Elements

State of the Art and Perspectives

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Contrastive Hierarchies and Phonological Primes

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1.

Introduction

Introduction

Contrastive Hierarchy Theory (CHT; Dresher 2009, 2018; Hall 2007, 2011) builds on Jakobson's (1941) basic insight that the contrasts of a language are organized in a hierarchical order.

CHT assumes that phonological primes are binary features, and in this sense parts company with versions of Element Theory (ET) and related approaches.

Nevertheless, there are a number of affinities between CHT and ET, and in this talk I will try to highlight what I think are some points in common, as well as some differences.

Introduction

I will start with a review of the main ideas that I take from Jakobson (1941), and briefly mention what became of these ideas in the 1950s and 1960s.

Then I will set out the main tenets of CHT and discuss the status of phonological primes (features in CHT, elements in ET) with respect to phonetics and substance-free phonology.

I will try to show that CHT and ET have a similar approach to these issues, whether we take the primes to be features or elements.

Introduction

Next I will focus on three- and four-vowel systems, where there may or may not be an important difference between CHT and ET with respect to contrast.

Then I will briefly survey some five-vowel systems with the aim of showing that contrastive hierarchies must be allowed to vary from one language to another.

Before concluding, I will make the same point with a diachronic example, showing how the five-vowel system of West Germanic reorganized its system of contrasts in early Old English.

Introduction

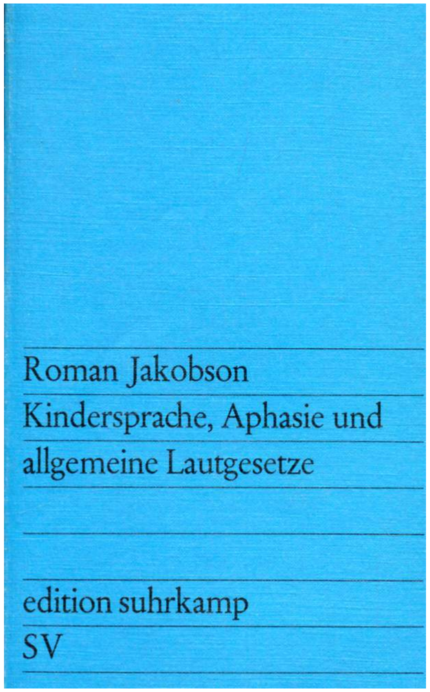
The talk is thus organized in 9 sections as follows:

- 1. Introduction
- 2. The acquisition of phonological contrasts
- 3. Contrastive Hierarchy Theory
- 4. Why are the primes as they are (whatever they are)?
- 5. Form and substance in phonology
- 6. Contrast and Element Theory: three- and four-vowel systems
- 7. Variability in contrastive hierarchies: five-vowel systems
- 8. Contrastive hierarchies in diachronic phonology: Old English *i*-umlaut
- 9. Conclusion

2.

The acquisition of phonological contrasts

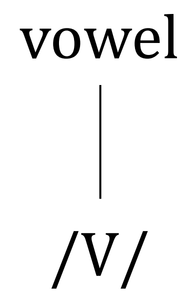
Jakobson's *Kindersprache*



Jakobson (1941) (English translation 1968, French in 1969), advances the notion that contrasts are crucial in phonological acquisition and that they develop in a hierarchical order.

In particular, he proposes that learners begin with broad contrasts that are split by stages into progressively finer ones.

Acquisition sequences (vowels)



The acquisition of vowel systems set out in Jakobson (1941) and its sequel, Jakobson & Halle (1956), follows this schema.

At the first stage, there is only a single vowel. As there are no contrasts, we can simply designate it /V/.

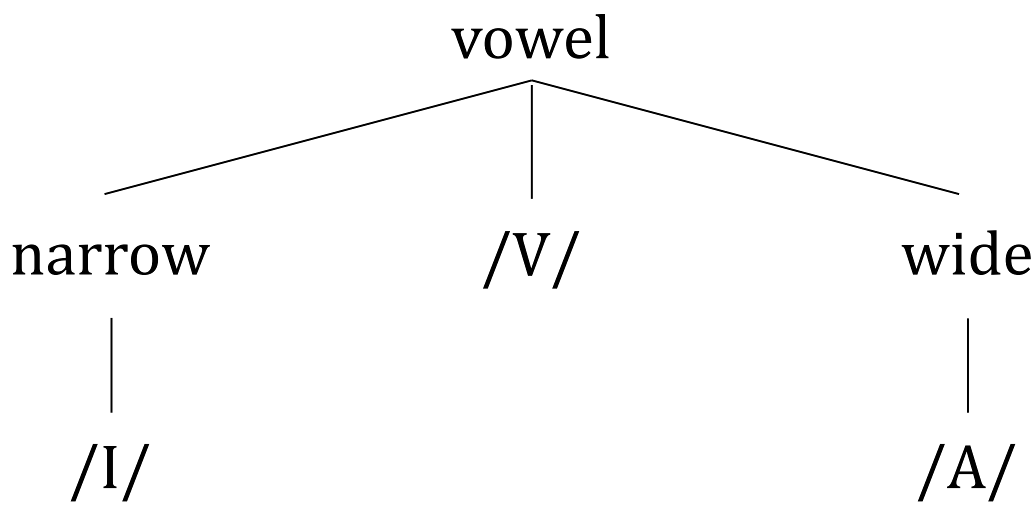
Acquisition sequences (vowels)

vowel
|
/V/
|
[a]

Jakobson & Halle write that this lone vowel is the maximally open vowel [a], the ‘optimal vowel’.

But we don’t need to be that specific: we can understand this to be a default value, or a typical but not obligatory instantiation.

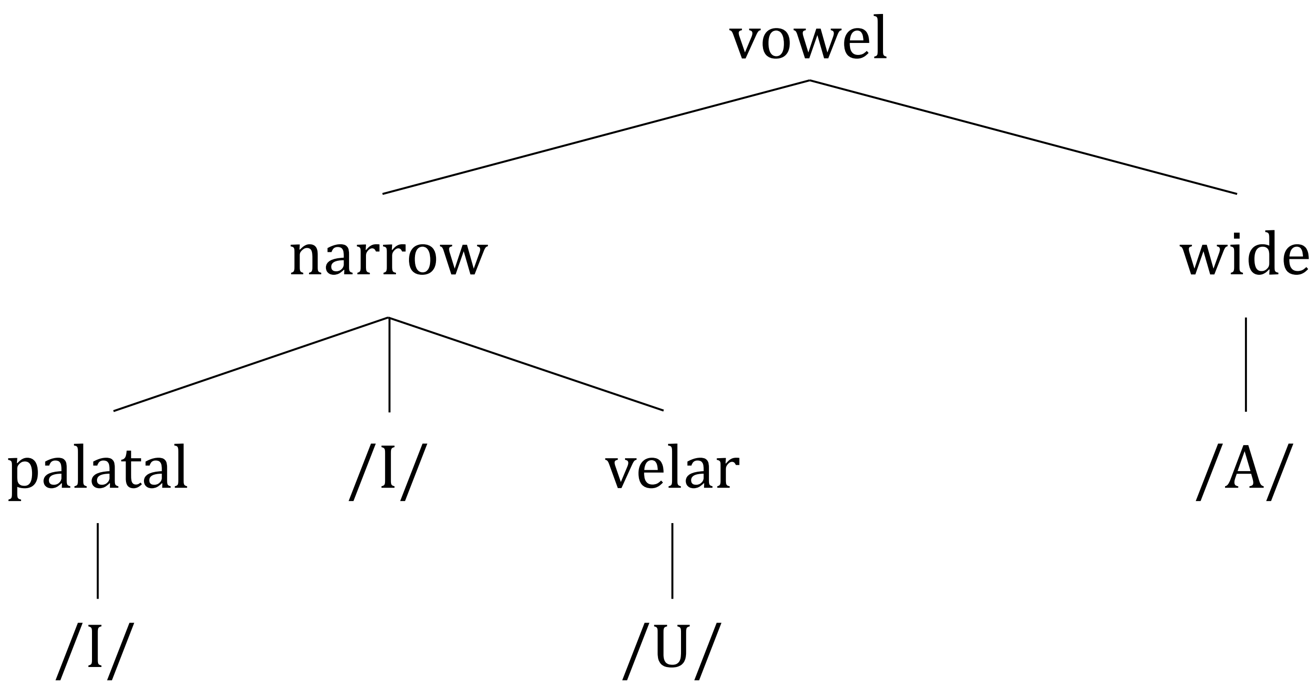
Acquisition sequences (vowels)



In the next stage it is proposed that the single vowel splits into a narrow (high) vowel /I/, which is typically [i], and a wide (low) vowel, /A/, typically [a].

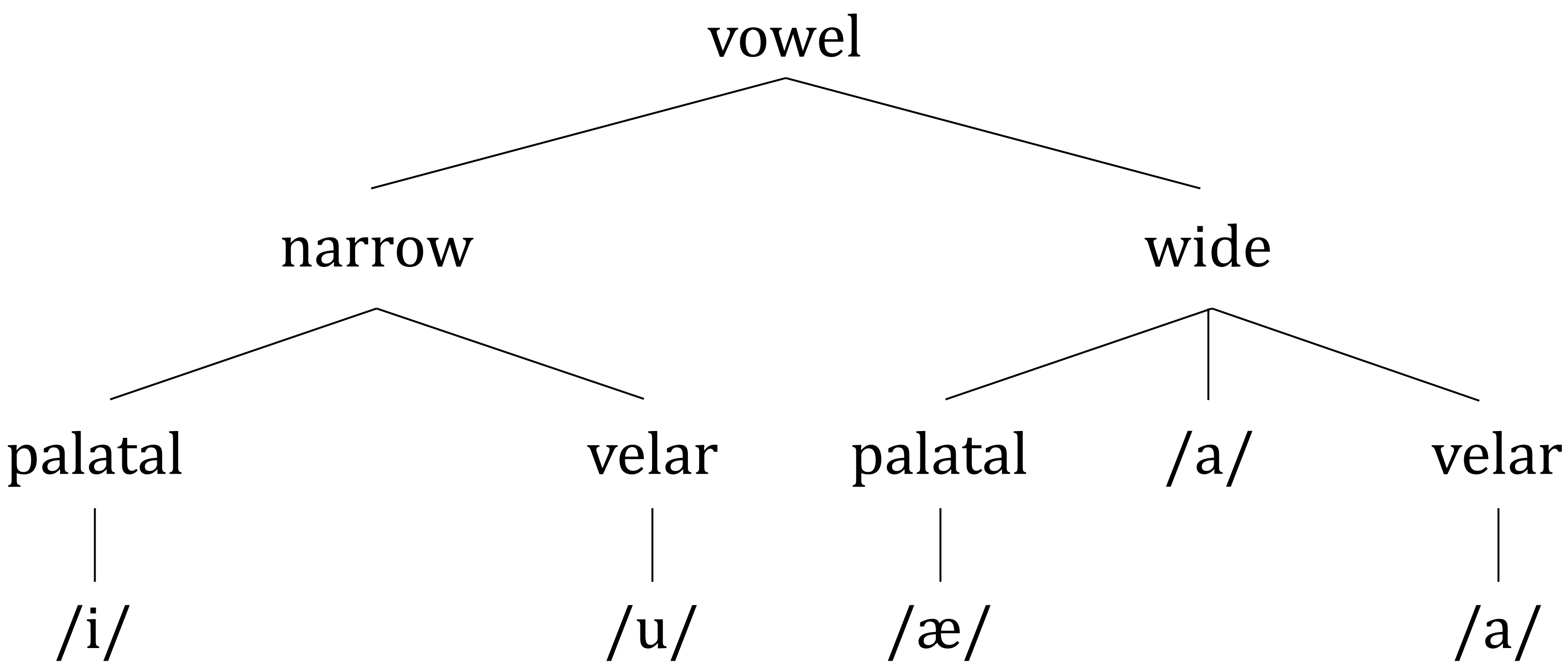
I will continue to understand these values as defaults; I use capital letters to represent vowels that fit the contrastive labels that characterize them.

Acquisition sequences (vowels)



In the next stage the narrow vowel splits into a palatal (front) vowel /I/ and a velar (back or round) vowel /U/, typically [u].

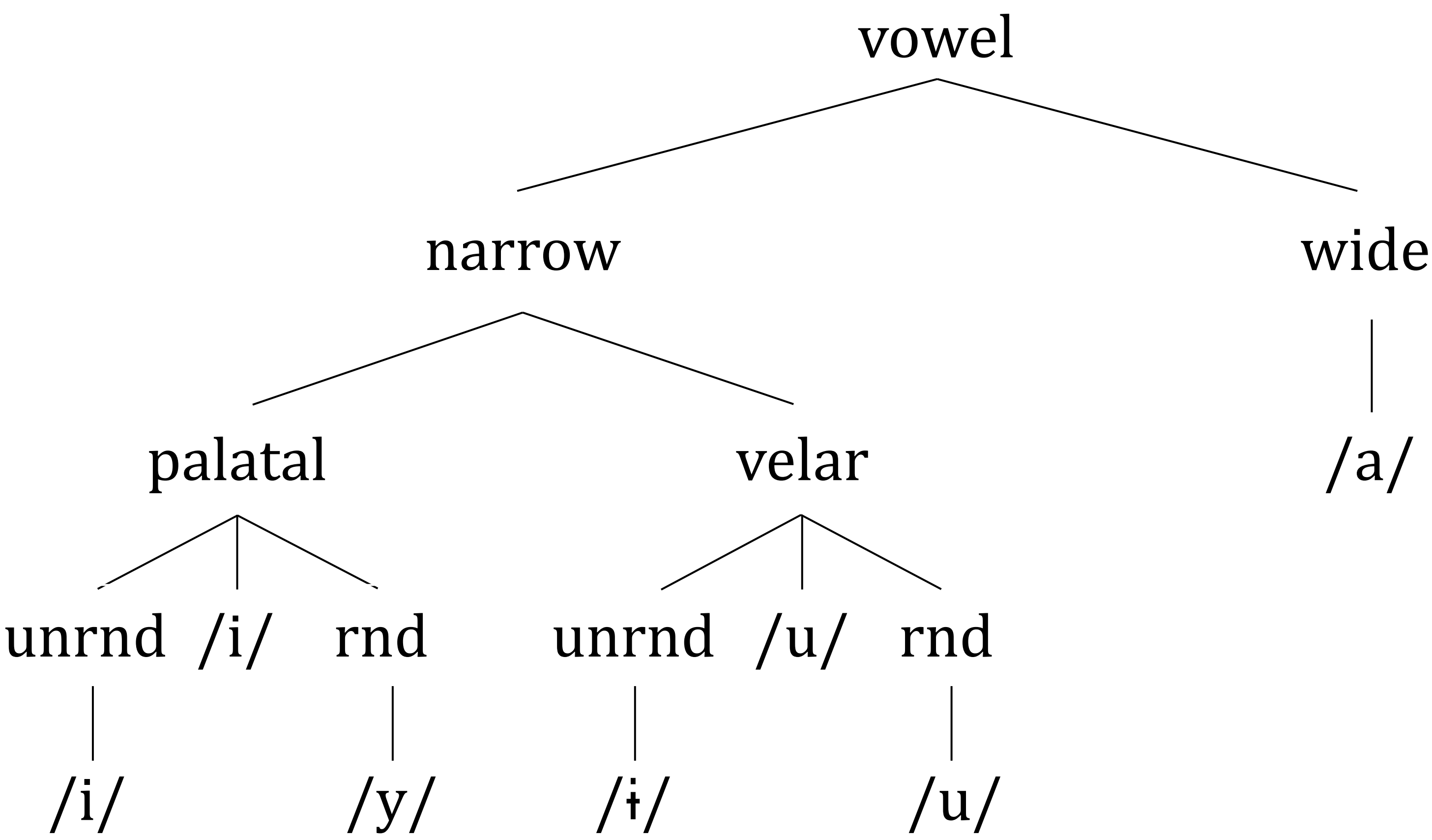
Acquisition sequences (vowels)



After the first two stages, Jakobson & Halle allow variation in the order of acquisition of vowel contrasts.

The wide branch can be expanded to parallel the narrow one.

Acquisition sequences (vowels)



Or the narrow vowels can develop a rounding contrast in one or both branches.

History of ‘branching trees’ in phonology

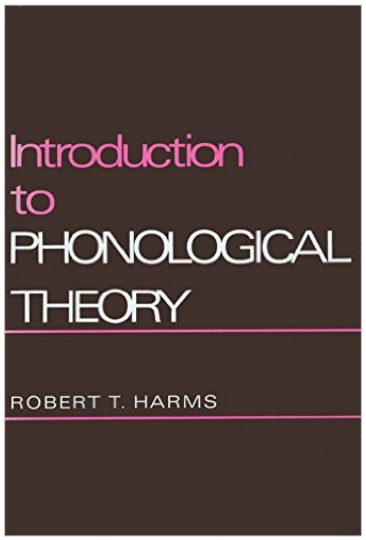
Continuing in this fashion we will arrive at a complete inventory of the phonemes in a language, with each phoneme assigned a set of contrastive properties that distinguish it from every other one.

I have been trying to reconstruct a history of ‘branching trees’ in phonology (Dresher 2009, 2015, 2016, 2018).

Early, though inexplicit, examples can be found in the work of Jakobson (1931b) and Trubetzkoy (1939) in the 1930s, and continuing with Jakobson 1941 and Jakobson & Lotz 1949.

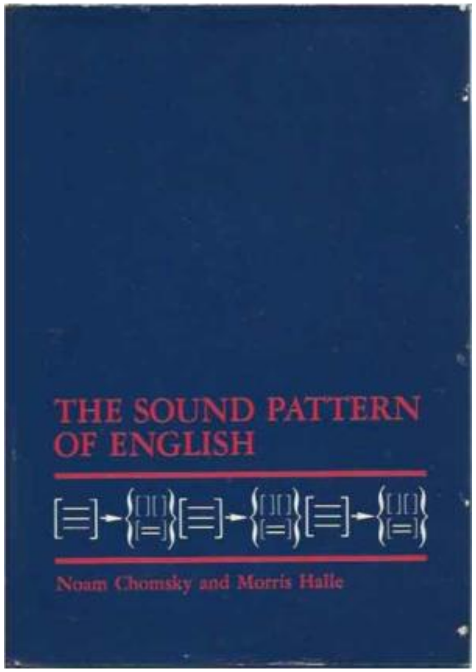
Then more explicitly in Jakobson, Fant, & Halle 1952, Cherry, Halle, & Jakobson 1953, Jakobson & Halle 1956, and Halle 1959.

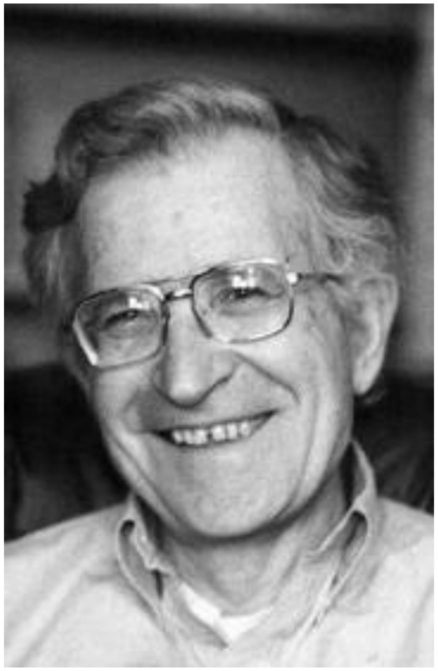
The Golden Age of branching trees



This approach was imported into early versions of the theory of Generative Phonology; it is featured prominently in the first Generative Phonology textbook by Robert T. Harms in 1968.

The decline of the branching trees





Nevertheless, for reasons I have discussed (Dresher 2009: 96–104), branching trees were omitted from Chomsky & Halle's *The sound pattern of English* (1968), and disappeared from mainstream phonological theory for the rest of the century.

Branching trees in child language

In child language studies, however, branching trees continued to be used, for they are a natural way to describe developing phonological inventories (Pye, Ingram and List 1987; Ingram 1988, 1989; Levelt 1989; Dinnsen et al. 1990; Dinnsen 1992, 1996; see Dresher 1998a for a review).

Fikkert (1994) presents observed acquisition sequences in the development of Dutch onsets that follows this general scheme.

Return of the branching trees

As a general theory of phonological representations, branching trees were revived, under other names, by Clements (2001; 2003; 2009), and independently at the University of Toronto, where they are called contrastive feature hierarchies (Dresher, Piggott, & Rice 1994; Dyck 1995; Zhang 1996; Dresher 1998b; Dresher & Rice 2007; Hall 2007; Dresher 2009; etc.).

It is the latter approach I will be presenting here. It has gone under various names: Modified Contrastive Specification (MCS), or 'Toronto School' phonology, or Contrast and Enhancement Theory, or just Contrastive Hierarchy Theory (CHT).

I don't claim there is any 'standard version' of this theory; in what follows, I will present the theory as I understand it.

3.

Contrastive Hierarchy Theory

Contrast and hierarchy

CHT has assumed that phonological primes are features; some CHT analyses have used privative features, but I will stick to binary ones.

The first major building block of our theory is that contrasts are computed hierarchically by ordered features that can be expressed as a branching tree.

Branching trees are generated by what I call the Successive Division Algorithm (Dresher 1998b, 2003, 2009):

The Successive Division Algorithm

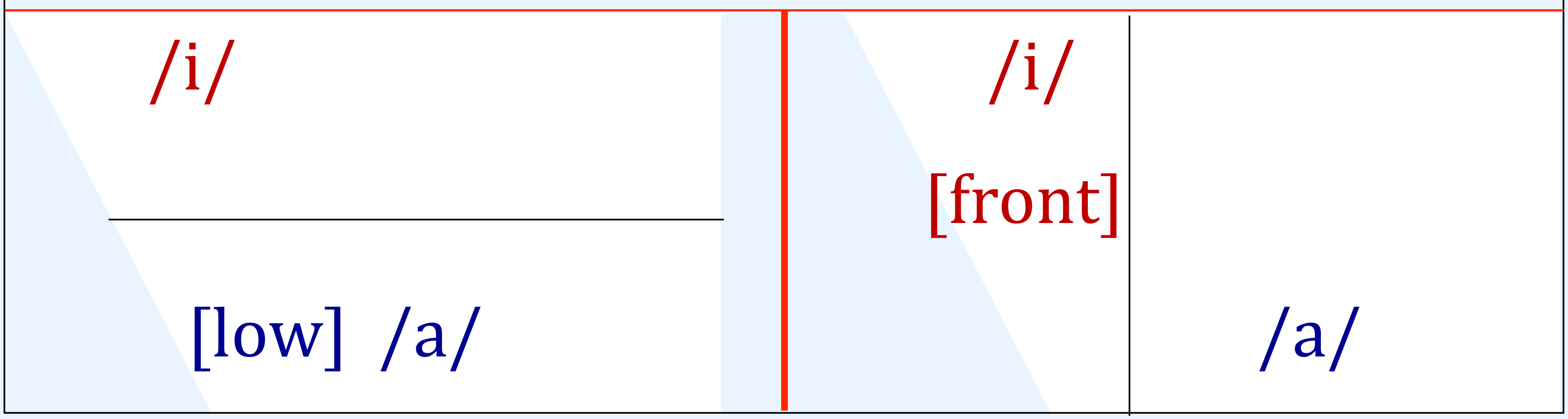
Assign contrastive features by successively dividing the inventory until every phoneme has been distinguished.

Criteria for ordering features

What are the criteria for selecting and ordering the features?

Phonetics is clearly important, in that the selected features must be consistent with the phonetic properties of the phonemes.

