

Foundations of Contrastive Hierarchy Theory

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1.

Introduction

Introduction

In this talk I will present a brief introduction to a theory of contrastive feature hierarchies in phonology.

This theory builds on ideas that can be traced to Roman Jakobson and N. S. Trubetzkoy, adapted to the framework of the generative phonology of Noam Chomsky and Morris Halle.

I will set out the main tenets of Contrastive Hierarchy theory, and consider what implications it has for understanding phonological features.

In particular, I will assume that features are 'emergent' and language particular, not innate and universal.

Introduction

I will argue that the language learner's task is to arrive at a set of hierarchically-ordered contrastive features that account for the phonological patterning of the input language.

Thus, it is the concept of a **contrastive feature hierarchy** that is universal, not the features themselves or their ordering.

I further adopt the hypothesis that **only** contrastive features may play a role in the lexical phonology; in the post-lexical domain, non-contrastive features can be added by **enhancement**.

These requirements put strong constraints on phonological representations, and account for why phonological systems resemble each other, without assuming that features are innate.

I will illustrate these notions and show how contrastive feature hierarchies contribute to synchronic and diachronic phonology.

Introduction

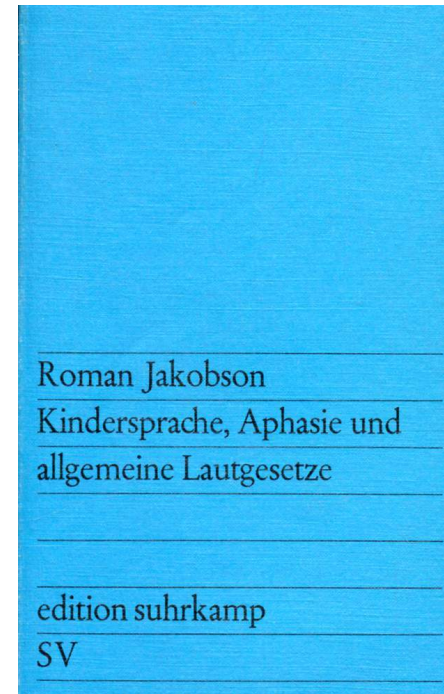
The talk is organized as follows:

- 1. Introduction
- 2. Jakobson's theory of phonological acquisition
- 3. Trubetzkoy's notions of phonemic content and contrast
- 4. History of branching trees in phonology
- 5. A theory of phonological contrast
- 6. Phonological features: innate or emergent?
- 7. Contrast shift and diachrony 1: Inuit dialects
- 8. Contrast shift and diachrony 2: Algonquian languages
- 9. Conclusions

2.

*Roman Jakobson:
The acquisition of
phonological contrasts*

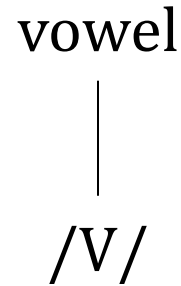
Jakobson's *Kindersprache*



Jakobson (1941) (English translation 1968, Spanish in 1974), 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.

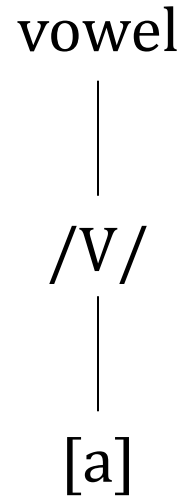
Acquisition sequences (vowels)



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/.

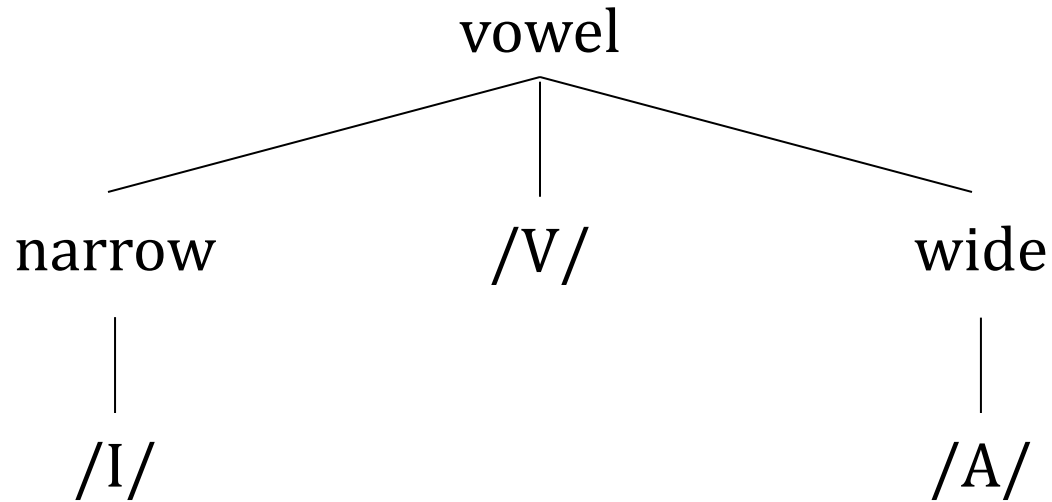
Acquisition sequences (vowels)



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.

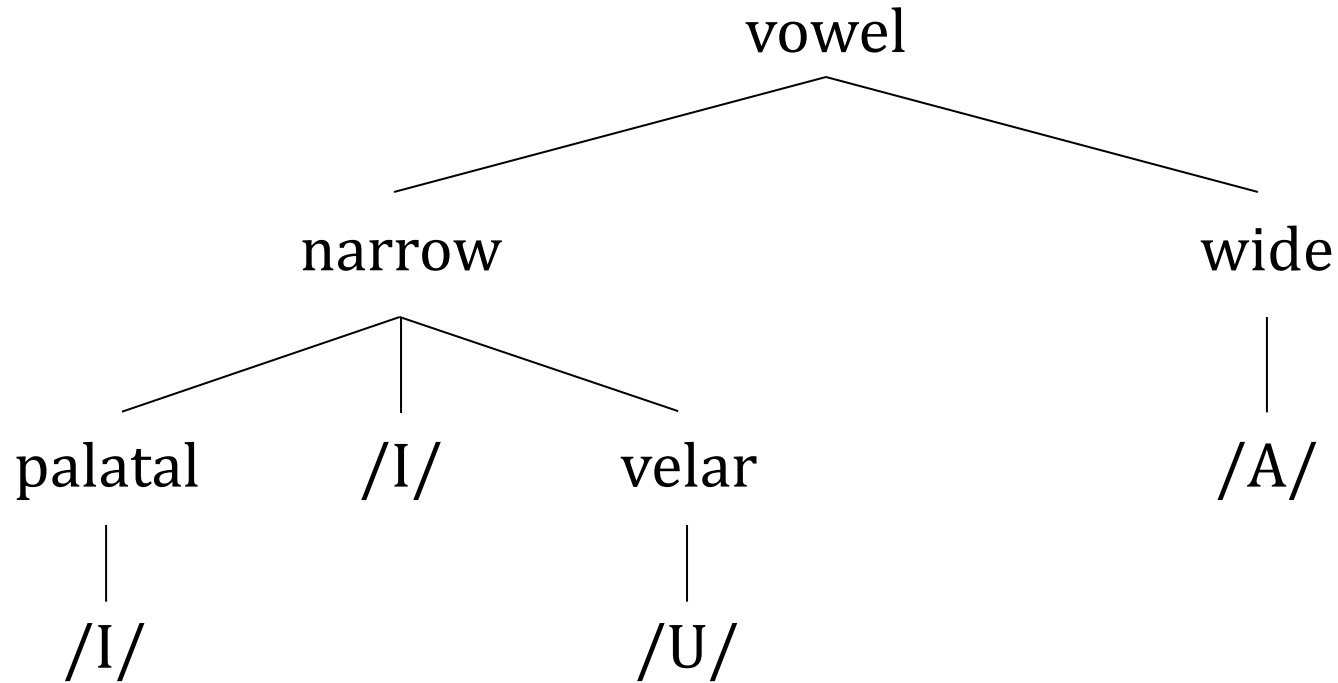
Acquisition sequences (vowels)



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].

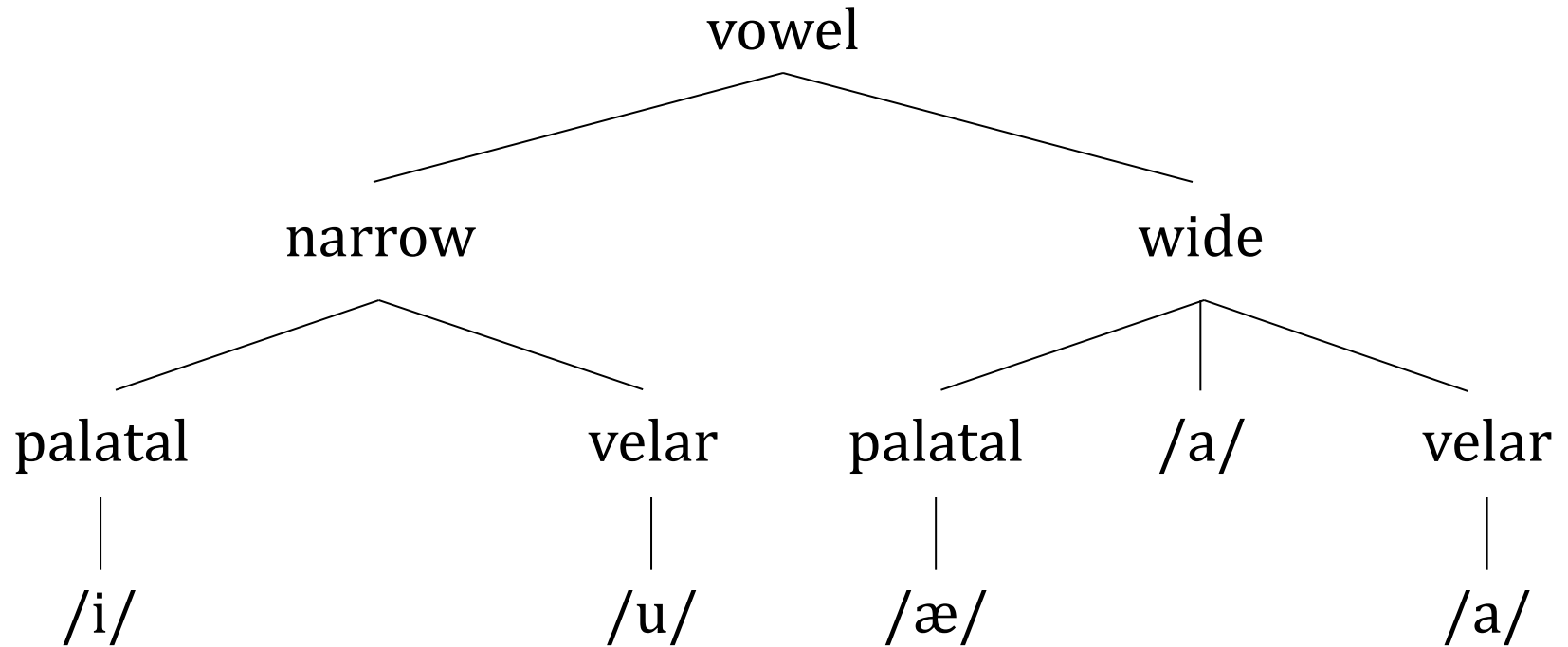
I will continue to understand these values as defaults; I use capital letters to represent vowels that fit the contrastive labels that characterize them.

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].

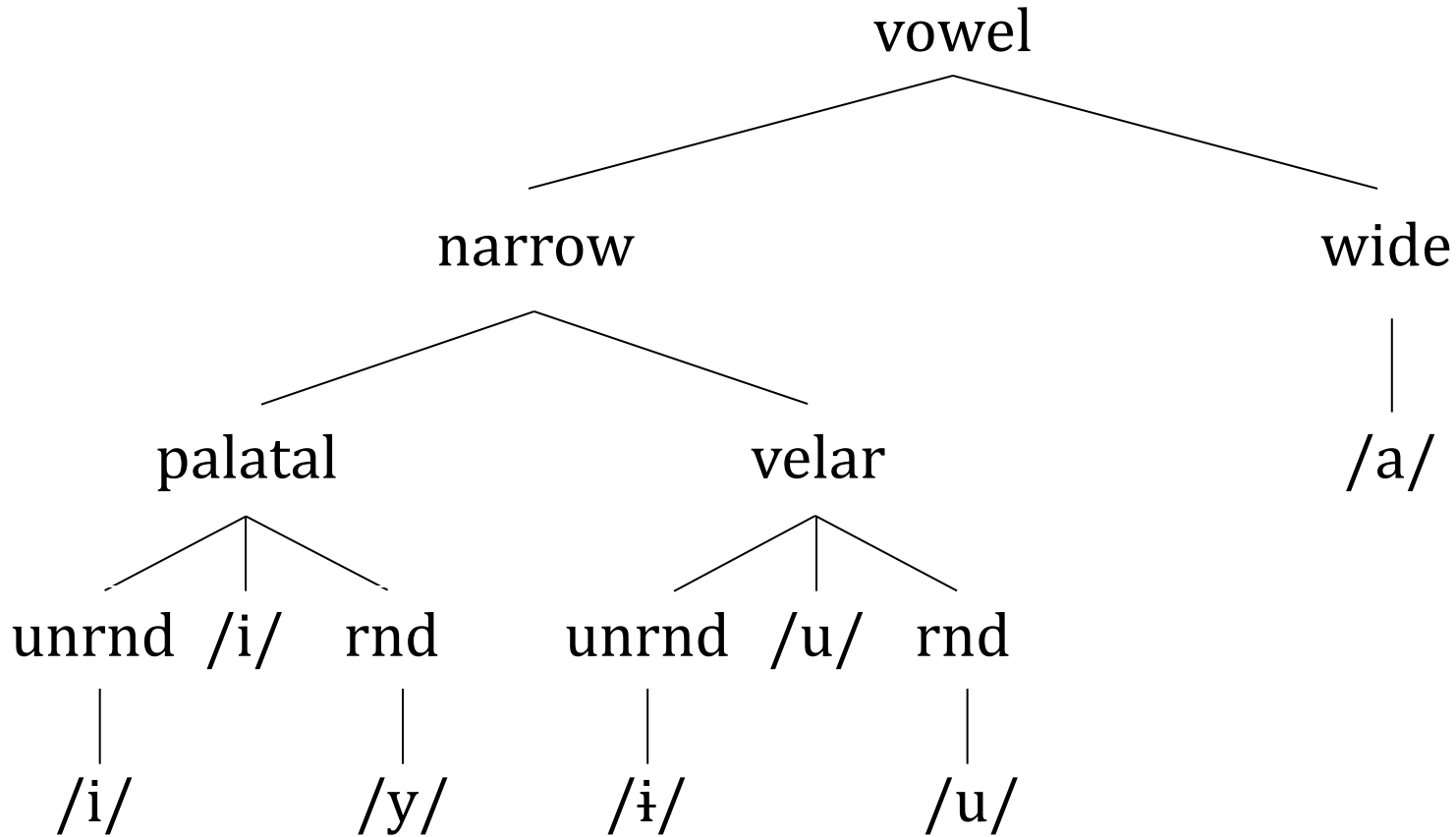
Acquisition sequences (vowels)



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.

Contrastive features assigned hierarchically

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.

This approach has two notable characteristics:

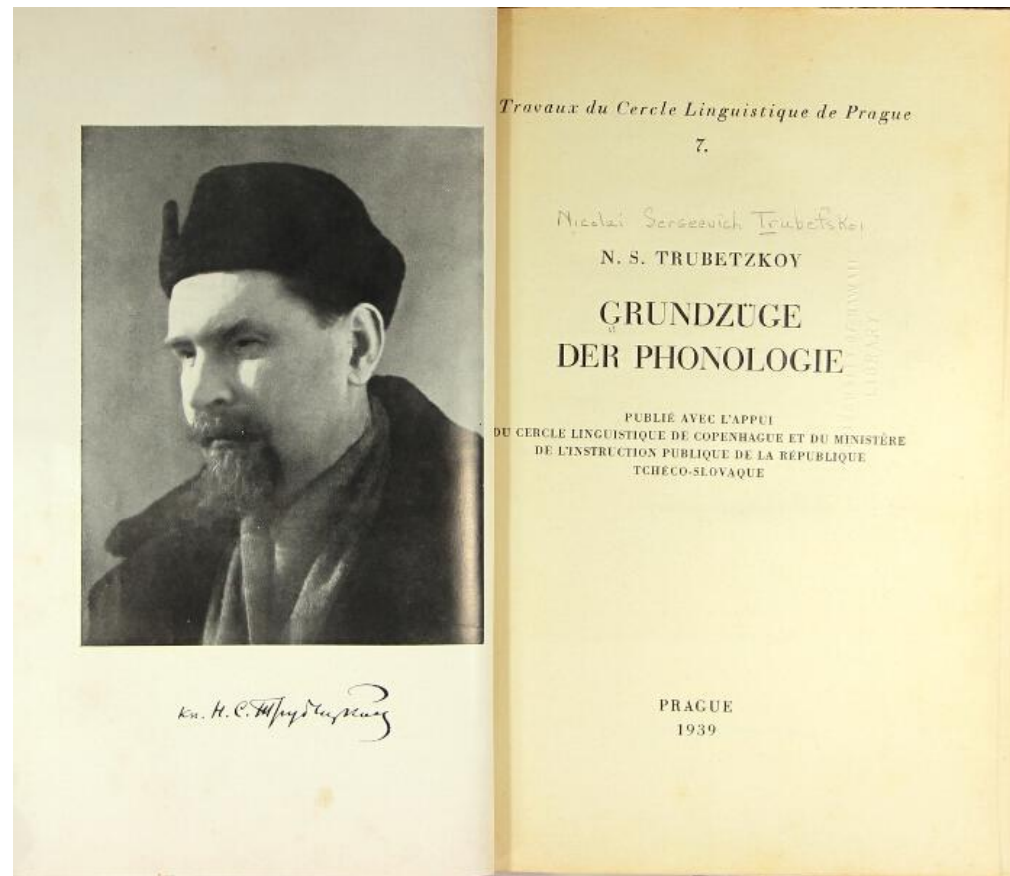
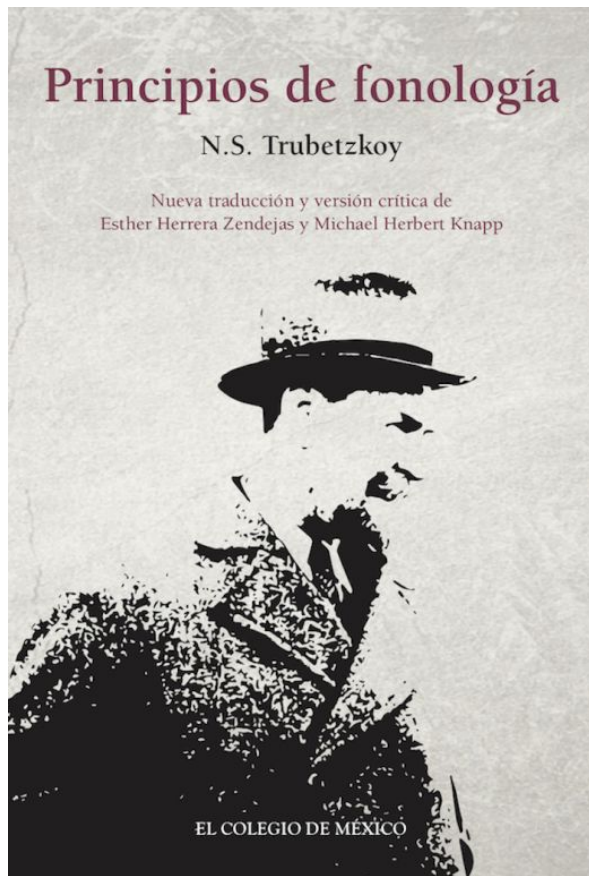
- Only **contrastive** features are assigned to each phoneme.
- Contrastive features are assigned **hierarchically**, in a way that can be represented by a **branching tree**.

I have argued that evidence for a similar way of thinking can be found in the work of Trubetzkoy, though some interpretation is required to see that.

3.

*N. S. Trubetzkoy:
Phonemic content and
contrast as 'point of view'*

Trubetzkoy's *Grundzüge der Phonologie*



N. S. Trubetzkoy's *Grundzüge der Phonologie* (1939; English version 1969, new Spanish 2019) is notable for its insights into the nature of contrast.

Phonemic content

An important notion of Trubetzkoy's is **phonemic content**: “By **phonemic content** we understand all phonologically distinctive properties of a phoneme...” (Trubetzkoy 1969: 66).

“Each phoneme has a definable phonemic content only because the system of distinctive oppositions shows **a definite order or structure.**” (1969: 67–8)

“the content of a phoneme depends on **what position this phoneme takes in the given phonemic system ...**”
(1969: 67)

Phonemic content and structure of the system

“the system of distinctive oppositions shows a definite order or structure ... the content of a phoneme depends on what position this phoneme takes in the given phonemic system ...”

The above remarks suggest that the phonemic content of a phoneme, that is, the set of its distinctive (contrastive) properties, ought to **derive** from its position in the system of distinctive oppositions.

Therefore, we need a way to determine a phoneme's position in the system of oppositions **before** we have determined its distinctive properties.

Phonemic content and structure of the system

*“the system of distinctive oppositions shows **a definite order or structure** ... the content of a phoneme depends on **what position this phoneme takes in the given phonemic system** ...”*

Trubetzkoy does not explicitly show us how to do this; however, the hierarchical branching trees that became prominent later in the work of Jakobson are a way of providing **an order or structure** to the system of contrasts.

Feature hierarchies are implicit in Trubetzkoy (1939); consider his discussion of Latin.

The vowel system of Latin

Trubetzkoy observes that in Latin, as in many five-vowel systems, the low vowel does not participate in tonality contrasts; ‘tonality’ refers to backness or lip rounding, that is, properties that affect the second formant (F2).

That is, the low vowel /a/ is assigned only the feature [+low].

Latin

| | |
|--------|-----|
| /i/ | /u/ |
| [-low] | |
| /e/ | /o/ |
| [+low] | |
| /a/ | |

But how can we prevent /a/ from receiving other features?

We can if we assign contrastive features in an **order**, in a **feature hierarchy**.

The vowel system of Latin

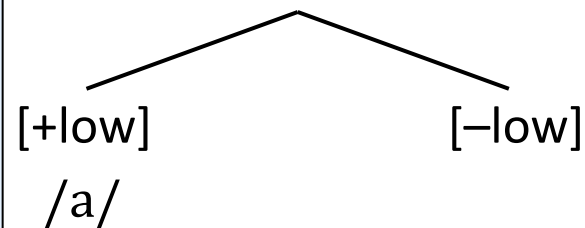
In order to exclude /a/ from receiving tonality features, it is necessary to order $[\pm\text{low}]$ at the top of the feature hierarchy: this has the effect of separating /a/ from the other vowels.

Since /a/ is already uniquely distinguished, it will receive no further features.

Latin

| | |
|-----------------|-----------------|
| /i/ | /u/ |
| | $[-\text{low}]$ |
| /e/ | /o/ |
| $[\text{+low}]$ | /a/ |

Top of the hierarchy: $[\text{low}]$

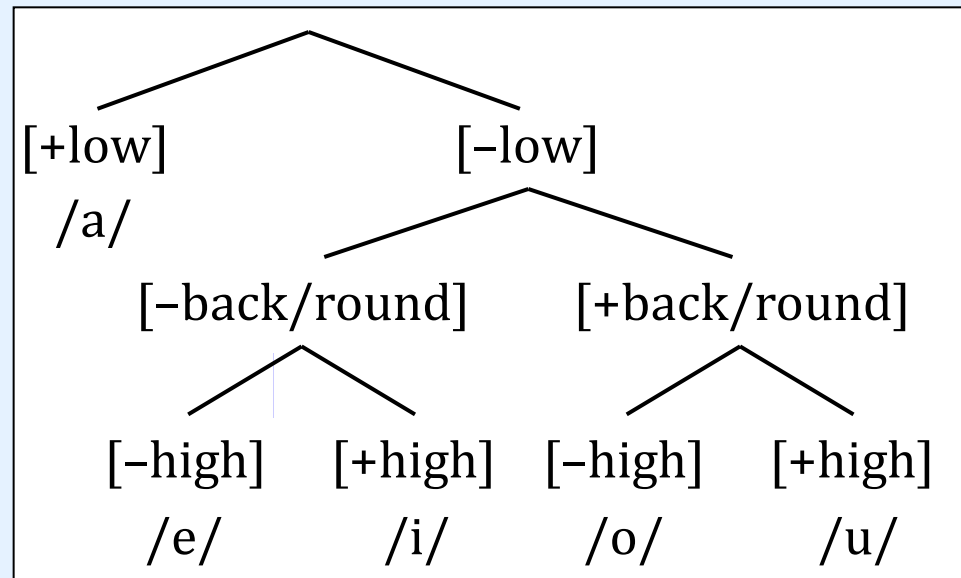


The vowel system of Latin

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

Common five-vowel systems use the features $[\pm\text{back}]$ or $[\pm\text{round}]$ to distinguish between /i, e/ and /u, o/, and $[\pm\text{high}]$ to distinguish between /i, u/ and /e, o/.

$[\text{low}] > [\text{back/round}] > [\text{high}]$



Polabian: “A certain hierarchy”

The notion of a feature hierarchy is only implicit in Trubetzkoy’s discussion of the Latin vowel system.

