Phonology in the 21st Century:
In Honour of Glyne Piggott

McGill University, May 7–9 2011

Is harmony limited to contrastive features?

B. Elan Dresher
University of Toronto

Jean-Roger Vergnaud
1945 - 2011

Jonathan Kaye, taalkundige en vader van
Kunstkind dat zelf accenten legt

Liesbeth Koenen

'Eindelijk bereiken we het punt waarop de taalkunde commercieel aantrekkelijk wordt, daar ben ik absoluut van overtuigd", zegt Jonathan Kaye. Kaye is van huis uit fonoloog, maar kijkt veel verder dan de klankleer lang is. Samen met prof. B. Dresher werkt hij al enkele jaren aan een klassieke vraag: Hoe leren kleine kinderen hun moedertaal? Maar hun aanpak is weinig conventioneel—ze laten een computer een kind simuleren.
Om hun computerkind een beetje overzichtelijk te houden, beperken ze zich voorlopig tot één onderdeel van de taalsystematiek: het klemtoonpatroon van woorden. Op welke lettergreep van een woord het accent komt te liggen verschilt van taal tot taal. Maar ook binnen een taal zijn er gewoonlijk uitzonderingen op de regel te vinden. Een 'vreemd' woord als *catálogus* valt buiten het Nederlandse systeem, dat juist *catalógus* voorspelt.
Het idee van Dresher en Kaye was een programma te schrijven dat voor *alle* talen werkt. Net zoals kleine kinderen iedere willekeurige taal kunnen leren—gewoon, door te luisteren naar de omgeving—zo moet ook de computer het klemtoonpatroon van een willekeurige taal kunnen oppikken uit de voorbeeldwoorden waarmee je hem 'voedt'. Heb je dat op de goede manier aangepakt, dan kan de machine na een tijdje bij nieuwe woorden zelf het juiste accent zetten. Natuurlijk is het systeem niet uitgeprobeerd op alle talen, maar de resultaten bereikt in verschillende taalfamilies zijn tot nu toe hoopgevend.

Een hoop geld

Kaye (45) is een Newyorker die al lange tijd verbonden is aan de universiteit van Québec in Montréal, Canada. Hij zit boordevol ideeën die er in rap tempo uitrollen. Druk gebarend en af en toe even zoekend naar een—liefst Nederlands—voorbeeld, snijdt hij het ene taalkundige onderwerp na het andere aan. Toch raakt hij de draad nooit kwijt, zelfs niet als we ons gesprek pas de volgende dag kunnen voortzetten. Ik sprak met hem in Venetië, tijdens het GLOW-congres, de belangrijkste jaarlijks terugkerende taalkundige conferentie in Europa. Kaye bleek er behalve voor taalkunde

Jonathan Kaye, fonoloog, is verbonden aan de universiteit van Quebec.

precies de problemen waar het in het linguistisch onderzoek van nu over gaat. Chomsky opperde een jaar of tien geleden een idee: dat systematische taalverschillen uitgedrukt kunnen worden in 'parameters'—en parameters zijn heel goed te verenigen met dat er 47 van die parameters zijn, ieder met een waarde A of B, of 'aan' of 'uit', je kunt het noemen zoals je wilt. Dat lijkt niet veel, maar levert maar liefst 2 tot de macht 47 mogelijke verschillende systemen op. Een astronomisch hoog aantal. Maar bekeken vangrieten'. Alle Europese talen vormen hun meervouden door middel van achtervoegsels. Bij veel Westafrikaanse talen wordt er juist iets vóór het woord gezet, *oeglas* is dan bijvoorbeeld een glas en *miglas* is het meervoud.
Zo zijn er misschien nog een paar andere mogelijkheden, maar het zijn er zeker niet veel. Geen enkele menselijke taal zal bij voorbeeld van een enkelvoud meervoud maken door het woord achterstevoren uit te spreken. Een kind zou dat nooit kunnen leren, zo zitten we niet in elkaar.
Baby's weten ongeveer wat ze kunnen verwachten en kijken uit naar iets aan het eind of aan het begin van een woord. Door te luisteren naar wat pappie en mammie tegen ze zeggen kunnen ze een paramater 'zetten': het knopje gaat om. Natuurlijk gebeurt dat allemaal volkomen onbewust. Als je een kind 'blootstelt' aan een taal pikt het er vanzelf de aanknopingspunten uit die nodig zijn om de knopjes in de juiste stand te fixeren. Taalkundigen kunnen erachter komen wat die aanknopingspunten zijn. Het onderzoek van Kaye is vooral daarop gericht.
Kaye: "Ik ben met die computer begonnen omdat ik me kwaad maakte over de psychologen uit de behavioristische hoek die altijd riepen: 'Leuk wat jullie allemaal bedenken, maar die theoretische modellen van taalkundigen zijn psychologisch gezien natuurlijk onzin, ze hebben niets met de realiteit te maken.' De mooiste manier om die mensen te laten zien dat ze ongelijk hadden leek mij om een model te maken dat *werkte*. Als je een model bouwt dat inderdaad kan doen wat een kind doet, dan kan niemand volhouden dat dat model onrealistisch is."
Het blijkt helemaal niet moeilijk om de juiste parameters in te voeren, die het accent op de goede plaats zetten. Kaye: "Maar wil je de machine, op basis van een rijtje woorden voorzien van de juiste klemtoon *zelf* de parameters laten fixeren, dan wordt het lastiger. En je komt in de problemen zodra de le uitzonderingen en tegenstrijdigheden heen.
Kaye: "Je moet dus achter de strategie waarmee ze dat doen zien te komen. Eén ding ligt daarbij voor de hand: uitzonderingen moeten speciaal onthouden worden. Als kinderen fouten maken dan gaat het altijd om uitzonderingen die ze behandelen als regelmatigheden. Ze zeggen bij voorbeeld *slaapte* en *ge-eten*. Een machine die leert als een mens moet dus ook bepaalde woorden 'onthouden', er een sterretje bij zetten, ze op de een of andere manier markeren. Kan hij dat, dan heb je meer dan alleen een werkend model, dan begin je een soort kunst-kind te krijgen."
Hoe kom je nu te weten bij welke woorden een sterretje moet staan? Je kunt kijken naar de aard van de uitzonderingen. Past een uitzondering in geen enkel klemtoonsysteem, dan is het gemakkelijk. Maar dikwijls is iets dat in de ene taal regel is, voor een andere taal uitzonderlijk. Kaye: "Toch zijn er in bepaalde gevallen wel vingerwijzingen te vinden. Het Pools heeft bij voorbeeld een relatief simpel klemtoonpatroon: het accent komt normaal gesproken op de één na laatste lettergreep. Daarnaast is er een groep leenwoorden waarbij het anders gaat, maar die woorden zijn wel herkenbaar: ze hebben namelijk allemaal dezelfde voorlaatste klinker. Ons programma kan in dit geval dus aan de vorm zien dat het om een uitzondering gaat, en zo'n woord dan van een sterretje voorzien."
Zulke onregelmatige woorden doen niet mee bij het bepalen van het klemtoonpatroon van een taal, ze worden gewoon opzij gezet. Anders gezegd: als er tegenstrijdige gegevens binnenkomen gaat de computer eerst kijken of er misschien een regelmaat in de uitzonderingen te ontdekken valt. Het echte 'leren' (de knopjes omzetten) gebeurt alleen op basis van regelmatige woorden.
Dat betekent dat de woorden niet meteen 'door mogen lopen' naar het systeem: er is altijd een 'buffer' nodig waar vooronderzoek plaatsvindt. Kaye: "We bereiken met behulp van die buffers hele behoorlijke resultaten, maar je kunt ook op een andere manier tegen dat leren aankijken. Het volgende idee blijkt in de praktijk veelbelovend: ga ervan uit dat een kind ter wereld komt met een aantal 'aannamen', het is zeg maar 'voorgeprogrammeerd' om een bepaalde 'parameter-standen' te

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Introduction

In an important paper (Variability in feature dependency: The case of nasality. *NLLT* 10: 33–77), Glyne Piggott (1992) proposed that cross-linguistic variation in nasal harmony does not result from idiosyncratic restrictions on *rules*, but rather is related to *variability in the representations* of segments.

In the first part of this talk I will show how the insights in this paper and related work form the basis of Modified Contrastive Specification (MCS; Dresher, Piggott and Rice 1994).

Introduction

In particular, Piggott showed the importance of *contrastive* features in characterizing the domain of nasal harmony.

In MCS, this follows from the *Contrastivist Hypothesis* (Hall 2007), which states that only contrastive features are computed by the phonology.

Introduction

Nevins (2010) proposes a new theory of vowel harmony that assigns an important role to contrastive features.

In keeping with the Contrastivist Hypothesis, he proposes that there are harmony processes that compute *only contrastive* features.

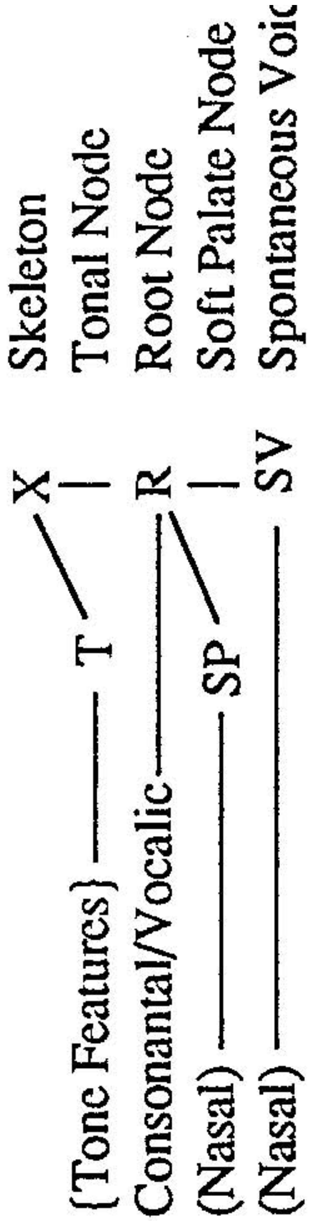
However, he follows Calabrese (2005) in also allowing harmony rules that compute *all* features, contrastive as well as non-contrastive.

Introduction

Allowing non-contrastive features to participate in harmony amounts to a significant weakening of the Contrastivist Hypothesis.

I will look at a case (Yoruba) where Nevins proposes that vowel harmony is sensitive to non-contrastive features.

I will argue that this is not a genuine counterexample to the Contrastivist Hypothesis; rather, in such cases it only *appears* that non-contrastive features are involved in harmony because Nevins adopts an incorrect notion of what features are contrastive.



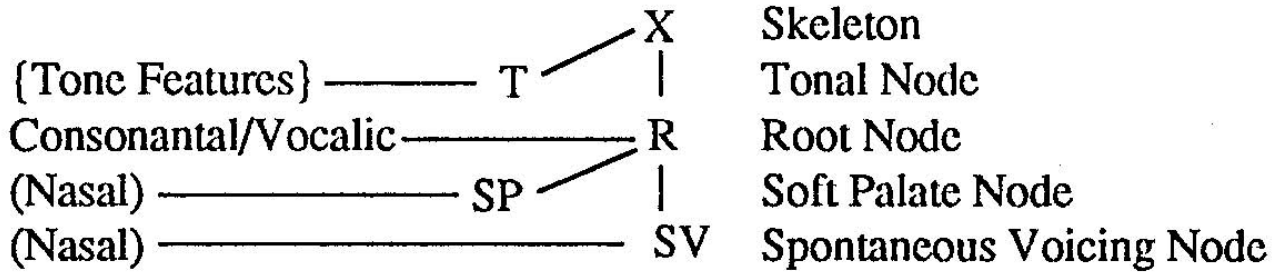
Piggott (1992)

Variability in Feature Dependency: The Case of Nasality

Piggott (1992)

Piggott (1992) proposed that cross-linguistic variation in nasal harmony is due to variability in the representations of segments.

(24) *The Variable Dependency of Nasality*

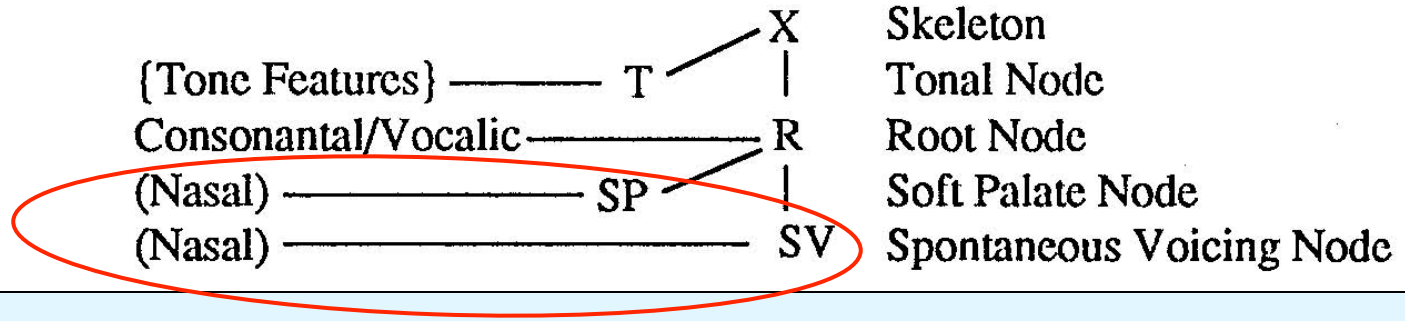


Piggott (1992)

Specifically, he proposed that the feature [nasal] could be a dependent of either the Soft Palate (SP) Node, or of the Spontaneous Voicing (SV) Node.