For example, a contrast between /i/ and /a/ would most likely involve a height feature like [low] or [high], though other choices are possible, e.g. [front] or [advanced/retracted tongue root].

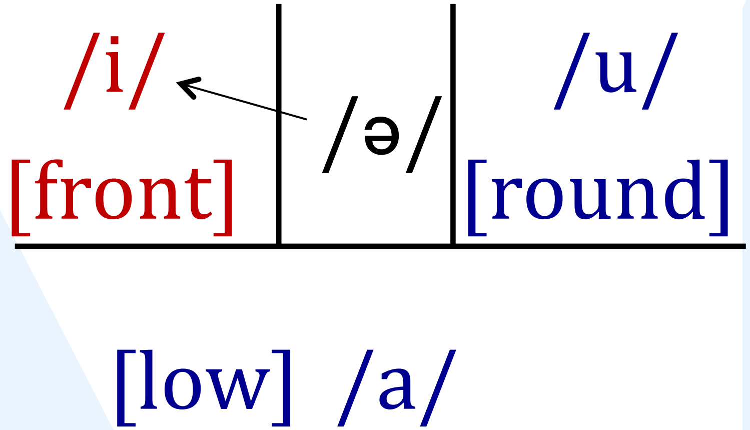


Criteria for ordering features

Of course, the contrastive specification of a phoneme could sometimes deviate from the surface phonetics.

In some dialects of Inuktitut, for example, an underlying contrast between /i/ and /ə/ is neutralized at the surface, with both /i/ and /ə/ being realized as phonetic [i] (Compton & Dresher 2011).

In this case, /i/ and /ə/ would be distinguished by a contrastive feature, even though their surface phonetics are identical.



Contrast and phonological activity

As the above example shows, the way a sound patterns can override its phonetics (Sapir 1925).

Thus, we consider as most fundamental that features should be selected and ordered so as to reflect the phonological activity in a language, where activity is defined as follows (adapted from Clements (2001: 77):

Phonological Activity

> A feature can be said to be active if it plays a role in the phonological computation; that is, if it is required for the expression of phonological regularities in a language, including both static phonotactic patterns and patterns of alternation.

A theory of contrastive specification

The second major tenet has been formulated by Hall (2007) as the Contrastivist Hypothesis:

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.

That is, only contrastive features can be phonologically active. If this hypothesis is correct, it follows as a corollary that

Corollary to the Contrastivist Hypothesis

> If a feature is phonologically active, then it must be contrastive.

Markedness

One final assumption is that the two values of a feature are not symmetrical: every feature has a marked and unmarked value.

I assume that markedness is language particular (Rice 2003, 2007), and is acquired based on phonological patterning.

I will designate the marked value of a feature F as [F], and the unmarked value as (*non-F*). I will refer to the two values together as [±F].

How the contrastive hierarchy works

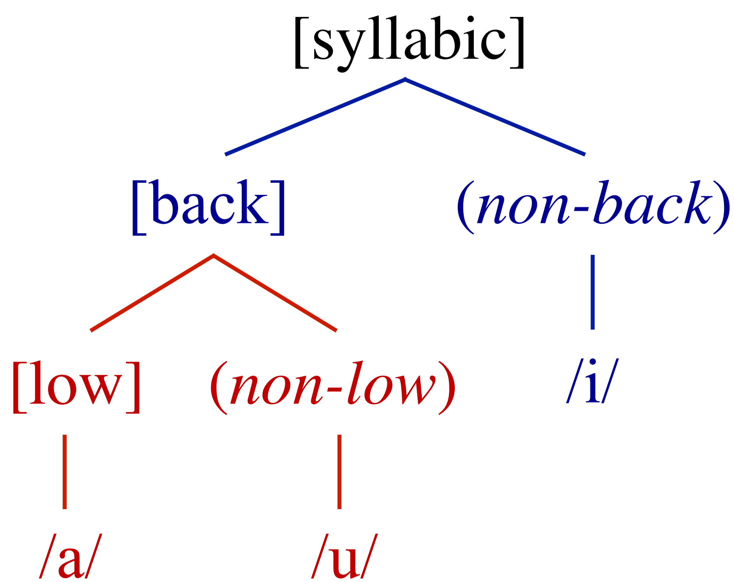
For example, if a language has three vowel phonemes /i, a, u/, and if the vowels are split off from the rest of the inventory so that they form a sub-inventory, then they must be assigned a contrastive hierarchy with two vowel features.

Though the features and their ordering vary, the limit of two features constrains what the hierarchies can be.

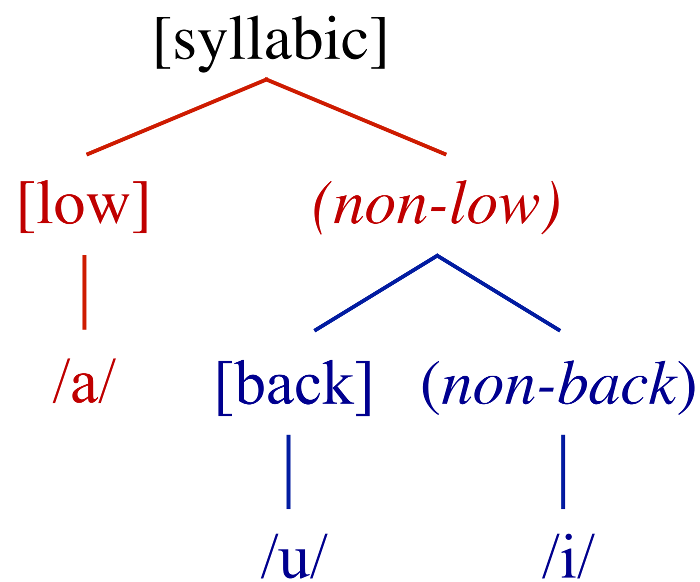
How the contrastive hierarchy works

Here are two possible contrastive hierarchies using the features **[back]** and **[low]**.

[back] > [low]



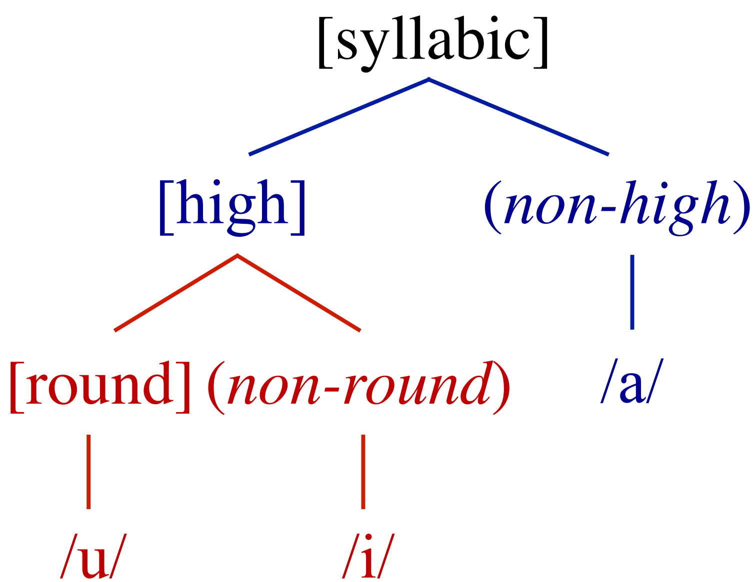
[low] > [back]



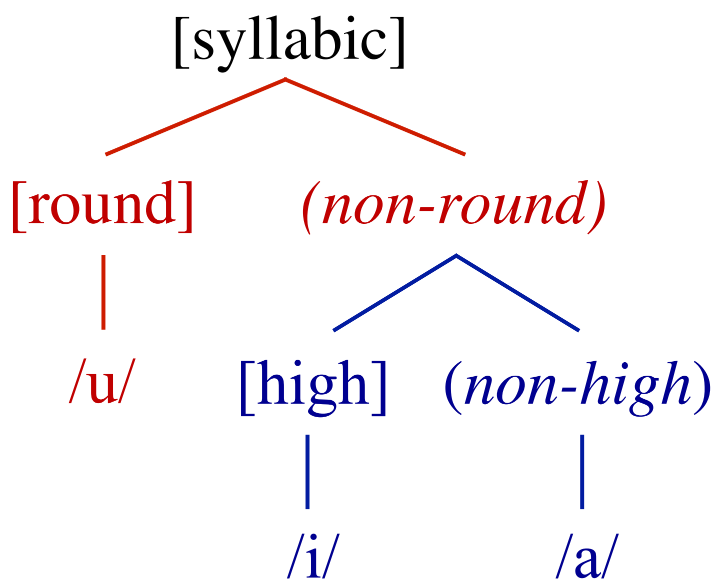
How the contrastive hierarchy works

Here are two more hierarchies, using **[high]** and **[round]**.

[high] > [round]



[round] > [high]

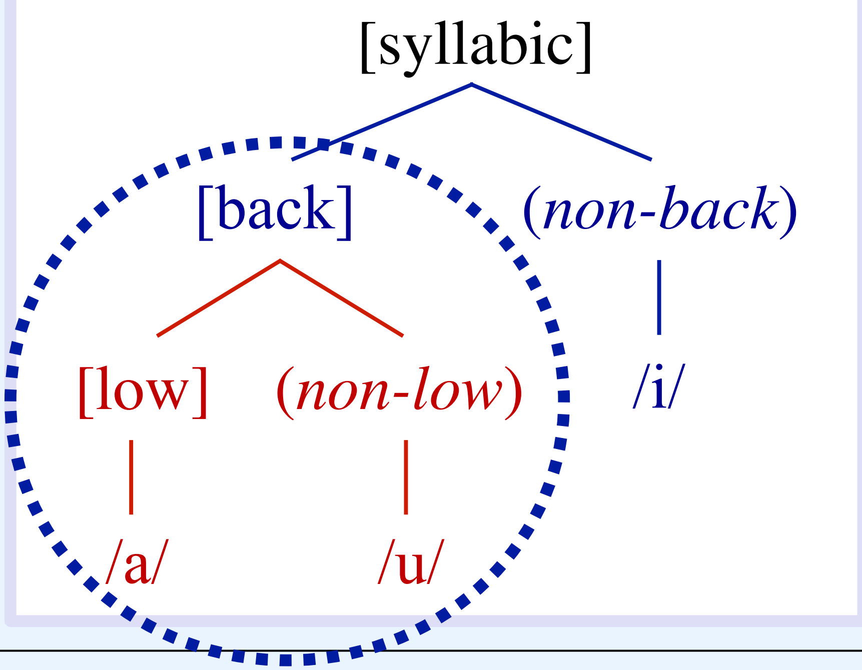


What does the hierarchy do? Synchrony

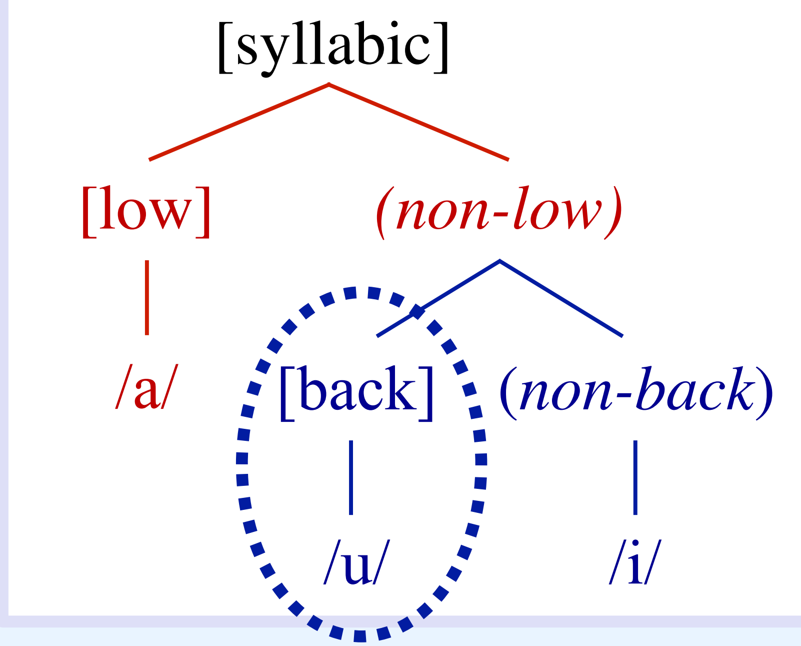
1. The hierarchy constrains phonological activity:
Only contrastive features can be phonologically active.

Which phonemes can trigger backing?

[back] > [low]



[low] > [back]



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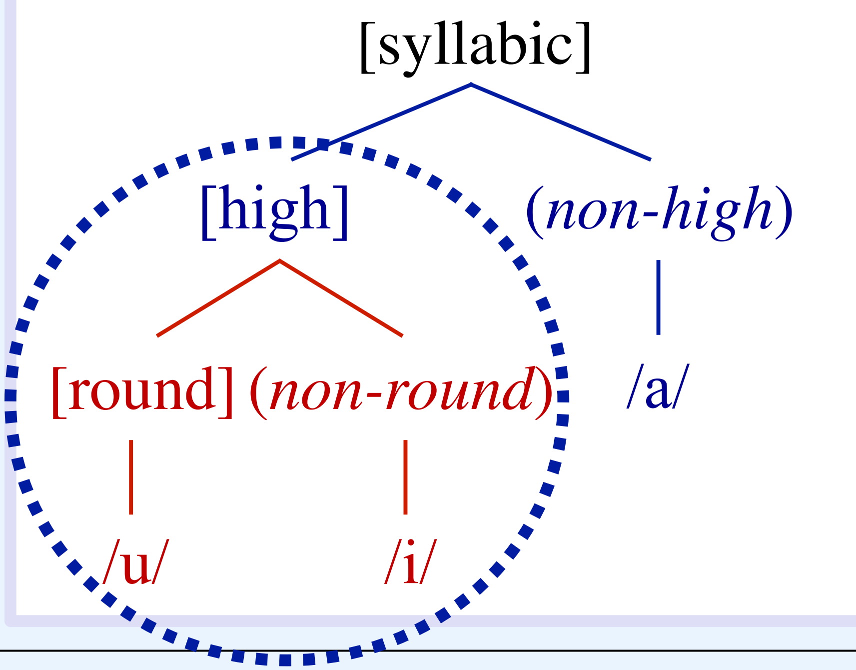
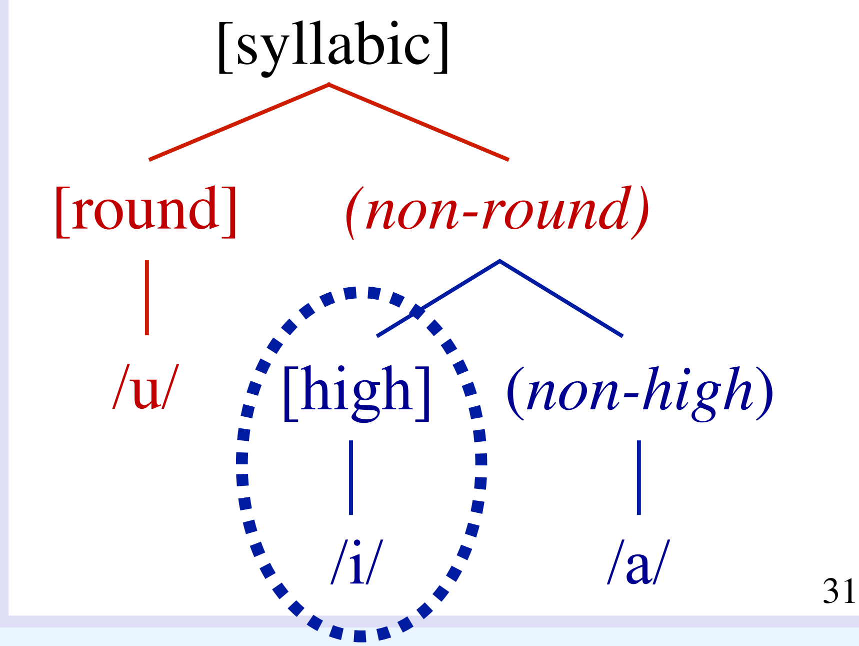
[high] > [round]



[round] > [high]



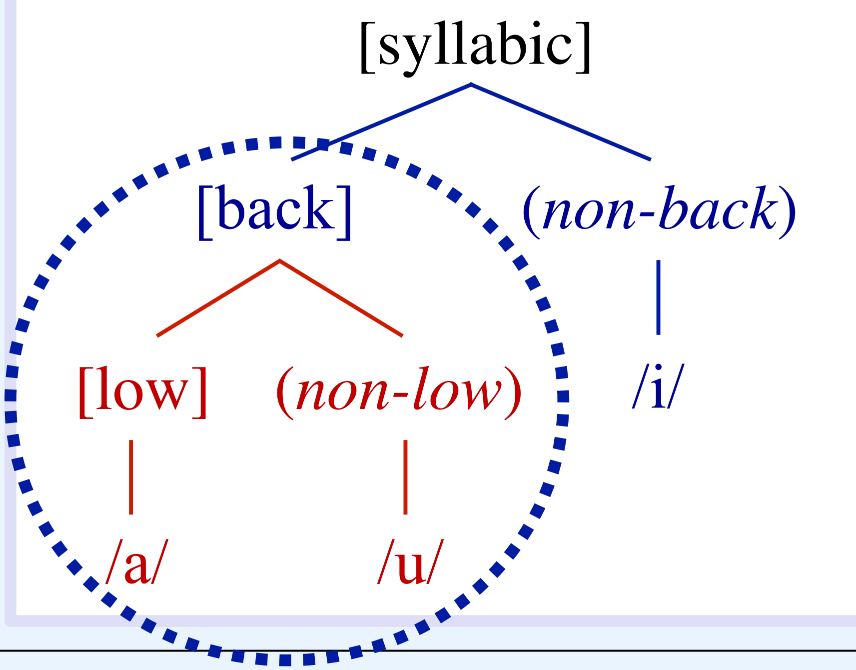
What does the hierarchy do? Diachrony

2. The hierarchy constrains neutralization and merger:

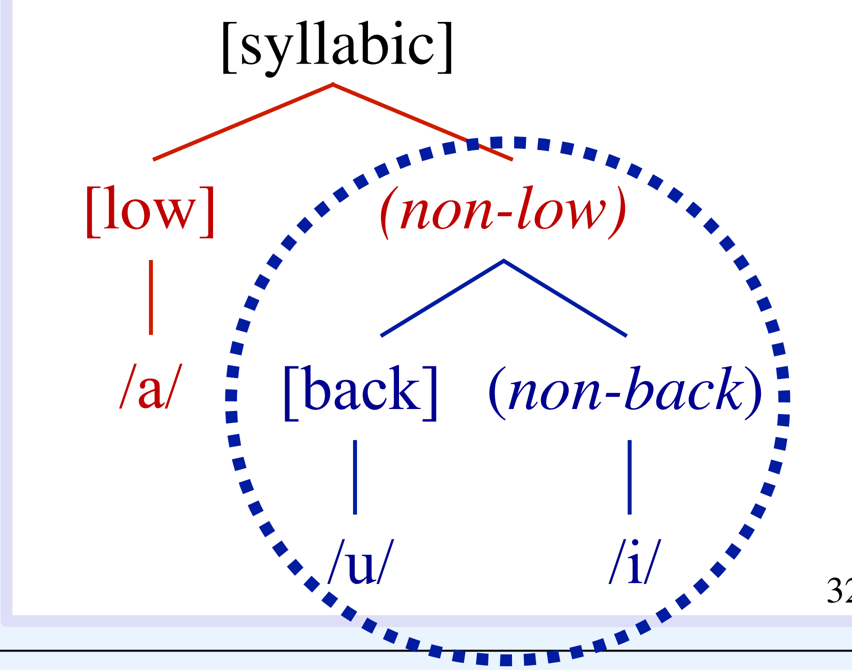
Mergers affect phonemes that are contrastive sisters.

Which phoneme can /u/ merge with?

[back] > [low]



[low] > [back]

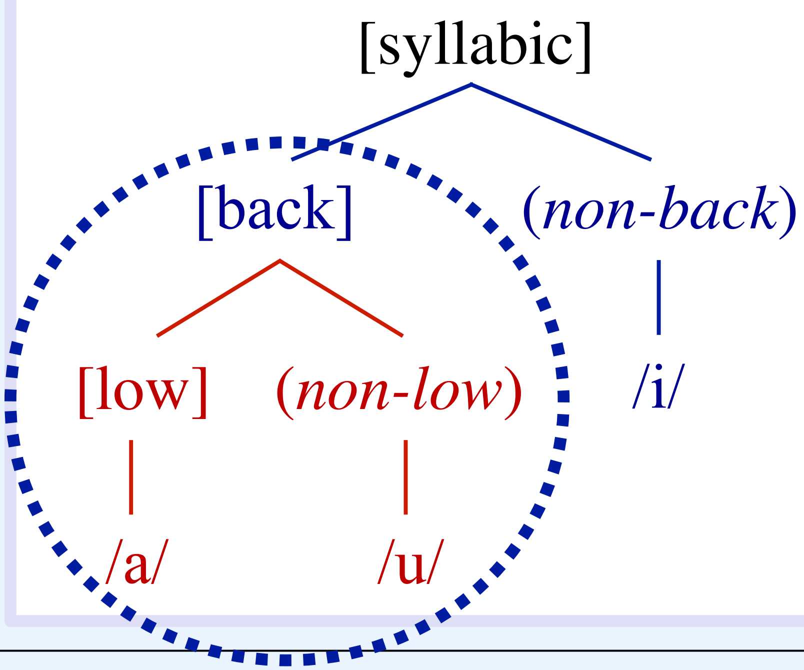


What does the hierarchy do? Diachrony

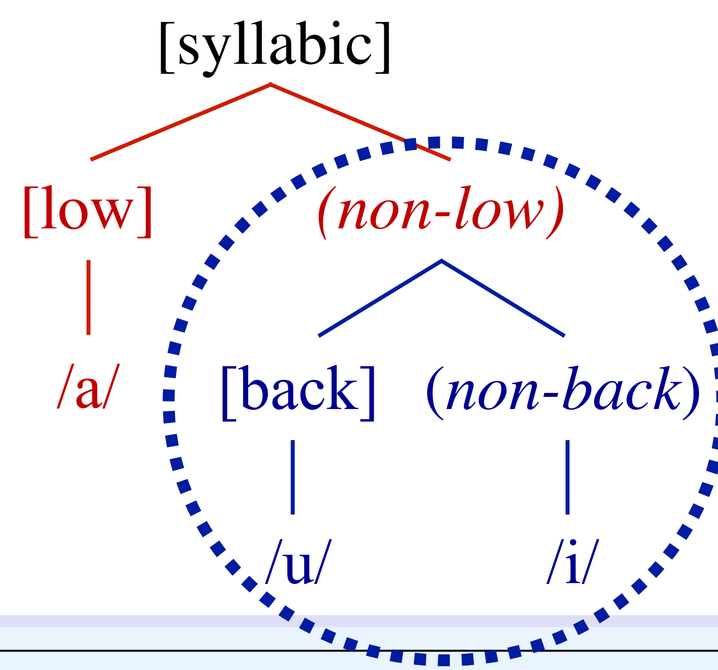
See Oxford 2015 for examples of merger patterns just like these in the history of Algonquian languages.

Which phoneme can /u/ merge with?