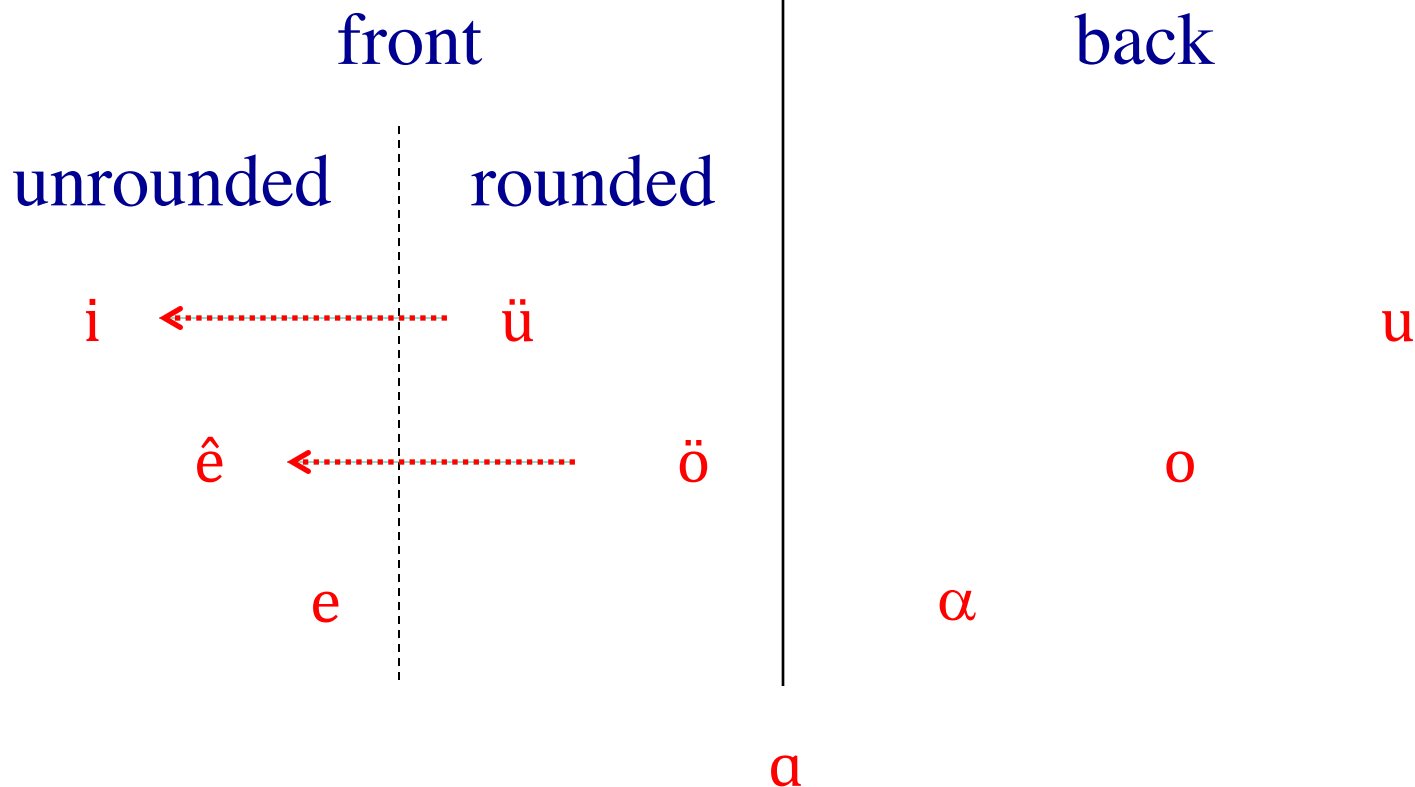
I **infer** that the analysis involves a feature hierarchy because that’s a way to make sense of it in a principled way.

In the case of Polabian, however, Trubetzkoy explicitly refers to a hierarchy.

He observes (1969: 102–3; 2019: 156) that “a certain hierarchy existed” in the vowel system of Polabian, whereby the contrast between front and back vowels is higher than the contrast between rounded and unrounded vowels.

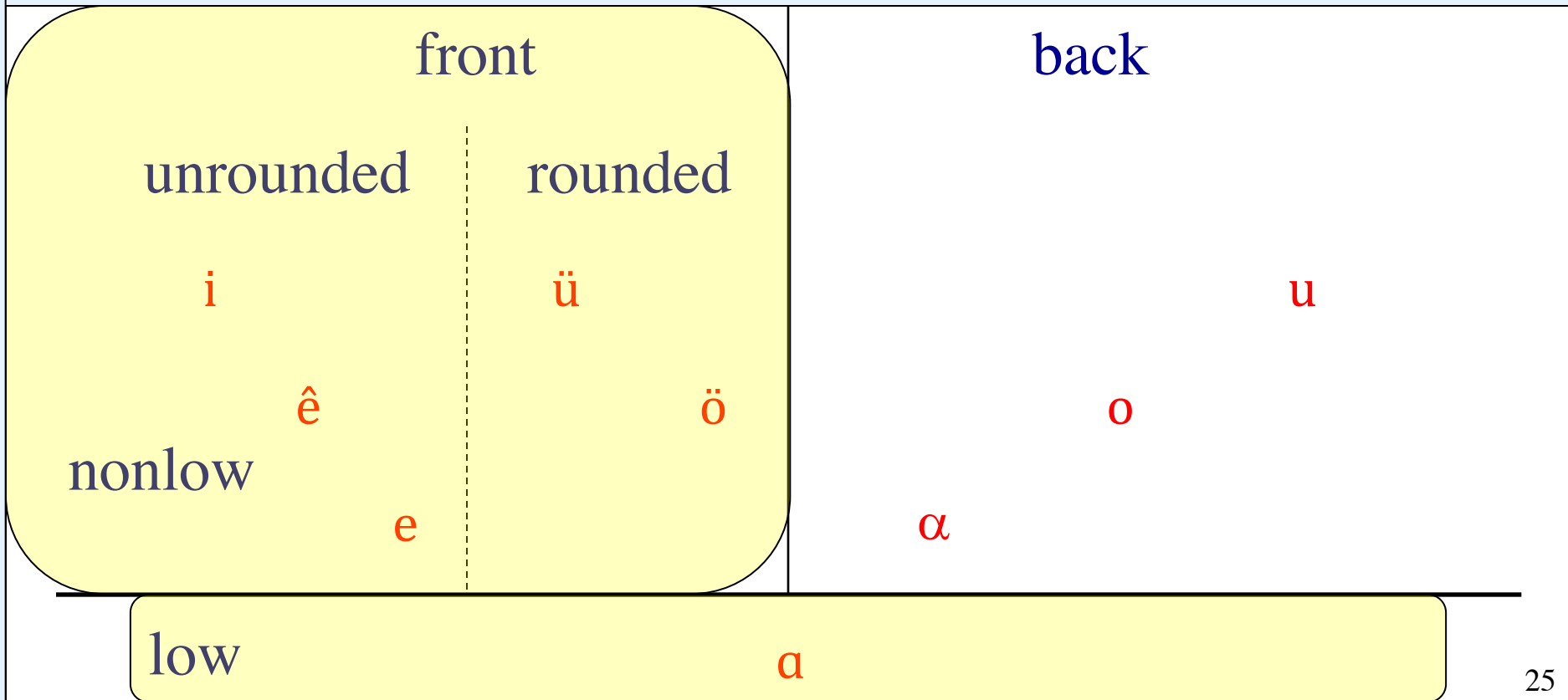
The Polabian vowel system

His evidence is that the oppositions between back and front vowels are **constant**, but those between rounded and unrounded vowels of the same height can **neutralize** to the unrounded vowels.



The Polabian vowel system

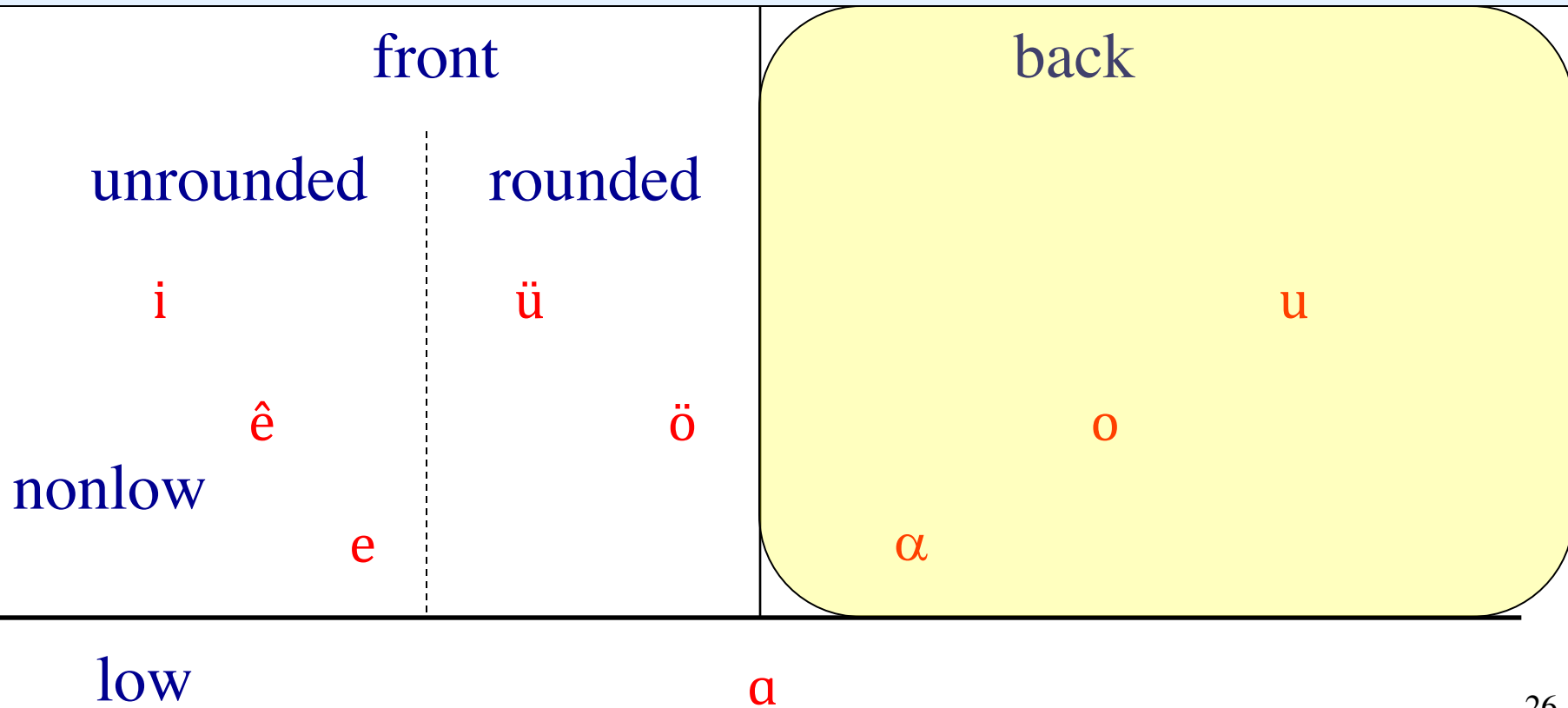
Further, palatalization in consonants is neutralized before all front vowels and before “the maximally open vowel **a** which stood outside the classes of timbre” (1969: 102; 2019: 156).



The Polabian vowel system

Trubetzkoy observes further: “the properties of lip participation were phonologically irrelevant for the back vowels.”

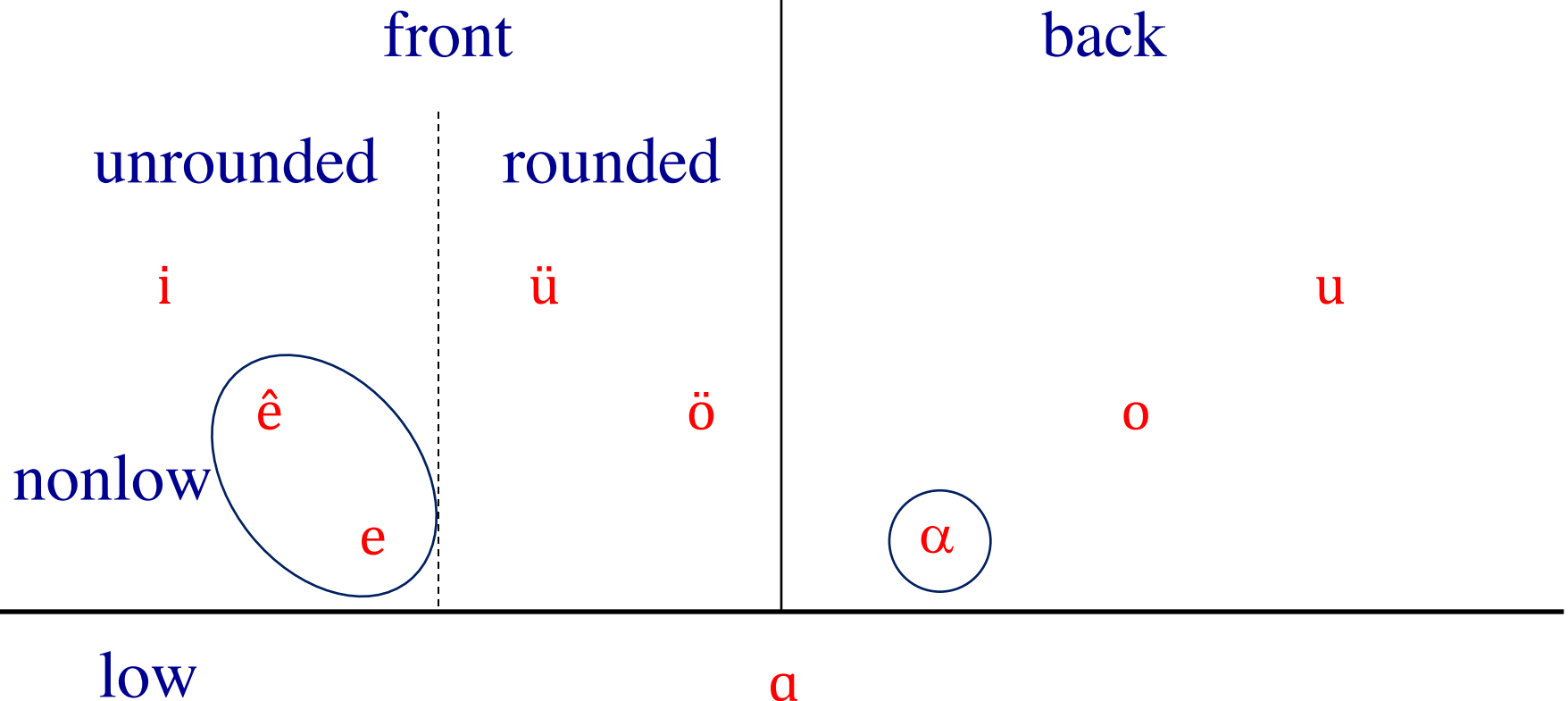
That is, unlike in the front vowels, rounding is not a distinctive phonological property of the back vowels.



The Polabian vowel system

While Trubetzkoy's general point is clear, his presentation of the Polabian vowel system is hard to understand:

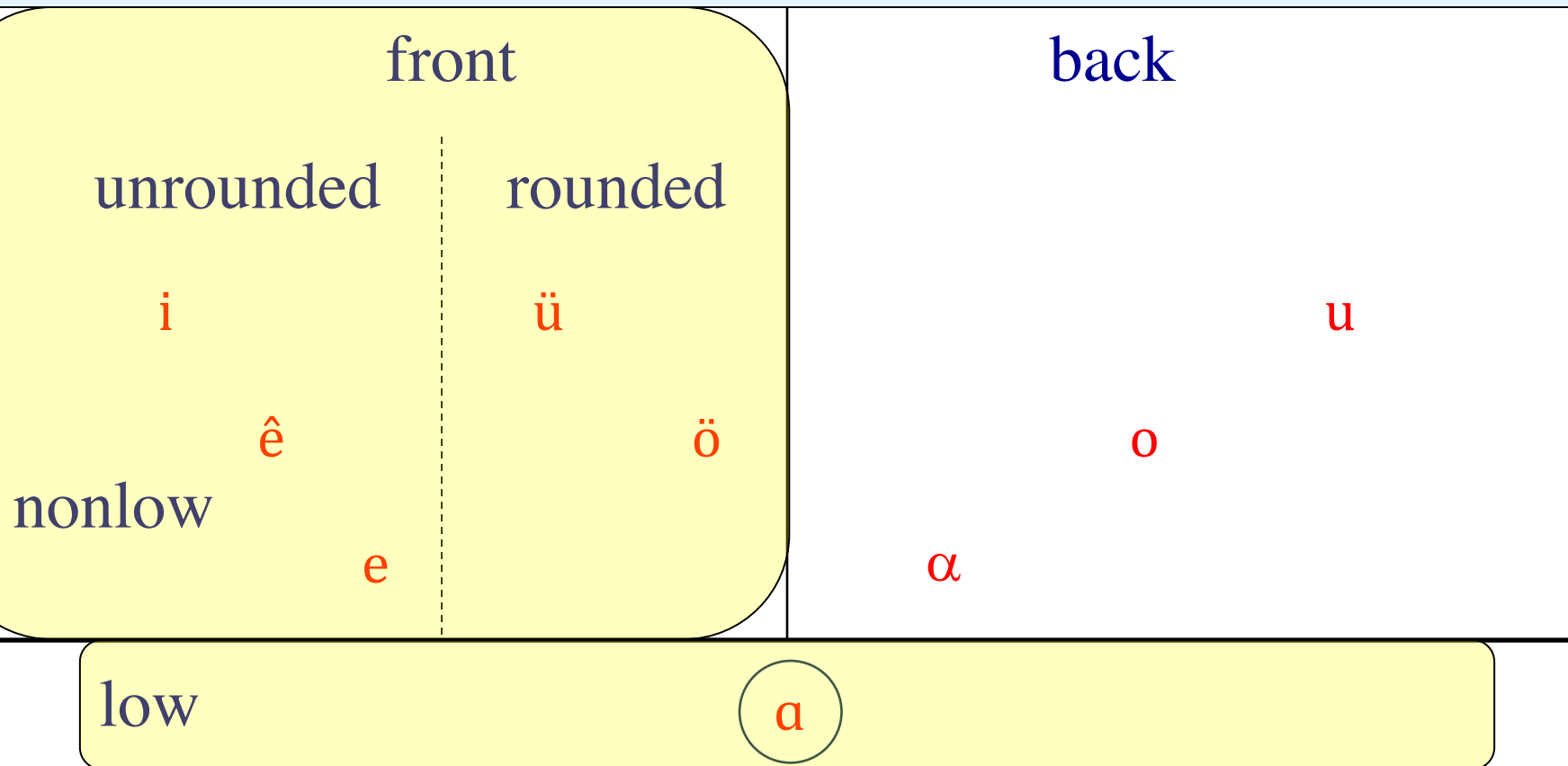
What vowel is / α /? What are the phonetic values of / \hat{e} / and / e /?



The Polabian vowel system

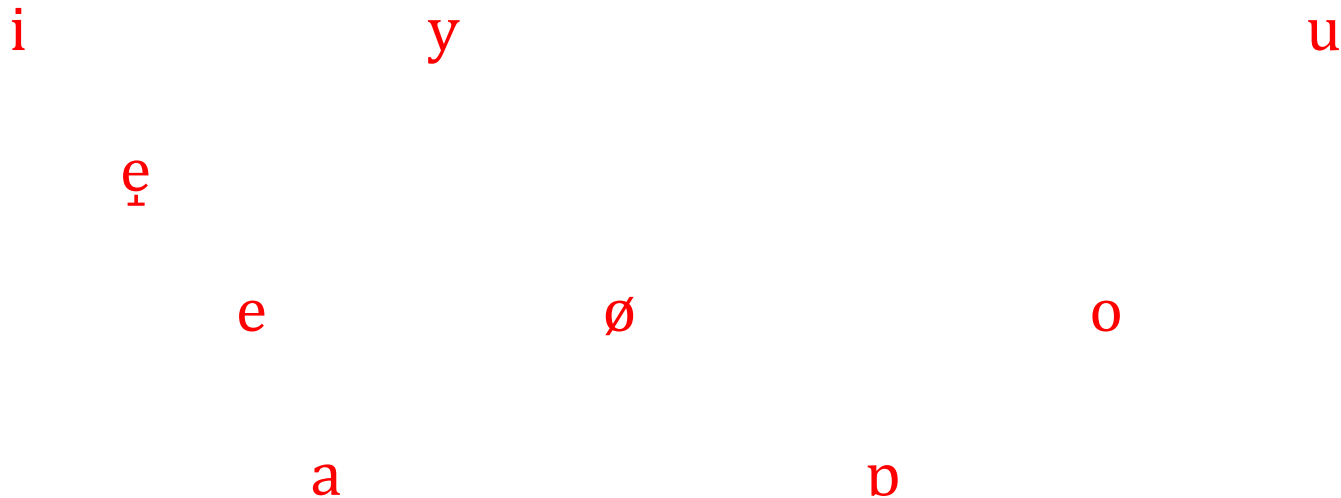
Finally, why does /a/, the vowel 'outside the classes of timbre', pattern with the front vowels in neutralizing palatalization?

The new edition by Herrera Zendeyas and Knapp sheds some light on this example.



The Polabian vowel system

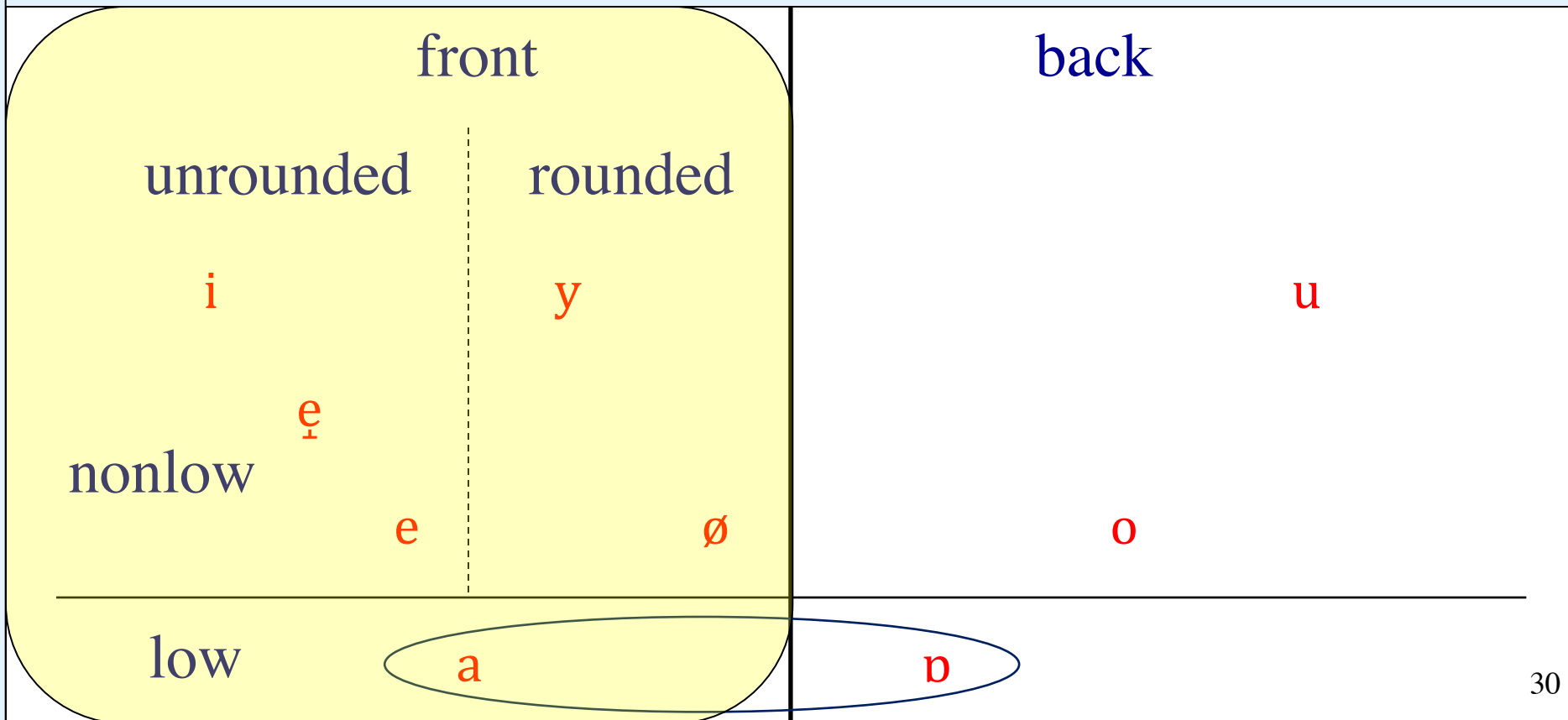
Next to Trubetzkoy's vowel chart, they present (2019: 157) an alternative more natural-looking chart by Polański (1993: 798–9).



The Polabian vowel system

Next to Trubetzkoy's vowel chart, they present (2019: 157) an alternative more natural-looking chart by Polański (1993: 798–9).

Now it becomes clear why /a/ patterns with the front vowels. It's because it is contrastively front in opposition to back /ɒ/.



Contrast depends on point of view

Another important insight is contained in a 1936 article addressed to psychologists and philosophers (Trubetzkoy 2001: 20):

The correct classification of an opposition “depends on one’s point of view”; but “it is neither subjective nor arbitrary, for the point of view is implied by the system.”

What does this really mean? All the terms in this statement need to be explicated and made operational, and here I will give my own interpretation of what I think he was getting at.

'Point of view' means contrast is variable

First, to say that the correct classification of an opposition depends on one's point of view means that the phonological contrasts in a language **vary** from language to language and cannot be determined simply by inspecting an inventory.

We have seen that in Latin the low vowel /a/ does not have features for [back] or [round], in Trubetzkoy's analysis.

| | | |
|--------|--------|-----|
| /i/ | | /u/ |
| | [-low] | |
| /e/ | | /o/ |
| <hr/> | | |
| [+low] | /a/ | |

'Point of view' means contrast is variable

But this is not the only way one can draw the contrasts in a five-vowel system.

It is possible, for example, to group the low vowel /a/ with the other [+back] vowels.

| [-back] | [+back] |
|---------|---------|
| /i/ | /u/ |
| /e/ | /o/ |
| | /a/ |

'Point of view' means contrast is variable

But this is not the only way one can draw the contrasts in a five-vowel system.

It is possible, for example, to group the low vowel /a/ with the other [+back] vowels.

