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The Abstractness of Minimal Contrast

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Introduction

Phonologists working in a variety of theoretical frameworks have independently proposed that ‘minimal contrast’ plays an important role in phonology (Padgett 2003a, Nevins 2004, Calabrese 2005, Campos Astorkiza 2007).

Minimal Contrast

According to the definition proposed by Nevins (2004: 142), a segment S with specification αF is *contrastive* for F if there is another segment S' in the inventory that is featurally identical to S , except that it is $-\alpha F$.

R	S		S'	T
$[\alpha E]$	$[\alpha E]$	\equiv	$[\alpha E]$	$[-\alpha E]$
$[\alpha F]$	$[\alpha F]$		$[-\alpha F]$	$[-\alpha F]$
$[-\alpha G]$	$[\alpha G]$	\equiv	$[\alpha G]$	$[-\alpha G]$
$[-\alpha H]$	$[\alpha H]$	\equiv	$[\alpha H]$	$[-\alpha H]$

Minimal contrast at the surface

This definition is generally understood as applying to **surface phonetic** forms.

Minimal pairs: Segments differing only in the feature [voice]

p

b

t

d

ts

tʃ

k

f

s

ʃ

x

v

z

ʒ

m

n

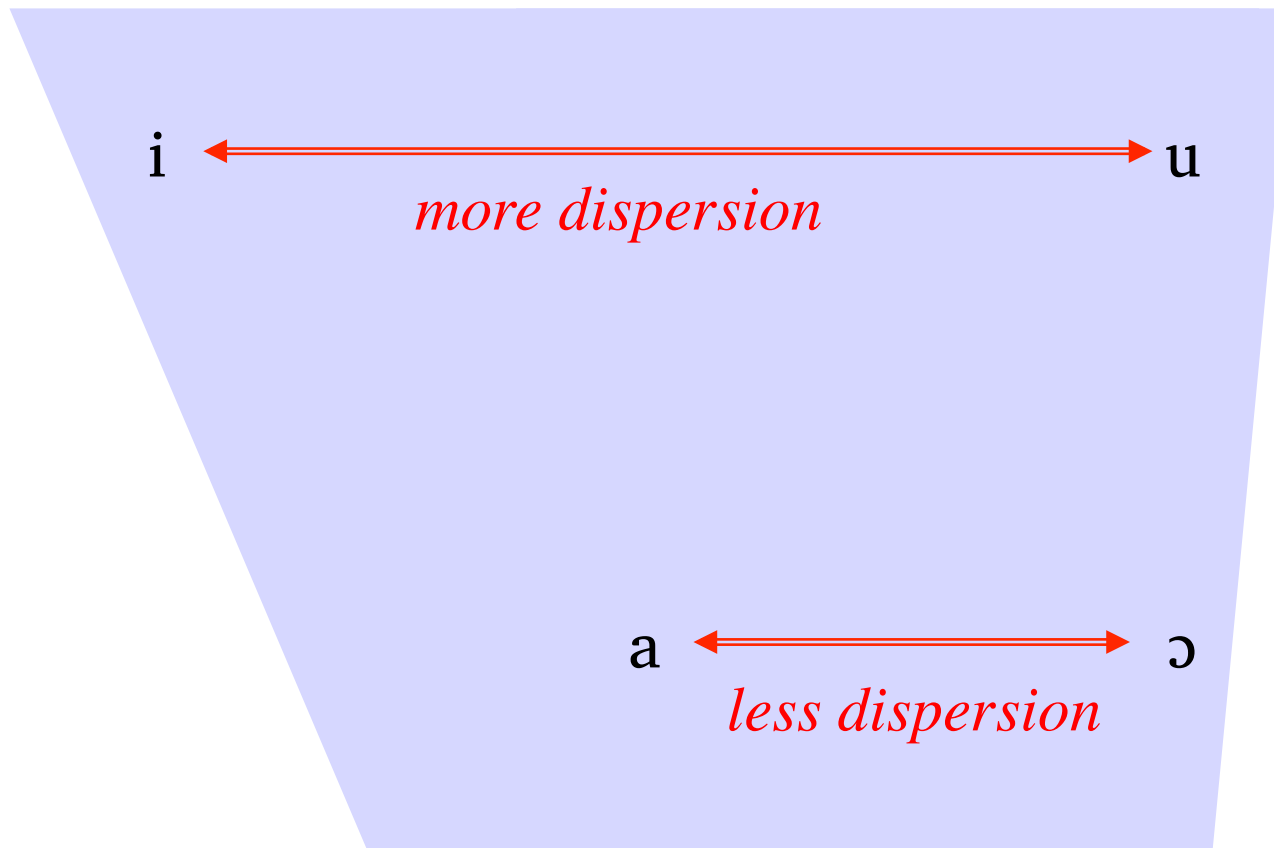
r

l

j

Minimal contrast at the surface

Dispersion-Theoretic (DT) approaches (Flemming 2002, 2004, Padgett 2003a, b, Campos Astorkiza 2007) explicitly evaluate contrast with respect to the phonetic surface.



Introduction

In this talk I will argue that the notion of minimal phonetic contrast is

- largely illusory
- often nonexistent
- and makes the wrong empirical predictions about the workings of the phonology

where it can be coherently defined.

Introduction

I will argue that phonology is indeed sensitive to contrast, but

- the appropriate level at which minimal contrast holds is at the **underlying phonemic** level
- and contrastive features must be assigned in an **order**, following language-particular **contrastive hierarchies**.

Introduction

That is, the correct notion of minimal contrast is *abstract* in two distinct ways:

- the level at which minimal contrast is evaluated: not the surface phonetic but at the **underlying phonemic** level
- regardless of the level, the minimality of contrast does not hold globally over pairwise comparisons, but is **relative to the position of the feature in the hierarchy**, a concept I will explain in more depth later on.

The Contrastivist Hypothesis

All the analyses to be considered here assume what Hall (2007: 20) calls the *Contrastivist Hypothesis*:

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

It follows that only *contrastive* features can *trigger* phonological processes.

In all the cases to be discussed contrastive features play a special role. The issue will be how to identify which features are contrastive.

The Contrastivist Hypothesis and Minimal Contrast

I will begin with a relatively simple case, Romance metaphony, that shows the importance of the Contrastivist Hypothesis and which seems at first to work well in terms of minimal surface contrast, though it doesn't really.

The next case involves Lithuanian vowel contrasts. I will argue that a Dispersion Theoretic analysis based on surface contrasts fails, and that again the relevant contrasts are found at an underlying phonemic level.

The Contrastivist Hypothesis and Minimal Contrast

The third case, comparing German and Czech /h/, will show more clearly the problems with minimal pairs even at the underlying level, and the necessity for a contrastive hierarchy of features.

I will then show how a contrastive feature hierarchy accounts for the three cases discussed to here.

The final case is a more extended example, concerning a change in East Slavic. It illustrates the main themes of this talk.

Cases

- Romance metaphony
- Lithuanian vowel contrasts
- German and Czech /h/
- East Slavic post-velar fronting

Metaphony in Iberian Spanish and Italian

Metaphony is a type of vowel harmony in which some high desinential vowels trigger raising of some stressed vowels.

The following are examples of metaphony in Pasiego (Romance, Spain), as given by Dyck (1995), adapted from Penny (1969). Centralization/laxing of unstressed vowels is not shown.

Metaphony (Pasiego)

Desinential /u/ triggers raising of stressed /é/ to [í] and stressed /ó/ to [ú]:

Unmetaphonized

afilit[é]ros ‘needle-cases’

g[ó]rdo ‘fat (neuter)’

ab[jé]rtos ‘open (plural)’

k[wé]rpos ‘bodies’

Metaphonized

afilit[í]ru ‘needle-case’

g[ú]rdu ‘fat (masculine)’

ab[jí]rtu ‘open (plural)’

k[wí]rpu ‘body’

Metaphony (Pasiego)

Stressed /í/, /ú/, and /á/ are not affected:

Unmetaphonized

luz m[í]yos ‘mine (plural)’

bj[ú]da ‘widow’

br[á]θos ‘arms’

Neutral

il m[í]yu ‘mine (singular)’

bj[ú]du ‘widower’

br[á] θu ‘arm’

Metaphony in Iberian Spanish and Italian

Dyck (1995), modifying an earlier observation by Penny (1970), formulates the following generalization about metaphony (raising) triggered by desinential vowels:

Dyck's Generalization

Desinential high vowels can trigger metaphony only if they contrast with a mid vowel in the same place.

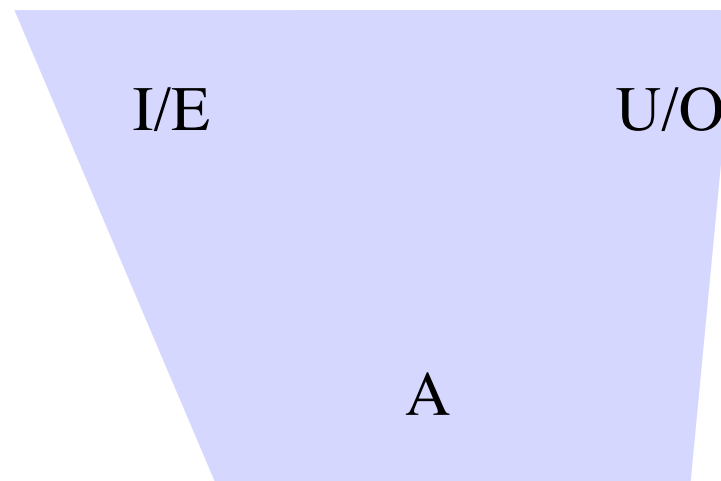
Note that we are referring here to contrasts *only among the desinential vowels*. In every dialect high vowels contrast with mid vowels in stressed syllables; but dialects have different inventories of desinential vowels, ranging from 3 to 5.

Dyck's Generalization

Desinential high vowels can trigger metaphony only if they contrast with a mid vowel in the same place.

Predictions

No raising in dialects with only 3 desinential vowels: there is no contrast between /I/ and /E/ or /U/ and /O/.