[back] > [low]



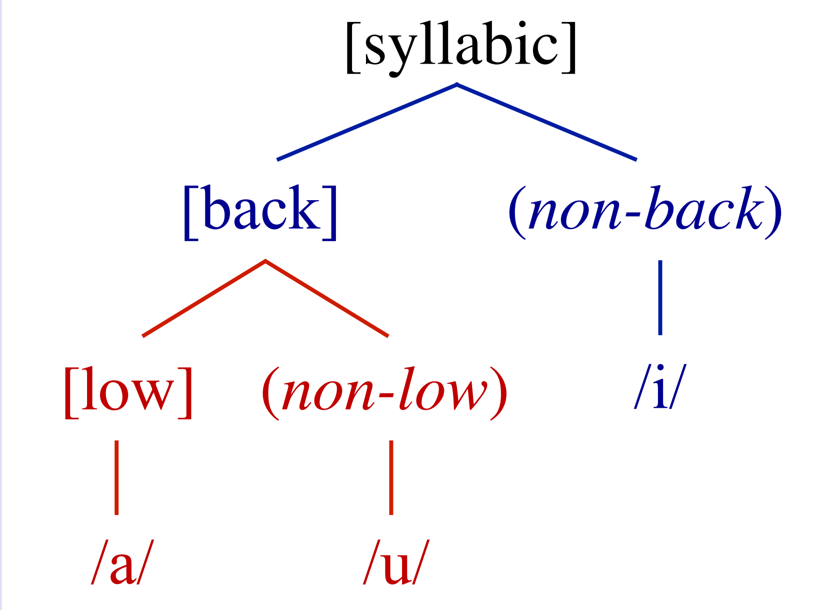
[low] > [back]



Where can we find typological generalizations?

Typological generalizations can thus not be found by looking at inventories alone (say, /i, a, u/), or at individual phonemes (/a/), or phones ([a]), without also considering the relevant contrastive feature hierarchy.

[back] > [low]



Enhancement of underspecified features

Unless a vowel is further specified by other contrastive features (originating in another vowel or in the consonants), it is made more specific only in a post-phonological component.

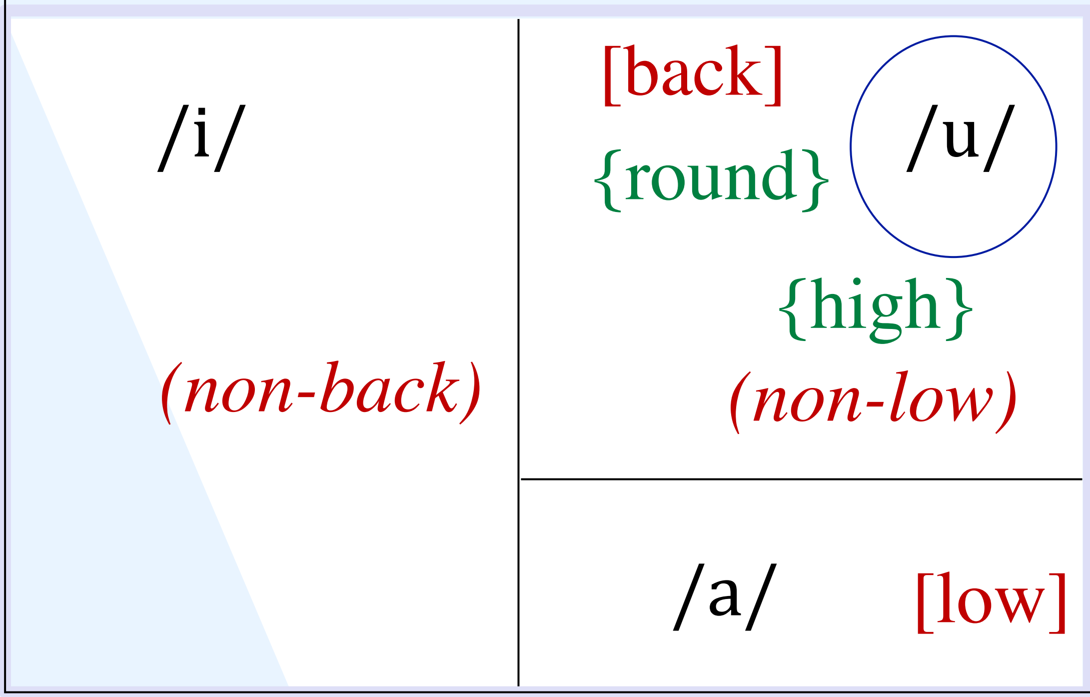
Stevens, Keyser, & Kawasaki (1986) propose that feature contrasts can be enhanced by other features with similar acoustic effects (see also Stevens & Keyser 1989; Keyser & Stevens 2001, 2006).

Hall (2011) shows how the enhancement of contrastive features can result in configurations predicted by Dispersion Theory (Liljencrants & Lindblom 1972; Lindblom 1986; Flemming 2002)

Enhancement of underspecified features

Thus, a vowel that is [back] and *(non-low)* can enhance these features by adding {round} and {high}, becoming [u].

I designate enhancement features with curly brackets { }.



These enhancements are not universal, however, and other realizations are possible (Dyck 1995; Hall 2011).

4.

Why are the primes as they are (whatever they are)?

Emergent features

There is a growing consensus that phonological features are not innate, but rather 'emerge' in the course of acquisition.

In a volume titled *Where do phonological features come from?* (Clements & Ridouane 2011), most of the papers take an emergentist position; none argue for innate features.

Mielke (2008) and Samuels (2011) summarize the arguments against innate features:

Against innate features

- from a biolinguistic perspective, phonological features are too specific, and exclude sign languages (van der Hulst 1993; Sandler 1993);
- empirically, no one set of features have been discovered that ‘do all tricks’ (Hyman 2011 with respect to tone features, but the remark applies more generally);
- since at least some features have to be acquired from phonological activity, a prespecified list of features becomes less useful in learning.

Why do features emerge at all?

But if features are not innate, what compels them to emerge at all? It is not enough to assert that features may emerge, or that they are a useful way to capture phonological generalizations.

We need to explain why features inevitably emerge, and why they have the properties that they do. In particular:

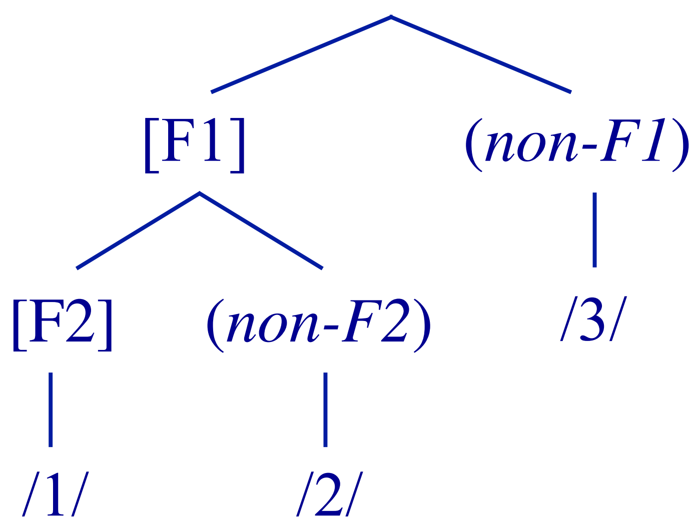
- Why don't learners, or some learners, simply posit segment-level representations?
- What controls the number of features—how broad or narrow are they? How many features should learners posit for 3 vowels, for example? Are there limits?

The contrastive feature hierarchy provides an answer to these questions: learners must arrive at a set of hierarchically ordered contrastive features.

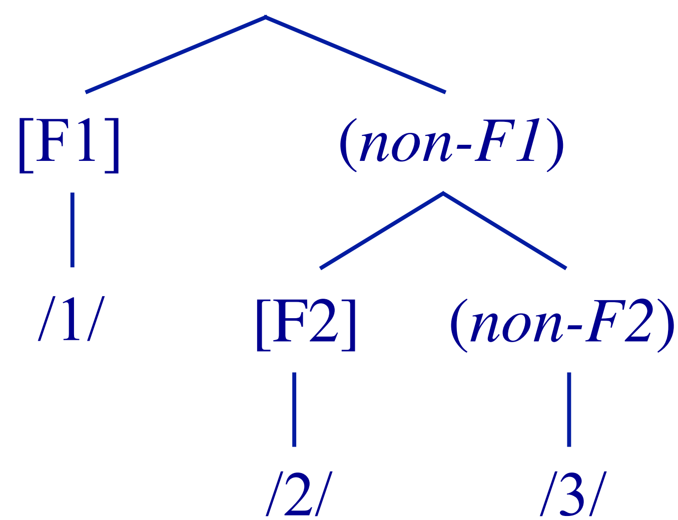
How many features are there?

An inventory of 3 phonemes allows exactly 2 contrastive features. Two variants are shown, differing in how marked features are distributed.

3 phonemes: F1 > F2



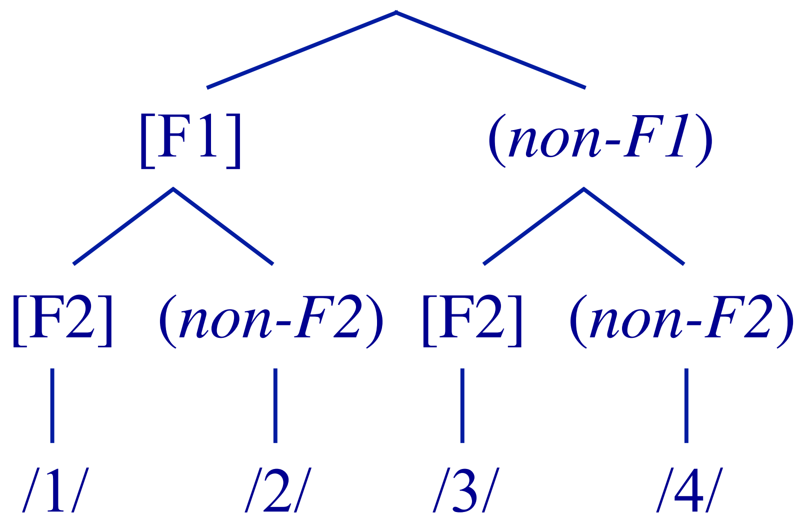
3 phonemes: F1 > F2



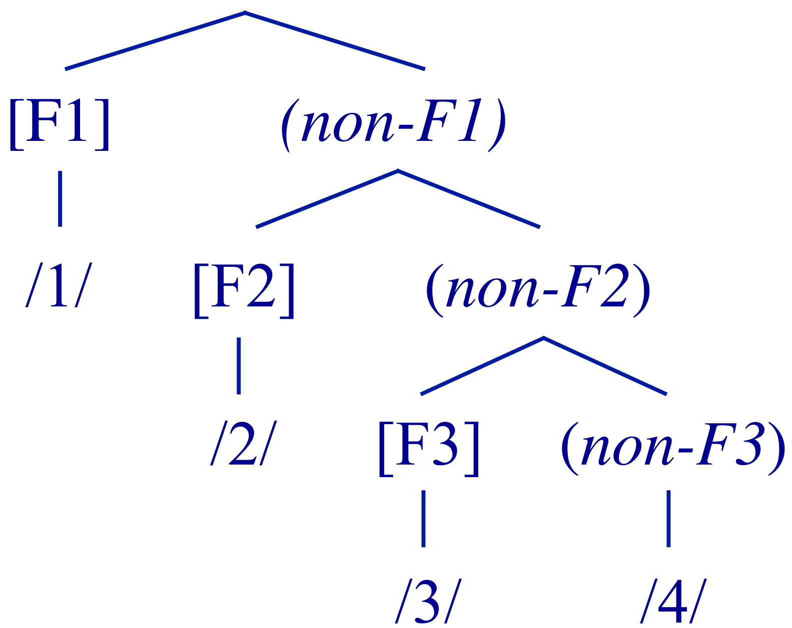
How many features are there?

A 4-phoneme inventory can have a minimum of 2 features and a maximum of 3.

4 phonemes: minimum



4 phonemes: maximum



How many features are there?

In general, the number of features required by an inventory of *n* elements will fall in the following ranges:

the minimum number of features = the smallest integer $\geq \log_2 n$

the maximum number of features = $n-1$

Phonemes	$\log_2 n$	min	max
3	1.58	2	2
4	2	2	3
5	2.32	3	4
6	2.58	3	5

How many features are there?

The minimum number of features goes up very slowly as phonemes are added.

The upper limit rises with *n*.

Phonemes	$\log_2 n$	min	max
7	2.81	3	6
8	3	3	7
10	3.32	4	9
12	3.58	4	11

How many features are there?

However, inventories that approach the upper limit are extremely uneconomical.

At the max limit, each new segment uses a unique contrastive feature unshared by any other phoneme.

Phonemes	$\log_2 n$	min	max
16	4	4	15
20	4.32	5	19
25	4.64	5	24
32	5	5	31

Emergent features and UG

Thus, the contrastive hierarchy and Contrastivist Hypothesis account for why phonological systems resemble each other in terms of representations, without requiring individual features to be innate.

For the content of features, learners make use of the available materials relevant to the modality:

Emergent features and UG

- for spoken language, acoustic and articulatory properties of speech sounds;

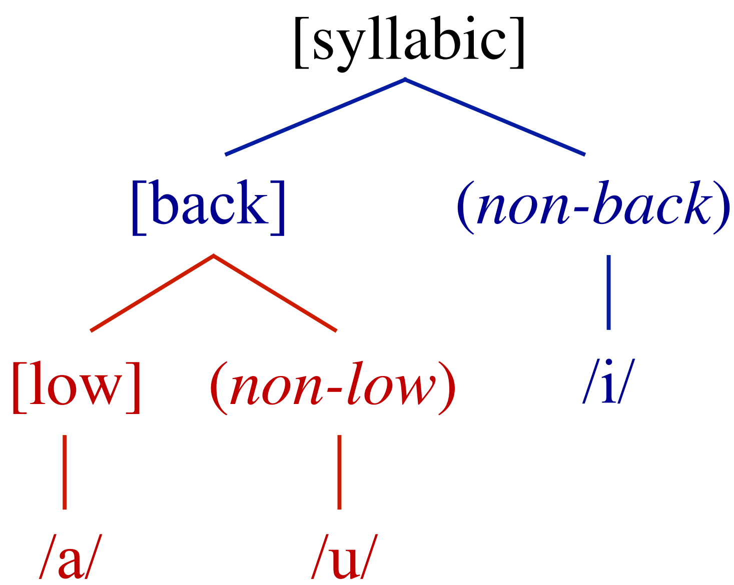
- for sign language, hand shapes and facial expressions.

On this view, the concept of a contrastive hierarchy is an innate part of Universal Grammar (UG), and is the glue that binds phonological representations and makes them appear similar from language to language (Dresher 2014a).

Phonological features are cognitive entities

It is important to emphasize that, though phonological features may make use of innate auditory dispositions, they are not the same as those, but are cognitive entities created by learners.

[back] > [low]



Thus, the contrasts indicated by [back] and [low] may be cross-linguistically common because we have neurons sensitive to formant transitions.

Phonological features are cognitive entities

It is important to emphasize that, though phonological features may make use of innate auditory dispositions, they are not the same as those, but are cognitive entities created by learners.

[back] > [low] ?

Thus, the contrasts indicated by [back] and [low] may be cross-linguistically common because we have neurons sensitive to formant transitions.

So, it appears, do ferrets (Mesgarani et al. 2008). But ferrets do not necessarily have our kind of phonological representations.

5.

Form and substance in phonology

Phonological primes and substance

I believe that CHT and ET are in agreement that phonological primes (features for CHT, elements for ET) are cognitive entities that are not determined by phonetics, in contrast to phonetically-based approaches to phonology (Steriade 2001; Flemming 2002; Hayes, Kirchner, & Steriade 2004).

On the other side, both CHT and ET are not as radical as various 'substance-free' theories in separating phonological representations from phonetics (Hale & Reiss 2000, 2008; Odden 2006; Blaho 2008; Mielke 2008; Samuels 2011; Reiss 2017).

Hall (2014) traces this approach back to Fudge (1967). He comments that substance-free theories are actually similar to substance-based theories in relegating the explanation for many aspects of phonology to phonetic factors and diachronic change.

Phonological primes and substance

Advocates of substance-free phonology (SFP) argue that phonology is concerned only with formal notions, and not with phonetic substance.

However, the line between form and substance is not as clear cut as advocates of SFP make it out to be.

Take, for example, markedness. Reiss (2017: 429) writes, 'The way forward, in the twenty-first century, is to abandon markedness'.

He assumes that markedness is not formal, but is part of substance.

Now there are different notions of what markedness is, and some of them might fall under 'substance'; but this is not the case for the version assumed in CHT.

Phonological primes and substance

I have proposed (Dresher 2014a) that the learners' task is to arrive at a set of contrastive primes that account for the contrasts and phonological activity of their language.

I have assumed that the primes are binary features, but much the same holds if we assume that they are privative features or elements.

These primes are not arbitrary diacritics or numbers but have phonetic correlates.

I also assume that features are asymmetrical in having a marked and unmarked value. These values, like the features themselves, are acquired by learners based on the evidence of their language.

Phonological primes and substance

Since markedness, on this view, is inherent in the definition of a feature, I consider it to be a part of the formal side of phonology, though it partakes of some aspects of phonetic substance.

The same holds even more obviously of phonological theories influenced by Kaye, Lowenstamm, & Vergnaud (1985) (KLV).

According to Jean-Roger Vergnaud (p. c.), one of the motivations for developing the KLV theory was to incorporate the *SPE* markedness theory directly into representations.

Markedness in Element Theory

For example, in Backley's (2011) *Introduction to Element Theory*, the vowels in a five-vowel system differ in the complexity of their representations.

The vowels [e] and [o] have more complex representations than [i, a, u].

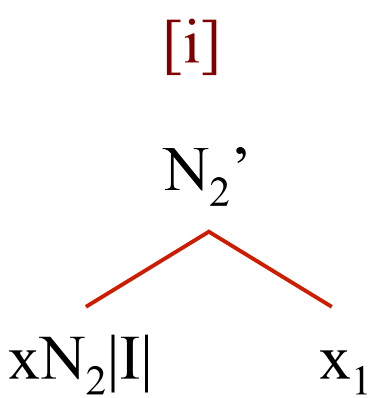
Five-vowel system

[i]	[e]	[a]	[o]	[u]
|I|	|I A|	|A|	|U A|	|U|

Markedness in GP 2.0

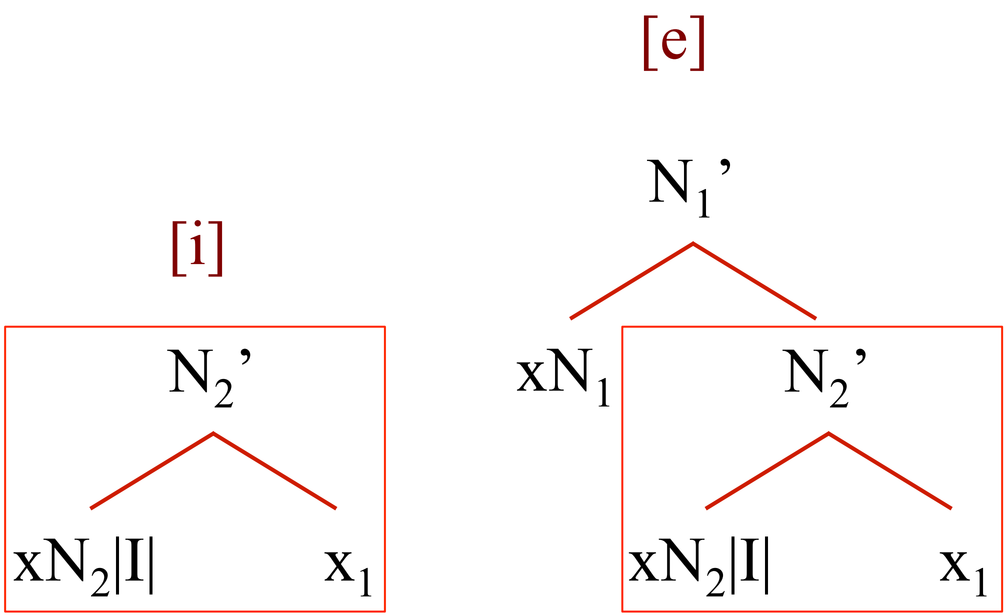
In GP 2.0 (Pöchtrager 2006, 2016; Živanović & Pöchtrager 2010; Kaye & Pöchtrager 2013; Voeltzel 2016) markedness is expressed structurally.

The vowel [i] has a relatively simple representation.



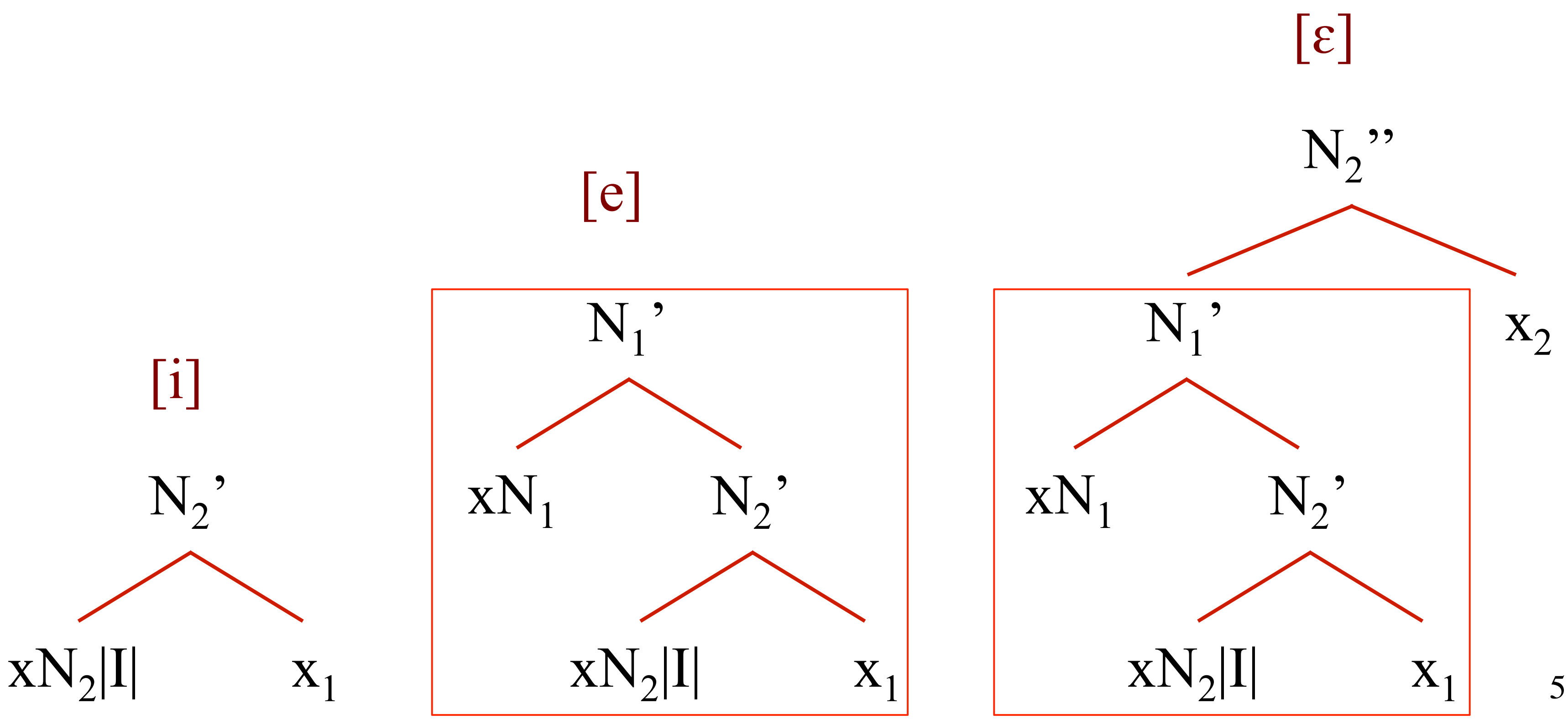
Markedness in GP 2.0

[e] is essentially an [i] with an additional layer of structure.