These options give rise to distinct systems of nasal harmony, Type A (SP) and Type B (SV).

(24) *The Variable Dependency of Nasality*

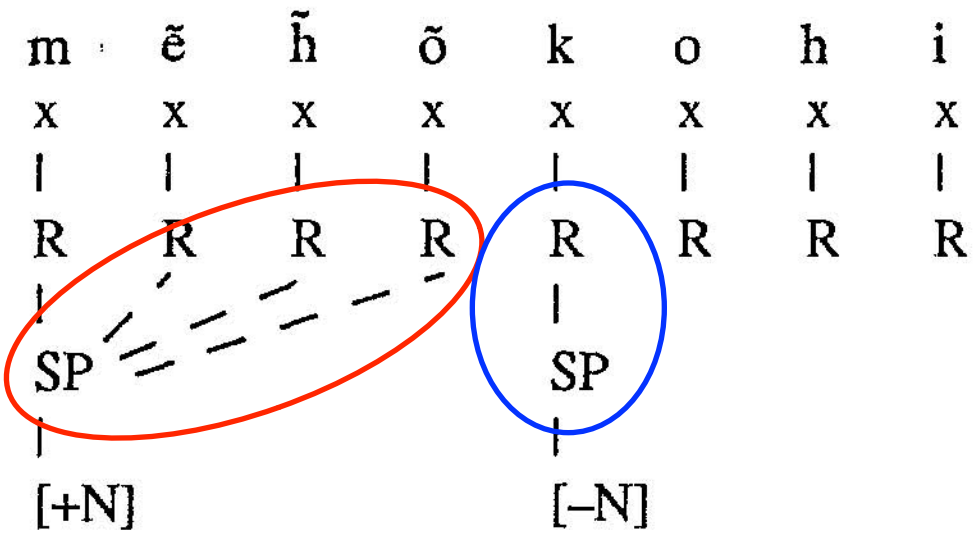


Nasal Harmony Type A

Piggott proposed that in Type A harmony, it is the SP node that spreads from nasal consonants to segments that are not specified for SP.

Segments specified for SP block the spread of nasality.

(8)a. *Warao*



Piggott (1992): The Role of Contrast

Though couched in feature-geometric terms, Piggott's proposal also gave a central position to the role of contrast.

Type A harmony, for example, is constrained by a principle of *Contrastive Nasality* (Piggott 1992: 41):

> If [+nasal] is an underlying property of [+consonantal] segments, then other segments specified underlying for a Soft Palate node must also be [+consonantal].

Warao Consonants (Osborne 1966)

In Warao, for example, /m, n/ trigger nasalization, /h, w, j/ are targets, and obstruents and liquids block nasal spread (opaque).

	Bilabial	Coronal	Velar		Glottal
Stops	p	t	k	k^w	
Fricatives		s			h
Flap		r			
Nasals	m	n			
Semi-vowels	w	j			

Warao Consonants

Piggott proposes that [+consonantal] segments block nasal spread; these segments are contrastive for SP. Targets, which are [–consonantal], are not in the contrastive domain of SP.

	Bilabial	Coronal	Velar	Glottal
[+consonantal]	p	t	k k^{w}	
		s		
domain of SP node		r		
	m	n		
[–consonantal]	w	j		h

Piggott (1992): Variability of Contrast

Another central claim of Piggott's analysis is that the contrastive domain of nasality can *vary* cross-linguistically.

Type A harmony shows variation in which segments are targets and which are opaque, due to variation in the domain of SP:

	Targets (lack SP)	*Opaque (contrastive for SP)*
i.	Vowels, laryngeals	Semivowels, liquids, fricatives, stops
ii.	Vowels, laryngeals, semivowels	Liquids, fricatives, stops
iii.	Vowels, laryngeals, semivowels, liquids	Fricatives, stops
iv.	Vowels, laryngeals, semivowels, liquids, fricatives	Stops

Piggott (1992): Variability of Contrast

Warao is an example of variation (i).

An example of variation (iii) is Kolokuma Ijo.

	Targets (lack SP)	*Opaque (contrastive for SP)*
i.	Vowels, laryngeals	Semivowels, liquids, fricatives, stops
ii.	Vowels, laryngeals, semivowels	Liquids, fricatives, stops
iii.	Vowels, laryngeals, semivowels, liquids	Fricatives, stops
iv.	Vowels, laryngeals, semivowels, liquids, fricatives	Stops

Kolokuma Ịjọ Consonants (Williamson 1965)

This is a chart given by Williamson (1965). /w, r, l, j/ and vowels are targets of nasal spreading, all other segments block it.

	Plosive		Continuant				
			Fricative		Sonorant		
					Non-lateral		Lateral
	Vl.	Vd.	Vl.	Vd.	Oral	Nasal	
Labial	p	b	f	v	w	m	
Alveolar	t	d	s	z	r	n	l
Back	k	g	(h)	(ɟ)	j	ŋ	
Labio-velar	kp	gb					

Kolokuma Ịjọ Consonants

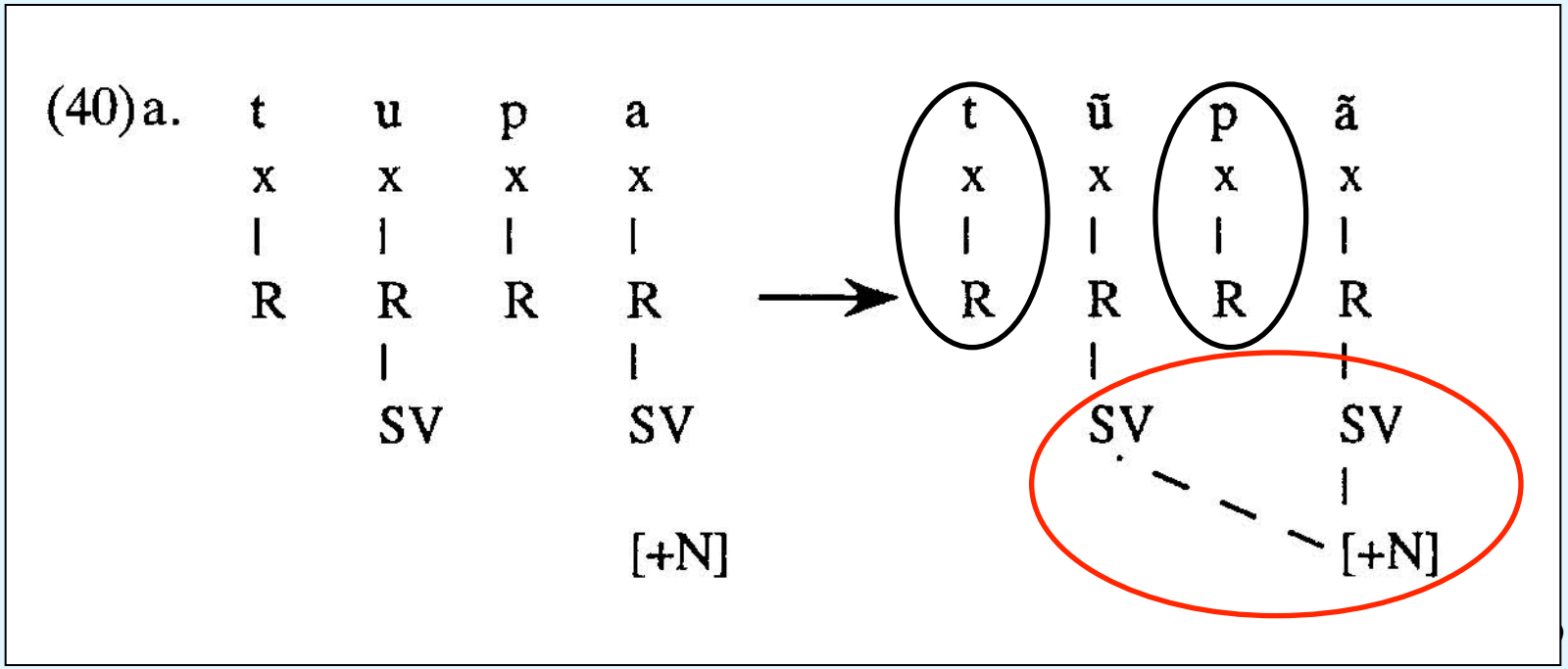
To better reflect nasal harmony we should rearrange the chart. The domain of the SP node is the class of [–approximant].

	[–approximant] *domain of SP node*					[+approximant]
	Plosive		Fricative		Nasal	
	Vl.	Vd.	Vl.	Vd.		
Labial	p	b	f	v	m	w
Alveolar	t	d	s	z	n	r l
Back	k	g			ŋ	j
Labio-velar	kp	gb				

Nasal Harmony Type B

A more dramatic variation occurs in Type B nasal harmony, where [nasal] is a dependent of SV, and spreads to SV nodes.

Obstruents unspecified for SV are transparent to the spread of nasality: they neither undergo nor block it.



Guaraní Consonants (Piggott 1992)

An example is Guaraní. /m, n/ and autosegmental [+nasal] trigger nasalization, /r, l, w/ and vowels are targets, and obstruents and glottals neither undergo nor block (transparent).

		Bilabial	Coronal	Velar	Glottal
	Stops	p	t	k k^w	ʔ
	Fricatives		s		h
Domain of SV node	Nasals	m	n	$ŋ^w$	
	Liquids		r l		
	Semi-vowels			w	

Domains and the Scope of Contrast

The above examples suggest that nasal harmony is sensitive to *contrastive domains* that can vary from language to language.

These domains regulate the *relative scopes* of distinctive features. That is, the feature that implements nasal harmony is contrastive in a domain defined by certain other features.

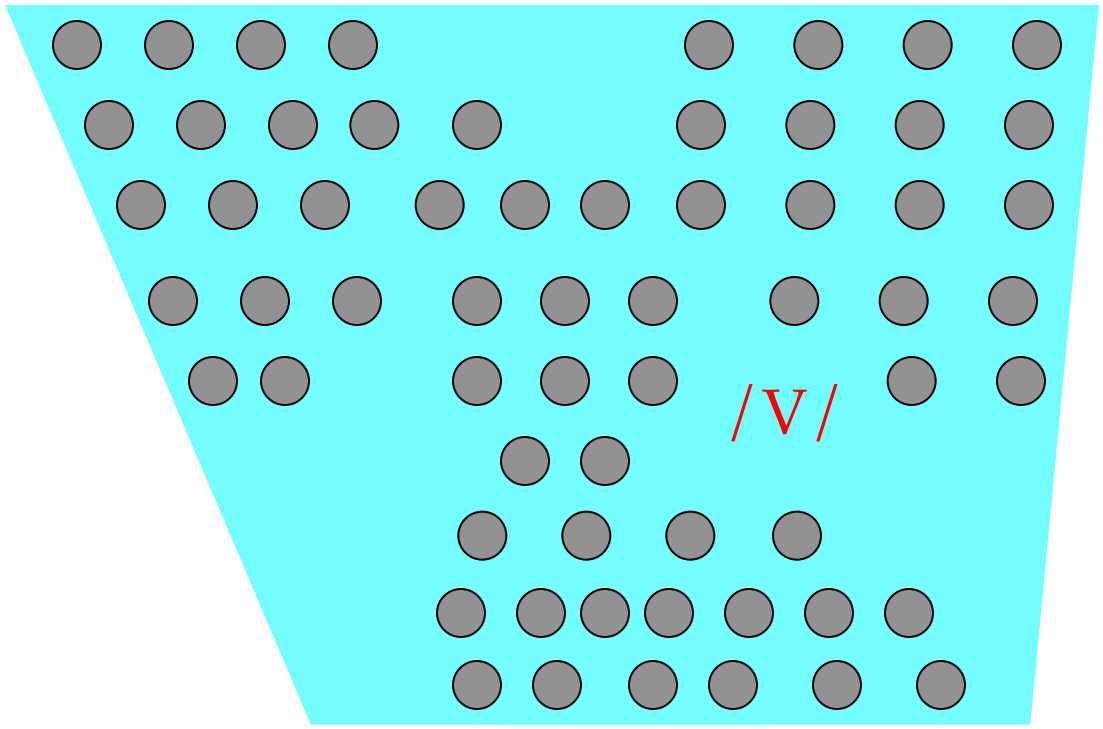
Another way to express this idea is in terms of *feature ordering*: a feature that is higher in the order takes wider scope than a lower-ordered feature.