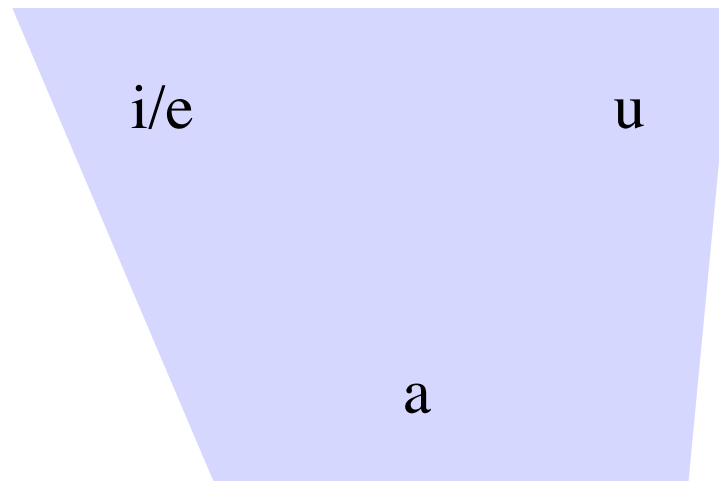


Dyck's Generalization

Desinential high vowels can trigger metaphony only if they contrast with a mid vowel in the same place.

Example

No raising reported in Leonese dialects, where desinences are phonetically [i,a,u] or [e,a,u], depending on the dialect. Thus, it is not sufficient for a desinential vowel to be phonetically high.



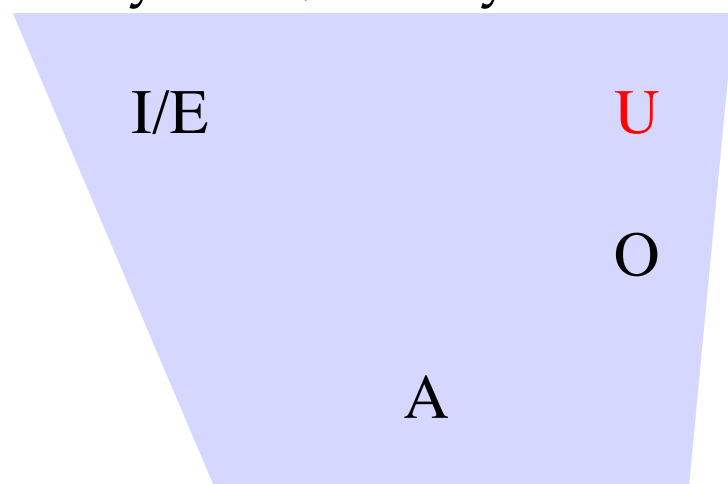
Dyck's Generalization

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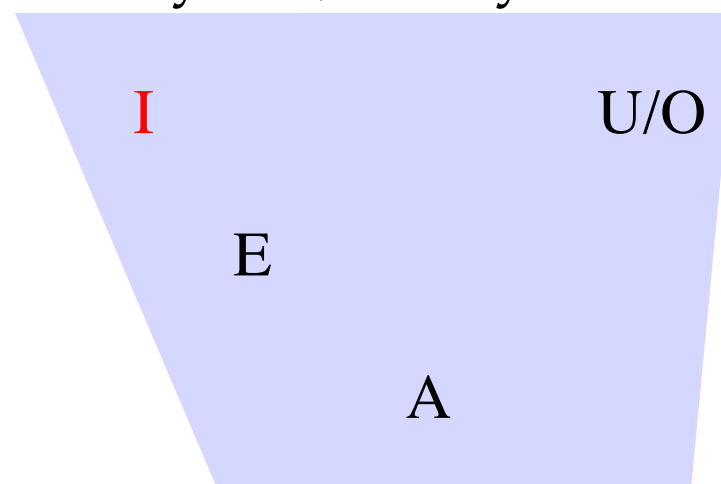
Predictions

In dialects with 4 desinential vowels:

Raising can be triggered
by /U/, not by /I/



Raising can be triggered
by /I/, not by /U/



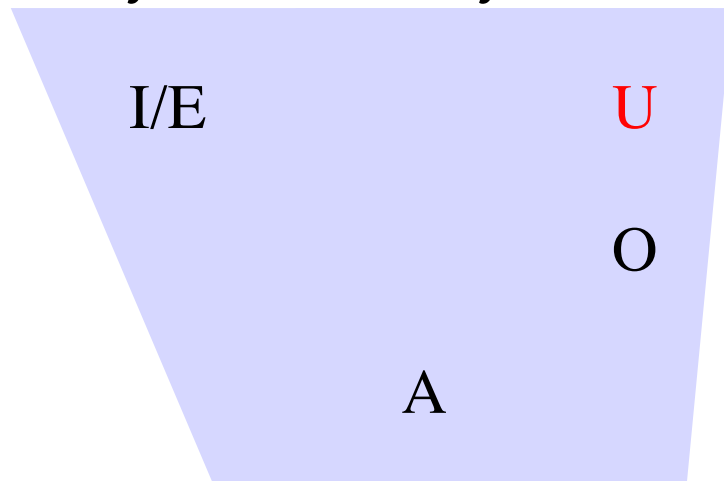
Dyck's Generalization

Desinential high vowels can trigger metaphony only if they contrast with a mid vowel in the same place.

Example

In dialects with 4 desinential vowels:

Raising can be triggered
by /U/, not by /I/



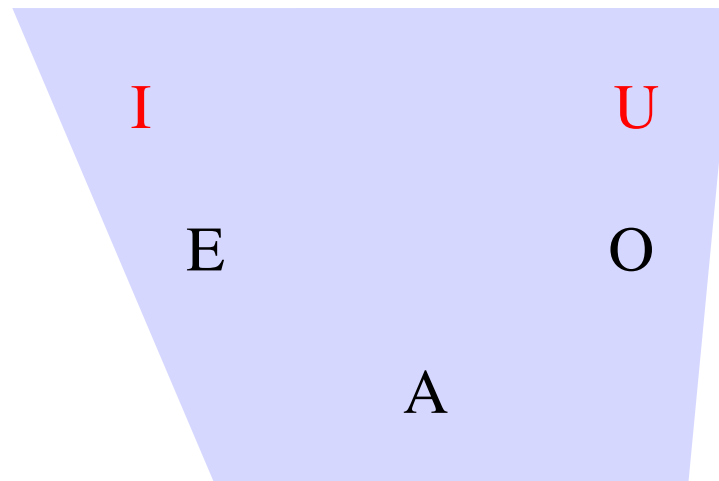
In Central Asturias, North Central Asturias, and Santander (Montañese dialects), /u/ contrasts with /o/, but there is only a marginal, archaic contrast between /i/ and /e/. Raising is triggered by [u], not by [i].

Dyck's Generalization

Desinential high vowels can trigger metaphony only if they contrast with a mid vowel in the same place.

Predictions

In dialects with 5 desinential vowels, both /I/ and /U/ can trigger raising:

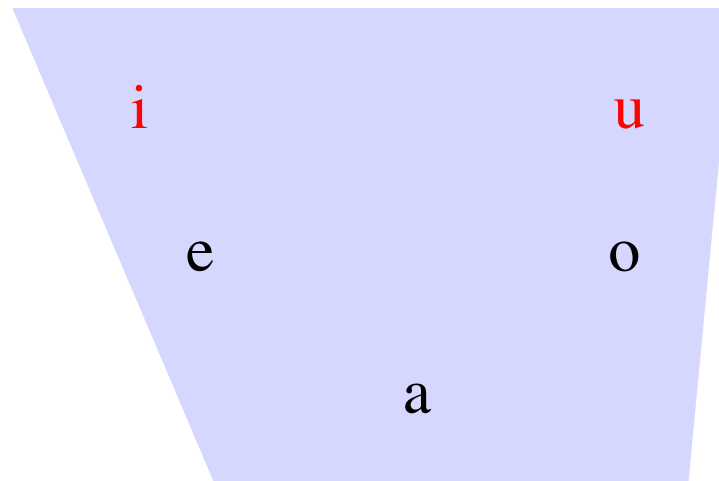


Dyck's Generalization

Desinential high vowels can trigger metaphony only if they contrast with a mid vowel in the same place.

Example

No Spanish dialects are of this type, but there are Italian dialects, such as Servigliano, that have 5 desinential vowels and raising. Both [i] and [u] trigger raising:



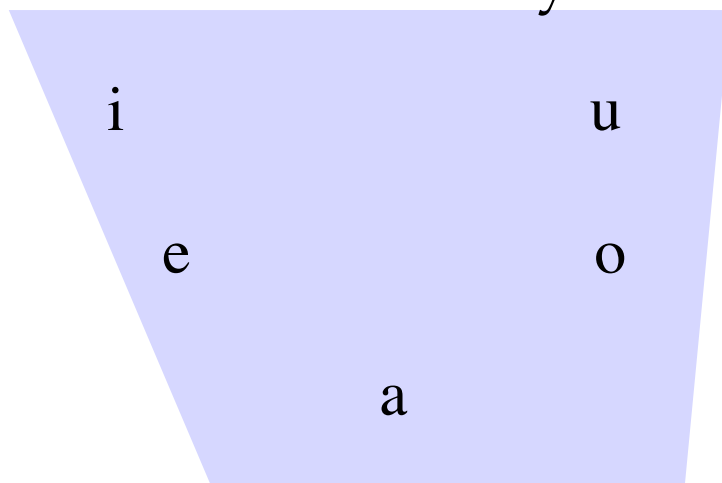
Accounting for Dyck's Generalization

Desinential high vowels can trigger metaphony only if they contrast with a mid vowel in the same place.