Or /a/ can be grouped with the [-round] vowels.

| [-back] | [+back] |
|---------|---------|
| /i/ | /u/ |
| /e/ | /o/ |
| | /a/ |

| [-round] | [+round] |
|----------|----------|
| /i/ | /u/ |
| /e/ | /o/ |
| | /a/ |

The point of view is implied by the system

This is what I think Trubetzkoy means by “the correct classification of an opposition **depends on one’s point of view**”.

But, he goes on, “**it is neither subjective nor arbitrary, for the point of view is implied by the system.**” What does that mean?

I understand this to mean that we can tell what the correct point of view is by looking at the way the sounds **behave** in the language, that is, by looking at **phonological activity**, which I will define more precisely later.

Trubetzkoy demonstrates what he means in his survey of vowel systems, including 5-vowel systems that are different from Latin.

Five-vowel systems: Archi

Archi (East Caucasian), a language of Central Daghestan, has a five-vowel system that looks like that of Latin.

Trubetzkoy observes that 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

| [-round] | [+round] |
|----------|----------|
| /i/ | /u/ |
| /e/ | /o/ |
| /a/ | |

“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: 100–1).

Five-vowel systems: Archi

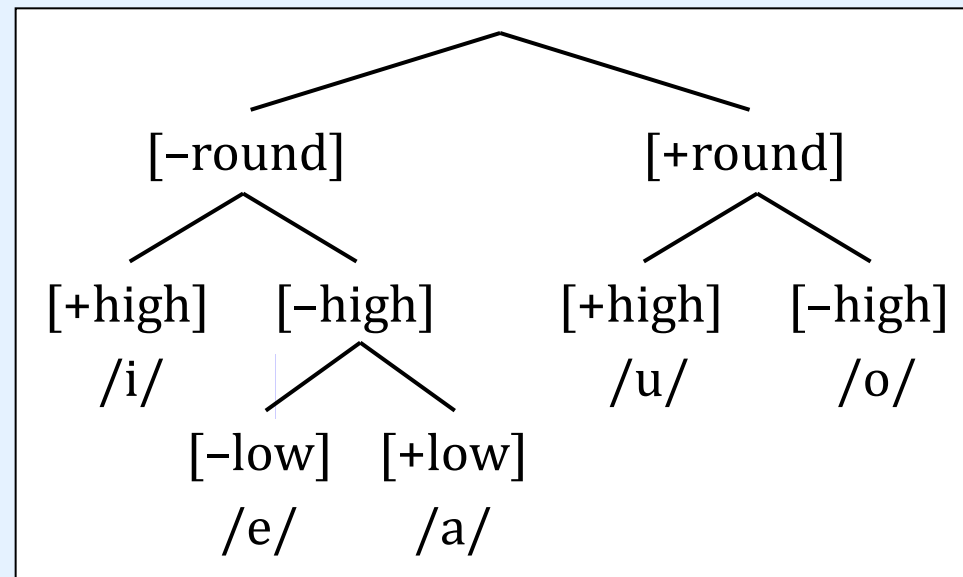
This analysis corresponds to ordering $[\pm\text{round}]$ first, dividing the vowels into two groups: /i, e, a/ and /u, o/.

Further distinctions within these groups are made by other features; the tree below shows one possible feature hierarchy.

Archi

| $[-\text{round}]$ | $[\text{+round}]$ |
|-------------------|-------------------|
| /i/ | /u/ |
| /e/ | /o/ |
| /a/ | |

$[\text{round}] > [\text{high}] > [\text{low}]$



Five-vowel systems: Japanese

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

Japanese

| [+front] | [-front] |
|----------|----------|
| /i/ | /u/ |
| /e/ | /o/ |
| | /a/ |

Five-vowel systems: Japanese

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

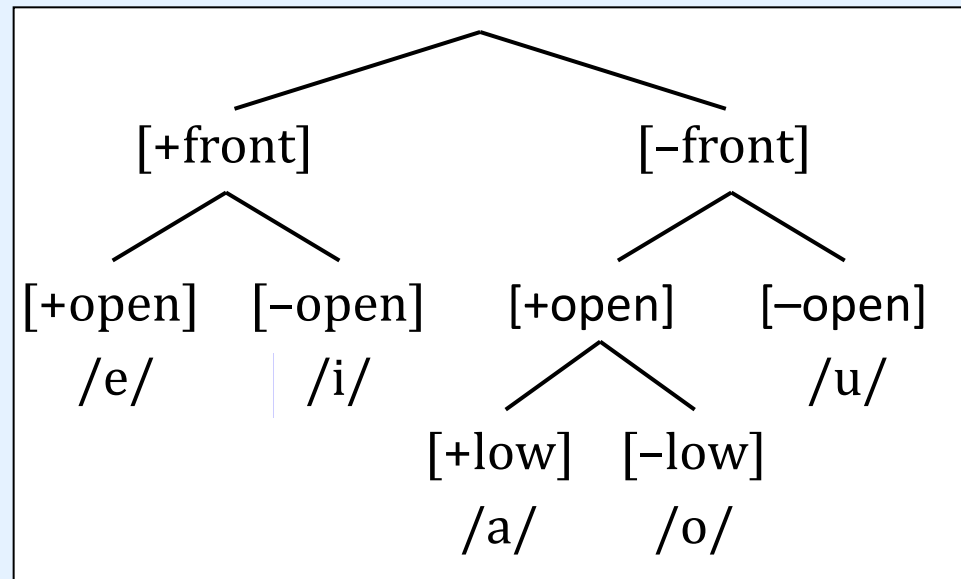
This analysis corresponds to ordering [front] first.

The rest of the tree is adapted from Hirayama (2003).

Japanese

| [+front] | [-front] |
|----------|----------|
| /i/ | /u/ |
| /e/ | /o/ |
| | /a/ |

[front] > [open] > [low]

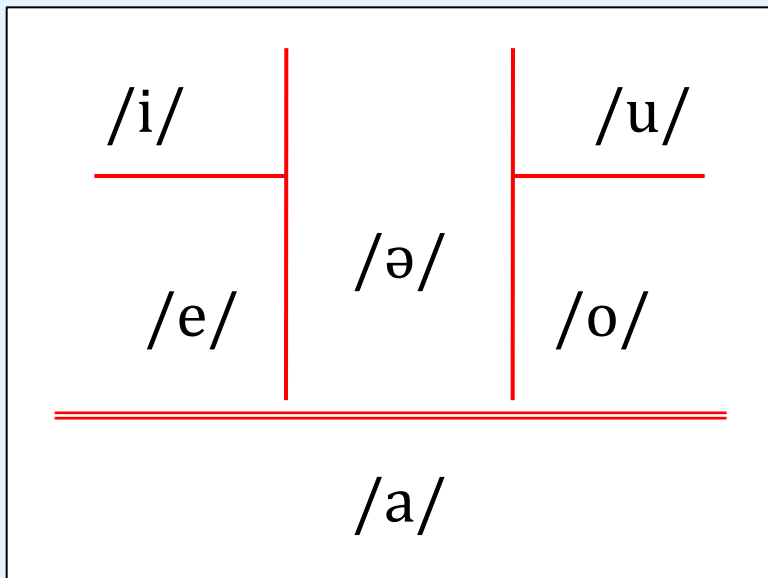


Five-vowels plus one

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’.

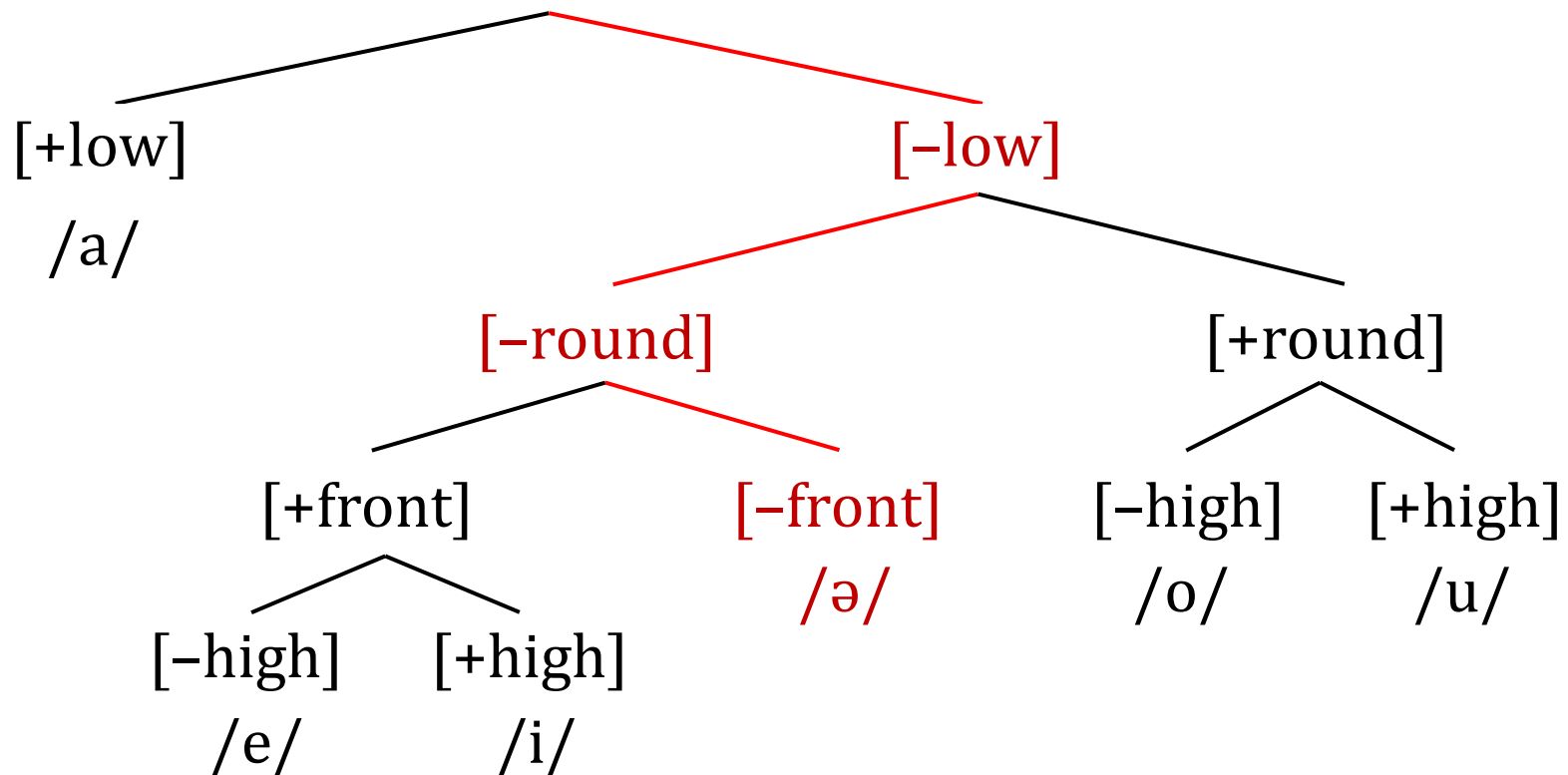
5 + 1: Common pattern



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].

Five-vowels plus one: Common pattern

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

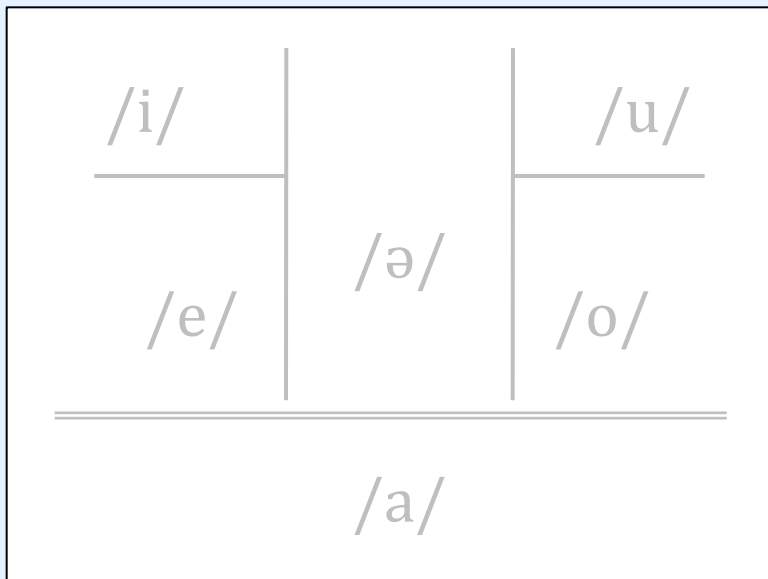


Five-vowels plus one

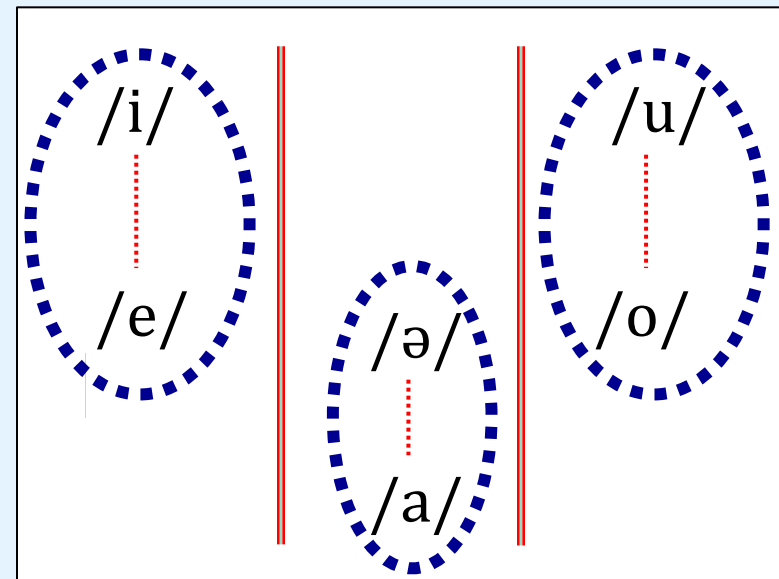
However, Trubetzkoy observes that in Bulgarian, the pairs /i, e/, /ə, a/, and /u, o/ neutralize in unstressed syllables.

This suggests that the central vowel has a special relationship with /a/.

5 + 1: Common pattern



5 + 1: Bulgarian

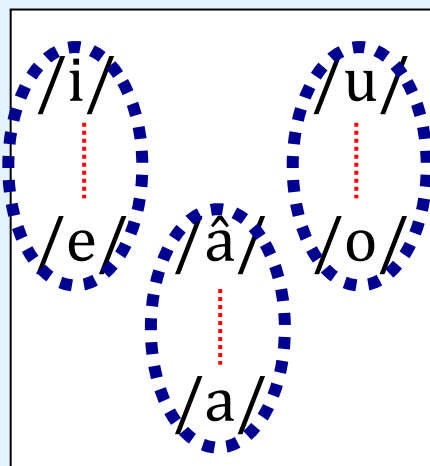


Vowel reduction in Bulgarian

Spahr (2014) shows how a contrastive feature hierarchy provides a natural way to account for vowel reduction in Bulgarian.

In stressed position Bulgarian has the 6 vowels shown below (Barnes 2006; he uses /â/ in place of /ə/).

Stressed Vowels



Depending on the dialect, these vowels neutralize in 3 pairs in unstressed positions (Scatton 1984), as observed by Trubetzkoy.

Scatton (1984) observes that these neutralizations occur in a hierarchy.

Vowel reduction in Bulgarian

All dialects and registers neutralize unstressed /a/ and /â/, realizing them as [ə].

In informal registers some dialects also neutralize /u/ and /o/ to [ʊ].

Some 'non-literary varieties' neutralize /i/ and /e/ to [ɪ].

Stressed Vowels

Unstressed Vowels

1st Reduction

2nd Reduction

3rd Reduction

| | | |
|-----|-----|-----|
| /i/ | /u/ | |
| /e/ | /â/ | /o/ |
| /a/ | | |

| | | |
|-----|-----|-----|
| /i/ | /u/ | |
| /e/ | [ə] | /o/ |

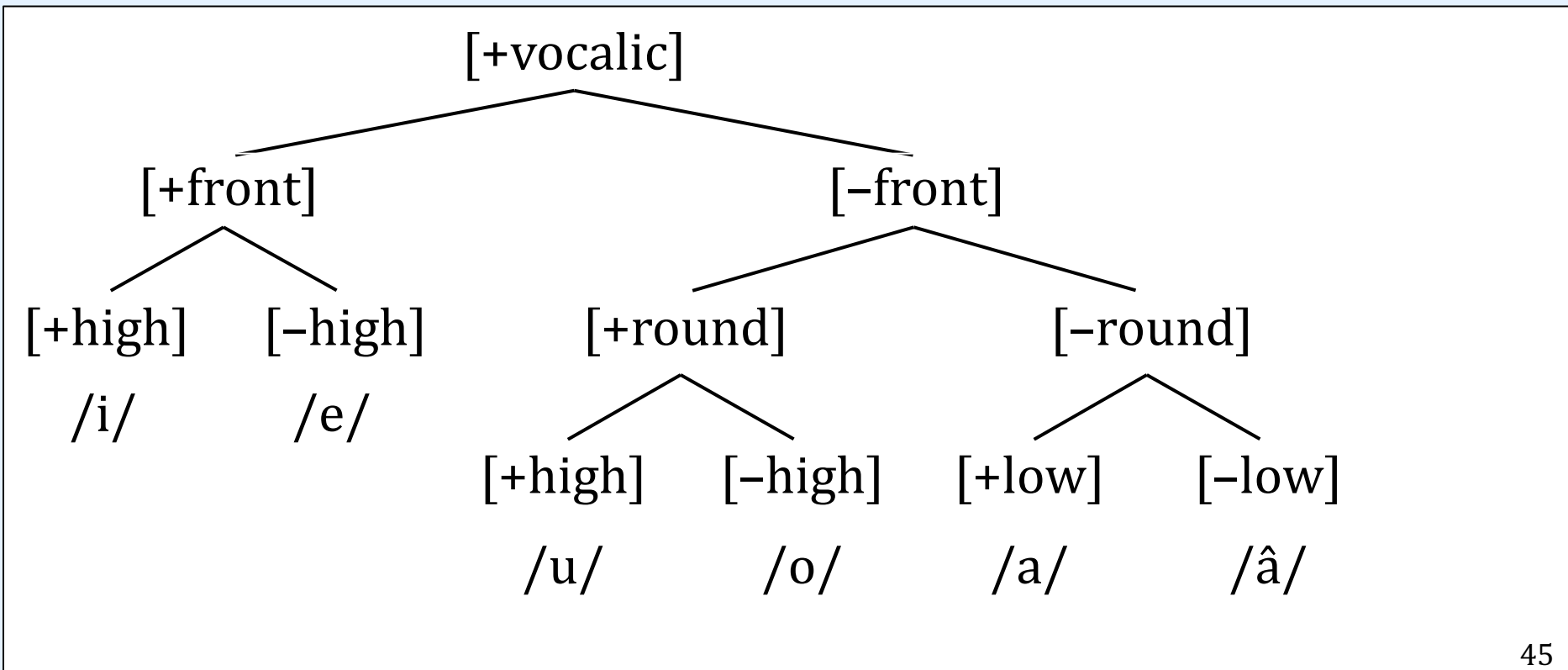
| | |
|-----|-----|
| /i/ | [ʊ] |
| /e/ | [ə] |

| | |
|-----|-----|
| [ɪ] | [ʊ] |
| | [ə] |

Bulgarian hierarchy (Spahr 2014)

Spahr (2014) proposes that the vowel reduction patterns point to a contrastive hierarchy such as the one below.

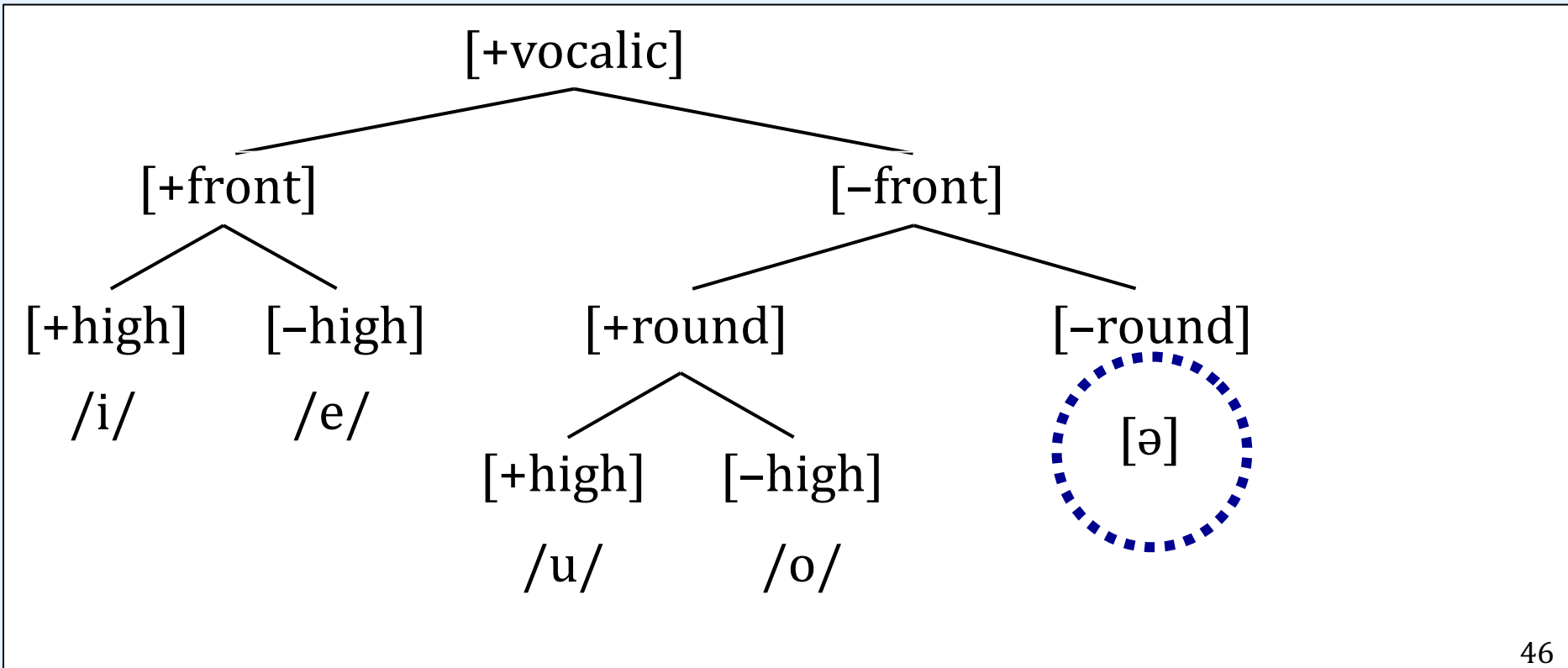
The various reductions can now be represented as the suspension of a contrast at the bottom of the feature tree.



Bulgarian hierarchy (Spahr 2014)

The first reduction neutralizes the [low] contrast to [ə].

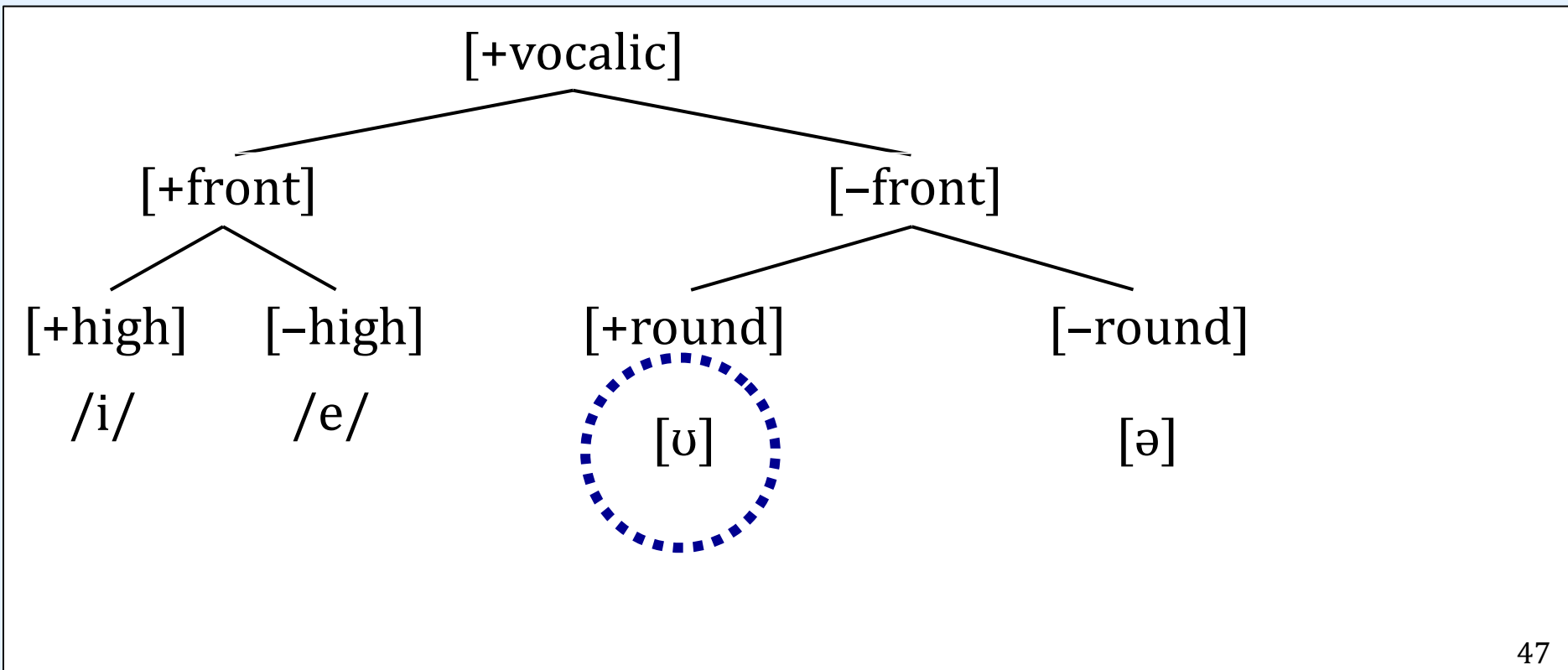
Spahr proposes that [ə] is neither [+low] nor [-low], but bears only the features [+vocalic], [-front], [-round].