Contrastive specification by a hierarchy of features

Feature ordering is a way of determining contrastive specifications, via the Successive Division Algorithm (Dresher 1998, 2003, 2009, based on Jakobson, Fant & Halle 1952, Jakobson & Halle 1956)

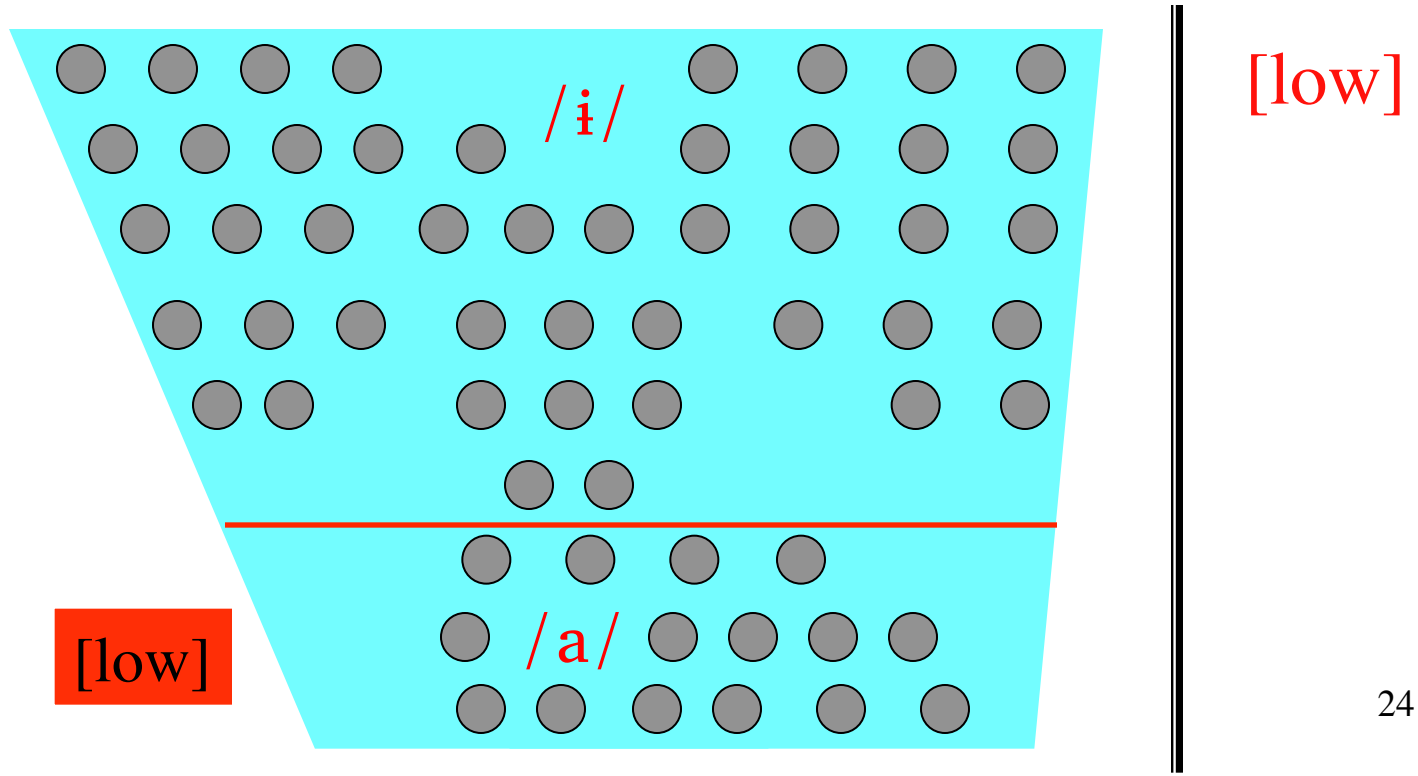
The Successive Division Algorithm

a. Begin with ***no*** feature specifications: assume all sounds are allophones of a single undifferentiated phoneme.



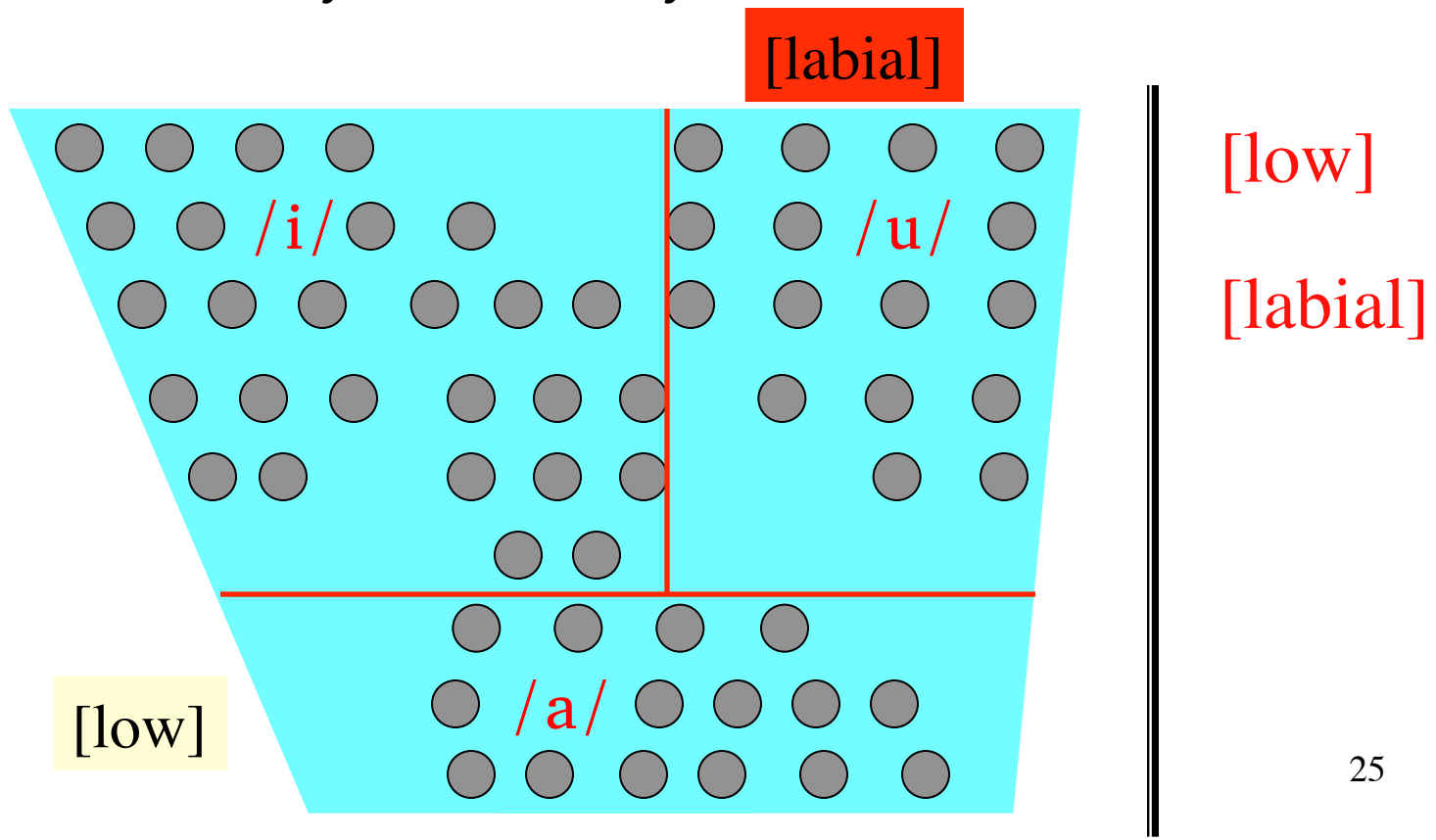
The Successive Division Algorithm

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.



The Successive Division Algorithm

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.



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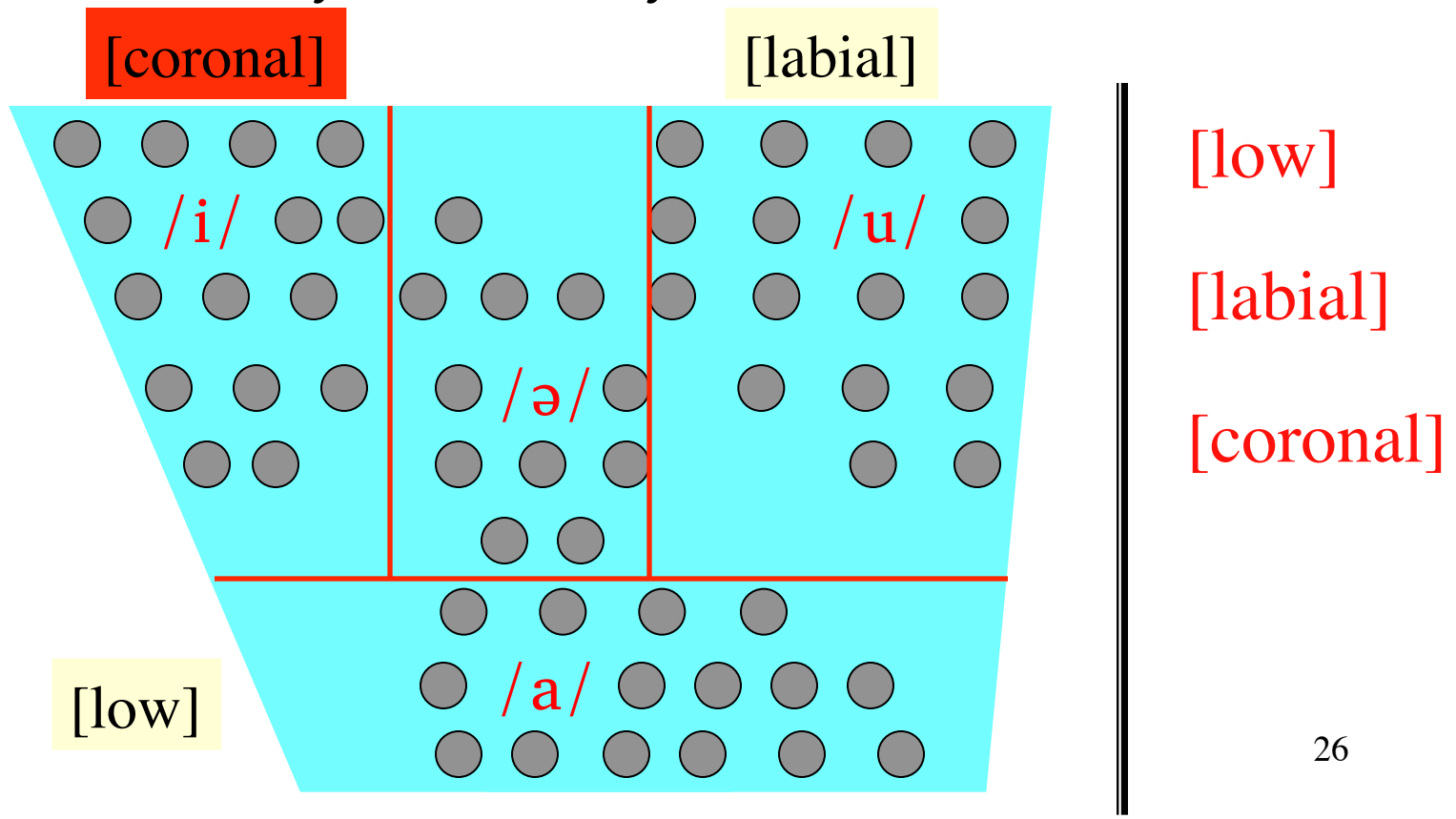
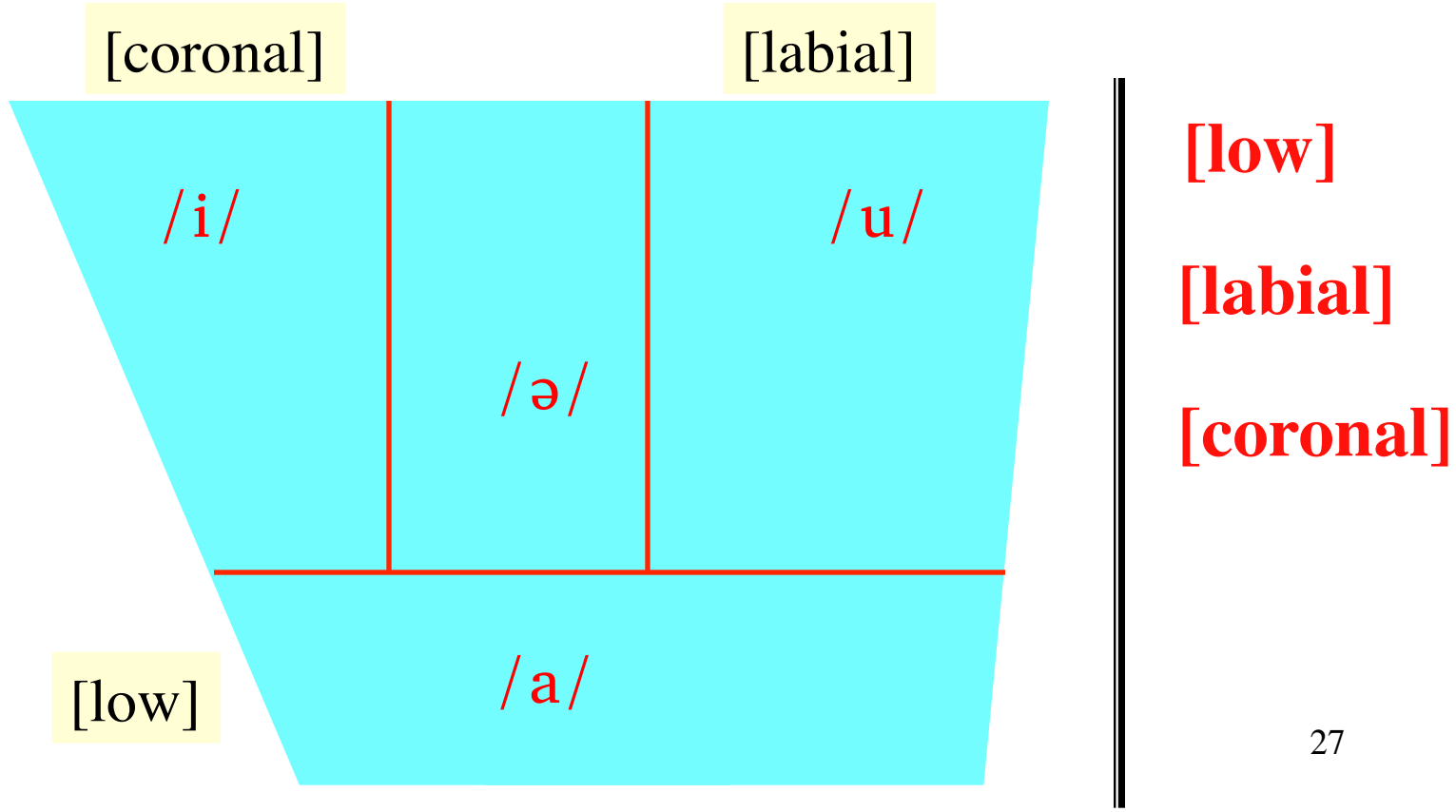