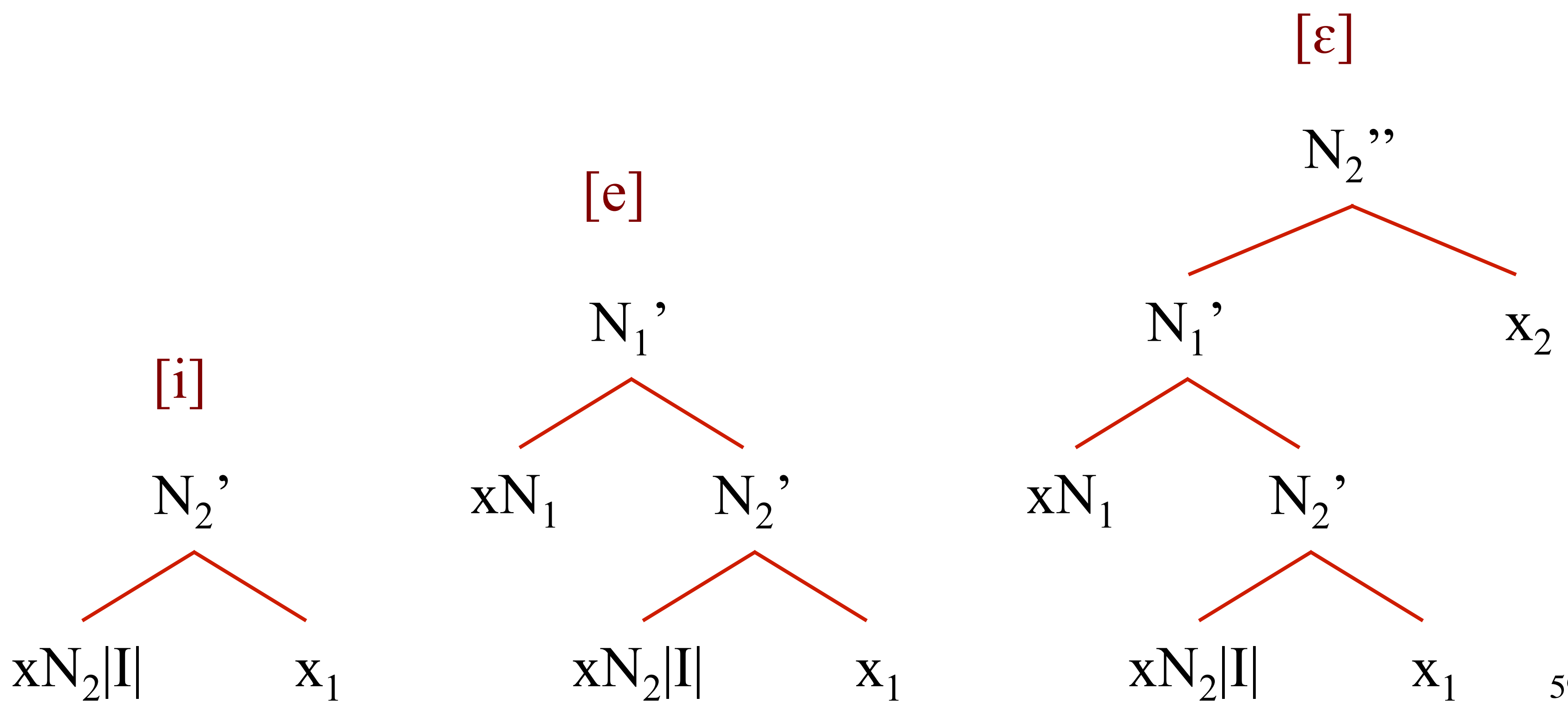
Markedness in GP 2.0

[ɛ] is essentially an [e] with a further layer of structure.



Markedness in GP 2.0

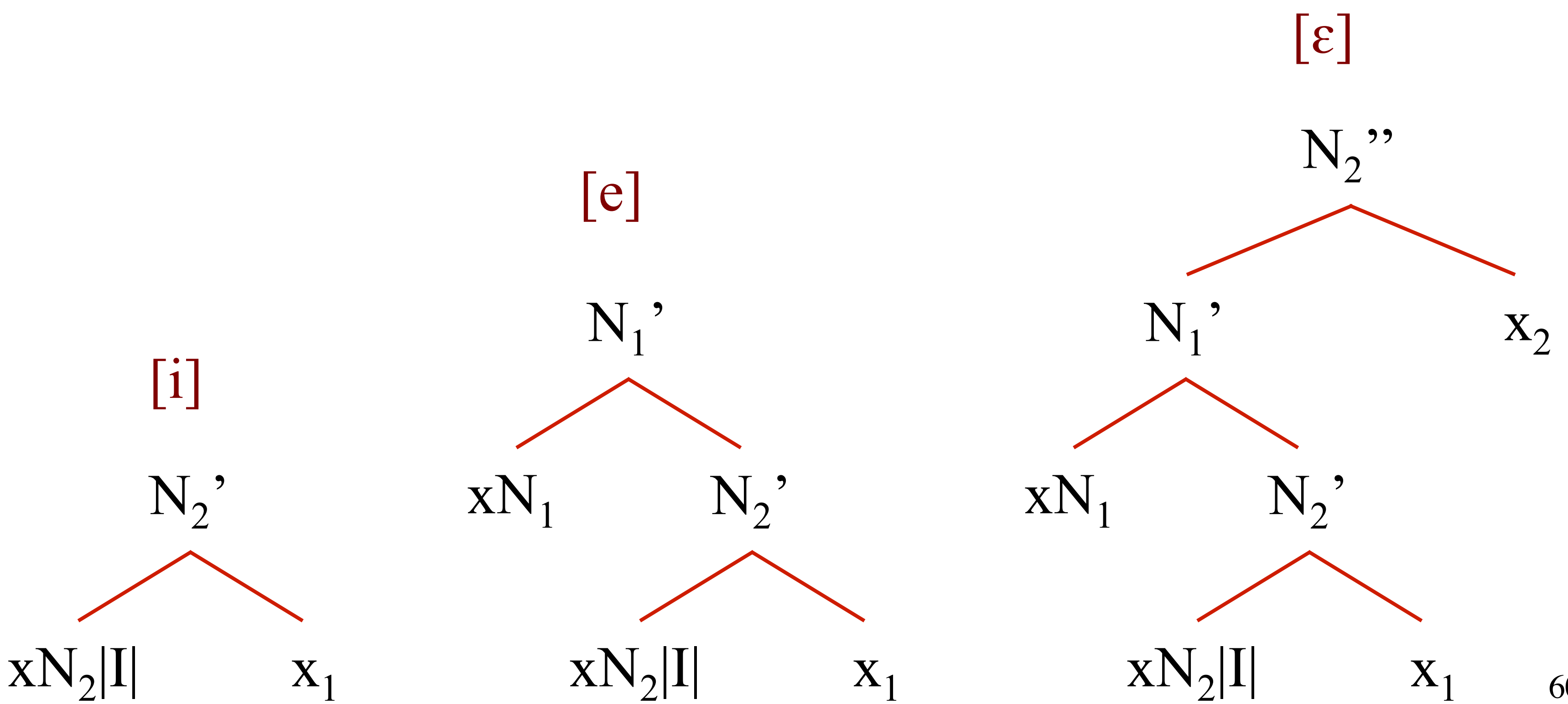
These structures are formal phonological representations, so not merely ‘substance’, though they relate to phonetic substance.



Vowel reduction in GP 2.0

Voeltzel (2016) summarizes Pöchtrager's (2016) account of vowel reduction in Brazilian Portuguese:

The stressed position of a word has 'room' for all three vowels.

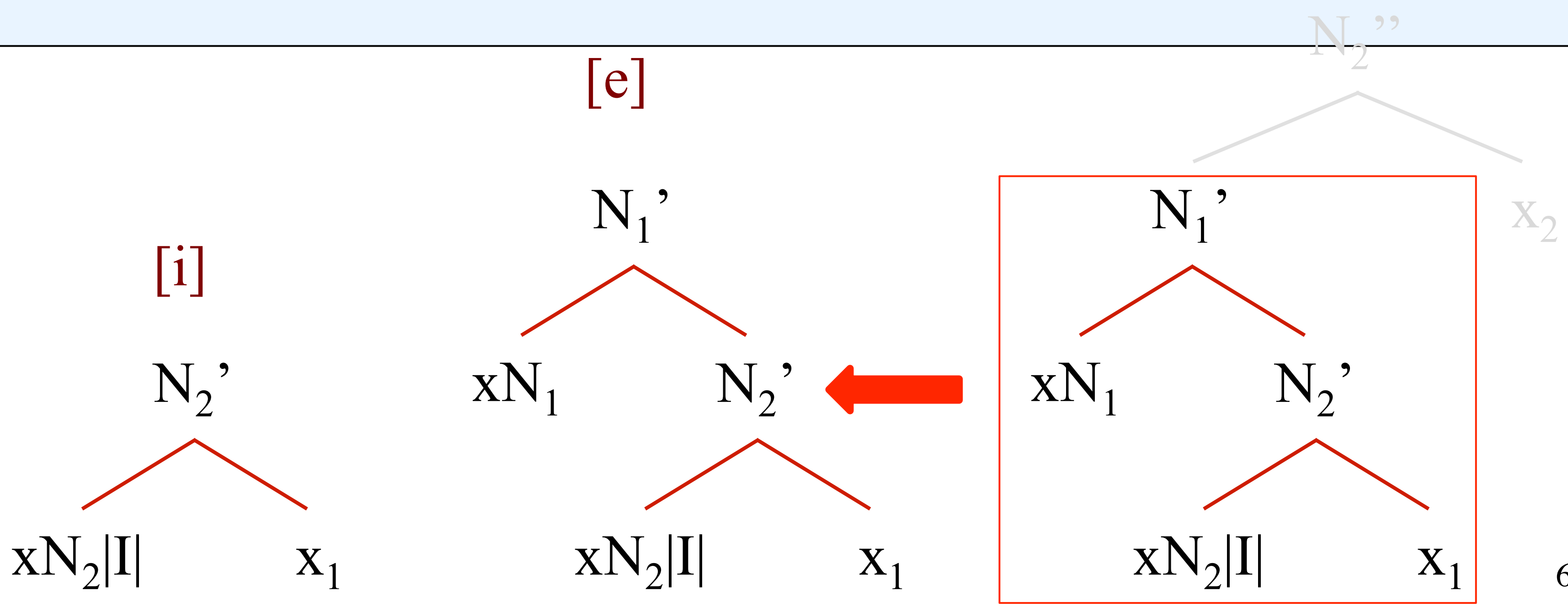


Vowel reduction in GP 2.0

Voeltzel (2016) argues that these structures give a good account of vowel reduction in Brazilian Portuguese:

The stressed position of a word has ‘room’ for all three vowels.

Before the stressed vowel there is no room for the most complex vowel, [ɛ], which reduces to [e].



Vowel reduction in GP 2.0

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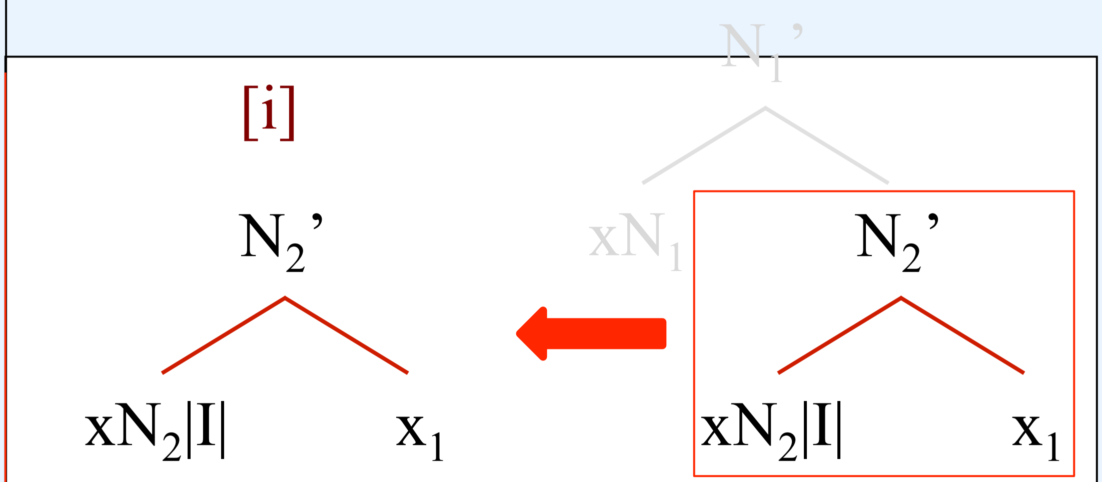
The stressed position of a word has 'room' for all three vowels.

Before the stressed vowel there is no room for the most complex vowel, [ɛ], which reduces to [e].

The most reduction occurs in final unstressed position, where all three front vowels appear as [i].



It's an empirical question whether this theory is correct, but I see no grounds for considering it to be a case of 'substance abuse'.

Markedness and variability

My reservations about this analysis concern variability and the phonetic interpretation of these representations.

With respect to variability, I have already mentioned that I follow Rice (2003, 2007) in assuming that markedness is language particular.

Thus, it does not appear to be the case that /e/ is always more marked than /i/ and that /ɛ/ is always more marked than /e/.

Indeed, Nevins (2012) writes that Brazilian Portuguese dialects themselves differ with respect to whether [e] or [ɛ] is the result of neutralization.

Markedness and variability

This is not an argument against a structural approach to markedness, but rather an argument that a given structure may have different phonetic interpretations in different systems.

Nevins (2012) considers flexibility of interpretation to be a desirable property of ET, in that it allows either /ɛ/ or /e/ to be assigned the more marked structure, as the evidence requires.

I would argue that the same holds of the relationship between other vowels, such as /i/ and /e/ or /i/ and /u/.

Markedness and vowel reduction

A second caveat that one might have about this type of analysis is that it equates the phonetic realizations of vowels in unstressed position with certain vowels in stressed position.

For example, the analysis suggests that final unstressed [i] in Brazilian Portuguese, which is the only front vowel in that position, is the same as stressed [í], which contrasts with two other front vowels.

One might be able to argue that this is the case in some languages, but in many languages it is clear that the reduced vowels cannot be phonetically equated with particular stressed vowels.

That is, neutralization is not always to the unmarked stressed vowel, but may be to a vowel that has a different representation from both the marked and unmarked stressed vowels.

Brazilian Portuguese vowel reduction

This actually appears to be the case in Brazilian Portuguese. According to Barbosa & Albano (2004), a São Paulo speaker had the vowels shown below.

They write (2004: 229) that in pre-stressed position, ‘the quality of the corresponding stressed vowel is roughly preserved’.

Stressed position	i	e	ɛ	a	ɔ	o	u
Before the stress	i	e		a	o		u
Final unstressed							

Brazilian Portuguese vowel reduction

This actually appears to be the case in Brazilian Portuguese. According to Barbosa & Albano (2004), a São Paulo speaker had the vowels shown below.

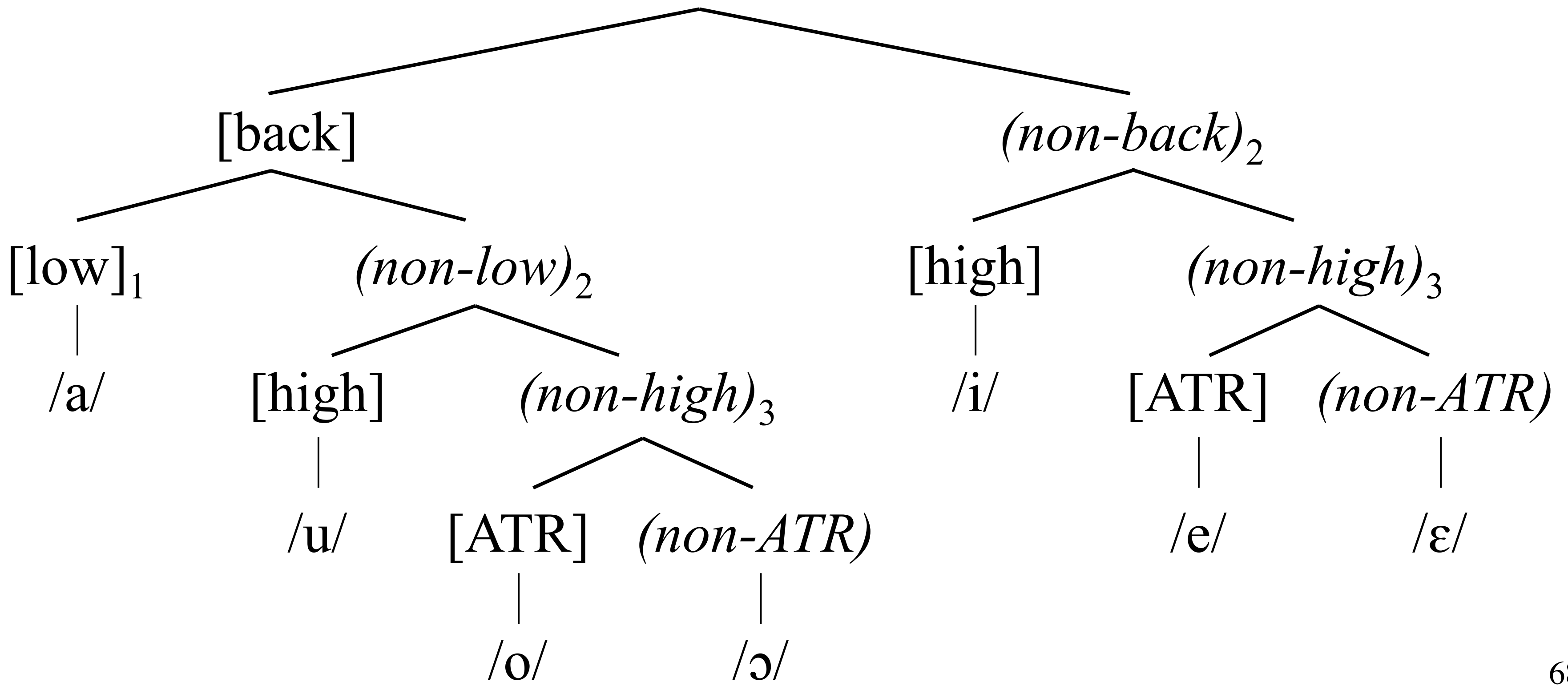
They write (2004: 229) that in pre-stressed position, ‘the quality of the corresponding stressed vowel is roughly preserved’.

But this is not the case for unstressed vowels in final position.

<table>
<tr><td>Stressed position</td><td>i</td><td>e</td><td>ɛ</td><td>a</td><td>ɔ</td><td>o</td><td>u</td></tr>
<tr><td>Before the stress</td><td>i</td><td colspan="2">e</td><td>a</td><td colspan="2">o</td><td>u</td></tr>
<tr><td>Final unstressed</td><td colspan="3">ɪ</td><td>ɐ</td><td colspan="3">ʊ</td></tr>
</table>

Vowel reduction in CHT

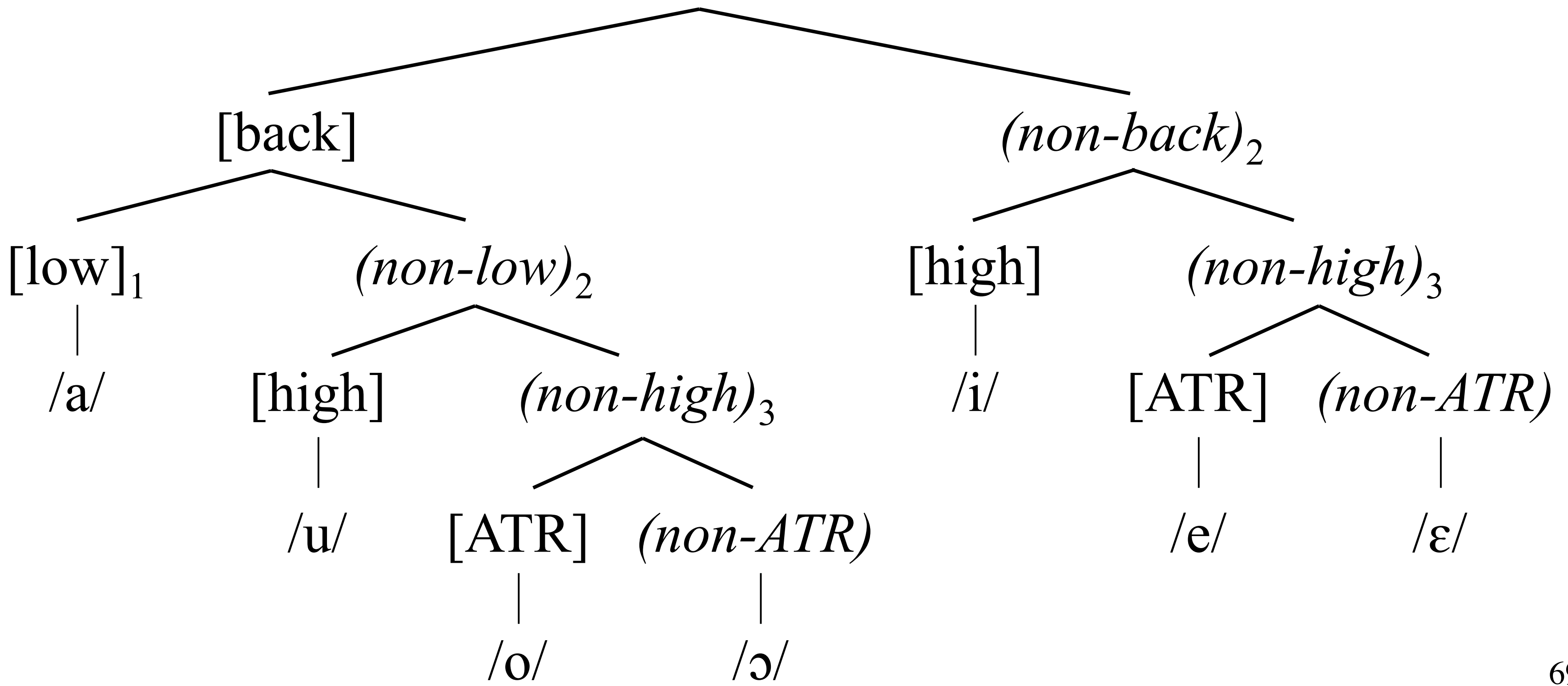
Spahr (2012) proposes a CHT account of Brazilian Portuguese vowel reduction; I have modified his hierarchy to that proposed by Bohn (2015, 2017) for the Paulista dialect.



Vowel reduction in CHT

The tree shows the seven vowels in stressed position. The hierarchy is [back] > [low] > [high] > [ATR].

