisain & Padgett 1997, Walker 1998a, 1999, and references therein). Transparency involves two agreement violations where just one is expected to be sufficient.

3.3 Analyses of transparency

Research on vowel transparency (see most of the references cited two paragraphs above) has clearly converged on the idea that transparent vowels, like opaque vowels, are the result of multiple-feature markedness constraints against their opposite-valued harmonic counterparts. This research is divided, however, on the question of how to account for the distinction between transparent and opaque vowels. The following are summaries, using the Nez Perce case as an example, of three analyses of transparency that have been proposed.¹³

- ¶ *Non-local assimilation.* Copying/spreading of [-ATR] somehow skips over /i/ (see e.g. Ringen 1975, 1980, Anderson 1980, Kiparsky 1981, Booij 1984, Spencer 1986, Archangeli & Pulleyblank 1987, Steriade 1987, Ka 1988, Vago 1988).

There have been many arguments in the literature against the non-locality of assimilation; as noted in Chapter 1, §1.2.2, I adopt this strictly local view here and therefore dismiss this style of analysis.¹⁴

¹³ A fourth analysis of transparency (Goldsmith 1985; cf. van der Hulst & Smith 1986) involves the idea that the harmonic feature is privative. The value that is compatible with the transparent vowel is the specified, spreading value while the other value is null and default for all other vowels; transparency is thus simply the result of default realization of all other vowels rather than spreading. This type of analysis is unworkable in the case of Nez Perce because harmony is dominant-recessive: the harmonic feature value that must spread, [-ATR], is the value that is incompatible with the transparent vowel. I therefore put this analysis aside here.

¹⁴ Smolensky (1993) and Cole & Kisseberth (1994a) propose variations on this kind of analysis by referring to featural domains, with transparency being the result of domain embedding (Smolensky) or featural non-expression (Cole & Kisseberth). These analyses maintain strict locality at the expense of substantially enriched assumptions concerning representations (Smolensky) or the interpretational component (Cole & Kisseberth), assumptions that do not seem to be independently required elsewhere (*pace* Goldrick 1999).

¶ *Feature copying.* /i/ blocks the spreading of [-ATR] as if it were opaque, but then the [-ATR] feature is copied onto a vowel on the opposite side of /i/ and spreading proceeds as usual (see Archangeli & Pulleyblank 1994, Pulleyblank 1996).

This style of analysis was originally proposed by Archangeli & Pulleyblank (1994:232ff, 364ff) in the form of a context-sensitive rule that copies rather than spreads the appropriate value of the harmonic feature. This rule potentially applies across a transparent vowel since these are not specified for the harmonic feature at the relevant stage of the derivation. The main idea behind this style of analysis is that while a single feature cannot be linked to two segments *x* and *z* without also being linked to any segment *y* between them — i.e., assimilation, *qua* feature spreading, is strictly local — separate instances of the same feature value *can* be linked to non-contiguous segments. Note, however, that the harmonic feature copying rule itself is non-local: transparent vowels are stipulated to be invisible to it. For this reason, I must also reject this style of analysis.¹⁵

¶ *Derivational opacity.* /i/ is harmonic, becoming [-ATR] at an intermediate level of representation and later being neutralized (i.e., becoming [+ATR]) at the surface (see e.g. Bach 1968, Vago 1976, Clements 1976b, McCarthy 1984, Hualde 1989, Ní Chiosáin & Padgett 1997, Walker 1998a, 1999).

At least two variations on this well-established style of analysis have been proposed within Optimality Theory. The first is the analysis of Ní Chiosáin & Padgett (1997), who propose that transparent vowels actually undergo vowel harmony in the phonological component; a subsequent, “realizational” component performs puts these transparent vowels back where they belong.¹⁶ The second is the analysis of Walker (1998a, 1999), who proposes that the constraint responsible for assimilation is recruited as the selector for a

¹⁵ Pulleyblank (1996) analyzes this feature-copying operation as a result of the same featural alignment constraint responsible for directional feature spreading, but this analysis crucially requires input underspecification of the harmonic feature. See Chapter 6 for arguments against underspecification generally.

¹⁶ This is to be distinguished from the participation of consonants in vowel harmony (Ohman 1966, Gafos 1996, 1998) which, as Ní Chiosáin & Padgett (1997:50) also note, has actual phonetic consequences.

sympathetic candidate in which the transparent vowel is forced to undergo harmony along with all of the other vowels in the form; the subsequent mapping from the sympathetic candidate to the actual surface output undoes only the change in the transparent vowel.¹⁷

This third style of analysis successfully maintains the strictness of strict locality, but with a special two-step twist: like the grand old Duke of York, this analysis marches transparent vowels up to the top of the hill and then marches them down again. It is, in other words, an instance of the so-called “Duke-of-York gambit,” originally discussed by Pullum (1976) and more recently by McCarthy (1999). In Pullum’s words, the gambit is

“a derivation of the general form $A \rightarrow B \rightarrow A$, that is a derivation in which an underlying representation (or some nonultimate remote representation) is mapped on to an intermediate form distinct from it, and then on to a surface (or other superficial) representation which is identical with the earlier stage” (Pullum 1976:83).

The main point of Pullum’s work seems to have been merely to show that Duke-of-York derivations have been regarded with a certain amount of (unjustified) methodological suspicion; McCarthy’s more recent work on the subject aims to show that the few seemingly inarguable cases of Duke-of-York derivations can and should be reanalyzed in non-gambit terms, given that OT — even supplemented with certain versions of Sympathy Theory (*pace* Itô & Mester 1997, de Lacy 1998, and especially Walker 1998a, 1999) — cannot reproduce Duke-of-York derivations, at least without invoking an essentially serial derivation of precisely the sort proposed by Ní Chiosáin & Padgett (1997).

In what follows I further the research program initiated by McCarthy (1999) and offer a general analysis of vowel transparency (again, using the Nez Perce case as a convenient empirical foundation) that eschews the Duke-of-York gambit. Because a mere footnote would not be sufficient, I must say here that I am grateful to Colin Wilson not only for planting the seed of this analysis in my head (indirectly, through my reading of Wilson 1999) but also for discussing it extensively with me, helping me to iron out the difficult spots, and allowing me the honor of taking the blame for any and all errors.

¹⁷ Walker (1998a, 1999) proposes a modification to Sympathy Theory that I will not go into here.

3.4 The targeted constraint analysis

There's fire all around, but this is all illusion.
Beastie Boys — Something's Got to Give

3.4.1 Minimal violation and opacity

Consider the case of transparent [i] in Nez Perce. According to the inventory analysis in §2, this vowel's harmonic counterpart could be either [i] or [ɛ], and the one markedness constraint responsible for the absence of both of these from the vowel inventory is the relatively high-ranked *[-BK, -ATR].¹⁸ In order to prevent AGREE[ATR] from incorrectly creating either of these potential counterparts, *[-BK, -ATR] must dominate AGREE[ATR].

While this ranking correctly accounts for the lack of a harmonic counterpart for [i], there is still a problem: there is nothing to force the double violation of AGREE[ATR] that a transparent-vowel candidate incurs. The only real choices available are to treat the [i] as dominant, making all [-ATR] vowels become [+ATR] and violating one or both of the highest-ranked local conjunctions, or to treat the [i] as opaque, violating AGREE[ATR] *minimally*. The choice between these two situations depends on the ranking between the local conjunctions and AGREE[ATR]; assuming that AGREE[ATR] is lower (because we are trying to force a double violation of it), the dilemma is exemplified in (308), comparing candidate outputs of the form in (306a.ii), /√wqt • √wæ:yik • s • æ / 'I am wading across'.

¹⁸ Jacobsen (1968) and Kiparsky (1968) propose that the underlying source of dominant [i] is something like /ɨ/ (see also Zwicky 1971), which could be another potential harmonic counterpart of [i]. These authors argue for their proposal based on historical considerations, the "naturalness" of the resulting underlying vowel system, and the resulting "attraction-to-[ɨ]" look of vowel harmony (cf. Rigsby & Silverstein 1969).

(308) Input: /√wqt • √wæ:yik • s • æ /

Candidates	*[-BK, -ATR]	*[+LO, +ATR] & IO-ID[ATR]	AGREE[ATR]
a. watwæ:yiksa	* !		
b.  watwæ:yiksa			** !
c.  watwæ:yiksæ			*
d. wæt wæ:yiksæ		* !	

