YORUBA VOWEL PATTERNS:
DERIVING ASYMMETRIES BY THE TENSION BETWEEN OPPOSING CONSTRAINTS

Douglas Pulleyblank
University of British Columbia

1 Introduction

It is frequently the case that phonological patterns exhibit asymmetric properties with respect to their featural content. Such asymmetries may involve a variety of properties including *stability*, *level of activity*, *nature of assimilatory target*, *nature of assimilatory trigger*, and *nature of epenthetic segment*. Consider examples of these properties briefly. With regard to stability, it may be the case, for example, that high tones are stable under deletion while nonhigh tones are not (e.g. Pulleyblank 1986), or that nasality is stable while orality is not (e.g. Prunet 1986). Some features may play an *active* role in the phonology, while a second feature may be relatively or completely *inert*. For example, some tongue root harmony systems exhibit active advancement (ATR) while others exhibit active retraction (RTR) (Archangeli & Pulleyblank 1994). Recurrent patterns where one segment type acts as the *target* of assimilation and another acts as the *trigger* are attested. For example, coronals are frequently observed to function as assimilation targets while noncoronals frequently function as assimilation triggers (Paradis & Prunet 1991). As a final example, certain features may more typically characterise *epenthetic* segments (Archangeli 1988): high vowels may be more frequently epenthesised than mid, front more frequently than back, oral more frequently than nasal, and so on.

Patterns of asymmetry have been encoded in different ways, dependent in part on their frequency of occurrence cross-linguistically, and hence on a hypothesised degree of universality. In some cases, the asymmetry may be so pervasive both within and across languages that it can be built into the structure of the featural representation. For example, Steriade (1995) suggests that the recurrent inertness of features such as orality, non-spread glottis, and non-constricted glottis warrants the postulation of monovalent features NASAL, SPREAD GLOTTIS and CONSTRICTED GLOTTIS. In general, work on privative features (e.g. Anderson & Ewen 1987, van der Hulst 1989, etc.) encodes a certain class of asymmetric properties intrinsically. The opposite end of the spectrum is to encode asymmetric properties into process-specific rules. In its least elaborated form, encoding featural behaviour as rule conditions amounts to the claim that there are no systematic asymmetric patterns at all. If a particular feature or segment recurs as a conditioning factor in multiple rules within or across languages, this is treated as accidental.

While appropriate for certain cases, neither extreme approach appears adequate as a general theory of asymmetric behaviour. In numerous cases, asymmetric behaviour cannot be reduced to structural considerations. Consider the example of tongue root effects mentioned above. Some languages exhibit dominant ATR and recessive RTR (a typical Nilotic pattern; see, for example, Levergood (1984) on Maasai, and Hall & Yokwe (1978) on Bari); other languages exhibit dominant retraction and recessive advancement (see, for example, Hall & Hall (1980) on Nez Perce (Sahaptian) and Doak (1992) on Coeur d'Alene (Salish)). Even if it turns out that advancement and retraction harmony exhibit somewhat different properties (see Goad (1993), but compare Leitch (1996)), languages clearly differ in their overall organisation of tongue root features. In general terms, structural encoding in terms of privative features is possible only in cases of absolute asymmetry. That is, monovalency is possible only if one value is always referred to and the other value is never referred to. In numerous attested cases, however, there are asymmetric patterns of a less absolute type. One value may be more frequently referred to within or across languages, but the other value can be referenced.

The case to be considered in this paper is of such a nonabsolute type. In Yoruba, a complex array of vocalic patterns are attested. Pulleyblank (1988) argues that high vowels in general and [i] in particular exhibit a special array of properties. For example, certain rules of assimilation and deletion are triggered by all vowels *except high vowels*. Other rules of assimilation target *only high vowels*. In loan vocabulary, [i] is the epenthetic vowel in non-assimilatory contexts. In Yoruba, as in numerous other cases in the literature, the recurrence of a particular feature as a conditioning or nonconditioning factor in various processes can be interpreted as an argument in favour of *underspecified* representations (Pulleyblank 1988). If [–high], [+back], etc. are structurally present in Yoruba vowels, but [+high] and [–back] are not, then the cited facts receive an explanation. When assimilation fails to be triggered by [i], this is due to the absence of features specified for that vowel. When only [i] is targeted by a rule, this is because the rule is structure-building, not structure-changing. The epenthesis of [i] is analysed as syllabically-motivated insertion of a featureless prosodic vowel.

Although such a case can be explained through language-specific underspecification, it is not readily interpreted as involving monovalency as the cross-linguistic evidence seems to point towards positing [+high] as the active value, not [–high] (see Steriade 1995 for discussion). Moreover, as Steriade (1995) also points out, there are numerous reasons within Yoruba itself for referring to [+high]: Clements & Ṣonaiya (1990) argue that a rule of *L Nasalisation* makes crucial reference to [+high], as does a Morpheme Structure Constraint; Akinlabi (1993) makes a similar argument for a rule of *r*-deletion; moreover, as seen below, the behaviour of word-initial *u*- in various dialects makes similar reference. Such patterns that reference [+high] are incompatible with an underspecified analysis of the Yoruba vowel system. Note in particular that certain rules requiring reference to [+high] apply very early (e.g. as a morpheme structure condition) while certain rules behaving asymmetrically apply very late (e.g. a rule of vowel deletion that crosses word boundaries). The apparent conflict in behaviour cannot be resolved, therefore, by assuming an early stage of underspecification followed by a subsequent stage of more complete specification.

It is important to consider the global consequences of the arguments that Clements & Ṣonaiya and Akinlabi demonstrate for an underspecified account of Yoruba. The basic observation behind the underspecification proposal is that high vowels in general and the vowel [i] in particular show an array of special properties. Underspecification in the Yoruba vowel system was proposed in an attempt to explain these properties. Two sorts of problems with such a proposal could be imagined. On the one hand, it might be demonstrated that the generalisation is wrong, that high vowels and [i] are not special. Such a demonstration would argue that an asymmetric approach to Yoruba is wrong-headed because the vowel system is not asymmetric. On the other hand, the basic generalisation might be correct, but the underspecified analysis could be inadequate. It is the latter case that has been argued. Significantly, although arguing against the underspecification of [+high], both the paper by Clements & Ṣonaiya and the paper by Akinlabi reinforce the asymmetric nature of high vowels, each presenting additional data of a special asymmetric nature. If we accept their arguments, it becomes even more important therefore to find a theoretical account that can satisfactorily account for the asymmetries in the Yoruba vowel system.

This paper discusses three possible analyses for Yoruba. First, it lays out the possibility that there are no special asymmetries at all, that the particular properties of any individual construction are due to idiosyncratic properties of individual rules. Second it examines the possibility that asymmetries are significant and due to a structural property such as underspecification (Pulleyblank 1988). Third, it explores the possibility that asymmetric behaviour results from the relative ranking of constraints (Prince & Smolensky 1993, Smolensky 1993). That is, the special properties of high vowels result not from structural encoding, but from the ranking of constraints on high vowels above and below constraints implicated in particular constructions.

The paper is structured as follows. First, the core elements of all three analytic possibilities are presented. The core analysis is then extended to additional patterns. It is shown that both rule-governed and underspecified accounts require special stipulations of an ad hoc nature as additional constructions are considered, where the constraint-based approach does not. The general conclusion is that a constraint-based approach resolves the problems raised by the analyses of Clements & Ṣonaiya and Akinlabi, as well as other problems intrinsic to the proposal of underspecification. The paper therefore constitutes an argument in favour of the encoding of asymmetries in a constraint grammar rather than in elaborated structures.

2 The analytic core: regressive and progressive assimilation

To illustrate the sort of asymmetry observed in Yoruba, and to sketch the basic analytic possibilities, I begin by considering patterns of feature assimilation that occur when two vowels are brought into contact with each other in a noun phrase.[1] Canonical nouns of Yoruba are *VCV* in structure. There is a genitive construction, “N of N”, where two nouns occur without any overt intervening genitival marker, making it possible to observe a sequence of adjacent vowels. In this configuration, it is typical for assimilation to cause the $\ldots V_1\ ][V_2\ldots$ sequence to surface as a sequence of identical vowels.

[1] These data have been discussed in some detail in the literature; the reader is referred to work such as Awobuluyi (1978), Pulleyblank (1988), Awoyale (to appear), for additional examples and discussion.

Where the second vowel (V_2) in the sequence is nonhigh, it will normally prevail in such a situation, resulting in a *…V_2][V_2…*surface pattern.[2]

(1) *Regressive feature assimilation in Standard Yoruba; the second vowel is nonhigh*

..NONHI] [NONHI..	a. owó Adé	[owó adé]	[owáadé]	'money of Ade'
	b. owó epo	[owó ekpo]	[owéekpo]	'money of oil'
	c. ẹ̀bá odò	[ɛ̀bá odò]	[ɛ̀bóodò]	'near the river'
..HI] [NONHI..	d. omi ẹran	[omĩ ɛrã]	[omɛ̃ɛ̃rã]	'water of meat'

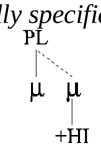
In contrast, when the second vowel is high, then it is replaced by the preceding vowel.

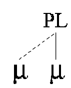
(2) *Progressive feature assimilation in Standard Yoruba; the second vowel is nonhigh*

..NONHI] [HI FRONT..	a. ilé iṣẹ́	[ilé iʃɛ́]	[ilééʃɛ́]	'place of work'
..HI BACK] [HI FRONT..	b. ẹrù igi	[ɛrù igi]	[ɛrùugi]	'bundle of wood'

These patterns are straightforwardly captured in rule-based accounts. If fully specified vowels are assumed, then a pair of rules can be posited. The first rule spreads vocalic place features progressively, under the specific condition that the second vowel in the sequence be [+high]; the second, more general, rule spreads vocalic place features regressively.

(3) *Rule-based approach, fully specified vowels*

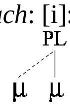
a. Progressive Spread:


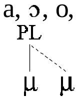
b. Regressive Spread:
(the elsewhere case)


By applying the specific rule before the general rule, the correct pattern is obtained. No specific prosodic structure or feature-hierarchical structure is crucial.

If underspecified vowels are assumed, then two rules are still required but the actual formulation of the rules is simplified.

(4) *Underspecification approach*: [i]: unspecified for PLACE vs. [e, ɛ, a, ɔ, o, u]: specified for PLACE

a. Regressive Spread:


b. Progressive Spread:
(the elsewhere case)


Regressive Spread now applies first, but fails to apply when V_2 is [i] since [i] has no place specifications. Progressive Spread applies only in those cases (namely with [i]) where Progressive Spread fails.