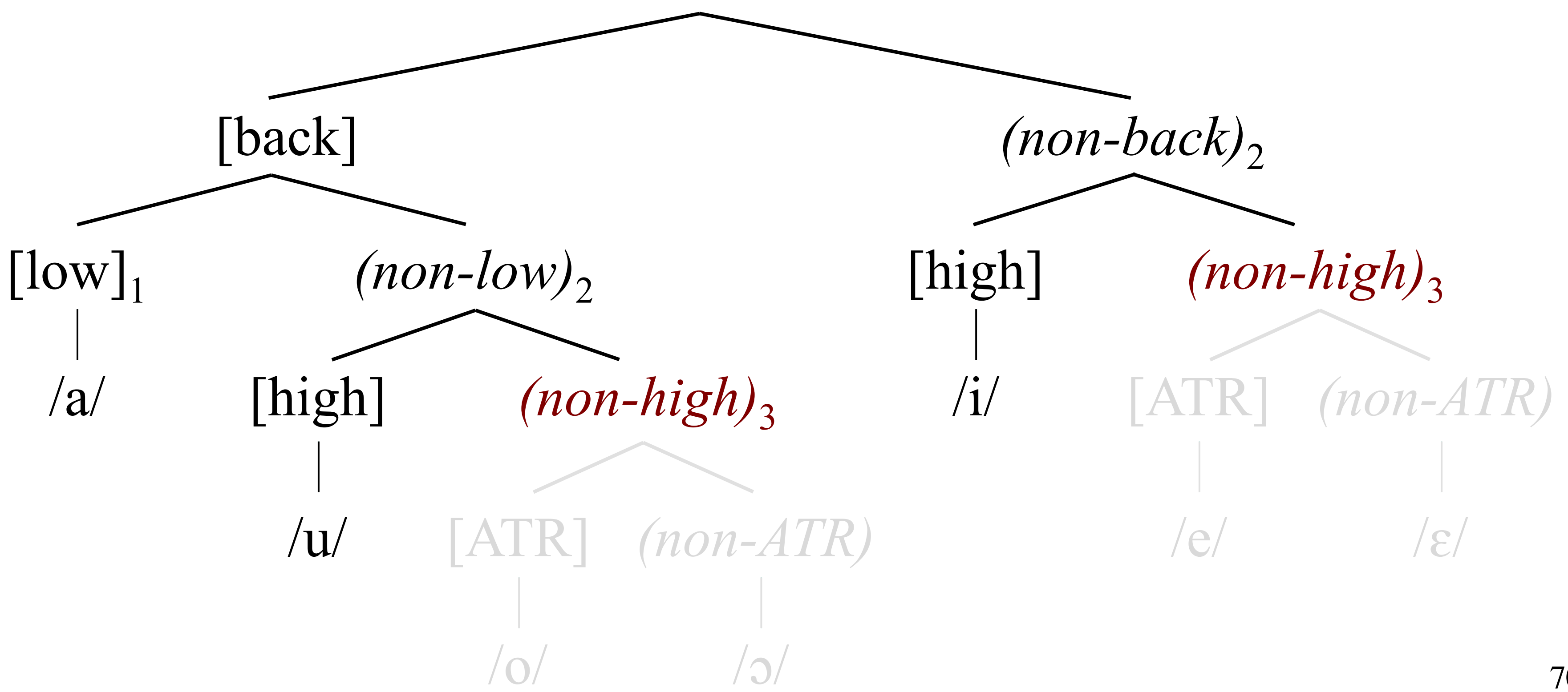
Bohn (2015, 2017) motivates this ordering based on the patterns of activity in this dialect.



Vowel reduction in CHT

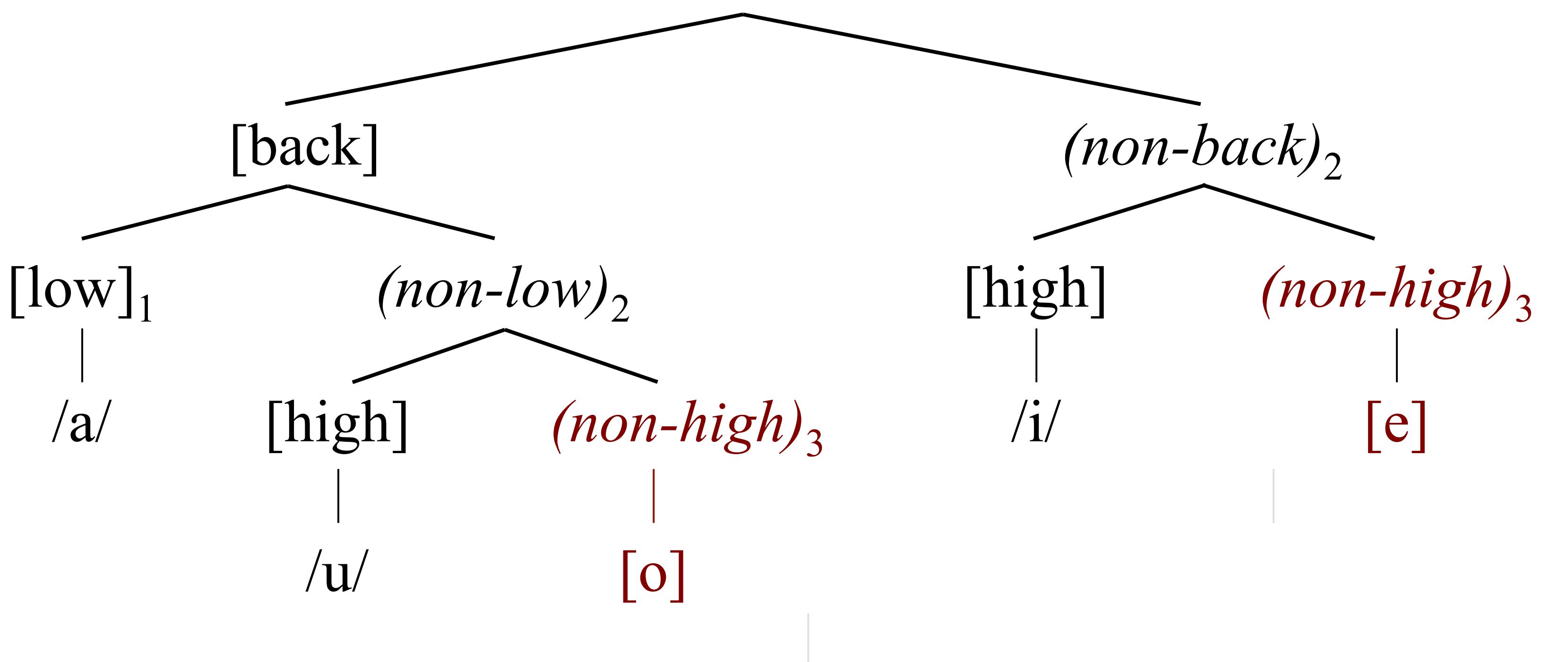
In pre-stressed position, there are no [±ATR] contrasts under the (*non-high*) nodes numbered 3.

Spahr proposes that these nodes are interpreted as archiphonemes à la Trubetzkoy.



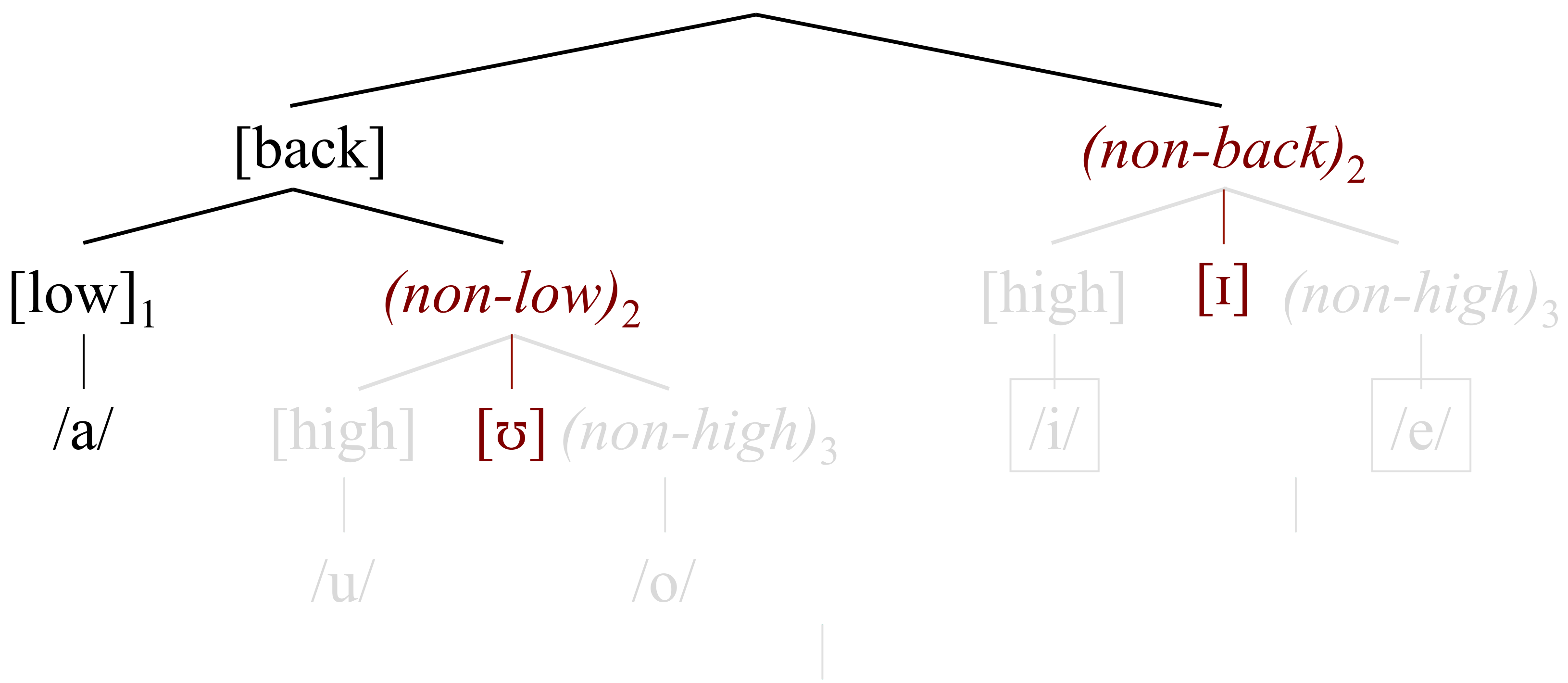
Vowel reduction in CHT

The new representations [back, *non-low, non-high*] and (*non-back, non-high*) receive their own phonetic interpretations, in this case [o] and [e], but in other dialects [ɔ] and [ɛ].



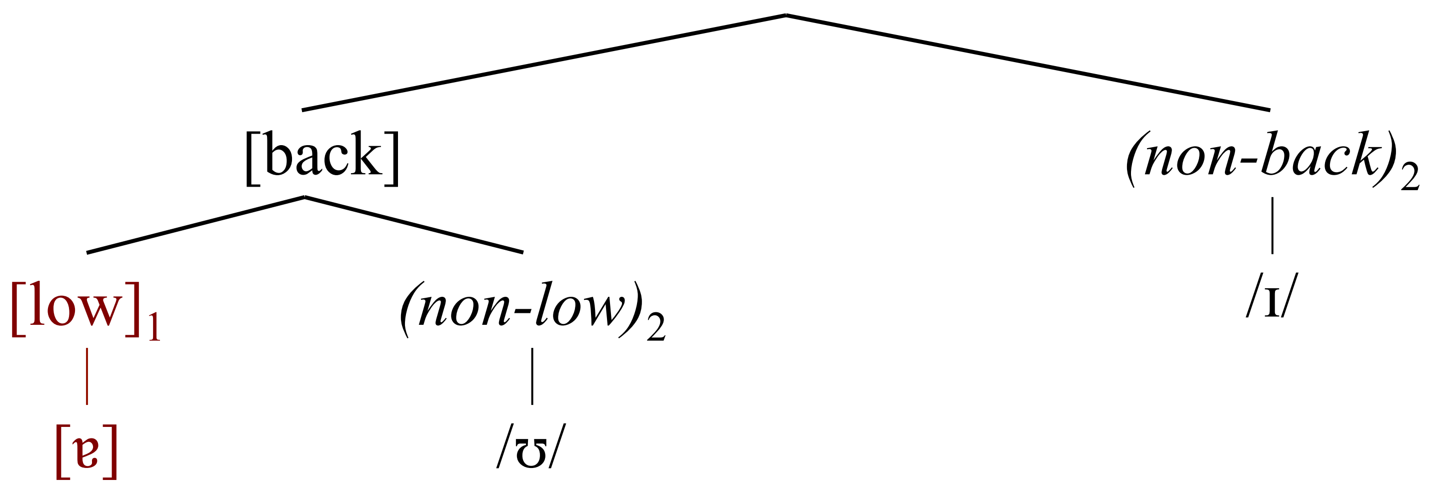
Vowel reduction in CHT

In unstressed final position the contrasts under the nodes numbered 2 are suppressed, and the segments under these nodes receive distinct phonetic interpretations as [ʊ] and [ɪ].



Vowel reduction in CHT

In this new set of contrasts the segment under node 1 also receives a distinct phonetic interpretation, [ɐ].



Vowel reduction and phonetic substance

Like in GP 2.0, this analysis uses representational complexity, though in a different way.

In both GP 2.0 and CHT, this complexity is part of the formal representational apparatus, though it partakes of aspects of phonetic substance.

Neither analysis involves 'substance abuse'.

Substance and descriptive adequacy

The consequences of remaining completely free of substance, in these cases, is that SFP frees itself from providing a descriptively adequate account of vowel reduction patterns.

Contrary to Reiss (2017), the way forward in the twenty-first century is not to abandon markedness and contrast on *a priori* grounds, but to incorporate them to the extent that they contribute to illuminating accounts of phonological patterns.

6.

Contrast and Element Theory: three- and four-vowel systems

Contrastive hierarchies and unary primes

At the Paris Conference on Theoretical Issues in Contemporary Phonology: Reading Tobias Scheer (Dresher 2014b), I attempted to answer the challenge posed by Scheer (2010), that the contrastive hierarchy 'is irrelevant should it turn out that unary primes are the correct approach to melodic representations.'

I argued there that contrastive hierarchies are relevant to representations made up of unary primes, as instantiated, for example, in Element Theory.

Further, I proposed that Element Theory itself inherently relies on contrastive considerations—and hence, on contrastive hierarchies—to a greater extent than is often recognized.

I would like to take a few minutes to review some of those arguments here.

Contrastive hierarchies and unary primes

With respect to the relevance of contrastive hierarchies, there have been a number of proposals to apply them to unary elements, so this is not a hypothetical possibility.

One such is Carvalho (2011). As he points out, 'the fundamental idea' of contrastive hierarchy theory is that 'infrasegmental structure … reflects the way features combine and behave in a given language', uniting both representation and computation.

Voeltzel & Tifrit (2013) and Voeltzel (2016) apply the hierarchical concept to representations based on Element Theory.

Voeltzel (2016) shows that an element-based hierarchy will not necessarily be a simple translation of a feature-based one; nevertheless, I would argue that it should be based on the same basic principles of contrast and hierarchy.

Contrast and Element Theory

Van der Hulst (2018) has an extensive discussion illustrating how the Successive Division Algorithm can be applied to the elements of Radical cv Phonology (van der Hulst 1995, 1996, 2005) .

While different versions of Element Theory may have different approaches to the role of contrast, I have proposed that most unary representational systems are based on contrast.

I say this even if it may not be stated explicitly, and even if contrastive considerations are not always applied consistently.

Consider the analysis of three-vowel systems by Backley (2011).

Contrast and Element Theory

Backley (2011: 19) observes that both Tamazight and Amuesha have the representations |I|, |U|, and |A|, despite their phonetic differences.

Tamazight			Amuesha		
[i]	[u]	[a]	[e]	[o]	[ɐ]
|I|	|U|	|A|	|I|	|U|	|A|

Contrast and Element Theory

Why are Amuesha [e] and [o] not represented as combinations of |I A| and |U A|, respectively, like [e] and [o] in five-vowel systems?

Presumably, because they are not in contrast with other vowels that are represented |I| and |U|, and further, because they do not behave as if they have complex representations.

As Backley (2011: 19) remarks, 'the vowels…are tokens of abstract phonological categories, and languages differ in the way they choose to phonetically interpret these categories.'

Amuesha (incorrect)			Amuesha		
[e]	[o]	[ɐ]	[e]	[o]	[ɐ]
*|I A|	*|U A|	|A|	|I|	|U|	|A|

Contrast and Element Theory

That is, it is phonological behaviour and contrast that govern the representations, in addition to phonetics.

In the case of Wapishana, Backley (2011: 31) proposes that [ə] is an unspecified vowel.

Apart from the fact that the spectral pattern of [ə] is different from the patterns typically associated with the basic elements |I|, |A|, and |U|, Backley supports the existence of vowels with empty elements by appealing to phonological behaviour.

Wapishana

[i]	[u]	[a]	[ə]
|I|	|U|	|A|	| |

Contrast and Element Theory

Again, phonetics is not the whole story:

For English weak vowels, for example, Backley (2011: 50) proposes the assignments below.

Here, [ə] is assigned the element |A|, unlike in Wapishana, and another vowel, barred [ɨ], is the empty vowel.

Notice that the Wapishana and English vowel representations are minimally contrastive.

Wapishana				English weak vowels			
[i]	[u]	[a]	[ə]	[ɪ]	[ʊ]	[ə]	[ɨ]
|I|	|U|	|A|	| |	|I|	|U|	|A|	| |

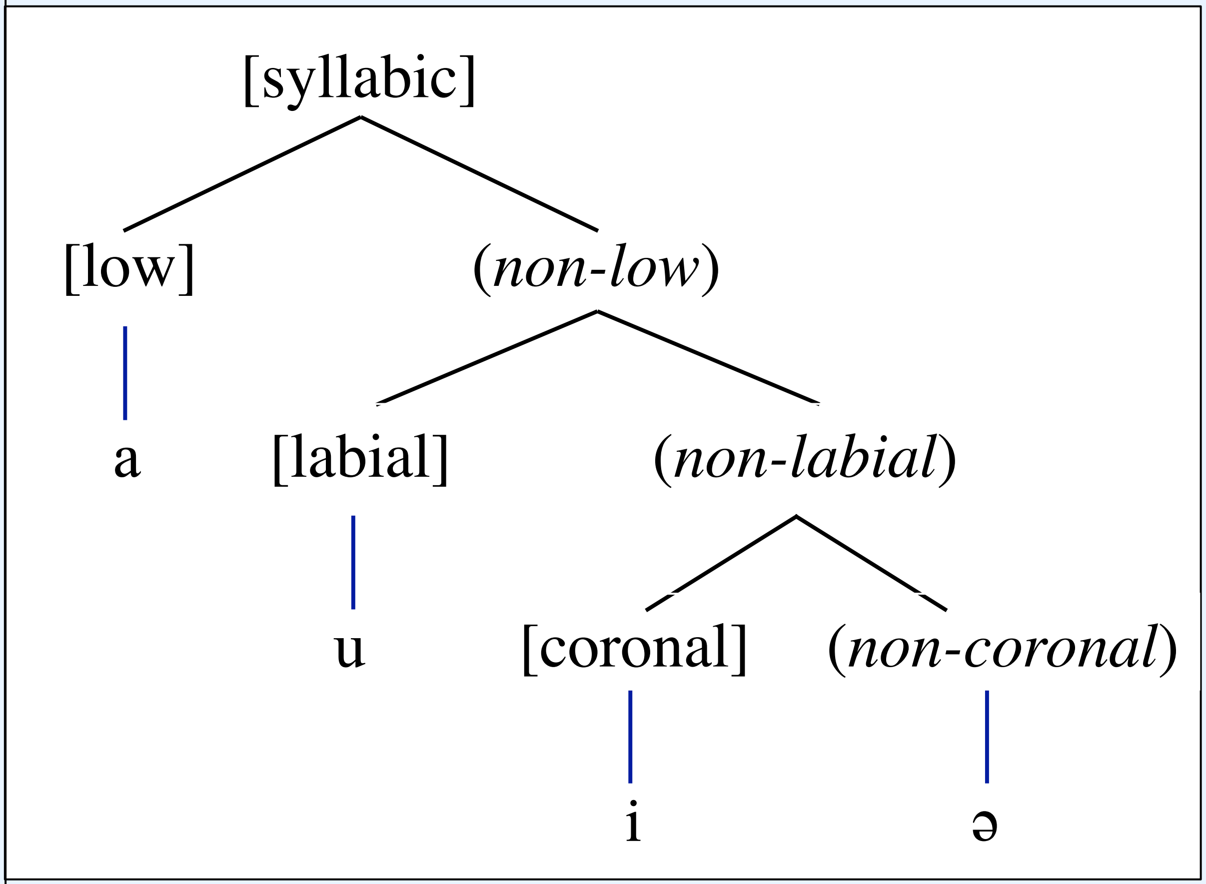
Contrast and Element Theory

In fact, the Wapishana vowel inventory is very similar to that of Proto-Eskimo.

Proto-Eskimo is commonly reconstructed to have the vowels */i/, */u/, */a/, and a fourth vowel assumed to be some sort of central vowel which we write schwa */ə/, following Fortescue, Jacobson, & Kaplan's *Comparative Eskimo dictionary* (1994).

Wapishana				Proto-Eskimo (Inuit and Yupik)			
[i]	[u]	[a]	[ə]	*/i/	*/u/	*/a/	*/ə/
|I|	|U|	|A|	| |				

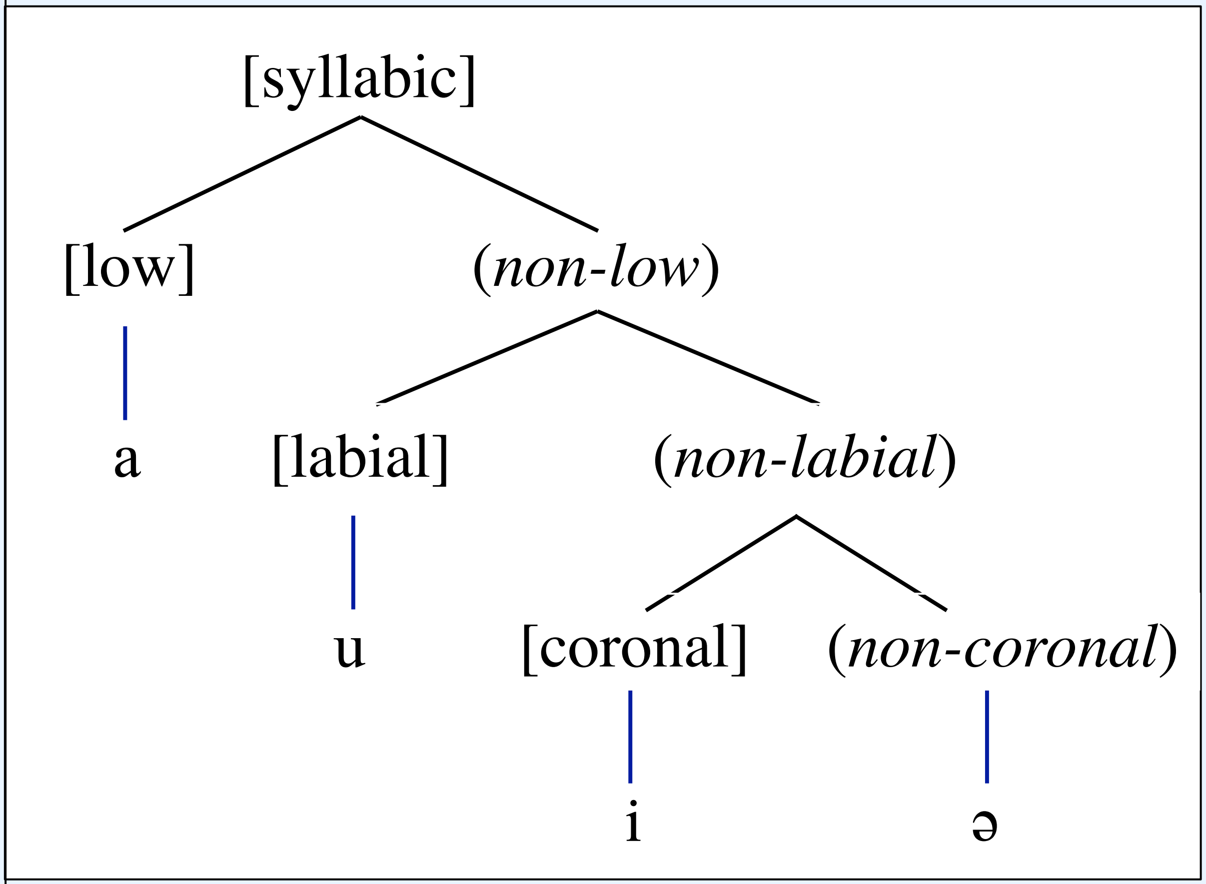
Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)



Compton & Dresher (2011) propose the contrastive hierarchy [low] > [labial] > [coronal].

