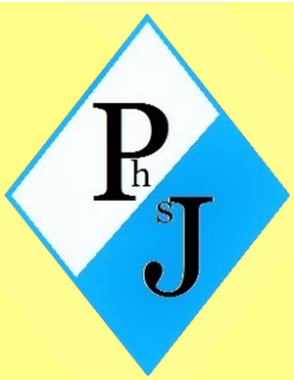

日本音韻論学会

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Contrastive Hierarchies and the Nature of Phonological Features

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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.

As a way into this theory, I will begin with a reconsideration of Roman Jakobson's account of phonological acquisition.

I will argue that if we abstract away from the details and focus on the main ideas, we will have a foundation on which we can construct an explanatory theory of phonological contrast.

I will set out the main tenets of this 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

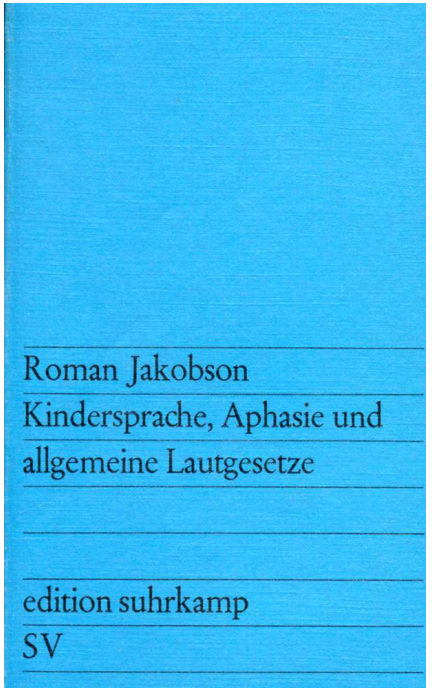
The talk is organized as follows:

- 1. Introduction
- 2. A reconsideration of Jakobson's theory of phonological acquisition: Some three-vowel systems
- 3. A theory of phonological contrast and markedness
- 4. Phonological features: innate or emergent?
- 5. Synchronic phonology with contrastive feature hierarchies: Some five-vowel systems, particularly Tokyo Japanese
- 6. Contrastive hierarchies in diachronic phonology: Old English *i*-umlaut, and allophones in the lexical phonology
- 7. Conclusions

2.

Jakobson's theory of phonological acquisition: a reconsideration

Jakobson's *Kindersprache*



Roman Jakobson's *Kindersprache, Aphasie und allgemeine Lautgesetze (*1941), translated into English as *Child Language, Aphasia and Phonological Universals* (1968), is important for its theory of phonological acquisition, as well as for how it connects acquisition to phonological theory more generally.

Fixed order of acquisition

Of the many influential ideas advanced in this book, the one that has attracted much discussion and criticism is the claim that acquisition proceeds in a fixed order.

Jakobson does indeed emphasize this idea throughout the book. For example:

> "The fact that a fixed order must be inherent in language acquisition, and in phonological acquisition in particular, has repeatedly been noticed by observers…" (1968: 20)

Fixed order of acquisition

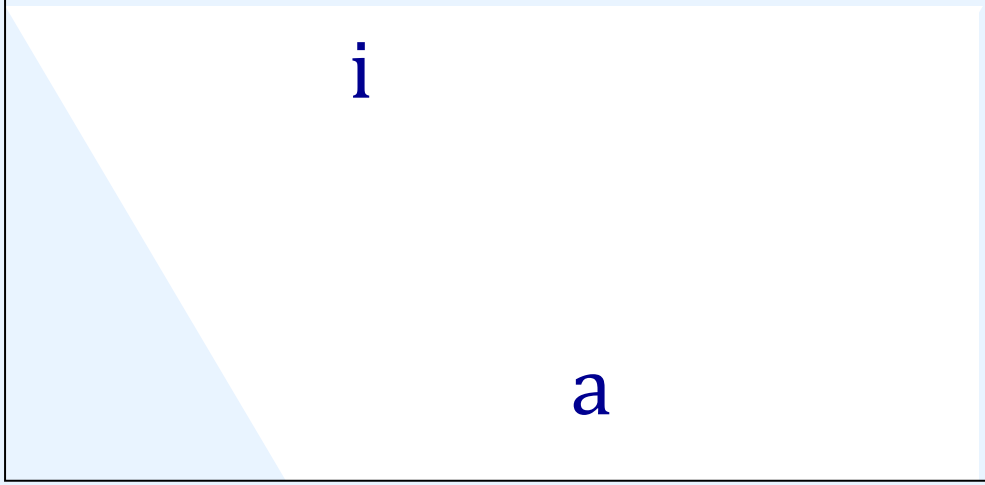
> "Again and again a number of constant features in the succession of acquired phonemes are observed…" (1968: 28)

In some passages, such as the above, Jakobson appears to be claiming that the fixed order of emergence refers to phonemes; for example, he writes that the acquisition of vowels is launched with a wide vowel, *a*, and that the first consonant is generally a labial stop, *p* (hence, the first syllable should be *pa*).

In other places, however, he refers to the emergence of oppositions, that is contrasts, not individual phonemes:

Fixed order of acquisition

Thus, he proposes that in the first vocalic opposition, a more narrow vowel, *i*, is opposed to the wide vowel, *a*.



Fixed order of acquisition

If the key notion, however, is contrasts, then the predictions about the order of emergence of individual sounds become much more obscure.

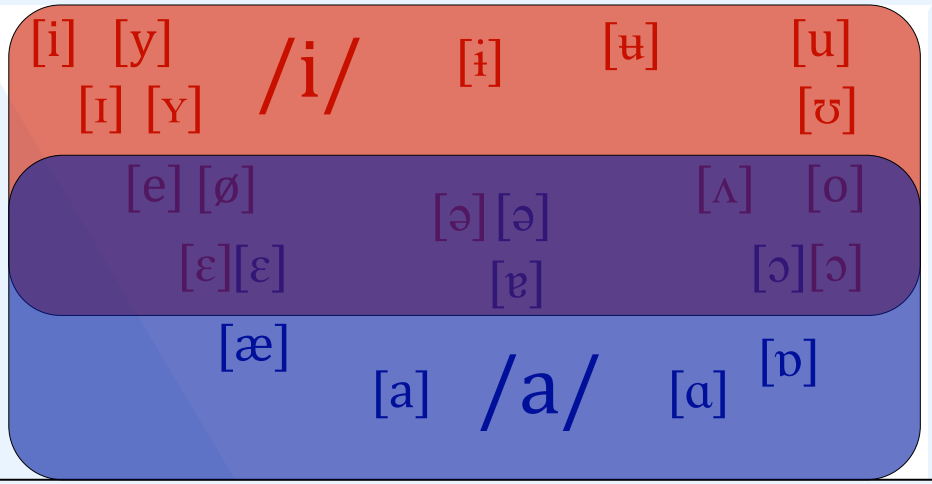
/i/

/a/

Fixed order of acquisition

If the key notion, however, is contrasts, then the predictions about the order of emergence of individual sounds become much more obscure.

This is because a contrast between a wider (lower) and narrower (higher) vowel can be phonetically realized in a variety of ways: the phonemic labels '/a/' and '/i/' can each represent a wide range of phonetic vowels.



Also, the boundary between two such phonemes can vary considerably from language to language.

Fixed order of acquisition

Hence the apocryphal tale recounted by Hyman (2008), about Jakobson giving a lecture in which he asserts that in all languages the child's first word is *pa*.

A member of the audience objects that *his* child's first utterance was *tʃɪk*.

Jakobson replies, "phonetic [tʃɪ^{k}], yes, but phonologically /pa/!"

This may be a joke, but there is truth to the notion that an emphasis on contrasts can overshadow the individual sounds that participate in a contrast.

Jakobson's better idea

This makes it harder than one might suppose to test Jakobson's predictions about a fixed order of acquisition (Ingram 1988, 1989).

Nevertheless, it appears that child phonology shows more variation, even within a single language, than Jakobson 1941 allows (Menn & Vihman 2011; Bohn 2015, 2017).

But the claim that acquisition of phonology proceeds in a fixed order is not the only idea put forward in *Kindersprache*.

More consequential, in my view, is the notion that contrasts are crucial and that they develop in a hierarchical order.

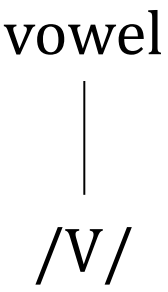
Emergence of contrasts

In particular, Jakobson proposes that learners begin with broad contrasts that are split by stages into progressively finer ones. He observes (1968: 65):

> "This system is by its very nature closely related to those stratified phenomena which modern psychology uncovers in the different areas of the realm of the mind."

> "Development proceeds 'from an undifferentiated original condition to a greater and greater differentiation and separation'." (citing E. Jaensch, *Zeitschr. f. Psychol.* 1928)

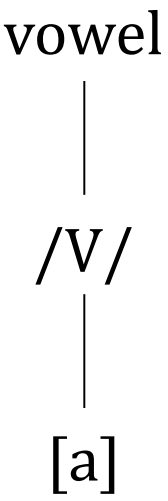
Acquisition sequences (vowels)



With this basic idea in mind, consider again the acquisition of vowel systems set out in Jakobson 1941 and its sequel, Jakobson & Halle 1956.

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

Acquisition sequences (vowels)

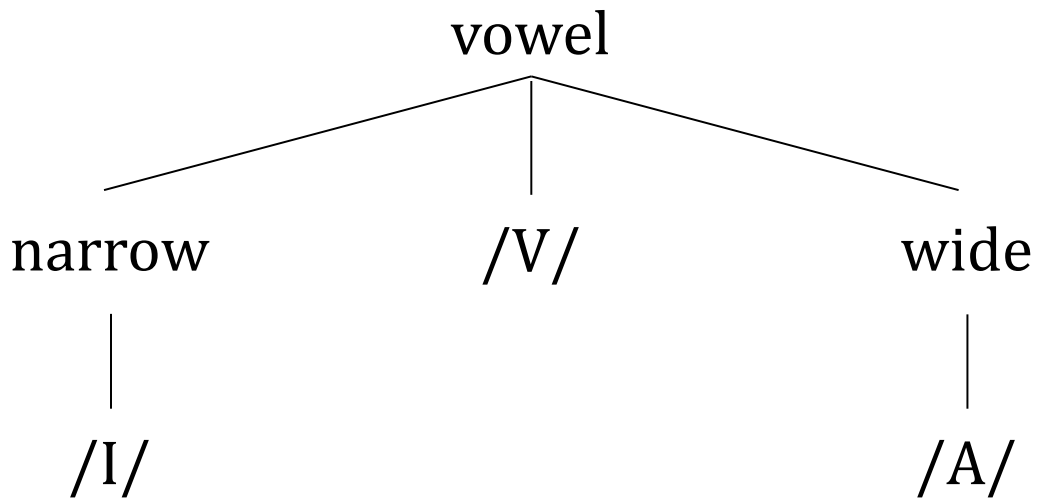


Jakobson & Halle write that this lone vowel is the maximally open vowel [a], the 'optimal vowel'.

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.

For contrastive purposes, any phonetic vowel will fit (e.g. [ɪ^{k}]!).

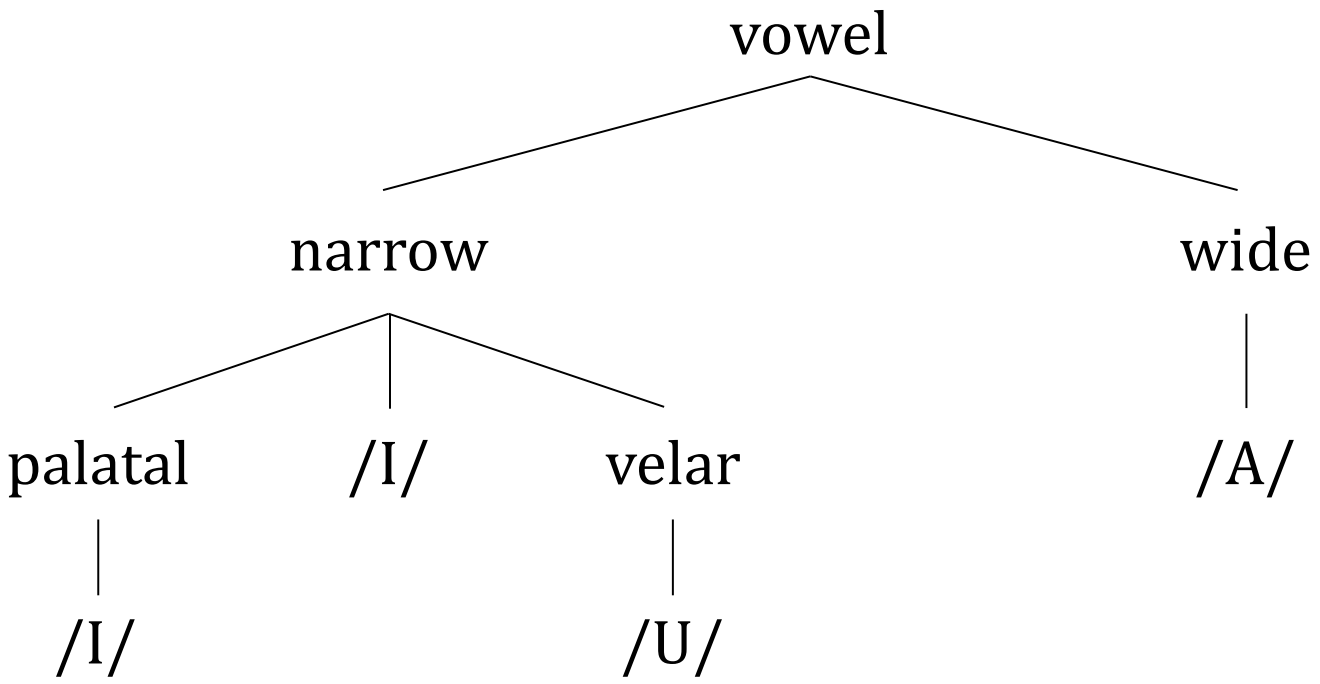
Acquisition sequences (vowels)



In the next stage, as mentioned, 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].

Jakobson (1968: 49) observes that this stage corresponds to the common 3-vowel system /i, a, u/.

Three-vowel systems

Of course, systems designated as /i, a, u/ vary considerably in their phonetic realizations.

Dresher & Rice (2015) survey some 3-vowel systems that are included in an online phonological database called PHOIBLE (Moran, McCloy & Wright 2014).

It lists 12 Pama-Nyungan (Australia) 3-vowel languages. Of these, 8 are given as /i, a, u/.