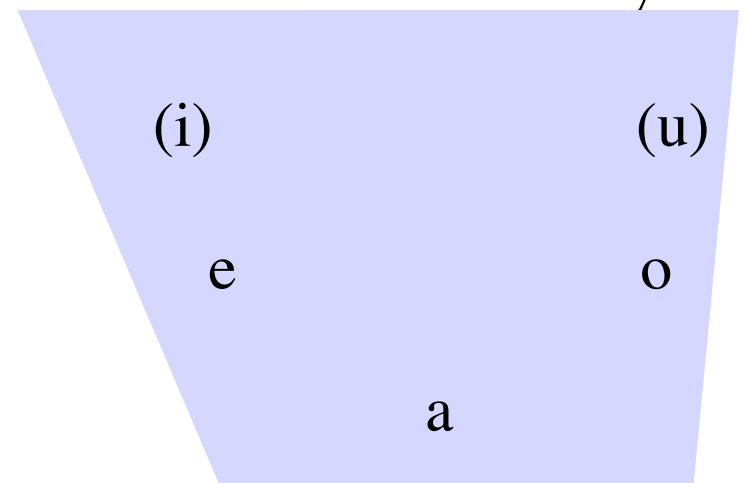
Assumptions

Vowel inventories are divided into stem inventories and desinential inventories. Contrasts in each inventory are assessed separately

Stem inventory



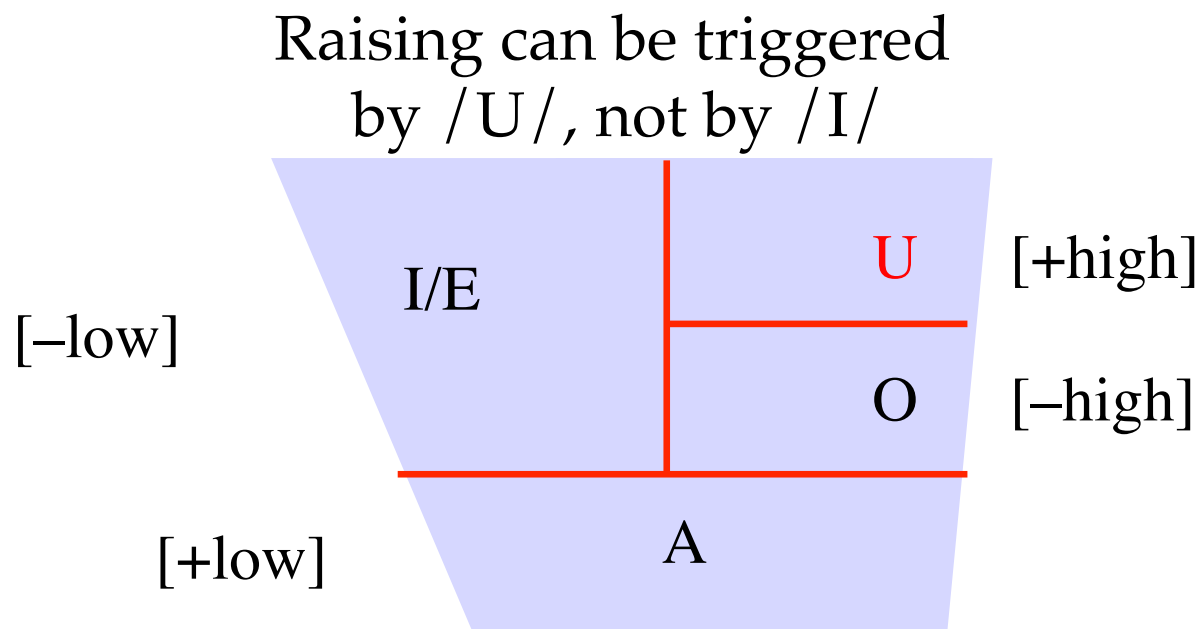
Desinential inventory



Accounting for Dyck's Generalization

Desinential high vowels can trigger metaphony only if they contrast with a mid vowel in the same place.

Now we can see that Dyck's Generalization follows from the Contrastivist Hypothesis: only desinential vowels bearing a *contrastive* [high] feature can trigger metaphony.



Contrast via Minimal Pairs?

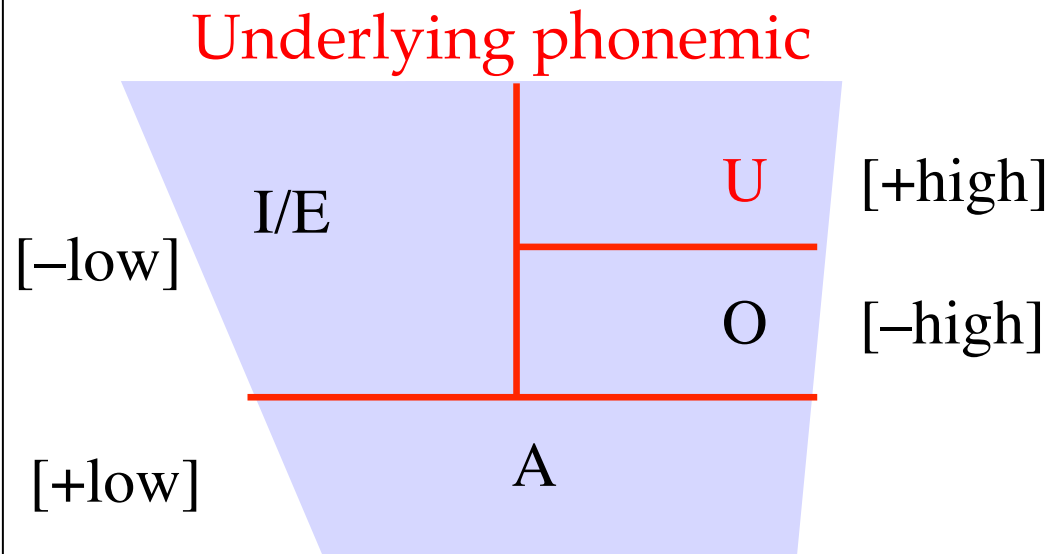
We might suppose that the definition of contrast in terms of minimal pairs applies here: [high] is contrastive in /U/ because there is a phoneme /O/ that differs from it *only* in this feature.

Recall the definition of minimal contrast: two segments that are identical in every feature except one.

I/E	U		O	A
[-low]	[-low]	=	[-low]	[+low]
[-high]	[+high]		[-high]	[-high]
[-back]	[+back]	=	[+back]	[+back]
[-rnd]	[+rnd]	=	[+rnd]	[-rnd]

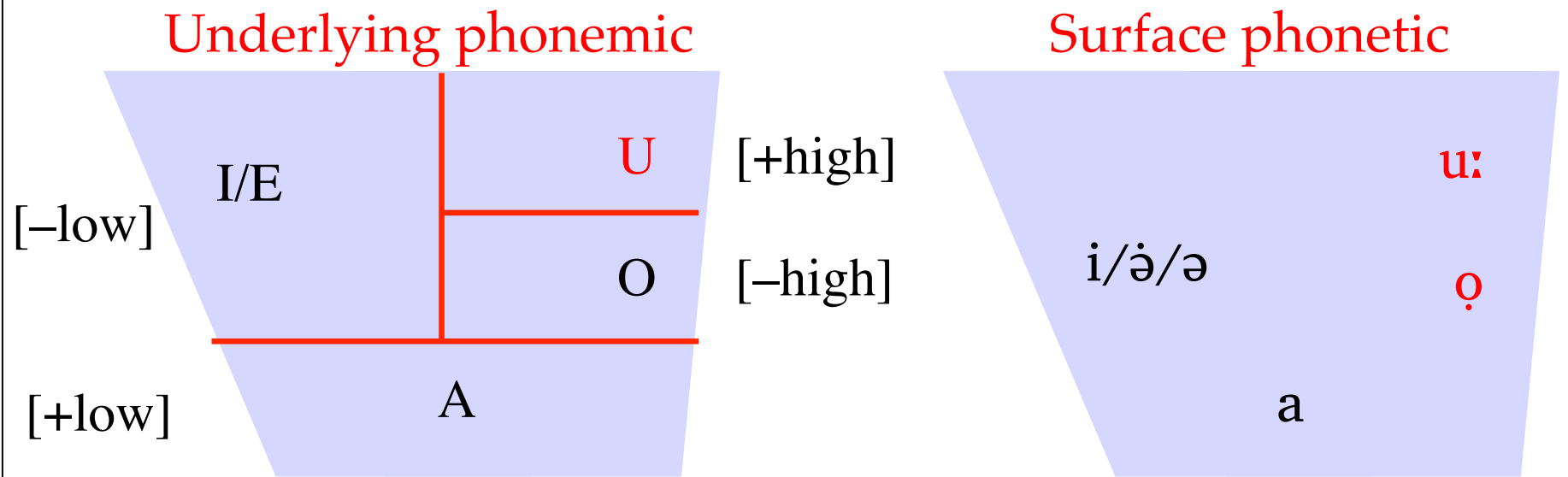
Contrast via Minimal Pairs?

But this is true only of *underlying* representations. On the surface these minimal contrasts are disturbed by further distinctions.



Contrast via Minimal Pairs?

The phonetic values of the desinential vowels do not exhibit minimal contrasts. According to Dyck (1995: 67, 177), the desinences of the dialect of Tudanca are as shown (based on data from Penny 1978 and from the *Atlas Lingüístico de la Península Ibérica* (ALPI). The high back vowel differs from the mid vowel in more than just height. Pasiego is similar (Penny 1969)

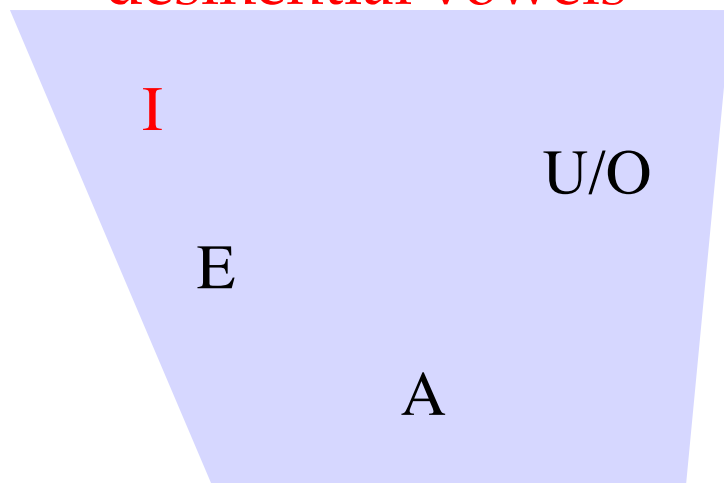


Contrast via Minimal Pairs?

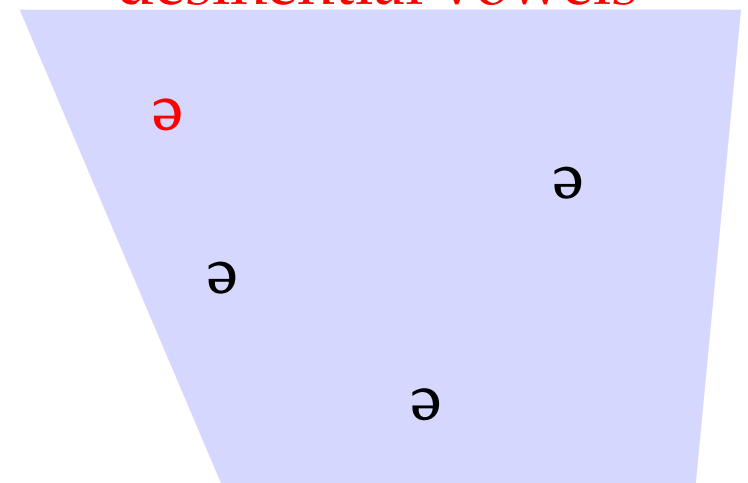
More dramatically, the Italian dialect of Calvello has a four-vowel desinential inventory in which /i/ causes raising.

