Esimbi Vowel Height Shift: Implications for Faith and Markedness*

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In this paper I discuss the theoretical implications of a vowel height transfer in Esimbi for three current issues in the analysis of featural phenomena in Optimality Theory (Prince and Smolensky 1993). Esimbi exhibits a remarkable surface distribution of vowels: a greater number of vowel height contrasts occur in prefixes than in roots. On the face of it, this appears to belie the generalization that affixes are universally unmarked relative to stems, a relation which McCarthy and Prince (1994, 1995) propose to capture in Optimality Theory with a metaconstraint universally ranking faithfulness constraints for roots over faithfulness for affixes. Previous work by Stallcup (1980a,b) and Hyman (1988) has convincingly shown that the vowel height distribution in Esimbi is produced by a transfer of height features from root to prefix vowels. I argue that this outcome is actually driven by the root versus affix faithfulness metaconstraint in concert with a word-initial licensing constraint for marked vowel height.

The height shift in Esimbi offers an interesting case of nontonal features behaving as true autosegments, independent of their segmental sponsors, a phenomenon which bears on two additional points of theoretical interest. First, the features that undergo the transfer act as autonomous structural elements, signaling a need to extend the correspondence relation to Esimbi vowel height features within Correspondence Theory (McCarthy and Prince 1995). This kind of relation does not fall under the usual IDENT[Feature] formulation of featural faith, which demands identical feature specification of segmental correspondents, rather it is expressed by a MAX[Feature] constraint, which evaluates correspondence between features themselves. Esimbi feature shift thus offers new support for the existence of MAX[Feature] constraints (see Lombardi 1995, 1998; Causley 1996; also discussion in Lamontagne and Rice 1995; McCarthy and Prince 1995). A related point concerns the constraint driving the mobility of height features. Because the shifted features originate in a different location from the one in which they surface, the licensing constraint motivating the transfer must be formulated as a requirement on the position of marked phonological structure, that is, it is an instance of *Positional Markedness* (Zoll 1996, 1998) — it cannot be expressed in terms of *Positional Faithfulness*, where faithfulness is specific to the context of the licensing position (Beckman 1997, 1998, and references therein). These analytical findings contribute to the wider debate on the extent to which nontonal features should be understood as having "autosegmental" status in phonological structure.

1 Background: Vowel Height Contrasts Originate in the Root

Esimbi (Bantoid; Cameroon) presents a surprising asymmetry in the height distinctions displayed in root versus prefix vowels: prefixes exhibit (at least) three degrees of vowel height, while root vowels are uniformly high. The surface distribution of vowels is shown in (1) (Stallcup 1980a,b; Hyman 1988).

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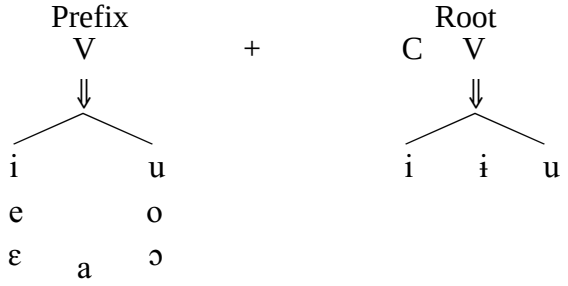
(1) Surface distribution of vowel height

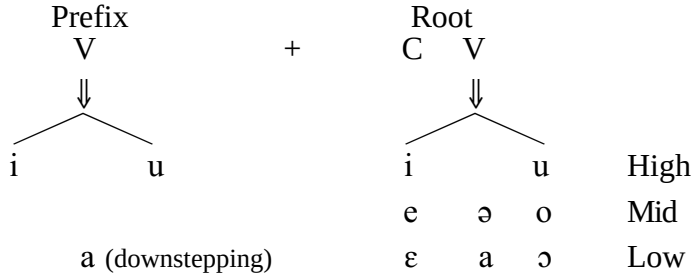


The distribution of vowel height is unusual, since contrasts in language are typically more robust in roots than in affixes, an observation expressed, for example, with the universal ranking of root faithfulness over affix faithfulness in (2) proposed by McCarthy and Prince (1994, 1995). As McCarthy and Prince point out, metaconstraints of this kind are well-established in the theory of phonological markedness developed by Prince and Smolensky (1993) and constitute claims about the universal prioritization of constraints in language.