The first candidate in (308a) is the one in which /i/ becomes [ɪ] (or [ɛ]; it doesn't matter) in order to agree with the dominant vowel present in the form. This candidate fatally violates *[-BK, -ATR], as desired. The last candidate in (308d) is the one in which the dominant vowel /æ/ changes to agree with the unshakable [i]; this candidate also fails, as desired, due to its fatal violation of the local conjunction *[+LO, +ATR] & IO-IDENT[ATR].

This leaves the two candidates in (308b) and (308c). The former is the transparent-vowel candidate in which the recessive vowel /æ/ on the side of [i] opposite the dominant vowel has changed to [ɑ] in non-local agreement with the dominant vowel, and the latter is the opaque-vowel candidate in which this recessive vowel remains [æ] in local agreement with [i]. AGREE[ATR], being a constraint that respects the strictness of strict locality, is incorrectly predicted to select (308c) as the optimal candidate. In the final analysis, this constraint *is* forced to be violated — but only minimally, not egregiously.

As hopeless as this result seems, recall that it is exactly the desired result for opaque vowels. The problem is not with the strictly local definition of agreement; rather, it is with the claim that the same type of markedness constraint is responsible for both opacity and transparency. The type of markedness constraint we are familiar with is clearly needed to account for opacity, but a different kind of constraint is needed in the case of transparency.

3.4.2 Targeting transparency

The essential problem with markedness constraints of the usual kind is that they basically bifurcate the candidate set, separating those that violate them from those that do not (putting aside multiple violations, which do not concern us here). Candidates with harmonic counterparts of harmonically unpaired vowels are lumped together in the pile of ‘losers’ and all other candidates are lumped together in the pile of ‘winners’. Most importantly, transparent-vowel and opaque-vowel candidates are not distinguished; the choice between them falls to the rest of the constraint hierarchy, the frontrunner of which is agreement. Transparent-vowel candidates never stand a chance under this scenario.

The alternative that I propose is that in addition to markedness constraints of the usual kind, there are also *targeted* markedness constraints, in the sense originally proposed by Wilson (1999). A targeted constraint does not bifurcate the candidate set into a set of winners and a set of losers; rather, it only imposes an ordering on *particular pairs* of candidates. The definition of a targeted constraint is deceptively simple:

(309) $\textcircled{[-BK, -ATR]}$ (targeted version of $*[-BK, -ATR]$)

Let x be any candidate and ζ be any $[-BK, -ATR]$ vowel in x . If candidate y is exactly like x except that ζ is not $[-BK, -ATR]$, then y is better than x .¹⁹

The targeted constraint in (309) imposes the following ordering on the candidate set in (308). The fully-harmonic candidate in (308a), which has a $[-BK, -ATR]$ vowel, is ruled to be worse than the transparent-vowel candidate in (308b), which is exactly like (308a) except that the corresponding vowel is not $[-BK, -ATR]$. No other ordering among the candidates in this set is established; in particular, the fully-harmonic candidate in (308a) is not judged to be worse than the opaque-vowel candidate in (308c), even though the former has a $[-BK, -ATR]$ vowel that the latter lacks. This is because (308c) is not otherwise exactly like (308a), since the former also has a final $[\text{æ}]$ while the latter has a final $[\text{ɑ}]$ instead.

¹⁹ I say ‘better than’ (and ‘worse than’) rather than Wilson’s ‘more harmonic than’ (and ‘less harmonic than’) in order to avoid confusion with the other very salient sense of the word ‘harmonic’ in the present context.

This does not mean that the opaque-vowel candidate in (308c) is not deemed to be better than any other possible candidate. It is indeed better than a candidate that is exactly like the it, but with $[\text{I}]$ instead of $[\text{i}]$. This candidate was not considered earlier because it violates both $*[-BK, -ATR]$ and $\text{AGREE}[\text{ATR}]$ with no apparent compensation on any other constraint of interest, but we will consider it here in the interests of giving the opaque vowel candidate the appearance of a shot at being optimal.²⁰

The operative intuition behind the constraint in (309) — an intuition that in fact also lies at the core of all three of the analyses of transparency discussed in §3.3 — is that transparent-vowel candidates have more in common with the ideal, fully-harmonic candidates than opaque-vowel candidates do. An opaque-vowel candidate may better satisfy agreement, but the transparent-vowel candidate still *sounds* more like the fully-harmonic candidate. I will return to more serious consideration of this intuition in §3.4.4 below.

A mini-tableau is given in (310) below, comparing the candidates just discussed against the constraint $\textcircled{[-BK, -ATR]}$ alone. Since the sparse, pairwise orderings imposed by this targeted constraint represent a fundamental departure from the divide-and-conquer behavior of the usual markedness constraints, the inherently comparative violations of $\textcircled{[-BK, -ATR]}$ cannot simply be represented with asterisks. Following Wilson (1999), I instead fill the cell corresponding to the worse of a pair of candidates with an explicit indication of the ordering between them (where ‘f’ means ‘is better than’).²¹

²⁰ Being of no particular interest at this point, the ‘dominance reversal’ candidate in (308d) will be ignored.
²¹ To the left of the tableau I have given each of the candidates a name which I will use to refer to it. I chose the name ‘absurdity’ for the candidate in (310d) for lack of a better one; recall that this candidate is only included here in order to give opacity (310c) a sporting chance.

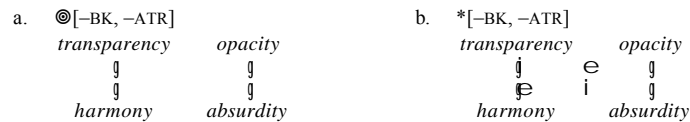
(310) Ordering imposed by $\textcircled{\text{[-BK, -ATR]}}$ on / $\sqrt{\text{wqt}} \cdot \sqrt{\text{wæ:yik}} \cdot \text{s} \cdot \text{æ} /$

	Candidates	$\textcircled{\text{[-BK, -ATR]}}$
<i>harmony</i>	a. watwa:yiksa	b f a
<i>transparency</i>	b. watwa:yiksa	
<i>opacity</i>	c. watwa:yiksæ	
<i>absurdity</i>	d. watwa:yiksæ	c f d
	<i>Cumulative ordering:</i>	b f a c f d

Harmony (310a) is shown to be worse than transparency in (310b) by the indication ‘b f a’ in harmony’s cell under the targeted constraint. Likewise, absurdity (310d) is shown to be worse than opacity (310c) by the indication ‘c f d’ in absurdity’s cell under $\textcircled{\text{[-BK, -ATR]}}$. The two orderings are also recorded together below the tableau under the row heading ‘cumulative ordering’. I return to the significance of this row shortly.

Note again that there is no ordering established between opacity and harmony, nor between transparency and absurdity. To appreciate this distinction between the targeted markedness constraint $\textcircled{\text{[-BK, -ATR]}}$ and its untargeted counterpart *[-BK, -ATR] , consider the following diagrams representing the orderings asserted by each.

(311) Ordering diagrams: targeted vs. untargeted markedness



In both cases, transparency is better than harmony and opacity is better than absurdity, and no ordering is established between transparency and opacity on the one hand nor between harmony and absurdity on the other. The similarity ends here, however: the untargeted constraint *[-BK, -ATR] in (311b) further asserts that opacity is better than harmony and that transparency is better than absurdity, while its targeted counterpart $\textcircled{\text{[-BK, -ATR]}}$ in (311a) leaves these orderings unspecified. These unspecified orderings are to be decided by constraints other than $\textcircled{\text{[-BK, -ATR]}}$; perhaps surprisingly, the ulti-

mate choice in favor of transparency is made by the constraint that is most violated by this candidate, AGREE[ATR] .

In brief, this unexpected outcome results as follows: $\textcircled{\text{[-BK, -ATR]}}$ having already established that transparency is better than harmony and that opacity is better than absurdity, AGREE[ATR] comes along and asserts that harmony is better than opacity. This results in a total ordering of the relevant candidates, with transparency at the top, followed by harmony, then opacity, and absurdity at the bottom. Transparency has thus been judged better than opacity *by transitivity* through harmony, and by the very same strictly local agreement constraint that has been shown to make exactly the opposite choice between opacity and transparency when left to its own devices (cf. (308) above).

3.4.3 Refining the cumulative ordering

The ‘cumulative ordering’ row at the bottom of the mini-tableau in (310) serves an important expository purpose by keeping track of the entire set of orderings established by the constraint hierarchy thus far. This is hardly useful or interesting in the case of (310), where there is only one constraint; this expository device only gets put to serious use when there are more constraints that further refine the ordering.