The identity of the four vowels is revealed under secondary stress. However, all phrase-final vowels in Calvello reduce to schwa (Dyck 1996: 81, Kaze 1989: 24-25).

Calvello underlying
desinential vowels



Calvello surface
desinential vowels

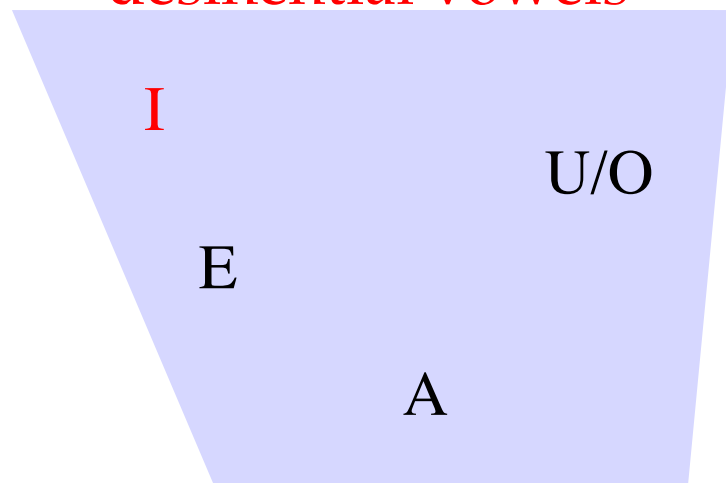


Contrast via Minimal Pairs?

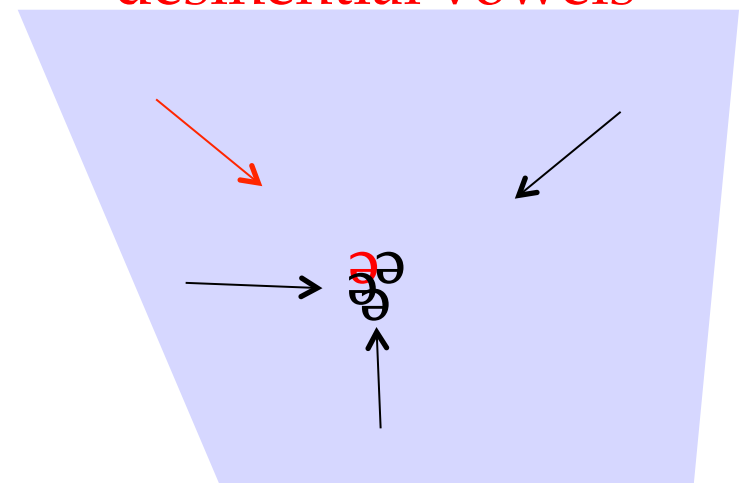
More dramatically, the Italian dialect of Calvello has a four-vowel desinential inventory in which /i/ causes raising.

The identity of the four vowels is revealed under secondary stress. However, all phrase-final vowels in Calvello reduce to schwa (Dyck 1996: 81, Kaze 1989: 24-25). Clearly, contrast cannot be assessed at the surface.

Calvello underlying desinential vowels



Calvello surface desinential vowels



The phonetic surface is the *worst* place to look for minimal contrasts

Dispersion and enhancement theorists have argued that poor contrasts tend to be magnified, and minimal contrasts tend to be *enhanced* by other phonetic differences.

In Calvello, phonetics do the opposite, and *neutralize* underlying contrasts.

Either way, the result is that *underlying* minimal contrasts between phonemes tend to be obscured at the surface.

Cases

- Romance metaphony
- Lithuanian vowel contrasts
- German and Czech /h/
- East Slavic post-velar fronting

Contrast in Lithuanian Vowels

Campos Astorkiza (2007) also proposes a special role for *minimal contrast*, two sounds that differ in just one property.

She argues that minimal contrast can influence phonetic effects.

For example, phonetic modification of vowel duration (lengthening before a voiced sound and shortening before a voiceless sound) can be minimized when there is a phonological vowel-length contrast, so as not to neutralize the contrast.

Contrast in Lithuanian Vowels

Campos Astorkiza reports that in Lithuanian, the effects of the voicing of final consonants are greater on the vowel /e:/, which has no short counterpart, than on the other long vowels, which have short counterparts.

	Front		Back	
	Short	Long	Short	Long
High	i	i:	u	u:
Mid		e:	(o)	o:
Low	æ	æ:	ɑ	ɑ:

Lithuanian Vowels

I assume that the facts and basic analysis of the Lithuanian vowel system are correct.

However, Campos Astorkiza (2007) incorrectly tries to define the relevant contrasts as applying to surface phonetic dimensions, rather than to underlying phonemic representations.

This analysis leads to many problems.

Lithuanian Vowels

Campos Astorkiza (2007: 81) defines a contrast-coindexing function that is supposed to apply to *minimally contrastive segments* that are able to distinguish *minimal pairs of words*.

She wishes to designate as a minimal pair Lithuanian words that differ only in that one contains a long vowel where the other has its short counterpart, and that the long-short vowel pair should be contrast-coindexed as differing *only* with respect to duration. A hypothetical example is shown here:

li:ta

lita

Lithuanian Vowels

Minimal contrasts apply in straightforward fashion as long as we stick to *phonemic* representations of Lithuanian vowels. Campos Astorkiza adopts a conventional phonemic analysis that distinguishes vowels along three dimensions:

Phonemic analysis (Campos Astorkiza 2007: 32)

	Front		Back	
	Short	Long	Short	Long
High	i	i:	u	u:
Mid		e:	(o)	o:
Low	æ	æ:	ɑ	ɑ:

Lithuanian Vowels

- Height: three contrastive categories, high, mid, and low

Phonemic analysis (Campos Astorkiza 2007: 32)

	Front		Back	
	Short	Long	Short	Long
High	i	i:	u	u:
Mid		e:	(o)	o:
Low	æ	æ:	ɑ	ɑ:

Lithuanian Vowels

- Height
- Backness: two contrastive categories, front and back

Phonemic analysis (Campos Astorkiza 2007: 32)

	Front		Back	
	Short	Long	Short	Long
High	i	i:	u	u:
Mid		e:	(o)	o:
Low	æ	æ:	ɑ	ɑ:

Lithuanian Vowels

- Height
- Backness
- Length: 2 categories, short and long

Phonemic analysis (Campos Astorkiza 2007: 32)

	Front		Back	
	Short	Long	Short	Long
High	i	i:	u	u:
Mid		e:	(o)	o:
Low	æ	æ:	ɑ	ɑ:

Lithuanian Vowels

In terms of phonetics, however, Lithuanian long vowels do not differ from their short counterparts only with respect to duration.

Phonemic values (Campos Astorkiza 2007: 32)

i	i:	u	u:
	e:	(o)	o:
æ	æ:	ɑ	ɑ:

Lithuanian Vowels

Each pair displays a further phonetic difference that is potentially contrastive in some other language:

Phonetic values (Campos Astorkiza 2007: 32)

	i:		u:
ɪ		ʊ	
	e:		o:
ɛ		(ɔ)	
	æ:	a	ɑ:

Lithuanian Vowels

- Compared to their short vowel counterparts, the long high vowels are either higher, or tenser, or have more advanced tongue root, or any two or three of these.

Phonetic values (Campos Astorkiza 2007: 32)

[+ATR]/[tense]

[-ATR]/[lax]

i:		u:	
i		u	
	e:		o:
ɛ		(ɔ)	
	æ:	a	ɑ:

Lithuanian Vowels

- The front short low vowel is higher than its long counterpart, and the short back (or central) low vowel is less retracted than its long counterpart.

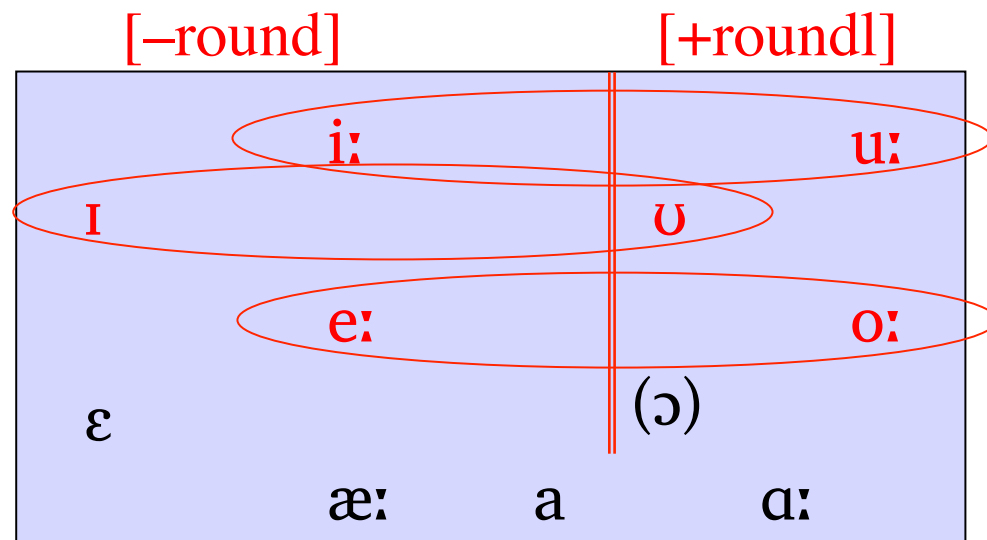
Phonetic values (Campos Astorkiza 2007: 32)

		[central]	[back]
	ɪ	ʊ	u:
	i:		u:
	e:		o:
	ɛ	(ɔ)	
	æ:	a	ɑ:
[-low]			
[+low]			

Lithuanian Vowels

- Further, the non-low vowels contrast in roundness as well as in backness.

Phonetic values (Campos Astorkiza 2007: 32)



Lithuanian Vowels

- Moreover, there is no phonetic basis to limit the number of front-back contrasts to two categories, rather than three, which appears to be closer to phonetic reality.

Phonetic values (Campos Astorkiza 2007: 32)

	[front]	[central]	[back]
	i:		u:
ɪ			ʊ
	e:		o:
ɛ			(ɔ)
	æ:	a	ɑ:

The phonetic surface is the *worst* place to look for minimal contrasts

It is apparent that the minimal contrasts Campos Astorkiza requires for her analysis do not exist at the phonetic surface.

What is needed is a theory that can assign the minimal contrasts identified by the phonemic analysis. To do this we must forget about the phonetic surface and take a more abstract approach to minimal contrast.