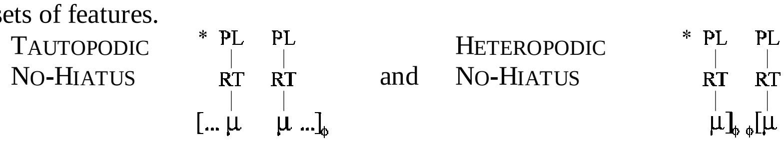
While the rule-based accounts, with or without underspecification, succeed in terms of descriptive adequacy, they fail in terms of explanatory adequacy. Principally, they provide no motivation for the occurrence of rule application, and they provide no explanation for why the rules apply in a pair. Although the rules of assimilation are optional, applying in casual speech, they must either both apply or both not apply. For example, in the fully specified account, if Progressive Spread did not apply (due to its optionality) but Regressive Spread did apply, then an ungrammatical form such as *[ilíiʃɛ́] could be derived for 'place of work' (2a). In the underspecified account, ungrammatical forms could also surface by allowing Regressive Spread to not apply (optionally) and then applying Progressive Spread; *[owóokpo] 'money of oil' (1b) is an example.

To search for a solution to these problems is a prerequisite to an analysis of assimilation in Optimality Theory. Unless pressure against the retention of an intact *…V_1][V_2…*pattern is identified, faithfulness constraints would require that input vowel sequences also appear in the output. It is proposed here that the observed alternations are driven by pressure to avoid sequences of vowels, that is, by the pressure to avoid instances of vowel hiatus (McCarthy 1993). Having a sequence of two nonidentical vowels requires resetting of the articulators when moving

[2] Yoruba data are presented in standard orthography as well as in a broad phonetic transcription. Relevant orthographic conventions are as follows: *ẹ* = [ɛ], *ọ* = [ɔ], *Vn* = nasalised vowel, *ṣ* = [ʃ], *p* = [k͡p], acute (´) = H, grave (`) = L, unmarked for tone = M.

from one vowel to the immediately following vowel, an articulatory cost. Formally, I will represent this pressure as follows:[3]

(5) *No-Hiatus*: Within a foot, and in two adjacent feet, it is illformed to have two adjacent vowels linked to different sets of features.



For reasons to be discussed below, I restrict the scope of hiatus avoidance to two foot-based domains: (i) foot-internally, (ii) between two adjacent feet.

Assuming that a *VCV* noun constitutes a foot (Ọla 1995), NO-HIATUS (Heteropodic) is violated by the forms in (1) and (2) that have not undergone assimilation. The problem remains, however, of determining whether the assimilation motivated by NO-HIATUS is progressive or regressive. I propose that two factors combine to determine the direction of assimilation. First, regressive assimilation is the generally preferred option due a constraint requiring left-edge anchoring. Second, retention of nonhigh vowels over high vowels is preferred for reasons to do with sonority.

Consider first the role of anchoring. To avoid hiatus, one vowel's domain is extended and another vowel is deleted. Deletion causes a disruption in correspondence at one edge of a morpheme or the other. Building on work by Prince & Smolensky (1993) and McCarthy & Prince (1993, 1995) on alignment, and supporting independent work by Blake (1998) on St'at'imcets, I argue that the optimal output must respect correspondence at the left edge of the morpheme. Consider the case of [owó ekpo].

(6) *Sequences of nonhigh vowels*

			NO-HIATUS	ANCHORL	ANCHORR
/owo ekpo/	a.	[owo ekpo]	*!		
	b.	[owo okpo]		*!	
	c. ☞	[owe ekpo]			*

If the [e] of [ekpo] deletes, then left-edge correspondence is disrupted (6b). If the final [o] of [owo] deletes, then right-edge correspondence is disrupted (6c). By ranking left-edge correspondence above right-edge correspondence, the observed surface form is achieved.

Anchoring is defined in (7). For general discussion, see McCarthy & Prince (1995).

---

[3] For various reasons, an account of hiatus avoidance relying on syllable well-formedness constraints such as ONSET is not a straightforward solution here (see, for example, Rosenthall 1994, Lamontagne & Rosenthall 1996, Casali 1996). Consider the structure of such an account. If a $CV_i.V_j$ sequence consists of two syllables, then the second syllable has no onset, an apparent violation of ONSET (Prince & Smolensky 1993, etc.). If the two vowels are combined into a single syllable, CV_iV_i, then the ONSET violation is resolved. Such an analysis of Yoruba is problematic on two counts. First, Ọla (1995) produces compelling evidence that the initial *V* in a canonical *VCV* noun is not part of a full syllable; crucially for Ọla, there is no syllable, just a nuclear mora, hence there is no ONSET violation. Second, Ọla argues that Yoruba nouns are subject to an unviolated minimality condition which requires that every noun contain a foot, where a foot contains at least two moras and one (onsetful) syllable. If a [VCV][VCV] sequence is syllabified as *V.CVV.CV*, then it is not clear how such minimality requirements could be satisfied: [V.CVV] and [CVV.CV] would constitute well-formed feet, but the remainder would not – and yet both parts are nouns, hence subject to noun minimality. Note in addition that there is no clear evidence in Yoruba for long vowels, nor for bimoraic syllables in general. The only possible cases of long vowels derive either from heteromorphemic vowel contact situations, or from intervocalic consonant deletion. Moreover, in such cases, the sequences of vowels that result are not restricted to two moras. Hence if vowel sequences are considered single syllables, then monomoraic, bimoraic, and trimoraic syllables would need to be envisioned.

(7) ANCHORL: Any element at the left edge of a morpheme in the input has a correspondent at the left edge of the morpheme in the output.

ANCHORR: Any element at the right edge of a morpheme in the input has a correspondent at the right edge of the morpheme in the output.

A couple of observations are relevant concerning anchoring. First, McCarthy and Prince (1995) make the point that a minimally stipulative analysis of reduplication ought to utilise for reduplication the same class of constraints as motivated elsewhere for nonreduplicative phenomena. Depending on whether "anchoring" can be successfully equated with "alignment", anchoring has been a potential problem in this regard in that its motivation appeared to be solely within the realm of reduplication. The suggestion made here is that anchoring does indeed play a general role, governing both reduplicative and nonreduplicative patterns. By providing instances of the crucial use of nonreduplicative anchoring, the use of anchoring in reduplication is supported. Second, I speculate that ANCHORL is harmonically ranked above ANCHORR.[4] For on-line processing, it is important to be able to locate stems in order to access lexical items. Frequently, indeed typically, lexical access is achieved prior to arrival at the right edge of a lexical item. As such, disruption at the left edge of a form will inhibit lexical access, whereas disruption at the right edge will in many cases have no serious effect since lexical access has already been achieved. For relevant discussion, see Cutler, Hawkins & Gilligan (1985), Hall (1992). For the remainder of this paper, ANCHORL will be included in relevant tableaux, while ANCHORR will be excluded since it is not ranked highly enough to play a crucial role in the phenomena under consideration.[5]

The constraint grammar considered so far would systematically result in regressive assimilation. While this is indeed the general case, it is also necessary to derive the instances involving [i] where progressive assimilation is attested—the cases that motivated an underspecified approach to vowel asymmetries. The basic proposal made here is to distinguish between the intrinsic sonority of different vowels, where [i] is assumed to be the least sonorous vowel.[6] Specifically, two featural dimensions are crucial in understanding sonority-based differences in Yoruba, namely the front-back dimension and the high-nonhigh dimension. Assuming that nonhigh vowels are more sonorous than high vowels, and that back vowels are more sonorous than front vowels, these two dimensions define four sonority classes (cf. Prince & Smolensky 1993). Three of the four play a role in Yoruba.

---

[4] Casali (1996) makes a related proposal, arguing that positional faithfulness to initial position universally outranks general faithfulness. Since deletion of a morpheme-initial vowel would cause a violation of such positionally restricted faithfulness while deletion of a morpheme-final vowel would not, retention of V_2 over V_1 is observed in a V_1##V_2 sequence.

[5] Lamontagne & Rosenthall (1996) discuss the general preference for retention of V_2 over V_1 in V_1##V_2 sequences, and argue that the preferential retention of V_2 derives principally from constraints on contiguity. In particular, 'juncture contiguity' requires that two segments that are adjacent in the input be adjacent in the output when they abut across a syllable boundary. Relating to input /owo ekpo/, a candidate such as [o.wo<u>o.kp</u>o] violates juncture contiguity while [o.we<u>e.kp</u>o] satisfies it. Whatever its general merits, such an account does not give the desired results for Yoruba. First, such an account depends on motivating deletion/merger/coalescence by syllable well-formedness constraints. This is problematical in Yoruba; see footnote 3. Second, such an account does not account for morpheme-internal cases such as /agogo/ ~ [aago] seen in section §0. Junctural integrity would be violated by the actually occurring surface form [a<u>a.g</u>o] but would be satisfied by the nonoccurring *[o<u>o.g</u>o]. As a general point, note that the junctural contiguity proposal predicts a distinction between deletion/merger/coalescence in open vs. closed syllables. With an input like /te abo/ where V_2 is open, deletion should optimally result in [ta.bo] if junctural contiguity is highly ranked: [t<u>e.b</u>o] violates junctural contiguity, [t<u>a.b</u>o] does not. In contrast, if V_2 is part of a closed syllable, then junctural contiguity is irrelevant. For an input like /te ambo/, both [te<u>m.b</u>o] and [ta<u>m.b</u>o] respect junctural contiguity. The choice between the two would therefore default to other constraints, which Lamontagne and Rosenthall show would favour V_1 retention. Hence it would be possible for the input /te abo/ to result in [ta.bo] but /te ambo/ to result in [tem.bo].

[6] At a presentation of a much earlier version of this paper, Armin Mester suggested to me that I try replacing structural underspecification with reference to sonority differences. To a significant extent, the current state of this paper represents my attempt to do just that.

(8) *Sonority*

NonHi Back a, o, ɔ	≻	NonHi Front e, ɛ	≻	Hi Back u	≻	Hi Front i
	A			B		C

Rather than evaluating nuclei as having a particular harmonic value dependent on their sonority (Prince & Smolensky 1993), I will evaluate sonority through the medium of faithfulness. The reasons from Yoruba for this interpretation are discussed in section 3 below; for general discussion, see Pulleyblank (1998). The basic idea is as follows. When an input contains some feature *F*, faithfulness to *F* depends on *F*'s intrinsic sonority: deletion or modification of a more sonorous element is evaluated as a more costly violation than deletion or modification of a less sonorous element. That is, the scale in (8) is interpreted in terms of a harmonic set of feature-based[7] Max constraints:[8]

(9) *Sonority through faithfulness*

a. Constraint set:

- MaxNonHiBk: Every NonHi Back element of the input has a correspondent in the output.
- MaxNonHiFr: Every NonHi Front element of the input has a correspondent in the output.
- MaxHiBk: Every Hi Bk element of the input has a correspondent in the output.
- MaxHiFr: Every Hi Fr element of the input has a correspondent in the output.

b. Harmonic ranking: MaxNonHiBk, MaxNonHiFr >> MaxHiBack >> MaxHiFront

These faithfulness constraints must be ranked below No-Hiatus in order for assimilation not to be blocked in a case like [owó ekpo]:

(10) *Sequences of nonhigh vowels, including faithfulness*

			No-Hiatus	Max NonHi	Max HiBack	Anchor	Max HiFront
/owo ekpo/	a.	[owo ekpo]	*!				
	b.	[owo okpo]		*		*!	
	c. ☞	[owe ekpo]		*			

To achieve the desired asymmetry with respect to the high front vowel, it is necessary to rank MaxNonHi above Anchor and MaxHiFront. This ranking ensures that *[ili iʃɛ] (11c) is ruled out in favour of the correct [ile eʃɛ] (11b).