The other 4 are listed as having different inventories:

/i, ɑ, u/
/ɪ, a, ʊ/
/ɪ, ɐ, ʊ/
/i, a, ə/

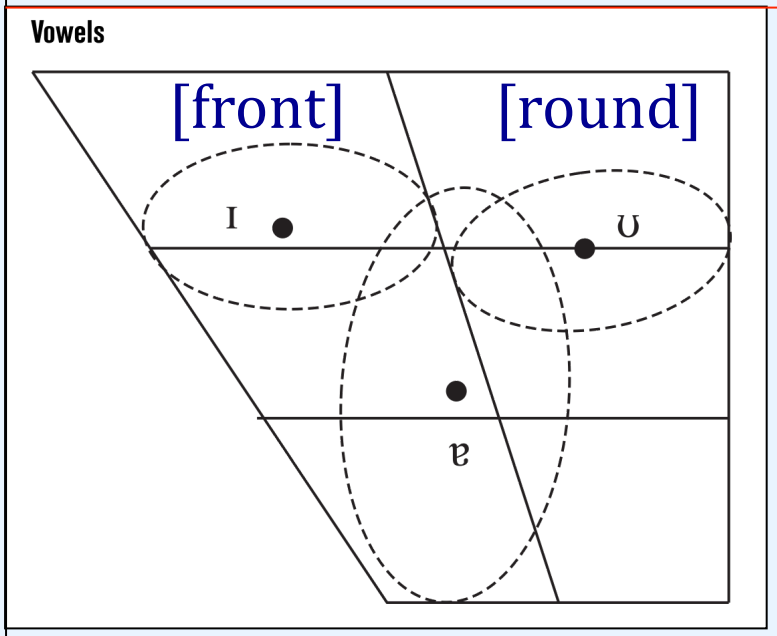
Three-vowel systems

We found that there are no principled criteria for distinguishing between these systems: distinctions between /i/ ~ /ɪ/, /a/ ~ /ɑ/ ~ /ɐ/, and /u/ ~ /ʊ/ ~ /ə/ do not necessarily indicate significant differences between the languages.

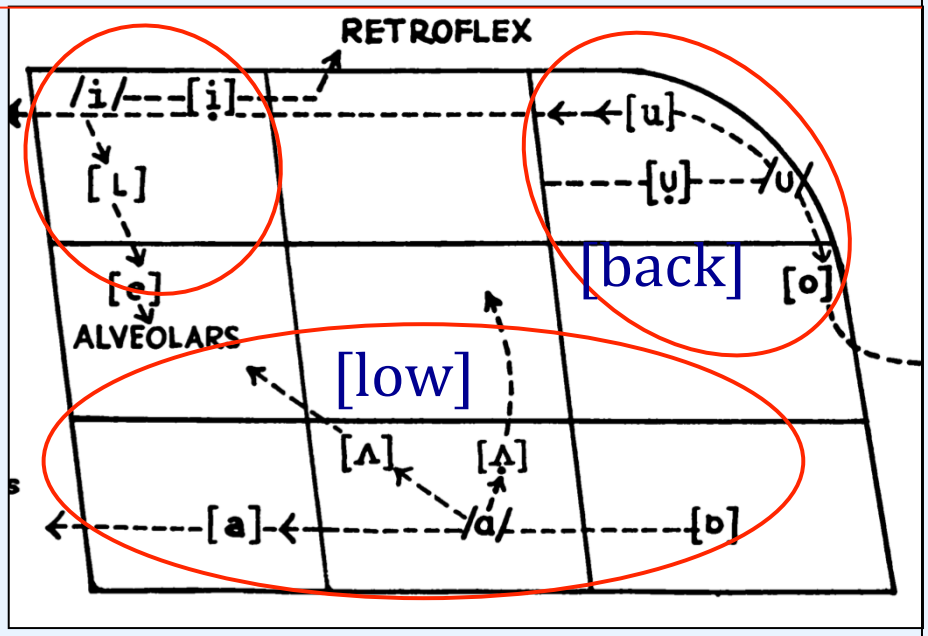
Conversely, the inventories designated /i, a, u/ exhibit considerable variation in the phonetic ranges covered by their 3 vowels.

Compare, for example, the vowel systems of two dialects of the Western Desert Language of central Australia: Pitjantjatjara (Tabain & Butcher 2014) and Antakarinya (Douglas 1955).

Some three-vowel systems



Pitjantjatjara

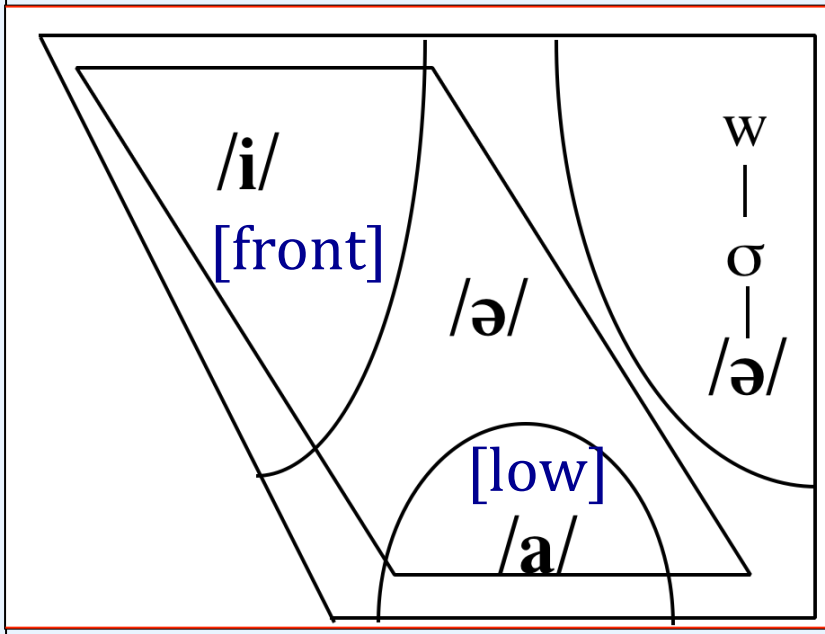


Antakarinya

The distributions of the vowels in the two languages are different, particularly that of the low vowel.

These distributions suggest that the languages may have different contrastive features, derived from different contrastive splits.

Some three-vowel systems



Western Arrarnta

Here are the vowel ranges of another Pama-Nyungan language, Western Arrarnta (Anderson 2000).

The vowel /a/ is restricted to a very small space; we infer it is [low].

/i/ "varies in quality from [ɛ] to [i]." We can assign it [front].

/ə/ is "extremely variable" in height and backness, with unrounded and rounded allophones (so it could be written /u/). It also appears to be the epenthetic vowel.

This distribution is consistent with /ə/ being non-low and non-front; in Jakobson's terms, narrow and velar, that is, /U/.

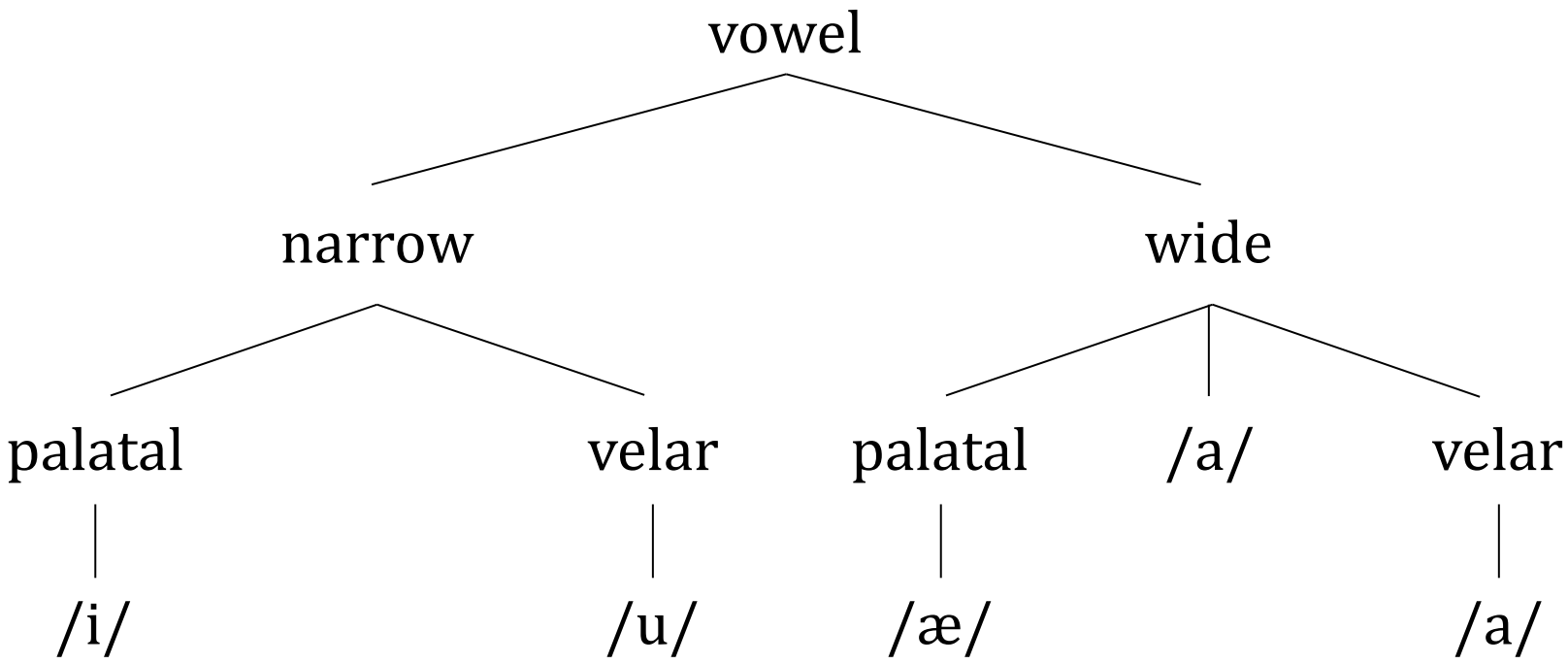
Three-vowel systems

We conclude, then, that the characterization of many three-vowel systems as /i, a, u/ may conceal the fact that they are very diverse.

Similarly, the first stages of phonological acquisition may not be as unvarying as proposed by Jakobson (1941) and Jakobson & Halle (1956).

On the other side, if Jakobson's basic idea about the development of contrasts is correct, then all three-vowel systems are similar in being characterized by two features, even if these features are not the same in each case, or even universal.

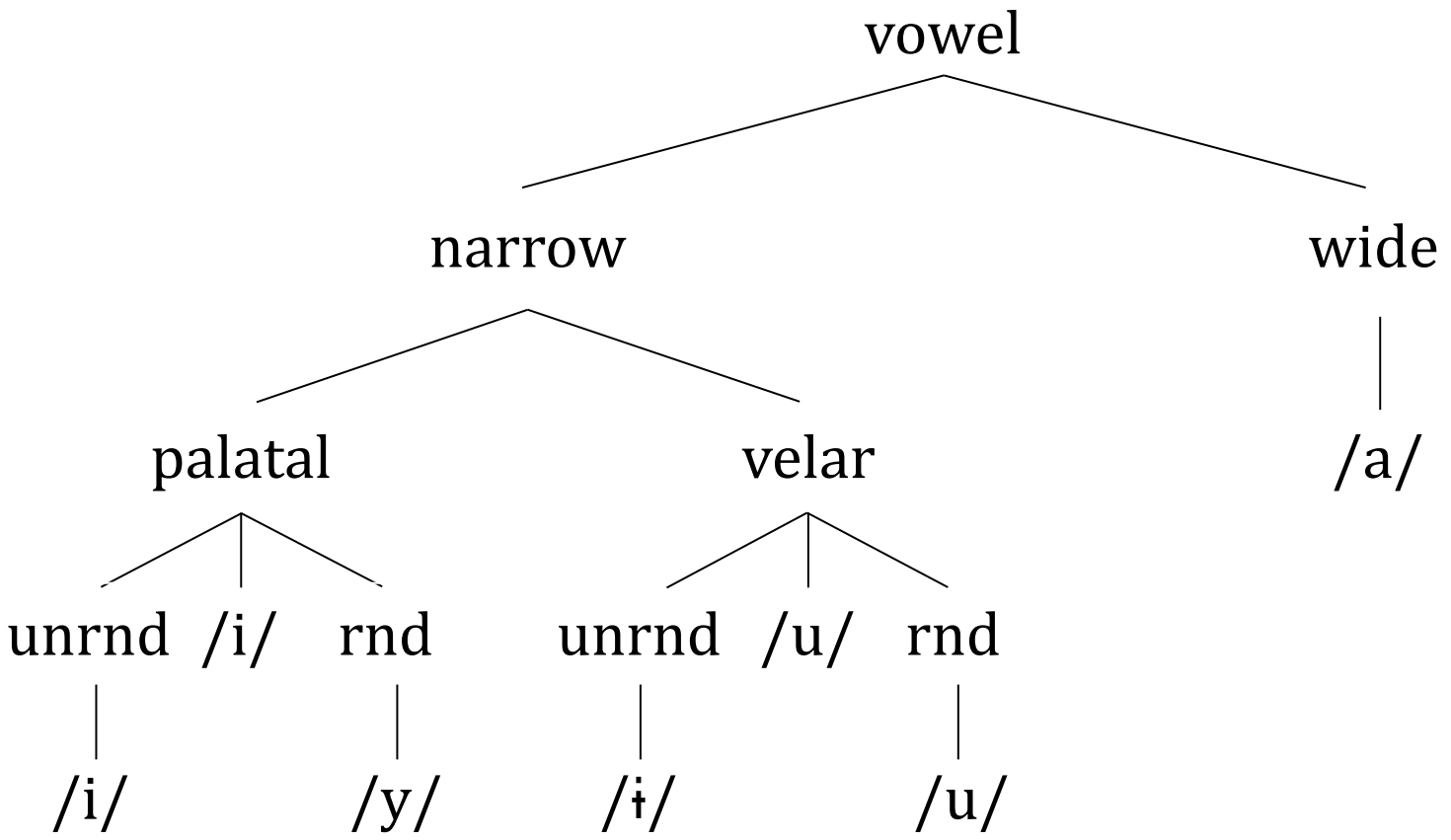
Acquisition sequences (vowels)



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)



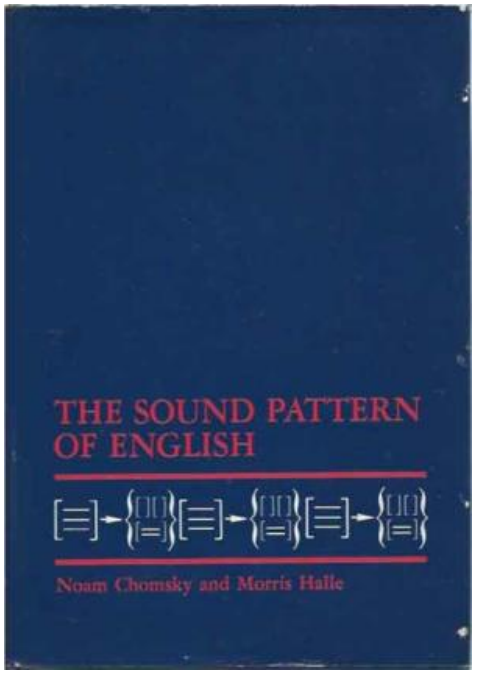
Or the narrow vowels can develop a rounding contrast in one or both branches.

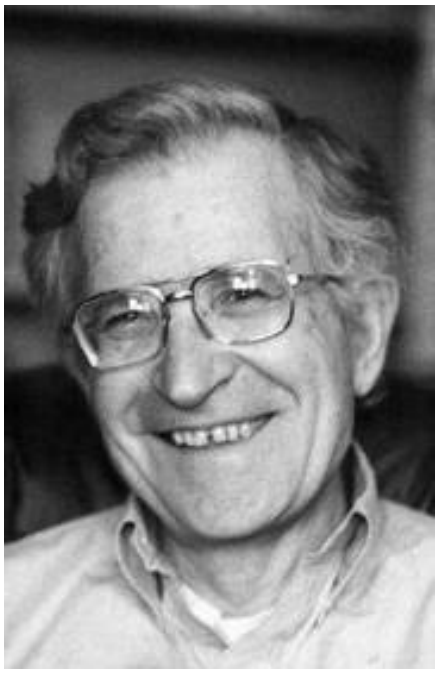
History of 'branching trees' in phonology

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.