(2) *Root-Affix Faithfulness Metaconstraint* (McCarthy and Prince 1995)
Root-Faith >> Affix-Faith

Careful examination of the data will reveal that the Root-Affix Faithfulness Metaconstraint is actually respected in Esimbi. This section presents evidence from studies by Stallcup (1980a,b) and Hyman (1988) establishing the descriptive generalization that the full range of vowel height contrasts occur in the root underlyingly, and a reduced number originate in the prefix, as outlined in (3). Following the work of these analysts, height features are then transferred from root to prefix to produce the surface distribution in (1).[1]

(3) Underlying distribution of vowel height



Various data support the claim that a three-way height contrast originates in vowels of the root. The first set of data shows that roots condition alternations in prefix vowel height. A given prefix will exhibit a three-way variation in vowel height, with the choice of height variant determined by the root to which it is affixed. This is illustrated in (4) for the infinitive prefix, with alternants [u-, o-, ɔ-]. The underlying vowel representations (after Hyman 1988:256) appear at the right (assuming full specification).[2]

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[1] The affixes Stallcup reports in his investigation of Esimbi are essentially all prefixal. He notes one occurrence of a post-stem morpheme [anɨ] in deverbal nominals; this morpheme neither affects nor is affected by the preceding stem vowel height. Although Stallcup 1980b refers to [anɨ] as a suffix; Stallcup (personal communication) later suggests that this kind of morphemic material which exhibits independent vowel height is not in fact a suffix.

[2] The phrase "underlying representation" is used here to refer to the (approximate) character of a form as it is represented in its lexical entry. This is distinct from the notion "input" used in Optimality Theory; see discussion in section 2.3.

(4)		*Infinitive: Prefix + root*		*Output pattern: Height contrast in prefix*	*Underlying vowels: Height contrast in root*
a.	High	u-ri	‘eat’	u - i	/u - i/
		u-zu	‘kill’	u - u	/u - u/
b.	Mid	o-si	‘laugh’	o - i	/u - e/
		o-tu	‘insult’	o - u	/u - o/
		o-dzɨ	‘steal’	o - ɨ	/u - ə/
c.	Low	ɔ-ri	‘daub’	ɔ - i	/u - ɛ/
		ɔ-hu	‘knead’	ɔ - u	/u - ɔ/
		ɔ-bɨ	‘come’	ɔ - ɨ	/u - a/

Although the prefix height depends on the root to which it is attached, there is nothing in the surface form of the root to condition the change. This is particularly clear from inspection of the near minimal triplets in (5) (Hyman 1988:257; diacritics mark tones).

(5)	a.	u-mu	‘drink’
		o-mu	‘go up’
		ɔ́-mu	‘sit’
	b.	u-wu	‘uproot’
		o-wŭ	‘burn’ (intr.)
		ɔ-wŭ	‘grind’

While the vowel height of the infinitive prefix changes with the root base, the round and back qualities of the prefix vowel remain fixed. This prefix vowel is posited underlyingly as /u-/, that is, [+round], [+back], [+high] ([+high] being the unmarked vowel height; under Hyman’s assumptions of underspecification this prefix is the archiphoneme /U-/ — specified only [+round]). Prefix vowels may also be fixed front and unrounded, as in the case of the singular class nine nominal prefix with alternants [i-, e-, ɛ-] shown in (6) (Hyman 1988:258). This prefix vowel is underlyingly /i-/ ([-round], [-back], [+high]).

(6)	Class 9	*Singular*		*Output pattern*	*Underlying*
a.	High	ì-bì	‘goat’	i - i	/i - i/
		ì-sù	‘fish’	i - u	/i - u/
b.	Mid	è-gbì	‘bushfowl’	e - i	/i - e/
		è-sù	‘hoe’	e - u	/i - o/
		è-bɨ	‘cane rat’	e - ɨ	/i - ə/
c.	Low	è-jìsi	‘hole’	ɛ - i	/i - ɛ/
		è-zù	‘snake’	ɛ - u	/i - ɔ/
		è-tlɨ̀	‘place’	ɛ - ɨ	/i - a/

A third kind of prefix vowel alternates in height at one step below the /i-/ and /u-/ prefix vowels; this kind of height alternation is termed “downstepped” by Hyman. An example occurs in the plural class 6 prefix, which exhibits alternants [o-, ɔ-/ɛ-, a-], as in (7) (Hyman 1988:259). For

comparison, forms of a singular class 3 prefix /u-/ (identical to the infinitive) on the same nouns are listed at the right.