Bulgarian hierarchy (Spahr 2014)

The second reduction neutralizes the [+high] contrast under [+round] to [ʊ].

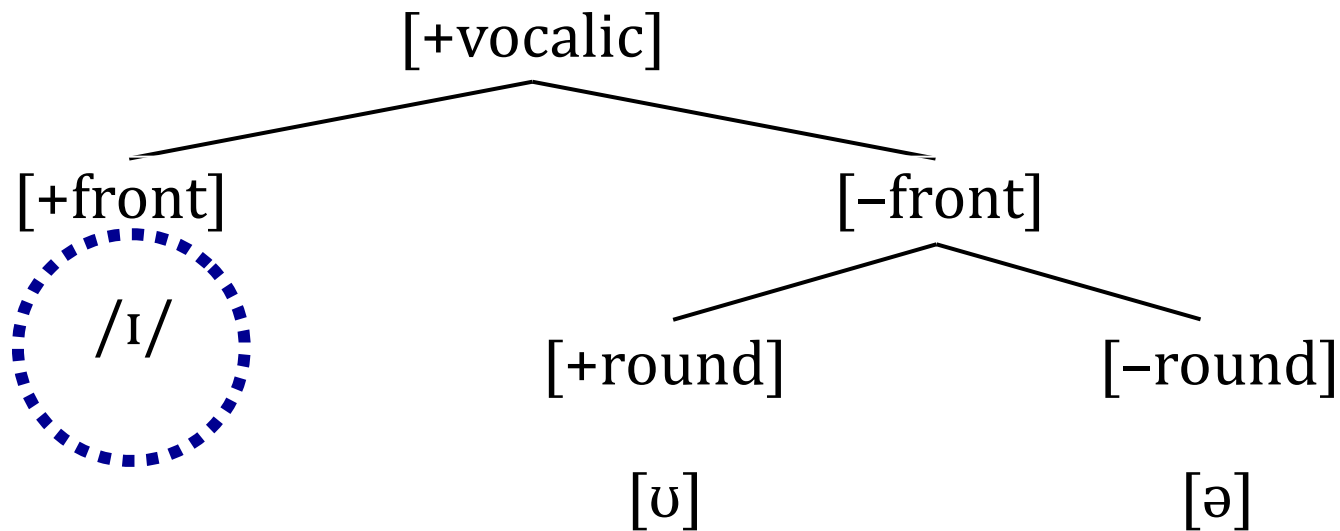
The resulting [ʊ] is neither [+high] nor [-high].



Bulgarian hierarchy (Spahr 2014)

The third reduction neutralizes the [high] contrast under [front].

This analysis of neutralization thus instantiates the Prague School notion of ‘archiphoneme’ (Trubetzkoy 1939; Davidsen-Nielsen 1978).



4.

*History of 'branching
trees' in phonology*

History of ‘branching trees’ in phonology

To sum up what I have tried to show to here, I have argued that Jakobson and Trubetzkoy both supposed that **only contrastive features** are assigned to phonemes.

Moreover, their early work shows evidence of a **hierarchical approach** to assigning these features, by means of what later became called ‘branching trees’.

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 (1931) and Trubetzkoy (1939) in the 1930s, and continuing with Jakobson 1941 and Jakobson & Lotz 1949.

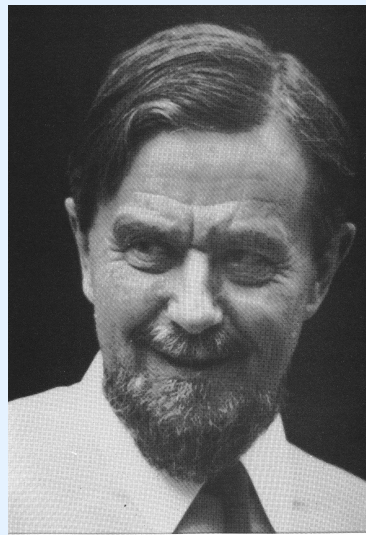
History of 'branching trees' in phonology



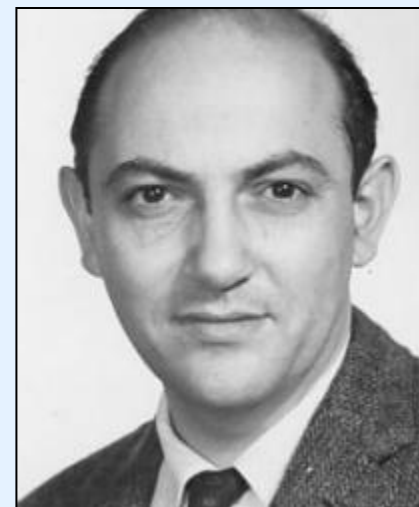
Jakobson



Fant



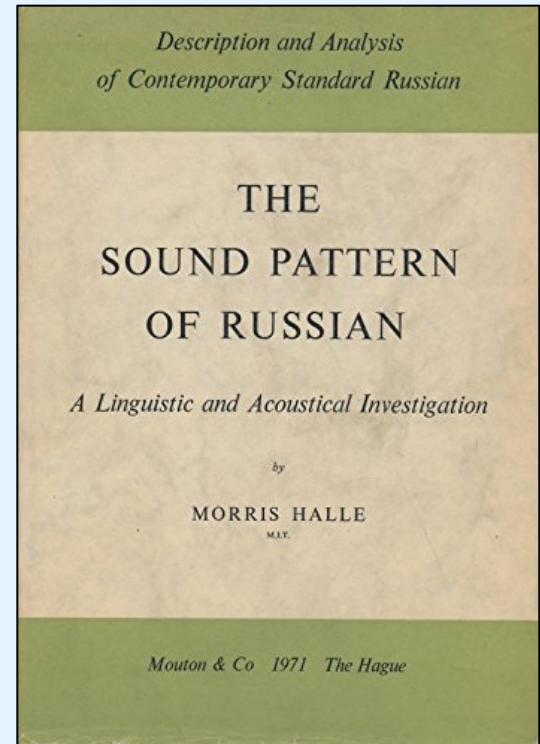
Cherry



Halle

The branching trees became increasingly explicit in the work of Jakobson and his collaborators in the 1950s, notably in Jakobson, Fant, & Halle 1952, Cherry, Halle, & Jakobson 1953, and Jakobson & Halle 1956.

History of 'branching trees' in phonology



This work culminated with Morris Halle's *The sound pattern of Russian* (Halle 1959).

On page 46 of *The sound pattern of Russian* is Figure I-1, a tree diagram that shows the contrastive feature specifications of every phoneme of Russian.

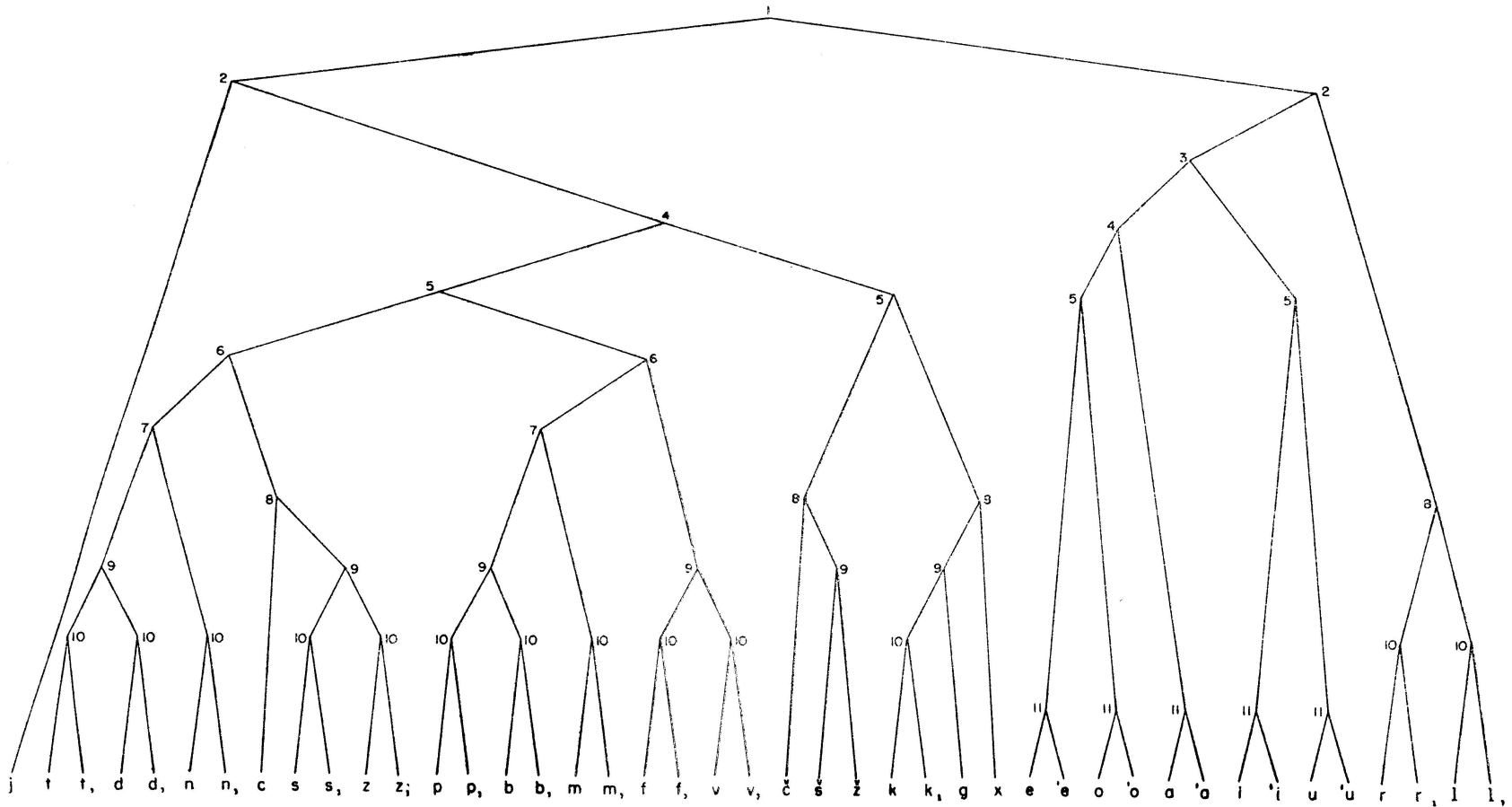
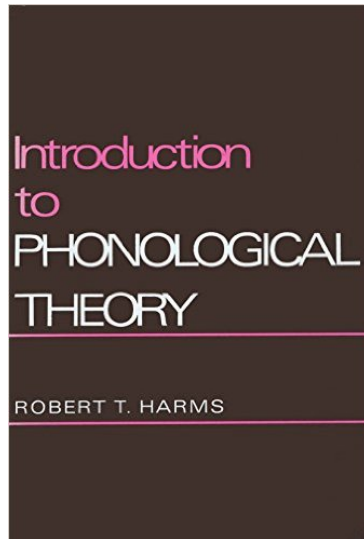


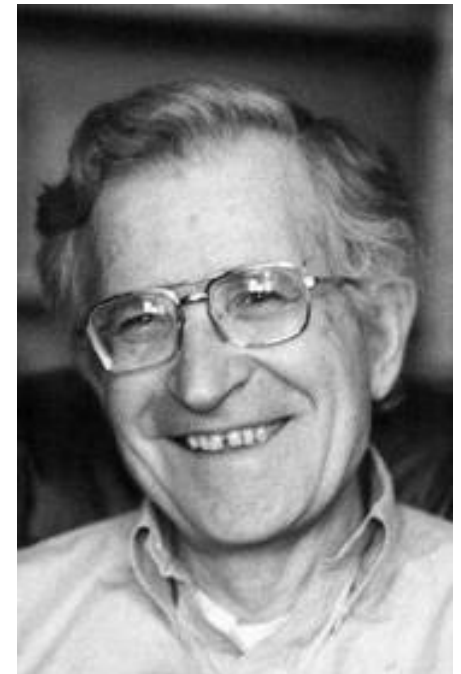
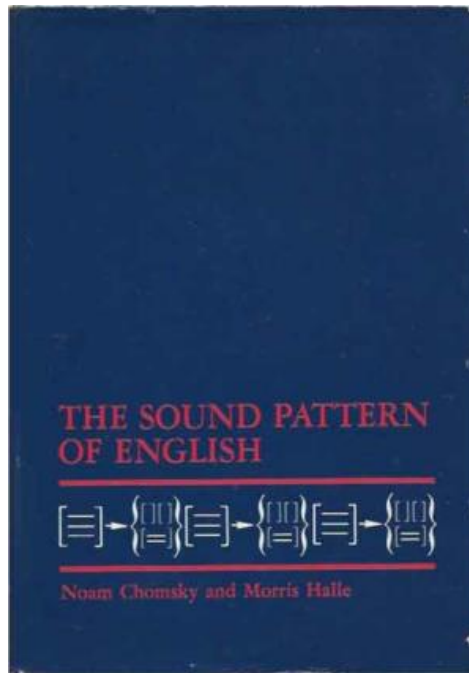
Fig. I-1. Branching diagram representing the morphemes of Russian. The numbers with which each node is labelled refer to the different features, as follows: 1. vocalic vs. nonvocalic; 2. consonantal vs. nonconsonantal; 3. diffuse vs. nondiffuse; 4. compact vs. noncompact; 5. low tonality vs. high tonality; 6. strident vs. mellow; 7. nasal vs. nonnasal; 8. continuant vs. interrupted; 9. voiced vs. voiceless; 10. sharpened vs. plain; 11. accented vs. unaccented. Left branches represent minus values, and right branches, plus values for the particular feature.

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.

(Some examples are: Pye, Ingram and List 1987; Ingram 1988, 1989; Levelt 1989; Dinnsen et al. 1990; Dinnsen 1992, 1996; see Drescher 1998a for a review, and see now Bohn 2015 on the acquisition of the Brazilian Portuguese vowel system.)

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

Development of Dutch onset consonants

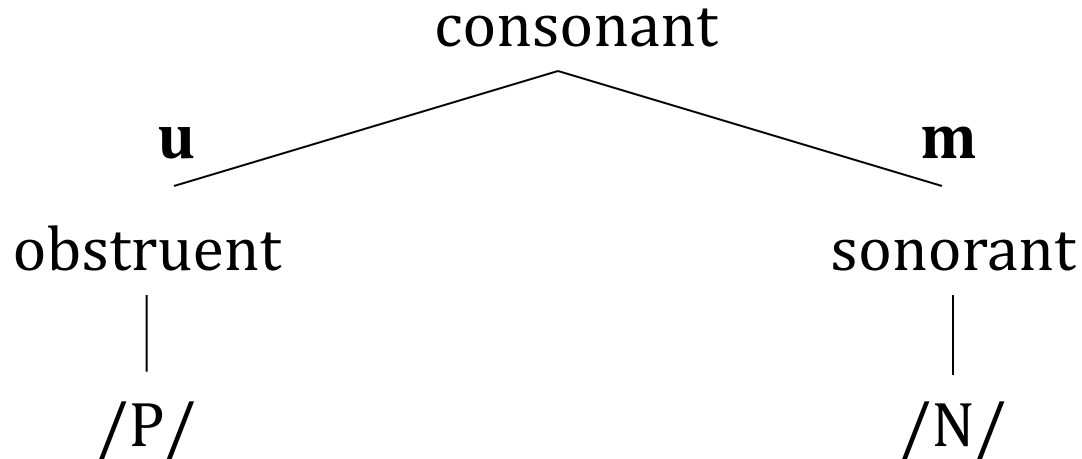
consonant

|
/P/

Stage 1

There are no contrasts. The value of the consonant defaults to the least marked onset, namely an obstruent plosive.

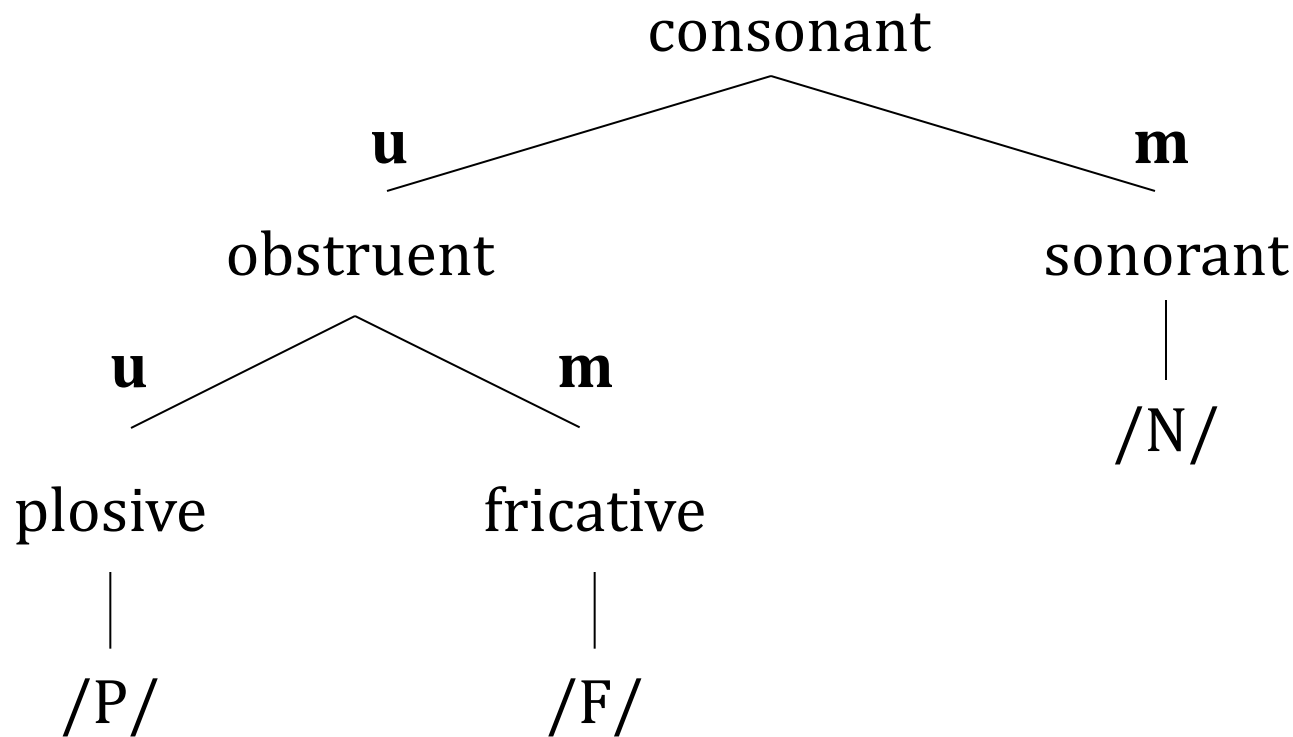
Development of Dutch onset consonants



Stage 2

The first contrast is between obstruent and sonorant. The former remains the unmarked option (**u**). The sonorant defaults to nasal.

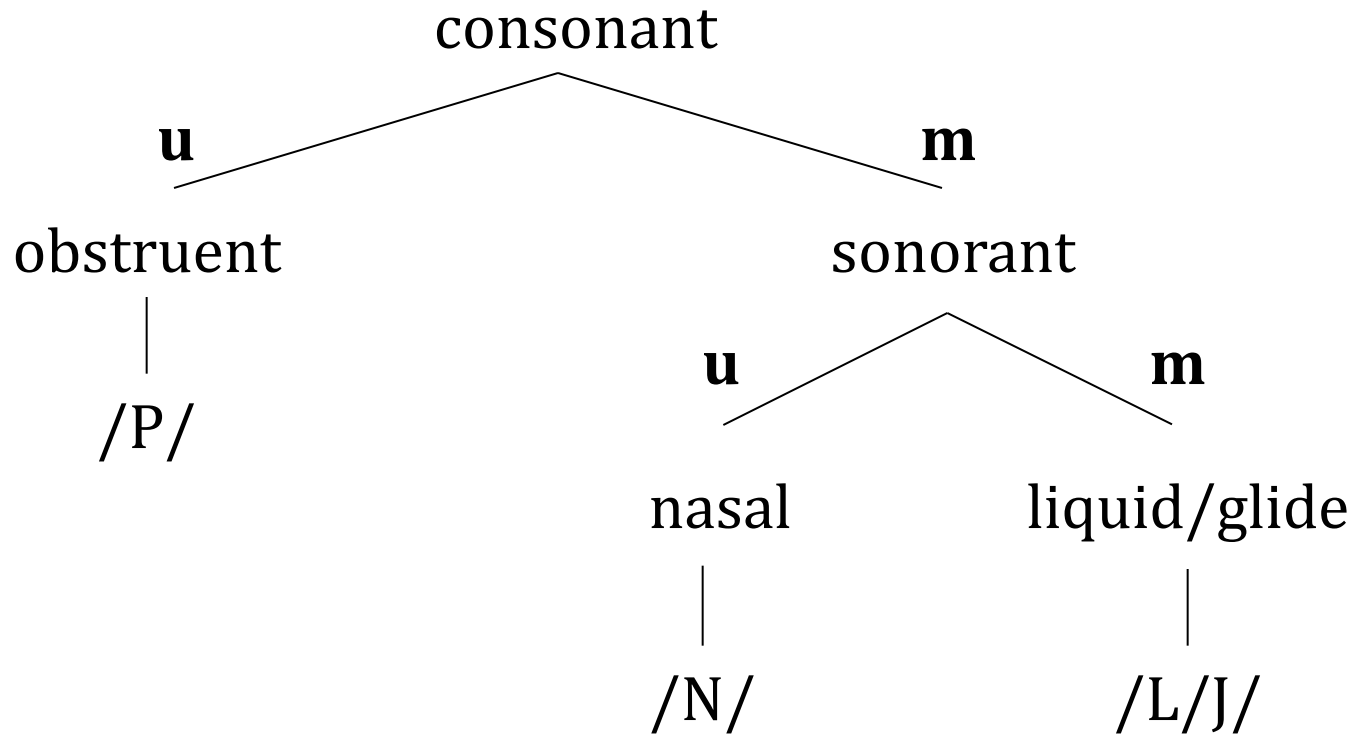
Development of Dutch onset consonants



Stage 3a

At this point children differ. Some expand the obstruent branch first, bringing in marked (**m**) fricatives in contrast with plosives.

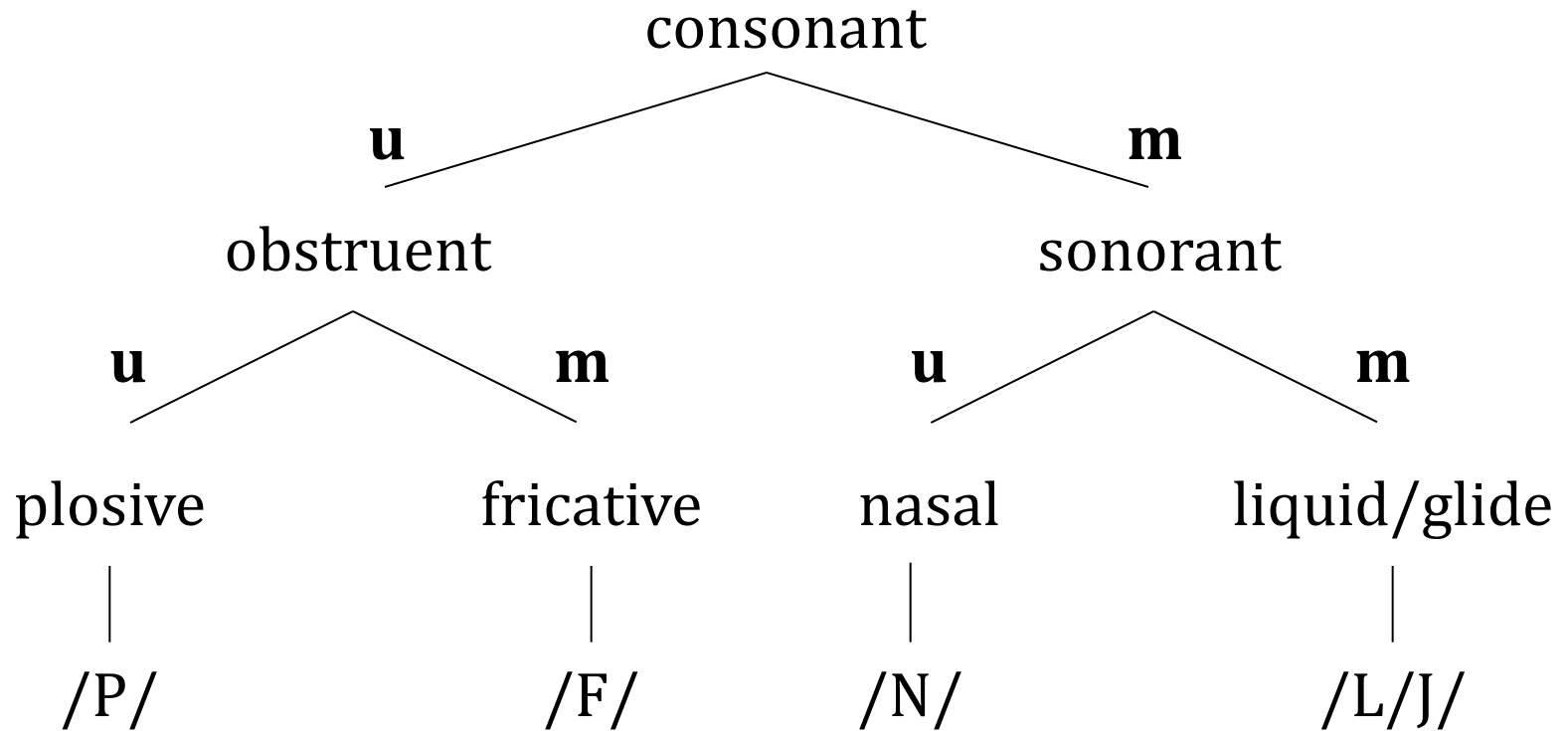
Development of Dutch onset consonants



Stage 3b

Others expand the sonorant branch, introducing marked sonorants (either liquids or glides).