By ‘refinement’ of the ordering I mean precisely that; every constraint, including targeted ones, asserts some (typically partial) ordering among members of the candidate set, and only those aspects of the ordering that do not contradict those asserted by higher-ranked constraints survive. The ordering asserted by any higher-ranked constraint is never *changed* by a lower-ranked one; a partial ordering can only be further *refined* until a unique, most optimal candidate is found (or until one runs out of constraints, whichever comes first). This much is in fact equivalent to the usual, violation-based candidate evaluation procedure, but because the orderings asserted by targeted constraints do not bifurcate the candidate set in the same way that untargeted constraints do, this order-based evaluation procedure allows targeted constraints to participate in selecting the optimal

candidate. A more formal definition of order-based optimization is given in (312) below.²²

(312) Order-based optimization (adapted from Wilson 1999:22)

- a. *Ordering*. Starting with the highest-ranked constraint in the hierarchy, if the current constraint asserts the ordering $x \prec y$, then add $x \prec y$ to the cumulative ordering O , except when the opposite ordering (i.e., $y \prec x$) is in O . Repeat for the next highest-ranked constraint in the hierarchy.
- b. *Transitive closure*. For any candidates x , y , and z , if both $x \prec y$ and $y \prec z$ are in the cumulative ordering O , then $x \prec z$ is also in O (i.e., $x \prec y \ \& \ y \prec z \Rightarrow x \prec z$).
- c. *Optimality*. A candidate is **optimal** iff it is not worse than any other candidate in the final cumulative ordering (i.e., when the loop in (a) ends).

Let's observe order-based optimization in action. The tableau in (313) below is just like the mini-tableau in (310) above except that AGREE[ATR] has been added and the candidates have been slightly re-ordered (for reasons that will become apparent soon enough).

(313) Input: / $\sqrt{w}qt \cdot \sqrt{w}æyik \cdot s \cdot æ /$

	Candidates	⊙[-BK, -ATR]	AGREE[ATR]
<i>harmony</i>	a. watwa:yiksa	d f a !	
<i>opacity</i>	b. watwa:yiksæ		a f b ?
<i>absurdity</i>	c. watwa:yiksæ	b f c !	a f c
<i>transparency</i>	d. watwa:yiksa		a f d b, c f d ?
	<i>Cumulative ordering:</i>	d f a b f c	?

As before, the targeted constraint ⊙[-BK, -ATR] deems transparency (313d) better than harmony (313a) and opacity (313b) better than absurdity (313c), a pair of judgments that guarantee the suboptimality of harmony and absurdity. The decision between the remaining candidates, opacity and transparency, is thus passed down to AGREE[ATR].

Now you might be asking yourself: if the decision between these two candidates is left to AGREE[ATR], won't this constraint simply decide (incorrectly, of course) in favor of opacity, just as it did in (308) above? Because of the orderings left unspecified by the

²² An even more formal definition can be found in the Appendix to Wilson 1999.

targeted constraint, the answer to this question is that it depends. Yes, opacity is better than transparency from AGREE[ATR]'s point of view, but this constraint also finds harmony to be better than opacity. Either one of these orderings can be added to the cumulative ordering, but not both: if harmony is better than opacity and opacity is better than transparency, then harmony is better than transparency (by transitive closure, (312b)). But this ordering contradicts the ordering already established by ⊙[-BK, -ATR], that transparency is better than harmony. Since contradictory orderings are not allowed by the ordering procedure in (312a) to be added to the cumulative ordering already established by higher-ranked constraints, only one of the two relevant orderings asserted by AGREE[ATR] can be added.

Since what we want is for transparency to win, the question now becomes: how do we guarantee that the ordering between harmony and opacity is decided before the ordering between opacity and transparency is considered? The answer to this question is that the order-based optimization procedure in (312a) must be further specified in order to properly handle ambiguous cases such as this one. As it stands, the procedure begins with the highest-ranked constraint in the hierarchy, adds any asserted orderings if they are not incompatible with the cumulative ordering so far (which is presumably irrelevant in the case of the highest-ranked constraint), and then moves on to the next highest-ranked constraint and repeats the procedure until it runs out of constraints (or until an optimal candidate is found). What is left unspecified by this procedure is the sequence in which the candidates are considered for the purpose of adding the asserted orderings among them to the cumulative ordering. If a principled sequence for the procedure to follow can be established that will guarantee the necessary result in the case at hand, then, we are in business.

Such a principled sequence can, in fact, be found. Consider the fact that every constraint asserts its own, hierarchy-independent partial ordering(s) on the candidate set.

For instance, AGREE[ATR] in and of itself asserts that harmony is better than both opacity and absurdity, both of which are in turn asserted to be better than transparency. If the ordering procedure considers the candidates in this sequence, the ordering between harmony and opacity is desirably guaranteed to be decided before the ordering between opacity and transparency is even considered. Consider the (final) tableau in (314) below.

(314) Input: / $\sqrt{wqt} \cdot \sqrt{w\ae:yik} \cdot s \cdot \ae /$

	Candidates	⊙[-BK, -ATR]	AGREE[ATR]
<i>harmony</i>	a. watwa:yiksa	d f a !	
<i>opacity</i>	b. watwa:yiksæ		a f b !
<i>absurdity</i>	c. watwa:yiksæ	b f c !	a f c
<i>transparency</i>	d. ☞ watwa:yiksa		a, b, c f d
	<i>Cumulative ordering:</i>	d f a b f c	d f a f b f c

As before, harmony (314a) and absurdity (314c) are lost causes due to their poor performances on ⊙[-BK, -ATR] as compared to transparency (314d) and opacity (314b), respectively. The ordering procedure now moves on to AGREE[ATR] and begins with its best candidate, harmony.²³ Since this candidate is the best, there are no orderings in its cell and therefore no orderings to be added to the cumulative ordering.²⁴ The procedure moves on to the next best candidates, opacity and absurdity, which can be considered either simultaneously or in some arbitrary sequence (see footnote 23). Let's consider opacity first. AGREE[ATR] finds opacity to be worse than harmony and this ordering does not contradict any of the orderings already established, so it is added to the cumulative ordering. There is no need to go any further, since the optimal candidate has just been found: transparency is better than harmony by ⊙[-BK, -ATR], harmony is better than

²³ If we were still considering the 'dominance reversal' candidate in (308d) — which also satisfies AGREE[ATR] — then the ordering procedure would consider them either simultaneously or in some arbitrary sequence.

²⁴ Note that it is just a notational accident that a given candidate's cell is filled with the orderings in which that candidate is *worse*, not better, than some other(s). The same results are guaranteed if each candidate's cell is filled with the orderings in which that candidate is the winner, a claim I leave for the reader to verify.

opacity by AGREE[ATR], and opacity is better than absurdity by ⊙[-BK, -ATR]. The result is that transparency is optimal.

Just to be sure, let's continue with the rest of the candidates. Absurdity is next. AGREE[ATR] finds absurdity to be worse than harmony, and this ordering does not contradict any of the orderings already established — in fact, it is an ordering already derived by transitive closure (312b) since opacity was (arbitrarily) considered first. Note that if absurdity had been considered before opacity, we'd end up with the same final result. Both orderings can be added to the cumulative ordering, in either sequence, without fear of contradiction.

Finally, then, we arrive at transparency, which must be considered last since it violates AGREE[ATR] the worst. All of the orderings asserted by AGREE[ATR] with respect to this candidate of course now contradict the cumulative ordering, since transparency is at the top of the cumulative ordering. Therefore, none of these new orderings can be added to the cumulative ordering and the result is, as desired, that transparency is optimal.

3.4.4 Substantive remarks on targeted constraints

I have just shown that targeted markedness constraints can technically get the job done, so to speak, in the analysis of transparent vowels within the agreement model. Assimilation remains as strictly local as ever; in fact, a strictly local agreement constraint is a crucial part of the equation, since it provides the ordering between harmony and opacity necessary to make transparency better than opacity by transitive closure.

This brings us back to the intuition behind targeted constraints like ⊙[-BK, -ATR], the definition of which is repeated in (315) below. As noted earlier, there is a sense in which transparency *sounds* more like harmony than opacity does, and this sense is expressed in the definition of the constraint by the portion that is underlined here.