In a number of publications I have tried to recover the history of 'branching trees' in phonology (Dresher 2009, 2015, 2016, 2017), tracing them back to the work of Jakobson and Trubetzkoy in the 1930s, through to the 1960s.

The decline of the branching trees





Nevertheless, for reasons I cannot discuss here, 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.

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 1998; 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.

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.

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 1998, 2003, 2009):

The Successive Division Algorithm

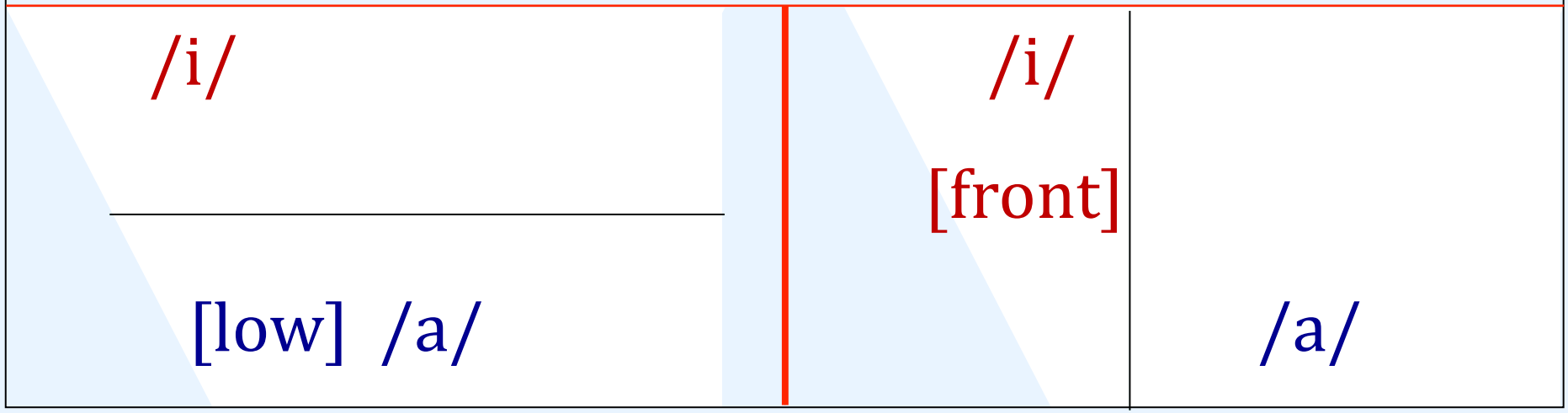
Assign contrastive features by successively dividing the inventory until every phoneme has been distinguished.

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].

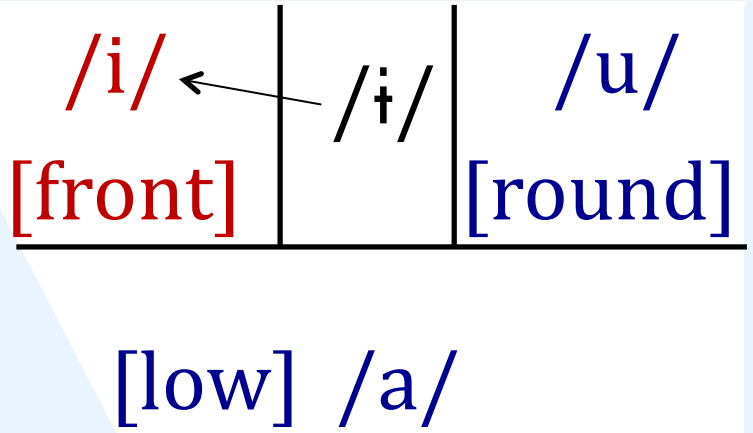


Criteria for ordering features

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 /ɨ/ is neutralized at the surface, with both /i/ and /ɨ/ being realized as phonetic [i] (Compton & Dresher 2011).

In this case, /i/ and /ɨ/ 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.

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.

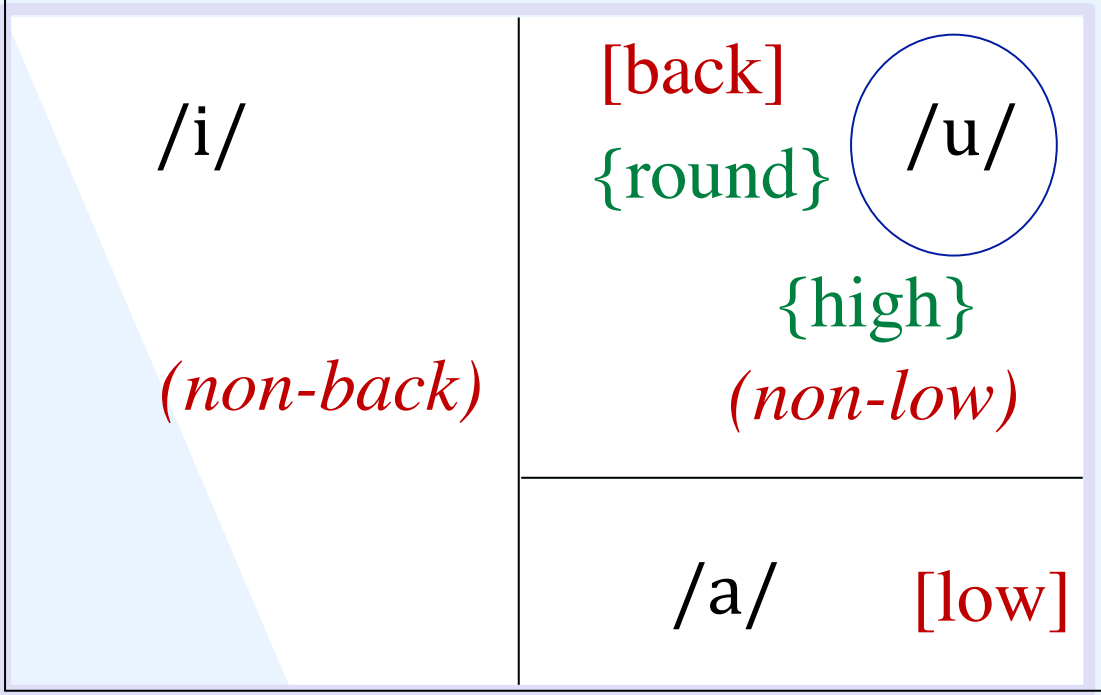
Stevens, Keyser & Kawasaki (1986) propose that feature contrasts can be enhanced by other features with similar acoustic effects (see also Stevens & Keyser 1989; Keyser & Stevens 2001, 2006).

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

Enhancement of underspecified features

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 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

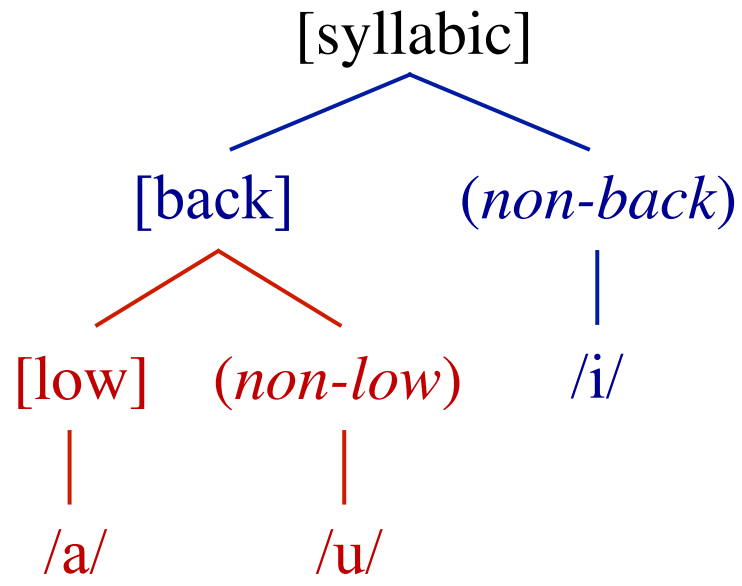
For example, if a language has three vowel phonemes /i, a, u/, and if the vowels are split off from the rest of the inventory so that they form a sub-inventory, then they must be assigned a contrastive hierarchy with two vowel features.

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

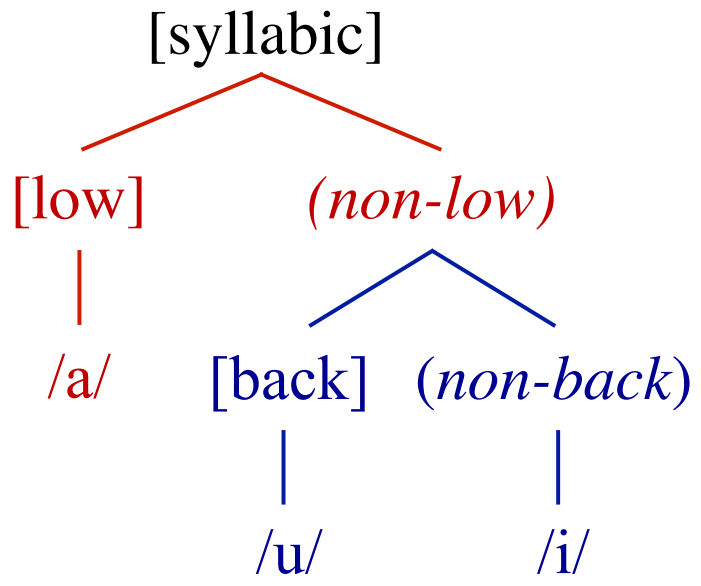
How the contrastive hierarchy works

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

[back] > [low]



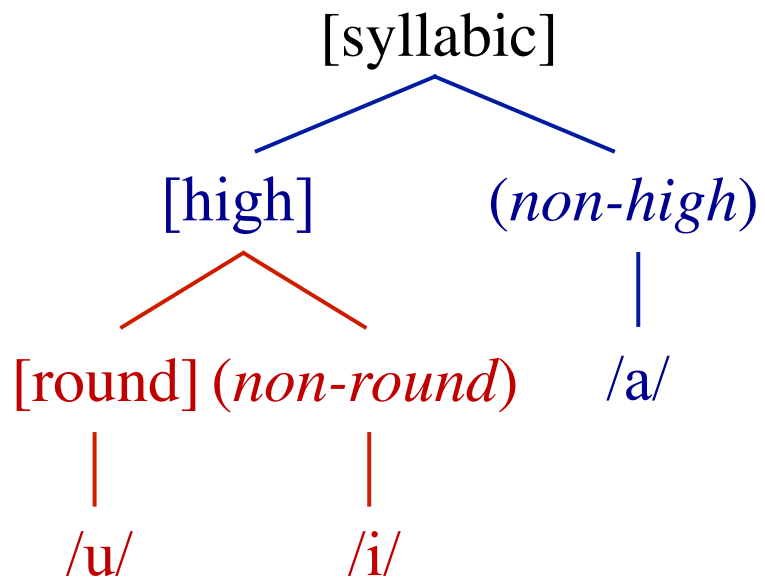
[low] > [back]



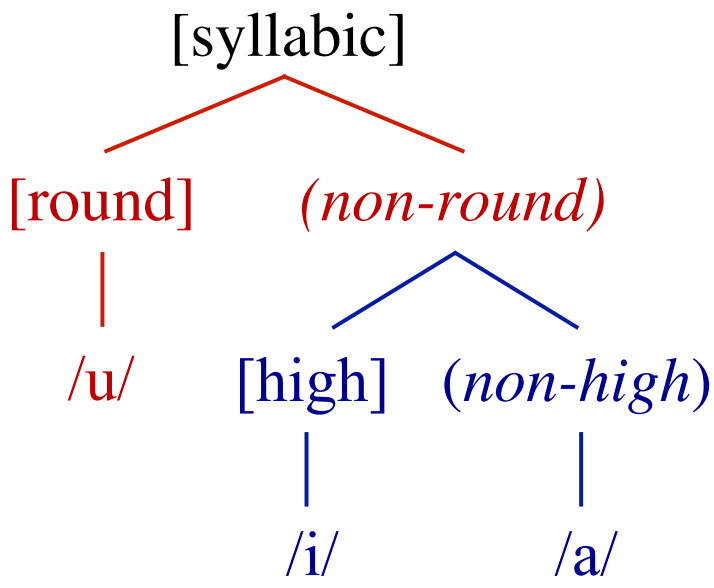
How the contrastive hierarchy works

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

[high] > [round]



[round] > [high]

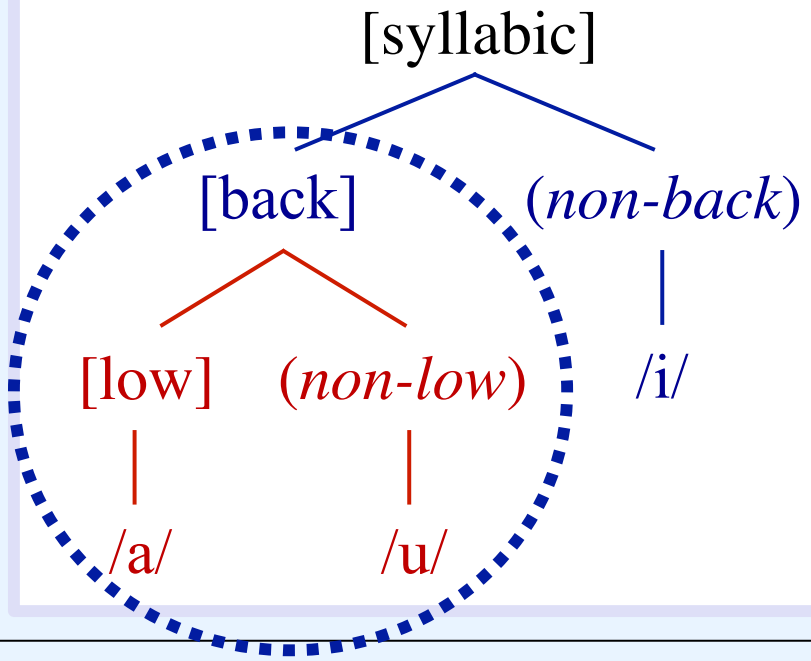


What does the hierarchy do? Synchrony

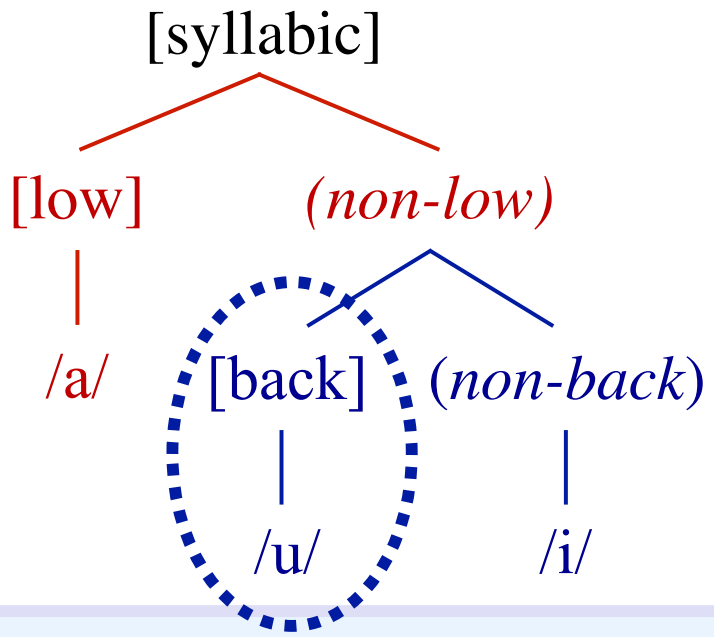
1. The hierarchy constrains phonological activity:
Only contrastive features can be phonologically active.