(7) Class 3/6	*Plural (/a-/)*		*Output pattern*	*Underlying*	*Singular (/u-/)*
a. High	o-tili	‘end’	o̲ - i	/a - i̲/	u̲-tili
	ó-ku	‘death’	o̲ - u	/a - u̲/	ú̲-ku
b. Mid	ɛ́-ki	‘tail’	ɛ̲ - i	/a - e̲/	ó̲-ki
	ɔ́-tu	‘ear’	ɔ̲ - u	/a - o̲/	ó̲-tu
	ɔ-tɨ	‘spear’	ɔ̲ - ɨ	/a - ə̲/	o̲-tɨ
c. Low	a-simi	‘grain’	a̲ - i	/a - ɛ̲/	ɔ̲-simi
	á-bu	‘hand’	a̲ - u	/a - ɔ̲/	ɔ̲́-bu
	á-bɨ	‘broom’	a̲ - ɨ	/a - a̲/	ɔ̲́-bɨ

The downstepped prefix vowel is analytically problematic: it raises questions about how to capture scalar height effects and about the height of [a] in relation to the other low vowels. It also presents unexpected rounding and backness alternations (compare /a-/→[o] conditioned by root vowel /i/ with /a-/→[ɛ] conditioned by /e/). Downstepping in Esimbi is discussed by Hyman (1988) and Clements (1991), and it will not be the subject of analysis here. I will simply characterize this prefix vowel as /a-/, a vowel bearing a height downstepping property; in Hyman’s analysis, this vowel has a [-ATR] specification that depresses vowel height.

To review, we have seen that prefix vowels come with one of three sets of fixed properties, corresponding to the underlying forms /i-, u-, a-/, and height variation is conditioned by the root. The underlying representations that have been posited attribute the height variations to a transfer of height from root to prefix. Yet it is also conceivable to claim that the prefix height alternations are not due to a phonological property of the root; the lexical entry for each root could instead contain a listing for each prefix notating the associated prefix form. However, this approach is not adequate for the data. Importantly, the height of prefix vowels attaching to a given root is not random: it is consistent across prefixes. This is illustrated in (8) with the singular and plural class 7/8 prefixes (Stallcup 1980b:142). The same kind of generalization across regular and downstepped prefixes can be seen in comparison of the singular and plural forms in (7), where the plural is predictably downstepped by one level from the singular.

(8) Class 7/8	*Singular*	*Plural*		*Underlying*
a. High	ki̲-ku	bi̲-ku	‘bone’	/i-u/
b. Mid	ke̲-hɨ	be̲-hɨ	‘bundle’	/i-ə/
c. Low	kɛ̲̀-sɨ̌	bɛ̲̀-sɨ̌	‘comb’	/i-a/

The conclusion that may be drawn from the uniformity of prefix vowel height for each root is that prefix height is a synchronic phonological property of the root that is transferred to the prefix; unlike spreading, height actually shifts from one vowel to another. Roots then distinguish three levels of vowel height in underlying representations, corresponding to the three levels of height exhibited in prefix alternations. Prefix vowels contribute an inherent two-way property influencing height: high (/i-/, /u-/) versus downstepped (/a-/), which determines whether the prefix alternates at the regular or downstepped level. Assuming full specification and binary features, I have posited the higher prefix vowels as [+high]. Other theories of vowel height features or underspecification may handle this specification somewhat differently, but this is not crucial to the main analytical points of this paper.

The transfer of height features from root to prefix is expressed schematically in (9). This informally illustrates the descriptive generalization which has been determined (after Stallcup 1980a,b; Hyman 1988).

(9) /V - C V/ → [V - C V]
| |
[αhigh] [αhigh]

Diachronic evidence supplies further support for a height transfer, showing that underlying root vowel height contrasts once actually appeared in the root (Hyman 1988:257).

(10)	*Proto-Bantu*	*Surface Esimbi*	*Esimbi underlying*
	*bá-	ɔ́-mɨ ‘to be’	/ú-ma/
	*táŋg-	ɔ-tɨŋɨ ‘to count’	/u-taŋa/
	*gàb-	ɔ-gɨbɨ ‘to divide’	/u-gaba/

Upon synchronic transfer of vowel height, root vowels in Esimbi are neutralized to high. They retain their underlying backness and rounding specification, as summarized in (11) for infinitive forms. Note that the occurrence of only mid and low prefix vowels with the root surface vowel [ɨ] indicates that underlying central vowels are only mid and low.

(11) *Neutralization of root vowel height*

a.	Front	/u-ri/ →	[u-ri]	‘eat’
		/u-se/ →	[o-si]	‘laugh’
		/u-rɛ/ →	[ɔ-ri]	‘daub’
b.	Central	/u-dzə/ →	[o-dzɨ]	‘steal’
		/u-ba/ →	[ɔ-bɨ]	‘come’
c.	Back	/u-zu/ →	[u-zu]	‘kill’
		/u-to/ →	[o-tu]	‘insult’
		/u-hɔ/ →	[ɔ-hu]	‘knead’

The resulting underlying root inventory contains three heights (eight vowels), as anticipated in (3). Comparing this to the reduced inventory for prefixes (high and downstepping, three vowels), it is apparent that the generalization that roots exhibit at least as many contrasts as affixes is maintained in the description of underlying forms of Esimbi. The next section explores why height is transferred from root to affix to give a different output distribution.