The Contrastive Hierarchy

The ordered list of features is called the *contrastive hierarchy* for the language in question.



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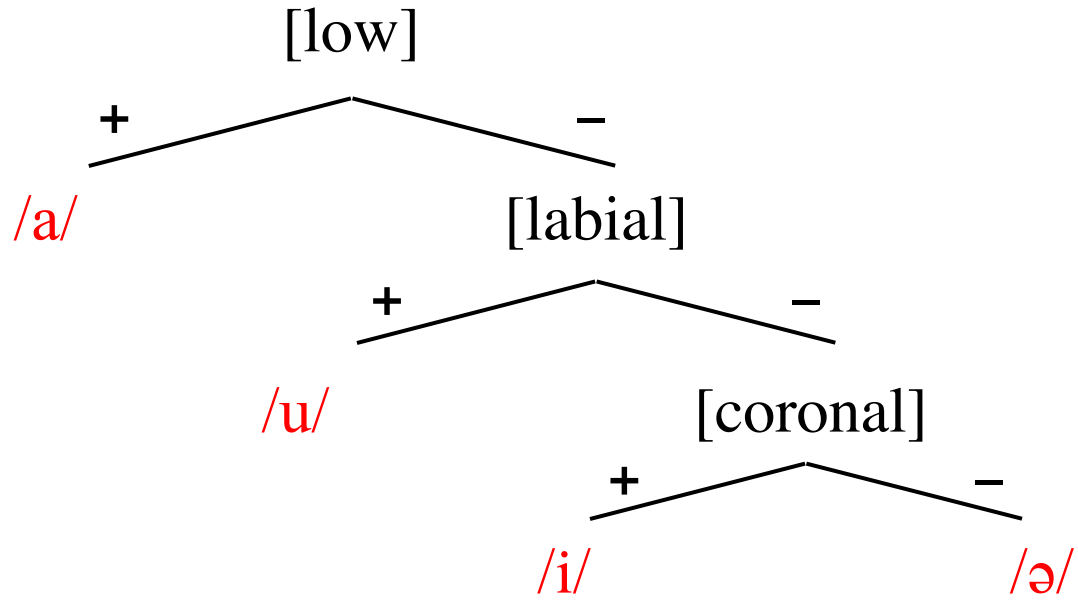


From Feature Geometry to Contrastive Hierarchy

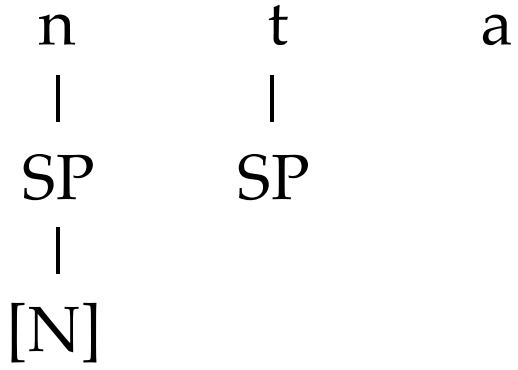
Feature geometric dependency relations can be recast as contrastive scope relations.

Thus, Piggott's variable feature geometries can be shown to correspond to different contrastive hierarchies.

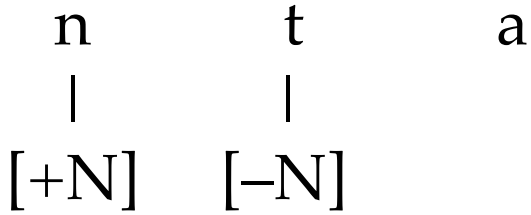
From Feature Geometry to Contrastive Hierarchy

Dresher, Piggott and Rice (1994) show that the Type A combination of SP and [nasal] can be converted to a ternary contrast involving only [±nasal]:

With SP and N



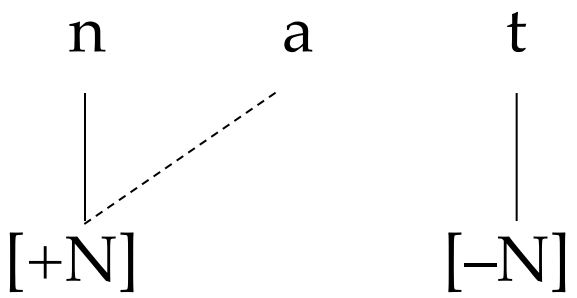
With binary [±N]



Type A: Binary [±nasal]

In Type A harmony, [+nasal] spreads to segments that have no specification for [nasal], and is blocked by contrastive [–nasal]. Both values of [±nasal] are active.

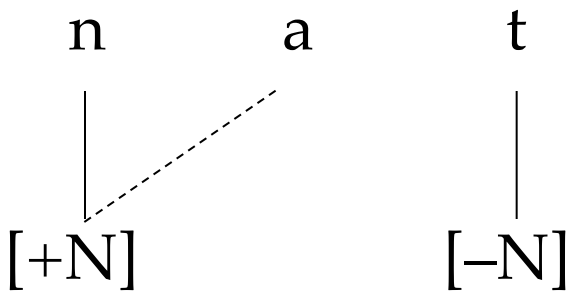
Type A harmony



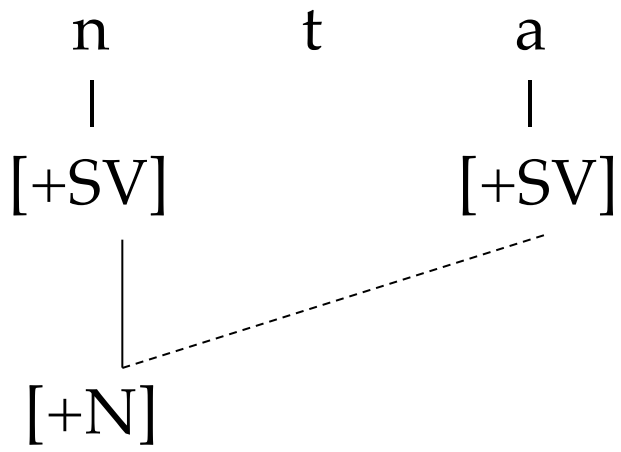
Type B: Marked [nasal]

In Type B harmony, [+nasal] spreads to segments that have contrastive [+SV]. [–nasal] does not seem to be computed, nor is [–SV], which does not block harmony. That is, only *marked* values of [nasal] and [SV] are active.

Type A harmony



Type B harmony



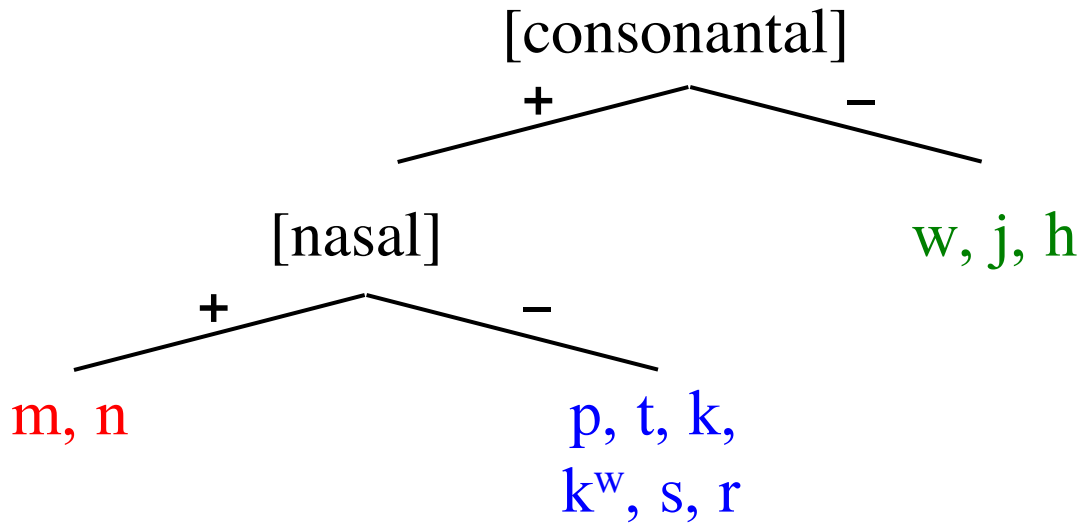
Warao Consonants

Recall that in Warao [+consonantal] segments are contrastive for SP; [–consonantal] segments are not in the contrastive domain of SP.

	Bilabial	Coronal	Velar	Glottal
[+consonantal]	p	t	k k^w	
		s		
domain of SP node		r		
	m	n		
[–consonantal]	w	j		h

Warao Contrastive Hierarchy

If we suppose a hierarchy of [consonantal] > [nasal], then the glides receive no specification for [nasal]; blockers are [–nasal].



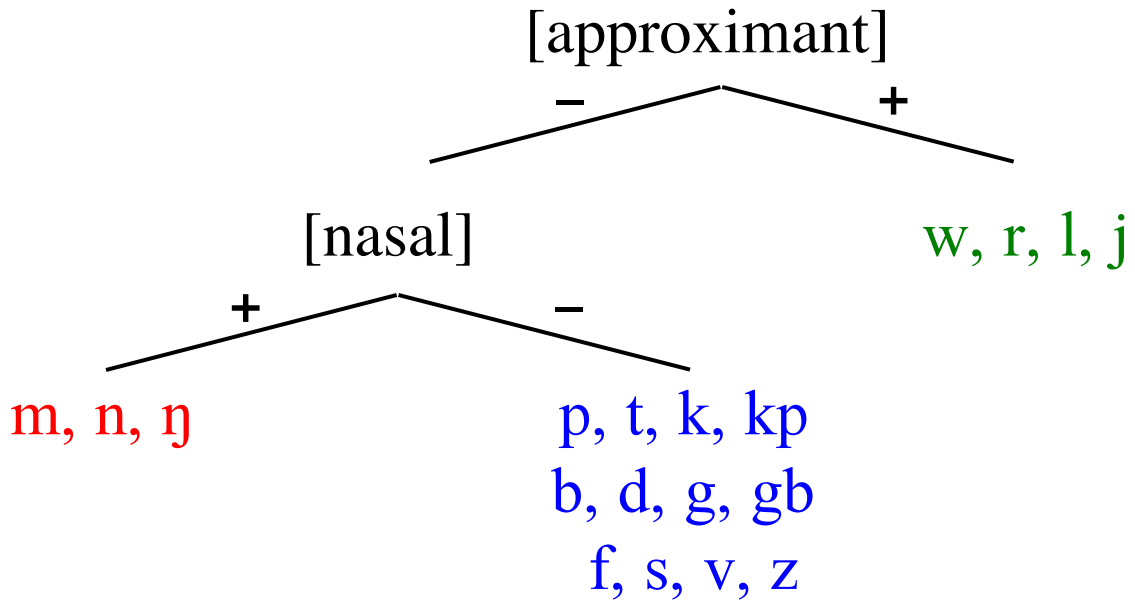
Kolokuma Ịjọ Consonants

The domain of the SP node is the class of [–approximant].