(11) *Vowel sequences where V_2 is high*

			No-Hiatus	Max NonHi	Max HiBack	Anchor	Max HiFront
/ile iʃɛ/	a.	[ile iʃɛ]	*!				
	b. ☞	[ile eʃɛ]				*	*
	c.	[ili iʃɛ]		*!			

Similarly, it is important that MaxHiBack be ranked above Anchor and MaxHiFront. This can be seen from a case like (12) where retention of [u] forces a violation of anchoring.

[7] For the relativisation of Max and Dep to feature-sized units rather than to segments, see McCarthy & Prince (1995), Lombardi (1995, 1998), Pulleyblank (1996, 1998), Myers (to appear), etc.

[8] In similar fashion, a sonority-based Dep scale evaluates insertion gradiently, with the insertion of more sonorous material constituting a more significant violation than the insertion of less sonorous material. Hence epenthesis of [i] is predicted by the same scale that predicts the deletability of [i].

(12) *Vowel sequences where V_1 and V_2 are high*

			NO-HIATUS	MAX NONHI	MAX HIBACK	ANCHOR	MAX HIFRONT
/ɛru igi/	a.	[eru igi]	*!				
	b. ☞	[eru ugi]				*	*
	c.	[eri igi]			*!		

This analysis makes one prediction that cannot be tested in Standard Yoruba. Because MAXNONHI is ranked above MAXHIBACK, the analysis predicts that a mid or low vowel would be retained at the expense of a high back vowel, without regard to anchoring. Hence a sequence like *…u][e…*and a sequence like *…e][u…*are both predicted to surface as *…e][e…*. Unfortunately, this prediction cannot be tested in Standard Yoruba because there is a general constraint prohibiting the occurrence of *u*-initial nouns. There are dialects, however, where *u*-initial nouns do occur; for discussion, see section §5.

In conclusion, let us compare the three accounts of vocalic asymmetries in *V V* assimilation. The fully specified rule-based account presents a solution that is essentially ad hoc. There is no particular reason for there to be two rules rather than one, or none, or three. In addition, there is no principled reason for the imposition of the height condition on progressive assimilation. In the underspecified account, there is similarly no reason for why assimilation comes in a regressive/progressive pair. There is, however, a possible explanation for why progressive spread applies only to [i]: since progressive spread applies after regressive spread, it can only affect sequences where regressive spread is inapplicable, with inapplicability defined by structural properties of the vowel [i]. Finally, the optimality theoretic account attempts to build motivation for assimilation directly into the constraint set posited. Hiatus avoidance plays a direct role in triggering assimilation, with the direction of assimilation determined by the interaction of anchoring with sonority effects.

While all three accounts are descriptively adequate, it will be argued in the following sections that only the optimality theoretic account explains the range of vocalic behaviour attested in Yoruba.

3 Consonant deletion and progressive assimilation

Whereas phrase-level *V V* sequences give rise to regressive assimilation, as just seen, *V V* sequences derived by the deletion of an intervocalic consonant give rise to progressive assimilation. Consider data such as those in (13).

(13) *Progressive Root Spread*

a.	agogo	[agogo]	aago	[aago]	'bell'
	otútù	[otutu]	oótù	[ootu]	'chill'
	èsúsú	[esusu]	èésú	[eesu]	'traditional form of banking'
b.	egungun	[egũgũ]	eegun	[eegũ]	'bone'
	ogùngùn	[ogũgũ]	oògùn	[oogũ]	'medicament'
	ọ̀kánkán	[ɔ̀kãkã]	ọ̀ọ́kán	[ɔ̀ɔ̀kã]	'open view'

The examples in (13a) illustrate consonant deletion between two oral vowels, while the examples in (13b) illustrate consonant deletion between an oral and a nasalised vowel. Consonant deletion itself is optional, depending on factors such as dialect and speech rate. Whenever consonant deletion takes place, however, then progressive assimilation is obligatory. For example, [agogo] alternates with [aago] (*[aogo]/*[oogo]) and [ɔ̀kãkã] alternates with [ɔ̀ɔ̀kã] (*[ɔ̀ãkã]/*[ààkã]/ *[àã̀kã]/ *[ã̀ã̀kã]).

Within rule-based accounts, such data are potentially problematic. A rule would need to be postulated that would spread a Root Node from left to right. The rule would need to refer to the Root Node because of the rule's effect on nasalised vowels: if the rule targeted the Place Node, assimilating only place features, then the target vowel would incorrectly retain its nasality in examples such as (13b). At issue is whether such a left-to-right rule could be collapsed with the previous rule of progressive assimilation.

Within a fully-specified account, the two rules could not be collapsed. As seen in the last section, progressive assimilation across word boundaries targets only the class of high vowels. In contrast, the word-internal progressive assimilation targets vowels of any height. Given the differing conditions, the two rules could not be collapsed. The result, therefore, is that the data in (13) require the postulation of an additional rule.

Within an underspecified account, the situation is potentially different. Across word boundaries, progressive assimilation applies only to the residue of cases where regressive assimilation cannot apply, crucially motivating an order of application where regressive assimilation applies before progressive assimilation. Since consonant deletion feeds progressive assimilation, not regressive, the correct results could be achieved by crucially ordering consonant-deletion after regressive assimilation, but before progressive assimilation:

(14) *Rule ordering*

/agogo/	
n/a	Regressive Assimilation
aogo	Consonant Deletion
aago	Progressive Assimilation
[aago]	

For a rule-based account, rule ordering is crucial if the two instances of progessive assimilation are to be analysed as instances of the same rule.

In the optimality theoretic account, the analysis proposed above for phrasal assimilation produces correct results in the consonant-deletion cases without any modifications. Consider the representative tableau in (15).[9]

(15) *Consonant deletion (abstracting away from the constraint whose effect is consonant deletion itself)*

			NO-HIATUS	MAX NONHI	MAX HIBACK	ANCHOR	MAX HIFRONT
/agogo/	a.	[aogo]	*!				
	b. ☞	[aago]		*			
	c.	[oogo]		*		*!	

The prohibition on nonidentical vowel sequences (NO-HIATUS) rules out **aogo* (15a). Since both *aago* (15b) and **oogo* (15c) violate MAXNONHI, the choice between the two defaults to a lower ranked constraint, specifically ANCHOR. Of interest in this account is that ANCHOR produces a surface effect here that is exactly the opposite to that seen previously. Recall that left-edge anchoring is highly ranked in Yoruba. In the phrasal cases, this means that ANCHOR protects V_2 in a $V_1][V_2$ sequence; in the consonant deletion cases, however, reference to a left-edge means that ANCHOR protects V_1 in a $[V_1V_2$ sequence. Exactly the same constraint, therefore, is responsible for the regressive assimilation phrasally and the progressive assimilation word-internally.

To conclude this discussion of assimilation induced by consonant deletion, I compare the three accounts. A rule-based account without underspecification is clearly undesirable in that it requires the postulation of a new rule for this class of cases, namely a rule of progressive assimilation without the [+high] condition seen phrasally. This is clearly an ad hoc solution to this class of cases. By including underspecification, a derivational account need not necessarily postulate a new rule, although it must invoke rule-ordering in a crucial fashion. Finally, the optimality theoretic account motivated earlier is entirely adequate for this class of cases without modification or enrichment.

4 Distributive reduplication

Assimilation between two vowels can be observed in an additional class of cases, namely cases of distributive reduplication (Akinlabi 1984, Fọlarin 1987, Pulleyblank 1988, Ọla 1995).

[9] The issue of how to account for the consonant deletion itself, while interesting, is orthogonal to the issue of vowel assimilation and will not be addressed here.

(16) *Distributive Reduplication*

a.	ọṣù	[ɔʃù]	ọṣooṣù	[ɔʃooʃù]	'month; every month'
	alẹ́	[alɛ́]	alaalẹ́	[alaalɛ́]	'night; every night'
	orí	[orí]	oroorí	[oroorí]	'head; every head'
b.	ojúmọ́	[oɟúmɔ̃́]	ojoojúmọ́	[oɟooɟúmɔ̃́]	'day; every day'
	ọdún	[ɔdṹ]	ọdọọdún	[ɔdɔɔdṹ]	'year; every year'
c.	ìtàdógún	[ìtàdógṹ]	ìtìtàdógún	[ìtìtàdógṹ]	'15th day; every 15th day'
	ìgbẹ́	[ìgbɛ́]	ìgbìgbẹ́	[ìgbìgbɛ́]	'forest; every forest'

"Perfect" reduplication (ignoring tone) would result in a form like **ìgbɛ̀ìgbɛ́*. The operation of assimilation on such a reduplicated form would then derive the correct surface form *ìgbìgbɛ́*.

These cases are interesting and problematic in that rule-based accounts would be forced to posit a new rule of regressive assimilation, whether or not underspecification is assumed. Compare the forms in (16a) and (16c). Of interest is the fact that high vowels in this reduplicative context behave in a manner that is fully comparable to the nonhigh vowels: there is no asymmetry. In the phrasal instances of regressive assimilation, nonhigh vowels trigger regressive assimilation while high vowels do not; in these reduplicative cases, both nonhigh and high vowels trigger assimilation. Because of this difference in the behaviour of high vowels, derivational accounts are forced to adopt special rules for the reduplicative context (see Pulleyblank 1988).

In marked contrast, the optimality account presented here does not need to posit any additional constraints other than the reduplicative constraints themselves. Assuming a basic correspondence approach to reduplication (McCarthy & Prince 1995), and assuming the analysis of distributive reduplication as foot-based (Ọla 1995), reduplication is analysed as resulting from the ranking of a constraint requiring that the reduplicant be a foot (RED=FOOT: The reduplicant is a foot)[10] above constraints requiring correspondence between the base and the reduplicant (MAX-BR: *Every segment of the base has a correspondent in the reduplicant* & DEP-BR: *Every segment of the reduplicant has a correspondent in the base*). Together, these constraints would derive *VCV* reduplication, with perfect correspondence between base and reduplicant. [Feet in (17) are indicated by parentheses; the reduplicant is indicated in boldface; the base is delimited by square brackets.]