2 Analysis of Feature Transfer

I formalize the analysis in the constraint-based framework of Optimality Theory (OT; see Prince and Smolensky 1993). I assume a basic familiarity with the underpinnings of OT and its formalisms as well as the relational approach to faithfulness known as Correspondence Theory (McCarthy and Prince 1995).

2.1 Featural Faith Independent of Sponsoring Segments

Esimbi height feature transfer has implications for the kinds of featural faith constraints needed in OT. Because vowel height features originate in the root but surface in the prefix, it presents a case

in which features are maintained in the output independent of their input-affiliated segments. In Correspondence Theory, featural faith is usually captured with IDENT[Feature] constraints, formulated as in (12), relating a string S_1 (an input) to S_2 (an output) (McCarthy and Prince 1995:264). Following Pater (in press), I assume IDENT can also be differentiated into [+F] and [-F] versions for the same feature.

(12) IDENT[F]: Let α be a segment in S_1 and β be any correspondent of α in S_2. If α is [γF], then β is [γF]. (Correspondent segments are identical in feature F.)

IDENT[F] does not posit a correspondence relation between input and output features themselves but rather evaluates the faithfulness of featural properties of input and output segment correspondents. This model of featural faith reflects the typical dependency of features on their input segment sponsors. Interestingly, the preservation of Esimbi root height features by transfer to a prefix vowel cannot be captured directly with this kind of constraint.

The problem is illustrated in (13). Let us assume that an undominated constraint requires that marked vowel height features occur only in the initial syllable (the precise nature of this constraint will be examined in the next section). Marked height is characterized descriptively as [-high], independent of specific theories of vowel height features which are not the concern here. Because of the undominated positional constraint on marked height features, a [-high] feature specification originating in a prefixed root cannot surface on its input sponsoring segment. The [-high] feature specification could either be transferred to the initial syllable (13a) or it could be lost altogether (13b). Candidate (a), which preserves but displaces the underlying root vowel height, is the one that wins in Esimbi (marked by the hand pointing to the right); however, IDENT constraints select candidate (b) instead (marked by the left-pointing hand). Since (b) incurs a subset of the violations that (a) does, no reranking of IDENT constraints will select (a) over (b).

(13) IDENT[F] cannot drive feature preservation under transfer

V - C V [+hi] **[-hi]**	IDENT[-high]	IDENT[+high]
a. ☞ V - C V **[-hi]** [+hi]	*	*!
b. ☜ V - C V [+hi] [+hi]	*	

IDENT[F] fails to capture the feature transfer because it evaluates featural faith in terms of identity of correspondent segments. Losing a root feature specification incurs one IDENT violation, but moving that specification to a prefix at the cost of the underlying prefix vowel specification, incurs two violations, one for the root vowel and one for the prefix.

IDENT[F] constraints cannot be rescued here by positing violations of UNIFORMITY, which penalizes output segments with multiple input correspondents (McCarthy and Prince 1995:371). Under this approach, the output prefix vowel is placed in correspondence with the input root vowel, explaining the transferred [-high] feature by a relation between its originating and output positions. Yet we have seen that the prefix vowel retains rounding and backness features of its own, as does the root vowel. This gives the relational structure in (14a), where the output prefix vowel must correspond with the input prefix vowel and root vowel, and the output root vowel must correspond to the input root vowel (subscripted numbers mark correspondents). Comparing (14b), which uniformly posits root vowel in correspondence with root vowel and prefix with prefix, it is apparent that again the winning outcome eliminates rather than transfers the root height feature.

(14) IDENT[F] fails under multiple correspondence

V_1 - C V_2 [+hi] **[-hi]**	IDENT[-high]	UNIFORMITY	IDENT[+high]
a. ☞ $V_{1,2}$ - C V_2 **[-hi]** [+hi]	*	*(!)	*(!)
b. ☜ V_1 - C V_2 [+hi] [+hi]	*		

In the situation presented in (14), IDENT[-high] is relevant for output correspondents of the root vowel. Since the input root vowel is still in a correspondence relation with the surface root vowel, a violation is incurred by both output candidates for the [+high] root vowel. The multiple correspondence posited in candidate (a) thus fails to resolve the problem in (13), because it does not incur fewer violations of IDENT[-high]. Candidate (14a) loses on the basis of a violation of either UNIFORMITY or IDENT[+high]. No reranking of the constraints can cause (a) to come out as the winner — this is an undesirable result.

The problem presented by IDENT for Esimbi calls for a re-examination of the level at which faith for transferred features is evaluated. In the Esimbi height shift, it is the root height feature itself that must be retained in the output, even under transfer to another segment. This kind of faithfulness relation is expressed by MAX[F], which evaluates correspondence between features directly (extending the segmental MAX family of constraints proposed by McCarthy and Prince 1995:264).

