Contrastive Features and Microvariation in Vowel Harmony*

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1. Introduction

Nevins (2010) looks at two Yoruba dialects that share the same basic type of vowel harmony, but differ in some important details. He proposes that in one dialect only vowels that are *contrastive* for the harmonizing feature participate, whereas in the other dialect *all* vowels with the relevant feature do. On this view, a major source of this kind of *microvariation* is whether noncontrastive features can participate in harmony: in some dialects they don't, in others they do.

How one defines contrast is crucial: features designated noncontrastive under one definition may be contrastive under another. I will argue that the Yoruba microvariation can be explained differently: harmony computes only *contrastive* features in *both* Yoruba dialects; the microvariation is a consequence of *feature ordering*, or feature *scope* differences between the dialects.

At issue is, technically, how one identifies which features are contrastive: I will argue that contrast follows from feature ordering. More generally, the larger question is whether contrastive features play a special role in the phonology: I will argue that the Yoruba facts are consistent with the view that only contrastive features are computed.

2. Vowel Harmony in Yoruba Dialects

In Ifẹ Yoruba, lax (or RTR) mid vowels /ɛ, ɔ/ can occur non-finally only when another lax mid vowel follows (1a,b). Harmony is computed only with respect to mid vowels (leaving aside /a/ for now); a high tense vowel can intervene (1c,d), even though high vowels are [-RTR]. Standard Yoruba has the same harmony (1e,f), except that high vowels count in the

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computation (1g,h). Only tense mid vowels may precede a high vowel, even if a lax mid vowel occurs to the right.

(1) *Vowel harmony in Ifẹ and Standard Yoruba*

	Ifẹ Yoruba		Gloss		Standard Yoruba	
a.	olè	*ɔlè	'thief'	e.	olè	*ɔlè
b.	ɔsɛ	*osɛ	'soap'	f.	ɔsɛ	*osɛ
c.	ɔrúkɔ	*orúkɔ	'name'	g.	orúkɔ	*ɔrúkɔ
d.	ὲlùbɔ́	*èlùbɔ́	'yam flour'	h.	èlùbɔ́	*ὲlùbɔ́

Nevins (2010: 16) explains the difference as follows:

> The locality of vowel harmony in Ifẹ Yoruba is determined by the closest vowel contrastive for the tense/lax distinction, while the locality of vowel harmony in Standard Yoruba is determined by the closest vowel, period.

Below in Figure 1 is how harmony applies to the word *ɔrúkɔ* 'name' in Ifẹ Yoruba, on Nevins's analysis. On his approach, the initial mid vowel is unspecified for [RTR] (designated "O") and seeks a value from the nearest contrastive source to the right. In Ifẹ Yoruba, the nearest such source is the [+RTR] mid vowel /ɔ/; it does not "see" the noncontrastive [-RTR] feature on the /ú/.

O	r	ú	k	ɔ
[ ]		[–RTR]		[+RTR]

= ɔrúkɔ

Figure 1. *Ifẹ Yoruba vowel harmony for* ɔrúkɔ *'name'*

Standard Yoruba, according to Nevins, computes all values of [RTR], contrastive as well as noncontrastive. The "needy" initial vowel first encounters the [-RTR] feature on the high vowel /ú/. It copies this noncontrastive [-RTR], so the result is *orúkɔ* (Figure 2).

O	r	ú	k	ɔ
[ ]		[–RTR]		[+RTR]

= orúkɔ

Figure 2. *Standard Yoruba vowel harmony for* orúkɔ *'name'*

3. Minimal Contrast

But how do we know that the high vowels in Yoruba have noncontrastive [RTR] features? How do we establish what the contrastive features are? Phonologists working in a variety of theoretical frameworks have independently proposed that "minimal contrast" (MC) plays an important role in phonology (Padgett 2003, Calabrese 2005, Nevins 2010 explicitly, and many others implicitly). According to the definition proposed by Nevins (2010: 98), a segment S with specification [αF] is contrastive for F if there is another segment S′ in the inventory that is featurally identical to S, except that it is [$-\alpha$F].