(17) *Reduplicative constraints isolated from assimilatory effects*

			RED=FOOT	MAX-BR	DEP-BR
(i) /RED+oɟumɔ/	a. *best reduplicant*	(**oɟu**)[(oɟu)(mɔ)]		**	
	b.	(**oɟu**)(**mɔ**)[(oɟu)(mɔ)]	*!		
	c.	(**oɟo**)[(oɟu)(mɔ)]		***!	*!
	d.	(**oɟu**)[(uɟu)(mɔ)]		***!	*!
(ii) /RED+igbɛ/	a. *best reduplicant*	(**igbɛ**)[(igbɛ)]			
	b.	**igb**[(igbɛ)]	*!	*	
	c.	(**igbi**)[(igbɛ)]		*!	*!
	d.	(**igbɛ**)[(ɛgbɛ)]		*!	*!

The preference for partial over complete reduplication with an example like *oɟooɟúmɔ̃́* shows that RED=FOOT must outrank the reduplicative faithfulness constraints. That is, a candidate like *oɟooɟúmɔ̃́* is preferred to a candidate such as **oɟumɔ̃oɟumɔ̃* (or its assimilated counterpart **oɟumooɟumɔ̃*). As to the relative ranking of MAX-BR and DEP-BR, either ranking is possible: the two constraints are not crucially ranked with respect to each other.

To incorporate the analysis of reduplication into the overall analysis, it is necessary to incorporate the reduplicative constraints into a general constraint ranking. That is, the set {NO-HIATUS >> MAXNONHI >> MAXHIBK >> ANCHOR >> MAXHIFR} must be combined with the set {RED=FOOT >> MAX-BR, DEP-BR}. There are various ways in which these sub-rankings could be combined. It would be possible, for example, to rank reduplicative correspondence above the NO-HIATUS constraint thereby deriving precisely the forms given in (17). The facts indicate, however, that the constraints on vowel sequences are operative in Yoruba even in reduplicative

[10] Although I have phrased the size delimiter as RED=FOOT, following Ọla (1995), an analysis in terms of generalised templates (see McCarthy & Prince *to appear* and references therein) would be possible.

contexts. This can be achieved by ranking MAX-BR and DEP-BR below the four constraints governing well-formed vowel sequences:

(18) *Bringing together the reduplicative constraints and the vowel sequence constraints*

NO-HIATUS >> MAXNONHI >> MAXHIBK >> ANCHOR >> MAXHIFR

⇓ ⇓ ⇓ ⇓ ⇓

NO-HIATUS RED=FT	MAXNONHI	MAXHIBK	ANCHOR	MAXHIFR MAX-BR, DEP-BR

⇑ ⇑

RED=FT >> MAX-BR, DEP-BR

The combination of these constraints correctly derives the surface forms of the distributive. Given the high ranking of RED=FT in both the specifically reduplicative sub-tableau of (17) and the combined tableau of (19), I consider only candidates where the reduplicant is a well-formed foot:

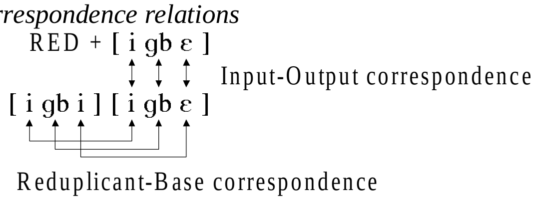
(19) *Combination of reduplicative constraints with vocalic constraints: the vowel-vowel effects*

			NO-HIATUS	RED =FT	MAX NONHI	MAX HIBK	ANCH	MAX BR	DEP BR	MAX HIFR
(i) /RED+oɟumɔ/	a.	(**oɟu**)[(oɟu)(mɔ̃)]	*!					**		
	b.☞	(**oɟo**)[(oɟu)(mɔ̃)]						***	*	
	c.	(**oɟu**)[(uɟu)(mɔ̃)]			*!		*	***	*	
(ii) /RED+igbɛ/	a.	(**igbɛ**)[(igbɛ)]	*!							
	b.☞	(**igbi**)[(igbɛ)]						*	*	
	c.	(**igbɛ**)[(ɛgbɛ)]					*!	*	*	*

Highly ranked NO-HIATUS is violated if the reduplicant ends in a vowel that is nonidentical to the initial vowel of the base. This excludes (19ia,iia), the candidates that would be reduplicatively perfect. The constraints on vowel sequences then come into play. Highest ranked are the faithfulness constraints governing retention of the most sonorous vowels. In (19ic), it is the violation of MAXNONHI that excludes **oɟuuɟumɔ̃*, with the result that *oɟooɟumɔ̃* (19ib) is optimal.

Why, we might ask, does MAXNONHI not similarly exclude (19iib), resulting in (19iic) being analysed as optimal? The answer lies in a careful assessment of how a violation of MAXNONHI is accrued. For reasons of label-length, MAXNONHI, MAXHIBK and MAXHIFR have not been labeled in this paper as "MAX-IO NONHI", "MAX-IO HIBK" and "MAX-IO HIFR". Nevertheless, the three constraints are constraints on input-output correspondence, as defined in (9). As such, they govern the retention of segments in the base, but they are irrelevant as far as segments in the reduplicant are concerned.

(20) *Correspondence relations*



A candidate like **oɟuuɟumɔ̃* (19ic) violates MAXNONHI since a mid vowel in the base is lost, while the optimal candidate *ìgbììgbɛ́* (19iib) does not incur a similar violation since the base vowels are faithfully retained. Indeed, the particular *V V* sequence observed in these reduplicative forms always prefers the output that is fully faithful to the base, respecting both MAX and ANCHORL.

In summary, we see that the analysis of distributive reduplication in terms of correspondence automatically derives the symmetrical behaviour of high and nonhigh vowels. To account for reduplication minimally requires the inclusion of reduplicative constraints in the set of constraints under examination. By ranking the base-reduplicant correspondence constraints below the sonority constraints and the anchoring constraint, correct surface forms are obtained. Of descriptive interest is the fact that the same constraints that treat high and nonhigh vowels asymmetrically when both vowel heights are underlying, now treat them symmetrically. Unlike the optimality theoretic analysis, derivational analyses of Yoruba are forced to posit special assimilation rules for the reduplicative cases.

5 Dialects with *u*-initial words

As noted in section §1, Standard Yoruba does not allow nouns to begin with [u-]. This unfortunately makes it impossible to test analytic predictions regarding the behaviour of *…V][u…* sequences. In certain dialects, however, the prohibition on *u*-initial words does not hold. We consider such cases in this section, examining the predictions made by derivational analyses with and without underspecification, and by the constraint-based analysis presented here. Specifically, we examine the dialect of Ekiti (Adeniyi 1988, Omisore 1989). A background assumption is that the only relevant distinction between Ekiti and Standard Yoruba is whether *u*-initial forms are allowed (Ekiti) or prohibited (Standard Yoruba). It will be shown that making this assumption, the constraint-based analysis presented here makes exactly the correct predictions for *u*-initial forms in Ekiti, while both derivational analyses make incorrect predictions.[11]

For sequences not involving *u*-initial nouns, all three analyses make identical predictions. Such sequences have been discussed above, and will be summarised here very briefly. Consider cases where the second vowel in a *…V_1][V_2…* is nonhigh. In both fully specified and underspecified derivational analyses, Regressive Spread will apply in such cases, deriving a surface result *…V_2][V_2…*; in the constraint-based analysis, anchoring will enforce the retention of V_2 whether V_1 is equally sonorous or less sonorous than V_2. Where V_2 is the high front vowel [i], the three analyses again make comparable predictions. Progressive Spread will apply in both derivational accounts deriving *…V_1][V_1…*; in the optimality theoretic account, MAXNONHI and MAXHIBK will similarly force the retention of V_1, even at the cost of violating ANCHORL.

These patterns constitute the control case. If the grammar of Ekiti is fully comparable to Standard Yoruba in its treatment of *…V][V…* sequences, then these sequences should behave in the same way in the two dialects—and this is indeed the case. The relevant patterns are summarised in the following schematic table, where E = any nonhigh vowel, I = any high front vowel, and U = any high back vowel.[12]

(21) *Summary where nouns are not* u*-initial*

	E_1][E_2	E][I	I][E	U][E	U][I
Fully specified:	E_2][E_2	E][E	E][E	E][E	U][U
Underspecification:	E_2][E_2	E][E	E][E	E][E	U][U
Optimality Theory:	E_2][E_2	E][E	E][E	E][E	U][U
Ekiti data:	E_2][E_2	E][E	E][E	E][E	U][U

Data exemplifying the Ekiti patterns are given in (22).

[11] This does not mean that derivational analyses cannot in one way or another account for the data observed in *u*-initial dialects. It does mean, however, that the behaviour with *u*-initial forms is unexpected, and must be accounted for by the postulation of special ad hoc rules.

[12] The *u*-initial dialects under consideration also exhibit harmonic variation in the high vowels, unlike Standard Yoruba. As a result, there are two high front vowels [i, ɪ] and two high back vowels [u, ʊ]. Advanced and retracted high vowels behave the same way with respect to vowel assimilation.

(22) *Ekiti patterns that are comparable to Standard Yoruba*

a. **V_2 retained: the general pattern**

...NONHI] [NONHI...	[ulé ɔ̀dʒó]	[ulóɔ̀dʒó]	'house of Ojo'
	[àbá ɛgbɛ́]	[àbɛ́ɛgbɛ́]	'father of club/patron'
	[ɔdʒà ɔba]	[ɔdʒɔ̀ɔba]	'market of king'
...HI FRONT] [NONHI...	[omĩ ɛrã]	[omɛ̃ɛ̃rã]	'water of meat'
...HI BACK] [NONHI...	[ɪlú ɔ̀wɔ̀]	[ɪlɔ́ɔ̀wɔ̀]	'a town'[13]

b. **V_1 retained: V_1 = high back; V_2 = high front**

...NONHI] [HI FRONT...	[eó igi]	[eóogi]	'money for wood'
...HI BACK] [HI FRONT...	[ɛrõ ìgbĩ́]	[ɛrõõ̀gbĩ́]	'mouth of snail'[14]

As these data illustrate, the basic pattern in Ekiti is comparable to that of Standard Yoruba, with the high front vowel behaving in an asymmetric pattern. Of interest are the cases where the second noun begins with [u-]. These cases turn out to be particularly interesting because the three analyses under discussion each make different predictions concerning such cases. There are two configurations of interest. In the first, a noun ending in a nonhigh vowel is followed by a noun that is *u*-initial; in the second, a noun ending in a high front vowel is followed by a noun that is *u*-initial. The predictions for such cases are schematised in (23)

(23) *Predictions where the second noun is* u-*initial*

	E][U	I][U
Fully specified:	E][E	I][I
Underspecification:	U][U	U][U
Optimality Theory:	E][E	U][U
Ekiti data:	E][E	U][U

In a fully specified account, Progressive Spread (3) is the first rule to apply and it targets high vowels. In any configuration where a high back vowel follows another vowel, therefore, the initial [u-] should undergo left-to-right assimilation (E][E & I][I). In contrast, the underspecified account applies Regressive Spread first. Since any vowel with specifications triggers Regressive Spread, the initial [u-] should trigger the rule, deriving a surface right-to-left pattern—the opposite result to the fully specified account (U][U in both cases). Finally, the optimality theoretic account should produce a result comparable to the fully specified derivation approach in one case and to the underspecified approach in the other. Consider each case.