(15) MAX-IO[γF]: Every occurrence of a feature specification [γF] in the input has a correspondent in the output.

McCarthy and Prince (1995:265) anticipate that floating feature phenomena may require extending the correspondence relation to features. Other cases used to argue for this kind of featural correspondence relation are discussed by Lombardi (1995, 1998) and Causley (1996) (see also Lamontagne and Rice 1995).[3]

MAX[-high] straightforwardly expresses the demand of retaining [-high] in the output for the kind of input we have been considering. In (16) notice that [-high] feature specifications are now themselves marked as correspondents. Candidate (a) respects MAX[-high] by shifting but preserving the feature specification, while (b) violates MAX by losing [-high] entirely; this achieves the desired outcome.

(16) MAX[-high] correctly selects output with transferred feature

V - C V [+hi] **[-hi]**$_1$	MAX[-high]
a. ☞ V - C V **[-hi]**$_1$ [+hi]	
b. V - C V [+hi] [+hi]	*!

Esimbi feature transfer thus provides a clear case in which a MAX[F] formulation is required and IDENT[F] constraints are insufficient; it is a case where satisfying featural correspondence is more important than satisfying featural identity of segment correspondents.

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[3] Additional work related to this issue includes Akinlabi (1996) on featural affixes. It should also be noted that the framework of Optimal Domains Theory (Cole and Kisseberth 1994) admits faithfulness to features independent of their sponsoring segment in the input, though this framework departs from the standard autosegmental theory assumed here.

2.2 Height Displacement as Positional Markedness

The next question to examine is what motivates the height displacement from the root to the prefix vowel. The vowel height shift moves marked height features to the word-initial syllable. This parallels other phenomena which restrict marked phonological structure to a "strong" or privileged position, such as the initial syllable (for studies of such effects and discussion of the basis for linguistic positional privilege, see Steriade 1995; Beckman 1997, 1998; Zoll 1996, 1998). I propose to characterize the positional restriction in Esimbi with a licensing constraint. Informally, this constraint demands the requirement in (17).

(17) LICENSE ([-high], σ_1): [-high] must be linked to the first syllable.

The licensing constraint in (17) is a context-specific markedness constraint. It can be expressed more formally as a constraint of the COINCIDE family, after Zoll (1996, 1998):

(18) COINCIDE ([-high], Leftmost(σ, word)):
$\forall x$ (x = [-high] $\rightarrow \exists y$ (y = Leftmost(σ, word) $\wedge$ Coincide (x, y))).
Coincide (x, y) is true iff y dominates x or x dominates y.

This constraint requires of all [-high] feature specifications in a representation that they coincide with the leftmost (initial) syllable of a word. The relation *coincide* holds between two elements if one element dominates the other. For our purposes, the relevant structure satisfying coincidence will be one in which the first syllable dominates the [-high] feature.[4]

Together with a MAX[F] constraint, licensing causes marked height features to migrate to the initial syllable. This is illustrated in (19). The input in this tableau contains a high prefix vowel and a root vowel with marked height. The winning candidate in (a) shifts the marked height feature to the initial syllable, satisfying both licensing and MAX[-high]. The alternative in (b), which fails to shift the marked height, loses on a violation of licensing, and (c), which eliminates the input root height feature, loses on MAX.

(19) Marked vowel height transfer to the initial syllable

V - C V [+hi] **[-hi]$_1$**	LICENSE ([-hi], σ_1)	MAX[-high]
a. ☞ **[-hi]$_1$** [+hi]		
b. [+hi] **[-hi]$_1$**	*!	
c. [+hi] [+hi]		*!

Interestingly, the licensing effect in Esimbi is one of Positional Markedness and not one of Positional Faith, that is, it can be captured with only one of the two major approaches to capturing positional limitations on feature distribution in OT. Crucially, the licensing constraint must express a condition on the position in which marked phonological structure may occur in the output, independent of where this structure occurs in the input. This is the Positional Markedness approach developed by Zoll (1996, 1998). An alternative context-specific faithfulness constraint for the initial licensing position enforcing correspondence (or identity) of elements in the initial syllable (after Beckman 1997, 1998) will not be sufficient, since the licensed height feature does

[4] This licensing effect could also conceivably be formulated as an alignment constraint requiring that all [-high] specifications be aligned with the first syllable. However, on the basis of licensing effects for which alignment is inadequate, Zoll argues that COINCIDE constraints express the appropriate requirement for context-specific markedness.

not originate in the initial syllable. Positional Faithfulness thus cannot express the necessary requirement in this case.