[low] > [labial] > [coronal]

Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)

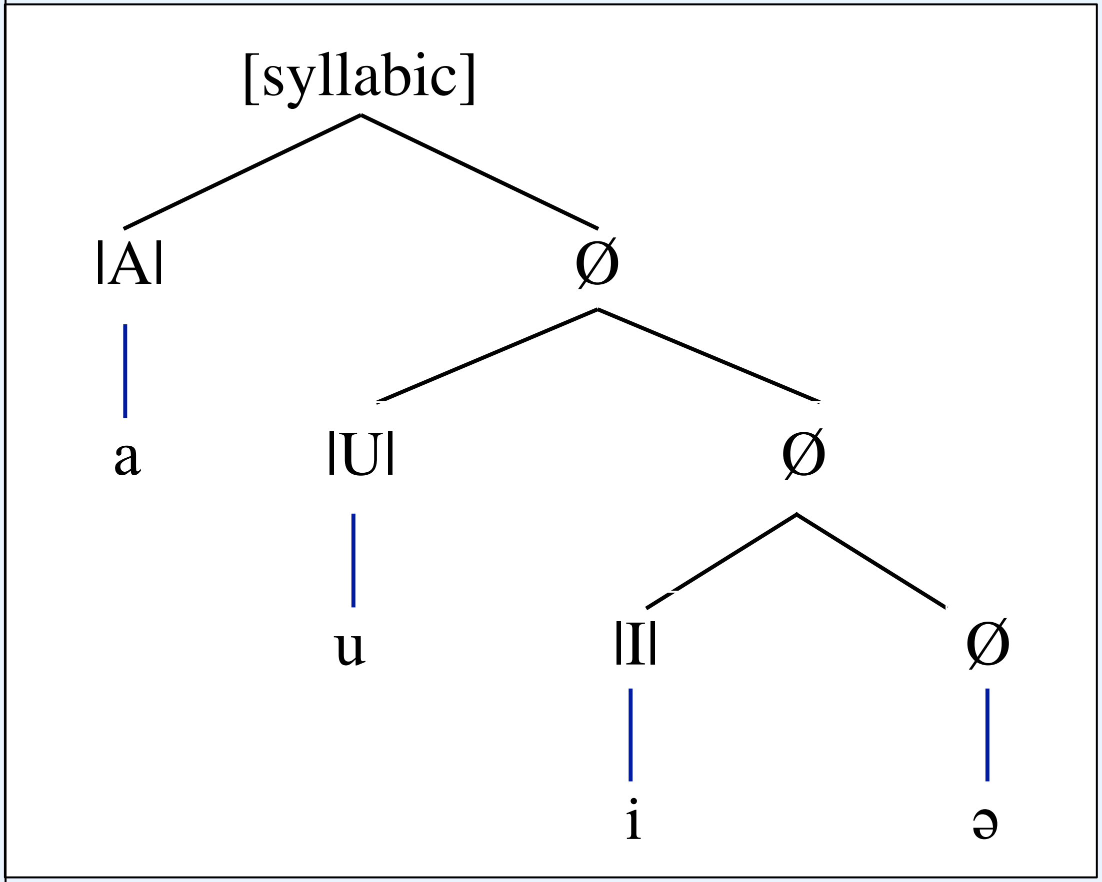


These asymmetric features are not far from a unary system.

Indeed, they can easily be translated into elements:

[low] > [labial] > [coronal]

Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)



|A| > |U| > |I|

Thus:
[low] becomes |A|,
[labial] becomes |U|,
[coronal] becomes |I|.

The unmarked /ə/ becomes empty.

In fact, exactly this tree and this ordering of elements is proposed for a four-vowel system by van der Hulst (2018).

Four-vowel Inuit dialects

Evidence for this type of representation for /ə/ comes from Yupik, which retains the four-vowel system.

Though present in the inventory, schwa does not have the same status as the other vowels.

According to Kaplan (1990:147), it 'cannot occur long or in a cluster with another vowel'; instead, it undergoes dissimilation or assimilation when adjacent to full vowels.

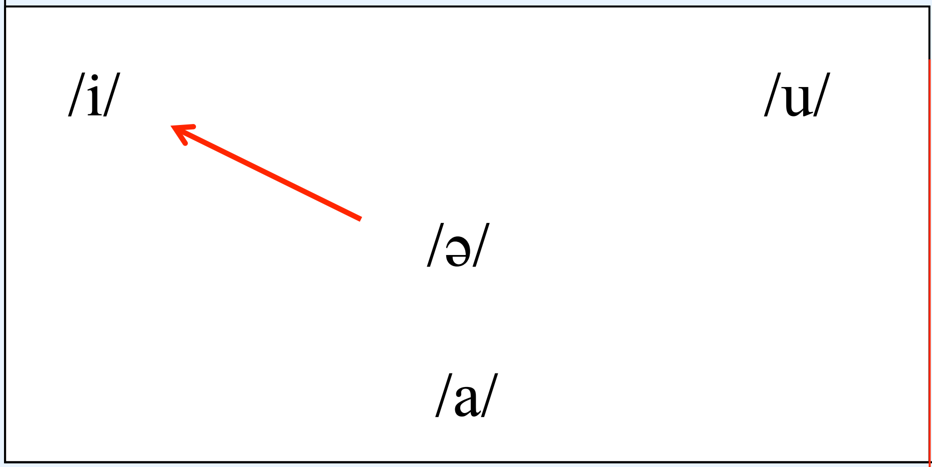
/i/	/u/	/a/	/ə/
|I|	|U|	|A|	| |
[coronal]	[labial]	[low]	[ ]

Four-vowel Inuit dialects

In other dialects underlying /ə/ has merged with /i/ at the surface, but can be distinguished from underlying /i/ by its distinct patterning.

In the literature this vowel is known as 'weak *i*', as opposed to the 'strong *i*' that descends from Proto-Eskimo *i.

In Barrow Inupiaq (Kaplan 1981:119), weak *i* changes to [a] before another vowel, but strong *i* does not.



Four-vowel Inuit dialects

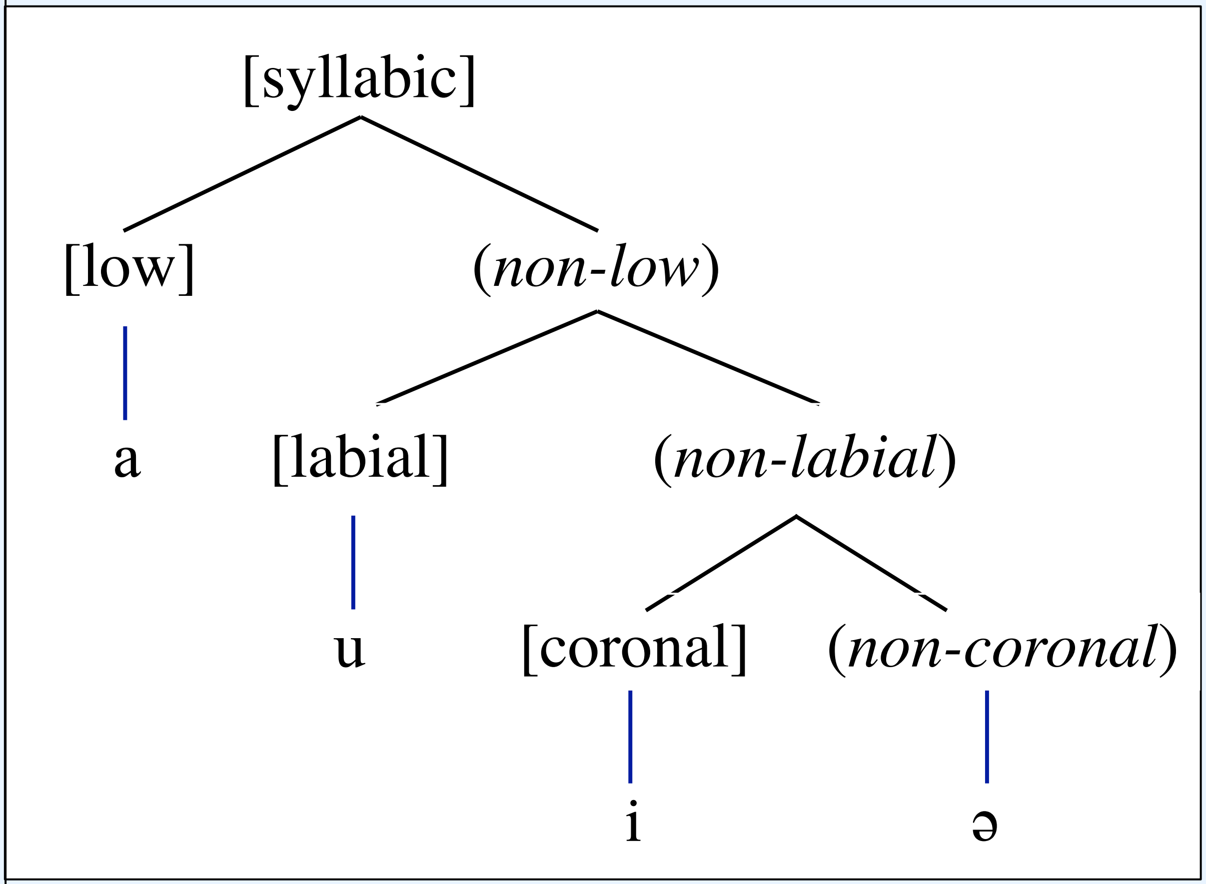
Original */i/ could cause palatalization of consonants, and some Inuit dialects show palatalization (or traces of former palatalization) (Dorais 2003: 33).

In the word ‘foot’ in the North Baffin dialect, *i* (from P-E *i) causes a following *t* to change to *s*. This assibilation is the most common manifestation of palatalization in Inuit dialects.

Compare the retention of [t] after weak *i* (from P-E *ə) in ‘palm of hand’.

	Proto-Eskimo		North Baffin	
Strong *i*	*itəγaʁ	>	isiɣak	‘foot’
Weak *i*	*ətəmaɣ	>	itimak	‘palm of hand’

Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)

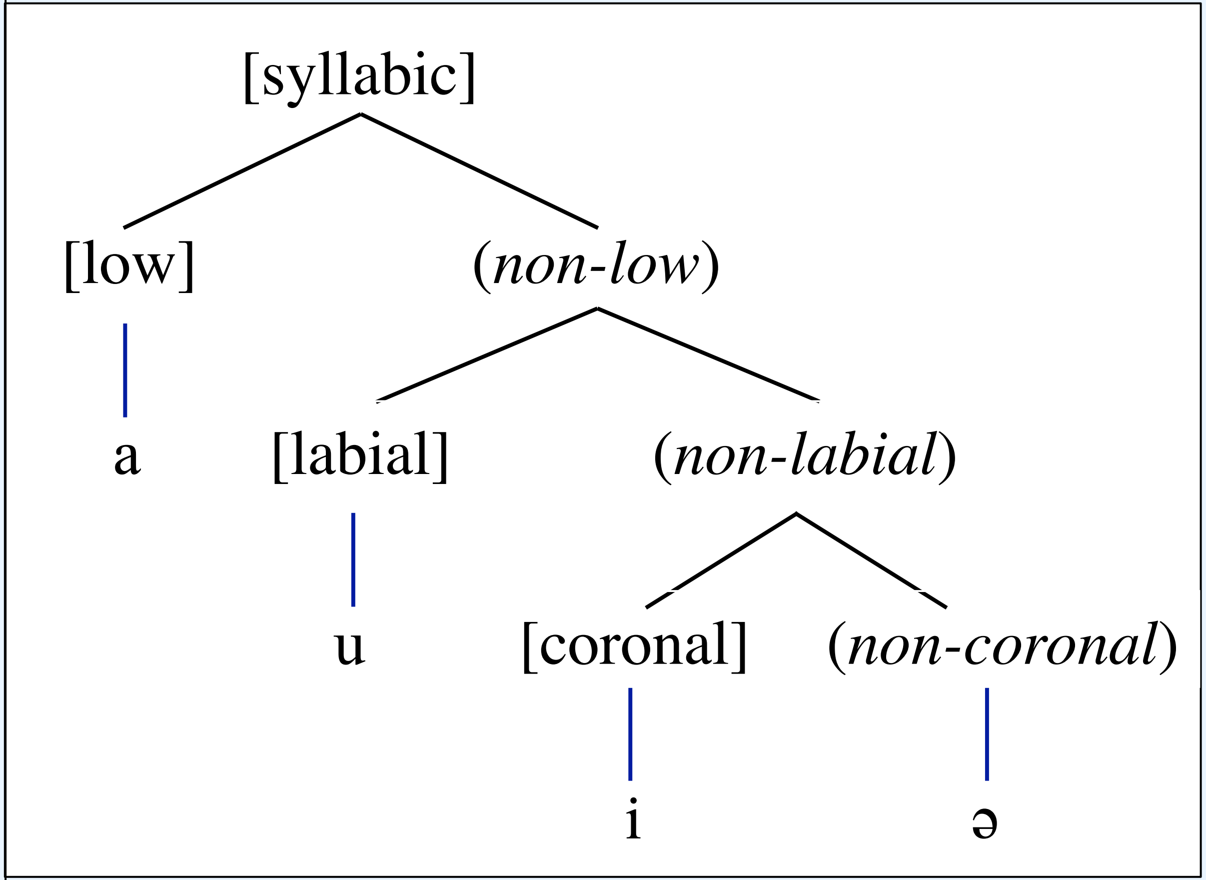


These examples support attributing a feature to /i/ that can cause palatalization:

Compton & Dresher (2011) call it [coronal], but it is very similar to the role played by |I| in Element Theory.

[low] > [labial] > [coronal]

Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)



Compton & Dresher (2011) also argue that there is evidence that the features [low] and [labial] are also phonologically active (participate in phonological processes).

[low] > [labial] > [coronal]

Inuit dialects

For four-vowel dialects like the ones discussed above, then, contrastive hierarchy theory and Element Theory are mostly in accord:

Each of /i/, /u/ and /a/ are represented by a single marked feature, and /ə/ is empty (in ET) or completely unmarked (in CHT).

But now let us turn to three-vowel Inuit dialects!

Four-vowel dialects

/i/	/u/	/a/	/ə/
|I|	|U|	|A|	| |
[coronal]	[labial]	[low]	[ ]

Three-vowel Inuit dialects

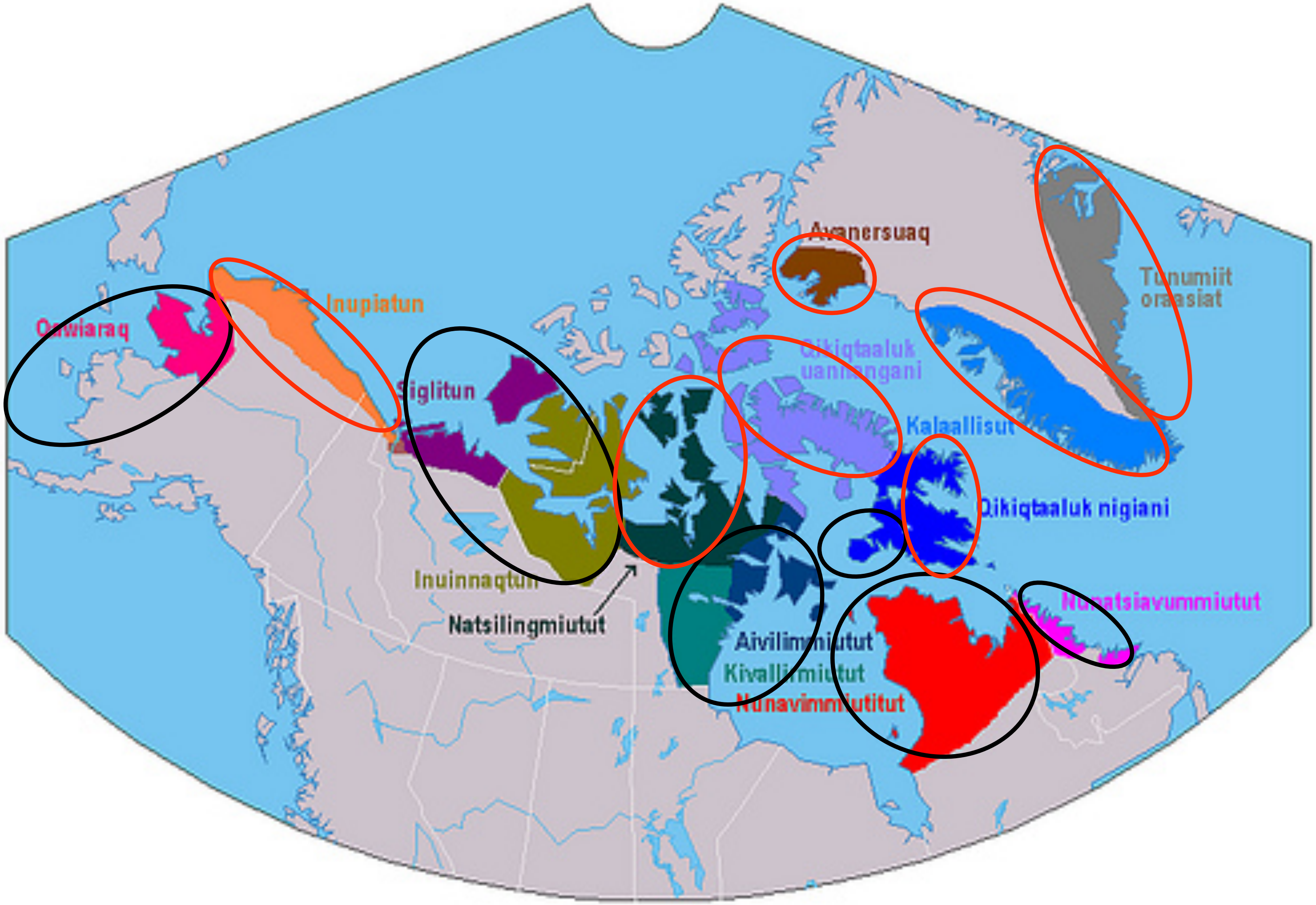
In many Inuit dialects the distinction between */i/ and */ə/ has been completely lost: these dialects have only three distinct vowels: /i/, /a/, and /u/.

Dialects with palatalization or with signs of former palatalization occur across the Inuit region, as do dialects without palatalization:

Four-vowel dialects				Three-vowel dialects		
/i/	/u/	/a/	/ə/	/i/	/u/	/a/
|I|	|U|	|A|	| |	?	|U|	|A|
[coronal]	[labial]	[low]	[ ]	?	[labial]	[low]

Inuit dialects

Dialects with (red circles) and without (blue circles) Palatalization



Inuit dialects

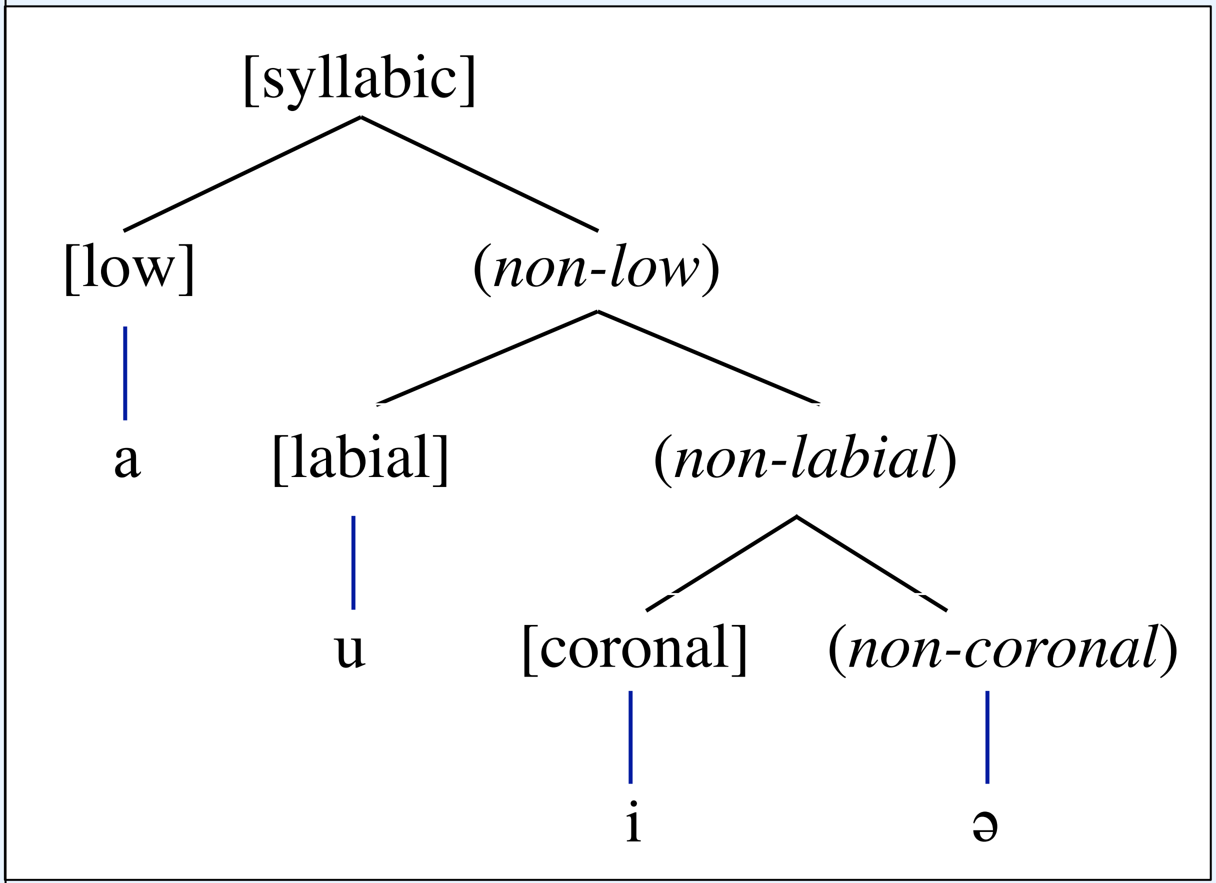
One might suppose that some dialects that once had palatalization would generalize it to occur after all /i/s, including original /i/ from *i and the new /i/ from *ə.

But this is not the case. Compton and Dresher (2011) observe a generalization about palatalization in Inuit dialects:

> Inuit /i/ can cause palatalization (assibilation) of a consonant only in dialects where there is evidence for a (former) contrast with a fourth vowel; where there is no contrast between strong and weak *i*, /i/ does not trigger palatalization.