With an input /…E][U…/, MAXNONHI militates in favour of retention (and therefore spreading) of the nonhigh vowel, while MAXHIBK and ANCHORL militate in favour of retention (ane therefore spreading) of the second vowel. Since MAXNONHI outranks the other two constraints, progressive assimilation is predicted: E][E.

With an input /…I][U…/, exactly the opposite pattern results. Since there are no nonhigh vowels, the constraint evaluation moves down the ranking to MAXHIBK, ANCHORL and MAXHIFR. The two highest constraints (MAXHIBK & ANCHORL) both favour retention of the high back vowel, resulting in the optimal surface form: U][U.

As can be seen from the final row of (23), it is the pattern predicted by the optimality theoretic analysis that is actually attested. Illustrative data from Ekiti (Adeniyi 1988, Omisore 1989) are presented in (24).

[13] Although not indicated in Omisore's (1989) transcription, this form presumably also undergoes glide deletion: [ɪlú ɔ̀ɔ̀]/[ɪlɔ́ ɔ̀ɔ̀]. See Omisore (1989) for discussion.

[14] The effect of tongue root harmony was not indicated in the form for 'mouth' ([ɛrõ]) at the place where 'mouth of snail' was presented in Omisore (1989), although the fact that the final vowel of [ɛrõ] is retracted is clearly indicated in Omisore's discussion of vowel harmony. I assume that this was a typographical error and have represented 'mouth of snail' accordingly.

(24) *Ekiti*

a. **V_2 retained: the general pattern**

...NONHI] [HI BACK... [ulé ʊʃɛ́] [uléeʃɛ́] ‘place of work’

b. **V_1 retained: V_1 = high back; V_2 = high front**

...HI FRONT] [HI BACK... [etí ulé] [etúulé] ‘near house’

Sample tableaux are presented in (25).

(25) *Phrasal vowel sequences in Ekiti*

			NO-HIATUS HETEROPODIC	MAX NONHI	MAX HIBACK	ANCHOR	MAX HIFRONT
(i) /ule ʊʃɛ/	a.	[ule ʊʃɛ]	*!				
	b.☞	[ule eʃɛ]			*	*	
	c.	[ulʊ ʊʃɛ]		*!			
(ii) /eo igi/	d.	[eo igi]	*!				
	e.☞	[eo ogi]			*	*	
	f.	[ei igi]		*!			
(iii) /eti ule/	g.	[eti ule]	*!				
	h.	[eti ile]			*!	*	
	i.☞	[etu ule]					*
(iv) /ɛrõ igbĩ/	j.	[ɛrõ igbĩ]	*!				
	k.☞	[ɛrõ õgbĩ]				*	*
	l.	[ɛri igbĩ]			*!		

While it is clearly possible to engineer accounts for Ekiti within rule-based theories, the point of interest here is that exactly the analysis proposed for Standard Yoruba within Optimality Theory accounts for Ekiti as well. The sole difference of consequence between the two varieties is whether *u*-initial nouns are permitted (Ekiti) or not (Standard Yoruba).[15] In particular, sequences like [ɛrù igi]/[ɛrùugi] ‘bundle of wood’ in Standard Yoruba demonstrate crucially that faithfulness to the more sonorous [u] takes precedence over faithfulness to the less sonorous [i] (see the tableau in (12)). For the relevant Ekiti sequence where an *i*-final noun precedes an *u*-initial noun, e.g. [etí ulé]/ [etúulé] ‘near house’, the same harmonic ranking of sonority-based faithfulness results in the retention of [u] in V_2 position.

6 *r*-Deletion

In this section, a pattern is discussed that constitutes a serious problem for the underspecified analysis of Yoruba. As mentioned in the introduction, such a case appear to be inconsistent with the underspecified approach to asymmetric behaviour, and yet crucially treats the vowel [i] in an asymmetric way. Hence while calling for a revision of the underspecified approach to Yoruba vowels, these data do not suggest a symmetrical treatment.

Oyelaran (1971) and Akinlabi (1993) discuss a process whereby the consonant /r/ deletes in Standard Yoruba. Two contexts for deletion are identified. First, *r*-deletion takes place between two identical vowels:

[15] There is another relevant difference. In Standard Yoruba, hiatus is disallowed both within feet and across feet (see (0)). In Ekiti, the situation is more subtle. It appears to be the case that the prohibition on hiatus between feet outranks MAXNONHI which in turn outranks the prohibition on foot-internal hiatus: HETEROPODIC NO-HIATUS >> MAXNONHI >> TAUTOPODIC NO-HIATUS. This ranking rules out a sequence of nonhigh vowels in an example like [ulé òdʒó]/ [ulóòdʒó] ‘house of Ojo’, but tolerates it in a word- and foot-internal case like [eó] ‘money’.

(26) *r-deletion between identical vowels*

a.	káàkiri	káàkii	'all about'
	akiribótó	akiibótó	'unsplit kolanut'
b.	wèrèpè	wèèpè	'nettle'
	àkèré	àkèé	'edible frog'
c.	ẹ̀rẹ̀kẹ	ẹ̀ẹ̀kẹ	'cheek'
	gbágẹrẹ	gbágẹẹ	'of flowing gown'
d.	wárápá	wáápá	'epilepsy'
	àbàrá	àbàá	'a slap'
e.	bọ̀rọ̀kìnní	bọ̀ọ̀kìnní	'a well-to-do gentleman'
	kọ́kọ́rọ́	kọ́kọ́ọ́	'key'
f.	orógùn	oógùn	'wooden stick for stirring food'
	kòkòrò	kòkòò	'insect'
g.	èkuru	èkuu	'cooked ground white beans'
	òfurufú	òfuufú	'space'

Second, *r*-deletion takes place adjacent to a high vowel (preceding or following):

(27) *r-deletion before or after high vowels in Standard Yoruba*

a.	òrìṣà	òòṣà	'god'
	oríkì	oókì	'(praise) name'
	ṣiré	ṣié	'play'
	adìrẹ	adìẹ	'chicken'
b.	òrùka	òòka	'ring'
	dárúkọ	dáákọ	'to name'
	ògùrọ̀	ògùọ̀	'bamboo-wine'
	àdúrà	àdúà	'prayer'
c.	orúnkún	oókún	'knee'
	ọlọ́run	ọlọ́un	'God'

Note that the high vowel may be oral, as in (27a,b), or nasalised, as in (27c) (recall that orthographic *Vn* indicates nasalisation).

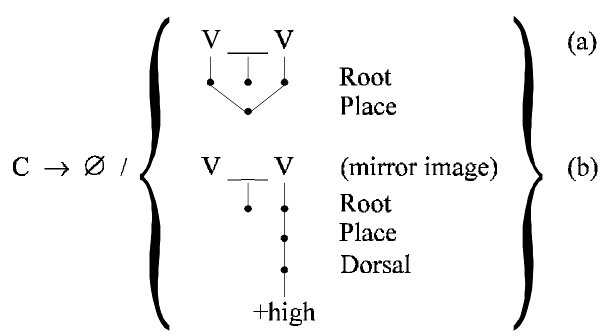
Deletion does not take place when /r/ is flanked by two nonidentical nonhigh vowels:

(28) *r-deletion inapplicable between nonidentical nonhigh vowels*

odáró	*odáó / *odáá / *odóó	'dyer'
òrayè	*òayè / *òoyè / *àayè	'fool'

Akinlabi (1993) proposes the following rule to account for *r*-deletion, where the "a" clause represents deletion between identical vowels and the "b" clause represents deletion adjacent to a high vowel:

(29) *r*-deletion



The crux of Akinlabi's argument is that for the rule to make reference to [+high], this value needs to be phonologically present—a compelling argument against the feature value's underspecification. As discussed in section §1, however, if the analysis of these cases simply invokes ad hoc reference to [+high], as in (29), then the observed featural asymmetry is at best described but not explained. Viewed from the perspective of Optimality Theory, there are two problems. The first is to motivate *r*-deletion at all; the second is to distinguish between the behaviour of high and nonhigh vowels. I consider these two problems in turn.

The problem of motivating *r*-deletion can be viewed from two perspectives. On the one hand, a prohibition on /r/ can be overruled by the pressure of faithfulness for its retention (30a). Alternatively, general faithfulness to input specifications of /r/ can be overruled by some prohibition on /r/ (30b) (see Prince & Smolensky 1993).

(30) *Inventory effects: feature retention and loss*

a. **Retention**: MAXIO[α] >> *α
b. **Loss**: *α >> MAXIO[α]

Given the "retention" ranking, /r/ would be expected to appear in a consistent fashion—a widely attested pattern cross-linguistically but not the pattern of Standard Yoruba. The deletion of /r/ in Standard Yoruba can be accounted for by adopting a "loss" ranking: /r/ will be retained in a representation only if the "*α" constraint is inapplicable, or if some higher ranked constraint forces a violation of "*α".

What then is the appropriate "*α" constraint? To answer this question satisfactorily would require a general examination of rhotics, along with their interaction with syllable structure, foot structure, and so on. For the purposes of this paper, I will simply denote the relevant constraint as "**r*", and discuss briefly two ways in which such a constraint could be motivated. One possibility is that this constraint is part of a family of constraints prohibiting particular features and segments (see Prince & Smolensky 1993). One could assume that for every feature there is a corresponding constraint prohibiting it. The justification for such a family might be articulatory, where segments could be ranked along some scale based on articulatory effort; all non-null phonological segments are costly in that they require some degree of articulatory effort, with the degree of effort correlating with the cost. A related alternative would be to evaluate a segment by criteria comparing the cost of articulating a segment with the perceptibility of the effort. That is, every segment involves some degree of effort, and results in a segment with some degree of perceptibility. Segments could be ranked such that the best minimise effort and maximise perceptibility, while the worst maximise effort and minimise perceptibility. A second, and related, possibility would be to relate segmental prohibitions to sonority and syllable structure (see also Prince & Smolensky 1993). Following work such as Clements (1988), one can identify the optimal onset as minimally sonorous and the optimal nucleus/coda as maximally sonorous. This defines obstruents and nasals as the best segments at the left edge of a syllable, and vowels and glides as the best segments at the right edge. Liquids, including /r/, are not particularly good onsets, nor are they particularly good codas. In Yoruba, codas of any type are disallowed. Under this account, the impossibility of /r/ in onset position could relate to its general poorness as an onset, due to its high level of intrinsic sonority.