With initial-syllable licensing driving the vowel height shift, it emerges that marked height is not a special property of prefixes per se, but rather it is drawn to the initial position, regardless of whether it falls in a root or prefix. This raises the question of what takes place in unprefixed forms. The occurrence of unprefixed roots in Esimbi words is rare, but Stallcup (personal communication) notes a few forms in the native vocabulary which exceptionally occur without a singular prefix. Some examples are given in (20).

(20) *Singular class 1/2*

bamɨ	'lake'
gwɔgu	'duck'

The exceptional roots in Stallcup's sample are not fully understood, as they behave in unusual ways in various inflectional classes. However, the unprefixed forms are consistent with the licensing analysis in that they exhibit marked vowel height in the initial syllable and high vowels noninitially.[5]

2.3 Root Faith versus Affix Faith

The status of the Root-Affix Faithfulness Metaconstraint proposed by McCarthy and Prince (1994, 1995) may now be evaluated in relation to the outputs of Esimbi. OT takes the position that cross-language variation results strictly from permuted rankings of a universal set of constraints — it does not derive from different sets of inputs. An important consequence of this is the principle of Richness of the Base (Prince and Smolensky 1993:191), which hypothesizes that all inputs are possible. The constraint hierarchy for a language must thus produce a grammatical output for any input, even if it contains structures that never surface in the language. Given this assumption, we must ensure that the analysis produces grammatical outputs for Esimbi for any input root and prefix vowel height specifications.[6]

As discussed in section 1, McCarthy and Prince propose a universal fixed ranking of Root Faith over Affix Faith. We will see that this metaconstraint is respected in Esimbi and actually plays a critical role in explaining output forms. The relevant ranking is given in (21). For ease of exposition, I use [height] to refer to any specification of vowel height features (e.g. [±high]).

(21) MAX-ROOT[height] >> MAX-AFFIX[height]

The ranking in (21) derives the result that root height features are maintained at the cost of prefix ones, for example, when a root height feature shifts to the initial syllable, any counterpart feature specification in the input form of the prefix will be lost. Note that the availability of root versus affix affiliation in output forms as well as inputs follows from the well-established principle of

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[5] A phenomenon distinct from licensing but connected to the height shift emerges in multiply-prefixed forms. No data with multiple prefixes are supplied in the sources, although according to Hyman (personal communication), such forms do occur in Esimbi. Hyman reports that in these forms, each of the prefixes displays the underlying root vowel height — not just the first prefix. If initial-syllable licensing were the only factor in vowel height realization, this distribution would be unexpected, as root vowel height should only occur in the initial syllable of the word. The form of vowels in noninitial prefixes of multiply-prefixed forms can be understood as a kind of paradigm uniformity effect, that is, for a given root, the form of each prefix it takes remains consistent. Paradigm uniformity effects can be captured with output-output constraints (see Benua 1995; McCarthy 1995; cf. Burzio 1997, also Kenstowicz 1995 on Uniform Exponence); however, a detailed account of the postinitial prefixes is beyond the scope of this paper.

[6] Of course, given Lexicon Optimization (Prince and Smolensky 1993:192), not all possible inputs for a given output will correspond to the underlying representations the learner actually posits, but this is a separate matter.

Consistency of Exponence (McCarthy and Prince 1993:20), which states that no changes in the exponence of a phonologically-specified morpheme are permitted. Taking into consideration MAX violations for any vowel height, licensing and MAX-ROOT[height] both force violations of affix faithfulness. This is shown in (22) for a hypothetical input with a [-high] root vowel and a [+high] prefix vowel.

(22) LICENSE ([-high], σ_1), MAX-ROOT[height] >> MAX-AFFIX[height]

V - C V $[+hi]_1$ **$[-hi]_2$**	LICENSE([-hi], σ_1)	MAX-RT[height]	MAX-AFX[height]
a. ☞ **$[-hi]_2$** $[+hi]_3$			*
b. $[+hi]_1$ $[+hi]_3$		*!	
c. $[+hi]_1$ **$[-hi]_2$**	*!		

Here I assume that the [+high] (default) specification in the output root vowel is not transferred from the prefix vowel, but is the product of featural epenthesis, as indicated by the indexing $[+high]_3$. Featural epenthesis (incurring a violation of DEP[+high]) is required in any case to handle inputs in which both the prefix and root vowel are [-high]. Further, although feature displacement is possible (for example, when driven by licensing), features do not freely scramble from input to output. With direct correspondence of features, this can be constrained by LINEARITY (McCarthy and Prince 1995:371), which enforces consistency of precedence structure in input and output.