Problems with Minimal Pairs

Trying to evaluate contrast at the surface rather than at a more abstract level of representation is not the only problem with the minimal pairs method.

Consider again the definition of minimal contrast (Nevins, Campos Astorkiza, Padgett, etc.):

Minimal Contrast

A segment S with specification αF is *contrastive* for F if there is another segment S' in the inventory that is featurally identical to S , except that it is $-\alpha F$.

R	S	S'	T
$[\alpha E]$	$[\alpha E]$	$[\alpha E]$	$[-\alpha E]$
$[\alpha F]$	$[\alpha F]$	$[-\alpha F]$	$[-\alpha F]$
$[-\alpha G]$	$[\alpha G]$	$[\alpha G]$	$[-\alpha G]$
$[-\alpha H]$	$[\alpha H]$	$[\alpha H]$	$[-\alpha H]$

Lithuanian Vowels

Now consider again Campos Astorkiza's *phonemic* analysis of Lithuanian vowels. This time I use the more realistic phonetic symbols.

Assuming the analysis shown is correct, the question arises: How does one arrive at this categorization over the other possibilities I mentioned earlier?

	Front		Back	
	Short	Long	Short	Long
High	ɪ	i:	ʊ	u:
Mid		e:	(ɔ)	o:
Low	ɛ	æ:	a	ɑ:

Lithuanian Vowels

That is, how does one decide that the relevant contrast in the non-low vowels is backness and not lip rounding? Why does length take precedence over tension in the high vowels, and over height and backness in the low vowels?

	Front		Back	
	Short	Long	Short	Long
High	ɪ	i:	ʊ	u:
Mid		e:	(ɔ)	o:
Low	ɛ	æ:	a	ɑ:

Minimal Contrast

None of these decisions follow from looking for minimal pairs starting from fully specified features.

[back] and [round] do the same contrastive work below, as do [long] and [ATR]. There are thus no minimal pairs here.

	ɪ	iː	ʊ	uː
[back]	–	–	+	+
[round]	–	–	+	+
[long]	–	+	–	+
[ATR]	–	+	–	+

Minimal Contrast

We need some procedure to decide which feature in each pair takes precedence: [back] or [round], and [long] or [ATR].

	i	i:	u	u:
[back]	-	-	+	+
[round]	-	-	+	+
[long]	-	+	-	+
[ATR]	-	+	-	+

Minimal Contrast

We need some procedure to decide which feature in each pair takes precedence: [back] or [round], and [long] or [ATR].

We can choose [back] and [long], as assumed above.

	i	i:	u	u:
[back]	-	-	+	+
[long]	-	+	-	+

Minimal Contrast

Or we could pick other features, say [round] and [ATR].

There are presumably empirical reasons for the other analysis, though no arguments are presented in this case.

	ɪ	i:	ʊ	u:
[round]	–	–	+	+
[ATR]	–	+	–	+

Minimal Contrast

Whichever we pick, the required minimal pairs are the *result* of a phonemic analysis, and do not exist prior to it.

	ɪ	iː	ʊ	uː
[back]	–	–	+	+
[round]	–	–	+	+
[long]	–	+	–	+
[ATR]	–	+	–	+

Cases

- Romance metaphony
- Lithuanian vowel contrasts
- German and Czech /h/
- East Slavic post-velar fronting

Problems with Minimal Pairs

Before offering a solution to this problem, it may be instructive to see one more example which illustrates the problem very clearly.

Let's compare Trubetzkoy's (1939 / 1969) analyses of German *h* and Czech *h̃*.

Problems with Minimal Pairs

According to Trubetzkoy (1969: 69), German *h* does not enter into a unique minimal contrast with any other phoneme.

p	pf	t	ts		k	
b		d			g	
	f		s	ʃ	x	h
	v		z			
m		n			ŋ	
			l		r	

Problems with Minimal Pairs

According to Trubetzkoy (1969: 69), German *h* does not enter into a unique minimal contrast with any other phoneme.

In particular, it is not in a minimal contrast with *x*: *h* is laryngeal and *x* is dorsal, and so there is no set of features that the two share exclusively.

p	pf	t	ts		k	
b		d			g	
	f		s	ʃ	x	h
	v		z			
m		n			ŋ	
			l			
				r		

Problems with Minimal Pairs

Looking at the Czech consonant inventory, one might suppose that Czech *h̃* is similarly isolated.

p

t

ts

c

tʃ

k

b

d

ʃ

g

f

s

ʒ

x

v

z

ʒ

h̃

m

n

ɲ

r

ř

l

j

Problems with Minimal Pairs

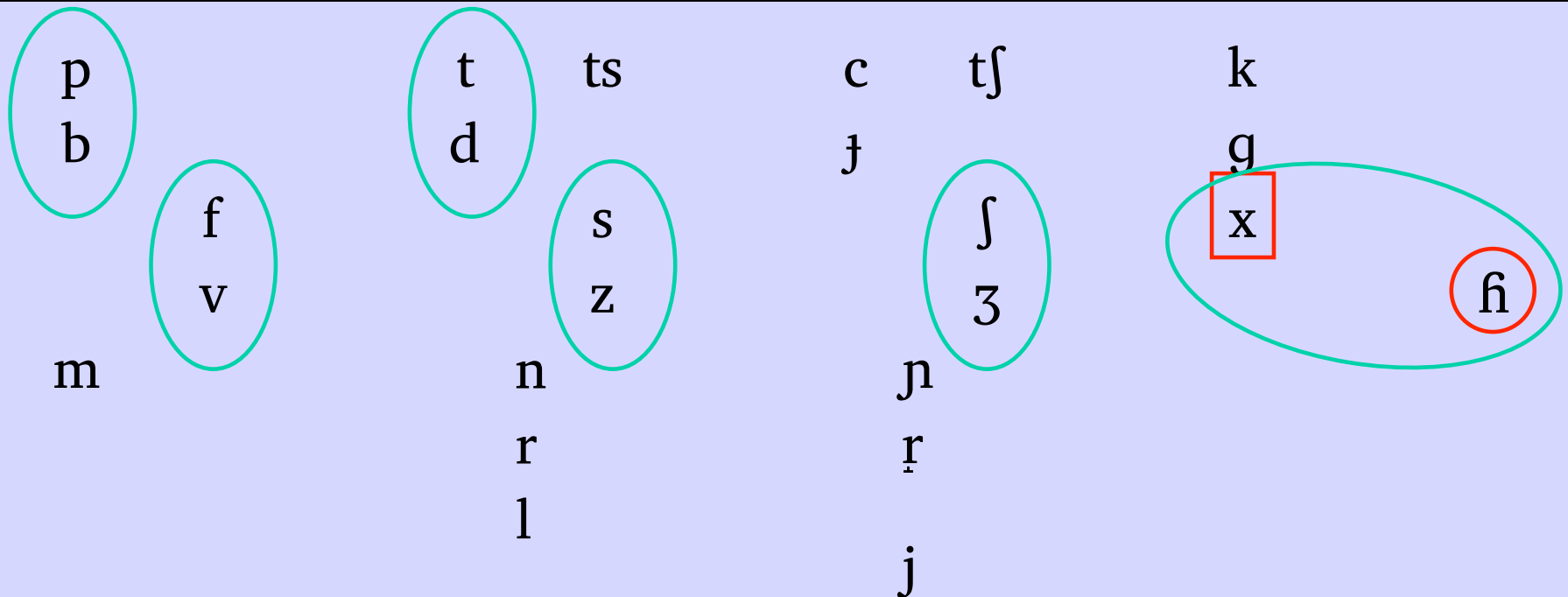
Looking at the Czech consonant inventory, one might suppose that Czech *h̃* is similarly isolated.

However, Trubetzkoy (1969: 124) proposes that Czech *h* (or more properly, *h̃*), forms a minimal contrast with *x*.

p		t	ts	c	tʃ	k	
b		d		ʃ		g	
	f		s		ʒ	x	
	v		z		ʒ		h̃
m		n		ɲ			
		r		ř			
		l		j			

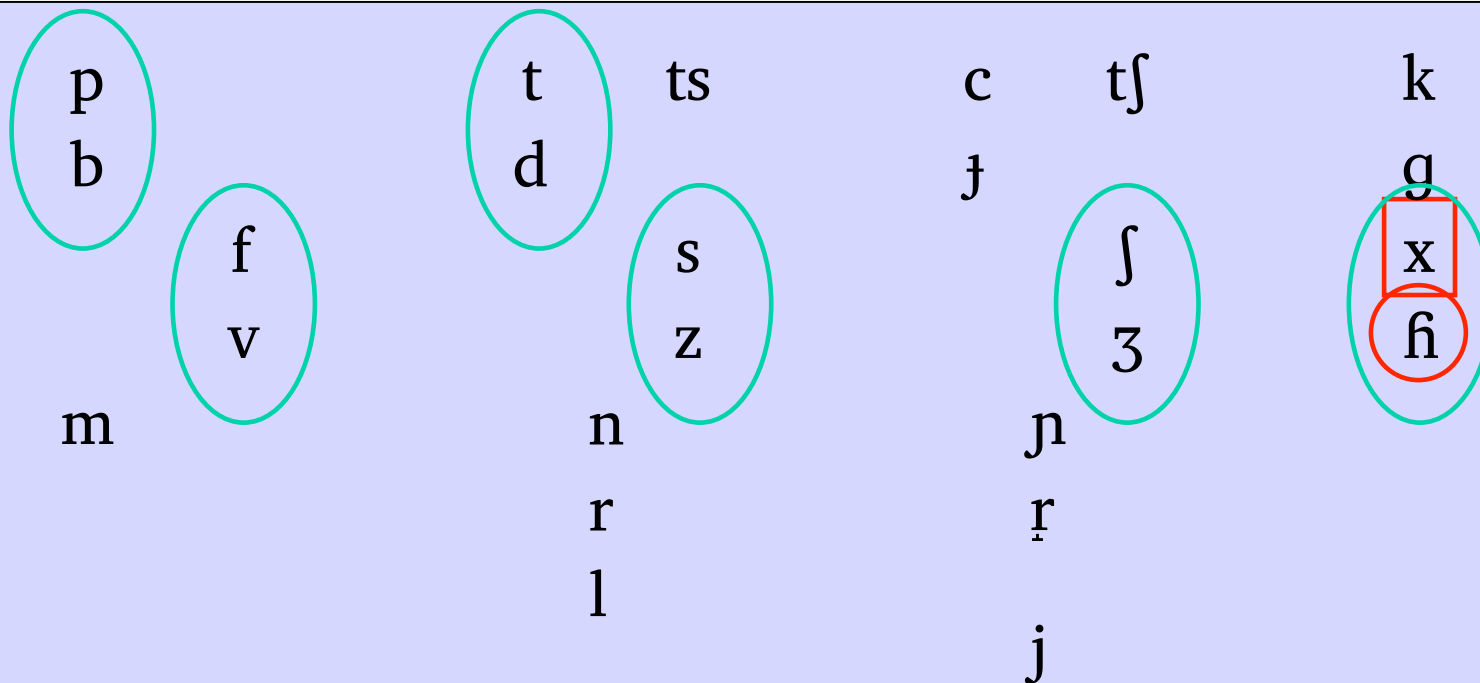
Problems with Minimal Pairs

The reason is that the distinction between these phonemes can be neutralized, for they behave phonologically like a voiced-voiceless pair, like the other such pairs in Czech.