Whatever its motivation and precise nature, by ranking the constraint against /r/ above faithfulness, the grammar predicts that any underlyingly specified /r/ should be lost on the surface. That is, /r/ is prohibited from occurring in Yoruba.[16] Earlier, the issue was raised as to how to motivate the deletion of /r/; now the issue is inverted, the problem being how to explain why /r/ ever surfaces at all. I suggest that three factors combine to force the surface appearance of /r/, and in so doing explain the patterns of *r*-deletion presented in Oyelaran's and Akinlabi's work.

First, whether or not /r/ is observed is a lexically idiosyncratic property. Some morphemes contain an /r/ in their representation; others do not. The appearance of /r/ is not phonologically conditioned in the way that "intrusive *r*" is in certain English dialects, for example.[17] Hence /r/ is a part of some input forms and not others.

Second, vowel hiatus avoidance and sonority factors play a significant role in forcing the retention of /r/. In the examination of distributive reduplication, it was necessary to integrate the sub-grammar for reduplication with

---

[16] I do not address here the question of optionality. Whether *r*-deletion applies or not depends on factors of dialect and speech style. While different dialects can be assigned different constraint rankings, interesting questions are raised as to how to represent differences of register. One possibility is to analyse *r as actually involving two sub-constraints, differentiated for register: $[*r]_{\text{CASUAL}}$ >> MAX-*r* >> *r. Given such a ranking, faithfulness would force the retention of /r/ in non-casual contexts, but $[*r]_{\text{CASUAL}}$ would prohibit /r/ in a casual register. Abstracting away from the issue of how to incorporate register, I represent $[*r]_{\text{CASUAL}}$ in the main text as *r.

[17] See McCarthy (1993) for some recent discussion within a constraint-based theory.

the sub-grammar governing vowel effects (see (18)). A similar integration is required here: *r and MAX-*r* must be integrated into the overall grammar.[18]

(31) *Bringing together the constraints on /r/ and the vowel sequence constraints*

NO-HIATUS >> MAXNONHI >> MAXHIBK >> ANCHOR >> MAXHIFR

⇓ ⇓ ⇓ ⇓ ⇓

NO-HIATUS	MAXNONHI	*r	MAXHIBK	ANCHOR	MAXHIFR MAX-*r*

⇑ ⇑

*r >> MAX-*r*

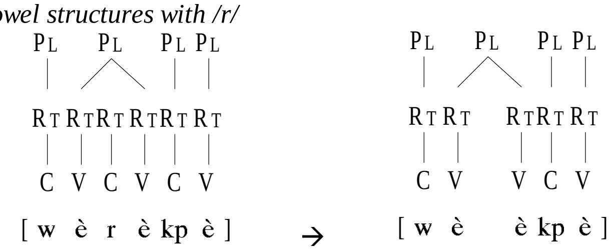
Crucially, I suggest that *r is ranked in between MAXNONHI and MAXHIBK. This ranking derives the effect of deletion adjacent to a high vowel, and prevents deletion between two mid vowels. Consider a case of each type. In *òrìṣà*: 'god' (27a), deletion of the /r/ combines with progressive assimilation to derive *òòṣà*. In contrast, *r*-deletion is blocked with *òrayè* 'fool' (28).

(32) *r-deletion in Standard Yoruba*

			NO-HIATUS	MAX NONHI	*r	MAX HIBACK	ANCHOR	MAX HIFRONT	MAX-r
(i) /òrìʃà/	a.	[oriʃa]			*!				
	b.	[oiʃa]	*!						*
	c.☞	[ooʃa]						*	*
	d.	[iiʃa]		*!					*
(ii) /òrayè/	a.☞	[oraye]			*				
	b.	[oaye]	*!						*
	c.	[ooye]		*!					*
	d.	[aaye]		*!					*

Deletion of /r/ between identical vowels works in a similar fashion. Akinlabi (1993) motivates branching structures for identical vowels over /r/.

(33) *Vowel structures with /r/*



He argues that place specifications on /r/ are unnecessary given the consonant inventory of Yoruba, and he presents evidence from loan-word incorporation that complete assimilation of vowels takes place over /r/ and nowhere else. The reader is referred to Akinlabi (1993) for discussion and argumentation.

Of relevance to the account presented here is that the result of *r*-deletion does not violate the NO-HIATUS constraint since the two moras share a single set of place specifications. As a consequence, *r*-deletion is optimal even in cases where the abutting vowels are mid. Faithfulness to /r/ is outranked by the prohibition on /r/; faithfulness to vocalic specifications is fully respected in the output. This is illustrated with the form for 'nettle': *wèrèpè* / *wèèpè*.

[18] For reasons of expository simplicity only, I do not include the reduplicative constraints here.

(34) *r-deletion between identical vowels*

		NO-HIATUS	MAX NONHI	*r	MAX HIBACK	ANCHOR	MAX HIFRONT	MAX-r
/wèrèpè/	a. [werepe]			*!				
	b.☞ [weepe]							*

Minimality constraints play a role when the base is smaller that in (26) and (27). As Akinlabi (1993) demonstrates, *r*-deletion is blocked in V-initial forms containing only two vowels. This is true whether the /r/ is between two identical vowels or adjacent to a high vowel.

(35) *Non-application of r-deletion between identical vowels*

ìrì	*ìì	'dew'
èrè	*èè	'profit'
ẹrẹ̀	*ẹẹ̀	'mud'
ara	*aa	'body'
ọ̀rọ̀	*ọ̀ọ̀	'speech/word'
orò	*oò	'form of masquerade'

(36) *Non-application of r-deletion before or after a high vowel*

a.	irú	*iú		'a type of seed'
	ire	*ie		'good'
	ìrẹ̀	*ìẹ̀		'grasshopper'
	irà	*ià		'swamp'
	irọ́	*iọ́		'lie'
	ìró	*ìó		'sound'
b.	ẹ̀rí	*ẹ̀í	*ẹ̀ẹ́	'evidence'
	ẹrú	*ẹú	*ẹẹ́	'slave'
	orí	*oí	*oó	'head'
	òru	*òu	*òo	'late night
	ọ̀run	*ọ̀un	*ọ̀ọ	'heaven'

Akinlabi addresses this pattern of non-application by means of a minimal *VCV* word constraint blocking rule application from producing a *[VV] form. Such an account can be transparently incorporated into Optimality Theory. The specific implementation I will assume follows Ọla (1995). In a detailed examination of prosodic phenomena in both Yoruba and a number of related languages, Ọla argues for a minimality condition where all Standard Yoruba words must contain a foot, and where every foot must contain at least one syllable with an onset.[19]

[19] There are a number of additional issues involving minimality, foot structure, and so on that are not addressed here. For example, *r*-deletion between the first and second vowels of a word results in a form with a long vowel of uniform quality: *òrìṣà* / *òòṣà* 'god'. When *r*-deletion occurs between two non-initial vowels, however, there is no assimilation: *ògùrọ̀* / *ògùọ̀* 'bamboo-wine'. I assume that this difference is due to several interacting factors. First, the prosodic structure is different in the two cases. As discussed by Ọla (1995), there is a strong preference in Standard Yoruba for a word to begin with a foot. Second, there is a requirement for feet to be bimoraic, a requirement that is overridden by the constraint that a foot must contain a syllable with an onset. Hence the foot structure in cases such as these can be argued to be different: *(òrì)(ṣà)* / *(òòṣà)* vs. *(ògù)(rọ̀)* / *(ògù)ọ̀*. Note in particular that the final vowel of *ògùọ̀* is not incorporated into a foot because the three requirements for a well-formed foot are already satisfied: word-initiality, bimoraicity, containing a syllable with onset. In contrast, the initial vowel of *òòṣà* must be part of a foot in order to satisfy word-initiality. As a result of the different prosodic structures, it is possible to formulate NO-HIATUS in a manner that is sensitive to foot structure – as already proposed in the text. Hiatus is prohibited within a foot (to derive the forms such as *òòṣà*) and across feet (to derive the reduplicative cases seen in section §0) but not between a footed vowel and a non-footed vowel (as in *ògùọ̀*). These interactions of prosodic structure with *r*-deletion require further investigation.

(37) *Minimality*

A word must contain a foot.
A foot must contain a syllable with an onset.

This condition is respected in the relatively long forms of (26) and (27), but is violated in the overly short forms of (35) and (36). Note that both Akinlabi's skeletal formulation of minimality and Ọla's prosodic characterisation correctly allow *r*-deletion in consonant-initial forms such as ***dára*** ~ ***dáa*** 'good' while prohibiting deletion in cases like (35) and (36).

(38) *r-deletion blocked by minimality*

			*HIAT	MINIM	MAX NONHI	*r	MAX HIBK	ANCHOR	MAX HIFRNT	MAX-r
(i) /ara/	a.☞	[ara]				*				
	b.	[aa]		*!						*
(ii) /orí/	a.☞	[ori]				*				
	b.	[oi]	*!	*!						*
	c.	[oo]		*!					*	*
	d.	[ii]		*!	*			*		*
(iii) /dára/	a.☞	[dara]				*!				
	b.	[daa]								*

To summarise and conclude, I have argued here that the asymmetries observed in connection to *r*-deletion are due to the same constraint hierarchy as observed for the other phenomena discussed here. The only additional types of constraints were of two types, both independently required. The *r and MAX-r constraints define the inventory possibilities with respect to *r*-sounds; the MINIMALITY constraints define possible and impossible prosodic shapes. Ranked appropriately with respect to the set of constraints already seen to govern vowel cooccurrence possibilities, correct surface patterns involving the retention and loss of *r* fall out automatically.