Development of Dutch onset consonants



Stage 4

And so on from there.

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.

5.

*A theory of
phonological contrast*

Contrast and hierarchy

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].

/i/

[low] /a/

/i/

[front]

/a/

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 & Drescher 2011).

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

| | | |
|---------|-----|---------|
| /i/ | | /u/ |
| [front] | /ə/ | [round] |
| <hr/> | | |
| [low] | /a/ | |

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.

Domain of the Contrastivist Hypothesis

When we say that only contrastive features can be active, we mean in a domain of the phonology that we can identify with what has been called the lexical phonology (Kiparsky 1985).

If we identify the lexical component as the domain in which the Contrastivist Hypothesis applies—what I will call the **contrastive phonology**—then the post-lexical domain, or the domain of ‘phonetic rules’, is where non-contrastive features can be added.

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).

My hypothesis is that enhancement takes place in the post-lexical component, or later, when further phonetic detail is specified.

Enhancement of underspecified features

A vowel that is [back] and (*non-low*) can enhance these features by:

adding {round} to enhance [back],

adding {high} to enhance (*non-low*).

I designate enhancement features with curly brackets { }.

| | |
|-----------------------|--|
| /i/ (non-back) | [back] {round} (u) {high} (non-low) |
| | /a/ [low] |

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

Markedness

One final assumption is that features are **binary**, and that every feature has a **marked** and **unmarked** value.

I assume that markedness is language particular (Rice 2003; 2007) and accounts for asymmetries between the two values of a feature, where these exist.

For example, we expect that unmarked values serve as **defaults**, and may be more or less inert.

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

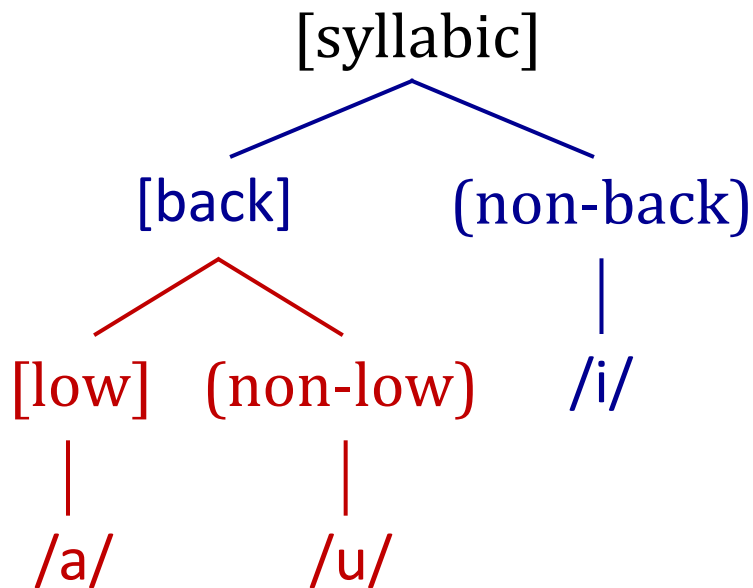
For example, if a language has three vowel phonemes /i, a, u/, and if the vowels are split off from the rest of the inventory so that they form a sub-inventory, then they must be assigned a contrastive hierarchy with two vowel features.

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

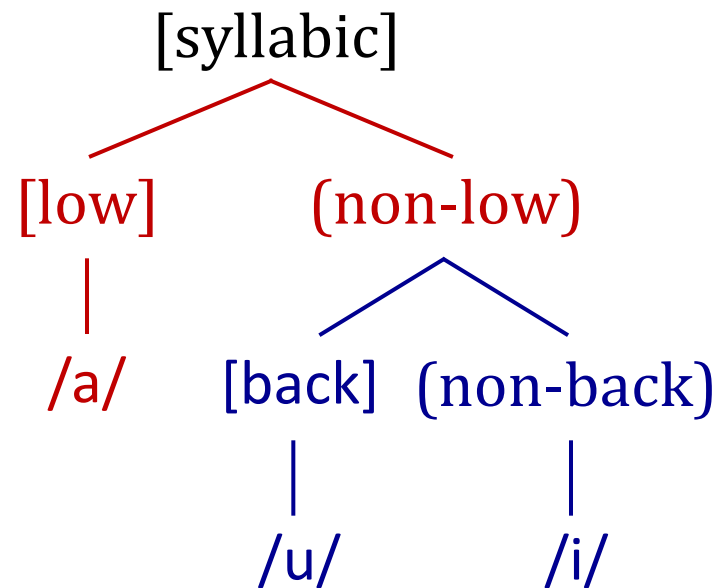
How the contrastive hierarchy works

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

[back] > **[low]**



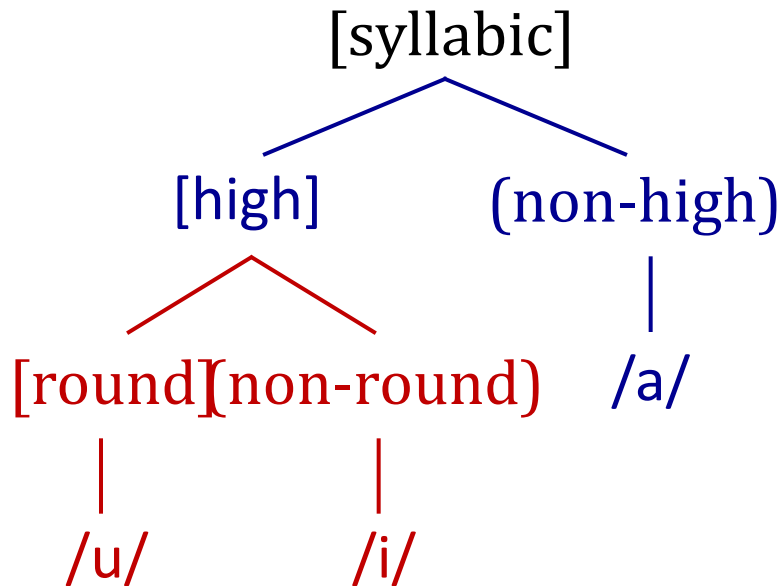
[low] > **[back]**



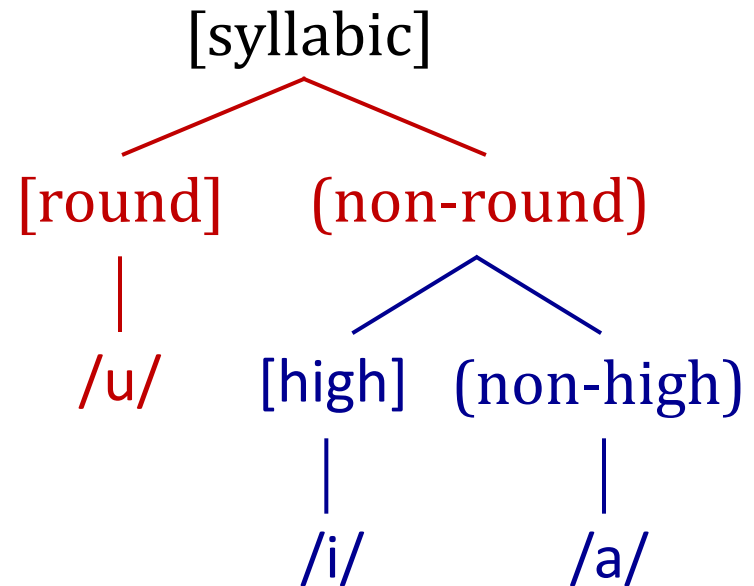
How the contrastive hierarchy works

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

[high] > [round]



[round] > [high]

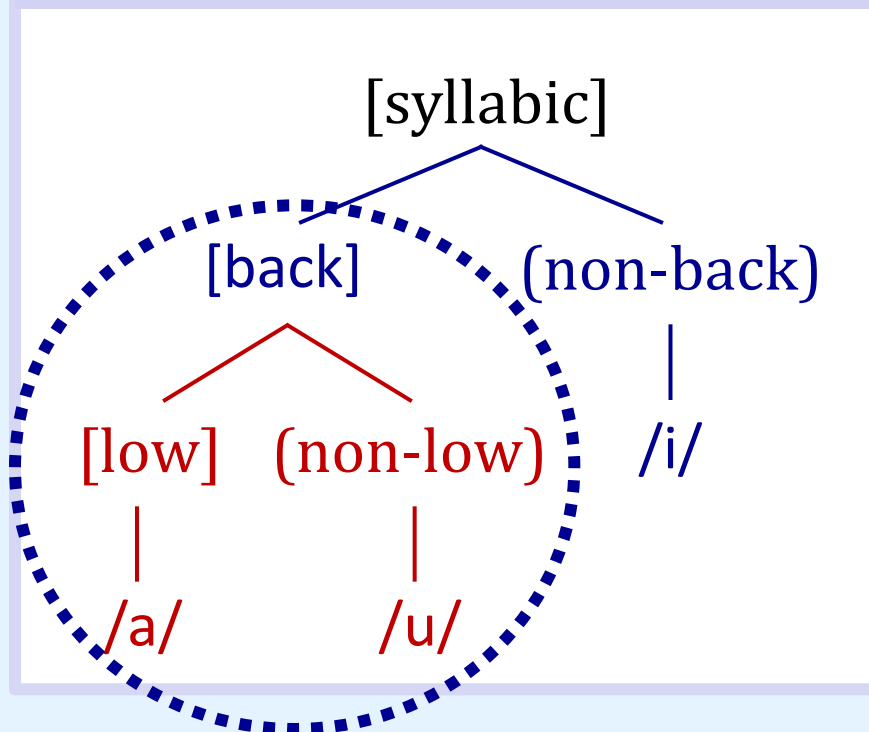


What does the hierarchy do? Synchrony

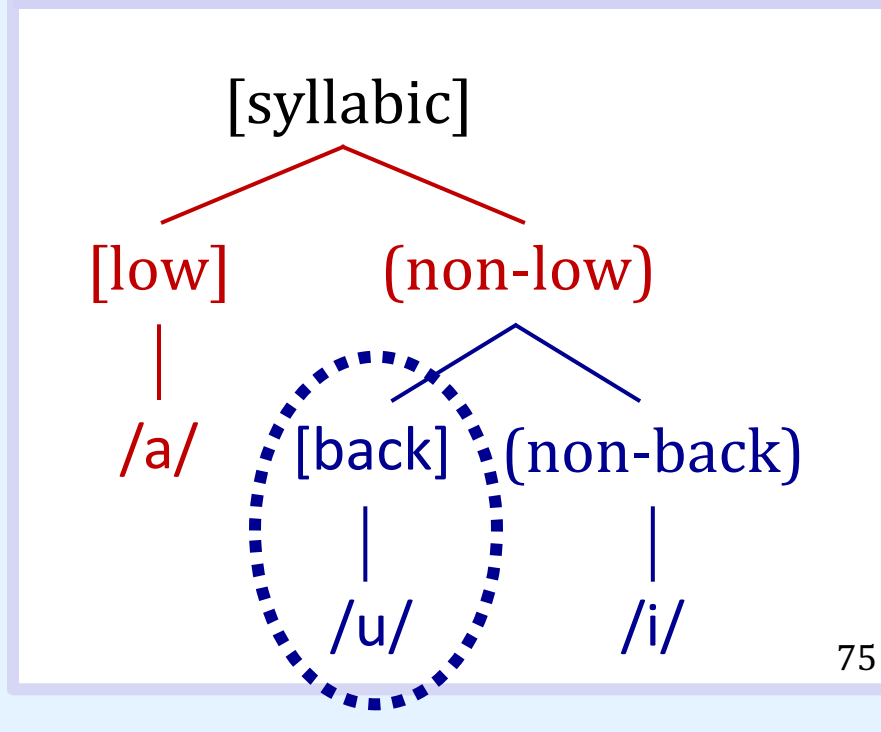
1. The hierarchy constrains phonological activity:
Only **contrastive** features can be **phonologically active**.

Which phonemes can trigger backing?

[back] > [low]



[low] > [back]

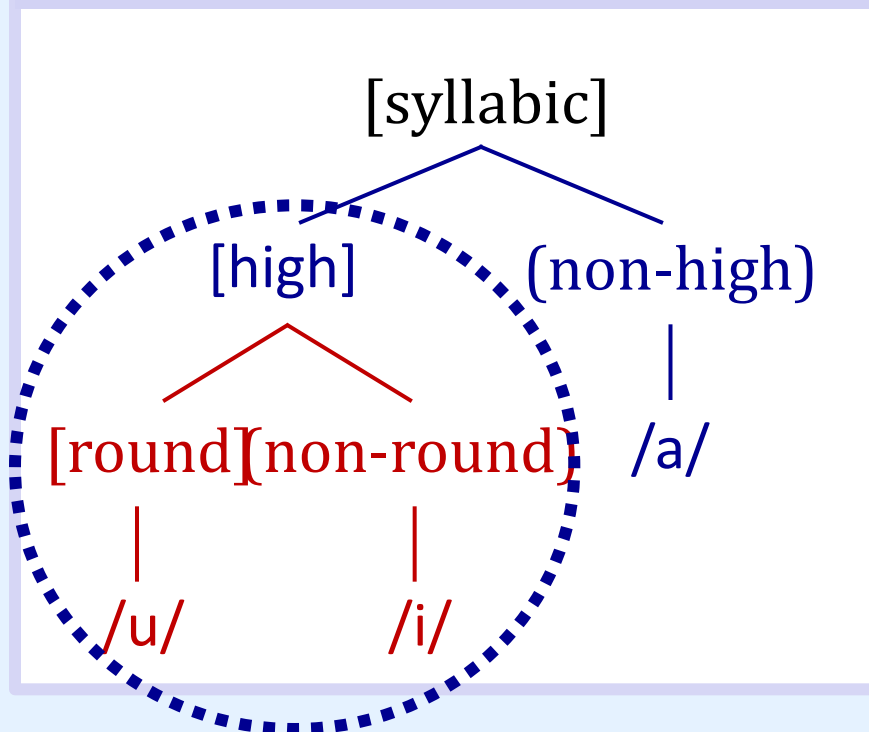


What does the hierarchy do? Synchrony

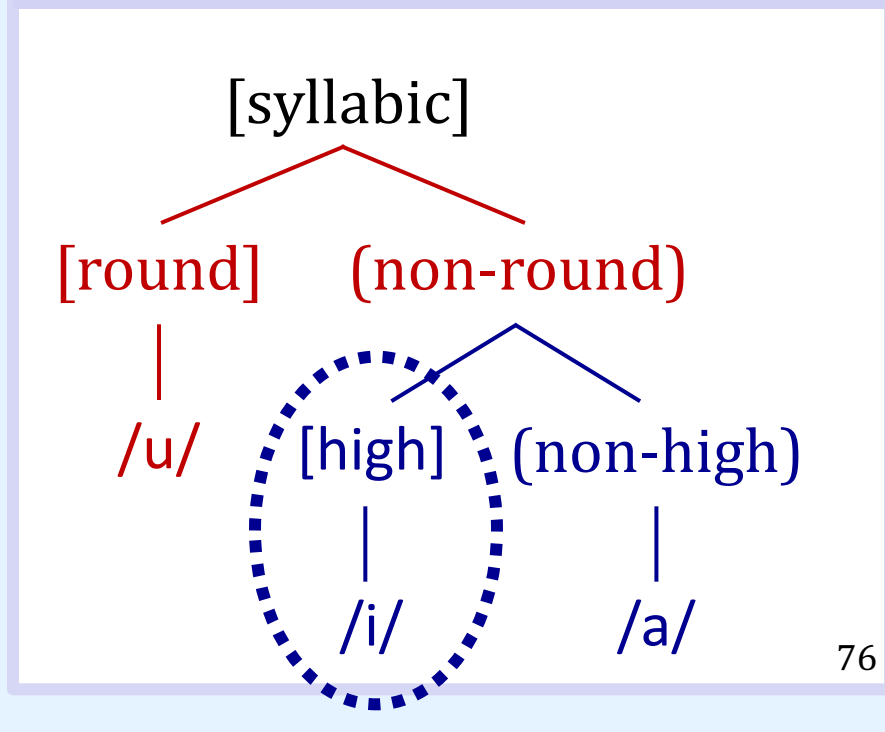
1. The hierarchy constrains phonological activity:
Only **contrastive** features can be **phonologically active**.

Which phonemes can trigger raising?

[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]

[syllabic]

[back]

(non-back)

[low]

(non-low)

/i/

/a/

/u/

[low] > [back]

[syllabic]

[low]

(non-low)

/a/

[back]

(non-back)

/u/

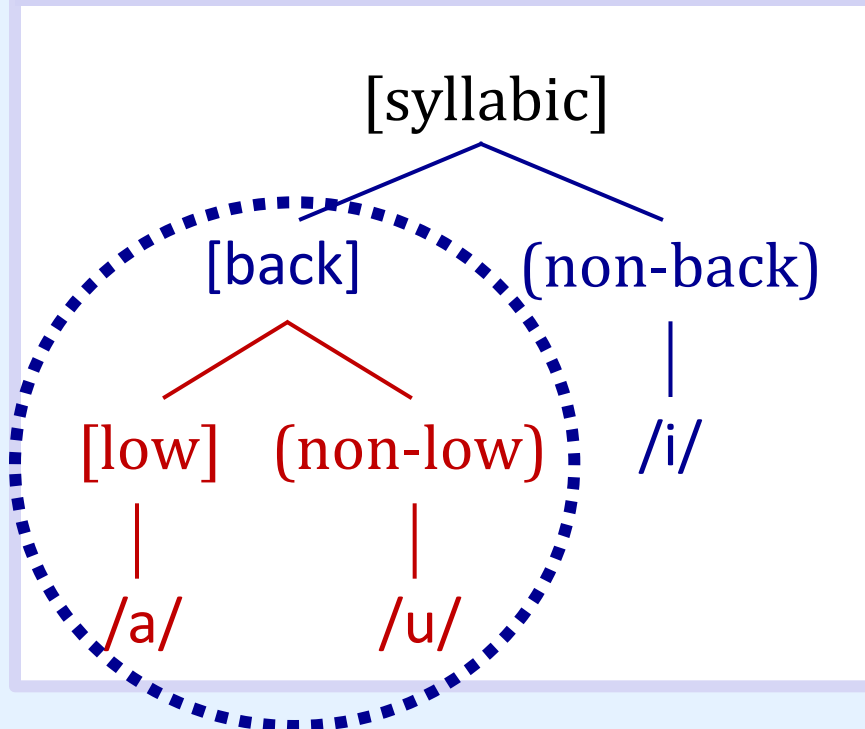
/i/

What does the hierarchy do? Diachrony

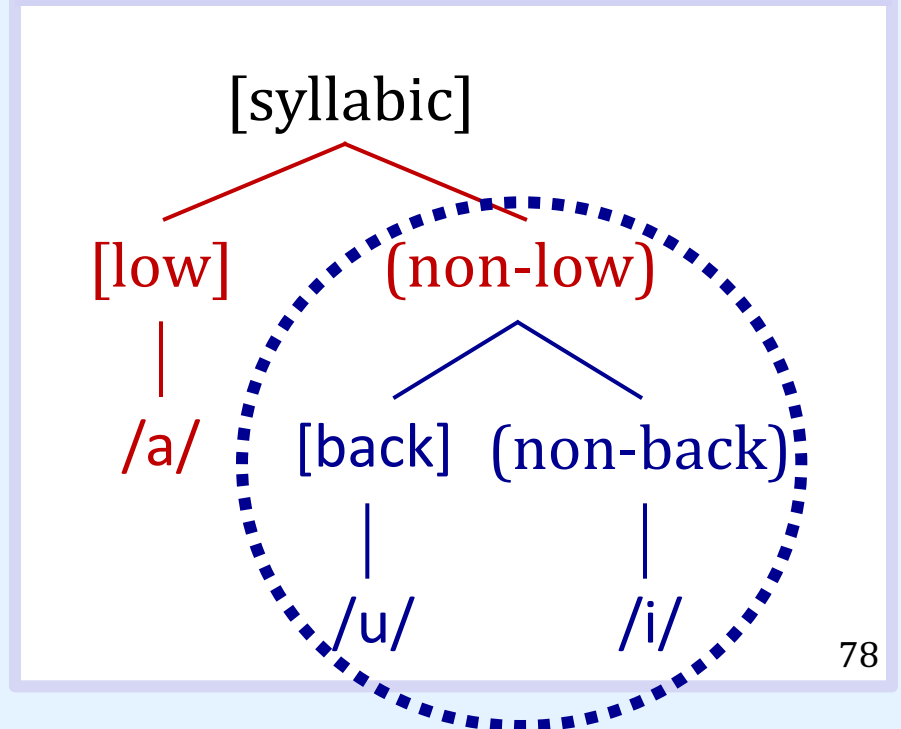
Oxford 2015 gives examples of merger patterns just like these in the history of Algonquian languages.

Which phoneme can /u/ merge with?

[back] > [low]

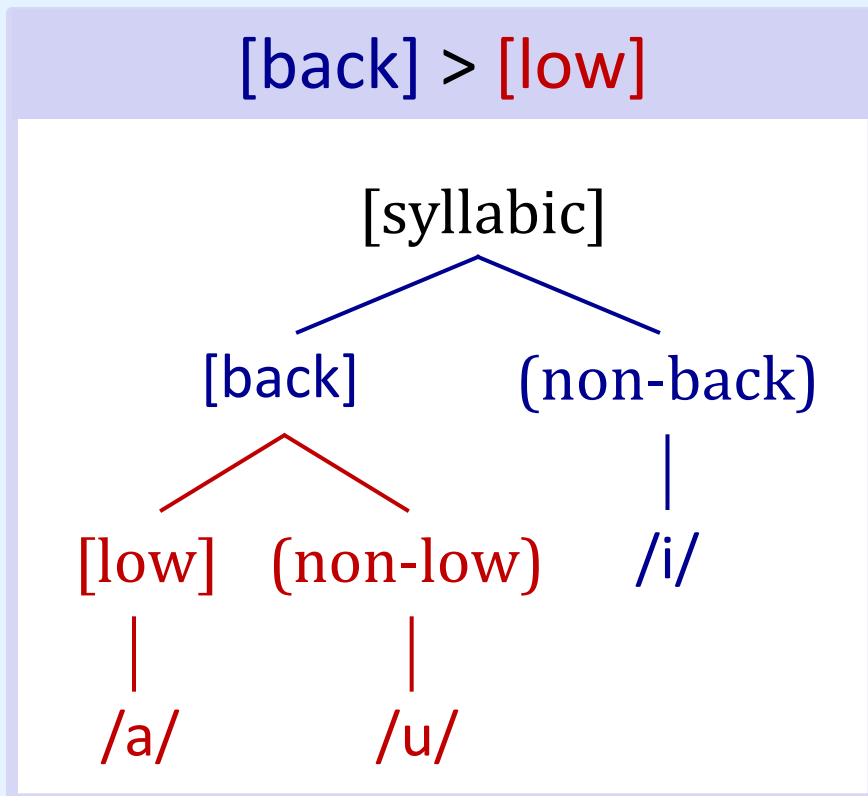


[low] > [back]



How the contrastive hierarchy works

I would like to stress that although contrastive representations are underspecified, they are not minimal in the sense of doing away with all redundant specifications.



For example, /a/ is the only [low] phoneme in this tree, so its [back] specification is technically redundant.

But it plays an important contrastive role: it groups /a/ with /u/ against /i/.

6.

*Phonological features:
innate or emergent?*

Emergent features

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

Mielke (2008) and Samuels (2011) summarize the arguments against innate features: they are too specific, and no single set of proposed features works in all cases.

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.

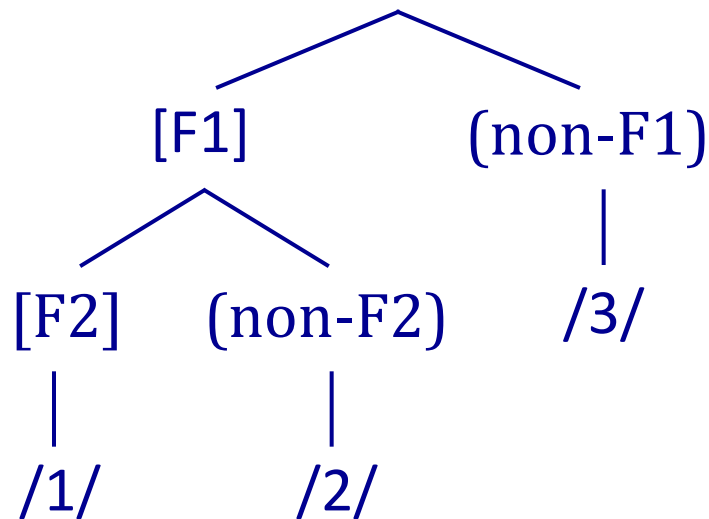
We need to explain why features **inevitably** emerge, and why they have the properties that they do.

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

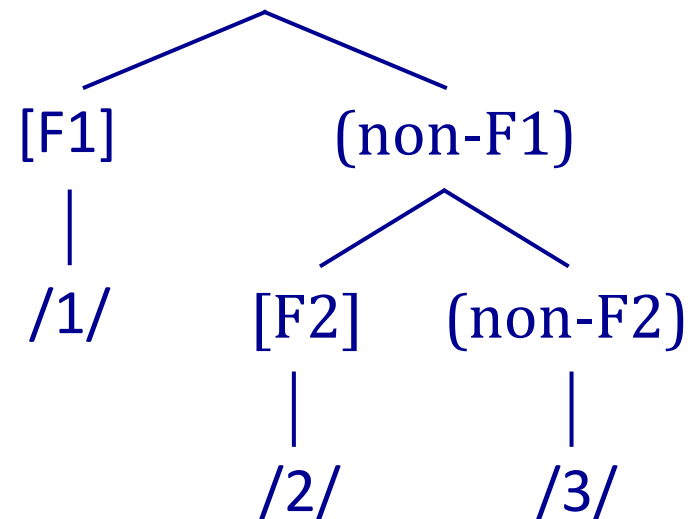
How many features are there?