Both Yoruba dialects have the seven vowels shown in (2). Let us assume that the vowels are specified for the features shown in (2a) (not an innocuous assumption). On the MC approach, only vowels that are identical except for their values of [RTR] can be contrastive for this feature. This is true only of the mid vowels. Since there no high vowels that are [+RTR], high vowels cannot be contrastive for this feature (2b). Therefore, if high vowels block harmony in Standard Yoruba, it must be because [RTR] harmony computes *all* features, not just contrastive ones.

(2) *Yoruba vowel inventory*

a. Fully specified (for the features below)

	i	e	ɛ	a	ɔ	o	u
[low]	–	–	–	+	–	–	–
[high]	+	–	–	–	–	–	+
[round]	–	–	–	–	+	+	+
[RTR]	–	–	+	+	+	–	–

b. MC contrastive features

	i	e	ɛ	a	ɔ	o	u
[low]			–	+			
[high]	+	–				–	+
[round]	–	–	–		+	+	+
[RTR]		–	+		+	–	

These conclusions follow from the MC approach to contrast; but I have argued (Dresher 2009) that MC is not the right way to establish which features are contrastive. The main problem with MC is that fewer phonemes than we might think are "featurally identical" with respect to *all* features that they might possibly possess. More usually we ignore "small" or "irrelevant" differences when assessing if two phonemes are minimally different.

An example of the shortcomings of MC and how they are often tacitly set aside is Nevins's discussion of the Turkish vowel system (2010: 26). In keeping with traditional analyses, he observes that the features [high], [back], and [round] are sufficient to uniquely determine each of the eight vowels of Turkish (Table 1). Every feature specification is contrastive, because the vowels completely fill the $2^3 = 8$ cell vowel space (Figure 3).

Nevins does not mention the feature [low], even though it is one of the features commonly employed in vowel systems. Limiting Turkish to a single height feature is crucial in achieving the elegant traditional classification of Turkish vowels. With just these three features, every feature specification is contrastive according to MC. Every vowel has three counterparts that differ from it with respect to exactly one feature. For example, /i/ differs from /y/ only in [round], from /ɨ/ only in [back], and from /e/ only in [high].

	[–back]		[+back]	
	[–round]	[+round]	[–round]	[+round]
[+high]	i	y	ɨ	u
[–high]	e	ø	a	o

Table 1. *Turkish vowels*

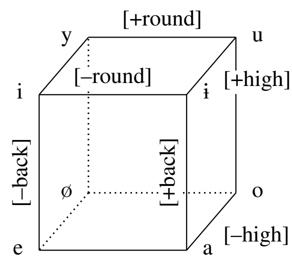


Figure 3. *Turkish vowel features*

If we were to include [low], the vowel system would look different. In Table 2, not all pairs are minimal: MC would not give the desired results. In particular, /ɨ/ is no longer contrastively [+high], /e/ is not contrastively [–back], and /o/ is not contrastively [+round]. /a/ has no contrastive features at all.

	[–back]		[+back]		
	[–round]	[+round]	[–round]	[+round]	
[+high]	i	y	ɨ	u	[–low]
[–high]	e	ø		o	[–low]
[–high]			a		[+low]

Table 2. *Turkish vowels with [low] included*

Dresher (2009: 19–29) argues that MC fails in many common situations to yield adequate contrastive representations. This is hardly a surprise: Archangeli (1988) showed the same. In fact, *everybody* knows that MC does not really work. Consider, for example, a simple three-vowel system with the feature specifications in (3).

(3) *A simple three-vowel system*

	i	a	u
[high]	+	–	+
[back]	–	+	+
[round]	–	–	+
[low]	–	+	–

There are no minimal contrasts here at all. The three phonemes are too far apart in the $2^4 = 16$ slot feature space. There are no minimal pairs, so MC would find no contrastive features. This is not a good result. However, most phonologists do not try to specify four features for a three-vowel system, so this failure of MC would not usually be noticed.

4. Contrastive Feature Hierarchies

There is in fact an alternative to MC that has an equally prestigious pedigree in phonological theory. This approach is based on *feature ordering*, that is, a *contrastive hierarchy* of features. Reflecting on the cases we have seen, we can see that feature ordering is actually implicit in rescuing MC. For example, ordering is implicit in the traditional analysis of Turkish vowels. The features [high], [back], and [round] are ordered ahead of [low] and other possible features, as in Figure 4.[1] Once the top three features have applied, all vowels are contrastive and no further contrastive features can be assigned. Ordering provides the *rationale* and *justification* for omitting [low] and [ATR] from the analysis of Turkish.