- (315) $\textcircled{[-BK, -ATR]}$ (targeted version of $\textcircled{[-BK, -ATR]}$)
 Let x be any candidate and ζ be any $[-BK, -ATR]$ vowel in x . If candidate y is exactly like x except that ζ is not $[-BK, -ATR]$, then y is better than x .

Following work by Steriade (1997) and others, Wilson's (1999) original idea behind targeted constraints is that they have as their substantive foundation the following principle.

- (316) Weak element principle (adapted from Wilson 1999:16)

A representation x that contains a perceptually/auditorily poorly-cued (or 'weak') element ζ is marked relative to the representation y that is identical to x except that ζ has been removed.

In more informal terms, Wilson (1999:16) goes on to explain the guiding intuition behind this principle: "given two surface representations that sound basically the same (and which could therefore be easily confused by the hearer), the more complex representation is marked relative to the less complex representation." In other words, targeted constraints mark candidates that contain perceptually/auditorily weak elements and that are thereby not easily distinguishable from otherwise identical candidates that lack those weak elements.

While a more comprehensive account of transparent vowels cross-linguistically must unfortunately await future research, there are some promising studies (Goldsmith 1985 and van der Hulst & Smith 1986 are two that immediately come to mind) that have recognized that a given vowel cannot be expected to be either opaque or transparent as an independent parametric choice; depending on the harmonic feature and on the structure of the vowel inventory, whether a harmonically unpaired vowel is opaque or transparent is often *predictable*. My suspicion is that this predictability is at least in part dependent on whether the expected harmonic counterpart is articulatorily marked (i.e., by an antagonistic feature combination), in which case there would be opacity, or perceptually/auditorily marked (in some sense yet to be fully defined), in which case there would be transparency.

Certainly, there is some overlap here. In the Nez Perce case, for instance, I don't know of any reason to assume that $[-BK, -ATR]$ is not an articulatorily antagonistic fea-

ture combination, as I had assumed in the analysis of the vowel inventory in §2, yet for the purposes of the targeted constraint I assume that it is (also) perceptually/auditorily marked.²⁵ Furthermore, there are clearly cases where it looks like the same vowels (say, high vowels) within the same basic inventory (say, with seven vowels) and given the same harmonic feature (say, $[ATR]$) are opaque in one language (e.g., Yoruba) and transparent in another (e.g., Wolof; see Ka 1988, Archangeli & Pulleyblank 1994, Pulleyblank 1996). The vowel space being how it is — small — this kind of overlap between articulatory markedness and perceptual/auditory markedness is perhaps not unexpected, but one would of course like to see some phonetic tests of this general hypothesis before concluding anything.

3.5 Concluding remarks

In these concluding remarks I briefly discuss an alternative to the analysis of transparency just proposed, one that succeeds in unifying the transparency of recessive $[i]$ in Nez Perce with the fact that some instances of $[i]$ are dominant. I argue that such a unification is spurious at best, based on evidence that these two phenomena do not necessarily co-occur.

The account of dominant and transparent $[i]$ that unifies the two phenomena is one involving derivational opacity — the sort of analysis proposed by most authors, in some form or another, who have worked on Nez Perce. If one postulates an intermediate level of representation at which a $[-ATR]$ counterpart of $[i]$ — say, $\|\mathbf{i}\|$ — is allowed to surface,²⁶ then both dominant and transparent $[i]$ are $\|\mathbf{i}\|$ at the intermediate level of rep-

²⁵ I should note here that the targeted constraint needn't in fact be $\textcircled{[-BK, -ATR]}$; it could be the perhaps more plausible constraint $\textcircled{[+HI, -ATR]}$, which expresses the perceptual/auditory antagonism between $[+HI]$, which lowers F1, and $[-ATR]$, which raises F1 (Archangeli & Pulleyblank 1994:248ff; see also Pike 1967, Ladefoged 1968, Halle & Stevens 1969, Lindau 1978, 1979, Ladefoged & Maddieson 1990). So long as one of the potential harmonic counterparts of $[i]$ — in this case, $[ɪ]$ — is targeted and $AGREE[ATR]$ is ranked below $\textcircled{[+HI, -ATR]}$ as well as $\textcircled{[-BK, -ATR]}$, the analysis proceeds exactly as before. The point being made in the text, however, still holds: there is also no reason to assume that $[+HI, -ATR]$ is not also an articulatorily antagonistic feature combination.

²⁶ I use the double vertical lines ' $\|\mathbf{i}\|$ ' to indicate intermediate levels of representation.

resentation, the former surfacing from underlying /ɪ/ and the latter from underlying-but-harmonized /i/. At the surface, both cases are absolutely neutralized to become [i].²⁷

As appealing as this unified analysis may be, it is not clear that transparent and dominant [i] should be unified in such an intimate fashion, since the two phenomena do not necessarily co-occur in other languages. Recall from Chapter 3 that in (Standard) Yoruba, for example, root instances of [i] that trigger [-ATR] harmony are the stem-controlled equivalent of dominant [i] in Nez Perce, yet non-root instances of [i] are *opaque* in Yoruba, not transparent. In Hungarian, there are root instances of [i] and [e] that opaquely trigger [+BK] harmony, and these vowels are also otherwise transparent; but in the near-identical harmony system of Finnish, these same vowels are also transparent, but root instances of them do not opaquely trigger [+BK] harmony.²⁸ (Wolof is like Finnish, except that the harmonic feature is [ATR] and the transparent vowels are [+HI].)

In sum, the derivational opacity account sketched above binds the two facts together when they are in fact frequently found to exist separately. This is not to say that transparent and dominant [i] are not in some way connected in the way that this account suggests; in fact, the behavior of [i] in Nez Perce seems to reflect the situation in its mother language Proto-Sahaptin, as argued in many of the references cited in footnote 1. There are six vowels reconstructed for Proto-Sahaptin, five of them corresponding to the five vowels of Nez Perce and the sixth vowel corresponding to the dominant counterpart of recessive [i]. The loss of this sixth vowel in the change from Proto-Sahaptin to Nez Perce has clearly left its mark on the vowel harmony system in the form of dominant and transparent [i], but there is no obvious reason why these two aspects of the ambiguous behavior of [i] should be synchronically analyzed with a single device like an intermediate

²⁷ Walker's (1998a, 1999) Sympathy Theory analysis of transparency is the one derivational opacity analysis that would not make a connection between dominant and transparent [i], since the selector is an assimilation constraint (which forces transparency) and not a faithfulness constraint (which could force dominance).

²⁸ There is a systematic (and extremely curious) exception to this statement about Finnish (Kiparsky 1981): monosyllabic, consonant-final roots with [i] or [e] *always* take [+BK] vowel-initial suffixes. Go figure.

representation in a serial derivation. There is in fact more reason to think that the two are analytically separate, given their independent manifestations in other languages for which the historical situation appears to have been similar (see Vago 1973 for relevant discussion).

CHAPTER SIX
CONCLUDING REMARKS

1. Introduction

In the foregoing chapters of this dissertation I have proposed a model of assimilation within Optimality Theory with two central characteristics that distinguish it from most models in current practice. One of these is that autosegmental representations are not necessary in the model; there is no crucial distinction between one-to-one and one-to-many relations between segments and features. The primary evidence for this is naturally to be found in the analyses that have been proposed in the preceding chapters, but some of the more recent and interesting work on vowel harmony within OT, which does rely on the distinction between one-to-one and one-to-many relations between segments and features, requires me to address the issue separately in §2 below.

The other characteristic that distinguishes the proposed model is that crucial input underspecification is also found to be unnecessary, which is a welcome result under the Richness of the Base hypothesis of OT, repeated from Chapter 1, §2 in (317) below. (The numerous positive consequences of adopting some form of the Richness of the Base hypothesis are to be found throughout the OT literature, and I will not go into them here.)

(317) The Richness of the Base hypothesis (from Smolensky 1996:3)

The source of all systematic cross-linguistic variation is constraint reranking. In particular, the set of *inputs* to the grammars of all languages is the same. The grammatical inventories of a language are the *outputs* which emerge from the grammar when it is fed the universal set of all possible inputs.

Underspecification has been a mainstay in the literature on vowel harmony in particular for quite some time, and it has proven to be very difficult to let go of this particular analytical crutch. I believe that the analyses contained in this dissertation have clearly shown

that this device is entirely dispensable, but in §3 below I provide a set of arguments, some novel and some more familiar, that I hope will serve to pound the final nail in the coffin.