	[–approximant] *domain of SP node*					[+approximant]
	Plosive		Fricative		Nasal	
	Vl.	Vd.	Vl.	Vd.		
Labial	p	b	f	v	m	w
Alveolar	t	d	s	z	n	r l
Back	k	g			ŋ	j
Labio-velar	kp	gb				

Kolokuma Ịjọ Contrastive Hierarchy

Here [approximant] > [nasal], so the glides and liquids receive no specification for [nasal]; blockers are [–nasal].



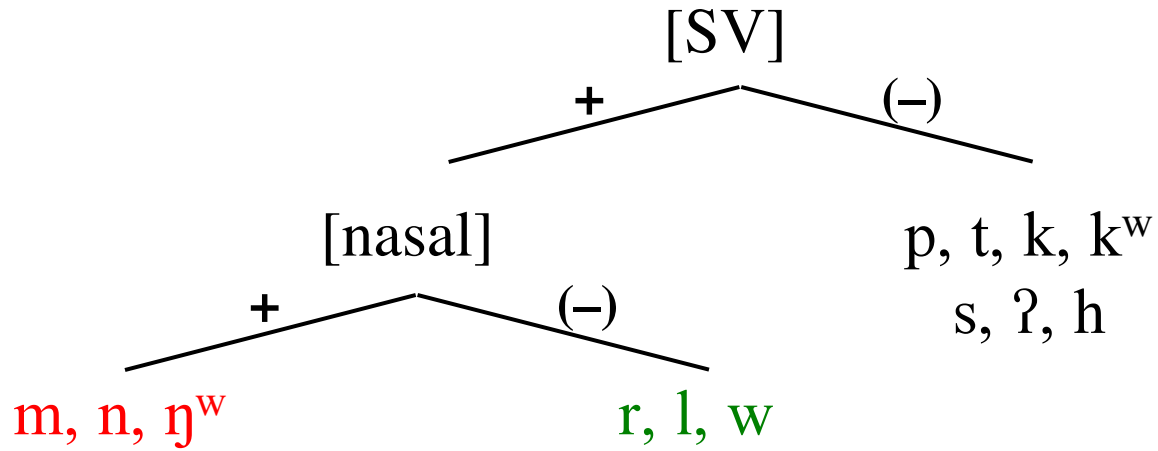
Guaraní Consonants

[+nasal] spreads to segments that have contrastive [SV].

		Bilabial	Coronal	Velar	Glottal
	Stops	p	t	k kʷ	ʔ
	Fricatives		s		h
Domain of SV	Nasals	m	n	ŋʷ	
	Liquids		r l		
	Semi-vowels			w	

Guaraní Contrastive Hierarchy

[+nasal] spreads to segments with contrastive [SV]. Only *marked* (+) values of [nasal] and [SV] are computed.



Piggott (1992): Redundant Features

Another characteristic of Piggott's nasal harmony analysis is the distinction it draws between contrastive and redundant features.

Southern Barasano, a Type B harmony language, has a set of voiced stops that can surface as prenasalized [ᵐb, ⁿd, ᵑg].

Piggott argues that nasalization here is not contrastive or present underlying, but is rather due to a phonetic implementation rule that adds a nasal phase to a SV segment that has a complete oral occlusion.

Piggott (1992): Redundant Features

In other words, prenasalization, which is only one of several instantiations of spontaneous voicing in stops, *enhances* the SV character of voiced stops.

Further, Piggott (1992: 49) observes:

> 'It is important to note that the nasality of prenasalized stops in languages like Southern Barasano is not a realization of the feature [nasal].'
>
> 'Consequently, in the Tucanoan pattern of nasal harmony, the spreading of nasality cannot be initiated by an underlying prenasalized segment.'

Contrast and Activity

In other words, only a *contrastive* [nasal] feature can trigger harmony; redundant features introduced by phonetic implementation are phonologically *inert*.

The above generalization follows from what Hall (2007: 20) calls the *Contrastivist Hypothesis*:

> The phonological component of a language L operates only on those features which are necessary to distinguish the phonemes of L from one another.

Contrast and Activity

This hypothesis suggests a heuristic: to identify which features are contrastive, look for features that are active.

For example, features that participate in vowel harmony are active; by hypothesis, therefore, they must be contrastive.

It would be a counterexample to the Contrastivist Hypothesis if we find active features that could not possibly be contrastive under any reasonable ordering of the features.

Nevins (2010)

Contrastive features in vowel harmony

Vowel Harmony: Contrastive Features

Nevins (2010) proposes a new theory of vowel harmony that assigns an important role to contrastive features.

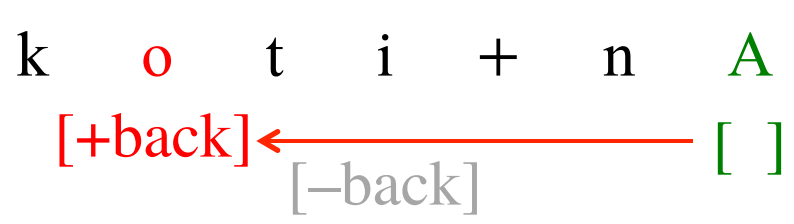
In keeping with the Contrastivist Hypothesis, he proposes that there are harmony processes that compute only contrastive features.

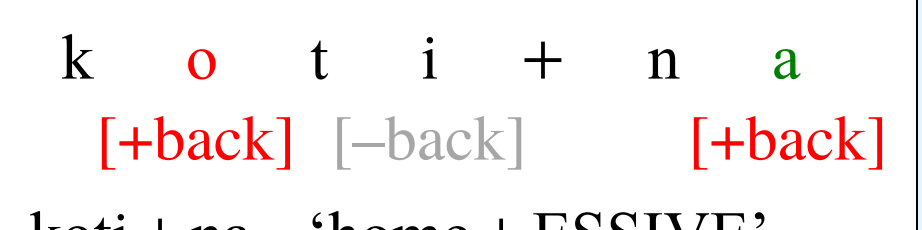
Finnish Vowel Harmony

In Finnish, for example, Nevins proposes that suffix vowels lack a value for the feature [back]. Here, the suffix /+nA/ has a low vowel with no specification for [back].

Unspecified vowels search for a value of [back] from a preceding vowel, but only one that has a *contrastive* value of the feature [back].

In this example, the suffix vowel harmonizes with the contrastive [+back] value of /o/, and not with the non-contrastive [–back] of /i/.





Finnish Vowel Harmony

Vowels with contrastive [±back] can participate in vowel harmony. The vowels /i/ and /e/ are neutral, because they lack contrastive [back].

		[–round]	[+round]	
			[–back]	[+back]
[–low]	[+high]	i	ü	u
	[–high]	e	ö	o
		[–back]	[+back]	
[+low]		ä	a	

Non-contrastive Features in Harmony?

Though Nevins cites many cases of this sort, he follows Calabrese (2005) in also allowing harmony rules that compute *all* features, contrastive as well as noncontrastive.

Allowing noncontrastive features to participate in harmony amounts to a significant weakening of the Contrastivist Hypothesis.

It is important to note in this connection that Nevins (2010) adopts a minimal difference (MD) approach to contrast:

Minimal Difference (MD) Approach to Contrast

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 [–αF].

R	S		S′	T
[αE]	[αE]	=	[αE]	[–αE]
[αF]	[αF]		[–αF]	[–αF]
[–αG]	[αG]	=	[αG]	[–αG]
[–αH]	[αH]	=	[αH]	[–αH]

Problems with Minimal Differences

The main problem with MD 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' features when assessing if two phonemes are minimally different.

Turkish Vowels

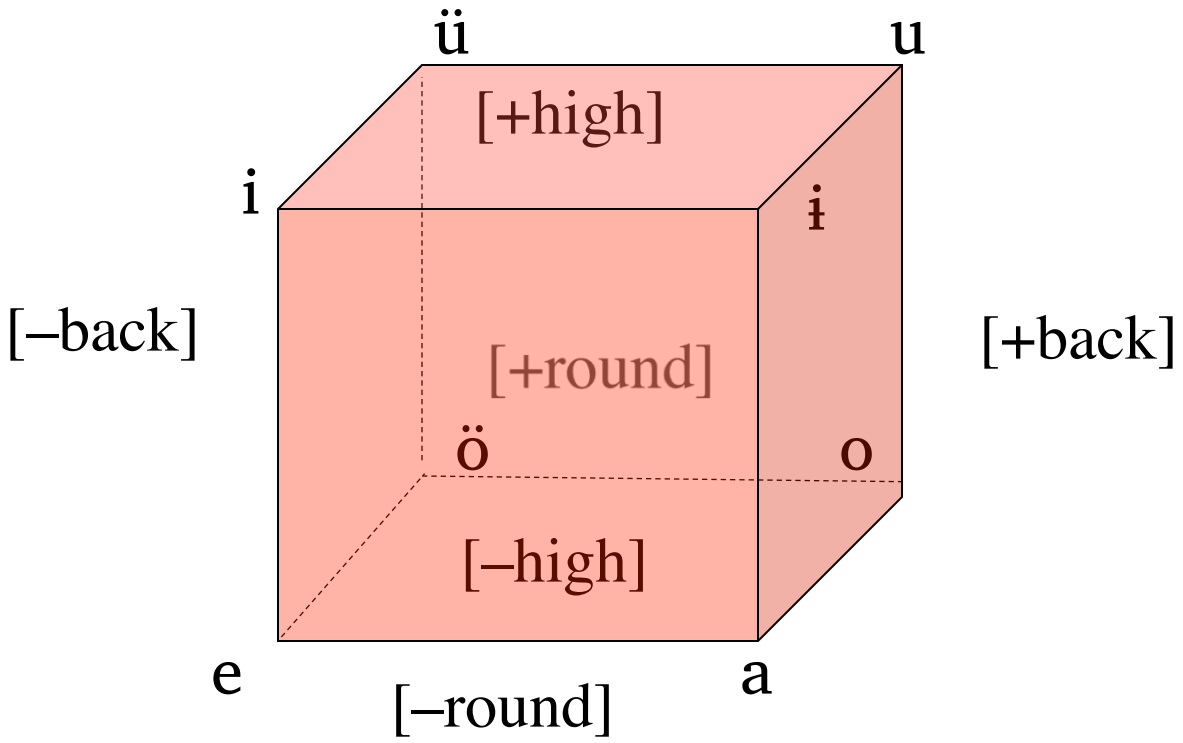
An example of the shortcomings of MD and how they are often tacitly set aside is Nevins's discussion of the Turkish vowel system (2010: 26).

In keeping with traditional analyses, Nevins observes that the features [high], [back], and [round] are sufficient to uniquely determine each of the eight vowels of Turkish.

	[–back] [–round]	[–back] [+round]	[+back] [–round]	[+back] [+round]
[+high]	i	ü	ɨ	u
[–high]	e	ö	a	o

Turkish Vowels

Here, every feature specification is contrastive, because the vowels completely fill the 2 x 2 x 2 = 8 cell vowel space.



Turkish Vowels

Nevins does not mention the feature [low], 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.

	[–back]		[+back]	
	[–round]	[+round]	[–round]	[+round]
[+high]	i	ü	ɨ	u
[–high]	e	ö	a	o

Turkish Vowels

If we included [low] the vowel system would look different. Here not all pairs are minimal; MD would not give the desired results.

Nevins's analysis is thus equivalent to ordering the features [high], [back], and [round] highest, making all other vowel features redundant and phonologically irrelevant in Turkish.

	[–back] [–round]	[–back] [+round]	[+back] [–round]	[+back] [+round]	
[+high]	i	ü	ɨ	u	
[–high]	e	ö		o	[–low]
			a		[+low]

Against the MD Approach

Dresher (2009) argues that MD fails in many common situations to yield adequate contrastive representations.

Also, MD labels *fewer* features as contrastive than does the SDA.

Which Features are Contrastive? MD

To take a simple example, consider an inventory with three vowels /a, i, u/ and the features [low] and [round] (if we pick any more features the MD approach won't work).

Minimal Difference

	a	i	u
[low]	+	–	–
[round]	–	–	+

Which Features are Contrastive? MD

To take a simple example, consider an inventory with three vowels /a, i, u/ and the features [low] and [round] (if we pick any more features the MD approach won't work).

Minimal Difference

	a	i	u
[low]	+	–	–
[round]	–	–	+

The feature [low] uniquely distinguishes /a/ from /i/.

Which Features are Contrastive? MD

To take a simple example, consider an inventory with three vowels /a, i, u/ and the features [low] and [round] (if we pick any more features the MD approach won't work).

Minimal Difference

	a	i	u
[low]	+	–	–
[round]	–	–	+

The feature [low] uniquely distinguishes /a/ from /i/.

The feature [round] uniquely distinguishes /i/ from /u/.

Which Features are Contrastive? MD

To take a simple example, consider an inventory with three vowels /a, i, u/ and the features [low] and [round] (if we pick any more features the MD approach won't work).