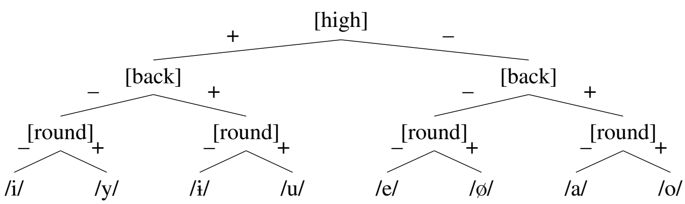
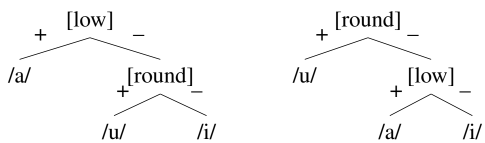


Figure 4. *A contrastive feature hierarchy for Turkish vowels*

Similarly, ordering allows us to select only two features for a three-vowel system, as in Figure 5.



(a) *[low] > [round]* **(b)** *[round] > [low]*

Figure 5. *Different orderings produce different contrastive specifications*

Branching trees that express contrasts have antecedents in the work of Roman Jakobson and his collaborators. A tree of this kind underlies the feature specifications in Jakobson and Lotz (1949), and is explicit in Jakobson et al. (1952), Jakobson and Halle (1956), and other publications. Such a tree is prominent in Halle's *Sound pattern of Russian* (Halle

[1] The tree shows one of several possible orderings of the top three features.

1959). Halle argues that such trees are the only way of ensuring that phonemes are properly distinctive.

Feature ordering is a way of determining contrastive specifications, via the *Successive Division Algorithm* (SDA, Dresher 1998, 2003, 2009; based on Jakobson et al. 1952, Jakobson and Halle 1956), given informally in (4).[2] The ordered list of features is called the *contrastive hierarchy* for the language in question.

(4) *The Successive Division Algorithm*

a. Begin with *no* feature specifications: assume all sounds are allophones of a single undifferentiated phoneme.
b. If the set is found to consist of more than one contrasting member, select a feature and divide the set into as many subsets as the feature allows for.
c. Repeat step (b) in each subset: keep dividing up the inventory into sets, applying successive features in turn, until every set has only one member.

Following work in the Modified Contrastive Specification (MCS) framework (Avery and Rice 1989, Dresher et al. 1994, Dresher and Rice 2007, Hall 2007, Dresher 2009, Mackenzie 2009), I assume that feature hierarchies may *vary* from language to language.

Even closely related dialects with identical-looking inventories may have different contrastive relations due to different feature orderings. A nice example of this is given by Mackenzie (2005, 2009). Both Anywa (Reh 1996) and Dholuo (Tucker 1994), related Nilotic languages, have a dental∼alveolar contrast in the coronal stops; in both languages, the alveolar nasal /n/ has no dental nasal partner (Table 3). Should /n/ be considered contrastively alveolar, or is it outside the dental∼alveolar contrast, being only redundantly alveolar?

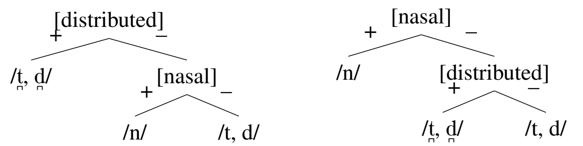
	Dental	Alveolar
Voiceless stops	t̪	t
Voiced stops	d̪	d
Nasals		n

Table 3. *Anywa and Dholuo coronal stops (Tucker 1994, Reh 1996)*

Mackenzie (2005, 2009) argues that the two languages adopt different solutions to this question: in Anywa /n/ acts as if it is contrastively alveolar with respect to co-occurrence restrictions; in Dholuo it acts neutrally with respect to the contrast. This difference can be accounted for by positing that in Anywa, the ordering is [distributed] > [nasal] (Figure 6a); in Dholuo, the ordering is [nasal] > [distributed] (Figure 6b).

It follows that, where MC always gives a *fixed* set of contrastive features for a given inventory, the SDA allows for a *variety* of outcomes, depending on how the features are

[2] For a more procedurely explicit version of the SDA, see Dresher (2009: 17n). The SDA itself does not specify the ordering of the features; this is something learners have to acquire. The algorithm is also agnostic as to whether features are innate or emergent.