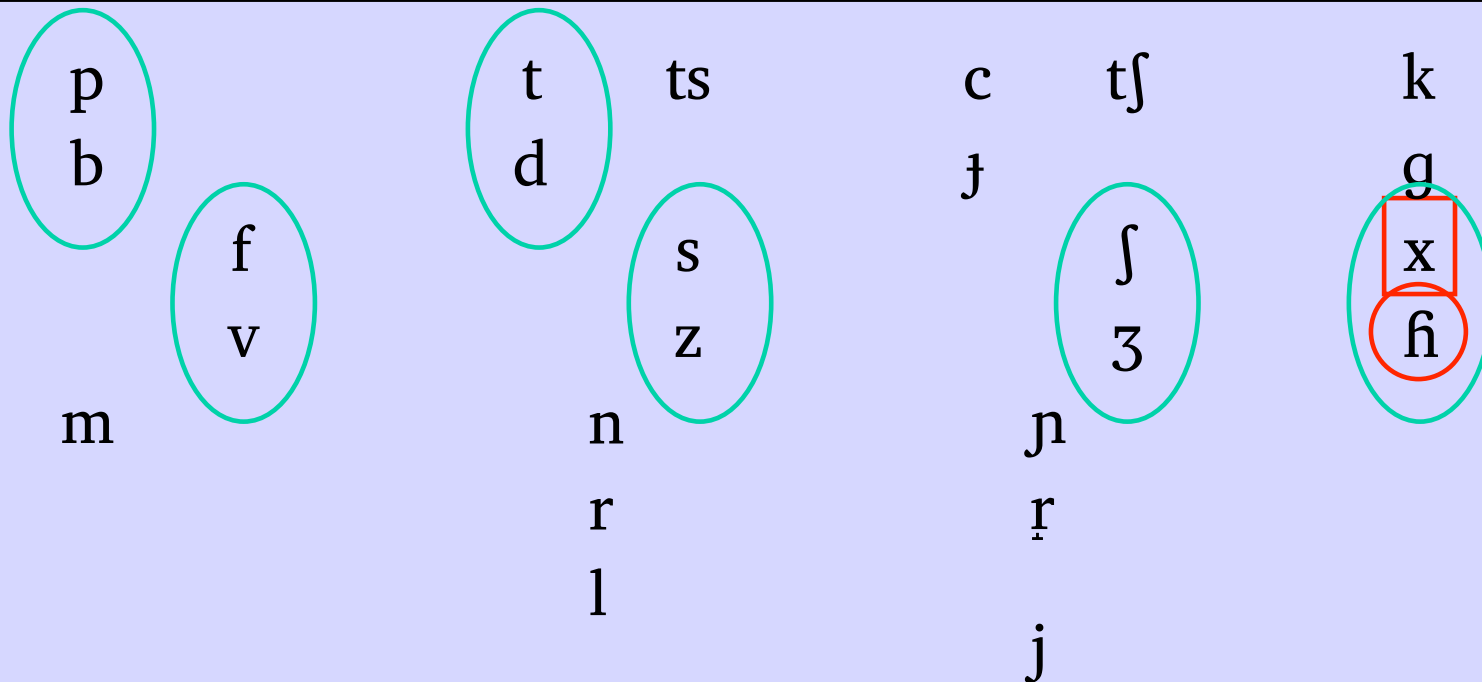
Problems with Minimal Pairs

“The *h* in Czech thus does not belong to a special laryngeal series, which does not even exist in that language. It belongs to the guttural series, for which, from the standpoint of the Czech phonological system, only the fact that lips and tip of tongue do not participate is relevant”. (1969: 124)



Problems with Minimal Pairs

That is, ɦ and x form a minimally contrastive pair in Czech, but we have to *abstract away* from differences that are not deemed to be phonologically relevant.



Contrast via Feature Ordering

An elegant solution to this problem is hinted at by Trubetzkoy and was subsequently developed by Jakobson and his collaborators.

This approach **assigns** precedence relations by **ordering** the features.

Contrast via Feature Ordering

In German, for example, the place feature distinguishing /h/ from /x/ takes precedence over other features that could distinguish /h/ from other consonants.

p	pf	t	ts		k	
b		d			g	
	f		s	ʃ	x	h
	v		z			
m		n			ŋ	
			l		r	

Contrast via Feature Ordering

In Czech, this feature is ordered lower in the hierarchy, too low to be contrastive for /h/.

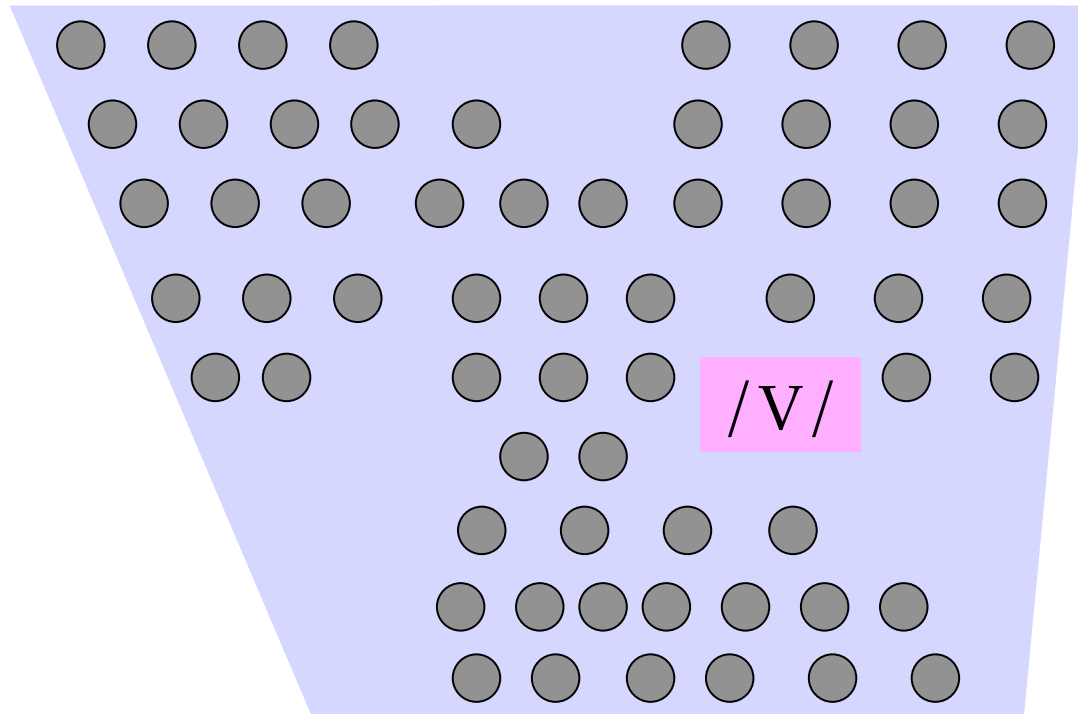
p		t	ts	c	tʃ	k	
b		d		ʃ		g	
	f		s		ʒ	x	
	v		z		ʒ		h
m		n		ɲ			
		r		ř			
		l		j			

Contrastive specification by a hierarchy of features

Rather than look for minimal pairs, I suppose that contrasts are determined by the **Successive Division Algorithm** (Dresher 1998, 2003a, 2003b, 2008, 2009, based on Jakobson, Fant & Halle 1952, Jakobson & Halle 1956)