Minimal Difference

	a	i	u
[low]	+	–	(–)
[round]	(–)	–	+

The feature [low] uniquely distinguishes /a/ from /i/.

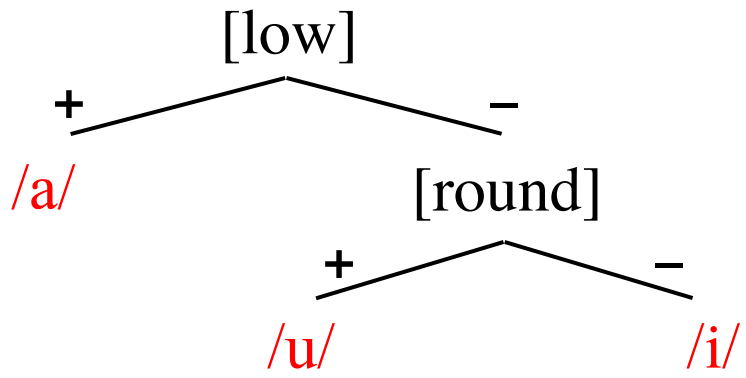
The feature [round] uniquely distinguishes /i/ from /u/.

There are 4 contrastive features and 2 non-contrastive features (circled).

Which Features are Contrastive? SDA

In a hierarchical approach we obtain different results. There are two outcomes, depending on the ordering of the features.

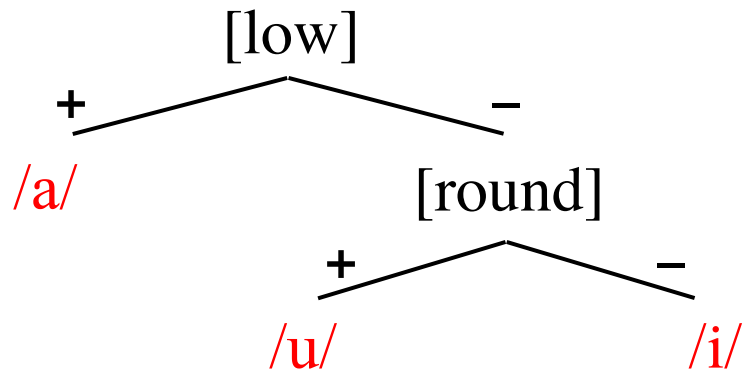
First, let's suppose that [low] is ordered above [round]:



Which Features are Contrastive? SDA

On this order, [low] is contrastive for all segments, and [round] is contrastive for /u/ and /i/.

5 features are contrastive and only 1 feature (circled) is non-contrastive.



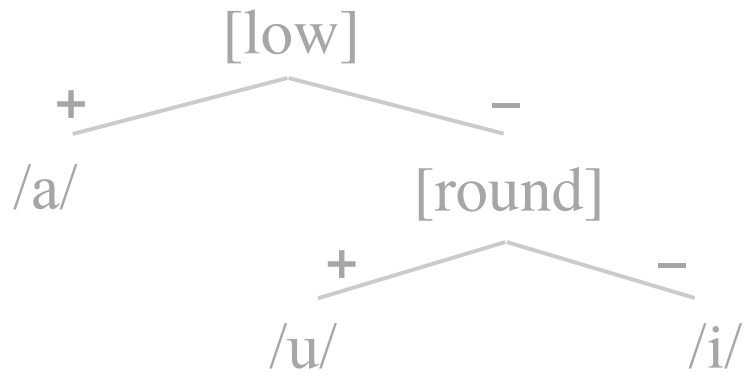
SDA 1: [low] > [round]

	a	i	u
[low]	+	–	–
[round]	(–)	–	+

Which Features are Contrastive? SDA

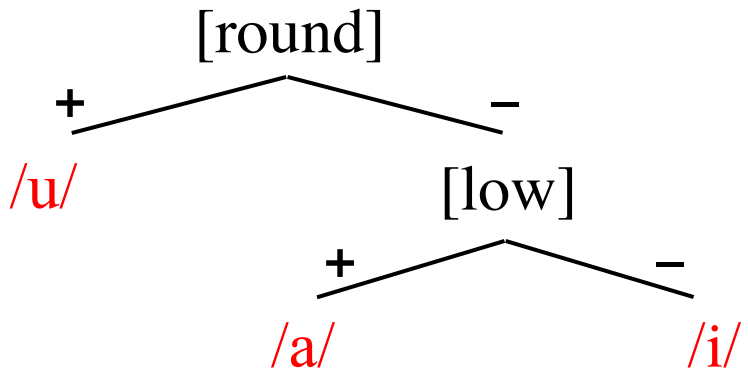
In the other possible order, [round] is contrastive for all segments, and [low] is contrastive for /a/ and /i/.

Again, 5 features are contrastive and only 1 is non-contrastive.



SDA 1: [low] > [round]

	a	i	u
[low]	+	–	–
[round]	–	–	+



SDA 2: [round] > [low]

	a	i	u
[low]	+	–	–
[round]	–	–	+

Which Features are Contrastive?

Comparing the two approaches, we observe that one or the other of the features that MD designates as non-contrastive is designated as contrastive by the SDA, in either ordering.

Minimal Difference

	a	i	u
[low]	+	–	(–)
[round]	(–)	–	+

SDA 1: [low] > [round]

	a	i	u
[low]	+	–	–
[round]	(–)	–	+

SDA 2: [round] > [low]

	a	i	u
[low]	+	–	(–)
[round]	–	–	+

Against the MD Approach

Therefore, we might expect that there are cases where in an MD analysis it *looks like* non-contrastive features are participating in vowel harmony; but those same features could be designated contrastive by the SDA.

I argue that such cases in fact arise in Nevins's analyses.

Yoruba Dialects

In Ifẹ Yoruba, lax (or RTR) mid vowels /ɛ, ɔ/ can occur non-finally only when another lax mid vowel follows (a, b).

Locality is computed only with respect to mid vowels (leaving aside /a/ for now); a high tense vowel can intervene (c, d).

Ifẹ Yoruba

a. olè ‘thief’ *ɔlè

b. ɔsɛ ‘soap’

c. ɔrúkɔ ‘name’

d. ɛ̀lùbɔ́ ‘yam flour’

Yoruba Dialects

Standard Yoruba has the same process (a, b), except that high vowels count in the computation (c, d).

Only tense mid vowels may precede a high vowel, even if a lax mid vowel occurs to the right.

Ifẹ Yoruba		Standard Yoruba	
a. olè	‘thief’	a. olè	‘thief’
b. ɔsɛ	‘soap’	b. ɔsɛ	‘soap’
c. ɔrúkɔ	‘name’	c. orúkɔ	‘name’
d. ɛ̀lùbɔ́	‘yam flour’	d. èlùbɔ́	‘yam flour’

Yoruba Dialects

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.

Nevins assumes that only mid vowels are contrastive for [RTR] in *both* dialects, in keeping with the MD approach to contrast.

MD Contrastive Features in Yoruba

Recall that on this approach contrastive features are those that uniquely distinguish two phonemes. (Following the usual practice I tacitly choose only one of [round] and [back] so that the MD method can appear to work.)

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

MD Contrastive Features in Yoruba

Only the mid vowels can be contrastive for [RTR] in any dialect with the same vowel inventory.

Therefore, if high vowels block harmony in Standard Yoruba, it must be because [RTR] harmony computes *all* features, not just contrastive ones.

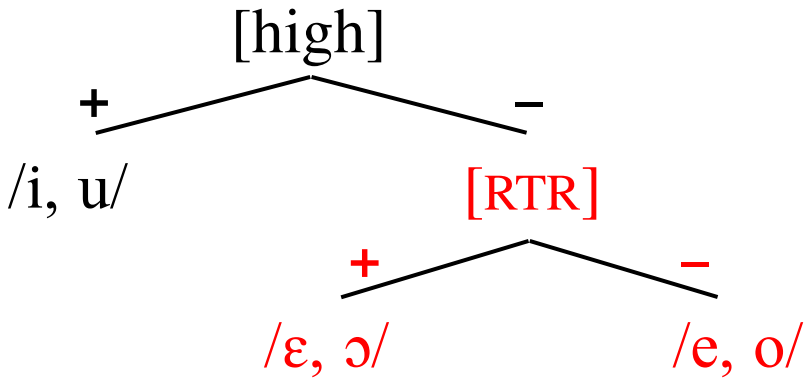
	i	e	ɛ	a	ɔ	o	u
[low]	–	–	–	+	–	–	–
[high]	+	–	–	–	–	–	+
[round]	–	–	–	–	+	+	+
[RTR]	–	–	+	+	+	–	–

SDA Contrastive Features in Yoruba

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].

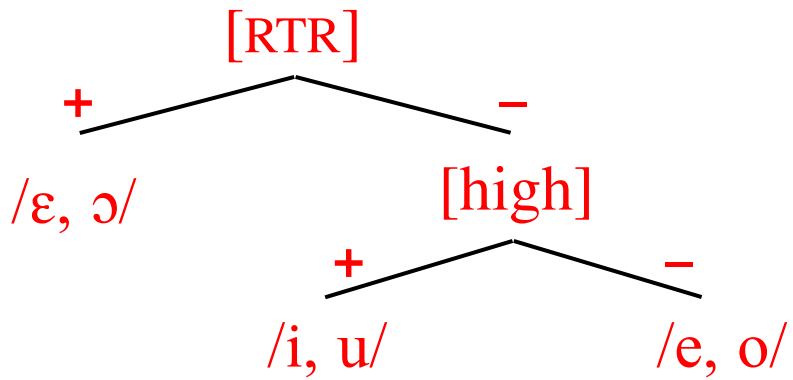
Ifẹ Yoruba: [hi] > [RTR]

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



SDA Contrastive Features in Yoruba

But the other ordering is also possible. On this ordering, *all* vowels are contrastive for [RTR], including the high vowels.



Standard Yoruba: [RTR] > [hi]

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

SDA Contrastive Features in Yoruba

It is thus not obvious that Standard Yoruba vowel harmony computes non-contrastive features. The difference between the dialects may be one of feature ordering, a difference in the relative scope of [RTR].

Ifẹ Yoruba: [hi] > [RTR]

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

Standard Yoruba: [RTR] > [hi]

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

SDA Contrastive Features in Yoruba

On this view, *both* Ifẹ and Standard Yoruba limit [RTR] harmony to contrastive values of [RTR].

The difference is in the contrastive scope of [RTR]: in Ifẹ Yoruba the high vowels are not included, in Standard Yoruba they are.

Ifẹ Yoruba: [hi] > [RTR]

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

Standard Yoruba: [RTR] > [hi]

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

Yoruba Vowel Harmony

Below is how harmony applies to the word *ɔrúkɔ~orúkɔ* 'name' in each dialect, using Nevins's theory of harmony, but the hierarchical approach to contrast, adhering to the Contrastivist Hypothesis.

The initial mid vowel is unspecified for [RTR] and seeks a value from the nearest contrastive source to the right.

In Ifẹ Yoruba the nearest such source is the mid vowel /ɔ/; in Standard Yoruba it is the high vowel /ú/.

Ifẹ Yoruba: [hi] > [RTR]	Standard Yoruba: [RTR] > [hi]
O r ú k ɔ [ ] ⟶ [+RTR] [–RTR]	O r ú k ɔ [ ] ⟶ [–RTR] [+RTR]
= ɔ r ú k ɔ	= o r ú k ɔ

MD Contrastive Features of /a/

Interesting support for the hierarchical approach to contrast comes from the behaviour of the low vowel /a/.

In the MD 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.

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

/a/ in [RTR] Harmony

On this approach we might expect, then, that /a/ would pattern parallel to 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).

EXPECT

Ifẹ Yoruba	Standard Yoruba
a. oba ‘king’	a. ɔba ‘king’
b. èpà ‘peanut’	b. ɛ̀pà ‘peanut’

/a/ in [RTR] Harmony

We might expect, then, that /a/ would pattern parallel to the high vowels: that it would be neutral to [RTR] harmony in Ifẹ Yoruba (compute contrastive values only), but that it would participate in Standard Yoruba (all values computed).

But this is not what happens: /a/ triggers [RTR] harmony in *both* dialects (Ola Orie 2001).

ACTUAL

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

Nevins (2010): Sonority Hurdles

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:

> 'certain 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.

SDA Contrastive Features in Yoruba

But a feature-ordering approach yields a simpler account.

We haven't considered where the feature [low] fits into the contrastive hierarchies of these dialects.