(a) *Anywa: [distributed] > [nasal]* **(b)** *Dholuo: [nasal] > [distributed]*

Figure 6. *Different feature orderings in two Nilotic dialects (Mackenzie 2009)*

ordered. In this connection it is also important to note that the MC approach labels *fewer* features as contrastive than does the SDA. For example, assuming that the three Nilotic phonemes /d̪, d, n/ are specified, among other features, by [distributed] and [nasal] (5a), MC designates four specifications as contrastive and two as redundant, as shown in (5b).

(5) *Anywa and Dhuluo feature specifications by MC: /d̪, d, n/*

a. Fully specified / b. MC contrastive features

d̪	d	n		d̪	d	n
+	−	−	[distributed]	+	−	
−	−	+	[nasal]		−	+

The SDA, however, designates five features as contrastive and only one feature as redundant, in either order, as shown in (6): example (6a) corresponds to Anywa (Figure 6a), and (6b) corresponds to Dhuluo (Figure 6b).

(6) *Anywa and Dhuluo feature specifications by the SDA: /d̪, d, n/*

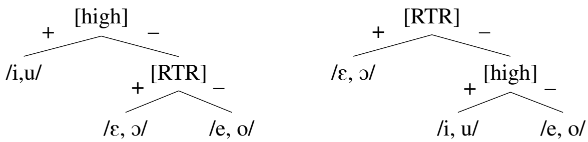
a. [dist] > [nasal] / b. [nasal] > [dist]

d̪	d	n		d̪	d	n
+	−	−	[distributed]	+	−	
	−	+	[nasal]	−	−	+

Therefore, we might expect there to be cases where in an MC analysis it *looks like* noncontrastive features are active in vowel harmony; but those same features could be designated contrastive by the SDA.

5. Yoruba Vowel Harmony Again

I argue that such cases in fact arise in Nevins's (2010) analyses of vowel harmony. Recall that in his analysis of Yoruba, only mid vowels are contrastive for [RTR]. This conclusion does not follow in a hierarchical approach to contrast. The SDA *can* limit contrastive [RTR] to mid vowels, corresponding to ordering the features [high] > [RTR] (Figure 7a). But the other ordering is also possible. On this ordering, *all* vowels are contrastive for [RTR], including the high vowels (Figure 7b).



(a) *[high] > [RTR] (Ifẹ Yoruba)* **(b)** *[RTR] > [high] (Std. Yoruba)*

Figure 7. *Determining contrastive features with the SDA*

It is thus not obvious that Standard Yoruba vowel harmony computes noncontrastive features. The difference between the dialects may be one of feature ordering, a difference in the relative scope of [RTR]: in Ifẹ Yoruba the high vowels are not included, and in Standard Yoruba they are. On this view, *both* Ifẹ and Standard Yoruba limit [RTR] harmony to contrastive values of [RTR].

Interesting support for the hierarchical approach to contrast comes from the behaviour of the low vowel /a/. In the MC approach, /a/ has a contrastive [+low] feature, but no other feature, including [RTR], is contrastive, because no other feature uniquely distinguishes /a/ from another phoneme, as was shown in (2). On this approach we might expect, then, that /a/ would pattern in parallel with the high vowels: that it would be neutral to [RTR] harmony in Ifẹ Yoruba (which computes contrastive values only), but that it would participate in harmony in Standard Yoruba (where all values are computed). But this is not what happens: /a/ triggers [RTR] harmony in *both* dialects, as shown in (7) (Ọla Orie 2001).

(7) /a/ *in Yoruba [RTR] harmony*

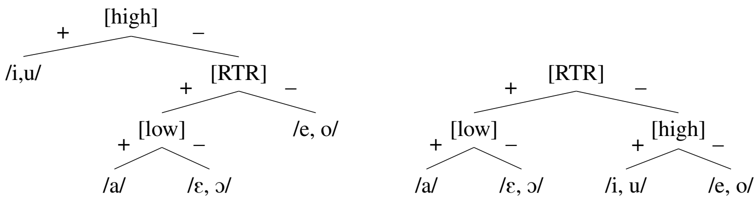
	Ifẹ Yoruba		Gloss	Standard Yoruba	
	Expected	Actual		Expected	Actual
a.	*oba	ɔba	‘king’	ɔba	ɔba
b.	*èpà	ɛ̀pà	‘peanut’	ɛ̀pà	ɛ̀pà

Nevins (2010: 194) has an explanation for why /a/ participates in [RTR] harmony in Ifẹ Yoruba, even though harmony in this dialect is limited to contrastive features, and /a/ is not contrastive for [RTR]. He writes:

> . . . elements can terminate the search as a result of their inherent high-sonority. These sonority-peaks should be excluded from the domain of search by their noncontrastive value, but impose a hurdle past which search cannot proceed.