Which phonemes can trigger backing?

[back] > [low]



[low] > [back]



What does the hierarchy do? Synchrony

1. The hierarchy constrains phonological activity:
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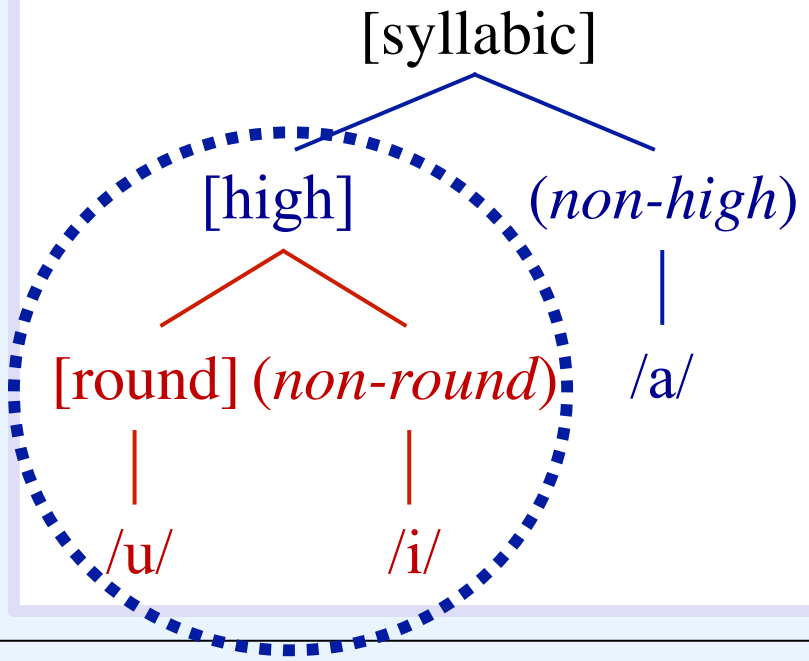
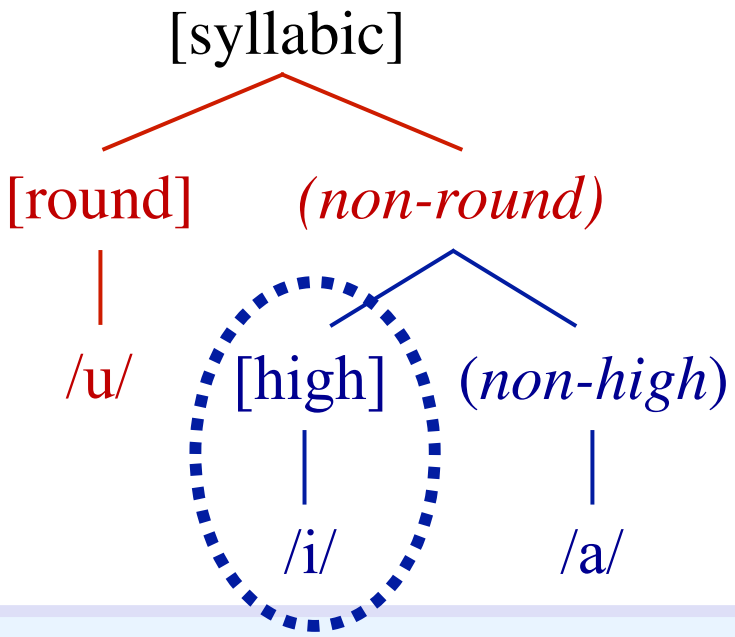
Which phonemes can trigger raising?

[high] > [round]



[round] > [high]

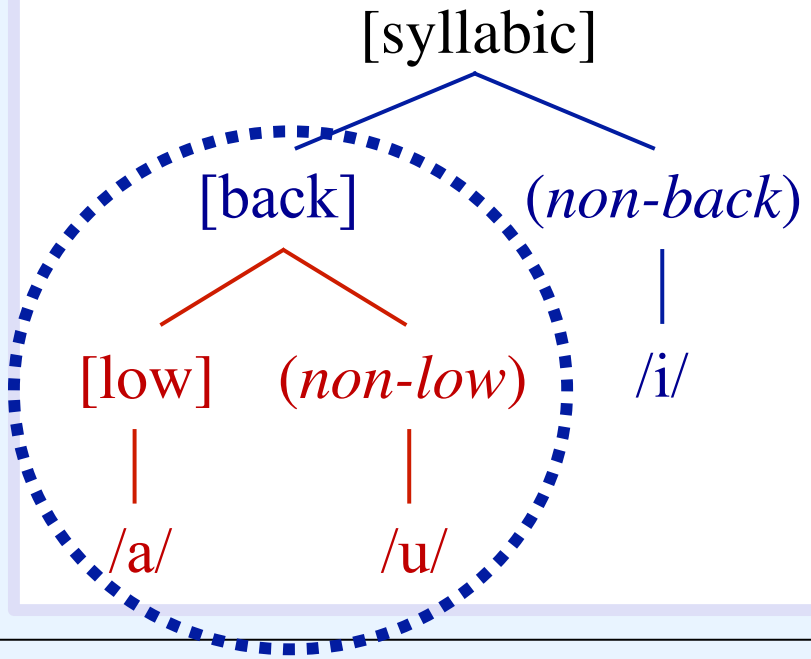


What does the hierarchy do? Diachrony

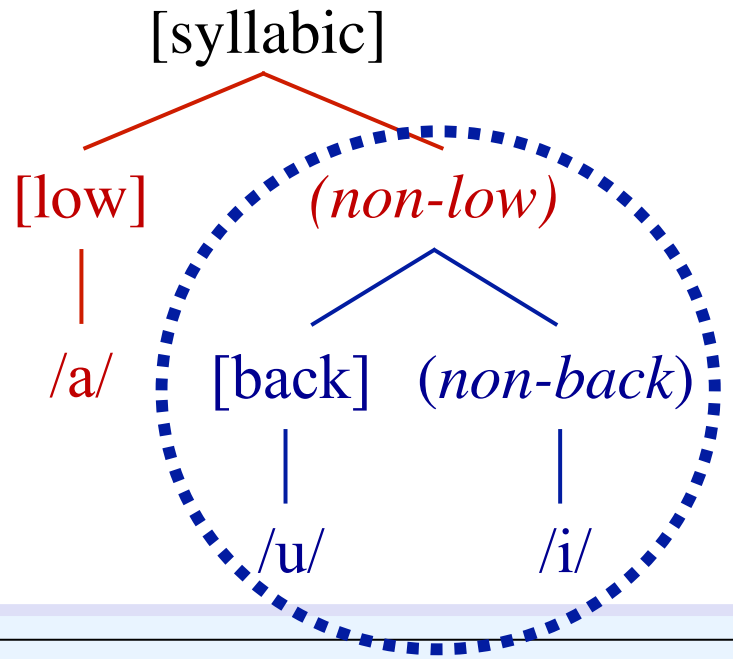
2. The hierarchy constrains neutralization and merger:
Mergers affect phonemes that are contrastive sisters.

Which phoneme can* /u/ *merge with?

[back] > [low]



[low] > [back]

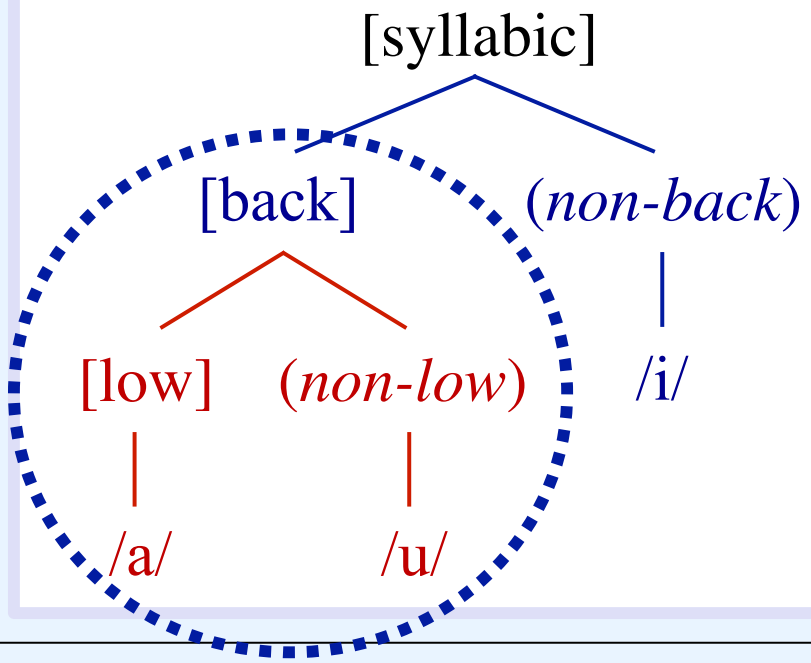


What does the hierarchy do? Diachrony

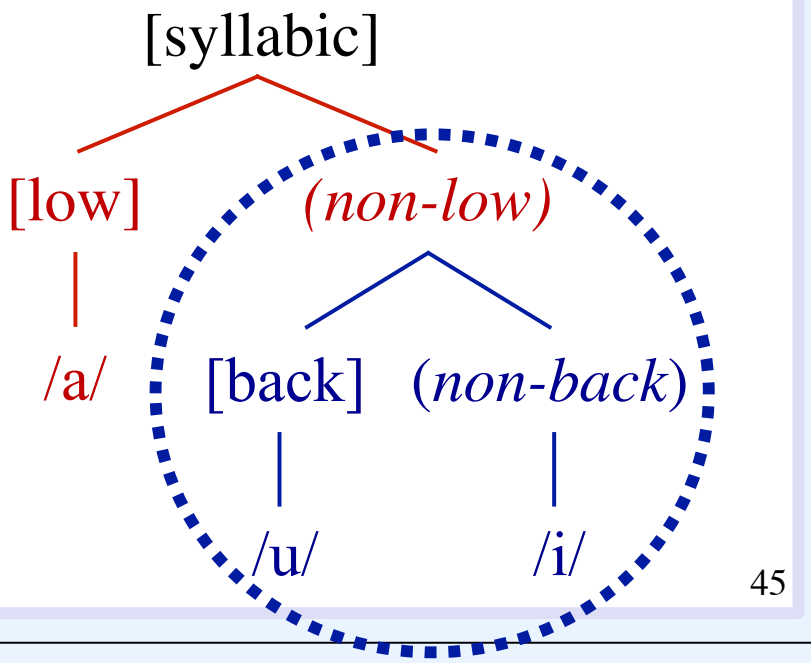
See Oxford 2015 for examples of merger patterns just like these in the history of Algonquian languages.

Which phoneme can* /u/ *merge with?

[back] > [low]



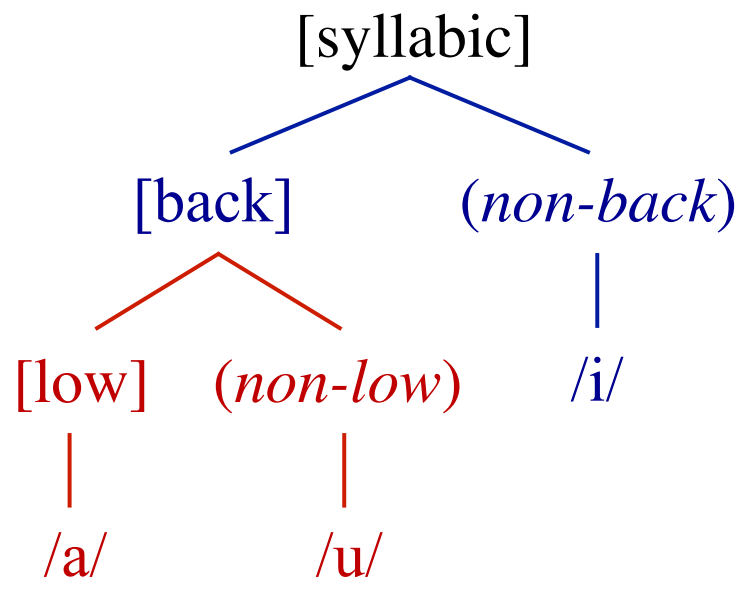
[low] > [back]



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.

[back] > [low]



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/.

4.

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.

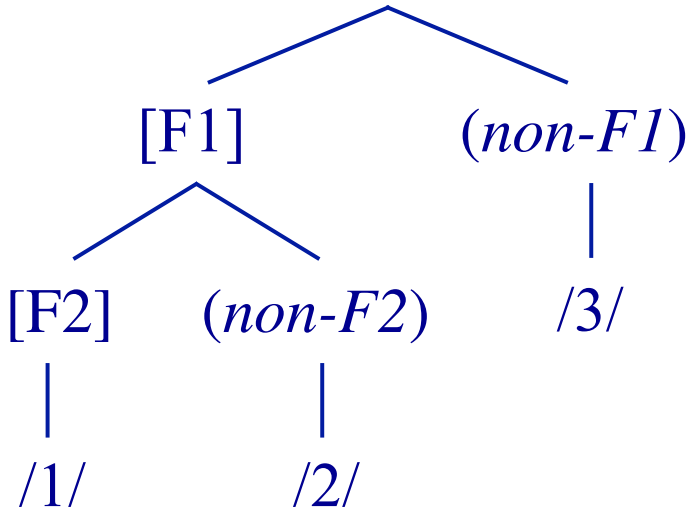
We need to explain why features inevitably emerge, and why they have the properties that they do.

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

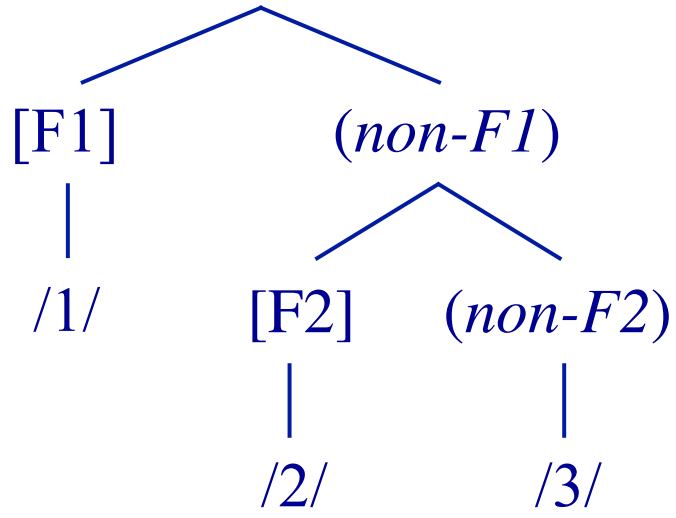
How many features are there?