Ifẹ Yoruba: [hi] > [RTR]

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

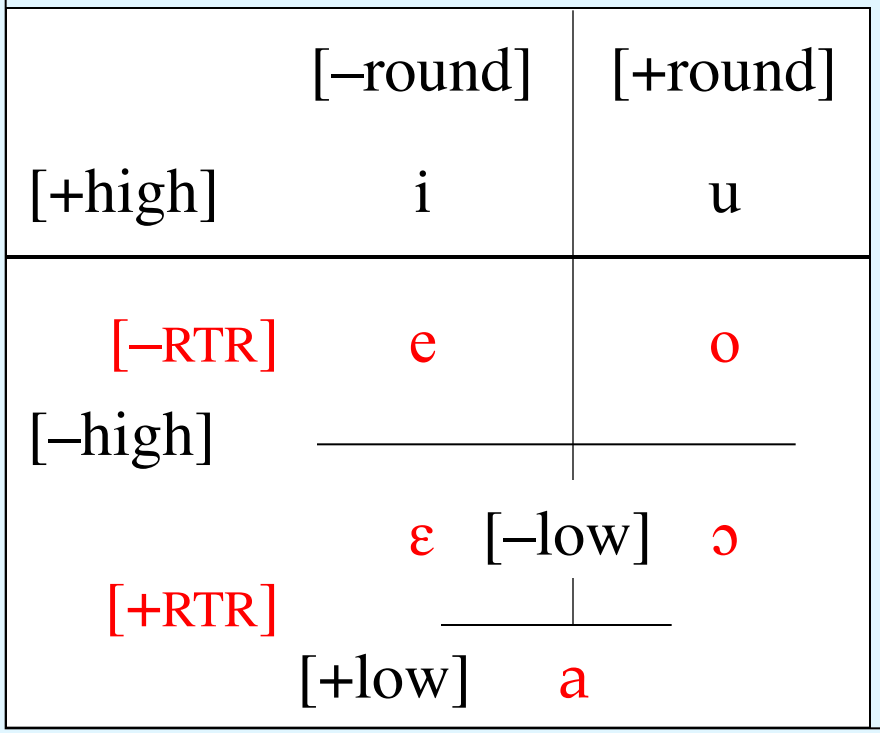
Standard Yoruba: [RTR] > [hi]

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

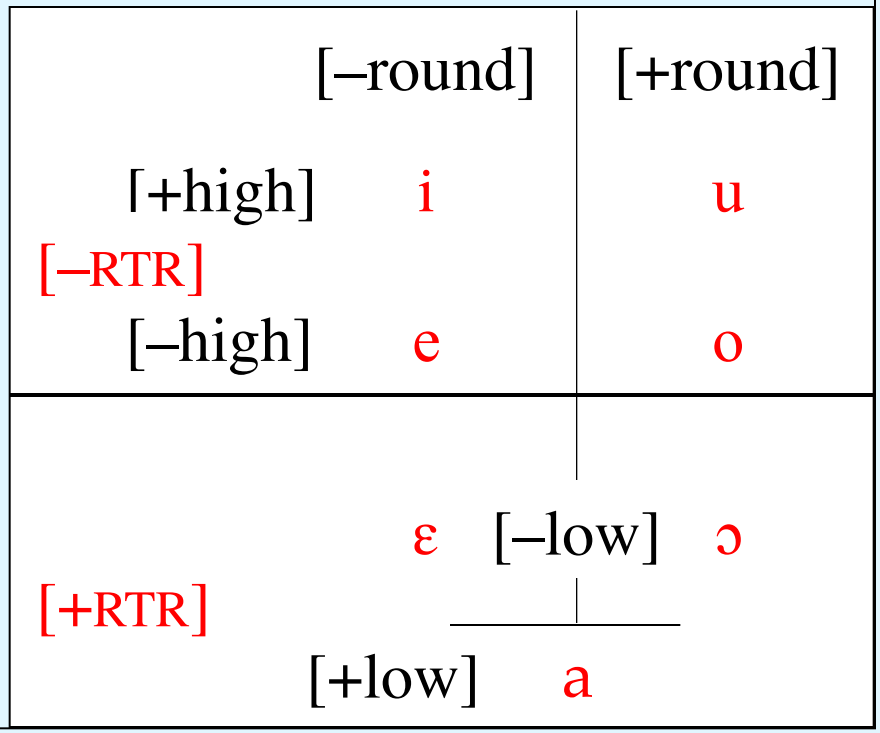
SDA Contrastive Features in Yoruba

Evidently, /a/ is contrastive for [RTR] in *both* dialects, the result of ordering [low] after [RTR] in both.

Ifẹ Yoruba: [hi] > [RTR] > [low]



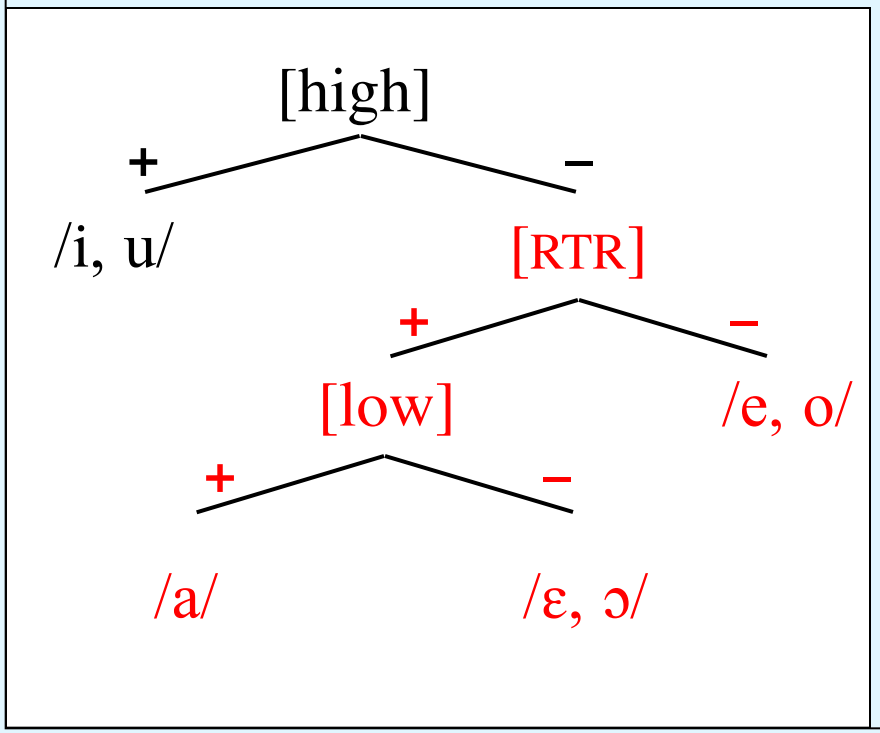
Std Yoruba: [RTR] > [hi] > [low]



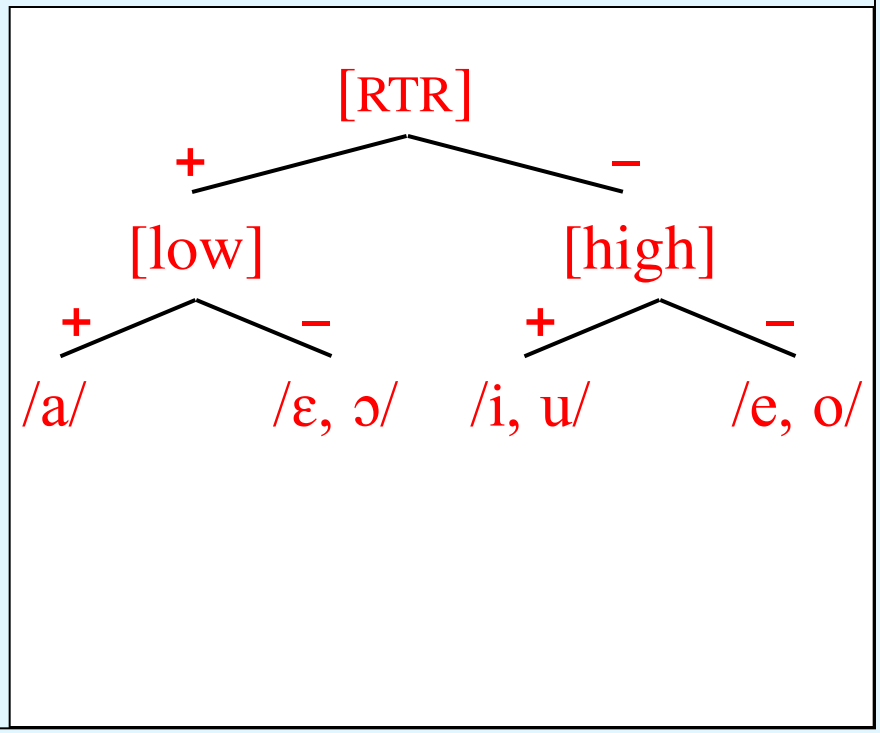
SDA Contrastive Features in Yoruba

Evidently, /a/ is contrastive for [RTR] in *both* dialects, the result of ordering [low] after [RTR] in both.

Ifẹ Yoruba: [hi] > [RTR] > [low]



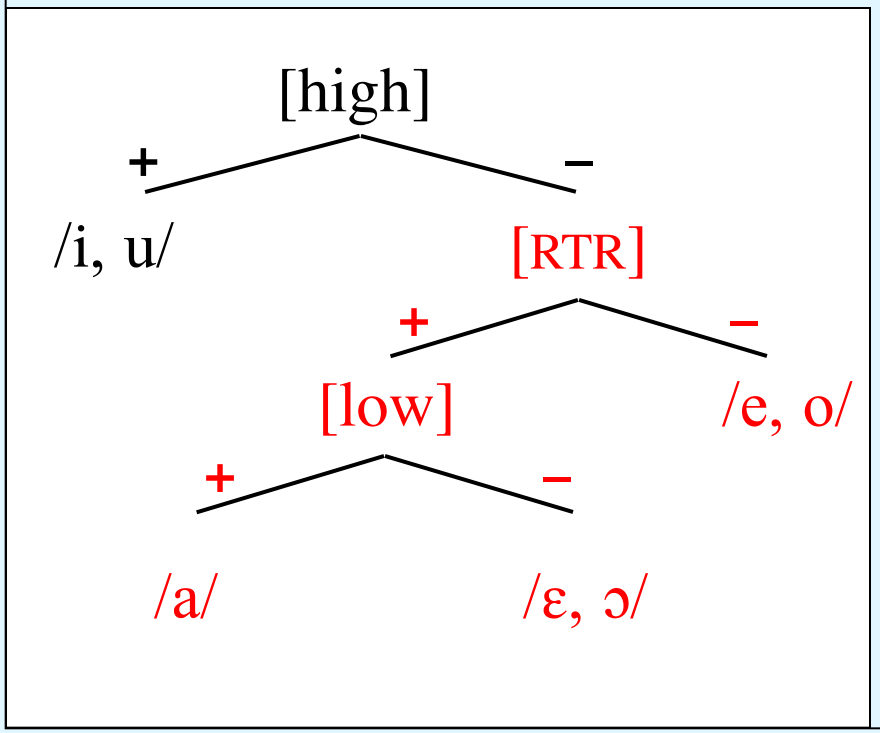
Std Yoruba: [RTR] > [hi] > [low]



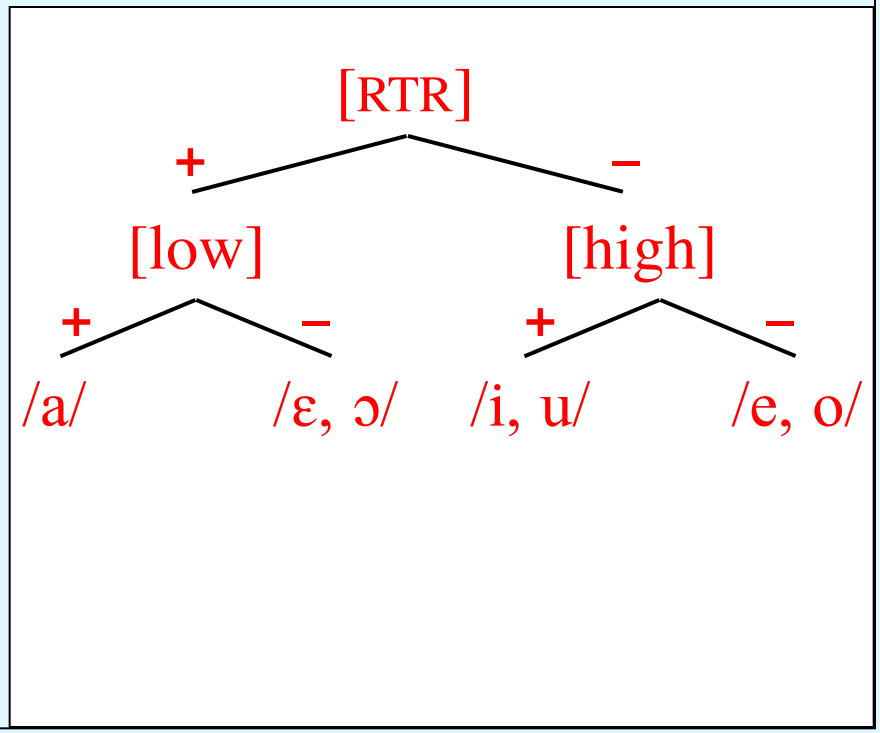
SDA Contrastive Features in Yoruba

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.