That is, Nevins needs to appeal to a special explanation for the patterning of /a/ in Ifẹ Yoruba, based on its sonority. But feature ordering yields a simpler account. We haven’t considered where the feature [low] fits into the contrastive hierarchies of these dialects. Evidently, /a/ is contrastive for [RTR] in both dialects, the result of ordering [low] after [RTR] in both, as shown in Figure 8.[3]

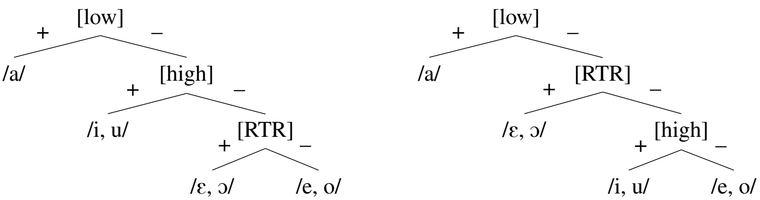
[3] The relative ordering of [high] and [low] in Standard Yoruba cannot be determined, because the two features do not interact.



(a) *[hi] > [RTR] > [low] (Ifẹ Yoruba)* **(b)** *[RTR] > [hi], [low] (Std. Yoruba)*

Figure 8. *SDA contrastive features in Yoruba*

One might argue that this result is not *required* by the SDA: we can order the features this way if this gives the correct result. But the theory also allows for other orderings; for example, we can put [low] at the top of the order, which puts /a/ outside the domain of [RTR] harmony (Figure 9).



(a) *[low] > [high] > [RTR]* **(b)** *[low] > [RTR] > [high]*

Figure 9. *Alternate Yoruba feature orderings*

Nevins (2010: 195) predicts that certain patterns allowed by free ordering do not occur. I paraphrase his formulation as follows:

> Given a language where some vowels are contrastive for a feature (e.g. [RTR]), and where other vowels are noncontrastive for that feature (by MC: here the high and low vowels); and given that harmony normally computes only contrastive features; then, if the noncontrastive vowels differ in sonority, it will never be the case that a higher sonority noncontrastive vowel (/a/) is transparent while a lower sonority noncontrastive vowel (/i, u/) is not.

Looking at this from the point of view of feature ordering, the prediction is that the order [low] > [RTR] > [high] is not permitted. In such a language, /a/ is outside the harmony domain, hence transparent and non-triggering, whereas the high vowels are in the scope of the harmonizing feature, hence are expected to block the spread of [+RTR], or be donors of [–RTR]. That is, in this language we might expect forms like *oba* and *orako*, as well as forms like *obi (*ɔbi*) and *orikɔ (*ɔrikɔ*).

It is not clear, however, that this prediction is correct. Leitch (1996) and Casali (2008) show that there is a lot of variation in the behaviour of /a/ in vowel systems with [RTR/ATR] harmony. For example, Leitch (1996: 127) observes that in Bolia, a Bantu (C-30) language with a seven-vowel system like that of Yoruba, the low vowel /a/ assimilates completely to a preceding [RTR] mid vowel. But this assimilation is blocked by a high vowel /i/. This pattern appears to go against the sonority-based prediction, which predicts that it will never be the case that a higher sonority noncontrastive vowel (/a/) is transparent while a lower sonority noncontrastive vowel (/i, u/) is not.

However, it should be noted that the behaviour of /a/ in these Bantu languages is completely different than in Yoruba, and the mechanism for the harmony in these languages may also be quite different. Therefore, it is possible that Nevins's sonority prediction may be saved once we further articulate the specific formal conditions under which it holds.