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



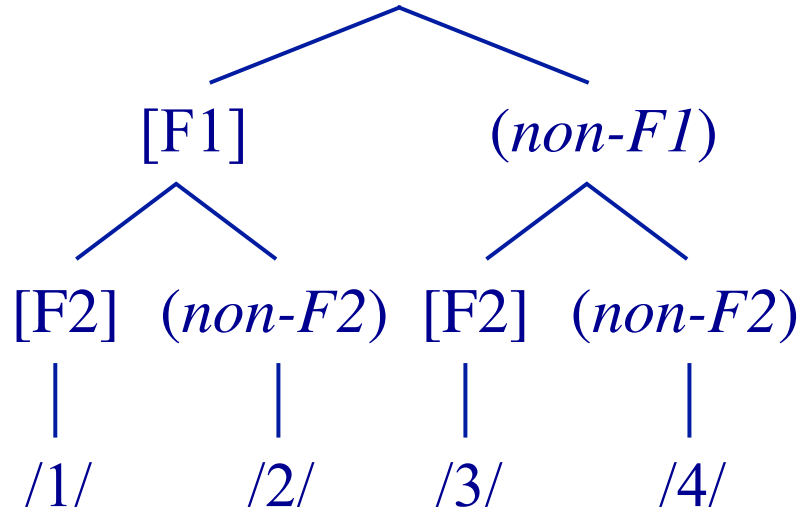
3 phonemes: F1 > F2



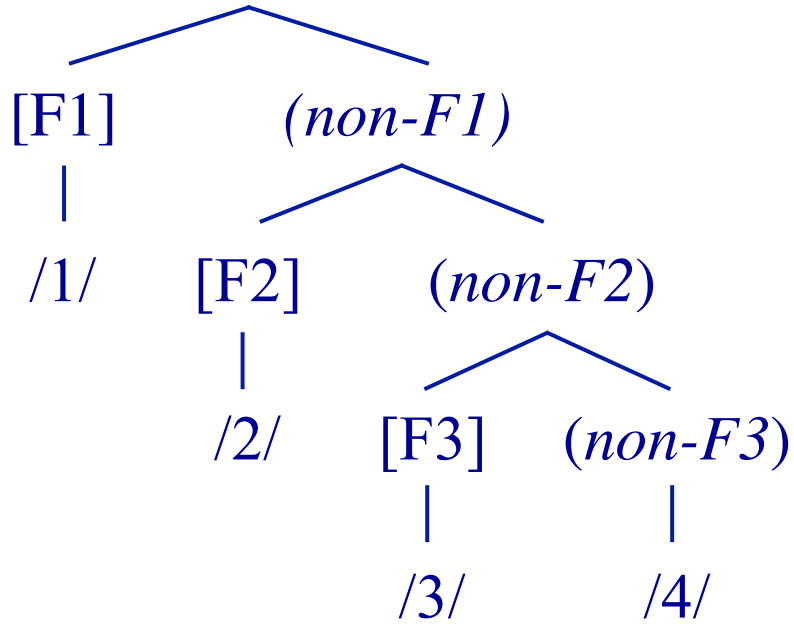
How many features are there?

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 ≥ $\log_2 n$

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.

5.

Some five-vowel systems

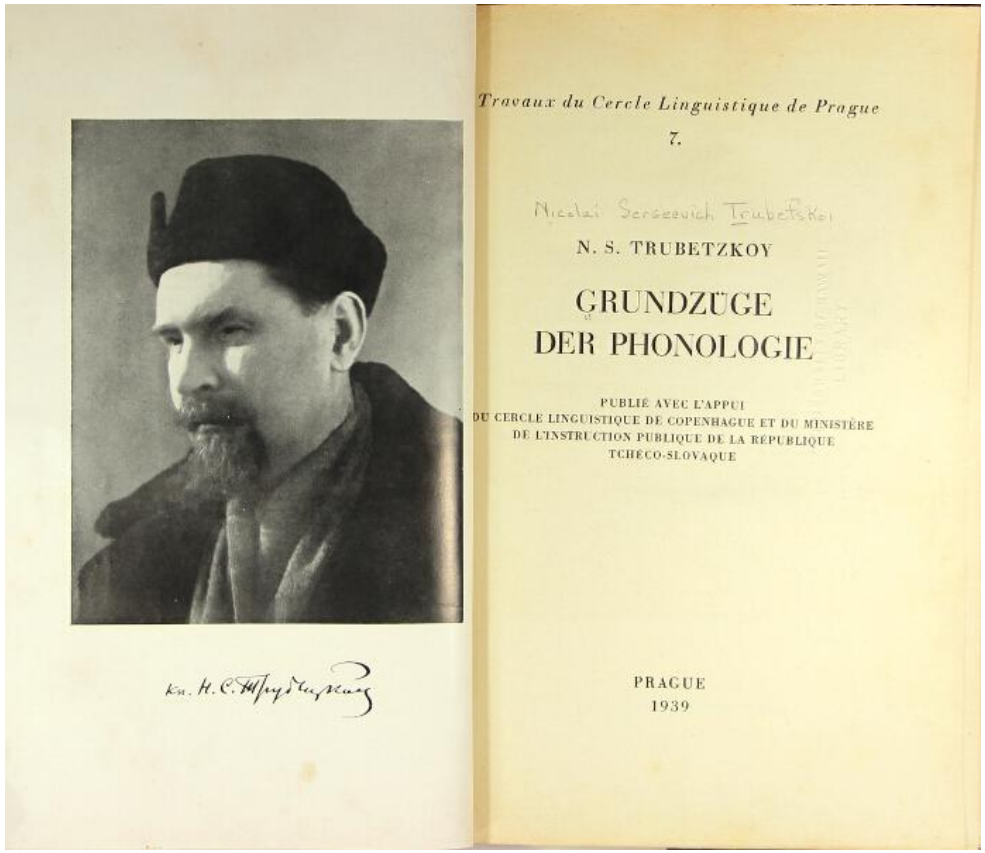
Five-vowel systems

Earlier, we looked at some three-vowel systems; we saw that they tend to resemble each other, in a rough way, because they can all be characterized by exactly two features.

However, when we look closer, we find that they differ in many details, including the choice and ordering of their contrastive features.

Similar considerations hold of five-vowel systems. Trubetzkoy (1939) reviews a number of them, and his analysis is relevant to our discussion here.

Trubetzkoy's *Grundzüge*



Travaux du Cercle Linguistique de Prague

7.

N. S. TRUBETZKOY

GRUNDZÜGE
DER PHONOLOGIE

PUBLIÉ AVEC L'APPUI
DU CERCLE LINGUISTIQUE DE COPENHAGUE ET DU MINISTÈRE
DE L'INSTRUCTION PUBLIQUE DE LA RÉPUBLIQUE
TCHECO-SLOVAQUE

PRAGUE
1939

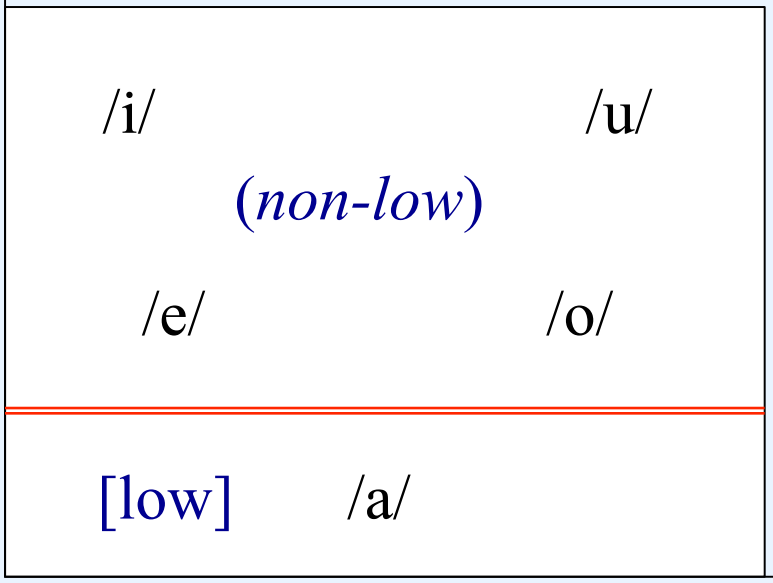
N. S. Trubetzkoy's *Grundzüge der Phonologie (*1939), translated into English as *Principles of phonology* (1969), in some ways anticipated the theory of contrast I have been arguing for here.

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



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

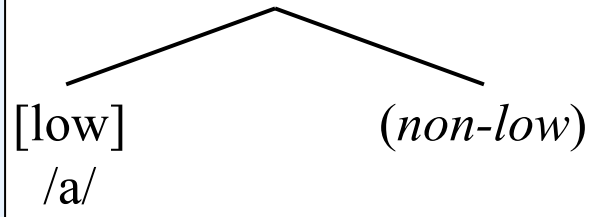
/i/ /u/

(*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

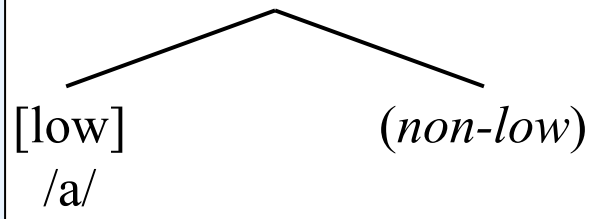
/i/ /u/

(*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

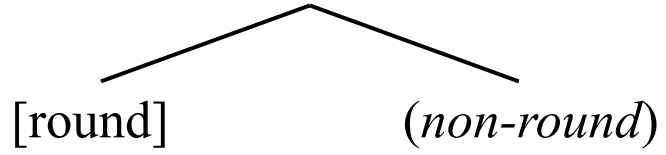
'This means that all vowels are divided into rounded and unrounded vowels, while the back or front position of the tongue proves irrelevant…' (Trubetzkoy 1969: 100-101).

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

Archi

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

[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

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

Five-vowel systems: Japanese

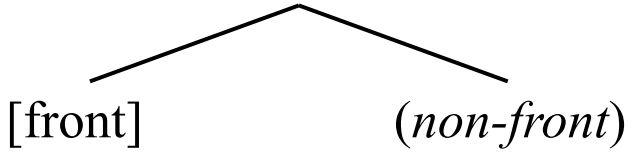
The governing opposition is that between front and back vowels, 'lip rounding being irrelevant' (Trubetzkoy 1969: 101).

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

Japanese

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

[front] > other features



Tokyo Japanese vowel features (Hirayama 2003)

Hirayama (2003) presents a more detailed analysis of Tokyo Japanese vowels; henceforth, I will follow her analysis, which illustrates a number of themes I have been talking about.

She bases her analysis on patterns of activity, including:

- epenthesis into loan words from English
- vowel coalescence
- affrication of consonants and vowel devoicing

Epenthesis into loan words from English

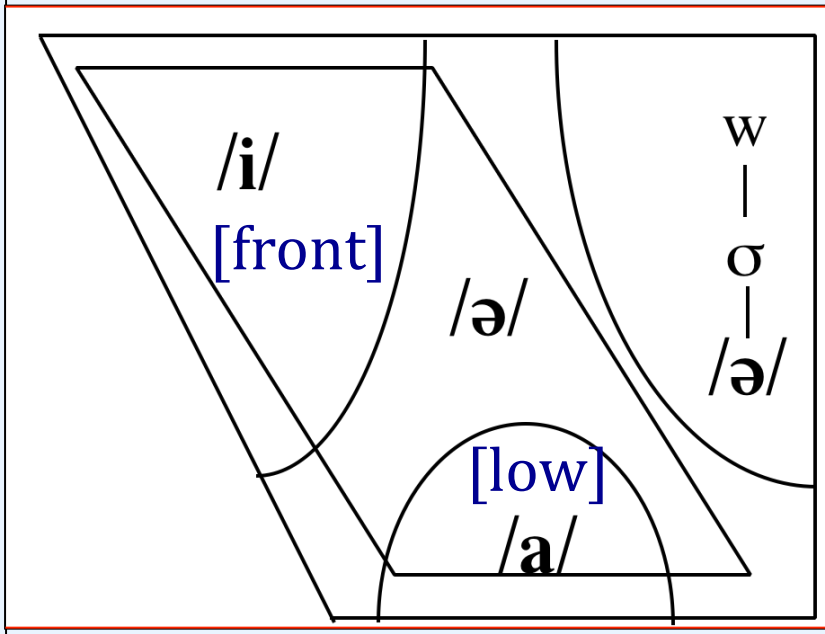
A vowel is inserted into a loan word from English that contains a consonant cluster or word-final consonant (Kubozono 2001):

/u/ is inserted after most English consonants:

English		*Japanese*
/paɪp/	'pipe'	/paipu/
/bif/	'beef'	/biihu/
/krɪsməs/	'Christmas'	/kurisumasu/
/θrɪl/	'thrill'	/suriru/

Hirayama (2003) assumes, as I did earlier with respect to the three-vowel system of Western Arrarnta, that epenthetic vowels tend to be unmarked. Recall:

Some three-vowel systems



Western Arrarnta

Here are the vowel ranges of another Pama-Nyungan language, Western Arrarnta (Anderson 2000).

The vowel /a/ is restricted to a very small space; we infer it is [low].

/i/ "varies in quality from [ɛ] to [i]." We can assign it [front].

/ə/ is "extremely variable" in height and backness, with unrounded and rounded allophones (so it could be written /u/). It also appears to be the epenthetic vowel.

The epenthetic vowel /ə/has no marked features: it is (*non-low*) and (*non-front*).

Epenthesis into loan words from English

If /u/ is the default epenthetic vowel, we might assume that it has no marked features, other things being equal.

/i/ is inserted after English /ʃ, tʃ, dʒ/ and, in older loans, after front /k/:

English		*Japanese*	
/brʌʃ/	'brush'	/burasi/	[buraɕi]
/bitʃ/	'beach'	/biiti/	[biːt͡ɕi]
/dʒʌdʒ/	'judge'	/djaddi/	[ʤaʤːi]
/keɪk/	'cake'	/keikki/	[keeki]

Hirayama observes that /i/ is chosen so as to maintain the palatality of the preceding consonants, which presumably share a front feature with /i/, consistent with Trubetzkoy's analysis.

Epenthesis into loan words from English

Hirayama (2003) calls it [coronal]; I will call it [front], but it amounts to the same thing.

/o/ is inserted after English /t, d, h/:

English		*Japanese*	**Result before /u/*
/treɪn/	'train'	/toreɪN/	*[c͡ɕu…]
/tɛnt/	'tent'	/teNto/	*[…c͡ɕu]
/dræmə/	'drama'	/dorama/	*[d͡zu…]
/hwaɪt/	'white'	/howaito/	*[ɸu…]

Hirayama (2003) suggests that /u/ is not chosen because it would create allophones of the preceding consonants that would make them too far from the English sounds.

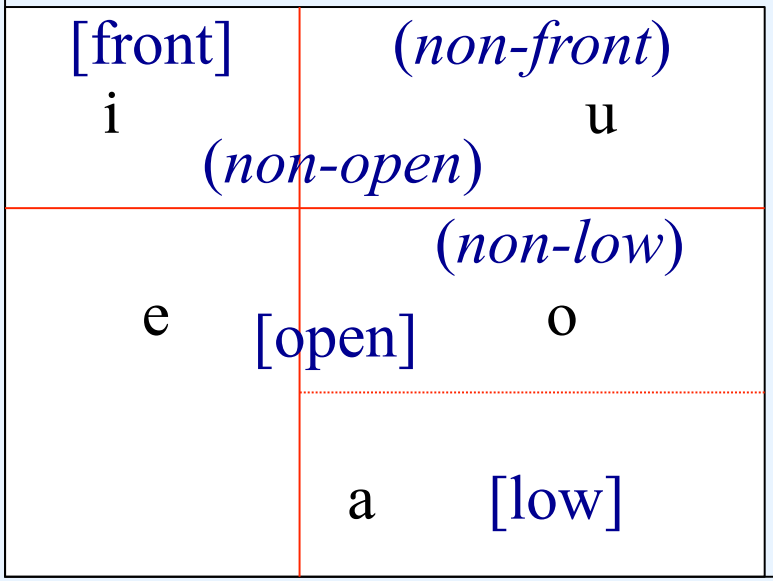
Tokyo Japanese vowel features

Based on epenthesis, we conclude that [front] is marked.