2. Autosegmental Representations

2.1 Introduction

As noted in Chapter 1, the approach to markedness taken in this dissertation is *segment-driven*; a given markedness constraint is violated once for each segment that bears the marked feature or feature combination. A markedness constraint *[+F] thus cannot distinguish between the following representations; they both violate *[+F] twice, because in both cases both segments *x* and *y* bear (= ‘are linked to’) [+F].

(318) Indistinguishable candidates in the agreement model

a.	<i>x</i>	<i>y</i>	b.	<i>x</i>	<i>y</i>
	↓	↓		↓	↓
	[+F]	[+F]		[+F]	[+F]

Under the autosegmental approach to markedness advocated in Beckman’s (1995, 1997, 1998) work (see also McCarthy & Prince 1994a, Itô & Mester 1994, Padgett 1995ab, Walker 1998b, Alderete et al. 1999), these two representations are distinguishable by markedness constraints, which count individual instances of features rather than the segments that bear them. Under this ‘feature-driven’ conception of markedness, then, (318a) violates *[+F] twice while (318b) violates the same constraint only once. All else being equal, the representation in (318a) could never be optimal next to the representation in (318b) under this approach, because the latter representation avoids the additional violation of *[+F] incurred by the former.

Beckman’s use of this autosegmental approach to markedness in her analysis of stem-controlled harmony neatly obviates the need to adopt a set of constraints specifically demanding assimilation, like the agreement constraints of the present model. The main ingredient of Beckman’s analysis is that only root vowels may license both values of

the harmonic feature [F].¹ This is accomplished by ranking root-specific positional faithfulness to [F], RT-IDENT[F], above the markedness constraints against either value of [F], *[-F] and *[+F], both of which in turn outrank faithfulness to [F] in general, IO-IDENT[F].

(319) Root-controlled harmony ranking (Beckman 1995, 1996, 1998)

RT-IDENT[F] » { *[-F], *[+F] } » IO-IDENT[F]

What this ranking ensures is that root vowels surface faithfully with whatever value of [F] they bear in the input, lest they violate top-ranked RT-IDENT[F]. Since RT-IDENT[F] is irrelevant to affix vowels, the decision in their case falls to the rest of the constraint hierarchy. Because a single feature spread between two segments incurs only one violation of the relevant markedness constraint, it is actually better under this particular constraint ranking for root and affix vowels to autosegmentally share a value of [F], violating only one of the markedness constraints once, than to have separately-specified root and affix vowels, violating both markedness constraints. Thus, if a root vowel must surface as [αF] because it is [αF] in the input, this feature value preferably spreads to affix vowels to minimize markedness violation.

The situation is shown in the tableau in (320) below. In the input, a root vowel is specified as [-F] and an affix vowel as [+F]. The candidates considered are a completely faithful surface rendition of the input (320a), a candidate in which the affix vowel is changed to [-F] (320b), one in which the root vowel is changed to [+F] (320c), one in which a single [-F] value is shared between the two vowels (320d), and one in which a single [+F] value is shared between them (320e).

¹ In the case of vowel harmony examined by Beckman, Shona, the actual distinction seems to be between the (root-)initial vs. non-initial syllable rather than root vs. suffix, just as in Turkish. I gloss over this distinction here as it does not bear directly on the discussion.

(320) Input: $\sqrt{V} \cdot V$
 $\begin{matrix} g & g \\ [-F] & [+F] \end{matrix}$

Candidates	RT-IDENT[F]	*[-F]	*[+F]	IO-IDENT[F]
a. $\begin{matrix} \sqrt{V} & \cdot & V \\ g & & g \\ [-F] & & [+F] \end{matrix}$		*	* !	
b. $\begin{matrix} \sqrt{V} & \cdot & V \\ g & & g \\ [-F] & & [-F] \end{matrix}$		** !		*
c. $\begin{matrix} \sqrt{V} & \cdot & V \\ g & & g \\ [+F] & & [+F] \end{matrix}$	* !		**	*
d. $\begin{matrix} \sqrt{V} & \cdot & V \\ y & t & \\ [-F] & & \end{matrix}$		*		*
e. $\begin{matrix} \sqrt{V} & \cdot & V \\ y & t & \\ [+F] & & \end{matrix}$	* !		*	*

The two candidates in which both vowels are specified as [+F], (320c) and (320e), fatally violate the highest-ranked constraint RT-IDENT[F] because the input root vowel is specified as [-F]. This leaves the completely faithful candidate in (320a) and the two candidates in (320b) and (320d) in which both vowels are specified as [-F]. Between candidates (320a) and (320b), the former is clearly superior because it avoids the additional violation of *[-F] that the latter incurs due to its two instances of [-F], one on each of the vowels. But candidate (320d), with a single [-F] specification shared between the two vowels, avoids violation of *[+F] entirely, bettering (320a) in this regard and emerging victorious in the evaluation of this candidate set.

As I have been argued at length in this dissertation, faithfulness constraints specific to the stem of affixation (ultimately, the root) — specifically, stem-affixed form faithfulness constraints — are indispensable to the analysis of stem control, lest the Richness of the Base hypothesis be compromised: the only other way to explain the asymmetry between stem and affix vowels in stem-controlled harmony systems is to stipulate that

stem vowels are specified for the harmonic feature while affix vowels are not. And, as I argued in Chapter 2, §2.4, I even believe that positional faithfulness constraints of the sort advanced in the work under discussion are also necessary. But the autosegmental approach to markedness is a matter quite independent of position-specific or morphologically-sensitive faithfulness, and there are two related problems that I see with this approach to markedness.

2.2 Problem 1: non-uniformity of emergent unmarkedness

One of the intended uses of root-specific faithfulness constraints is to account for markedness asymmetries between roots and affixes, the latter often exhibiting significantly less marked structure than the former — the distribution of $[-HI, +RD]$ vowels in Turkish is an example of this kind (putting aside the co-existent $[RD]$ harmony process, on which see §2.3 below). The positional faithfulness + feature-driven markedness approach is an attempt to analyze stem control in the same terms as this basic markedness asymmetry. There is, however, a notable difference between the markedness asymmetry on the one hand and stem control on the other: in the former case, affix segments never bear the marked feature value, while in the latter, they do if root segments do. Recall the emergence of the unmarked (TETU) ranking proposed for Turkish in Chapter 2, §2.4.2.²

(321) Turkish TETU ranking

RT-IDENT $[RD]$ » $*[-HI, +RD]$ » IO-IDENT $[RD]$

This ranking is shown to work in (322) below, so long as each *segment* dominating the marked $[-HI, +RD]$ feature combination is assessed a separate violation of $*[-HI, +RD]$. A $[-HI, +RD]$ vowel in the root is unavoidable due to high-ranking RT-IDENT $[RD]$, but another $[-HI, +RD]$ vowel in a suffix means an additional and unmotivated violation of $*[-HI, +RD]$, forcing violation of IO-IDENT $[RD]$ ('delabialization') in such a case.

² Again, putting aside the root vs. root-initial distinction; see footnote 1.

(322) Input: / $\sqrt{g\acute{o}z \bullet l\acute{o}r}$ / 'eye (plural)'

Candidates	RT-ID $[RD]$	$*[-HI, +RD]$	IO-ID $[RD]$
a. g\acute{o}zl\acute{o}r		** !	
b. gezler	* !		**
c. g\acute{o}zler		*	*

The feature-driven approach to markedness, by contrast, predicts that two $[-HI, +RD]$ vowels are optimal if the vowel in the root and the one in the suffix autosegmentally share this marked feature combination, because this candidate is no worse, markedness-wise, than the candidate with delabialization of the suffix vowel, and is in fact better in terms of featural faithfulness. This is shown by the tableau in (323) below.³

(323) Input: / $\sqrt{g\acute{o}z \bullet l\acute{o}r}$ / 'eye (plural)'

Candidates	RT-ID $[RD]$	$*[-HI, +RD]$	IO-ID $[RD]$
a. g\acute{o}z l\acute{o}r g [RD] g [RD]		** !	
b. g\acute{o}z l\acute{o}r y t [RD]		*	
c. gez ler y t [-RD]	* !		**
d. g\acute{o}z ler g g [RD] [-RD]		*	* !