Second, if the prediction is correct, then it is still compatible with a feature-ordering approach. In particular, it would indicate that there are constraints on possible feature ordering, an interesting result if true. But the point still stands that there is no reason to suppose that Standard Yoruba harmony computes noncontrastive features.[4]

6. The Contrastivist Hypothesis

We have seen that, once we abandon the MC approach to contrast and adopt feature ordering, it is no longer necessary to allow Yoruba vowel harmony to target noncontrastive features in either of the two dialects considered above. It follows that Yoruba remains consistent with what Hall (2007: 20) calls the *Contrastivist Hypothesis* (8):

(8) *The Contrastivist Hypothesis*
The phonological component of language L operates only on those features which are necessary to distinguish the phonemes of L from one another.

As Clements (2001: 79) remarked: “This hypothesis is attractive in that, if true, it would place strong constraints on the nature of feature representation.” Clements himself thought that the hypothesis is too strong, and he allowed noncontrastive features to be added if required by phonological activity. I have argued (Dresher 2009: 235–237) that Clements's conclusion follows from his adoption of a universal (with some modifications) feature hierarchy. As is the case with MC, a universal feature hierarchy may misidentify which features are actually contrastive in a given language.

7. Variation in Feature Hierarchies

Since variation in the feature hierarchy is a key element of the theory proposed here, one may question to what extent the sort of variation proposed above for Yoruba and Nilotic dialects is attested in other languages. A survey of the literature reveals a great deal of such variation, though not usually acknowledged as such.

[4] This conclusion holds with respect to the vowel harmony facts considered by Nevins (2010). A complete demonstration that Yoruba phonology computes only contrastive features would require that we look at all forms of phonological activity in these dialects.

Consider, for example, some recent analyses of the Catalan vowel system. The Catalan vowel inventory is superficially similar to that of Yoruba, and we find different approaches to the relative scopes of the height features and [ATR]. In Crosswhite's (2001) analysis of Eastern Catalan (Table 4), [ATR] is limited to the mid vowels; it has narrow scope relative to [high] and [low]. In the analyses of Walker (2005) and Lloret (2008), Valencian Catalan [ATR] is contrastive over all vowels (Table 5); it takes scope over the height features.

		[+front]	[–front]
[+high]		i	u
	[+ATR]	e	o
	[–ATR]	ɛ	ɔ
[+low]		a	

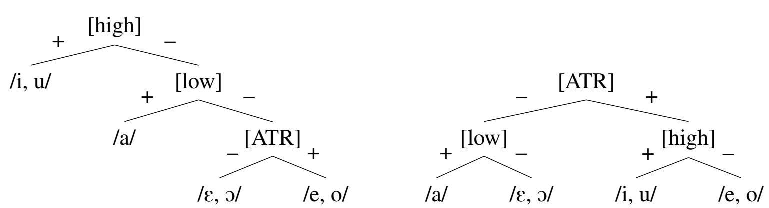
Table 4. *Eastern Catalan (Crosswhite 2001)*

		[front]	[back]
[+ATR]	[high]	i	u
		e	o
[–ATR]		ɛ	ɔ
	[low]	a	

Table 5. *Valencian Catalan (Walker 2005, Lloret 2008)*

The analysis of Eastern Catalan is tantamount to ordering the features [high] and [low] over [ATR]. The tree in Figure 10a represents one ordering consistent with this analysis, [high] > [low] > [ATR]. The analysis of Valencian Catalan is tantamount to ordering [ATR] over the height features, an ordering reflected by the tree in Figure 10b, which expresses the order [ATR] > [high], [low].

It could be that these dialects really differ in this way, or perhaps one of these analyses is incorrect. The point is that variation in the relative scopes of features is common in the literature, and it is likely that at least some of this variation reflects actual cross-linguistic variation in feature hierarchies.



(a) *[high] > [low] > [ATR] (Eastern Catalan)* **(b)** *[ATR] > [high], [low] (Valencian Catalan)*

Figure 10. *Different feature orderings in Catalan*

8. Conclusion

I have argued that contrast must be assessed hierarchically, and I have tried to show that this approach is already implicit in many phonological analyses in the literature. I have also shown that non-hierarchical approaches to contrast, or approaches that assume a fixed universal feature hierarchy, tend to mistakenly identify as noncontrastive certain features that may in fact be contrastive. When the theory advocated here is adopted, an apparent counterexample to the Contrastivist Hypothesis (Standard Yoruba) can be shown to be consistent with this hypothesis. It follows that the evidence for this hypothesis is stronger than has been widely assumed.