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

3 phonemes: $F1 > F2$



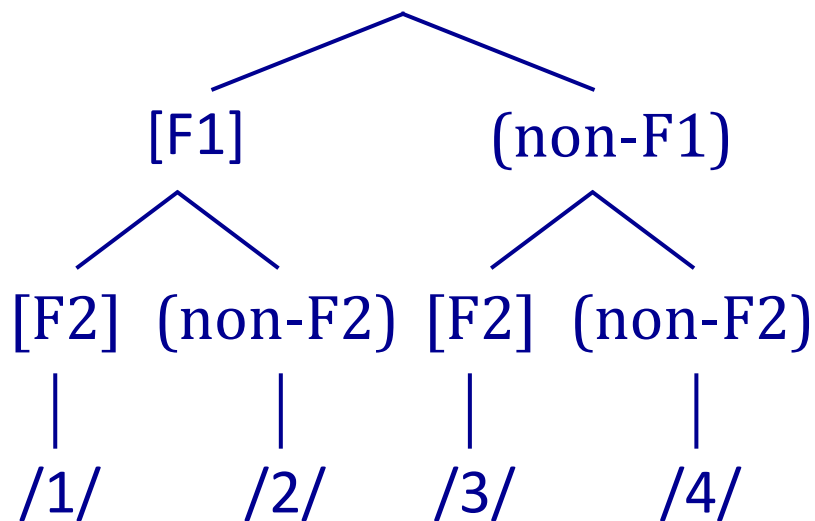
3 phonemes: $F1 > F2$



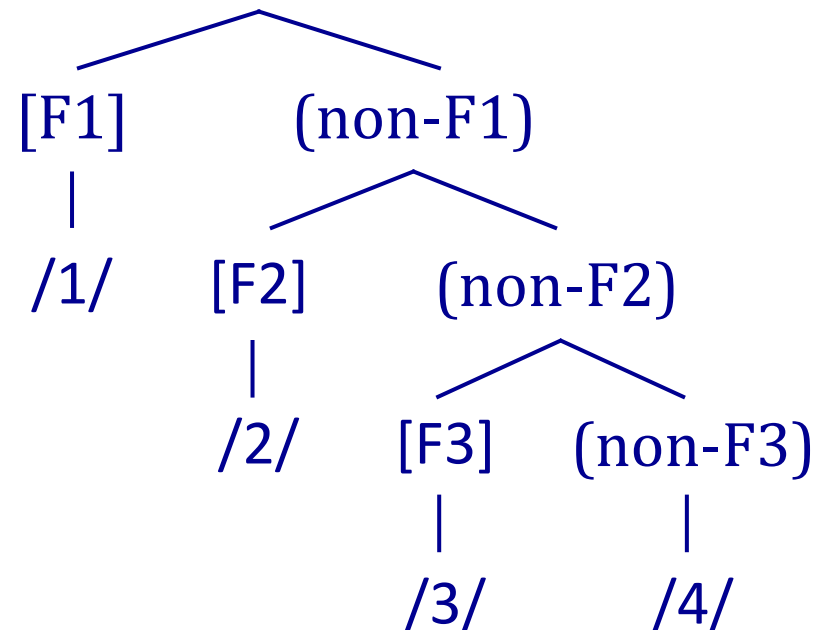
How many features are there?

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.

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.

7.

*Contrast Shift and
Diachrony 1:
Inuit dialects*

Contrast shift and grammar change

The notion that contrast shift is a type of grammar change has proved to be fruitful in the study of a variety of languages.

Examples using contrastive feature hierarchies include:

Zhang (1996) and Dresher and Zhang (2005) on Manchu; Barrie (2003) on Cantonese; Rohany Rahbar (2008) on Persian; Dresher (2009: 215–225) on East Slavic; Ko (2010, 2011, 2018) on Korean, Mongolic, and Tungusic; Compton & Dresher (2011) on Inuit; Gardner (2012), Roeder & Gardner (2013), and Purnell & Raimy (2013) on North American English vowel shifts; Harvey (2012) on Ob-Ugric (Khanty and Mansi); Oxford (2012, 2015) on Algonquian; Voeltzel (2016), Schalin (2017), and Sandstedt (2018) on Scandinavian; and Krekoski (2017) on Chinese tonal systems.

Proto-Eskimo vowel system

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).

Proto-Eskimo (Inuit and Yupik)

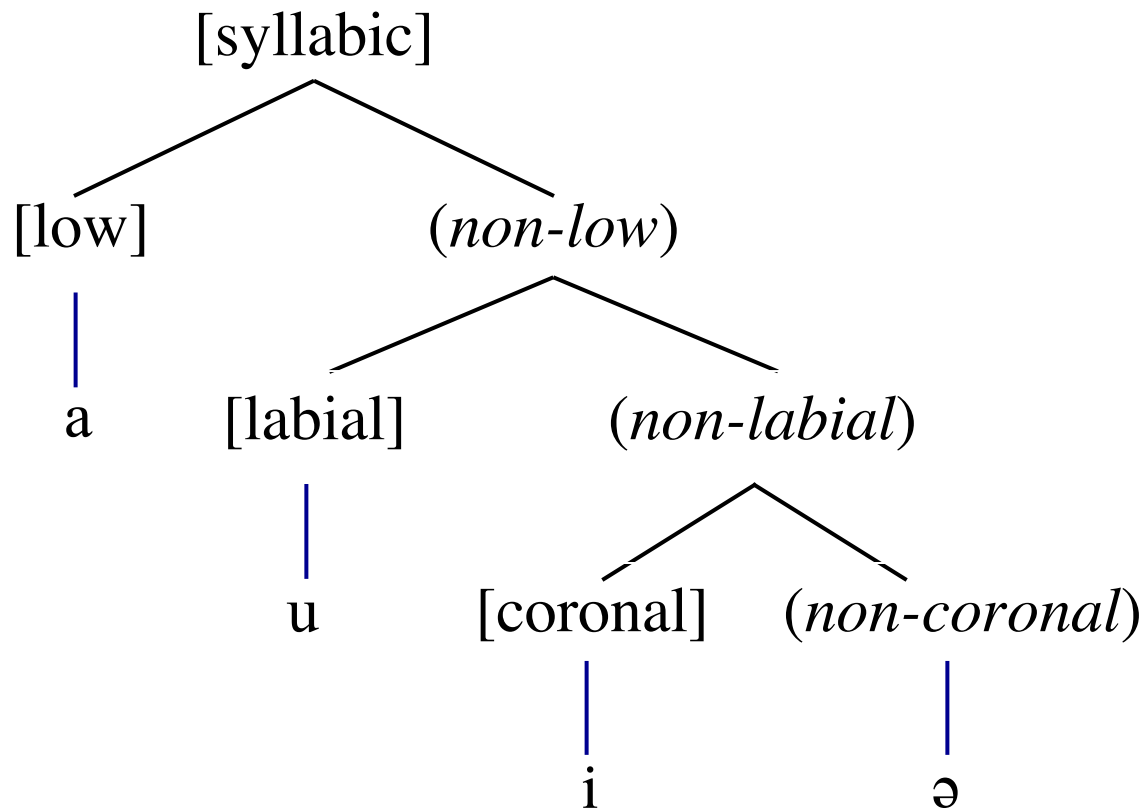
/i/

/u/

/ə/

/a/

Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)



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

[low] > [labial] > [coronal]

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/ |
|-----|-----|-----|-----|

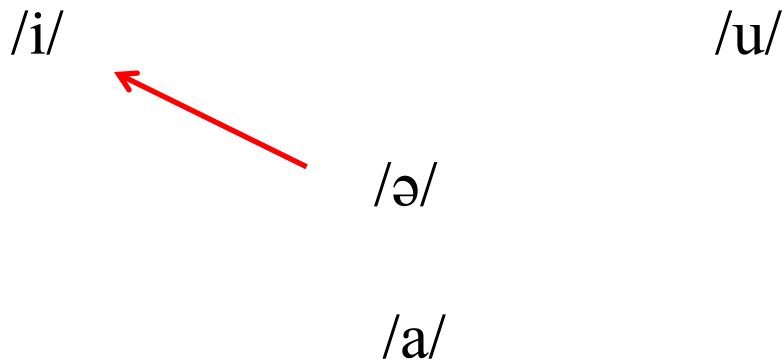
| | | | |
|-----------|----------|-------|-----|
| [coronal] | [labial] | [low] | [] |
|-----------|----------|-------|-----|

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

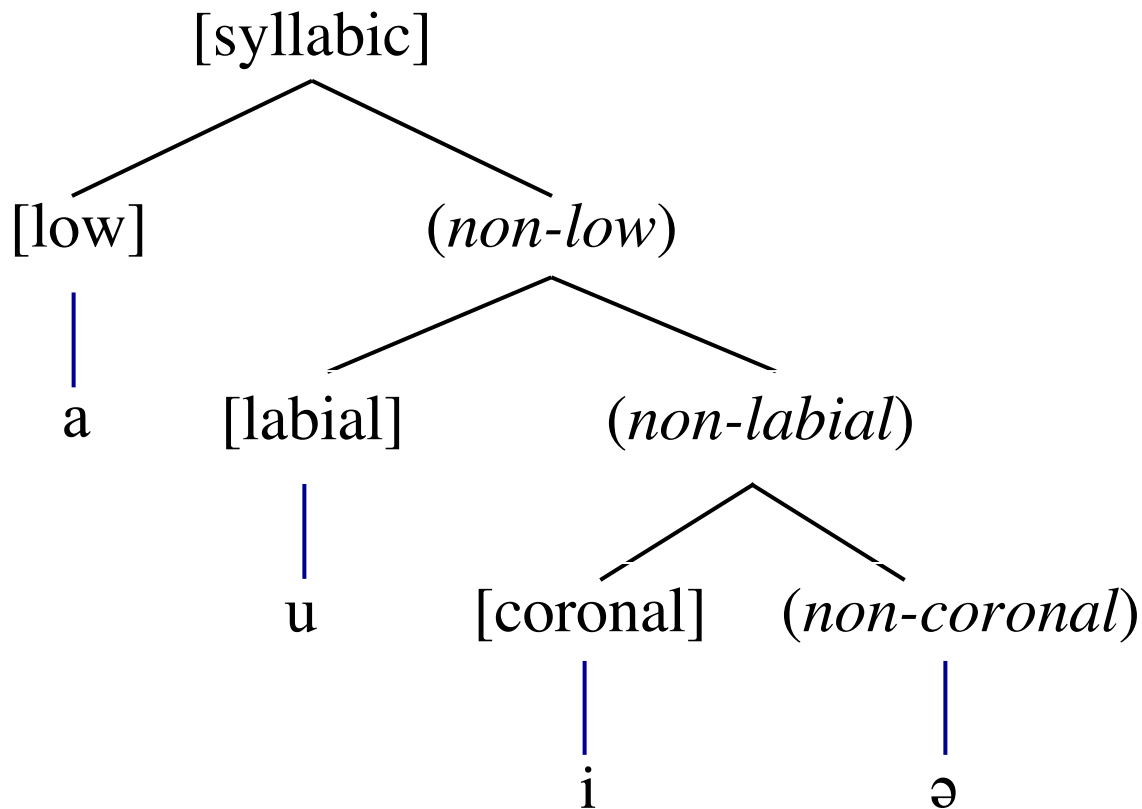
Original */i/ could cause palatalization of consonants, and some Inuit dialects show palatalization (or traces of former palatalization) (Dorais 2003: 33).

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>i</i> | * <i>itə</i> γak | > | <i>isi</i> yak | ‘foot’ |
| Weak <i>i</i> | * <i>ətə</i> may | > | <i>iti</i> mak | ‘palm of hand’ |

Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)

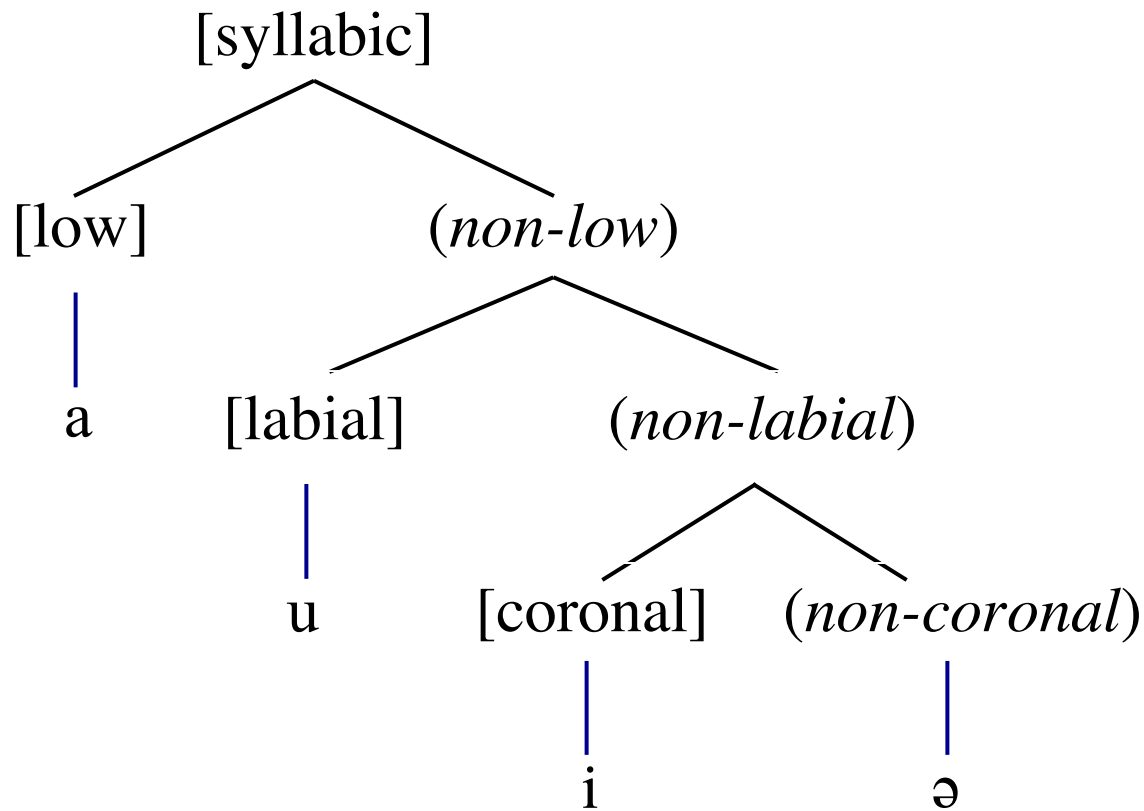


These examples support attributing a feature to /i/ that can cause palatalization:

Compton & Dresher (2011) call it [coronal], but we could just as well call it [front].

[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).

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

[low] > [labial] > [coronal]

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

/i/ /u/ /a/ /ə/

[coronal] [labial] [low] []

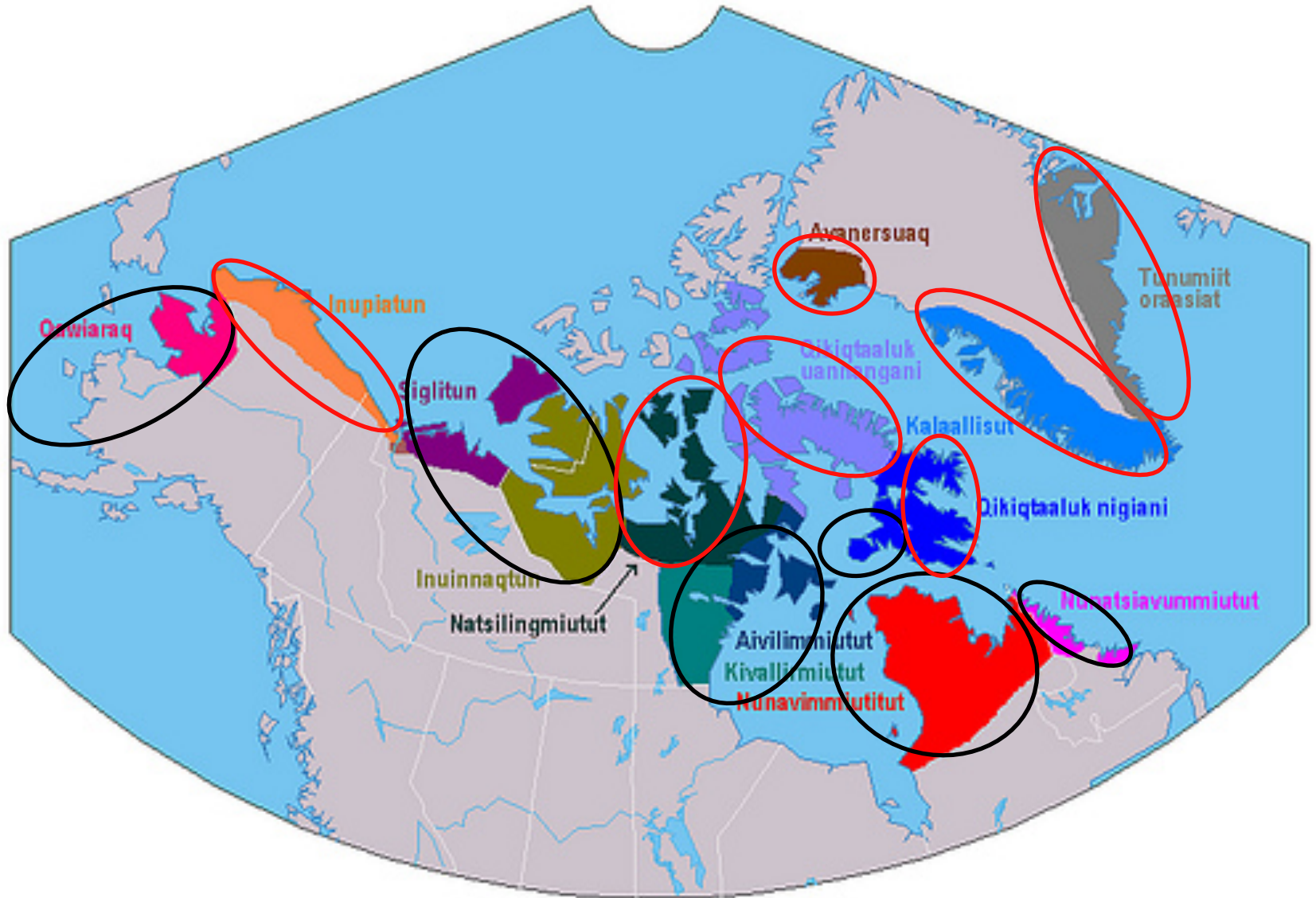
Three-vowel dialects

/i/ /u/ /a/

? [labial] [low]

Inuit dialects

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



Inuit dialects

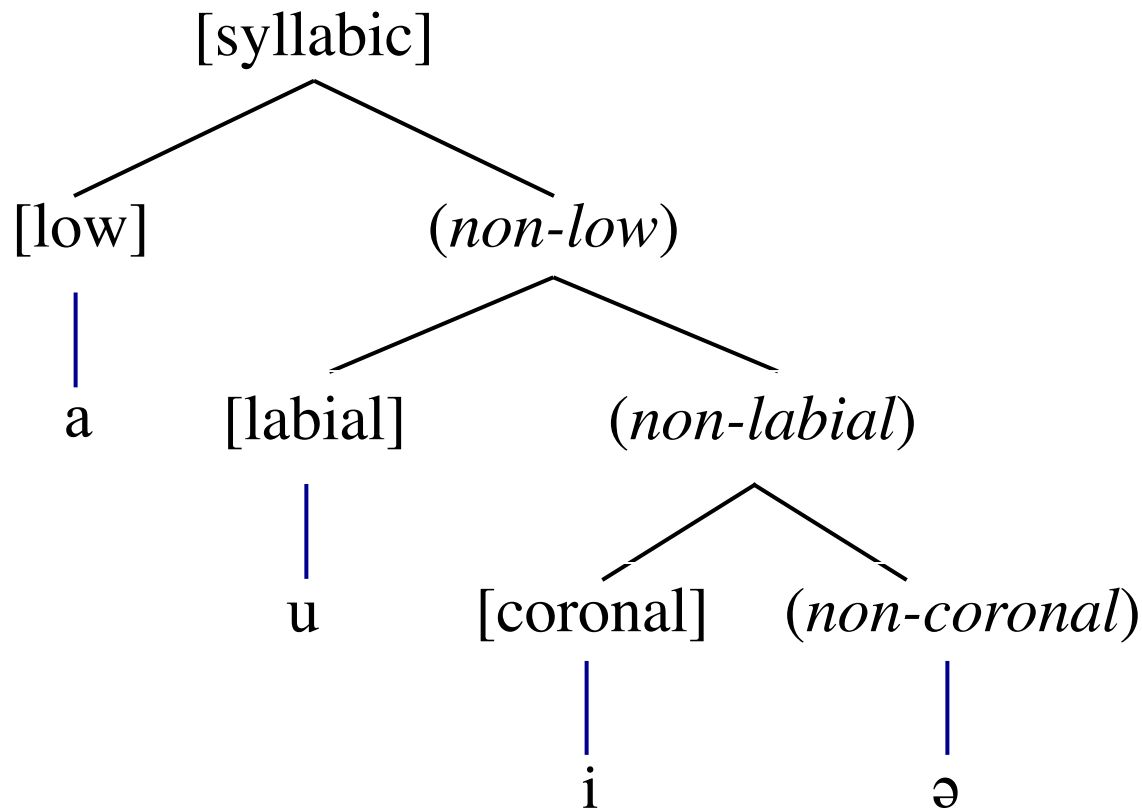
One might suppose that some dialects that once had palatalization would generalize it to occur after all /i/s, including original /i/ from *i and the new /i/ from *ə.

But this is not the case. Compton and Drescher (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]:

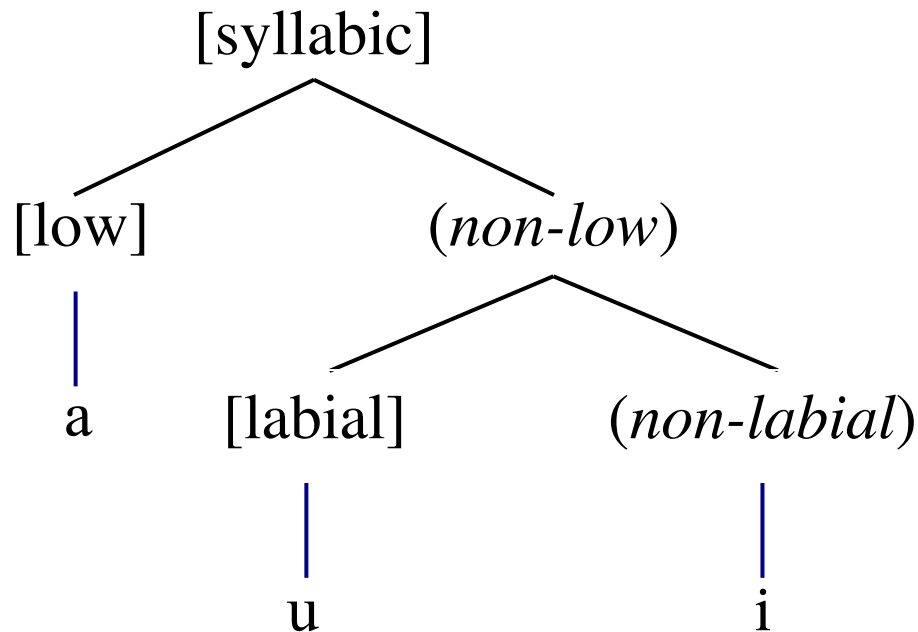
Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)



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)



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.

[low] > [labial]

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]

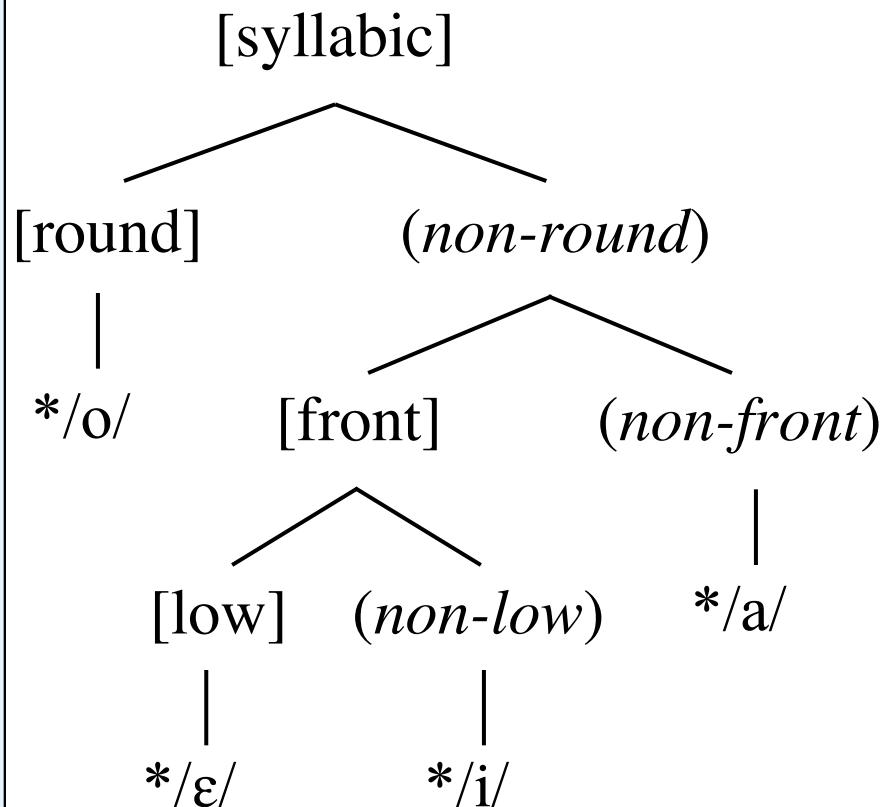
8.