In the case of polysyllabic roots the question arises which root vowel determines the prefix height — all root vowels are neutralized to [+high] in the output, for example, o-jihiri 'learn', o-juwuru 'hear', o-nɨmɨnɨ 'think'. There is insufficient data to conclusively identify the originating vowel for the transferred height feature, but cross-linguistic evidence of Positional Faithfulness offers insight on this point (Beckman 1997, 1998). Beckman proposes that faith constraints may be context-specific, placing greater demands on faith in linguistically-privileged positions. She argues that one such privileged position is the root-initial syllable; a MAX constraint, which requires that every element of S_1 has a correspondent in S_2, can thus be rendered positionally sensitive by placing a root-initial syllable restriction on S_1 and/or S_2. Beckman (1998:212, fn. 2) notes that while syllabification in S_1 is available in output-output correspondence, it presumably is not in the case of input-output relations. However, it is reasonable to suppose that root-initial syllable strength is part of a more general phenomenon of privilege attributed to root-first elements. With this extension, it is possible to formulate a positional MAX constraint requiring that a vowel-height feature appearing in root-initial position in the input has a correspondent feature in the output: MAX-$ROOT_1$[height]. The root-initial status of the first vowel feature is supported by the work of Öhman (1966), who finds that consonantal articulations are constrictions imposed on a score of vowel gestures. Ranking MAX-$ROOT_1$[height] over the more general constraint, MAX-ROOT[height] yields an outcome in which the first height feature of the root is preserved over postinitial height features. On this basis, I tentatively posit the first root height feature as the one that shifts to the prefix.[7]

[7] Esimbi root vowels exhibit neutralization beyond just vowel height. Hyman (1988:256) notes that all vowels in a root are identical, that is, in addition to all surfacing as [+high], they agree in color (rounding and backness). The height neutralization is explained by initial licensing, but vowel color does not shift from the root. Agreement for rounding and backness may be attributed to a vowel color harmony in the root, as also seen, for example, in Turkish.

3 Markedness and Inputs Containing High Root Vowels

So far only inputs with high prefix vowels and marked height in the root have been considered. I turn now to forms in which the root vowel is [+high] in the input. Since [+high] is not a marked feature specification in need of licensing, we must explain why prefix vowels are always high when the root vowel is underlyingly high. That is, why does an input such as that in (23) with a [-high] specification in the prefix come out with two high vowels rather than with a completely faithful output? Assuming Richness of the Base, inputs such as this must be accounted for. I propose that in these forms the prefix vowel comes out as [+high] in order to satisfy a markedness constraint, *[-high]. Ranking this constraint above MAX-AFFIX[height] results in the loss of [-high] affix features.[8]

(23) *[-high] >> MAX-AFFIX[height]

V - C V **[-hi]$_1$** [+hi]$_2$	LIC([-hi], σ_1)	MAX-RT [height]	*[-high]	MAX-AFX [height]
a. ☞ [+hi]$_3$ [+hi]$_2$				*
b. **[-hi]$_1$** [+hi]$_2$			*!	

*[-high] must itself be outranked by root faith to derive the shift rather than deletion of marked features originating in the root. Comparing (24) to (23) shows unambiguously that Root and Affix Faith must be differentiated. A single MAX constraint is insufficient to produce different outcomes for marked height features deriving from roots versus prefixes.

(24) MAX-ROOT[height] >> *[-high]

V - C V [+hi]$_1$ **[-hi]$_2$**	LIC([-hi], σ_1)	MAX-RT [height]	*[-high]	MAX-AFX [height]
a. ☞ **[-hi]$_2$** [+hi]$_3$			*	*
b. [+hi]$_1$ [+hi]$_3$		*!		

This analysis finds that prefix agreement with input root vowel height is achieved by feature transfer when root height is marked ([-high]) and by default agreement when root height is unmarked ([+high]). A conceivable alternative would be to seek an analysis positing initial linkage of the height feature in both cases. For example, another approach to handling a [-high] prefix and [+high] root input (see (23)) could aim to produce linkage of the [+high] root feature to both root and prefix vowel in the output rather than having separate [+high] specifications on each vowel. However, I assume this representation is not optimal, because it violates a featural tautosyllabicity constraint, TAUTSYLL[height], which prohibits linkage of height features across syllables (after Walker 1997 extending the notion of Crisp Edges of Itô and Mester (in press); Merchant (1995)). If multiply-linked height features were permitted, so that a feature could at once be licensed by membership to the initial syllable and also belong to its underlying root segment, then [-high] specifications would also be expected to appear in both prefix and root vowels in the output — a false prediction. The elimination of this outcome is illustrated in (25).[9] Satisfaction of featural tautosyllabicity is at the cost of DEP[+high] (violated by the epenthesized feature).

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[8] I assume that *[-high] does not eliminate the height-depressing property of the downstepping prefix vowel. This is consistent with Hyman's analysis of this vowel as [-ATR].

[9] Tautosyllabicity constraints for other features may be ranked separately. For example, color harmony for vowels in the root will produce violations of TAUTSYLL for backness and rounding features.