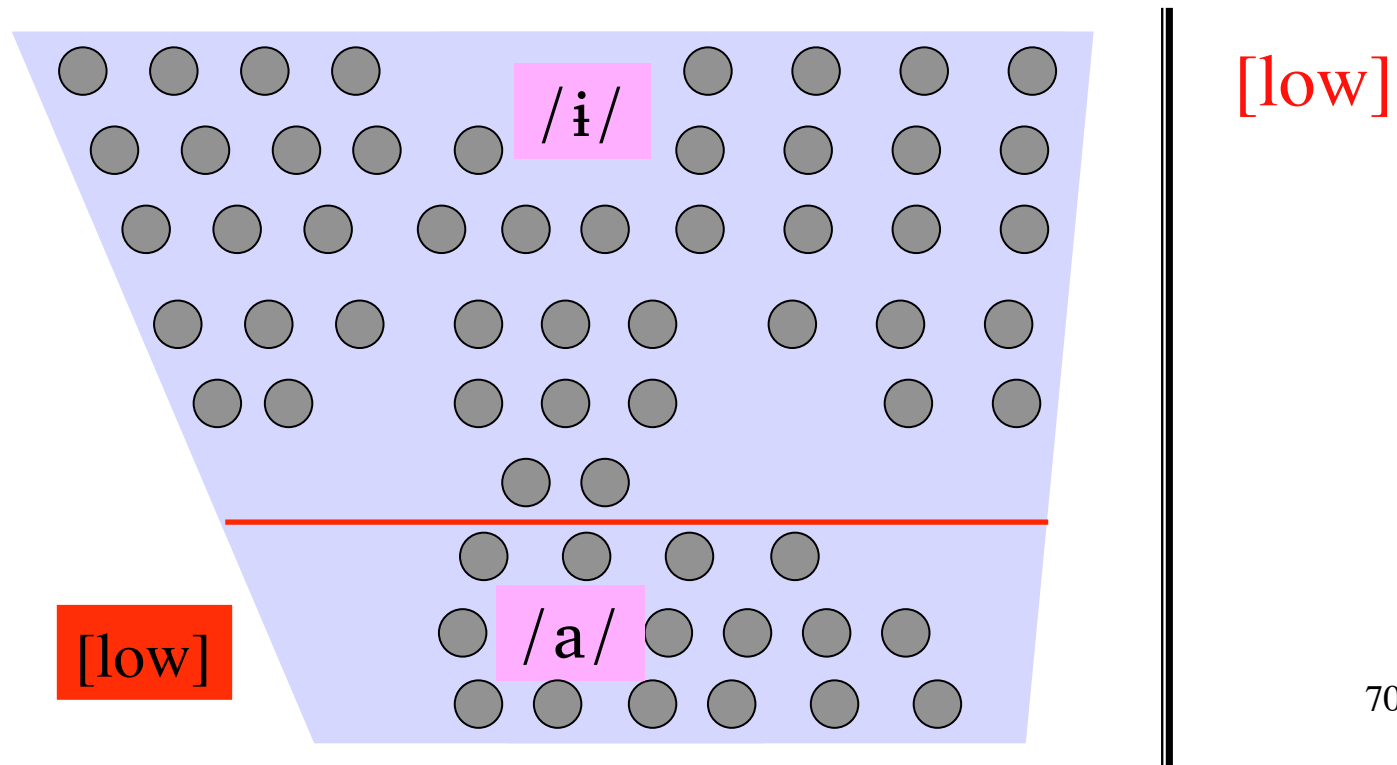
The Successive Division Algorithm

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



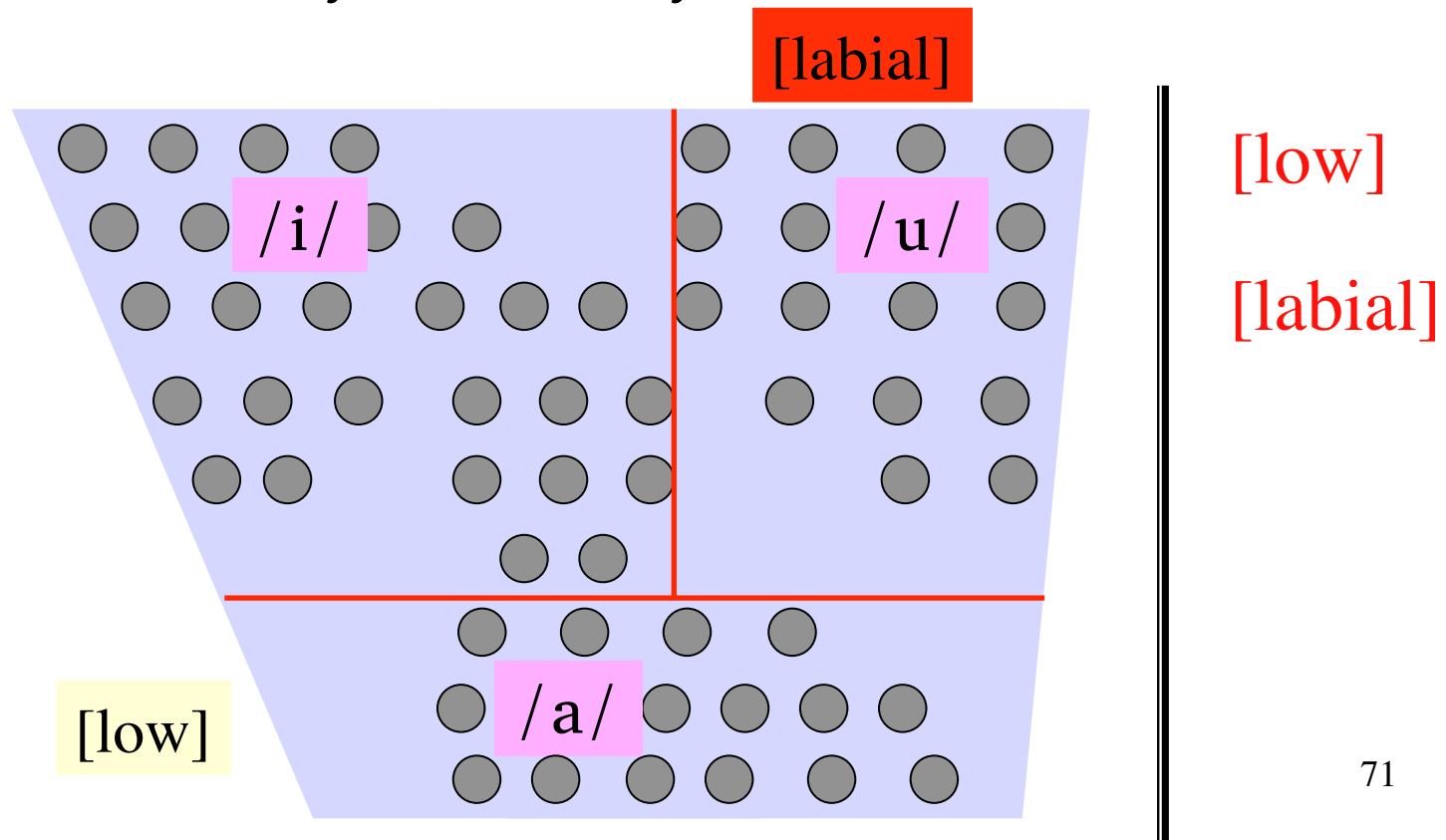
The Successive Division Algorithm

- b. If the set is found to consist of more than one contrasting member, select a feature and divide the set into as many subsets as the feature allows for.



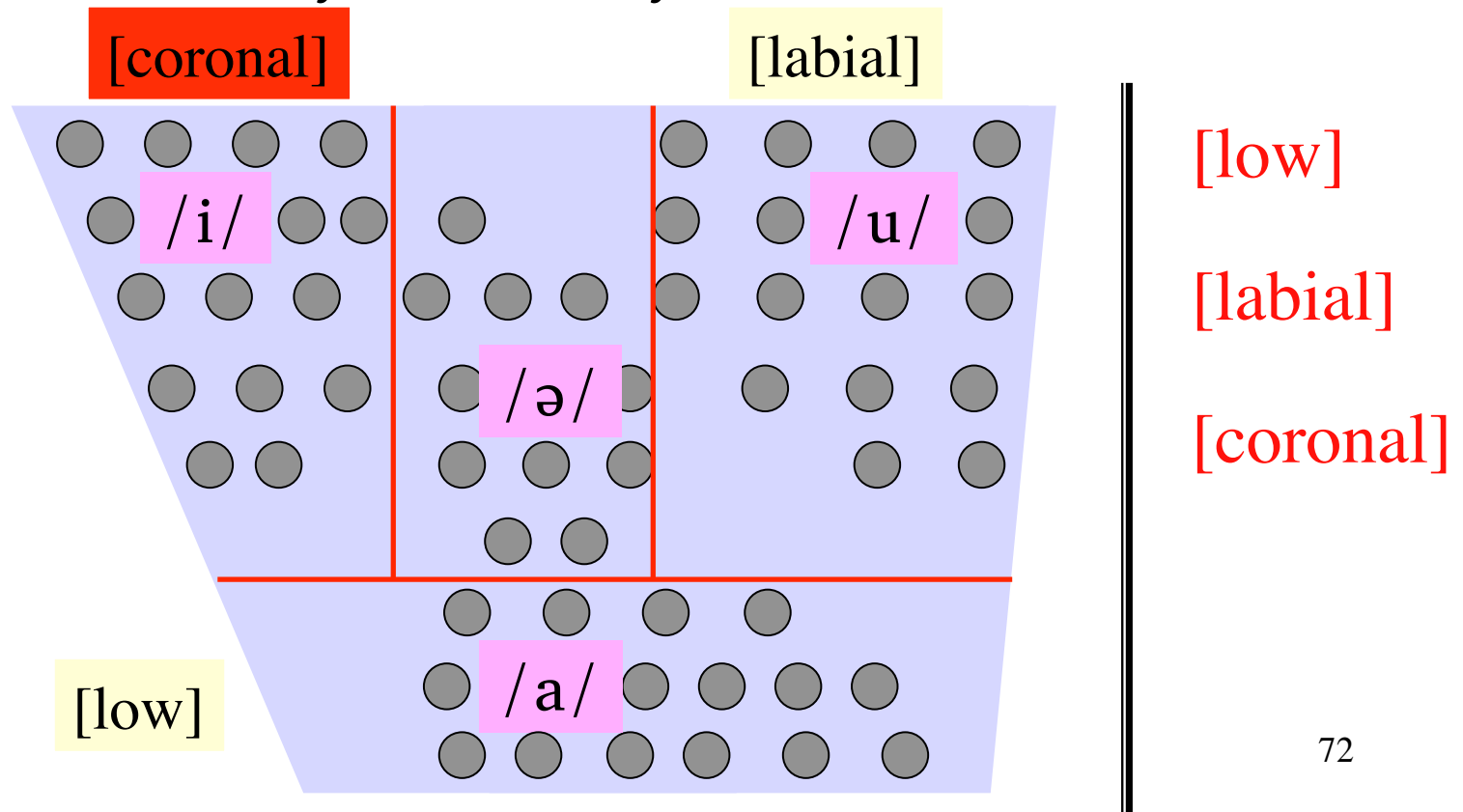
The Successive Division Algorithm

- c. Repeat step (b) in each subset: keep dividing up the inventory into sets, applying successive features in turn, until every set has only one member.