Some additional constraint must rule out the optimal feature-sharing candidate in (323a) in order for the desired result in (322) to emerge. Beckman (1998:82), following a proposal made by Benua (1996), invokes a constraint UNIQUE for just this purpose. UNIQUE specifically rules out feature sharing between segments, and so it is able (albeit in an ad hoc manner) to make the necessary distinction. If UNIQUE is ranked above IO-IDENT $[RD]$ in (323), the candidate in (323c) is correctly predicted to be optimal, as shown in (324).

³ Since all vowels considered are $[-HI]$, only the relevant values of $[RD]$ are shown here.

(324) Input: /√gøz • lør / ‘eye (plural)’

Candidates	RT-ID[RD]	*[-HI, +RD]	UNIQUE	IO-ID[RD]
a. gøz lør g g [+RD] [+RD]		** !		
b. gøz lør y t [+RD]		*	* !	
c. gez ler y t [-RD]	* !		* !	**
d. ^{ɛɤ} gøz ler g g [+RD] [-RD]		*		*

Apart from the ad hoc manner in which the analysis of featural TETU must be saved under this approach, the real problem here is that the necessary invocation of a constraint like UNIQUE is entirely unique to the analysis of the emergent unmarkedness of distinctive feature values. TETU effects with other units of structure, such as segments themselves, are analyzed with nothing more than a simple ranking of constraints conforming to the TETU schema. A language with, say, closed syllables in roots but not in affixes can be accounted for with the ranking in (325), with no need to invoke a constraint like UNIQUE.⁴

(325) Closed syllable TETU ranking
RT-MAX » NOCODA » IO-MAX

Since a form with a closed syllable in the root and another in an affix violates NOCODA twice no matter how you slice it (i.e., there is no way for a closed syllable in an affix to somehow parasitically satisfy NOCODA because there is also a closed syllable in the root), the result under this ranking will be exactly like in (322) above. The candidate with two instances of the marked element (two [-HI, +RD] vowels, two closed syllables) incurs an additional and unmotivated violation of markedness (*[-HI, +RD], NOCODA); since root-

⁴ MAX (McCarthy & Prince 1995, 1999) is a faithfulness constraint demanding that every segment in one string (e.g., the input) have a correspondent segment in another string (the output). It is the Correspondence-theoretic analog of PARSE in earlier OT work. NOCODA is a markedness constraint against closed syllables.

specific faithfulness demands that a marked element in the root be tolerated, the optimal candidate exhibits emergent unmarkedness in the affix alone. This is shown in (326) below.

(326) Input: /√CVC • CVC /

Candidates	RT-MAX	NOCODA	IO-MAX
a. √CVC • CVC		** !	
b. ^{ɛɤ} √CVC • CV		*	*
c. √CV • CV	* !		**

The upshot is that while the two cases of emergent unmarkedness in (322) and (326) are of a kind, the autosegmental approach to markedness requires that an additional constraint be appropriately ranked to correctly account for the featural case of TETU, as shown in (324). Such an analytical move is not required for the structural case of TETU in (326).

2.3 Problem 2: interaction of TETU and stem control

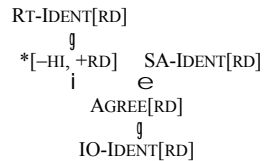
Intimately related to the problem just noted — but significantly more problematic — are cases where root/affix TETU effects interact with stem control, as they do in Turkish.⁵ As just noted above, there is an emergent unmarkedness effect in Turkish such that non-initial syllables cannot contain [-HI, +RD] vowels although root-initial syllables can. The co-existent stem-controlled [RD] harmony process of Turkish also does not create [-HI, +RD] vowels; if it did, then there would in fact be no emergent unmarkedness effect to speak of, since non-initial syllables would simply contain [-HI, +RD] vowels.

Under the segment-driven markedness assumptions of the agreement model, this situation is analyzable as the combination of the ranking claimed to be responsible for the opacity of [-HI] vowels to [RD] harmony (see Chapter 2, §2.3.1.1) with the ranking

⁵ I thank Jill Beckman for discussion of the issues raised in this section.

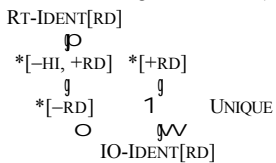
claimed to be responsible for the TETU effect itself (see Chapter 2, §2.4.2 as well as §2.2 above). This combined ranking is shown in (327) below.

(327) Combined ranking for Turkish (segment-driven markedness)



Now recall from the discussion in §2.1 above that in the positional faithfulness + feature-driven markedness model, harmony is driven not by agreement-type constraints but by markedness constraints against individual values of the harmonic feature themselves, ranked below positional faithfulness but above general faithfulness. Recall also from §2.2 that a constraint referred to as *UNIQUE* must dominate *IO-IDENT[RD]* in order to correctly prevent $[-\text{HI}, +\text{RD}]$ vowels from arising parasitically in non-initial syllables. Combining these two rankings yields the ranking in (328) below.

(328) Combined ranking for Turkish (feature-driven markedness)



An unintended side-effect of this analysis is that $[\text{+RD}]$ vowels *in general*, not just $[-\text{HI}]$ ones, are prevented from arising parasitically (that is, harmonically) in non-initial syllables. This is because *UNIQUE* dominates *IO-IDENT[RD]*, preventing *any* feature-sharing outputs that violate general faithfulness to $[\text{RD}]$. But this is of course contrary to fact; non-initial $[\text{+HI}]$ vowels do harmonize with root-initial $[\text{+RD}]$ vowels in Turkish.

The unfortunate result of this side-effect is that root/affix TETU effects that interact with a stem-controlled vowel harmony process, in the way that these processes do in Turkish, must be due not to positional faithfulness but to positional *markedness*; to wit,

a markedness constraint against non-initial $[-\text{HI}, +\text{RD}]$ vowels in the case of Turkish. While such an analysis is not unimaginable, it significantly undermines the positional faithfulness approach to positional neutralization (cf. Zoll 1998a).⁶

2.4 Summary

There can be no doubt that the analysis of stem control in OT requires an element of faithfulness to the stem of affixation to explain the basic asymmetry between stem and affix, at least without compromising the Richness of the Base principle and stipulating on a language-particular basis that, for example, root vowels underlyingly bear the harmonic feature while affix vowels do not. However, the complete reduction of stem control to a particular interaction among root-specific faithfulness, general faithfulness, and autosegmental markedness constraints leads to the necessary invocation of an otherwise poorly-motivated constraint specifically militating against feature sharing between segments, *UNIQUE*, to avoid harmony in favor of TETU. Such a constraint is not needed to analyze TETU in other, non-featural domains, casting significant doubt on the validity of the autosegmental approach to markedness. Furthermore, the invocation of *UNIQUE* predicts that there can only be harmony or TETU but not both, which is counterexemplified by the Turkish example to which much attention has been devoted here and in Chapter 2.

My conclusion is that vowel harmony, and assimilation in general, must be driven by a family of constraints independent of markedness and faithfulness; namely, the agreement constraint family (see also Lombardi 1996ab, 1999). The autosegmental approach to markedness is rendered unnecessary and ultimately undesirable by this conclusion: as the individual analyses in preceding chapters of this dissertation have attested, no distinction between the representations in (329) below, repeated from (318) above, is ever

⁶ Another possibility might be to split *UNIQUE* up into various constraints, each taking different features or feature classes as arguments. This solution to the problem is also ad hoc and somewhat less than satisfying, especially since it is not clear what feature or feature class could be used to distinguish the cases at hand.

needed. Lacking evidence to the contrary, I thereby conclude that such distinctions — that is, autosegmental spreading representations — are dispensable.

(329) Indistinguishable candidates in the Agreement model

a.	x	y	b.	x	y
	$\underset{g}{\downarrow}$	$\underset{g}{\downarrow}$		$\underset{y}{\downarrow}$	$\underset{t}{\downarrow}$
	[+F]	[+F]		[+F]	

I must reiterate here that my claim is not that (329b) is an *impossible* phonological representation; I simply find no reason to *distinguish* it phonologically from (329a) based on the behavior of vowel harmony systems. It is precisely the behavior of these systems that provided abundant evidence in favor of the autosegmental model of assimilation over twenty years ago (beginning with Clements 1976a), but phonological theory has seen developments since then — in particular, the advent of OT — that quell the significance of such evidence. Earlier evidence for autosegmental spreading representations in the tonal domain (Leben 1973, Goldsmith 1976, Williams 1976) may still hold up under scrutiny, but Zoll (1998b) has significantly reinterpreted some of this evidence, apparently without any particular reliance on such representations. Other evidence may bear on this question, but my claim is that none of it will come from the phonology of vowel harmony.