*Contrast Shift and Diachrony 2:
From Proto-Algonquian to the
modern Algonquian languages*

In a survey of the historical development of Algonquian vowel systems, Oxford (2015) observes that a large set of separate changes can be understood if we posit a single contrast shift.

Contrastive hierarchy for Proto-Algonquian vowels (Oxford 2015)

[round] > [front] > [low]



Oxford (2015) posits this feature hierarchy for **Proto-Algonquian** (length contrast omitted for ease of exposition).

***/o/ is [round]:** triggers rounding

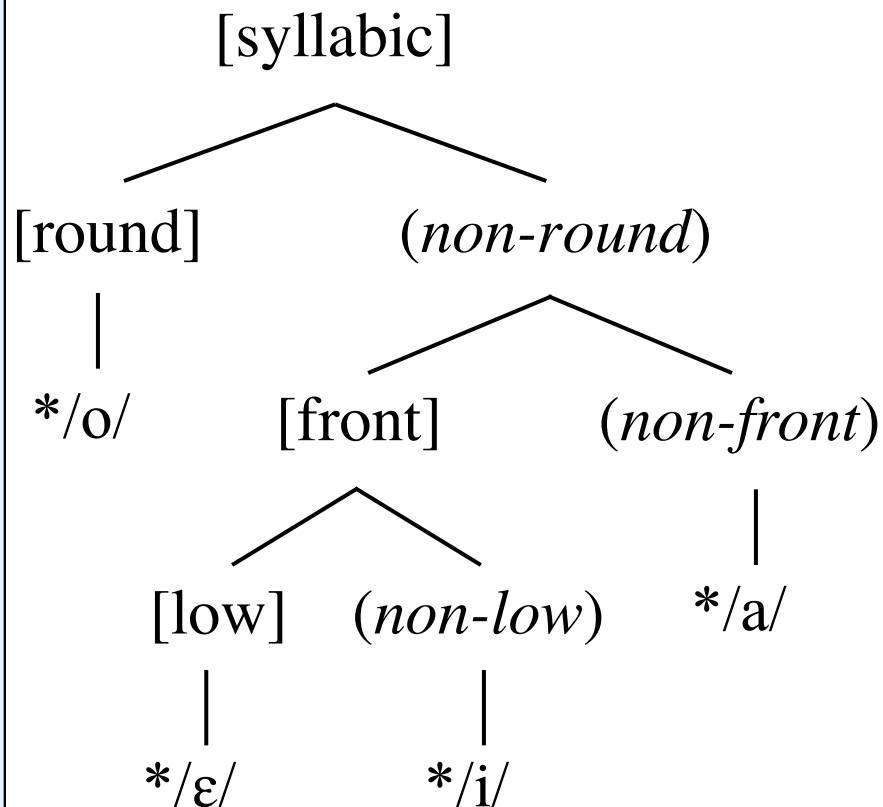
***/i/ is [front]:** triggers palatalization

***/i, ε/ sisters:** partial neutralization

***/a/ has no marked contrastive features:** is never a trigger

Contrastive hierarchy for Proto-Algonquian vowels (Oxford 2015)

[round] > [front] > [low]

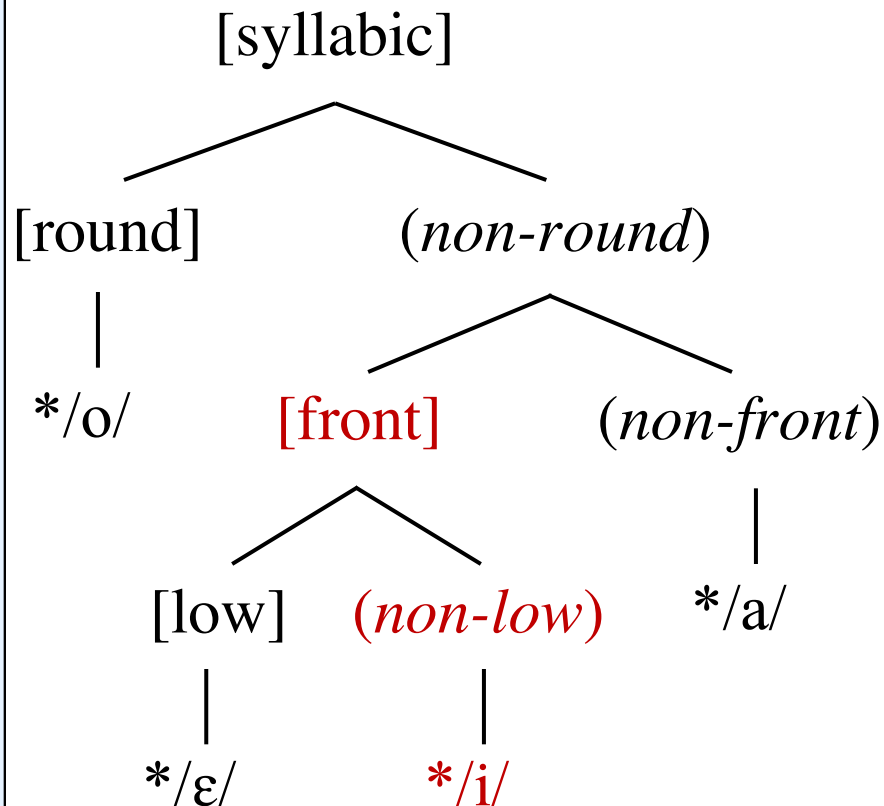


The PA hierarchy continues unchanged in the **Central Algonquian** languages and in **Blackfoot**.

It accounts for **two recurring patterns**:

Contrastive hierarchy for Central Algonquian and Blackfoot

[round] > [front] > [low]



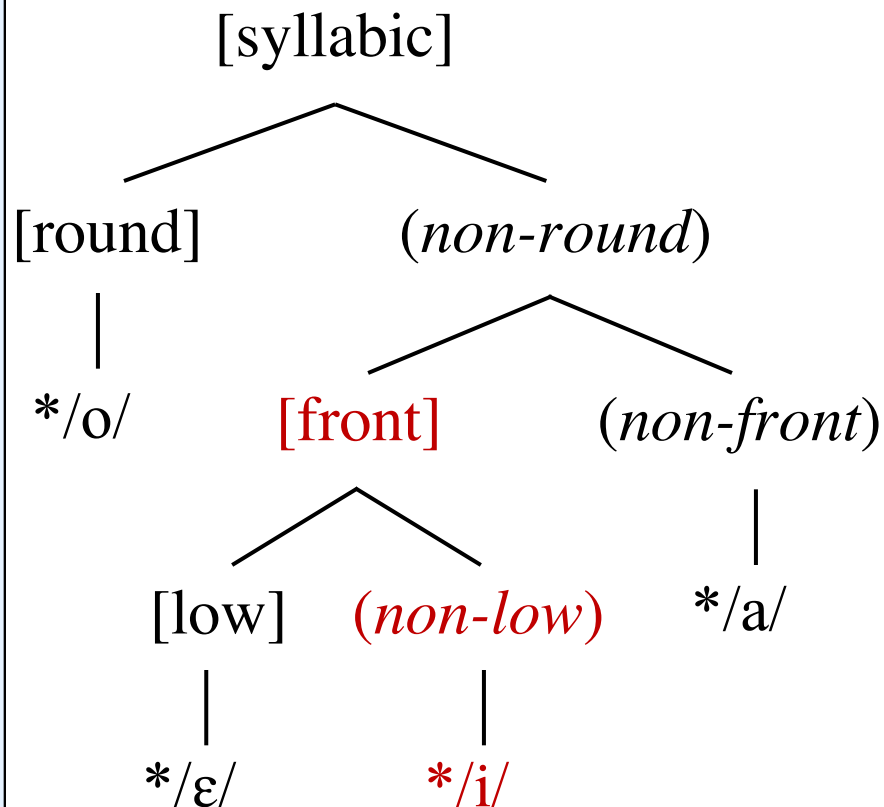
1. Palatalization always includes */i/ as a trigger

PA */t, θ/-palatalization is triggered by */i, i:/

Innu */k/-palatalization is triggered by */i, i:, ε:/

Betsiamites Innu /t/-palatalization is triggered by /i:/

Contrastive hierarchy for Central Algonquian and Blackfoot [round] > [front] > [low]

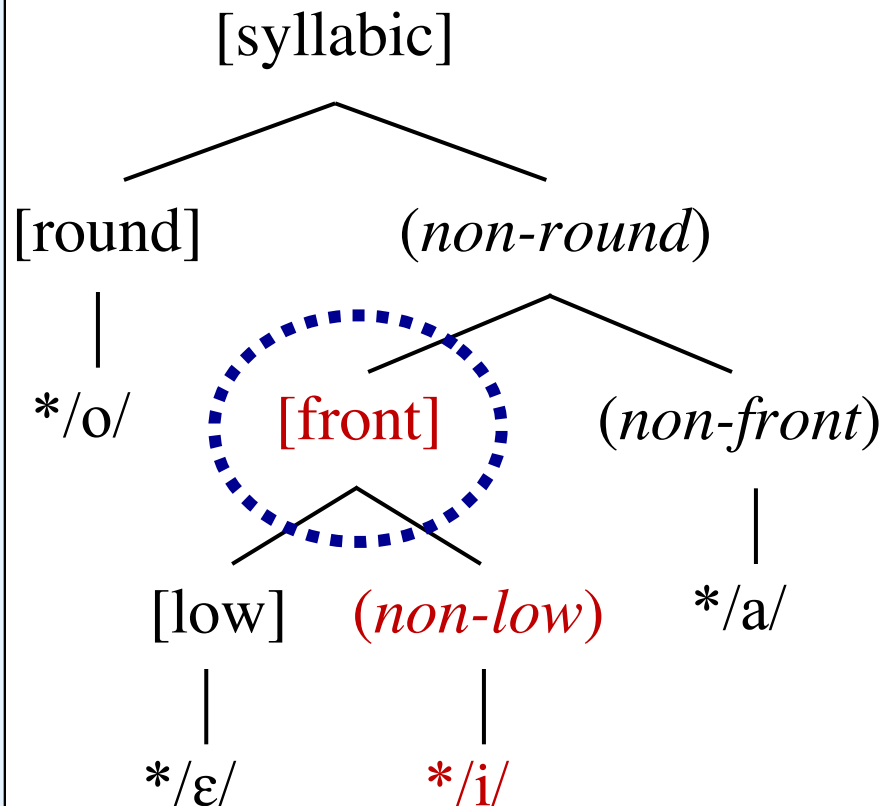


1. Palatalization always includes */i/ as a trigger

Blackfoot */k/-assibilation is triggered by PA */i, i:/'

Blackfoot /t/-assibilation is triggered by Blackfoot /i, i:/'

Contrastive hierarchy for Central Algonquian and Blackfoot [round] > [front] > [low]

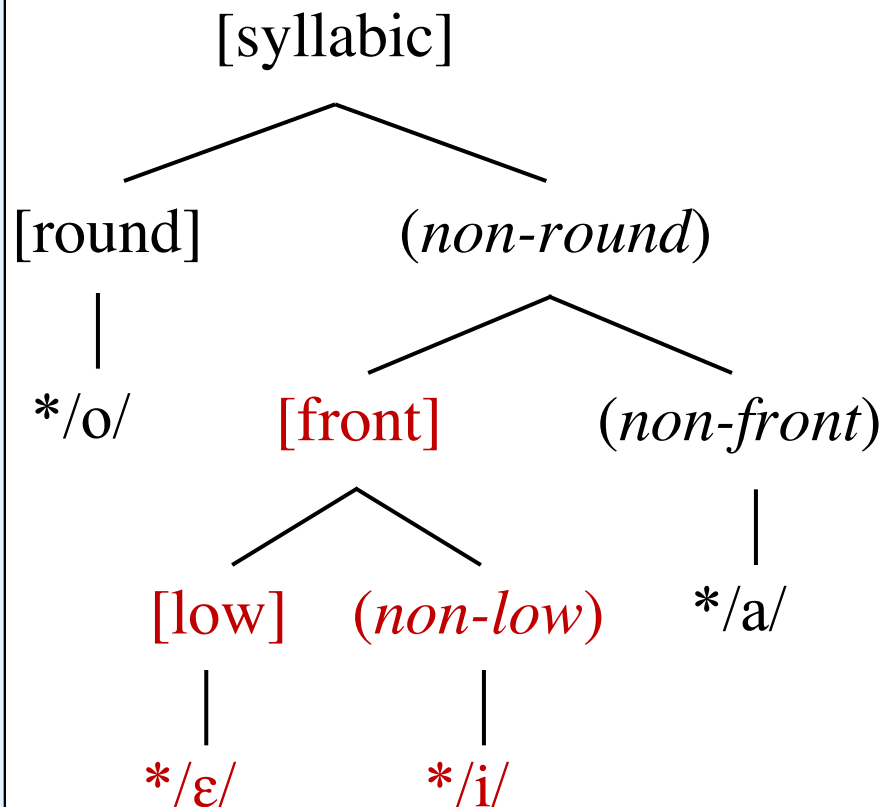


1. Palatalization always includes */i/ as a trigger

These patterns support the view that palatalization is triggered by a contrastive [front] feature, and favours vowels that are (non-low).

Contrastive hierarchy for Central Algonquian and Blackfoot

[round] > [front] > [low]



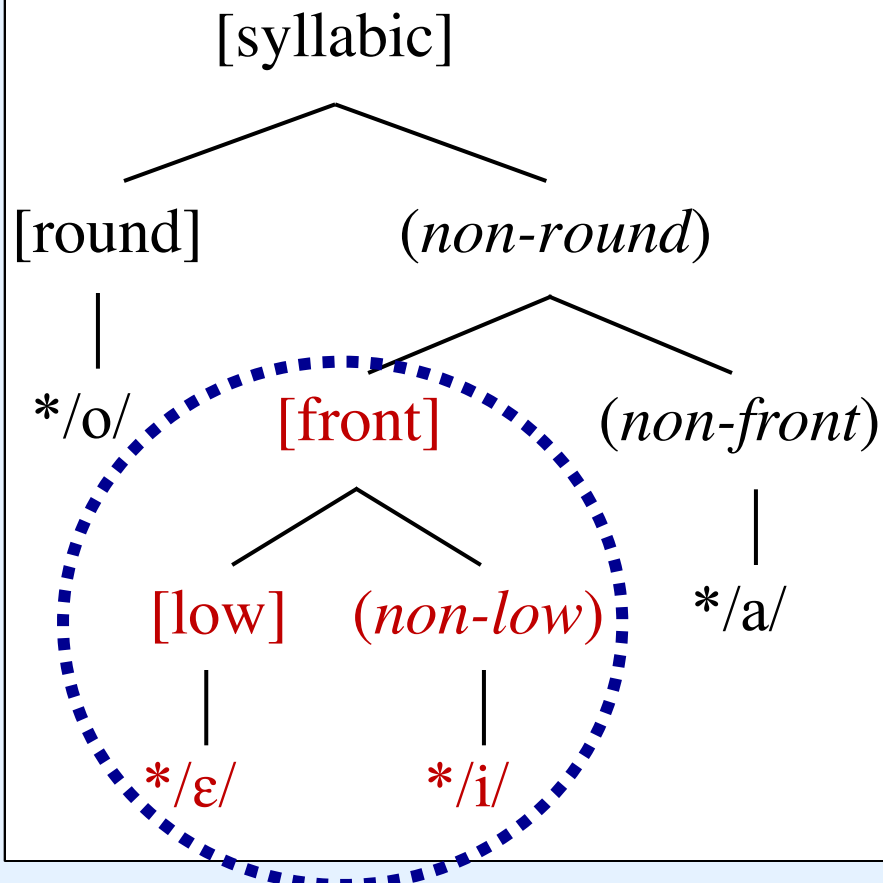
2. */ε/ regularly merges with */i/

Partial or complete mergers of short */ε/ > /i/ occur in Fox, Shawnee, Miami-Illinois, Cree-Innu, Ojibwe, and Blackfoot

Long */ε:/ > /i:/ in Woods Cree, Northern Plains Cree, and Blackfoot

Contrastive hierarchy for Central Algonquian and Blackfoot

[round] > [front] > [low]

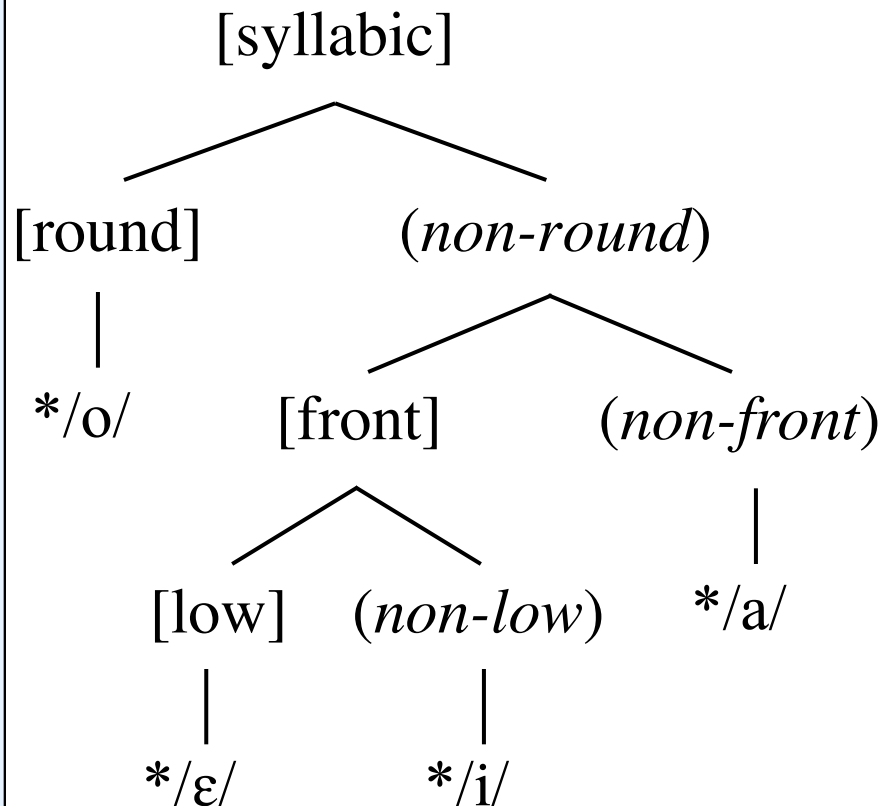


2. */ε/ regularly merges with */i/

These mergers are consistent with the idea that merger will tend to involve terminal nodes in the feature tree.

Eastern and Western Algonquian

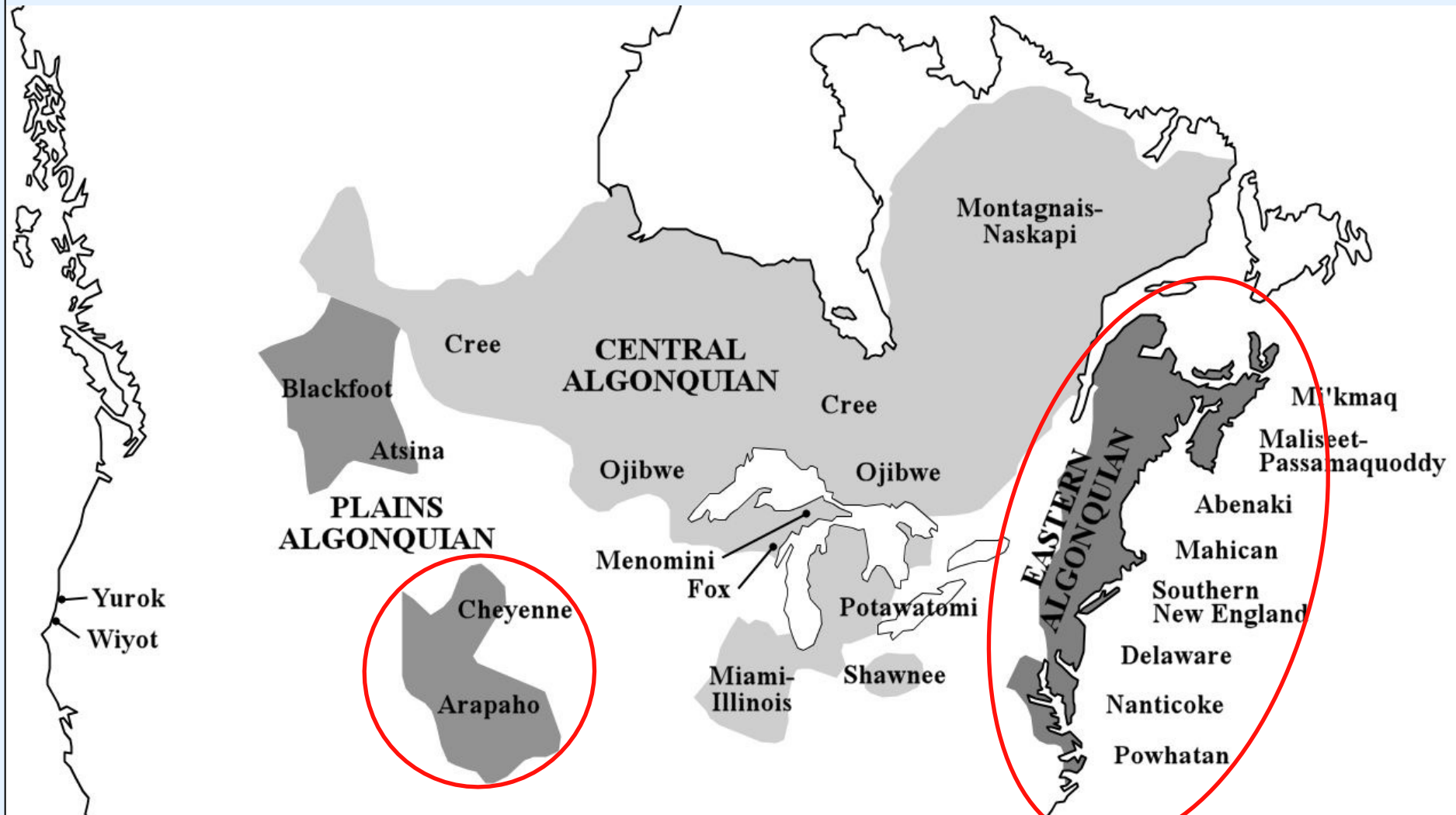
[round] > [front] > [low]



On the eastern and western edges of the Algonquian area, developments diverge from the predictions of the PA hierarchy.