7 Excursus on sonority as faithfulness

It has been proposed here (see (9)) that vowel-sensitive faithfulness incorporates reference to sonority. The alternative would be to encode reference to sonority in well-formedness constraints that are not of the faithfulness family. For example, according to the basic proposals of Prince & Smolensky (1993), vowels of Yoruba could be assessed for their sonority-based harmony, such that nonhigh vowels are more harmonic than high back vowels which in turn are more harmonic than high front vowels:

(39) *The Nuclear Harmony Constraint (HNUC):*

a. A higher sonority nucleus is more harmonic than one of lower sonority (Prince & Smolensky 1993:16).
b. Yoruba: Nuc/Nonhi ≻ Nuc/HiBk ≻ Nuc/HiFrt

In numerous cases, an analysis based on HNUC would derive comparable results to the account presented here. For example, given the ranking NO-HIATUS >> HNUC >> ANCHOR, correct results can be achieved in cases such as /owo ekpo/ ~ [owe ekpo] (10), /ile iʃɛ/ ~ [ile eʃɛ] (11), and /ɛru igi/ ~ [ɛru ugi] (12) as seen in the tableaux below.

Where the two vowels in contact are both mid, HNUC makes no distinction between the different nuclei and the optimal candidate is determined by other constraints:

(40) *Comparison with HNUC: two mid vowels*

			NO-HIATUS	HNUC	ANCHOR
/owo ekpo/	a.	[owo ekpo]	*!	|nonhi| |nonhi|	
	b.	[owo okpo]		|nonhi| |nonhi|	*!
	c. ☞	[owe ekpo]		|nonhi| |nonhi|	

Where the two vowels in contact are mid and high, HNUC favours the result with nonhigh vowels:

(41) *Comparison with HNUC: mid and high vowels*

			NO-HIATUS	HNUC	ANCHOR
/ile iʃɛ/	a.	[ile iʃɛ]	*!	|nonhi| |hi|	
	b. ☞	[ile eʃɛ]		|nonhi| |nonhi|	*
	c.	[ili iʃɛ]		|hi| |hi|*!	

Where the two vowels in contact are high, but where one if front and one is back, then HNUC favours the back vowel:

(42) *Comparison with HNUC: high back and high front vowels*

			NO-HIATUS	HNUC	ANCHOR
/ɛru igi/	a.	[eru igi]	*!	|hi back| |hi front|	
	b. ☞	[eru ugi]		|hi back| |hi back|	*
	c.	[eri igi]		|hi front| |hi front|*!	

The nuclear harmony possibility fails, however, to correctly derive other types of patterns. For example, the pattern of epenthesis in Yoruba whereby [i] is preferred as an epenthetic vowel (Pulleyblank 1988) derives automatically from a theory where the insertion of a more sonorous vowel entails the violation of a higher faithfulness constraint than does the insertion of a less sonorous vowel (see Pulleyblank 1998). Formally, such cases result from the harmonic ranking of a set of DEP constraints: DEPNONHI >> DEPHIBACK >> DEPHIFRONT. A different type of argument emerges from an examination of the pattern of *r*-deletion seen in section §6. The problem is the following. According to an analysis where nuclear harmony is a well-formedness condition independent of faithfulness, faithfulness itself is blind to the sonority values of the segments it governs. This makes it difficult or impossible to correctly rank the condition that prohibits the presence of /r/ in Standard Yoruba.

Consider the two examples seen in (32), namely *òrìʃà* ~ *òòʃà* and *òrayè* ~ **òoyè*. Recall that *r*-deletion is possible in the former case (because of the presence of a high vowel) and impossible in the latter. To derive this difference, the account proposed in section §6 analyses *faithfulness* to nonhigh vowels as more important than the prohibition on /r/, and the prohibition on /r/ as more important than *faithfulness* to high vowels: MAXNONHI >> *r >> MAXHIBACK >> MAXHIFRONT. If the assessment is with respect to HNUC, then there is no ranking of *r that will correctly differentiate between high and nonhigh vowels.

If *r is ranked above HNUC, then *r*-deletion should apply to both cases, with HNUC simply picking the most harmonic vowel available given the requirements of NO-HIATUS and *r. This correctly derives [ooʃa] but incorrectly derives [ooye] (shown by the skull and crossbones (☠)).

(43) *Ranking *r above HNUC*

			NO-HIATUS	*r	MAXV IDENTV	HNUC	ANCHOR	MAX-r
(i) /òrìʃà/	a.	[oriʃa]		*!		o i		
	b.	[oiʃa]	*!			o i		*
	c. ☞	[ooʃa]			*	o o		*
	d.	[iiʃa]			*	i i *!		*
(ii) /òrayè/	a.	[oraye]		*!		o a		
	b.	[oaye]	*!			o a		*
	c. ☠	[ooye]			*	o o		*
	d.	[aaye]			*	a a	*!	*

Note that *r would have to be ranked above either MAXV or IDENTV (faithfulness constraints forcing the retention/featural identity of vowels) in order to make *r*-deletion possible at all. Given the established high ranking of NO-HIATUS, it would be impossible to ever delete /r/ if both NO-HIATUS and MAXV/IDENTV were highly ranked.

The alternative to ranking HNUC below *r would be to rank it above. A consideration of this alternative shows that it fails seriously, however. Since *r must outank either MAXV or IDENTV, then if HNUC outranks *r, the ranking established would be: HNUC >> *r >> MAXV/IDENTV. This ranking would cause nuclear harmony to overrule faithfulness, presumably replacing all nonharmonic high vowels with more harmonic nonhigh vowels. And even if this undesirable result were curtailed in some way, the analysis would fail by again treating nuclear harmony as ranked as a unit above *r with the result that high and nonhigh vowels should behave in the same way with respect to *r*-deletion.

One might attempt to salvage an HNUC analysis by unpacking HNUC but keeping it separate from faithfulness. According to this view, the relevant grammaticisation of HNUC for Yoruba could be as follows:

(44) *The Nuclear Harmony Constraint unpacked:*
*NUC/HIFRONT >> *NUC/HIBACK >> *NUC/NONHI

Such an account fails for reasons comparable to those just seen for the unpacked nuclear harmony constraints. To see this, consider possible rankings of the prohibition on /r/ with respect to the nuclear harmony constraints. As background, note as above that MAXV/IDENTV must be ranked above the constraints in (44) since otherwise all but the optimal vowel would be excluded in general; similarly, NO-HIATUS must be ranked above MAXV/IDENTV since otherwise vowel identity would be required even in a *V V* sequence. Given high ranking of MAXV/IDENTV, and given the harmonically fixed ranking of the nuclear harmony constraints, the relevant rankings including *r would be as follows:

(45) *Possible rankings with *r*
a. NO-HIATUS >> *r >> MAXV/IDENTV >> *NUC/HIFRONT >> *NUC/HIBACK >> *NUC/NONHI
b. NO-HIATUS >> MAXV/IDENTV >> *r >> *NUC/HIFRONT >> *NUC/HIBACK >> *NUC/NONHI
c. NO-HIATUS >> MAXV/IDENTV >> *NUC/HIFRONT >> *r >> *NUC/HIBACK >> *NUC/NONHI
d. NO-HIATUS >> MAXV/IDENTV >> *NUC/HIFRONT >> *NUC/HIBACK >> *r >> *NUC/NONHI
e. NO-HIATUS >> MAXV/IDENTV >> *NUC/HIFRONT >> *NUC/HIBACK >> *NUC/NONHI >> *r

To assess these rankings, three candidate types need to be considered: (i) V_i *r* V_j, (ii) V_i V_j , (iii) V_j V_j / V_i V_i. In the first type, there is no *r*-deletion, hence such forms violate *r. In the second type, *r*-deletion results in a violation of NO-HIATUS. In the third type, *r*-deletion and vocalic changes ensure that *r and NO-HIATUS are respected, but there is some violation of faithfulness, either MAXV or IDENTV. Given the high ranking of NO-HIATUS in all of (45), the second type of case (V_i V_j) would correctly be ruled out by all rankings. Consider therefore the choice between the type of candidate retaining /r/ (V_i *r* V_j) and the types of candidates involving loss of /r/ in conjunction with assimilation (V_j V_j / V_i V_i). Since the cases retaining /r/ violate *r, and since the cases involving assimilation violate either MAXV or IDENTV, the choice between the two types of candidates falls entirely on the relative ranking of *r with respect to MAXV/IDENTV. Hence the grammar in (45a) would evaluate the V_j V_j / V_i V_i types as optimal, while all four grammars in (45b-d) would evaluate the V_i *r* V_j type as optimal. None of the grammars make the necessary distinction between forms where /r/ occurs adjacent to a high or a nonhigh vowel. I illustrate this first with the ranking of (45a) and then with the ranking of (45e).

As seen in (43), ranking *r above MAXV/IDENTV incorrectly makes forms involving *r*-deletion optimal no matter what the vowel height is:

(46) *High ranking of *r*

			NO-HIATUS	*r	MAXV IDENTV	*NUC/ HIFRONT	*NUC/ HIBACK	*NUC/ NONHI	ANCHOR
(i) /òrìʃà/	a.	[oriʃa]		*!		*		**	
	b.	[oiʃa]	*!			*		**	
	c. 👍	[ooʃa]			*			**[20]	
	d.	[iiʃa]			*	*!		*	*
(ii) /òrayè/	a.	[oraye]		*!				***	
	b.	[oaye]	*!					***	
	c. ☠	[ooye]			*			**	
	d.	[aaye]			*			**	*!

To exclude forms such as *[ooye] and *[aaye], it must be the case that a constraint violated by both occurs above some constraint violated by [oraye] – the form that should be optimal. This would indeed be the result of a ranking such as (45e).

(47) *Low ranking of *r*

			NO-HIATUS	MAXV IDENTV	*NUC/ HIFRONT	*NUC/ HIBACK	*NUC/ NONHI	*r	ANCHOR
(i) /òrìʃà/	a. ☠	[oriʃa]			*		**	*	
	b.	[oiʃa]	*!		*		**		
	c.	[ooʃa]		*!			**		
	d.	[iiʃa]		*!	*		*		*
(ii) /òrayè/	a. 👍	[oraye]					***	*	
	b.	[oaye]	*!				***		
	c.	[ooye]		*!			**		
	d.	[aaye]		*!			**		*

Unfortunately, by lowering *r, the retention of /r/ becomes optimal in *all* cases, no matter what the vowel sequence is. Intermediate positions for *r would have no different results since the nuclear harmony family is irrelevant in any grammar where MAXV/IDENTV outrank *r.

I conclude that no ranking of *r with respect to a family of nuclear harmony constraints derives the correct result in the Yoruba case. This failing is a direct consequence of the lack of formal relation between nuclear harmony and faithfulness. If harmonic sonority relations are encoded as an integral part of the faithfulness relation, then the problem examined in this section disappears – as already demonstrated in section §6.

8 Conclusion

Structural properties of vowel representation seem largely orthogonal to the asymmetries observed in the Yoruba vowel system. Of crucial importance is a harmonic scale where the inertia of more sonorous vowels prevails over that of less sonorous vowels. The grammaticisation of this sonority-based pattern interacts with constraints governing various specific patterns of Yoruba phonology to produce interlocking patterns of vocalic asymmetries.