We assume that /u/ is also not marked for height: Hirayama proposes that the height feature is [low], comprising /e, o, a/.

I will call this feature [open], since the only vowels that are (*non-open*) are the high vowels.

Japanese



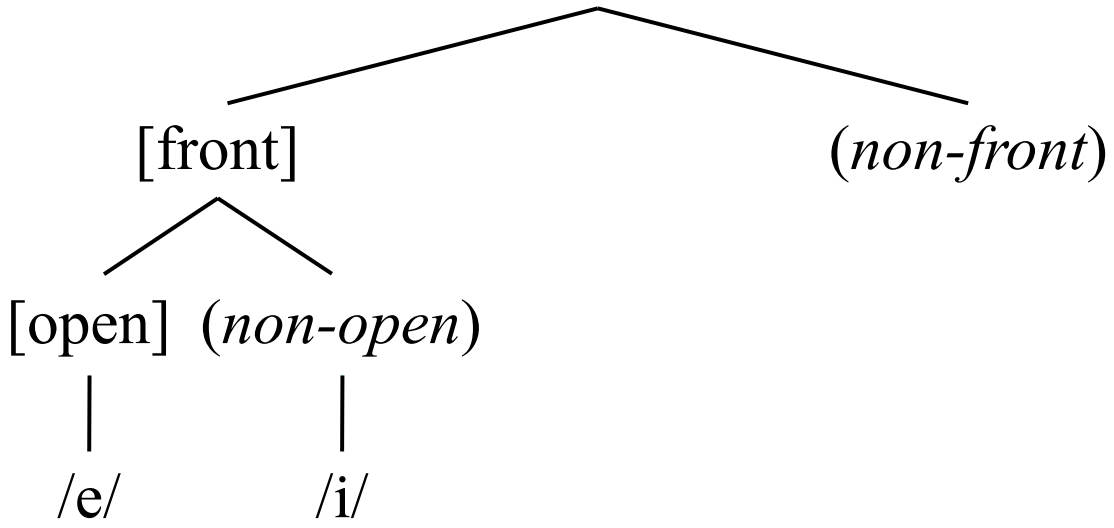
It remains to distinguish /o/ and /a/. I depart from Hirayama's analysis in this regard: I suppose that /a/ is more marked than /o/, because /o/ is epenthetic after /t, d, h/, not /a/.

I will call this third feature [±low]

Tokyo Japanese vowel hierarchy

We have seen no evidence that would decide the ordering of [front] and [open] in the hierarchy; either choice would work.

I will follow Trubetzkoy in putting [±front] first. There are only two [front] vowels, distinguished by [±open].

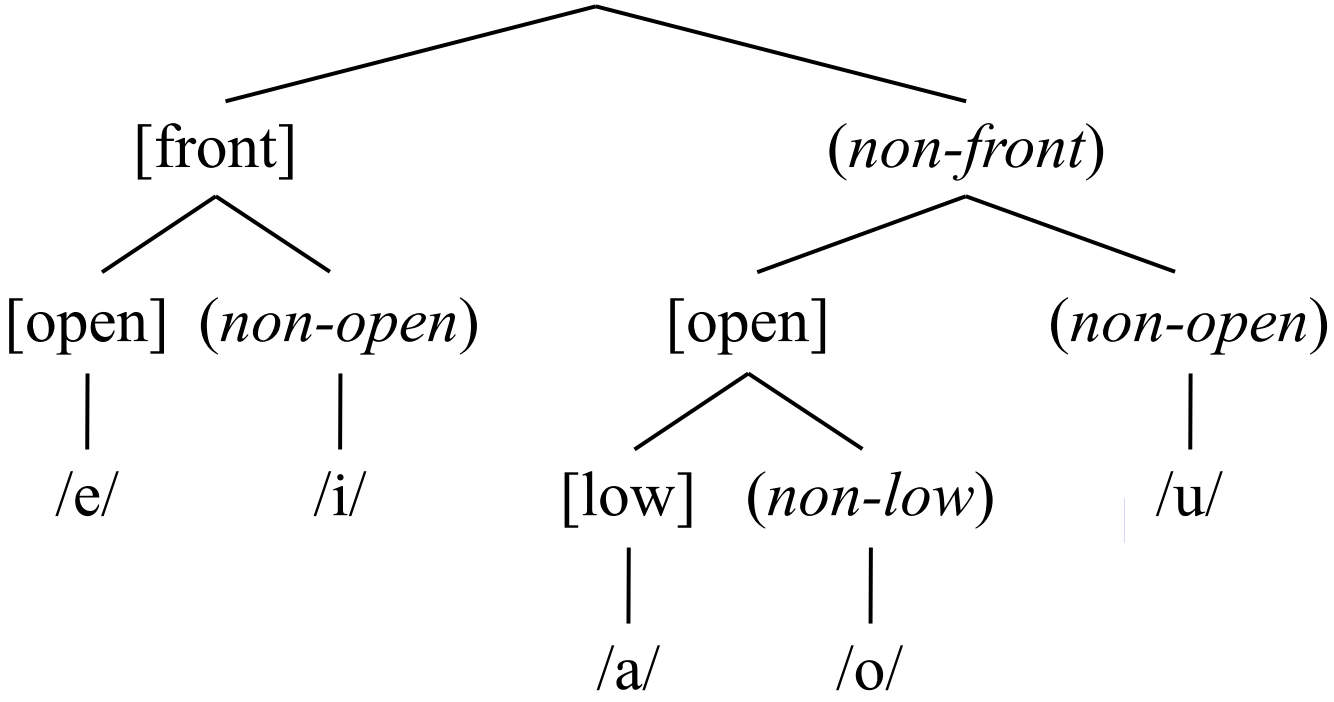


Tokyo Japanese vowel hierarchy

The (*non-front*) vowels are also divided by [±open]: there is one (*non-open*) vowel, /u/.

The two [*non-front,* open] vowels are divided by [±low].

[front] > [open] > [low]



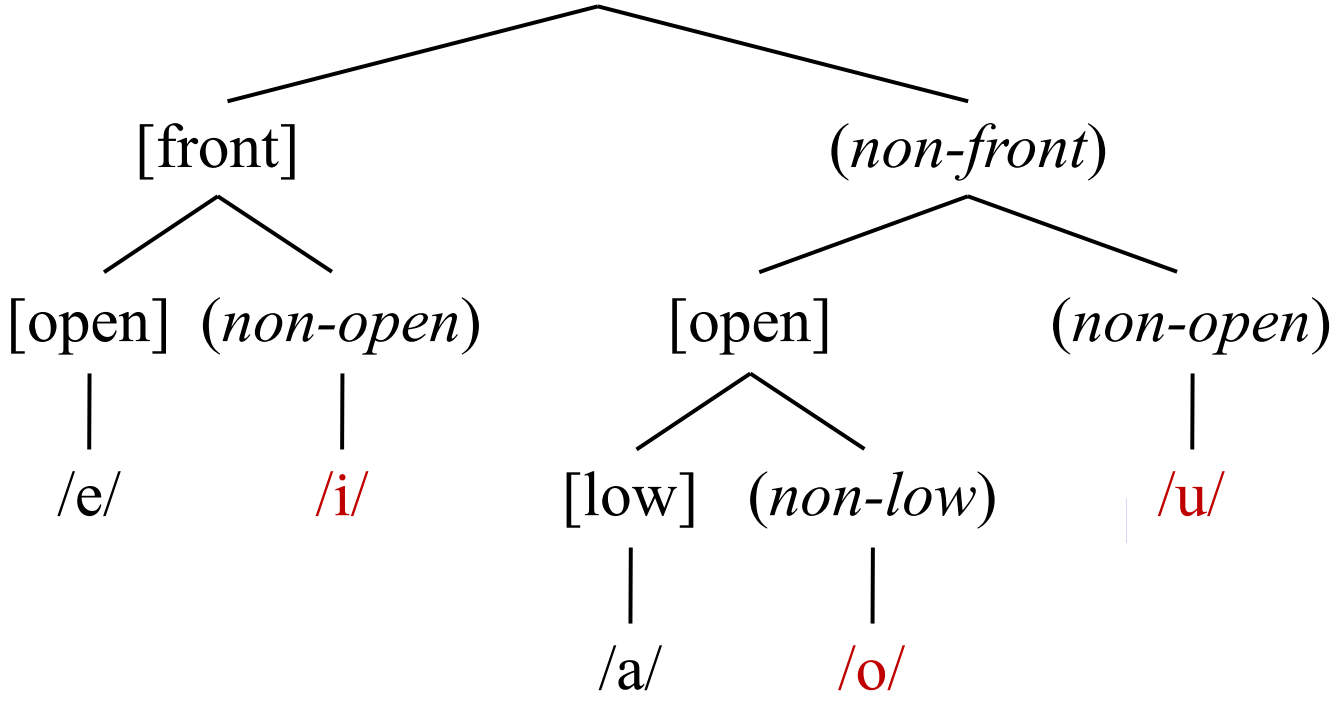
Tokyo Japanese vowel hierarchy

With respect to the choice of epenthetic vowel:

/u/ has no marked features, and is the default epenthetic vowel;

/i/ is the least marked [front] vowel, when [front] is required;

/o/ is the next-least marked (*non-front*) vowel.



Tokyo Japanese vowel hierarchy

The contrastive features for each vowel are as shown:

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

Vowel coalescence

Another process involving vowels is vowel coalescence, whereby two adjacent vowels combine to form one long vowel (Kubozono (1999, 2001), McCawley (1968):

/uma+i/	‘good’	⟶	/umee/	/ai/ > [ee]
/sugo+i/	‘amazing’	⟶	/sugee/	/oi/ > [ee]
/mazu+i/	‘bad in taste’	⟶	/mazii/	/ui/ > [ii]
/omae/	‘you’	⟶	/omee/	/ae/ > [ee]
/osie+te/	‘Tell me’	⟶	/oseete/	/ie/ > [ee]
/taka+ku/	‘tall, high’	⟶	/takoo/	/au/ > [oo]
/atarasi+ku/	‘new’	⟶	/atarasjuu/	/iu/ > [uu]

Vowel coalescence

Hirayama (2003) follows Causley (1999) in proposing that the resolution of vowel hiatus should reflect the feature specifications of the vowels involved.

Specifically, all things being equal, it is the marked features that decide the quality of the resultant vowel, while unmarked features are inert in coalescence (see also St-Amand 2012 for a similar analysis of vowel coalescence in Québec French).

In Japanese, markedness decides the height of the resulting vowel; the place is determined by the place of the rightmost vowel.

Vowel coalescence

/a/	/i/				
(*non-front*)	[front]	⟶	[front]	⟶	[front] = /ee/
[open]	(*non-open*)		[open]		[open]
[low]			[low]		~~[low]~~

When /a/ coalesces with /i/, the result is /ee/. The place is taken from the second vowel, /i/; this yields [front].

/a/ has two marked height features, [open] and [low]. However, the combination [front, open, low] does not exist in Japanese, and cannot be created by coalescence.

Therefore, one of [open] or [low] must be deleted. Since [low] depends on [open], it is deleted; the result is [front, open] = /e/.

Vowel coalescence

/a/	/u/		
(*non-front*)	(*non-front*)	⟶	(*non-front*) = */aa/
[open]	(*non-open*)		[open]
[low]			[low]

When /a/ coalesces with /u/, the result is /oo/. As Hirayama (2003) points out, there is a problem here.

The marked features come from /a/. If we add the default place, (*non-front*), we obtain */aa/, which is incorrect.

In order to obtain /oo/, we need to add a feature to /u/ that /a/ does not have; Hirayama (2003) suggests [peripheral], defined by Rice (2002) as dorsality or labiality or both.

However, the only way we can add more vowel features is by enhancement or by other post-lexical processes.

Post-lexical phonology and enhancement

Hirayama (2003) argues that vowel coalescence occurs in the post-lexical component (Pulleyblank 1983; Kiparsky 1985).

The reason is that vowel coalescence in Japanese is variable and depends on style differences. According to Lombardi (1996), an optional process that depends on style and speed is post-lexical (or later).

Post-lexical phonology and enhancement

Following Hirayama's (2003) account, we can suppose that (*non-front*) vowels that are not [low] enhance their (*non-front*) feature with a place feature.

Rather than [peripheral], I will call it {back}. This enhancement does not apply to [low] vowels, hence it does not apply to /a/.

High vowels enhance (*non-open*) with {high}.

/i/	/e/	/a/	/o/	/u/
[front]	[front]	(*non-front*)	(*non-front*)	(*non-front*)
			{back}	{back}
(*non-open*)	[open]	[open]	[open]	(*non-open*)
{high}				{high}
		[low]	(*non-low*)	

Vowel coalescence with enhancement

/a/	/u/		
(*non-front*)	(*non-front*)	⟶	= /oo/
	{back}	{back}	
[open]	(*non-open*)	[open]	
[low]	{high}	~~[low]~~ ~~{high}~~	

Returning to the coalescence of /a/ + /u/ to /oo/, once we add the enhancement features, we transfer {back}, the place feature of /u/, and [open], a marked feature on /a/.

The features [low] and {high} cancel each other out (or alternatively, are not compatible with the features {back} and [open]), , and we are left with a vowel that is {back} and [open], that is, /oo/.

Affrication and high vowel devoicing

Two processes that involve the high vowels /i/ and /u/ are affrication of coronal consonants and high vowel devoicing.

Coronal plosives /t, d/ are affricated before high vowels /i, u/;

and the high vowels /i, u/ devoice between voiceless obstruents (Hirayama 2003, citing Kubozono 1999; Sugito 1997; Vance 1987; see also Hirayama 2009).

/t, d/	→	palatal affricate	[c͡ɕ, ɟ͡ʑ]	/ _____ *i, j*
	→	alveolar affricate	[t͡s, d͡z]	/ _____ *u*
	→	dental plosive	[t̪, d̪]	/ _____ elsewhere (*e, a, o*)
/i, u/	→	[–voice] / C _____ C [vl, obst] [vl, obst]		[kᵤ̥tsuᵤ̥ita] ‘sock(s)’

Affrication and high vowel devoicing

Hirayama (2003) proposes that these processes are also post-lexical, because they create allophones rather than change one phoneme into another.

In addition, Hirayama (2009) points out that high vowel devoicing shows other characteristics of post-lexical rules: it applies across a word boundary, it has no exceptions, its outputs are gradient, and it is not categorical.

Therefore, as these rules are post-lexical, they are able to refer to the enhancement feature {high}, which picks out /i/ and /u/.

Affrication and high vowel devoicing

Without disputing that these rules apply post-lexically in Japanese, I observe that it is possible to have rules that create allophones in the contrastive phonology, that is, in the lexical phonology.

The pre-history of Old English gives an example of this, as well as illustrating how a post-lexical rule can become lexical, and how an enhancement feature can become contrastive.

6.