References

Archangeli, Diana. 1988. Aspects of underspecification theory. *Phonology* 5:183–207.

Avery, Peter, and Keren Rice. 1989. Segment structure and coronal underspecification. *Phonology* 6:179–200.

Calabrese, Andrea. 2005. *Markedness and economy in a derivational model of phonology*. Berlin: Mouton de Gruyter.

Casali, Roderic F. 2008. ATR harmony in African languages. *Language and Linguistics Compass* 2:496–549.

Clements, G. N. 2001. Representational economy in constraint-based phonology. In *Distinctive feature theory*, ed. T. Alan Hall, 71–146. Berlin: Mouton de Gruyter.

Crosswhite, Katherine M. 2001. *Vowel reduction in Optimality Theory*. New York: Routledge.

Dresher, B. Elan. 1998. On contrast and redundancy. Paper presented at the annual meeting of the Canadian Linguistic Association, May, Ottawa. Ms., University of Toronto, Toronto, Ont.

Dresher, B. Elan. 2003. Contrast and asymmetries in inventories. In *Asymmetry in grammar, vol. 2: Morphology, phonology, acquisition*, ed. Anna-Maria di Sciullo, 239–257. Amsterdam: John Benjamins.

Dresher, B. Elan. 2009. *The contrastive hierarchy in phonology*. Cambridge: Cambridge University Press.

Dresher, B. Elan, Glyne L. Piggott, and Keren Rice. 1994. Contrast in phonology: Overview. *Toronto Working Papers in Linguistics* 13:3–17.

Dresher, B. Elan, and Keren Rice. 2007. Markedness and the contrastive hierarchy in phonology. URL `http://homes.chass.utoronto.ca/~contrast`.

Hall, Daniel Currie. 2007. The role and representation of contrast in phonological theory. Doctoral dissertation, University of Toronto, Toronto, Ont.

Halle, Morris. 1959. *The sound pattern of Russian: A linguistic and acoustical investigation*. The Hague: Mouton, second printing, 1971 edition.

Jakobson, Roman, C. Gunnar Fant, and Morris Halle. 1952. *Preliminaries to speech analysis: The distinctive features and their correlates*. MIT Acoustics Laboratory, Technical Report, No. 13. Reissued by MIT Press, Cambridge, Mass., eleventh printing,

1976 edition.
Jakobson, Roman, and Morris Halle. 1956. *Fundamentals of language*. The Hague: Mouton.
Jakobson, Roman, and John Lotz. 1949. Notes on the French phonemic pattern. *Word* 5:151–158.
Leitch, Myles. 1996. Vowel harmonies of the Congo basin: An Optimality Theory analysis of variation in the Bantu zone C. Doctoral dissertation, University of British Columbia, Vancouver.
Lloret, Maria-Rosa. 2008. On the nature of vowel harmony: Spreading with a purpose. In *Proceedings of the XXXIII Incontro di Grammatica Generativa*, ed. Antonietta Bisetto and Francesco E. Barbieri, 15–35. Bologna: University of Bologna.
Mackenzie, Sara. 2005. Similarity and contrast in consonant harmony systems. *Toronto Working Papers in Linguistics (Special Issue on Similarity in Phonology)* 24:169–182.
Mackenzie, Sara. 2009. Contrast and similarity in consonant harmony processes. Doctoral dissertation, University of Toronto, Toronto, Ont.
Nevins, Andrew. 2010. *Locality in vowel harmony*. Cambridge, Mass.: MIT Press.
Ọla Orie, Ọlanikeẹ. 2001. An alignment-based account of vowel harmony in Ifẹ Yoruba. *Journal of African Languages and Linguistics* 22:117–143.
Padgett, Jaye. 2003. Contrast and post-velar fronting in Russian. *Natural Language and Linguistic Theory* 21:39–87.
Reh, Mechthild. 1996. *Anywa language: Description and internal reconstructions*. Cologne: Ruddiger Koppe.
Tucker, Archibald. 1994. *A grammar of Kenya Luo (Dholuo)*. Cologne: Ruddiger Koppe.
Walker, Rachel. 2005. Weak triggers in vowel harmony. *Natural Language and Linguistic Theory* 23:917–989.

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