(25) TAUT-SYLL[height] >> DEP[+high]

V - C V [+hi]$_1$ **[-hi]$_2$**	TAUT-SYLL[height]	DEP[+high]
a. ☞ **[-hi]$_2$** [+hi]$_3$		*
b. V C V \ / **[-hi]$_2$**	*!	

A related point concerns the material requiring initial licensing. The constraint in (17) expresses a licensing requirement for [-high] only. If an active licensing effect were instead posited to drive shift of *all* height feature specifications, the resulting predictions would be problematic. Because root vowels in Esimbi always come out as [+high], there is no licensing distribution in evidence for [+high]. Otherwise an input [-high] root feature would not shift to the prefix, as the output high root vowel would still fail on licensing. This is illustrated in (26) replacing LICENSE(*[-high]*, σ_1) with LICENSE(*[height]*, σ_1).

(26) LICENSE (*[height]*, σ_1) produces wrong result

V - C V [+hi]$_1$ **[-hi]$_2$**	LIC([height], σ_1)	MAX-RT[height]	MAX-AFX[height]
a. ☞ **[-hi]$_2$** [+hi]$_3$	*		*!
b. ☜ [+hi]$_1$ **[-hi]$_2$**	*		

Both of the candidates in (26) incur a licensing violation. Candidate (a) is the desired winner, but it loses to the completely faithful rival in (b) by virtue of a MAX violation. A problem will also arise for inputs of the form /[-high] - [+high]/ which will map faithfully to the output under the constraints in (26). The correct outcome for these forms, [[+high] - [+high]], is obtained with the markedness constraint *[-high], as was shown in (23).

4 Conclusions and Further Research

To conclude, a summary of the constraint structure needed for the transfer of vowel height in Esimbi is given in (27).

(27) *Summary of rankings*
- a. Faith: MAX-ROOT[height] >> *[-high] >> MAX-AFFIX[height], DEP[+high]
- b. Licensing: LICENSE([-high, σ_1) >> MAX-AFFIX[height], DEP[+high]
- c. Tautosyllabicity: TAUT-SYLL[height] >> DEP[+high]

Underlying the constraints and their rankings are three key points of theoretical interest. First, Esimbi respects the Root-Affix Faithfulness Metaconstraint, although it at first appears to counter-exemplify this generalization; in fact, the ranking of MAX-ROOT[height] over MAX-AFFIX[height] ranking plays a crucial role in the analysis. Second, Esimbi vowel height transfer requires a MAX[F] formulation of featural faith — IDENT[F] is insufficient to characterize this phenomenon. And third, the shift of height features in Esimbi from one vowel in the input to another in the output finds support for formal Positional Markedness constraints as a means of characterizing positional neutralization or licensing effects; this kind of transfer cannot be captured with Positional Faithfulness.

This discussion has focused on the kind of analysis required for featural faith and licensing in the Esimbi height transfer. From a broader theoretical perspective these findings contribute to the continuing investigation into the characterization of these kinds of phenomena. Esimbi shows

that features can behave autonomously, providing an argument for extending the correspondence relation to features; however why nontonal features do not consistently exhibit the same range of segment-independent processes as tonal features remains to be fully understood. The more common segment-bound patterning of features motivates the IDENT formulation of featural faith, but we have seen that this is not sufficient for the full range of featural behavior. Other work on featural correspondence has identified links between the mobile patterning of features and certain kinds of events. For example, Causley (1996) and Lamontagne and Rice (1995) establish a connection between coalescence and the need for a correspondence view of features, that is, correspondence between features is required when a segment is deleted but some of its features are preserved. In a related discovery, Lombardi (1998) finds that MAX[F] constraints are needed to obtain an opaque postnasal voicing effect in Japanese; in derivational terms this is a situation where a velar stop which is deleted (or surfaces as a glide) passes through an intermediate stage as a nasal and thereby triggers voicing on a following segment. The preservation of [voice] from the deleted (or transformed) stop by transfer to the following segment drives the requirement for direct correspondence between features.

Esimbi exemplifies a rather different case. In this instance, a feature is transferred even though the basic character of the segment on which it originates does not change in the output (it remains vocalic). Here the feature transfer is driven not by deletion but by context-specific markedness which prohibits the feature from remaining in its original position. In Esimbi, we thus find a connection between the autosegmental status of marked height features and the demand of Positional Markedness, that is, it appears that the MAX[F] over IDENT[F] ranking status for height is linked in some way to the status of Positional Markedness over Positional Faith. The interesting direction for future research is then to explore how the correlations between feature mobility and certain phenomena are to be reflected formally in Universal Grammar while still capturing the usual segment-bound patterning of features.

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