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

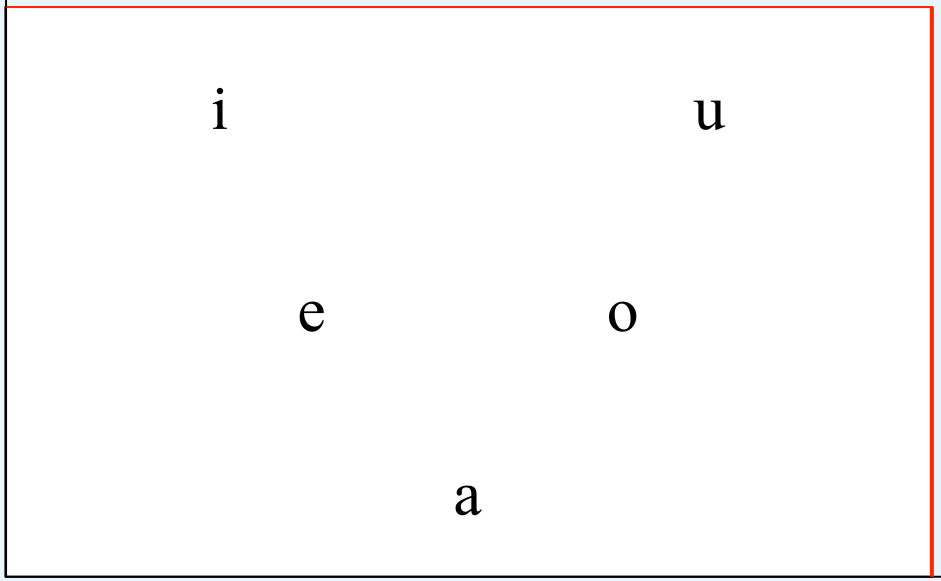
At a certain time, the West Germanic vowel system had five short and five long vowels (Antonsen 1965; Ringe & Taylor 2014: 106).

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).

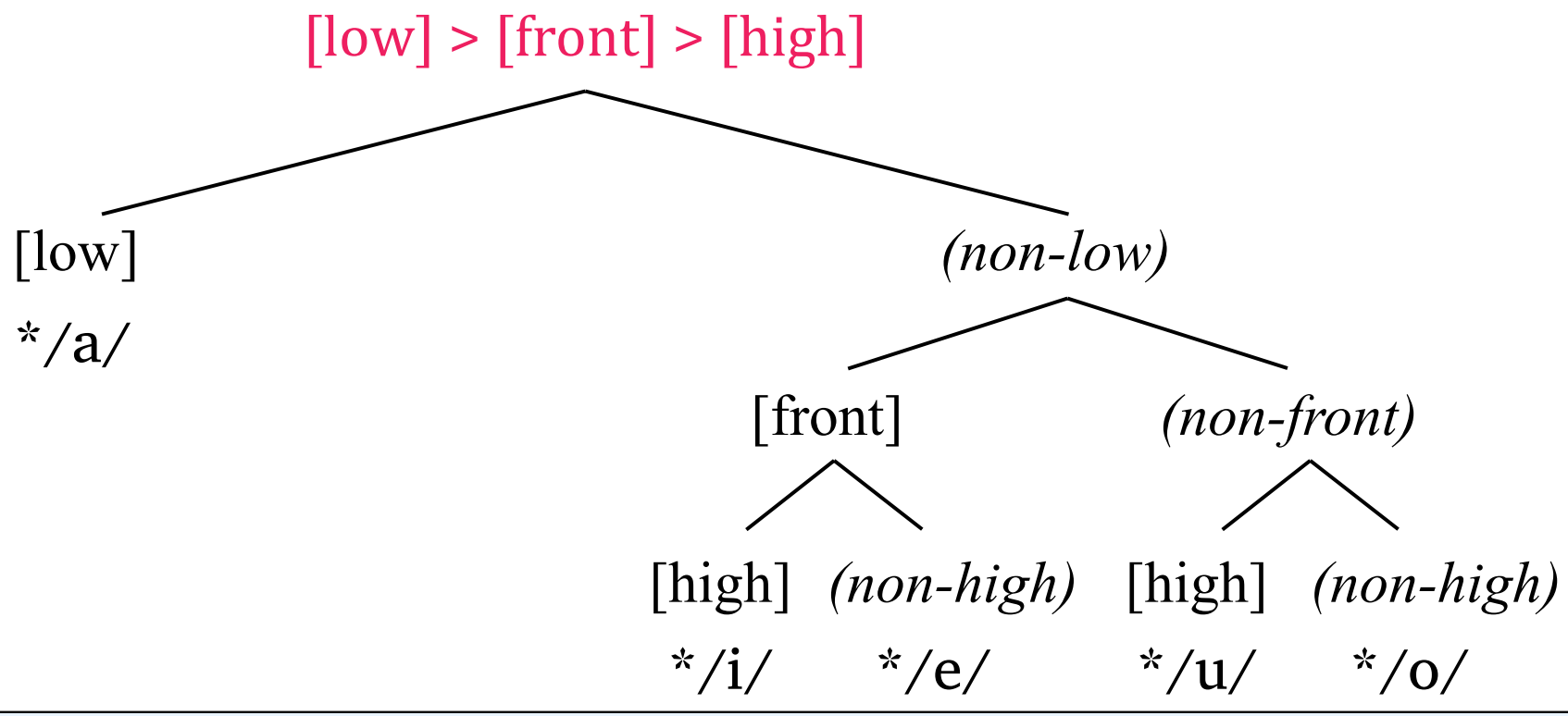
I will henceforth disregard vowel length.



West Germanic feature hierarchy

I have argued (Dresher 2017) that at this stage West Germanic had the vowel feature hierarchy [low] > [front] > [high].

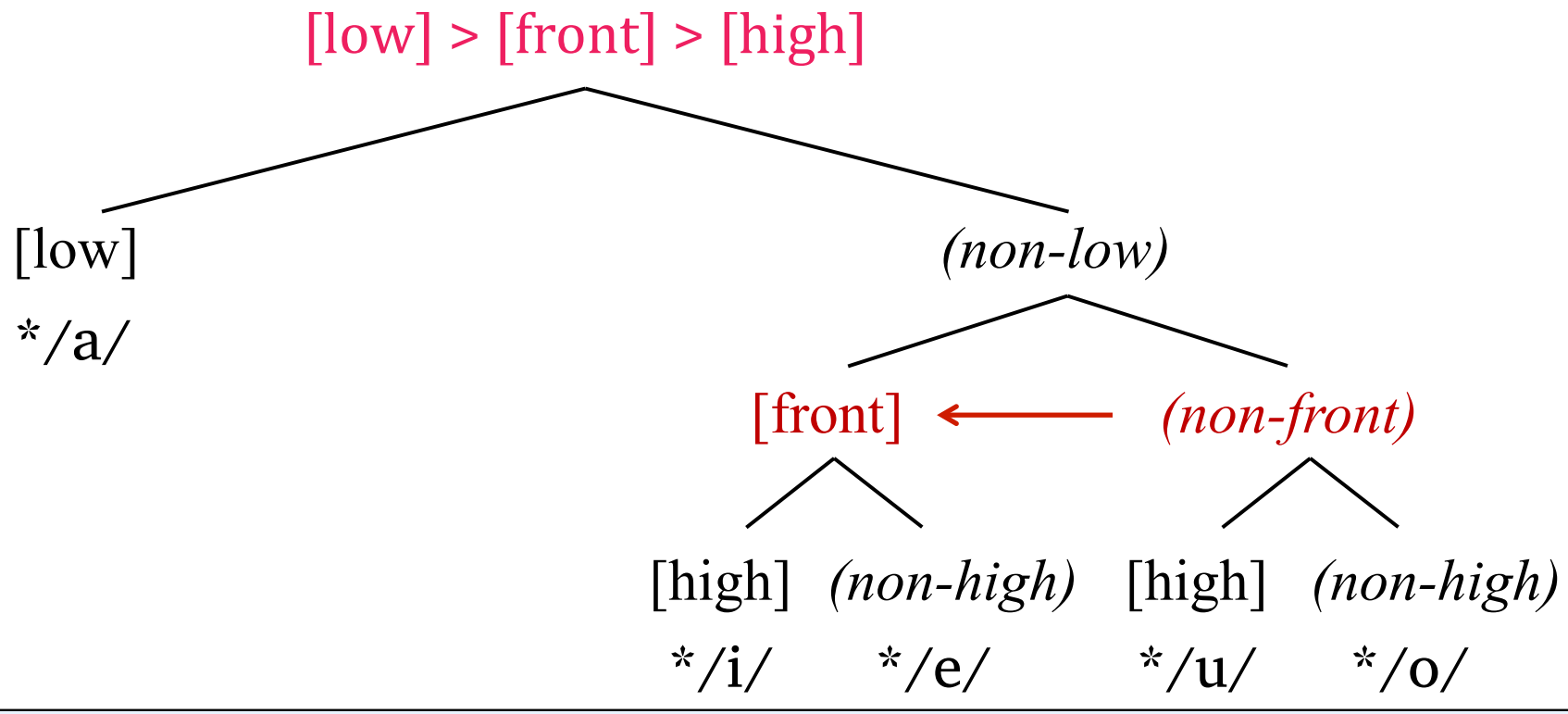
The feature [round] is not contrastive at this point.



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

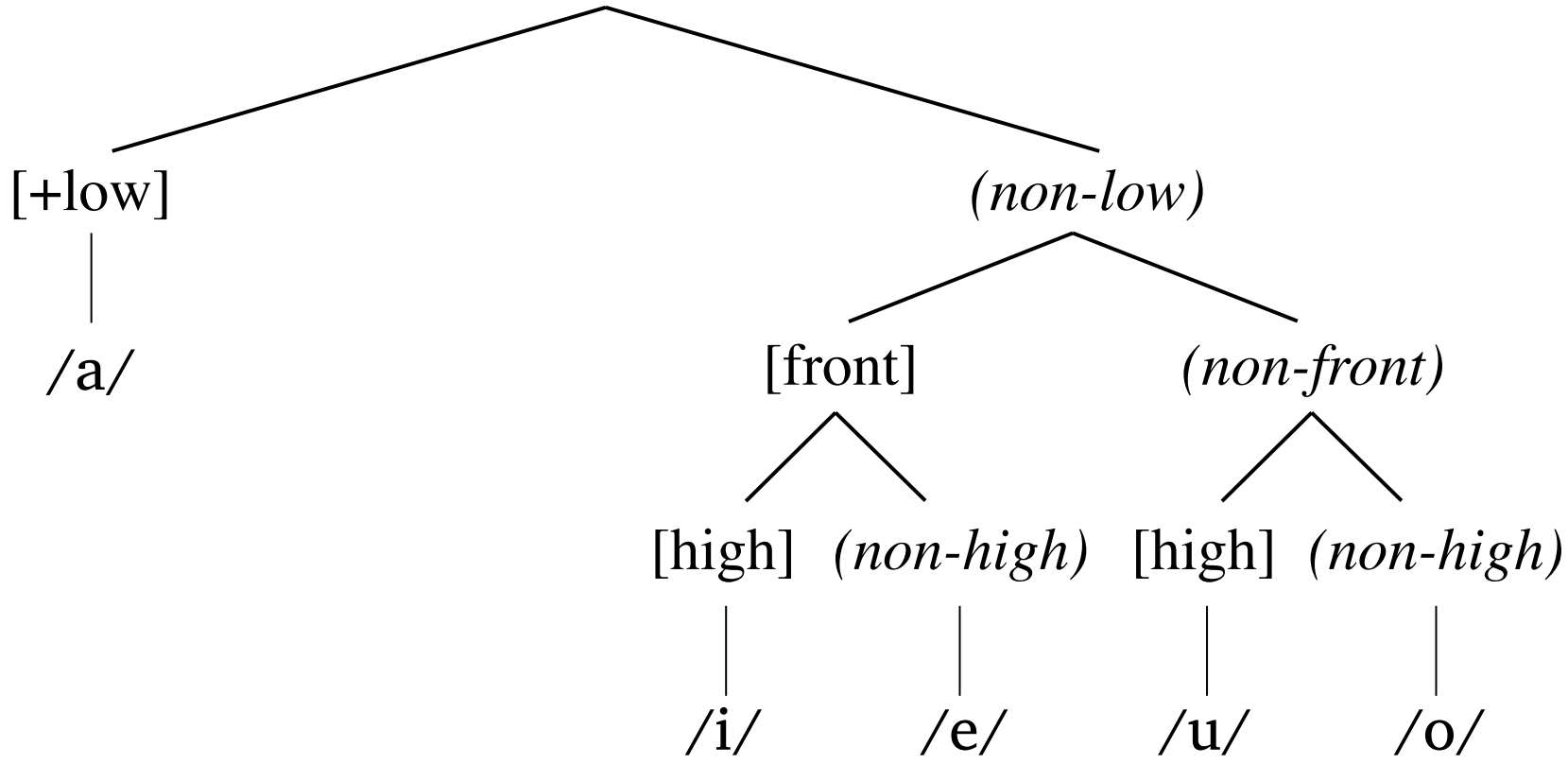
Over time, however, there is evidence that *i*-umlaut became a lexical rule, even while it was still creating fronted allophones of the vowels */u/ and */o/ (see Liberman 1991, Fertig 1996, Janda 2003, and P. Kiparsky 2015 for discussion).

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.

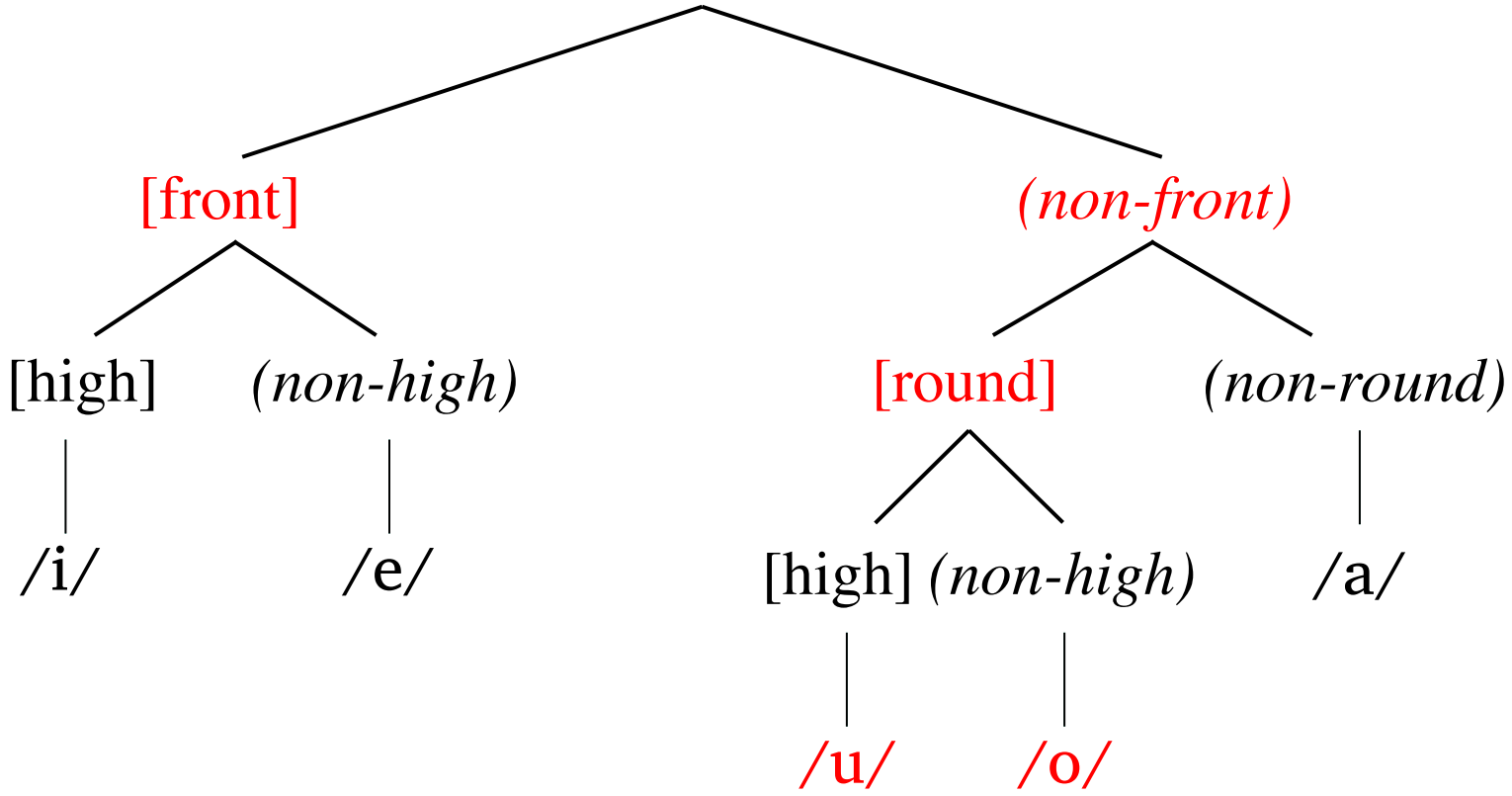
This hierarchy requires demoting [low] to allow [round] to be contrastive over the non-front vowels.