Ifẹ Yoruba: [hi] > [RTR] > [low]



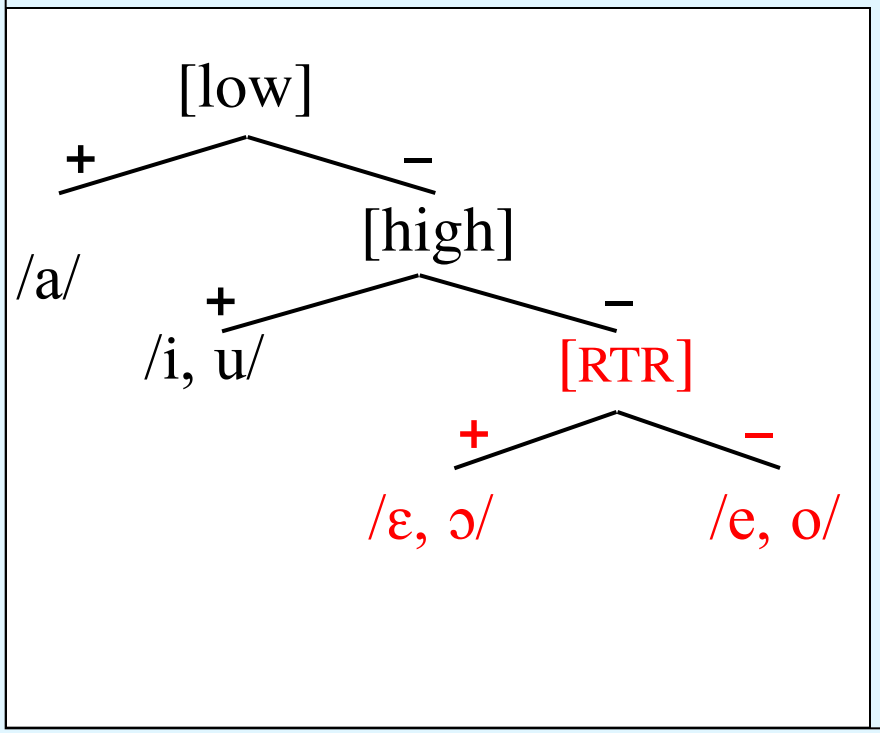
Std Yoruba: [RTR] > [hi] > [low]



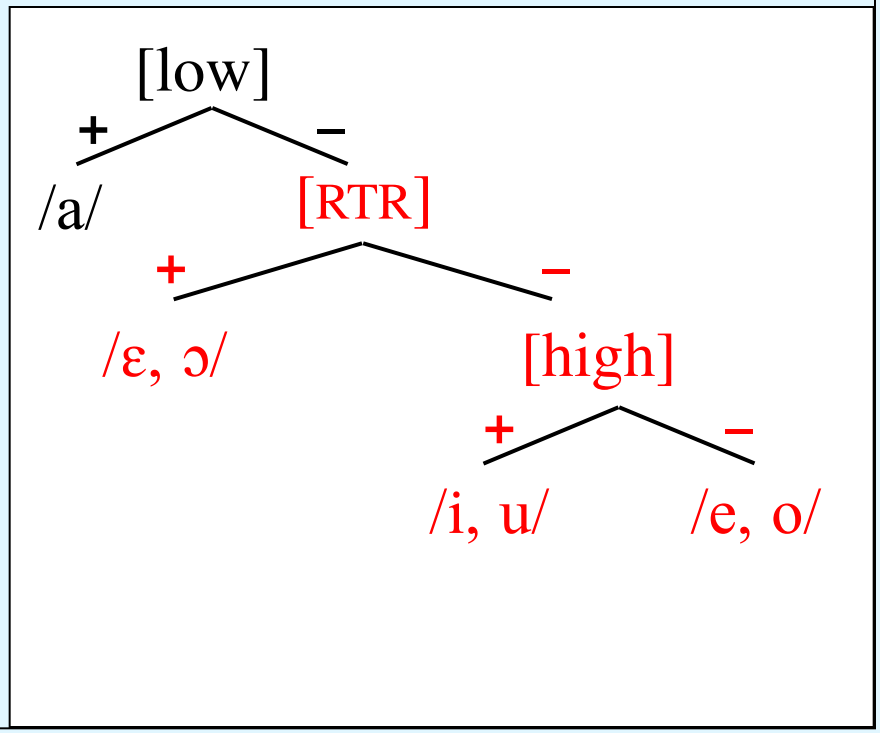
SDA Contrastive Features in Yoruba

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.

Or: [low] > [hi] > [RTR]



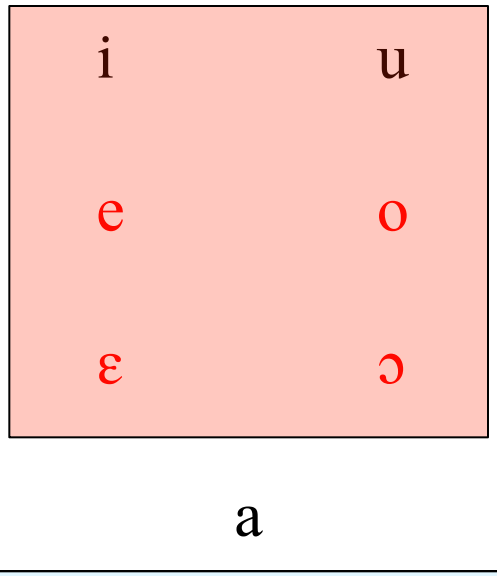
Or: [low] > [RTR] > [high]



A Sonority-based Prediction

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 MD: here the high and low vowels); and given that harmony normally computes only contrastive features; then if the noncontrastive vowels differ in sonority:

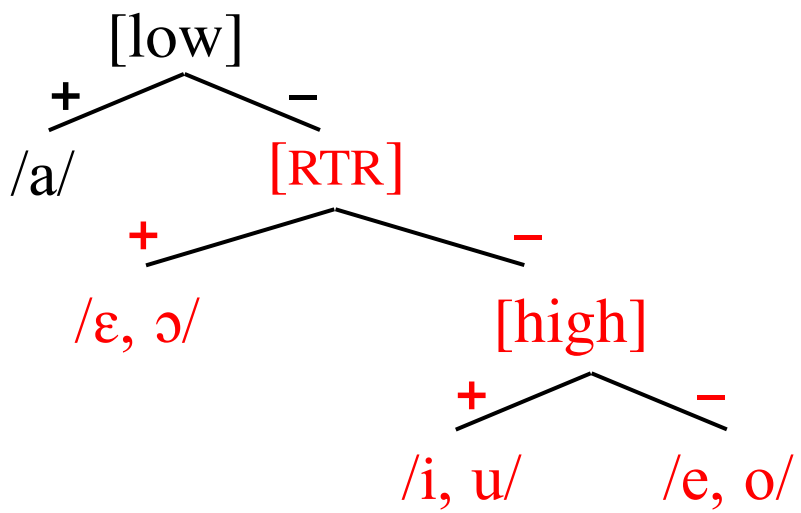


it will never be the case that a higher sonority noncontrastive vowel (/a/) is transparent while a lower sonority noncontrastive vowel (/i, u/) is not.

A Sonority-based Prediction

Looking at this from the point of view of feature ordering, the prediction is that the order [low] > [RTR] > [high] is not permitted.

[low] > [RTR] > [high]

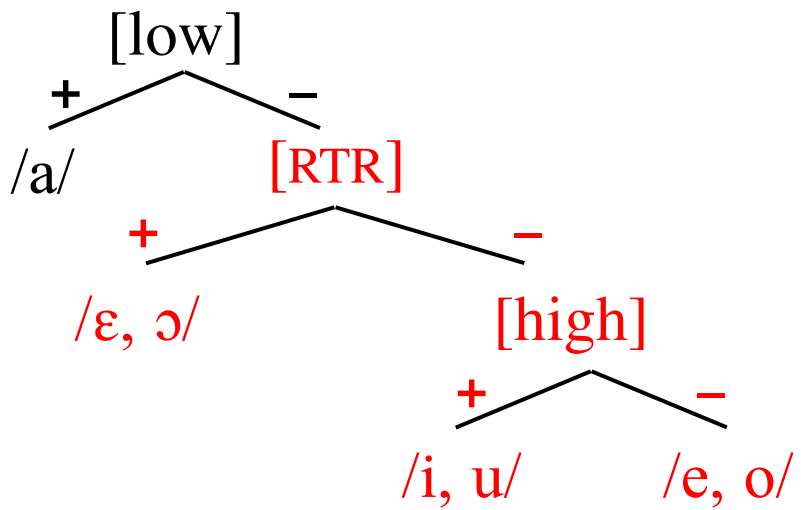


In this language, /a/ is outside the harmony domain, hence transparent and non-triggering, whereas the high vowels are in the scope of the harmonizing feature, hence are expected to block the spread of [+RTR], or be donors of [–RTR].

A Sonority-based Prediction

Looking at this from the point of view of feature ordering, the prediction is that the order [low] > [RTR] > [high] is not permitted.

[low] > [RTR] > [high]



That is, in this language we might expect forms like

oba and orako

as well as forms like

obi *ɔbi and orikɔ *ɔrikɔ

Reply to the Sonority-based Prediction

By way of reply, I note the following:

First, it is not clear 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 of the relevant kind.

Second, if the prediction is correct, then it points to constraints on possible feature ordering. But the point still stands that there is no reason to suppose that Standard Yoruba harmony computes noncontrastive features.

Is Feature Ordering Necessary?

One might question the need for feature ordering and hierarchical organization of contrast: it imposes a burden on learners, it is somewhat abstract relative to the data, etc.

As an anonymous reviewer has written, "Haven't we been getting by fine without it all these years?"

Actually, no. I have tried to show that making decisions about the relative scopes of features and feature ordering is unavoidable, and that such decisions are made tacitly all the time.

Is Feature Ordering Necessary?

As a parting example, consider two analyses of the Catalan vowel system in the recent literature.

Eastern Catalan (Crosswhite 2001)

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

Crosswhite (2001) makes Eastern Catalan look like Ifẹ Yoruba (except for [low]): [ATR] is limited to the mid vowels.

Valencian Catalan (Walker 2005; Lloret 2008)

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

Walker (2005) and Lloret (2008) make Valencian Catalan look like Standard Yoruba: [ATR] is contrastive over all vowels.

Is Feature Ordering Necessary?

None of these authors mentions feature ordering or scope, but they are present in their analyses nonetheless.

Eastern Catalan (Crosswhite 2001)

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

Eastern Catalan

[high], [low] > [ATR]

Valencian Catalan (Walker 2005; Lloret 2008)

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

Valencian Catalan

[ATR] > [high], [low]

Conclusions

Once we replace the Minimal Difference approach to contrast with the Successive Division Algorithm applying to an ordered list of features, there is no longer reason to suppose that Standard Yoruba [RTR] harmony computes all features rather than just contrastive features.

Therefore, both dialects of Yoruba remain consistent with the Contrastivist Hypothesis. So to answer the question in the title of this talk:

Is harmony limited to contrastive features?

So far, Yes!

I am grateful to members of the project on *Markedness and the Contrastive Hierarchy in Phonology* at the University of Toronto (Dresher and Rice 2007):

http://homes.chass.utoronto.ca/~contrast/

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References

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* 2/3: 496–549.

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.

Dresher, B. Elan. 2003. Contrast and asymmetries in inventories. In Anna-Maria di Sciullo (ed.), *Asymmetry in grammar, volume 2: morphology, phonology, acquisition*, 239–57. Amsterdam: John Benjamins.

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

References

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

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

Jakobson, Roman and Morris Halle. 1956. *Fundamentals of Language.* The Hague: Mouton.

Jakobson, Roman, C. Gunnar M. Fant and Morris Halle. 1952. *Preliminaries to Speech Analysis.* MIT Acoustics Laboratory, Technical Report, No. 13. Reissued by MIT Press, Cambridge, Mass., Eleventh Printing, 1976.

Leitch, Myles. 1996. Vowel harmonies of the Congo basin: an Optimality Theory analysis of variation in the Bantu zone C. Doctoral dissertation, Department of Linguistics, University of British Columbia.

References

Lloret, Maria-Rosa (2008). On the nature of vowel harmony: spreading with a purpose. In Antonietta Bisetto and Francesco E. Barbieri (eds.), *Proceedings of the XXXIII Incontro di Grammatica Generativa*, 15–35. Bologna: University of Bologna.

Nevins, Andrew. 2010. *Locality in vowel harmony*. Cambridge, MA: MIT Press.

Ọla Orie, Ọlanikẹẹ. 2001. An alignment-based account of vowel harmony in Ife Yoruba. *Journal of African Languages and Linguistics* 22: 117–43.

Osborn, H.A. 1966. Warao I: phonology and morphophonemics. *International Journal of American Linguistics* 32/2: 108–123.

Piggott, Glyne L. 1992. Variability in feature dependency: the case of nasality. *Natural Language & Linguistic Theory* 10: 33–77.

Walker, Rachel. 2005. Weak triggers in vowel harmony. *Natural Language and Linguistic Theory* 23: 917–89.

Williamson, K. 1965. *A grammar of the Kolokuma dialect of Ijo*. Cambridge: Cambridge University Press.

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