This generalization follows if we assume that the feature hierarchy for Inuit and Yupik is [low] > [labial] > [coronal]:

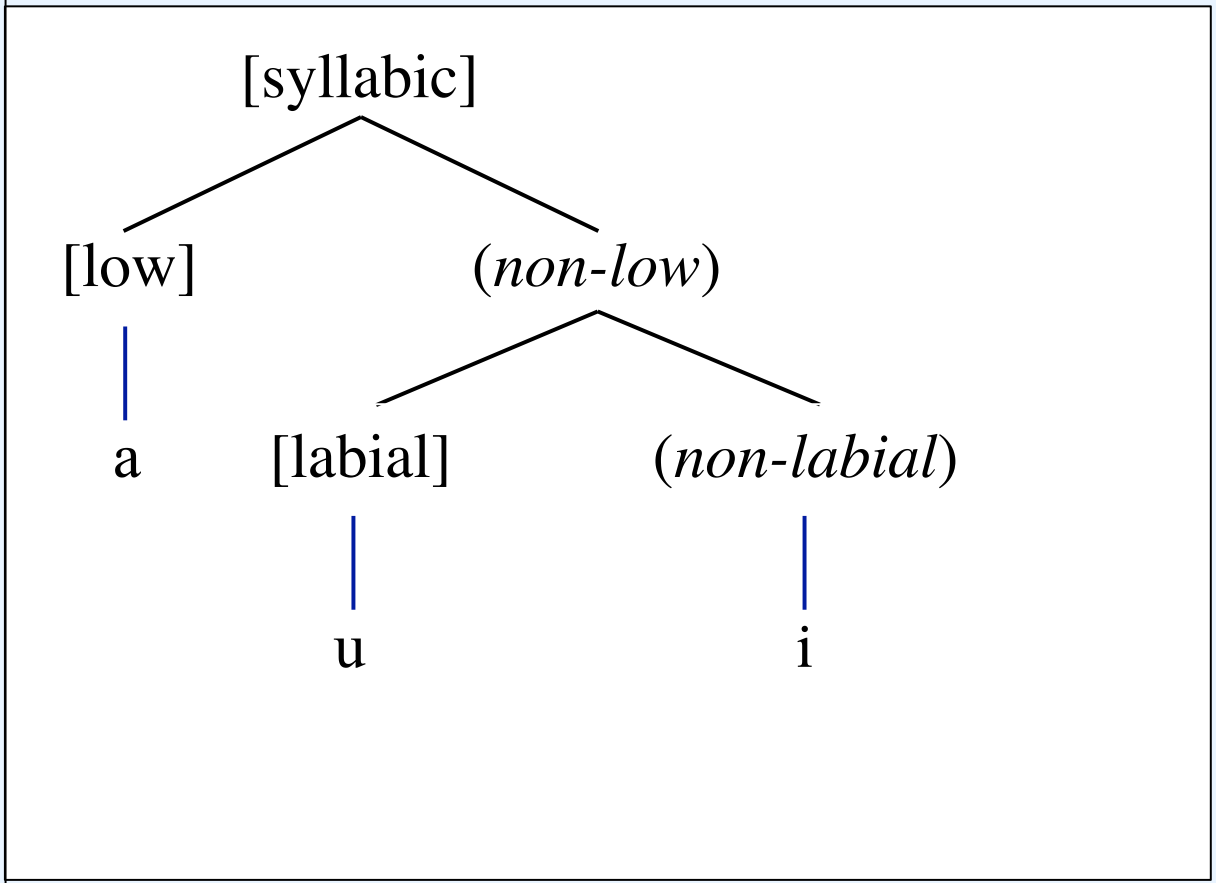
Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)



When the fourth vowel is in the underlying inventory, /i/ has a contrastive [coronal] feature that enables it to cause palatalization.

[low] > [labial] > [coronal]

Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)



[low] > [labial]

But in the absence of a fourth vowel, [coronal] is not a contrastive feature.

By the Contrastivist Hypothesis, if a feature is not contrastive, it may not be active.

Three-vowel Inuit dialects

Therefore, the restriction of a three-vowel inventory to two features, required by the Contrastivist Hypothesis and the Successive Division Algorithm, is supported by evidence from phonological patterning.

The result of our analysis is that the representation of an /i/ in a three-vowel dialect is closer to that of /ə/ in a four-vowel dialect than it is to the representation of /i/ in a four-vowel dialect.

Four-vowel dialects				Three-vowel dialects		
/i/	/u/	/a/	/ə/	/i/	/u/	/a/
[coronal]	[labial]	[low]	[ ]	[ ]	[labial]	[low]

Contrast and Element Theory

In this light let us return to Backley's (2011) analysis of three-vowel inventories.

He employs three elements, meaning that his analysis is not in accord with the Successive Division Algorithm and the Contrastivist Hypothesis.

Nor is it consistent with his practice in the case of systems with four or more vowels.

Tamazight			Amuesha		
/i/	/u/	/a/	/e/	/o/	/ɐ/
|I|	|U|	|A|	|I|	|U|	|A|

Contrast and Element Theory

His assumption that Tamazight, Amuesha, and other languages with three vowels all use the three elements |A|, |U|, and |I| is also not consistent with his own statement (Backley 2011: 20) that

> ‘What counts in ET is the way a segment behaves, particularly in relation to natural classes and to other segments in the system. Its behaviour determines its phonological identity, and therefore, its element structure.’

Tamazight			Amuesha		
/i/	/u/	/a/	/e/	/o/	/ɐ/
|I|	|U|	|A|	|I|	|U|	|A|

Contrast and Element Theory

The prediction of the Successive Division Algorithm, as shown in detail for Element Theory by van der Hulst (2018), is that one vowel in every inventory should be empty.

This prediction is supported in three-vowel Inuit dialects.

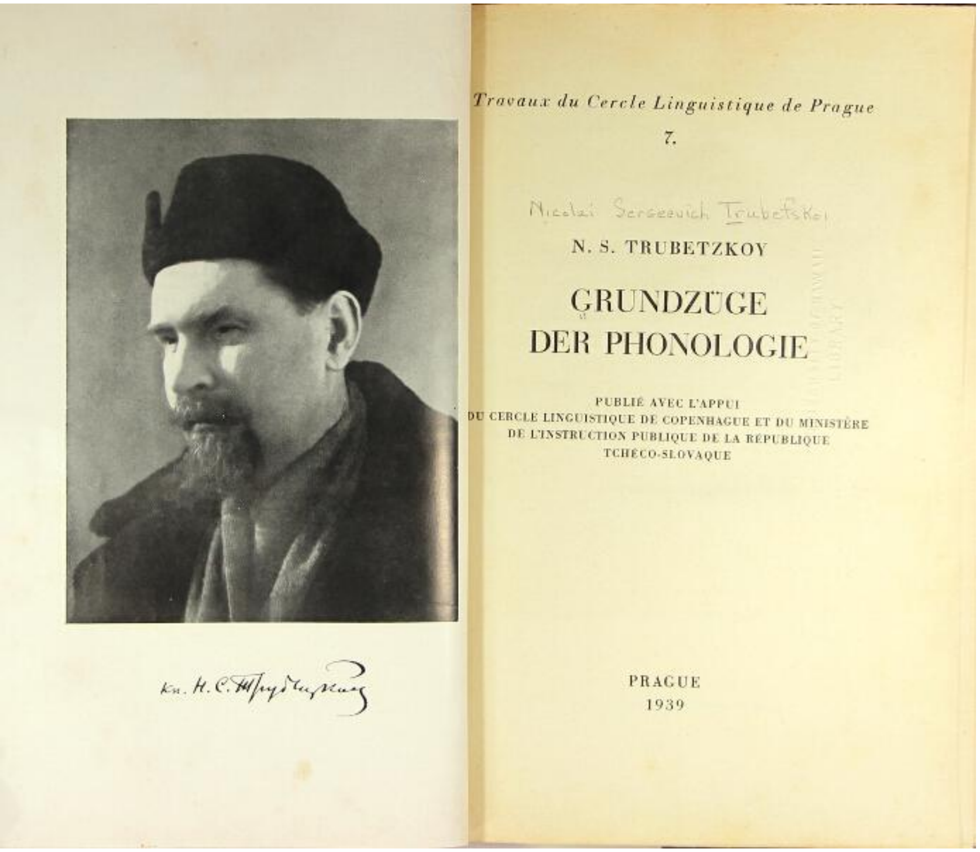
We similarly expect that one vowel in Tamazight and Amuesha (not necessarily the same one) is empty. We need to determine which elements are actually active in these languages.

Inuit			Tamazight			Amuesha		
/i/	/u/	/a/	/i/	/u/	/a/	/e/	/o/	/ɐ/
| |	|U|	|A|	2 of |I|, |U|, |A|			2 of |I|, |U|, |A|		

7.

Variability in contrastive hierarchies: five-vowel systems

Trubetzkoy's *Grundzüge*



N. S. Trubetzkoy's *Grundzüge der Phonologie (*1939) (translated into French in 1949, into English in 1969), in some ways anticipated the theory of contrast I have been arguing for here.

Five-vowel systems: Latin

Trubetzkoy observes that in many five-vowel systems—he gives Latin as an example— the low vowel does not participate in tonality contrasts; ‘tonality’ refers to backness or lip rounding, that is, properties that affect F2.

In the diagram below, the low vowel /a/ is separated from the other vowels by the feature [±low].

Latin

/i/		/u/
	(*non-low*)	
/e/		/o/
[low]	/a/	

Five-vowel systems: Latin

In order to exclude /a/ from receiving tonality features, it is necessary to order [±low] at the top of the feature hierarchy: this has the effect of separating /a/ from the other vowels.

The diagram on the left thus corresponds to the partial feature tree on the right.

Latin

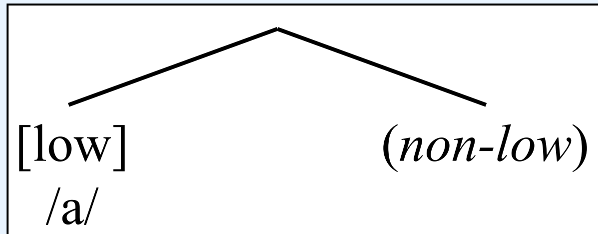
/i/ /u/

(*non-low*)

/e/ /o/

[low] /a/

Top of the hierarchy: [low]



Five-vowel systems: Latin

What the other two (or, more unusually, three) features are depends on the evidence from the language.

Latin

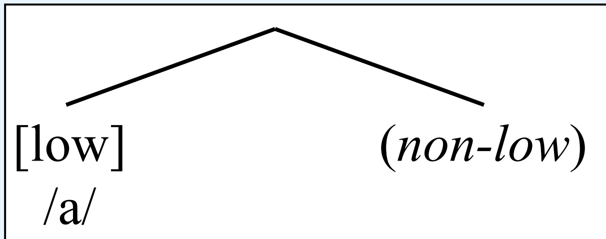
/i/ /u/

(*non-low*)

/e/ /o/

[low] /a/

[low] >



Five-vowel systems: Archi

Trubetzkoy observes that other types of 5-vowel systems exist.

In Archi (East Caucasian), a language of Central Daghestan, a consonantal rounding contrast is neutralized before and after the rounded vowels /u/ and /o/. 'As a result, these vowels are placed in opposition with…unrounded *a, e,* and *i*'.

Archi

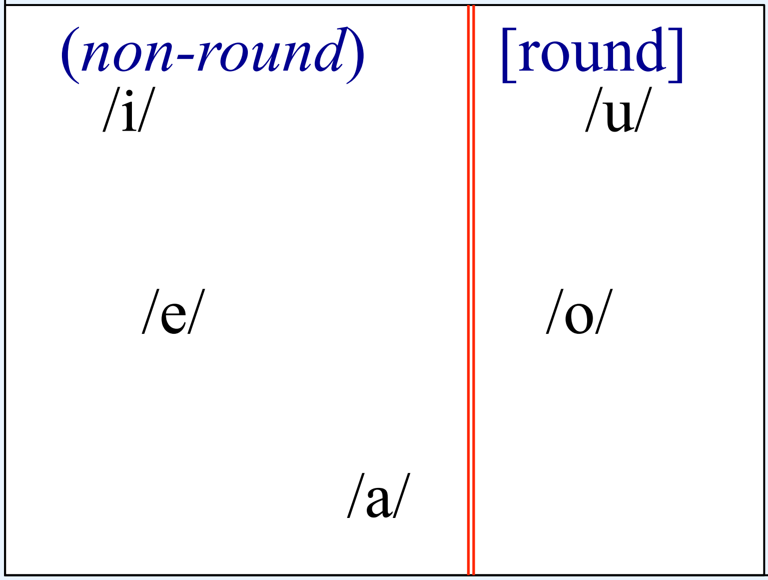
(*non-round*)	[round]
/i/	/u/
/e/	/o/
/a/	

Five-vowel systems: Archi

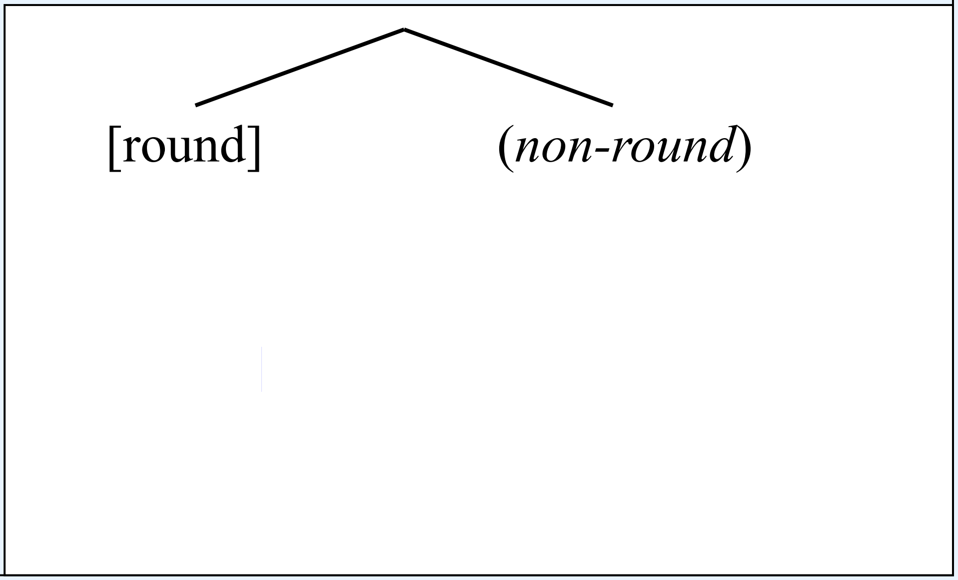
‘This means that all vowels are divided into rounded and unrounded vowels, while the back or front position of the tongue proves irrelevant…’ (Trubetzkoy 1969: 100-101).

This analysis corresponds to ordering [±round] first, followed by the other contrastive features.

Archi



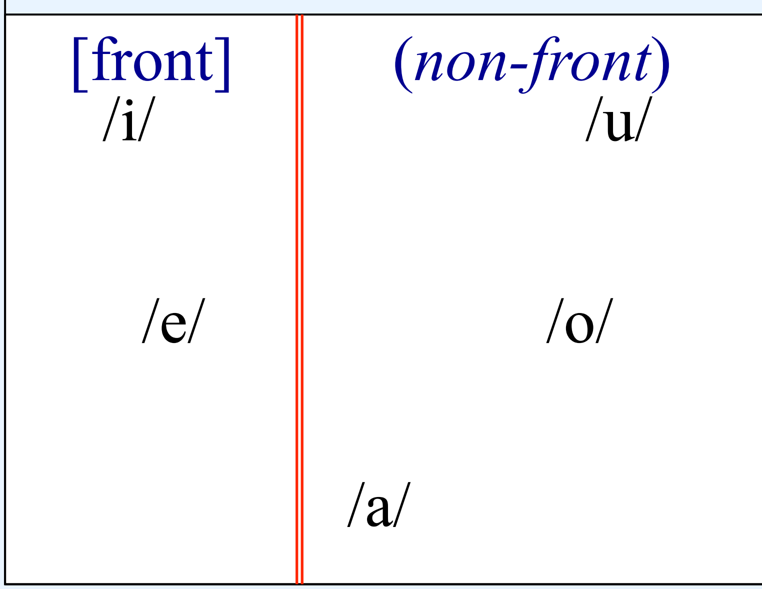
[round] >



Five-vowel systems: Japanese

Trubetzkoy argues that neutralization of the opposition between palatalized and non-palatalized consonants before *i* and *e* in Japanese shows that these vowels are put into opposition with the other vowels /a, o, u/.

Japanese

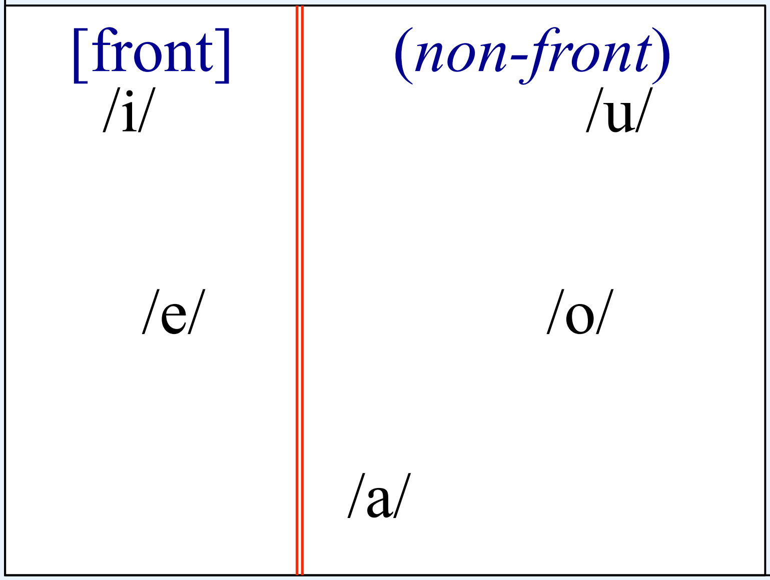


Five-vowel systems: Japanese

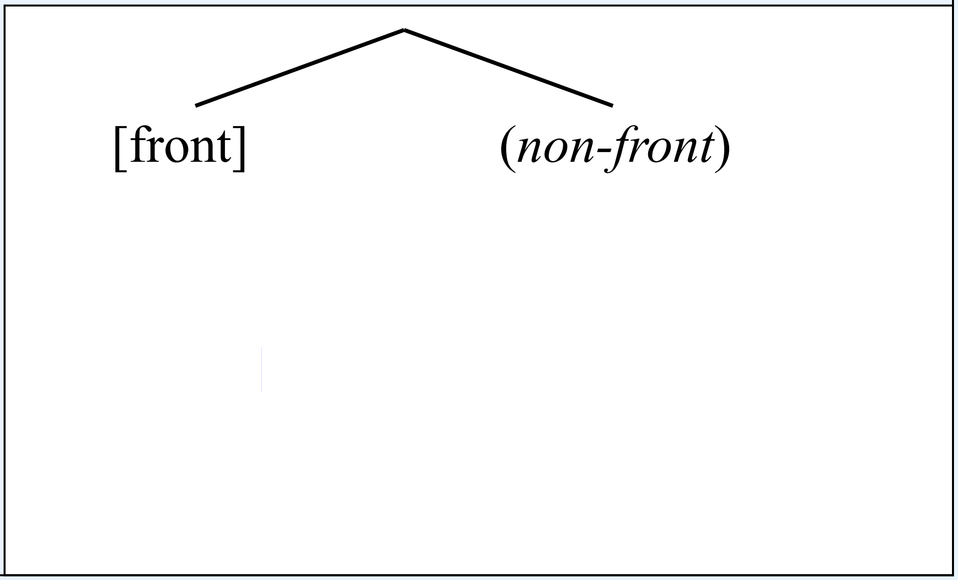
The governing opposition is that between front and back vowels, ‘lip rounding being irrelevant’ (Trubetzkoy 1969: 101).

This analysis corresponds to ordering [front] first, followed by the other features.

Japanese



[front] > other features

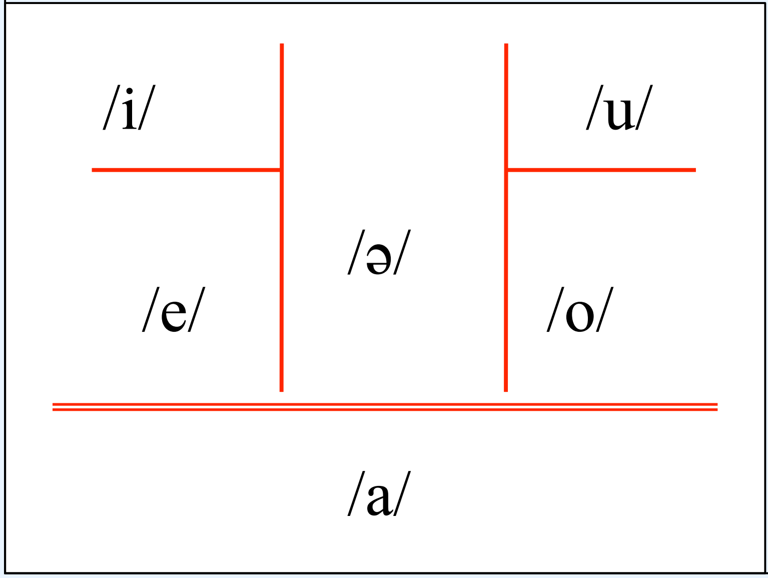


Five-vowels plus one

Finally, Trubetzkoy considers systems with five vowels plus a central 'indeterminate vowel', often written as /ə/.

He writes that in the usual case, this vowel 'does not stand in a bilateral opposition relation with any other phoneme of the vowel system', but is 'characterized only negatively'.

5 + 1: Common pattern



If we follow the Latin pattern, /a/ is the only [low] vowel, and /i, e, o, u/ are distinguished by [high], [back] or [round], and [front].

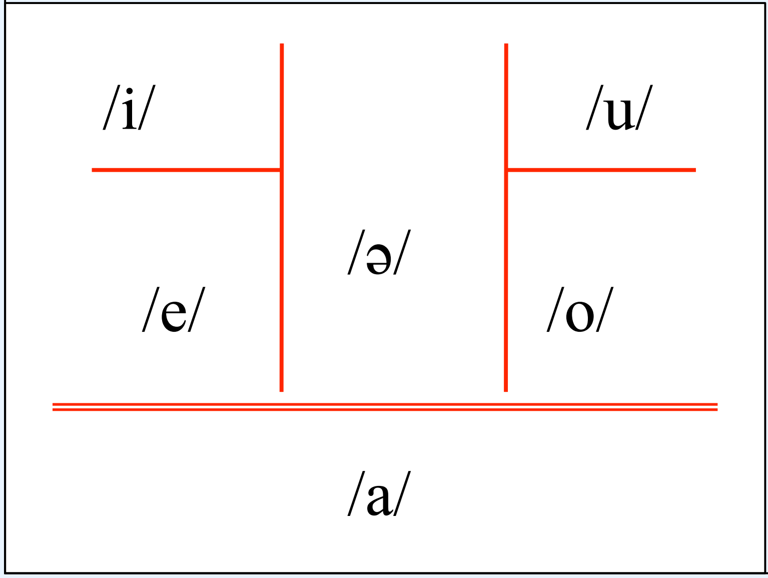
/ə/ is thus (*non-low, non-high, non-back/round, non-front*), that is, 'characterized only negatively'.