In tree form this new hierarchy looks as follows:

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

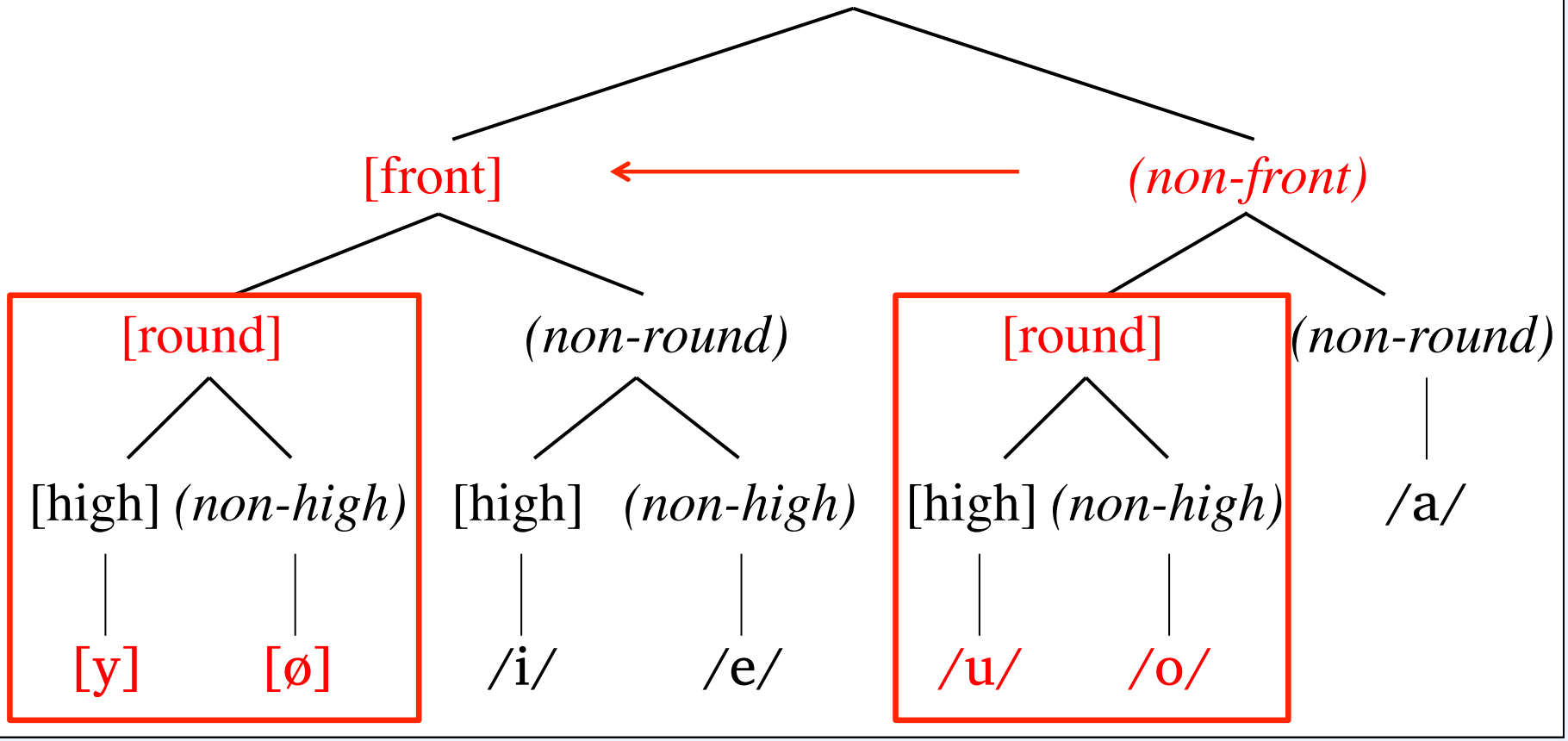
West Germanic feature hierarchy 2

[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.

7.

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!

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


AND THANK YOU!


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References

Anderson, Victoria Balboa. 2000. Giving weight to phonetic principles: The case of place of articulation in Western Arrernte. Doctoral dissertation, UCLA.

Antonsen, Elmer H. 1972. The Proto-Germanic syllabics (vowels). In Frans van Coetsem & Herbert L. Kufner (eds.), *Toward a grammar of Proto-Germanic*, 117–40. Tübingen: Max Niemeyer.

Benediktsson, Hreinn. 1967. The Proto-Germanic vowel system. In *To honor Roman Jakobson*, Vol. 1, 174–96. The Hague & Paris: Mouton.

Bohn, Graziela. 2015. Aquisição das vogais tônicas e pretônicas do Português Brasileiro. Doctoral dissertation, University of São Paulo.

Bohn, Graziela. 2017. How to get there from here: Building hierarchies in Brazilian Portuguese. Presented at Georgetown University Round Table, March 2017.

Causley, Trisha Kathleen. 1999. Complexity and markedness in Optimality Theory. Doctoral dissertation, University of Toronto.

Chomsky, Noam & Morris Halle. 1968. *The sound pattern of English*. New York, NY: Harper & Row.

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

Clements, G. N. 2003. Feature economy in sound systems. *Phonology* 20. 287–333.

Clements, G. N. 2009. The role of features in speech sound inventories. In Eric Raimy & Charles E. Cairns (eds.), *Contemporary views on architecture and representations in phonological theory*, 19–68. Cambridge, MA: MIT Press.

Compton, Richard & B. Elan Dresher. 2011. Palatalization and 'strong *i*' across Inuit dialects. *Canadian Journal of Linguistics/ Revue canadienne de linguistique* 56. 203–28.

Douglas, Wilfrid H. 1955. Phonology of the Australian Aboriginal language spoken at Ooldea, South Australia, 1951-1952. *Oceania* 25. 216–29.

Dresher, B. Elan. 1998. On contrast and redundancy. Presented at the annual meet-ing of the Canadian Linguistic Association, Ottawa. Ms., University of Toronto.

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

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

Dresher, B. Elan. 2015. The motivation for contrastive feature hierarchies in phonology. *Linguistic Variation* 15. 1–40.

Dresher, B. Elan. 2016. Contrast in phonology 1867–1967: History and development. *Annual Review of Linguistics* 2. 53–73.

Dresher, B. Elan. 2017. Contrastive Feature Hierarchies in Old English Diachronic Phonology. *Transactions of the Philological Society*, doi:10.1111/1467-968X.12105.

Dresher, B. Elan, Glyne L. Piggott & Keren Rice. 1994. Contrast in phonology: Overview. *Toronto Working Papers in Linguistics* 13.1. iii-xvii.
Dresher, B. Elan & Keren Rice. 2007. Markedness and the contrastive hierarchy in phonology. http://homes.chass. utoronto.ca/~contrast/.
Dresher, B. Elan & Keren Rice. 2015. Phonological typology with contrastive hierarchies. MOLT Phonology Atelier, University of Toronto, March 2015.
Dyck, Carrie. 1995. Constraining the phonology–phonetics interface, with exemplification from Spanish and Italian dialects. Doctoral dissertation, University of Toronto.
Fertig, David. 1996. Phonology, orthography, and the umlaut puzzle. In Rosina L. Lippi-Green & Joseph C. Salmons (eds.), *Germanic linguistics: Syntactic and diachronic*, 169–184. Amsterdam/Philadelphia: John Benjamins.
Hall, Daniel Currie. 2007. The role and representation of contrast in phonological theory. Doctoral dissertation, University of Toronto.
Hall, Daniel Currie. 2011. Phonological contrast and its phonetic enhancement: Dispersedness without dispersion. *Phonology* 28. 1–54.
Hirayama, Manami. 2003. Contrast in Japanese vowels. *Toronto Working Papers in Linguistics* 20: 115–32.
Hirayama, Manami. 2009. Postlexical Prosodic Structure and Vowel Devoicing in Japanese. Doctoral dissertation, University of Toronto.
Hyman, Larry M. 2008. Universals in phonology. *The Linguistic Review* 25. 83–137.

Ingram, David. 1988. Jakobson revisited: Some evidence from the acquisition of Polish phonology. *Lingua* 75. 55–82.
Ingram, David. 1989. *First language acquisition: Method, description and explanation*. Cambridge: CUP.
Jakobson, Roman. 1941. *Kindersprache, Aphasie, und allgemeine Lautgesetze*. Uppsala: Uppsala Universitets Arsskrift.
Jakobson, Roman. 1968. *Child language, aphasia, and phonological universals*. Translation of Jakobson 1941 by A. R. Keiler. The Hague: Mouton.
Jakobson, Roman & Morris Halle. 1956. *Fundamentals of language.* The Hague: Mouton.
Janda, Richard D. 2003. "Phonologization" as the start of dephoneticization – or, on sound change and its aftermath: Of extension, generalization, lexicalization, and morphologization', in Brian D. Joseph & Richard D. Janda, (eds.), *The handbook of historical linguistics*, 401–22. Oxford: Blackwell.
Keyser, Samuel Jay & Kenneth N. Stevens. 2001. Enhancement revisited. In Michael J. Kenstowicz (ed.), *Ken Hale: A life in language*, 271–91. Cambridge, Mass.: MIT Press.
Keyser, Samuel Jay & Kenneth N. Stevens. 2006. Enhancement and overlap in the speech chain. *Language* 82. 33–63.
Kiparsky, Paul. 1985. Some consequences of lexical phonology. *Phonology Yearbook* 2. 85–138.

Kiparsky, Paul. 2015. Phonologization. In Patrick Honeybone & Joseph Salmons (eds.), *The handbook of historical phonology*, 563–79. Oxford: Oxford University Press.
Kiparsky, Valentin. 1932. Johdatusta fonologiaan. *Virittäjä* 36. 230–50.
Kubozono, Haruo. 1999. *Nihon-go no onsei [Sounds of Japanese]*. Tokyo: Iwanami Syoten.
Kubozono, Haruo. 2001. Epenthetic vowels and accent in Japanese: Facts and paradoxes. In Jeroen van de Weijer and Tetsuo Nishihara (eds.), *Issues in Japanese phonology and morphology*, 111-40. Berlin: Mouton de Gruyter.
Liberman, Anatoly. 1991. Phonologization in Germanic: Umlauts and vowel shifts. In Elmer H. Antonsen & Hans Henrich Hock (eds.), *Stæfcræft: Studies in Germanic Linguistics*, 125–37. Amsterdam: John Benjamins.
Lombardi, Linda. 1996. Postlexical rules and the status of privative features. *Phonology* 13. 1–38.
McCawley, James D. 1968. The phonological component of a grammar of Japanese. The Hague: Mouton.
Menn, Lise & Marilyn Vihman. 2011. Features in child phonology: Inherent, emergent, or artefacts of analysis? In G. N. Clements & Rachid Ridouane (eds.), *Where do features come from? Cognitive, physical and developmental bases of distinctive speech categories,* 261–301. Amsterdam: John Benjamins.
Mielke, Jeff. 2008. *The emergence of distinctive features*. Oxford: OUP.

Moran, Steven, Daniel McCloy & Richard Wright (eds.) 2014. PHOIBLE Online. Leipzig: Max Planck Institute for Evolutionary Anthropology. (Available online at http://phoible.org, Accessed on 2017-02-27.)
Moulton, Keir. 2003. Deep allophones in the Old English laryngeal system. *Toronto Working Papers in Linguistics* 20. 157–73.
Oxford, Will. 2015. Patterns of contrast in phonological change: Evidence from Algonquian vowel systems. *Language* 91. 308–357.
Penzl, Herbert. 1972. Methods of comparative Germanic linguistics. In Frans van Coetsem & Herbert L. Kufner (eds.), *Toward a grammar of Proto-Germanic*, 1–43. Tübingen: Max Niemeyer.
Pulleyblank, Douglas. 1983. *Tone in Lexical Phonology*. Dordrecht: D. Reidel.
Rice, Keren. 2002. Vowel place contrasts. In Mengistu Amberber & Peter Collins (eds.), *Language universals and variation*, 239–69 Westport, CT & London: Praeger.
Rice, Keren. 2003. Featural markedness in phonology: Variation. In Lisa Cheng & Rint Sybesma (eds.), *The second Glot International state-of-the-article book: The latest in linguistics*, 387–427. Berlin: Mouton de Gruyter.
Rice, Keren. 2007. Markedness in phonology. In Paul de Lacy (ed.), *The Cambridge handbook of phonology*, 79–97. Cambridge: CUP.
Ringe, Donald & Ann Taylor. 2014. *A linguistic history of English. Volume 2: The development of Old English*. Oxford: OUP.

Samuels, Bridget D. 2011. *Phonological architecture : A biolinguistic perspective*. Oxford: OUP.
Sapir, Edward. 1925. Sound patterns in language. *Language* 1. 37–51.
St-Amand, Anne. 2012. Hiatus and hiatus resolution in Québécois French. Doctoral dissertation, University of Toronto.
Stevens, Kenneth N. & Samuel Jay Keyser. 1989. Primary features and their enhancement in consonants. *Language* 65. 81–106.
Stevens, Kenneth N., Samuel Jay Keyser & Haruko Kawasaki. 1986. Toward a phonetic and phonological theory of redundant features. In Joseph S. Perkell & Dennis H. Klatt (eds.), *Symposium on invariance and variability of speech processes*, 432–69. Hillsdale, NJ: Lawrence Erlbaum.
Sugito, Miyoko. 1997. *Onsei hakee wa kataru* [*Sound waves speak*], Volume 4 of *Nihongo onsei no kenkyu* (Study of Japanese Sounds). Osaka: Izumi Syoin.
Tabain, Marija & Andrew Butcher. 2014. Pitjantjatjara. *Journal of the International Phonetic Association* 44/2. 189–200.
Trubetzkoy, N. S. 1939. *Grundzüge der Phonologie*. Göttingen: Vandenhoek & Ruprecht.
Trubetzkoy, N. S. 1969. *Principles of phonology*. Translation by Christiane A. M. Baltaxe of Trubetzkoy 1939. Berkeley: University of California Press.
Twaddell, W. Freeman. 1938. A note on OHG umlaut. *Monatshefte für deutschen Unterricht* 30. 177–81.

Vance, Timothy J. 1987. *An introduction to Japanese phonology*. Albany: State University of New York Press.

Zhang, Xi. 1996. Vowel systems of the Manchu-Tungus languages of China. Doctoral dissertation, University of Toronto.