3. Underspecification in Vowel Harmony

3.1 Introduction

The interaction among markedness, faithfulness, and agreement constraints obviates not only autosegmental representations but also the need for underspecification in the analysis of vowel harmony, either in underlying representations or in surface forms. Underspecification itself is not incompatible with OT (as demonstrated in Inkelas 1994 and Itô, Mester, and Padgett 1993, 1995 — but cf. Artstein 1998a), but its often crucial use in underlying representations in analyses of vowel harmony in particular is incompatible with the output orientation of OT — specifically, with the Richness of the Base hypothesis. This hypothesis does not in and of itself proscribe the use of input underspecification; it is

the *crucial* use of input underspecification in statements like “affix vowels are not specified in the input for the feature [F]” and “only [αF] (and not [−αF]) is specified on vowels in the input”, so often found in vowel harmony analyses, that is forbidden by the Richness of the Base hypothesis.

Apart from the general parsimonious character of this consequence of the Richness of the Base hypothesis, there are more specific conceptual and even empirical reasons to reject the crucial use of input underspecification in the analysis of vowel harmony.⁷ I clarify in this section what these reasons are by way of a condensed and expurgated review of the history of underspecification within the vowel harmony literature.

3.2 Arbitrariness of specification

Underspecification has led a rather topsy-turvy life in the vowel harmony literature. It began mostly as a representational substitute for making an arbitrary decision between the regular harmonic alternants of a morpheme. For example, since the value of the feature [BK] is predictable in Turkish suffix vowels from the value of [BK] in root vowels, it would be arbitrary to assign one or another value of [BK] to the input of a suffix vowel. Therefore, either value — *or no value* — will do; the vowel harmony process takes care of assigning the correct feature value in the output regardless of the feature value in the input.

To clarify this point, suppose that the grammar of Turkish contains a requirement to the effect that in the output, suffix vowels must have the same value of the feature [BK] as root vowels do; the “vowel harmony process” ensures that this requirement is respected. Now so long as this process is allowed to change the feature value of a suffix vowel if necessary, there is absolutely no way to decide whether a given suffix vowel is specified in the input as [+BK], [−BK], or [ØBK] (no specification for [BK]) — any one of these choices leads to the correct output in any case, as shown by the example input-output mappings in (330).

⁷ For comprehensive critical reviews of underspecification generally, see Mohanan 1991 and Steriade 1995.

(330) Example input-output mappings

- | | | |
|---------------------------|---------------------------|---------------------------|
| a. Dative suffix is [+BK] | b. Dative suffix is [-BK] | c. Dative suffix is [ØBK] |
| /el + a/ → [el + e] | /el + e/ → [el + e] | /el + A/ → [el + e] |
| /kol + a/ → [kol + a] | /kol + e/ → [kol + a] | /kol + A/ → [kol + a] |

In each of these examples, the [-HI] vowel of the dative suffix is assumed to have a different value of the feature [BK] in the Input: ‘+’, ‘-’, or ‘Ø’ (none). If the suffix vowel is [+BK] as in (330a) then the vowel harmony process will change it to [-BK] when attached to the root /el/ ‘hand’, the vowel of which is [-BK]. On the other hand, no change in the suffix vowel’s value of [BK] is necessary to ensure that the suffix and root vowels have the same value of the feature in the case of the root /kol/ ‘arm’, the vowel of which is [+BK]. Conversely, if the suffix vowel is [-BK] as in (330b) then no change is necessary in the case of /el/ but a change to [+BK] is necessary in the case of /kol/. Finally, if the suffix vowel is not specified for a value of [BK] as in (330c) then a change is needed in both cases: the suffix vowel needs to be specified as [-BK] in the case of /el/ and as [+BK] in the case of /kol/.

Although the choice among these three possible inputs is technically arbitrary — that is, any of them will work just fine — arguments have been made for one or another of them on some purportedly non-arbitrary basis. Of particular interest here is the argument that is often made in favor of the underspecified input in (330c), which is representationally “simpler” than the other two because it lacks information that the others have; i.e., a specification for the feature [BK]. This simplicity argument crucially depends, however, on two questionable assumptions: first, that simplicity in underlying representations is the only type of simplicity that counts in the evaluation of a grammar, and second, that the lack of a specification even constitutes a move in the direction of simplicity.

In response to this first assumption, notice that along with the apparent gain in simplicity with the underspecified input in (330c) there is a concomitant complication in the operation of the grammar: no matter what root the dative suffix is attached to, a

change of specification must take place, as was noted above. With either of the other two input possibilities in (330a) and (330b), a change in specification must only take place when specifications disagree — a simpler proposition by any account.

With regard to the second assumption, notice that while it is true that an underspecified representation is simpler than a specified one by some quantitative measure, such simplicity cannot be taken at face value. If the vowels of Turkish suffixes all lack a specification of the feature [BK], there must be a statement to this effect somewhere in the grammar of Turkish, lest an important generalization be missed. But such a statement is actually an added complication to the grammar. The same grammar without that statement, allowing the vowels of Turkish suffixes to be freely specified any old arbitrary way, would be simpler just by virtue of the fact that it lacks the additional statement.

This particular counter-argument applies equally well, of course, to any proposal that the vowels of Turkish suffixes must be either all [-BK] or all [+BK]. However, an argument can be made (and in fact has often been made) that one of these latter two specifications is the “unmarked” value of the feature, and that it therefore complicates the grammar not at all for all suffix vowels of Turkish to have this unmarked value in the input. One problem with this sort of argument is that relative “markedness” is by necessity a property of surface forms, not underlying representations, and it is unclear that this property should be extended to underlying representations. It may be more difficult to *produce* a [-BK, +RD] vowel than it is to produce a [+BK, +RD] vowel, but is it thereby more difficult to *store the lexical representation* of a [-BK, +RD] vowel than that of a [+BK, +RD] vowel?⁸

⁸ Hale & Reiss (to appear) take this kind of argument one step further, pointing out that output representations are themselves not “bodily outputs” and so should not in principle be governed by considerations of phonetic motivation. This is one step further than I am willing to take this argument. Input and output representations are qualitatively different in that the latter presumably interface directly with an interpretive component that produces the eventual physical output. I find reason to believe that a certain amount of phonetic motivation in the phonological component serves the valuable function of facilitating this interface.

I must note that none of these counter-arguments are offered here as serious counter-proposals for a possible grammatical evaluation metric. I state them here merely to make the point that phonological theory is hardly in a position to definitively ascertain what constitutes a relevant dimension along which to assess simplicity. As Kiparsky (1968:151) very aptly put it, “[i]t is pointless to define evaluation measures until we know what kinds of phonological descriptions we want them to select.”

3.3 *Automatic convention*

Early work in the autosegmental model (Clements 1976a *et seq.*) denied that there was anything like a requirement that, for example, Turkish suffix vowels must have the same value of the feature [BK] as root vowels do. Assimilation is the result of feature spreading in this model, and in the early work I refer to all feature spreading was accomplished by automatic and universal convention — part of the Well-formedness Condition of Goldsmith 1976 — triggered by crucially underspecified representations. For example, if Turkish suffix vowels are assumed to be unspecified in the input for the feature [BK], then the fact that all vowels must eventually be specified for some value of [BK] in the output ensures that the value of [BK] in the root vowel will automatically spread to suffix vowels.

An apparent benefit of this approach is that vowels that behave disharmonically can simply be pre-specified for some value of the harmonic feature, so that no other value of the feature needs to (or can) spread to them. For example, non-initial [–HI] vowels in Turkish must be [–RD] and so their value of [RD] — unlike that of [+HI] vowels in suffixes — is not determined by the root vowel’s value of [RD]. This state of affairs can be described in the autosegmental model by pre-specifying non-initial [–HI] vowels as [–RD] in Turkish. Similarly, the pre-specification device can be used to describe the behavior of vowels that are unpredictably disharmonic, like the idiosyncratically opaque affix vowels of both Turkish and Kalenjin (see Chapter 2, §2.3 and §3.3). The choice of underspecified representations in the autosegmental model is thus not arbitrary nor dependent on

questionable assumptions of simplicity; rather, it is integral to the analysis of vowel harmony because a harmonic feature spreads to a segment if and only if that segment is unspecified for the harmonic feature.