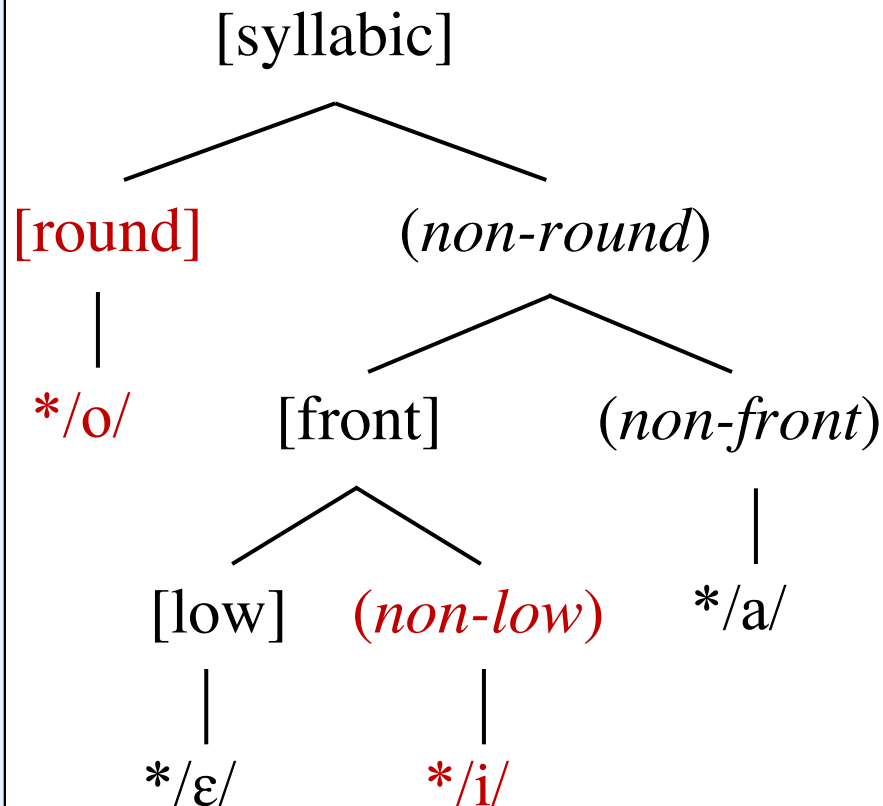
Map of Algonquian languages

Eastern and Western (Cheyenne-Arapaho) are circled in red



Eastern and Western proto-languages

[round] > [front] > [low]



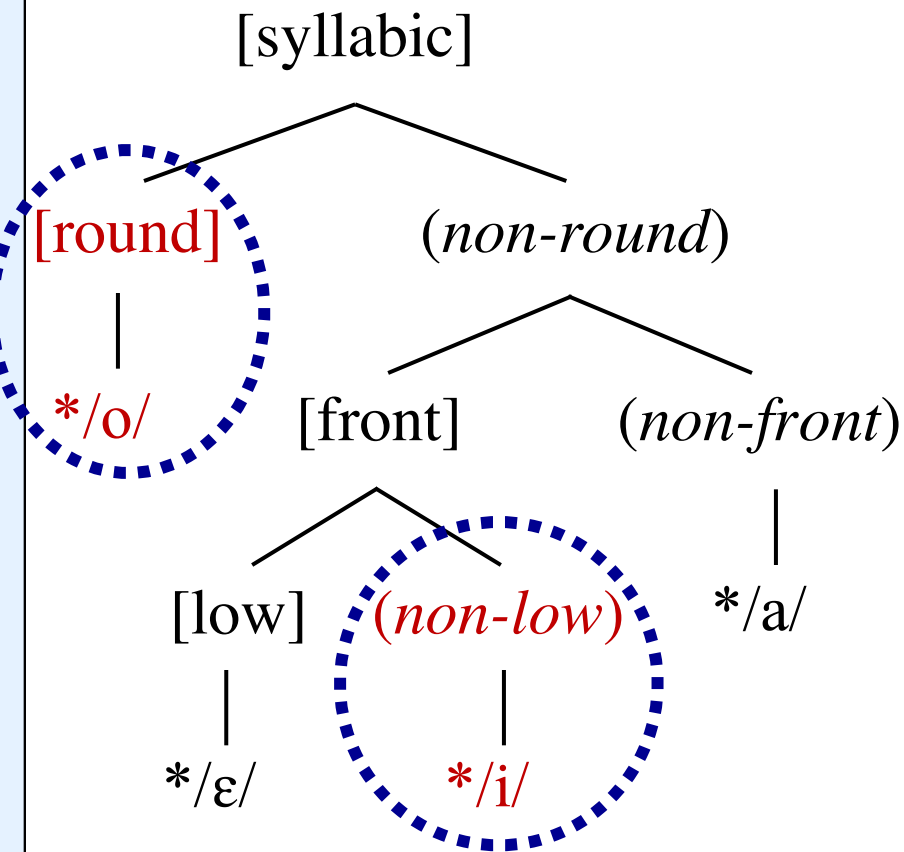
The high vowels begin to pattern together

In the east: Proto-Eastern Algonquian lost the length contrast only in the high vowels (reflexes of */o/, */i/)

In the west: Proto-Arapaho-Atsina and Pre-Cheyenne merge */o, o:/ with */i, i:/

Eastern and Western proto-languages

[round] > [front] > [low]

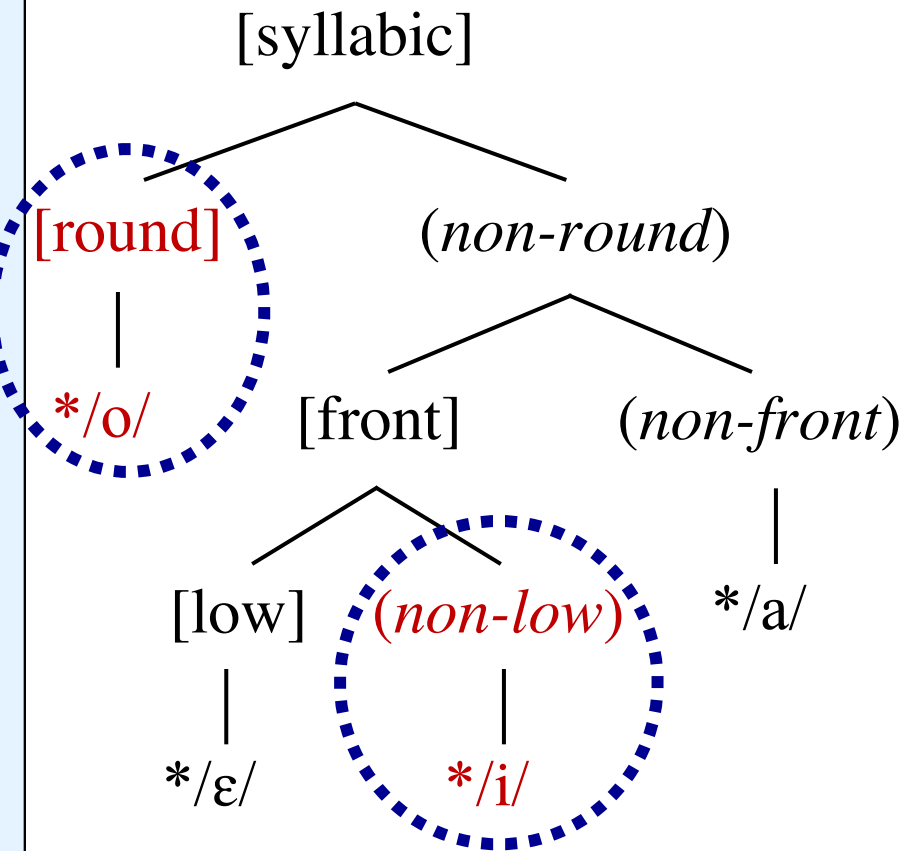


The high vowels begin to pattern together

But under the hierarchy inherited from PA, the high vowels are **not a natural class!**

Eastern and Western proto-languages

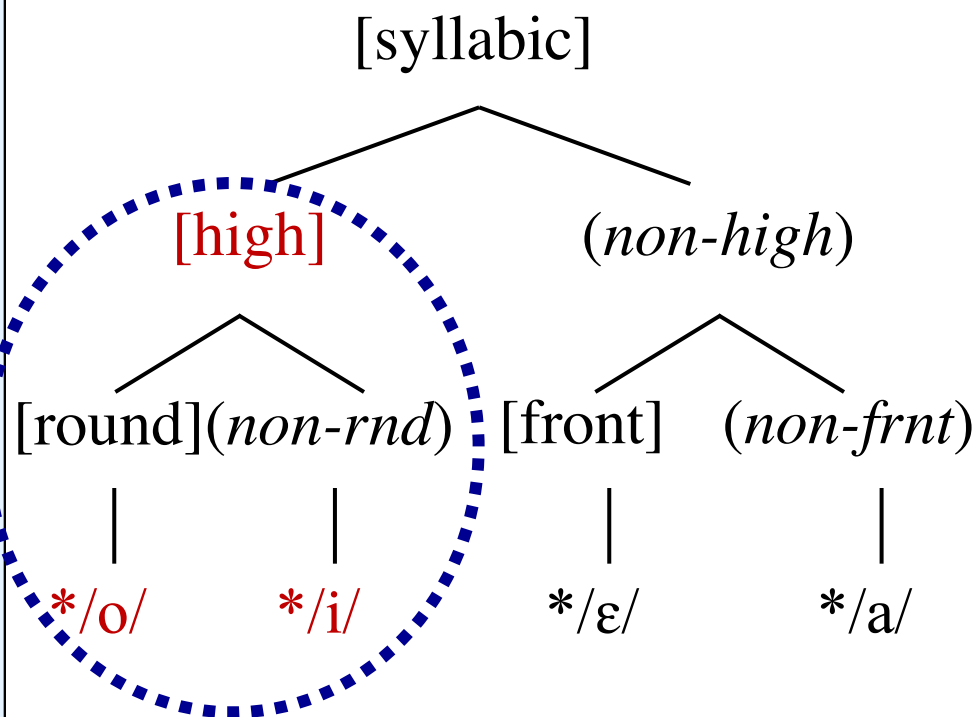
←
[round] > [front] > [high]



If the hierarchy constrains patterning, then the height contrast (reinterpreted as [high]) must have come to outrank place contrasts

Eastern and Western proto-languages

[high] > [round] > [front]

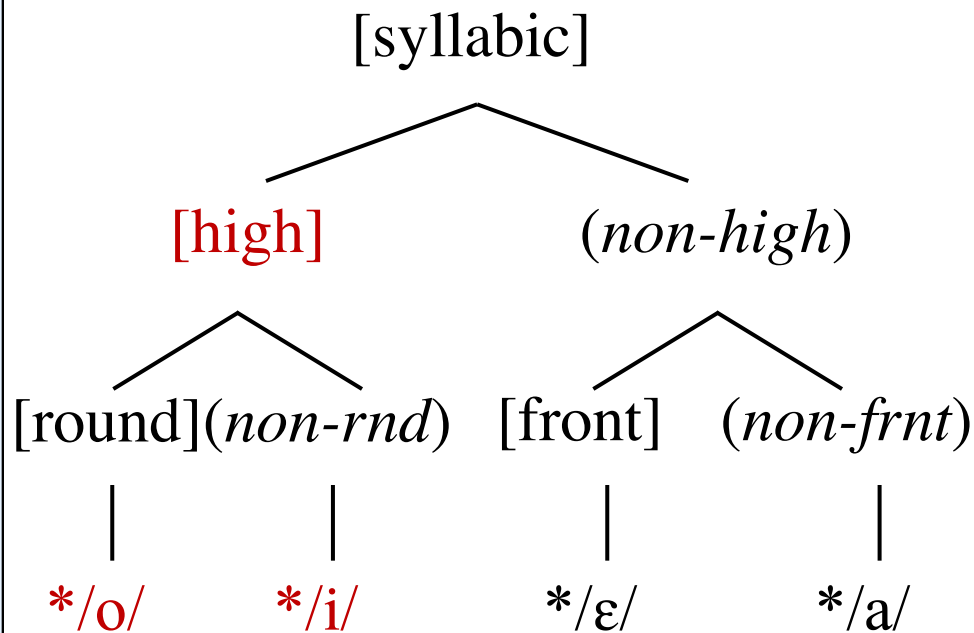


If the hierarchy constrains patterning, then the height contrast (reinterpreted as [high]) must have come to outrank place contrasts

That is, the feature [high] moves to the top of the hierarchy.

Eastern and Western daughter languages

[high] > [round] > [front]

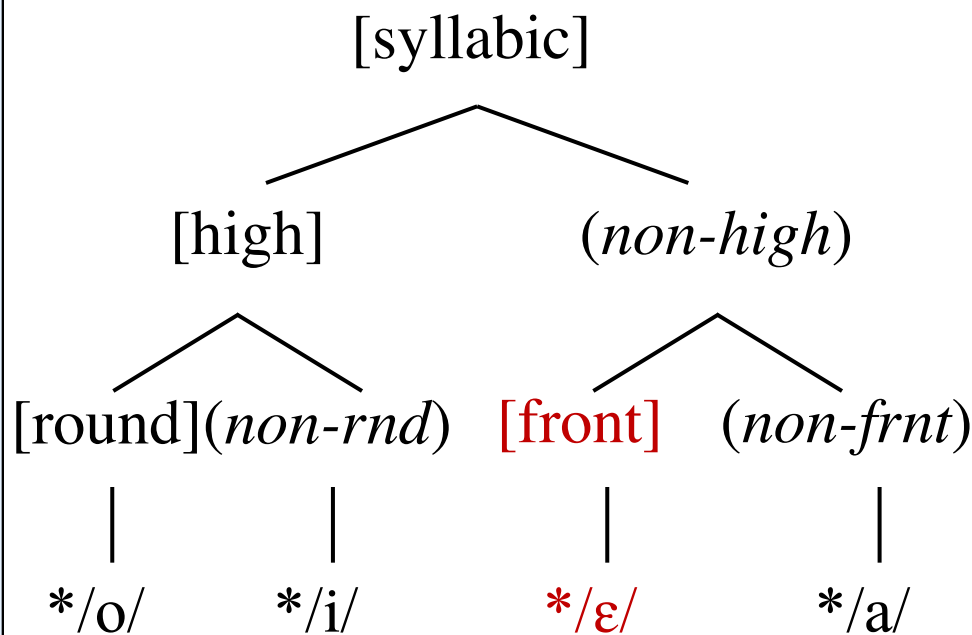


Subsequent developments in the eastern and western daughter languages **follow the predictions of the new hierarchy.**

The patterns consistently differ from those of Central Algonquian:

Eastern and Western daughter languages

[high] > [round] > [front]



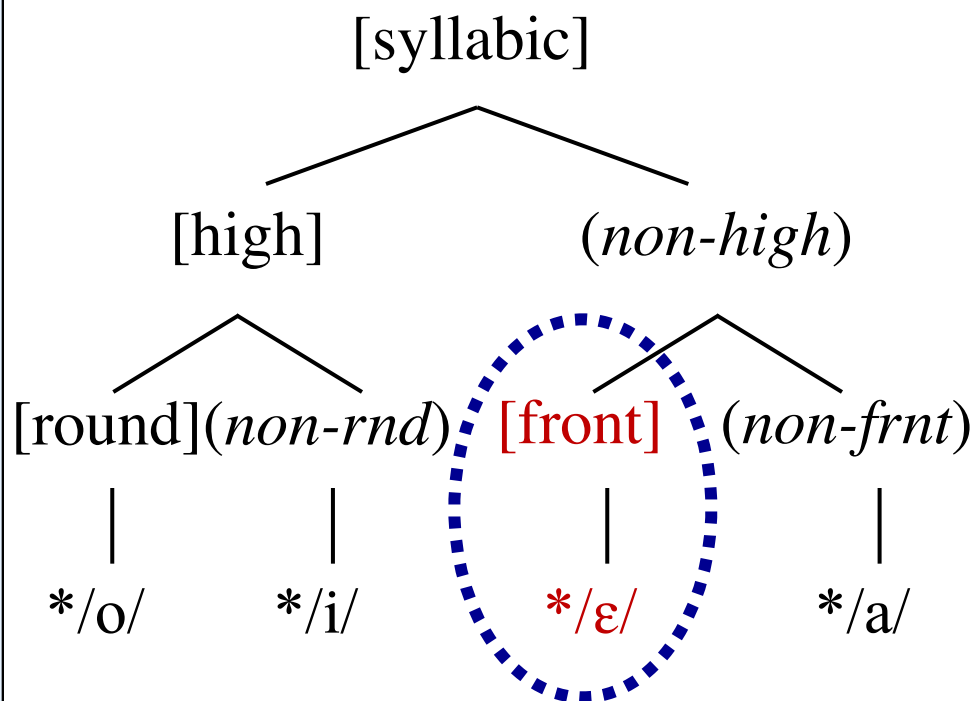
1. Palatalization is triggered by */ε/ but excludes */i/

Massachusetts */k/-palatalization is triggered by PEA */ε:/ but not /i:/

Cheyenne “yodation”, where */k/ > /kj/, is triggered by */ε(:)/ only

Eastern and Western daughter languages

[high] > [round] > [front]



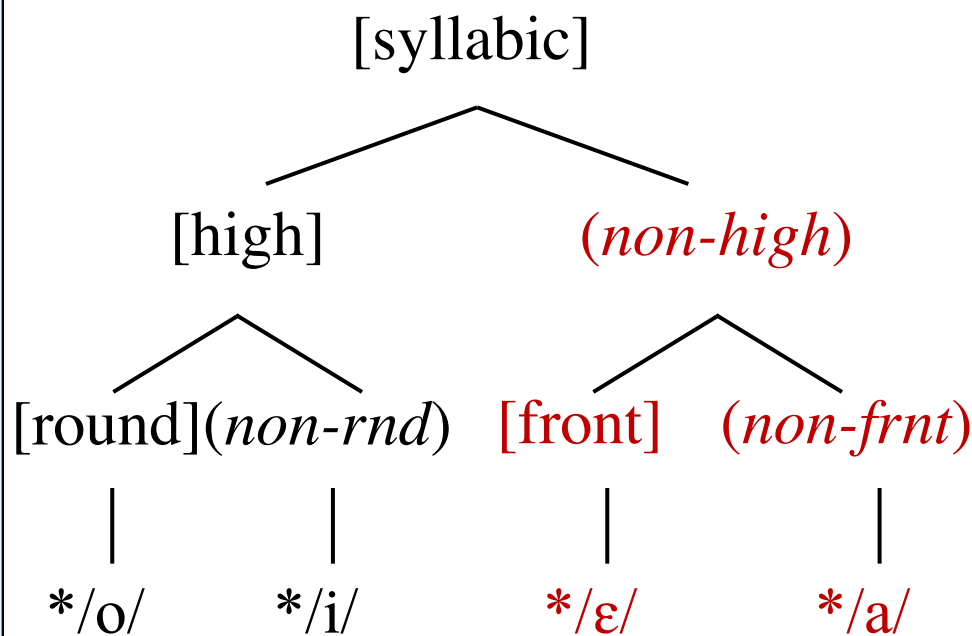
1. Palatalization is triggered by */ε/ but excludes */i/

Again, these patterns support the view that palatalization is triggered by a contrastive [front] feature.

Only /ε/ is contrastively [front] in these languages.

Eastern and Western daughter languages

[high] > [round] > [front]



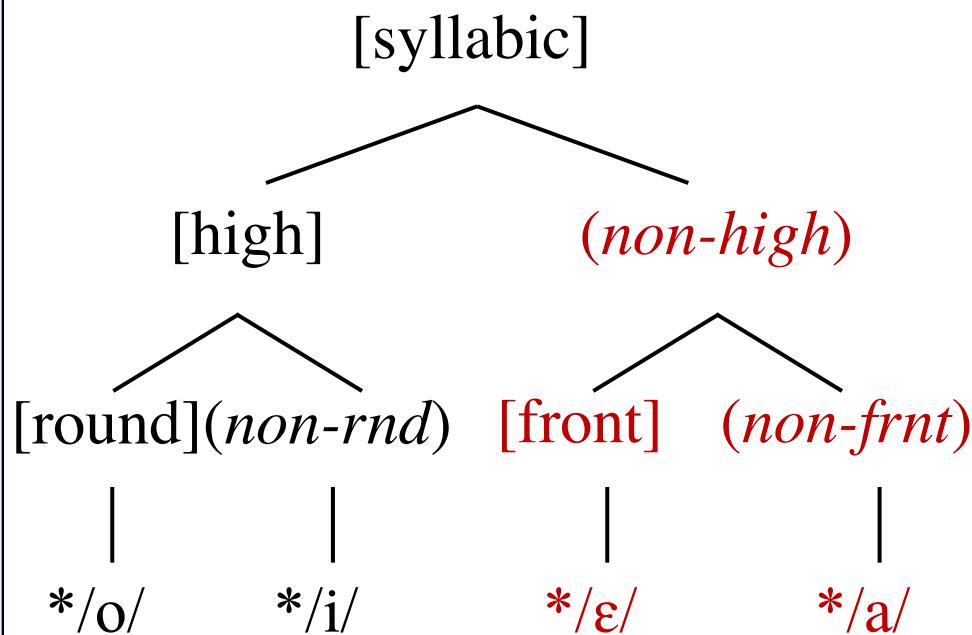
2. */ε/ merges with or shifts to */a/

Partial or complete mergers of PA short */ε/ with */a/ occur in **Abenaki, Mahican, Mi'kmaq, and Maliseet-Passamaquoddy**

PEA long */ε:/ shifts to /a:/ in **Massachusetts** and merges with */a/ in **Western Abenaki**

Eastern and Western daughter languages

[high] > [round] > [front]



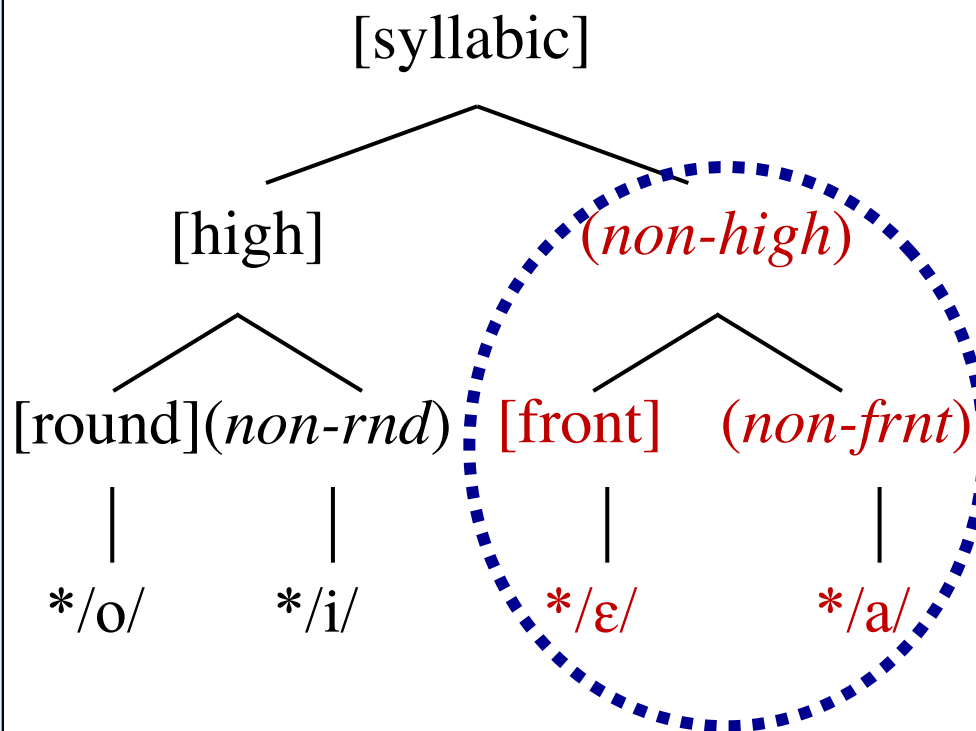
2. */ε/ merges with or shifts to */a/

Long and short */ε(:)/ shift to */a(:)/ in **Cheyenne**

Vowel harmony involves */ε(:)/ and */a(:)/ in **Arapaho**

Eastern and Western daughter languages

[high] > [round] > [front]

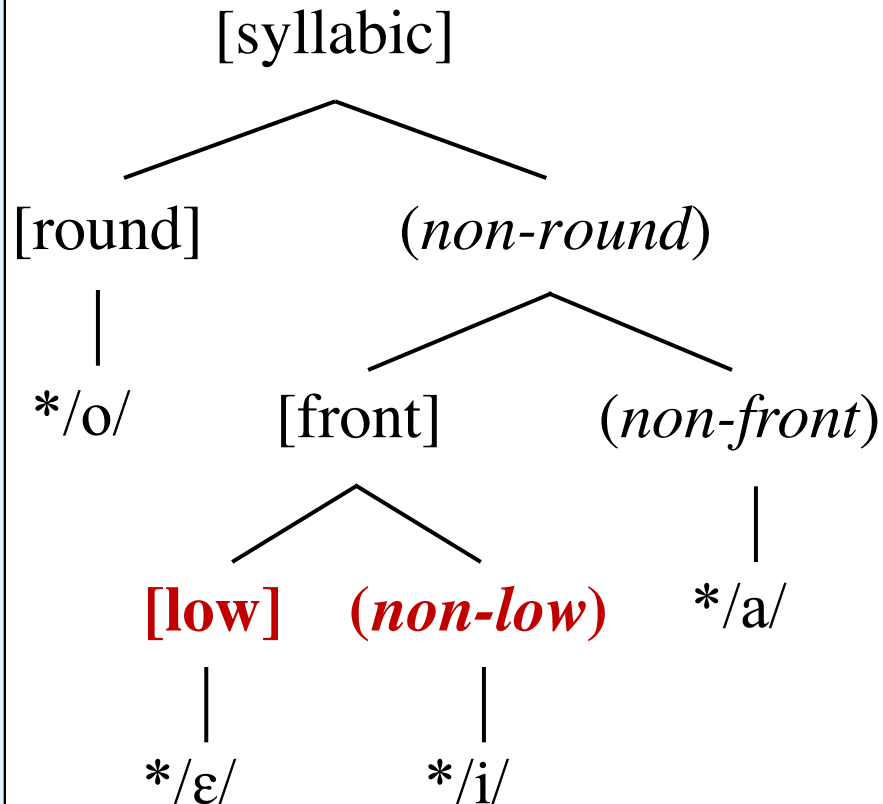


2. */ε/ merges with or shifts to */a/

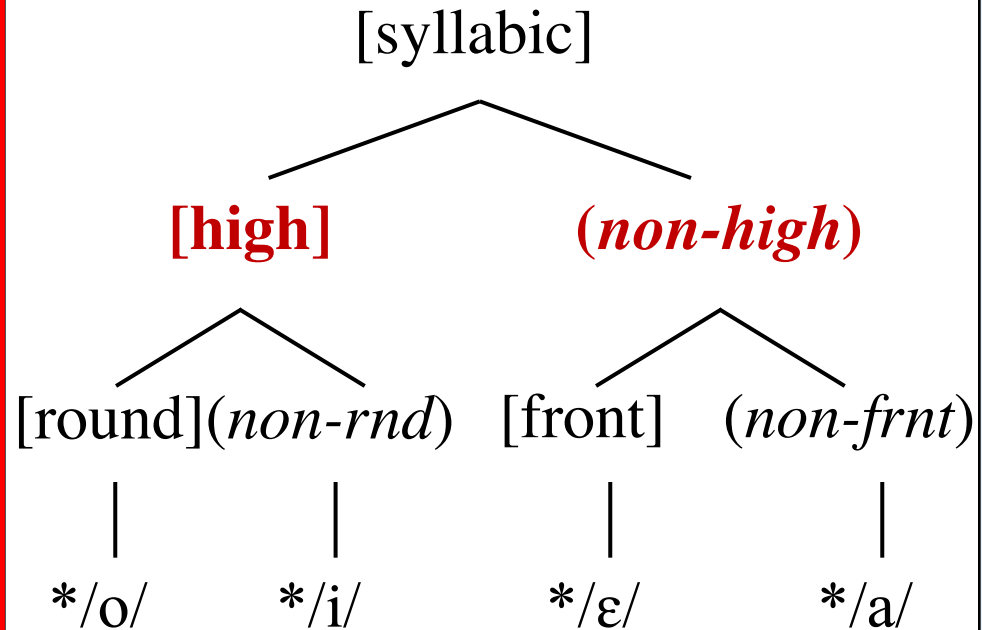
This follows from the sisterhood of */ε/ and */a/ under the new hierarchy.

A single contrast shift thus accounts for the patterning of a large number of phonological changes across the Algonquian family.

PA and Central languages



Eastern and Western languages



9.

Conclusions

Conclusions

To sum up, the line of research that stems from Jakobson's *Kindersprache* is correct in positing that the phonological systems of the world's languages use a very limited set of features.

However, this is not because there is a limited set of innate universal features; 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 feature hierarchies: this is why features are **required** to 'emerge' in the course of acquisition.

Conclusions

Contrastive feature hierarchies together with the Contrastivist Hypothesis limit the number of features that are available to the lexical phonology.

As we have seen, additional features become available only in the post-lexical component.

The theory thus makes clear empirical predictions about the relationship between contrast and phonological activity.

These predictions are falsifiable, but so far, in most cases, they appear to be true!

For discussions, ideas, and analyses I would like to thank Graziela Bohn, Elizabeth Cowper, Daniel Currie Hall, Paula Fikkert, Ross Godfrey, Christopher Harvey, Ross Krekoski, Will Oxford, Keren Rice, Christopher Spahr, and Zhang Xi.

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

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¡Gracias!
and thank you!



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