Five-vowels plus one

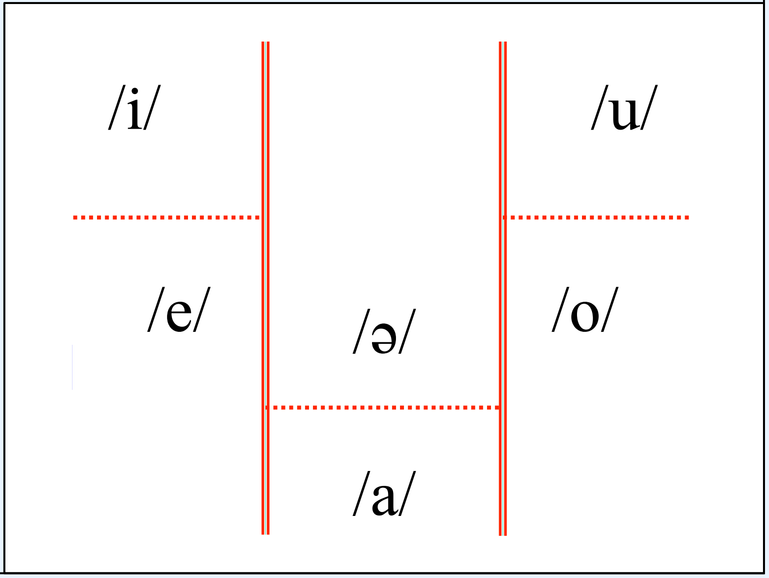
However, Trubetzkoy observes that in Bulgarian, the pairs /i, e/, /ə, a/, and /u, o/ neutralize in unstressed syllables.

This suggests that the central vowel has a special relationship with /a/; see Spahr (2014) for a CHT analysis of this system.

5 + 1: Common pattern



5 + 1: Bulgarian



8.

Contrastive hierarchies in diachronic phonology: Old English i-umlaut

i-umlaut

The rule of *i*-umlaut began in early Germanic as a phonetic process that created fronted allophones of the back vowels when */i(ː)/ or */j/ followed (V. Kiparsky 1932; Twaddell 1938; Benediktsson 1967; Antonsen 1972; Penzl 1972).

In the examples below, */u/ is fronted to [y] and /oː/ is fronted to [øː]:

Gloss	‘evil N.S.’	‘foot N.P.’
Early Germanic	*ubil	*foːt + i
i-umlaut	*ybil	*føːt + i

West Germanic vowel system

At a certain time, the West Germanic vowel system had five short and five long vowels (Antonsen 1965; Ringe & Taylor 2014: 106).

Short vowels			Long vowels		
i		u	iː		uː
e		o	eː		oː
	a			aː	

West Germanic vowel system

At a certain time, the West Germanic vowel system had five short and five long vowels (Antonsen 1965; Ringe & Taylor 2014: 106).

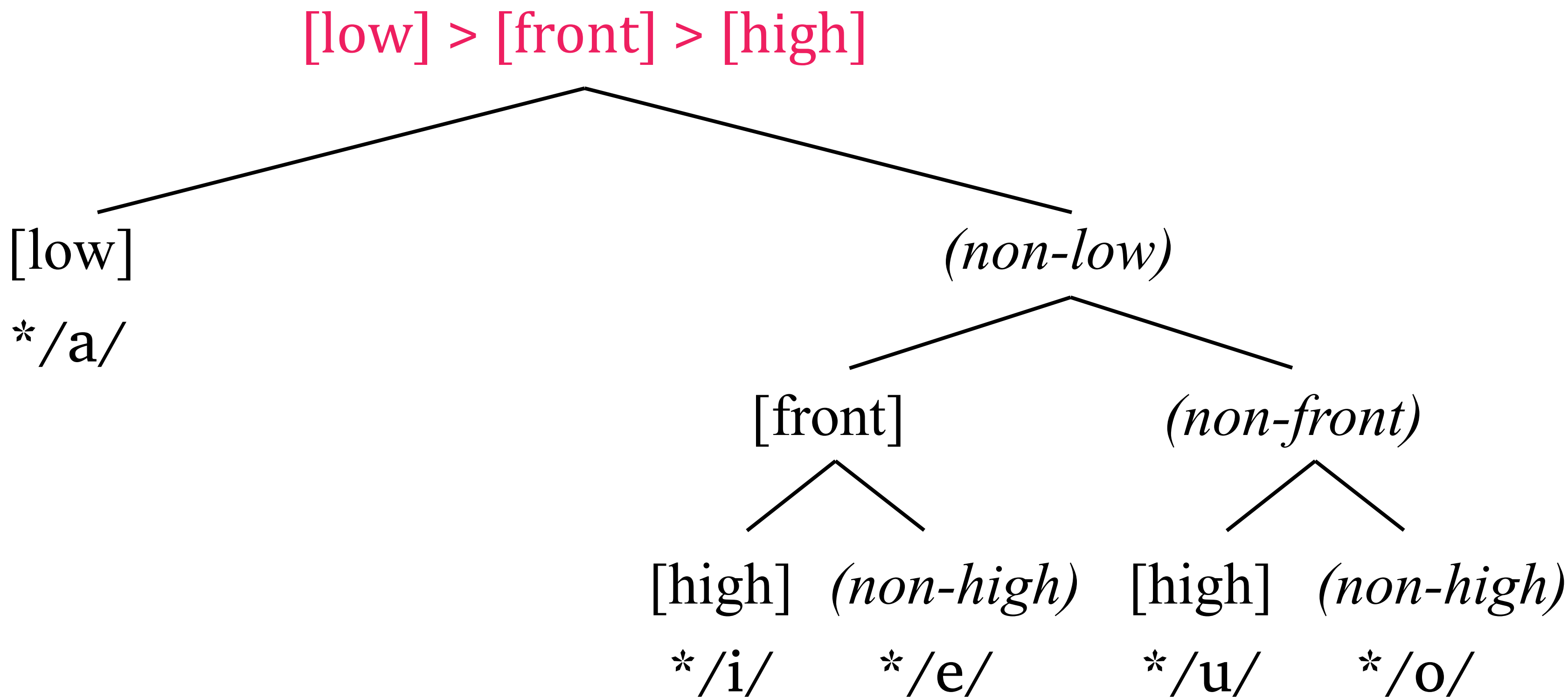
I will henceforth disregard vowel length.

i				u
	e		o	
		a		

West Germanic feature hierarchy

Inspired by Purnell & Raimy (2015), I have argued (Dresher 2018) that at this stage West Germanic had the vowel feature hierarchy [low] > [front] > [high].

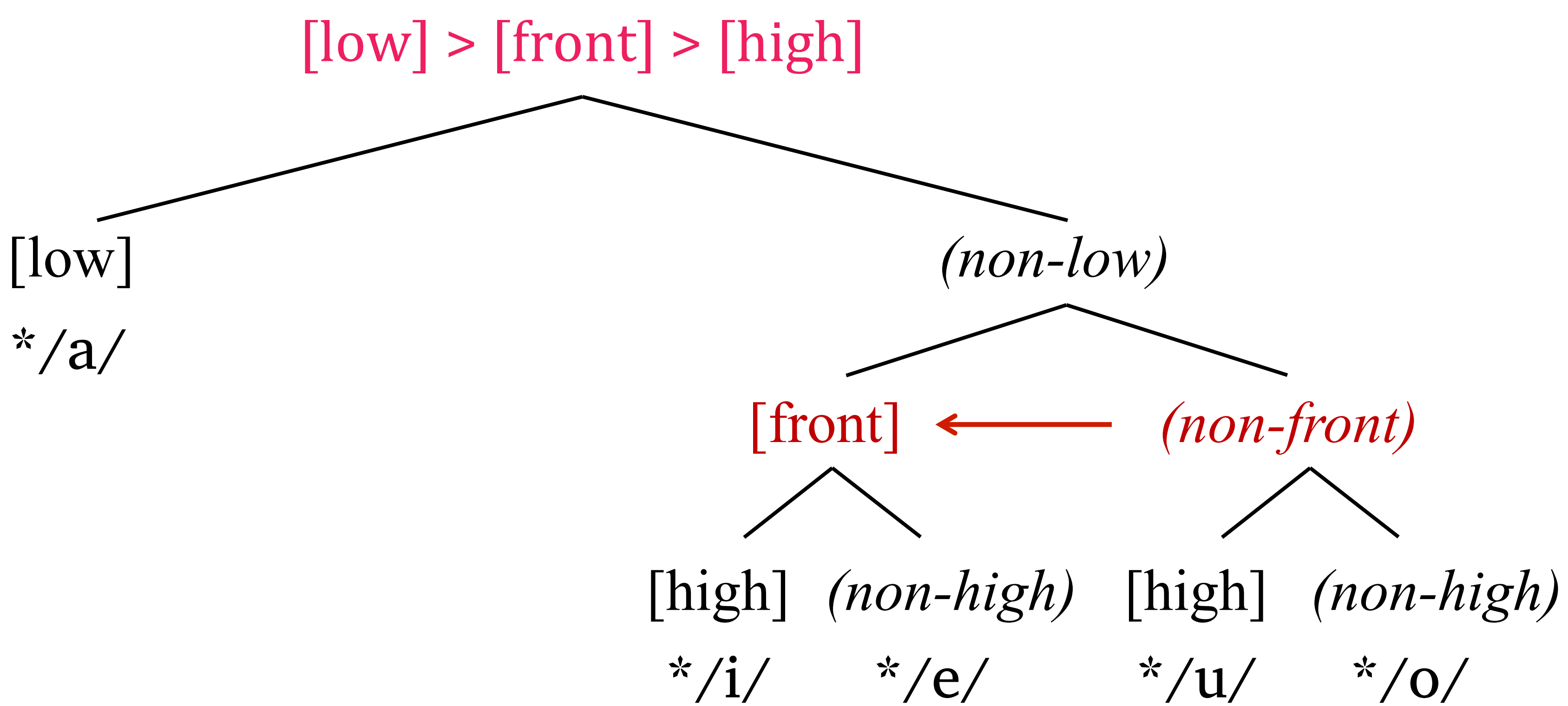
The feature [round] is not contrastive at this point.



The origins of *i*-umlaut

Given our analysis of the West Germanic vowel system, the result of fronting */u, o/ in the contrastive phonology would be to simply make them identical to */i, e/.

But *i*-umlaut crucially preserves the rounded nature of the fronted vowels.



i-umlaut

Therefore, the enhancement feature {round} must be in play at the point that */u, o/ are fronted.

This conclusion is consistent with the assumption of many commentators, beginning with V. Kiparsky (1932) and Twaddell (1938), that *i*-umlaut began as a late phonetic, or post-lexical rule, and not part of the contrastive, or lexical phonology.

*u	b	i	l	→	*y	b	i	l
(non-low)		*(non-low)*			*(non-low)*		*(non-low)*	
[front]		[front]			[front]		[front]	
[high]		[high]			[high]		[high]	
{round}		{non-round}			{round}		{non-round}	

i-umlaut becomes a lexical rule

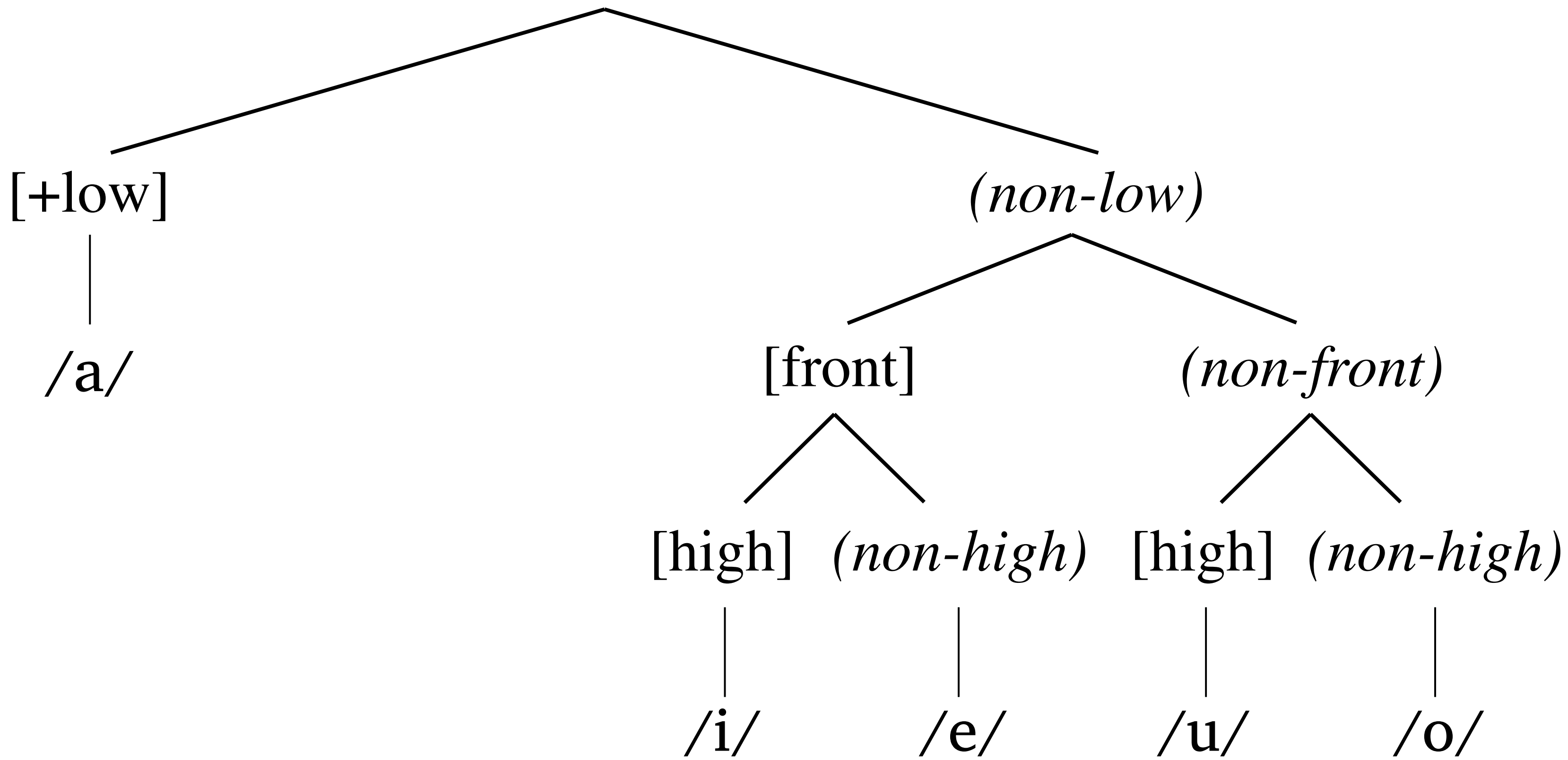
Over time, however, there is evidence that *i*-umlaut became a lexical rule, even while it was still creating fronted allophones of the vowels */u/ and */o/ (see Liberman 1991, Fertig 1996, Janda 2003, and P. Kiparsky 2015 for discussion).

How could this happen?

West Germanic feature hierarchy 1

Recall that {round} was an enhancement feature and not contrastive in West Germanic , for which we posited the feature hierarchy:

[low] > [front] > [high]



Contrast shift in West Germanic

However, another feature hierarchy can be constructed that includes [round] as a contrastive feature.

This hierarchy requires demoting [low] to allow [round] to be contrastive over the non-front vowels.

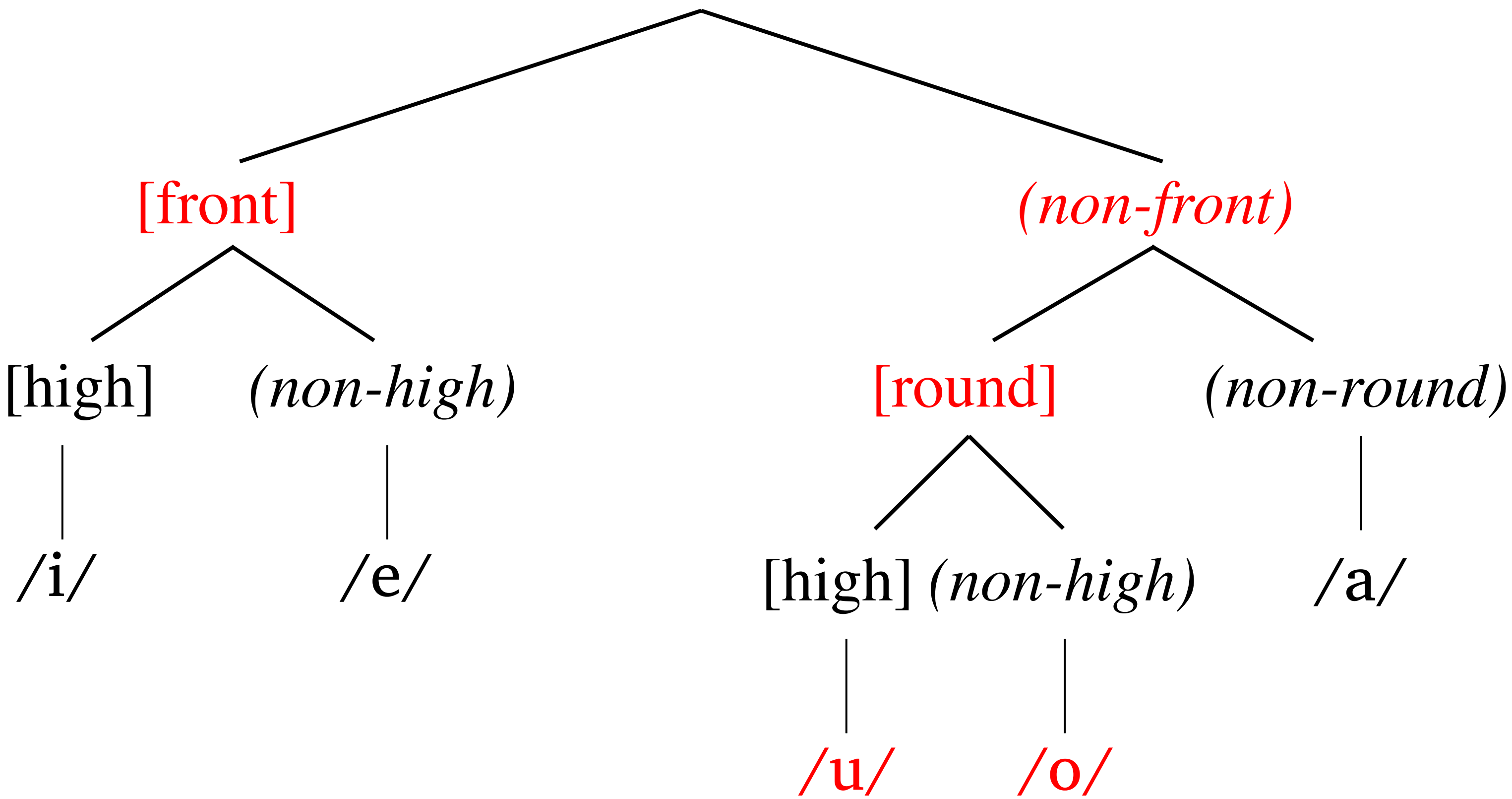
In tree form this new hierarchy looks as follows:

Earlier hierarchy: [low] > [front] > [high]

Later hierarchy: [front] > [round] > [high]

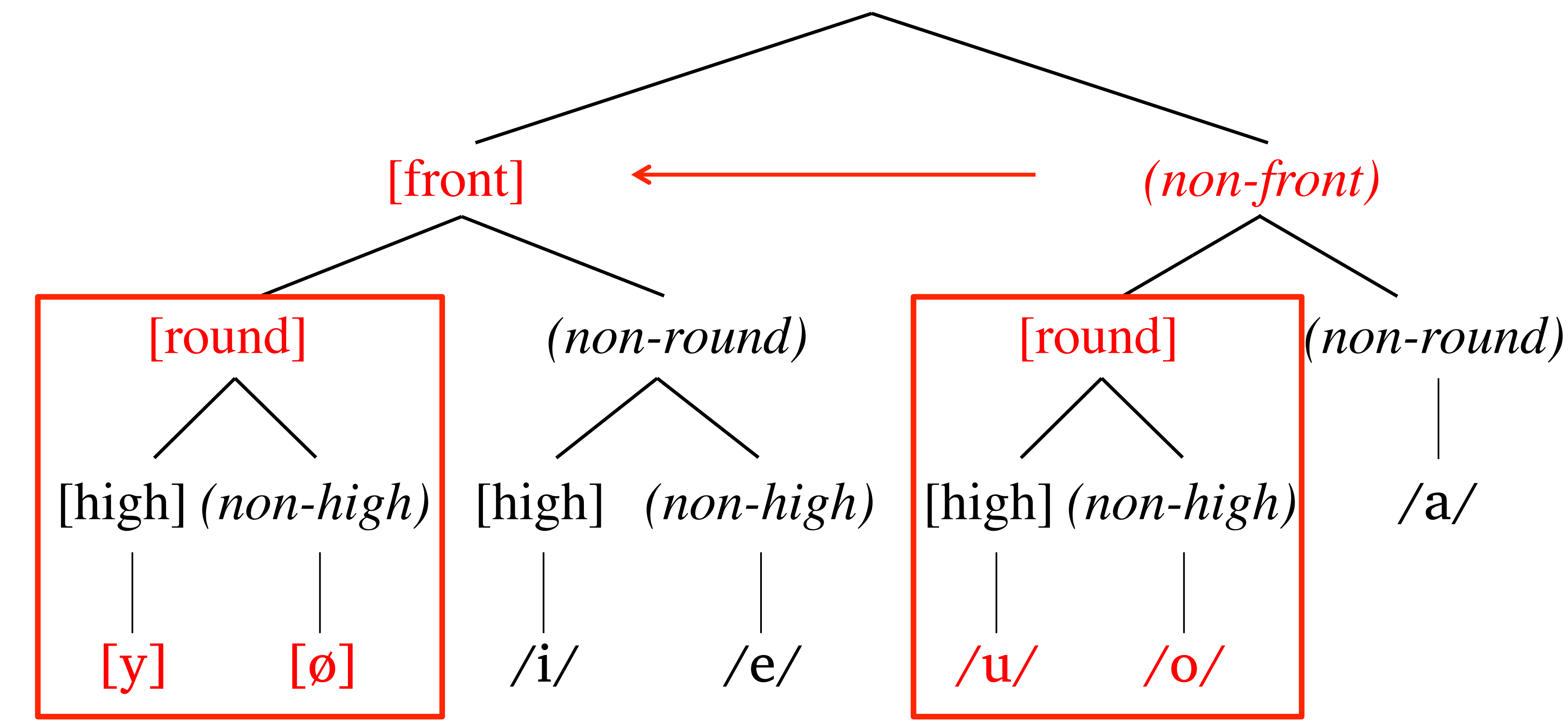
West Germanic feature hierarchy 2

[front] > [round] > [high]



West Germanic feature hierarchy 2

Now changing the *(non-front),* [round] vowels to [front] results in new front rounded vowels, which begin as allophones.



Deep allophones

Although they are allophones, they can arise in the contrastive phonology because they consist only of contrastive features.

They are thus what Moulton (2003) calls 'deep allophones', referring to the Old English voiced fricatives which also arise early in the contrastive (lexical) phonology.

Deep allophones are possible because contrastive features are not all necessarily unpredictable in a hierarchical approach.

9.

Conclusion

Conclusion

To sum up, many phonologists have had the intuition that the phonological systems of the world's languages use a limited set of primes, be they features or elements.

However, this is not because there is a limited set of innate universal primes; the impression that all languages use the same substantive features is to some extent an illusion.

Rather, it is because Universal Grammar requires speakers to construct contrastive hierarchies, and they limit the number of primes available to the phonology.

It follows that contrastive hierarchies show considerable cross-linguistic variability, both in the selection of particular primes and in their ordering in the hierarchy.

Conclusion

I have also argued that CHT and ET have in common that they take a middle course between phonetic determinism on one side, and substance-free phonology on the other.

In both CHT and ET, phonological primes are cognitive entities that form a bridge between the mental representations and operations of the phonological component and their external phonetic manifestations.

Whether the primes are binary features or unary elements or something else is an empirical matter to be decided on the basis of evidence, not on logic or *a priori* notions of where to draw the line between form and substance.

For publications, presentations, and references related to this talk please see:

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


MERCI!

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