Rule-based accounts of Yoruba vowel patterns succeed in describing the range of patterns, but fail to explain them. Whether direct reference to feature values such as [+high] and [–high] is allowed, or whether underspecification for [±high] is assumed, rule-based accounts of Yoruba require a plethora of rules, each one tailored to a particular construction and building in the particular behaviour of vowels with respect to their height. Note in particular that the underspecified approach of Pulleyblank (1988) predicts some of the patterns of vowel behaviour, but predicts the opposite of the observed facts in other cases – obviously a serious problem for such an

---

[20] I assume that the [oo] of a form like [ooʃa] and the [ii] of a form like [ooʃa] count as single *NUC/NONHI violations since the forms would involve single sets of features linked to two moras in order to satisfy the NO-HIATUS constraint.

account. Were such an analysis to be reframed in terms of monovalent features, the problem would only be aggravated due to the structural inflexibility of such features.

In marked contrast, the optimality theoretic account proposed here succeeds by postulating a basic constraint set governing faithfulness to vocalic specifications, where the proposed set is based on considerations of sonority. This basic vocalic set then interacts directly with the constraints that govern other aspects of Yoruba phonology, for example, the constraints on hiatus, reduplication, the consonant inventory, and so on. The core of the proposal is the core set of vocalic constraints – those governing vocalic faithfulness.

The proposed account examines a significant portion of the phonology of Yoruba involving vowels, but is not, however, exhaustive. Matters of vowel epenthesis were mentioned only briefly, vowel harmony has been left unexamined[21] as has a relevant morpheme structure constraint discussed by Clements & Ṣonaiya (1990). While it would be desirable for a comprehensive treatment of vocalic phenomena to include these phenomena, there is no principled reason why a constraint-based approach to Yoruba vowels should be incompatible with such patterns. One phenomenon of particular relevance to the issues addressed here involves the pattern of nasality on both consonants and vowels. The relevance of this phenomenon is clear from both Pulleyblank (1988) and Clements & Ṣonaiya (1990). I have chosen to address this issue separately (Pulleyblank *in prep*) because of its relevance for general issues of fixed segmentism in reduplication (Alderete *et al* 1997), but argue that the observed patterns are fully compatible with the proposals for vocalic asymmetries presented here.

References

Adeniyi, Harrison Oluwadurotimi. 1988. *Aspects of the phonology and morphology of Ekiti*. M.A. thesis, University of Ibadan.

Akinlabi, Akinbiyi. 1984. *Tonal Underspecification and Yoruba Tone*. Ph.D. dissertation, University of Ibadan.

Akinlabi, Akinbiyi. 1993. Underspecification and the Phonology of Yoruba /r/. *Linguistic Inquiry* 24, 139–160.

Alderete, John, Jill Beckman, Laura Benua, Amalia Gnanadesikan, John McCarthy, & Suzanne Urbanczyk. 1997. Reduplication with Fixed Segmentism. Ms. University of Massachusetts, Amherst; University of Iowa; University of Maryland, College Park; Rutgers University; University of British Columbia.

Anderson, John M. & Colin J. Ewen. 1987. *Principles of Dependency Phonology*. Cambridge University Press, Cambridge.

Archangeli, Diana. 1988. *Underspecification in Yawelmani Phonology and Morphology*. Garland Press, New York.

Archangeli, Diana & Douglas Pulleyblank. 1989. Yoruba Vowel Harmony. *Linguistic Inquiry* 20, 173–217.

Archangeli, Diana & Douglas Pulleyblank. 1993. Two rules or one...or none? [ATR] in Yoruba. *Proceedings of the Nineteenth Annual Meeting of the Berkeley Linguistics Society*, Berkeley Linguistics Society, Berkeley, California, 13–26.

Archangeli, Diana & Douglas Pulleyblank. 1994. *Grounded Phonology*. MIT Press, Cambridge, MA.

Awobuluyi, Ọladele. 1967. Vowel and Consonant Harmony in Yoruba. *Journal of African Languages* 6, 1–8.

Awobuluyi, Ọladele. 1978. *Essentials of Yoruba Grammar*. Oxford University Press, Ibadan.

Awoyale, Yiwọla. To appear. Vowel assimilation and elision in Yorùbá: the interface of phonology and syntax. In B.R. Badejọ, ed., *Current Perspectives in African Linguistics*.

Bamgboṣe, Ayọ. 1967. Vowel Harmony in Yoruba. *Journal of African Languages* 6, 268–273.

Blake, Susan. 1998. The OCP and Root-Affix Faithfulness in St'át'imcets (Lillooet Salish). Ms., University of British Columbia.

[21] See Awobuluyi (1967) on front/back harmony and Bamgboṣe (1967), Awobuluyi (1967), Archangeli & Pulleyblank (1989, 1993, 1994), etc. on tongue root harmony.

Casali, Roderic F. 1996. *Vowel Elision in Hiatus Contexts: Which Vowel Goes?* Ph.D. dissertation, University of California, Los Angeles.

Clements, George N. 1988. The Role of the Sonority Cycle in Core Syllabification. *Working Papers of the Cornell Phonetics Laboratory* 2, 1–68.

Clements, George N. & R. Ṣonaiya. 1990. Underlying Feature Representation in Yoruba. *Studies in the Linguistic Sciences* 20, 89–103.

Cutler, Anne, John A. Hawkins, & Gary Gilligan. 1985. The suffixing preference: a processing explanation. *Linguistics* 23, 723–758.

Doak, Ivy G. 1992. Another look at Coeur d'Alene harmony. *International Journal of American Linguistics* 58, 1–35.

Fọlarin, Antonia Yetunde. 1987. *Lexical Phonology of Yoruba Nouns and Verbs*. Ph.D. dissertation, University of Kansas.

Goad, Heather. 1993. *On the Configuration of Height Features*. Ph.D. dissertation, University of Southern California.

Hall, Beatrice L. and R.M.R. Hall. 1980. Nez Perce vowel harmony: an Africanist explanation and some theoretical questions. In R.M. Vago, ed., *Issues in Vowel Harmony*, 201–236. John Benjamins, Amsterdam.

Hall, Beatrice L. and Eluzai Moga Yokwe. 1978. Bari vowel harmony: the evolution of a cross-height vowel harmony system. *Cunyforum* 5–6, 285–294.

Hall, Christopher J. 1992. *Morphology and Mind: A Unified Approach to Explanation in Linguistics*. Routledge, London.

Hulst, Harry van der. 1989. Atoms of segmental structure: components, gestures and dependency. *Phonology* 6, 253–284.

Lamontagne, Greg & Sam Rosenthall. 1996. Contiguity constraints and persistent vowel parsing. Ms. University of British Columbia & The Ohio State University.

Leitch, Myles. 1996. *Vowel Harmonies of the Congo Basin: An Optimality Theory Analysis of Variation in the Bantu Zone C.* Ph.D. dissertation, University of British Columbia.

Levergood, Barbara. 1984. Rule Governed Vowel Harmony and the Strict Cycle. In *Proceedings of NELS 14*, 275–293. GLSA, University of Massachusetts, Amherst.

Lombardi, Linda. 1995. Why Place and Voice are different: Constraint interactions and feature faithfulness in Optimality Theory. Ms., University of Maryland, College Park. ROA-105.

Lombardi, Linda. 1998. Evidence for MaxFeature constraints from Japanese. Ms., University of Maryland, College Park.

McCarthy, John. 1993. A Case of Surface Constraint Violation. *Canadian Journal of Linguistics* 38, 169–195.

McCarthy, John & Alan Prince. 1993. Generalized Alignment. In Geert Booij & Jaap van Marle, eds., *Yearbook of Morphology 1993*, 79–153. Kluwer, Dordrecht.

McCarthy, John & Alan Prince. 1995. Faithfulness and reduplicative identity. In Jill N. Beckman, Laura Walsh Dickey, and Suzanne Urbanczyk, eds., *Papers in Optimality Theory*, University of Massachusetts Occasional Papers 18, 249–384.

McCarthy, John & Alan Prince. To appear. Faithfulness and identity in prosodic morphology. In René Kager, Harry van der Hulst, and Wim Zonneveld, eds., *The Prosody Morphology Interface*. Cambridge University Press, Cambridge.

Myers, Scott. *To appear*. OCP effects in Optimality Theory. *Natural Language and Linguistic Theory*.

Ọla, O. (1995) *Optimality in Benue-Congo prosodic phonology and morphology*. Ph.D. dissertation, University of British Columbia.

Omisore, Folasade Omolola. 1989. *A comparative study of Ife, Ijesa and Ekiti dialects*. B.A. Long Essay, University of Ilọrin.

Oyelaran, Ọlasope Oyediji. 1971. *Yoruba Phonology*. Ph.D. dissertation, Stanford University.

Paradis, Carole & Jean-François Prunet. Editors. 1991. *The Special Status of Coronals: Internal and External Evidence*, Phonetics and Phonology, Volume 2, Academic Press, San Diego.

Prince, Alan & Paul Smolensky. 1993. *Optimality Theory: Constraint Interaction in Generative Grammar*. Ms. Rutgers University and University of Colorado, Boulder.

Prunet, Jean-François. 1986. *Spreading and Locality Domains in Phonology*. Ph.D. dissertation, McGill University.

Pulleyblank, Douglas. 1986. *Tone in Lexical Phonology*. D. Reidel, Dordrecht.

Pulleyblank, Douglas. 1988. Vocalic Underspecification in Yoruba. *Linguistic Inquiry* 19, 233–270.

Pulleyblank, Douglas. 1996. Neutral Vowels in Optimality Theory: A Comparison of Yoruba and Wolof. *Canadian Journal of Linguistics* 41, 295–347.

Pulleyblank, Douglas. 1998. Markedness-based feature-based faithfulness. Paper presented at the South Western Optimality Theory Conference, University of Arizona.

Pulleyblank, Douglas. In preparation. Markedness in Yoruba gerundive reduplication.

Rosenthall, Sam. 1994. Vowel/Glide Alternation in a Theory of Constraint Interaction. Ph.D. dissertation, University of Massachusetts, Amherst.

Smolensky, Paul. 1993. Harmony, markedness, and phonological activity. Paper presented at the Rutgers Optimality Workshop #1, Rutgers University.

Steriade, Donca. 1995. Underspecification and Markedness. In John Goldsmith, ed., *The Handbook of Phonological Theory*, 114–174. Basil Blackwell, Cambridge, MA.

1998 June 29

Department of Linguistics
University of British Columbia
E270-1866 Main Mall
Vancouver, BC V6T 1Z1

Douglas.Pulleyblank@ubc.ca