But there is some evidence that even regularly harmonic vowels have particular specifications of the harmonic feature, and thus that a feature may at least potentially spread to pre-specified segments. Vago (1973:592-593) notes that certain regularly harmonizing suffixes in Hungarian independently occur as roots, and that the value for the harmonic feature [BK] of these roots is unpredictable: some, like [næk] ‘from’, are [–BK], while others, like [na:l] ‘at’, are [+BK]. In like fashion, Dimmendaal (1983:341-344) and Albert (1995:23-25) show that possessive pronouns in Turkana harmonize regularly when incorporated as prefixes but that they have unpredictable specifications for the harmonic feature [ATR] — [kɔsɪ] ‘our’ is [–ATR] while [koni] ‘your’ is [+ATR] — when they occur unincorporated. In order to maintain the claim that a feature spreads to a segment if and only if that segment is unspecified for the spreading feature, one would be forced to the undesirable conclusion that the relevant morphemes in Hungarian have no specification for [BK] when they are suffixes but some arbitrary [BK] specification when they are roots, and that possessive pronouns in Turkana have no specification for [ATR] when they are incorporated but some arbitrary [ATR] specification when they are not.⁹

Another example of the feature-changing ability of vowel harmony comes from Pasiego (Penny 1969ab, 1970, McCarthy 1984, Spencer 1986, Demirdache 1988, Vago 1988, Hualde 1989, Flemming 1993, Ni Choisain & Padgett 1997, Polgárdi 1998). In Pasiego, [HI] harmony functions as follows: all non-final, non-low vowels in a word agree in terms of the feature [HI], the value of which is determined by the stressed vowel.

⁹ Cf. Steriade 1981, footnote 9, with respect to the Hungarian case.

(331) Pasiego [HI] harmony

	<i>gloss</i>	INF.	2 PL. IND.	1 PL. IND.	1 PL. SUBJ.
a.	'feel'	sintír	sintís	sentémus	sintémus
b.	'drink'	bebér	bibís	bebémus	bebémus
c.	'take'	koxér	kuxís	koxémus	koxémus
d.	'loosen'	ɛfloxér	ɛfluxís	ɛfloxémus	ɛfloxémus

As shown in the first person plural subjunctive examples in the final column, the stressed low vowel [ɛ] does not trigger [HI] harmony (because it is neither [+HI] nor [-HI], under McCarthy's (1984) analysis).¹⁰ Note that the rest of the non-final vowels in these forms surface with contrastive values of [HI]: comparing the form in (331a) with the form in (331b), for instance, we see that the input of the verb root meaning 'feel' must be /sint/, with a [+HI] vowel, while the input of the verb root meaning 'drink' must be /beb/, with a [-HI] vowel.¹¹ Since this distinction is otherwise neutralized, harmony must be feature-changing.

Empirical considerations such as these suggest that vowel harmony processes should be applicable to pre-specified vowels, and that the predictable exceptionality of certain (classes of) vowels, like non-initial [-HI] vowels in Turkish, should be accounted for by some other device. Idiosyncratically opaque vowels in certain morphemes, such as the progressive suffix in Turkish, require special stipulation in any case precisely because they are idiosyncratic; their exceptionality is no more explained by pre-association of the harmonic feature than by an arbitrary diacritic, since the former solution leaves unexplained why pre-association is the exception and underspecification the rule. Kiparsky (1968:153) put it this way: "what is phonologically predictable should in fact be predicted phonologically, and what is not phonologically predictable should be treated by means of diacritic features."

¹⁰ The low vowel also does not undergo nor block [HI] harmony (i.e., it is transparent) as shown by (331c,e).

¹¹ Note that in Standard Spanish, the cognates of these verb roots have mid vowels: [sentír] 'to feel', [bebér] 'to drink'. However, only the first of these diphthongizes under stress: [sjénto] 'I feel', [beþo] 'I drink'.

3.4 Spreading by rule

Later work in the autosegmental model, led by Pulleyblank 1986, abandoned the automatic convention idea in favor of language-particular spreading rules. Underspecification still plays a crucial role in many analyses of this later period, because even though a feature does not *necessarily* spread to a segment that is unspecified for that feature, it is still the case that a feature may spread to a segment *only if* that segment is unspecified for that feature.

A guiding principle in the work of this period, at least within what is known as the "radical underspecification" literature, is that predictable information should be entirely absent from underlying representations. Such predictable information includes, for example, the values of the features [BK] and [RD] in the harmonic suffix vowels of Turkish, because the grammar of Turkish contains a rule (or rules) that spreads values of these features from root vowels to suffix vowels, meaning that the values of these features in suffix vowels are predictable from their values in root vowels. Therefore, the features [BK] and [RD] should be unspecified in the underlying representations of suffix vowels in Turkish.

Likewise — and unlike early work in the autosegmental model — the feature [RD] should be unspecified in non-initial [-HI] vowels of Turkish: they are always [-RD], and so this feature value is predictable information. To ensure that a [-HI] suffix vowel emerges as [-RD] when attached to a root with a [+RD] vowel, the rule predictably specifying non-initial [-HI] vowels as [-RD] simply needs to apply before the vowel harmony rule. Spreading of [RD] by vowel harmony is then crucially blocked by this added [-RD] specification, just as it was by the pre-specified [-RD] value in earlier work in the autosegmental model.

The empirical arguments made in §3.3 above concerning Hungarian, Turkana and Pasiego apply equally well to this only slightly different approach to underspecification. These arguments aside, however, I believe that this approach is flawed due to its critical

circularity. Since the target of a spreading rule must be unspecified for the spreading feature in order to be a target in the first place, this feature is “predictable” by the spreading rule only insofar as it is unspecified in the target. However, recall that a feature is unspecified in underlying representations only insofar as it is predictable by a rule! Under this approach, spreading rules and input underspecification are interdependent in such a way that the function of each at best largely duplicates the function of the other.

3.5 Summary

If you choose not to decide, you still have made a choice.
Rush — Freewill

No one would disagree that specifying a particular segment for one or another value of a feature in the underlying representation is arbitrary when the surface value of that feature on that segment is always completely predictable from context. However, it does not follow from this that predictable feature values must be unspecified in the underlying representation. Deciding that a segment cannot be specified for one or another feature value is no different than deciding that it must be specified for one value or the other; any of these three choices has potential empirical consequences, or else underspecification would simply be a non-issue. Just considering the couple of autosegmental approaches to vowel harmony reviewed just above, it is clear that affix vowels specified for some value of the harmonic feature crucially behave differently than affix vowels not specified for some value of the feature.¹² So, in fact, even non-specification is an arbitrary choice; the only real choice is to live with lexical arbitrariness and let the grammar itself do the work it is intended to do.

The Richness of the Base hypothesis states nothing other than this very claim. Under this hypothesis, there can be no reliance at all on the quirks of a language-particular lexicon; all language particularity derives from the one difference that there is allowed to

¹² This point is similar in kind to the sometimes underappreciated point originally made by Lightner (1963) and Stanley (1967) with regard to the fact that underspecification can function as an additional feature value. Note that this does not preclude the possibility that there are ternary feature scales of phonological features, as argued recently within OT by Gnanadesikan (1997).

be among languages: in the relative ranking of constraints. It is thereby incumbent on the constraints and their ranking alone to account for that for which it seems that crucial underspecification is necessary, as I argue here is necessary and possible for vowel harmony.

REFERENCES

Abbreviations:

BLS	=	(Proceedings of the) Berkeley Linguistics Society
CLS	=	(Proceedings of the) Chicago Linguistics Society
IULC	=	Indiana University Linguistics Club
IJAL	=	International Journal of American Linguistics
JAL	=	Journal of African Languages
JALL	=	Journal of African Languages and Linguistics
JL	=	Journal of Linguistics
JWAL	=	Journal of West African Languages
LA	=	Linguistic Analysis
LI	=	Linguistic Inquiry
MITWPL	=	MIT Working Papers in Linguistics
NLLT	=	Natural Language and Linguistic Theory
NELS	=	(Proceedings of the) Northeastern Linguistics Society
PASC	=	Phonology at Santa Cruz
ROA	=	Rutgers Optimality Archive (http://rucss.rutgers.edu/roa.html)
SEALS	=	(Proceedings of the) Southeast Asian Linguistics Society
SLS	=	Studies in the Linguistic Sciences
UCPL	=	University of California Publications in Linguistics
UMOP	=	University of Massachusetts Occasional Papers
WCCFL	=	(Proceedings of the) West Coast Conference on Formal Linguistics

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