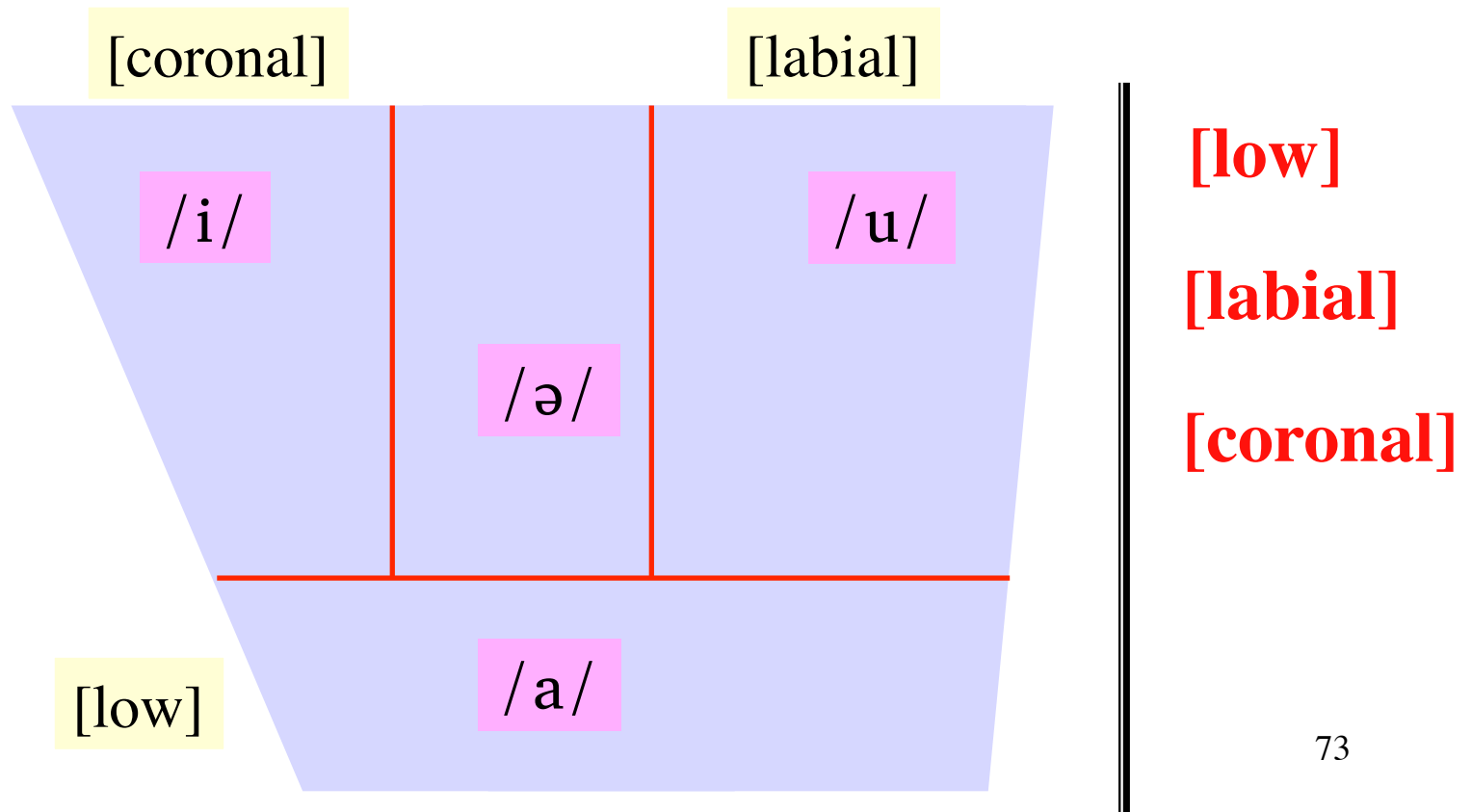
The Successive Division Algorithm

- c. Repeat step (b) in each subset: keep dividing up the inventory into sets, applying successive features in turn, until every set has only one member.



The Contrastive Hierarchy

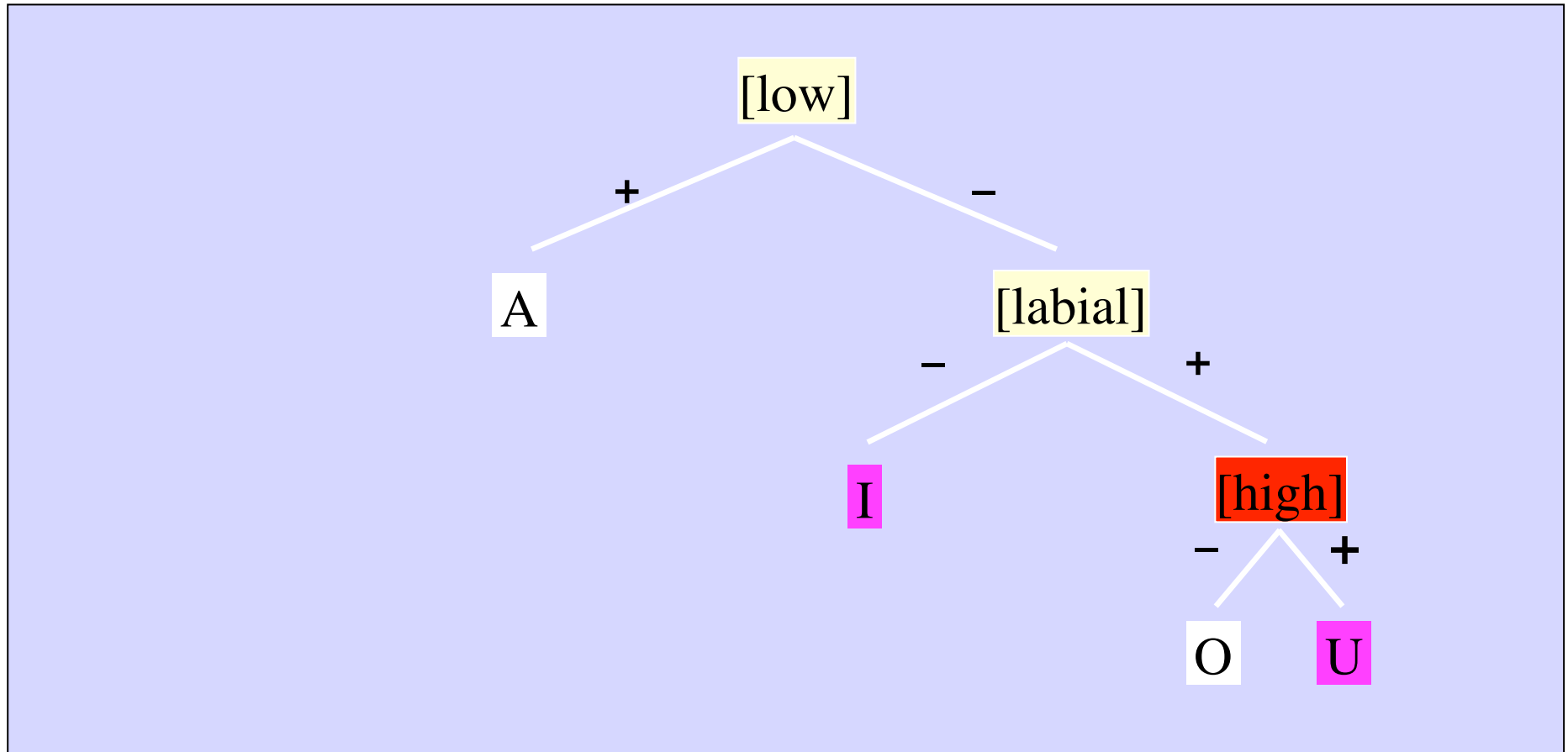
The ordered list of features is called the *contrastive hierarchy* for the language in question.



Contrastive specification by a hierarchy of features

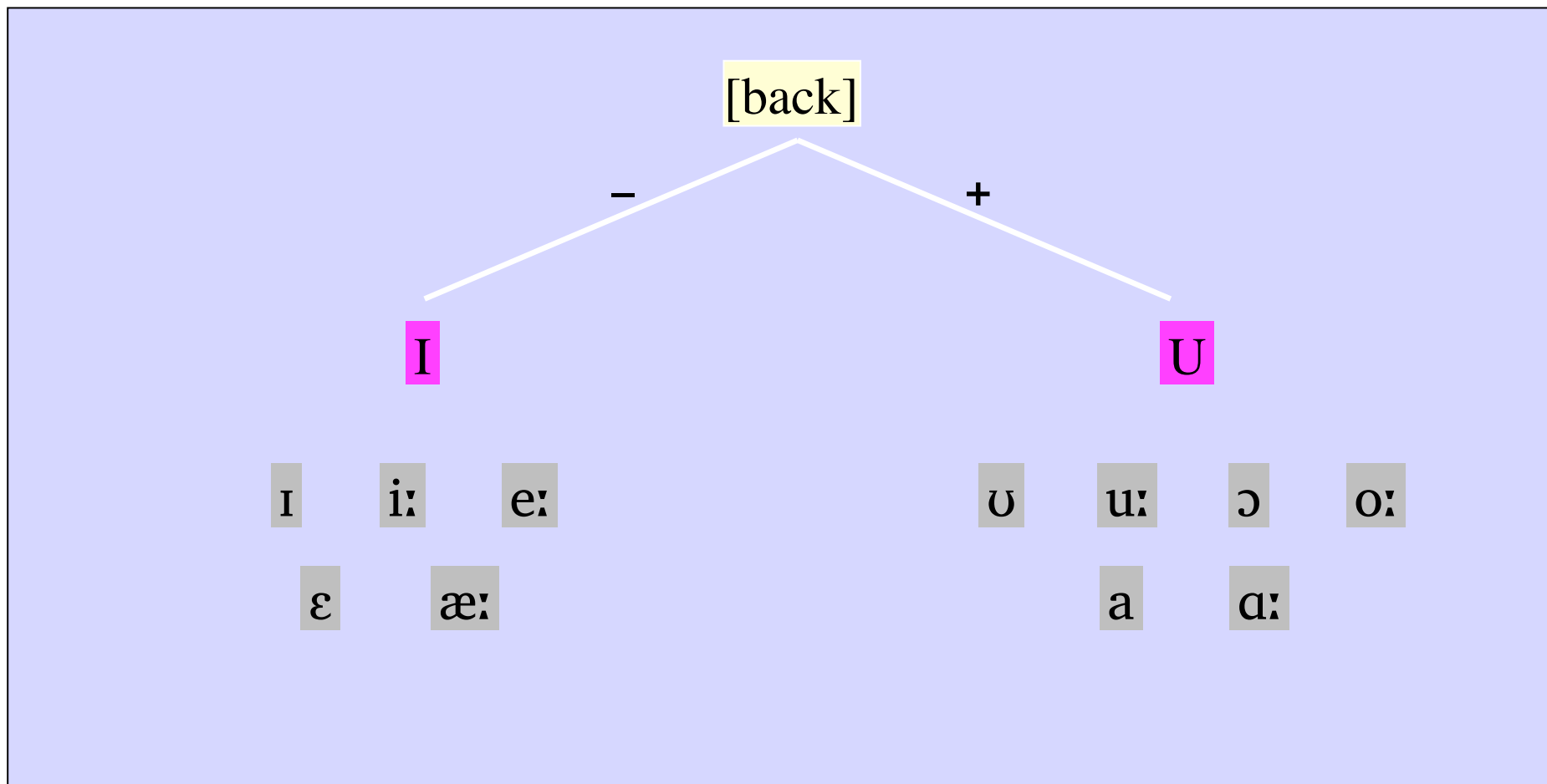
All the cases that have been attributed to minimal pairs can be accounted for in terms of feature ordering.

Contrastive Hierarchy for Romance Desinential Vowels



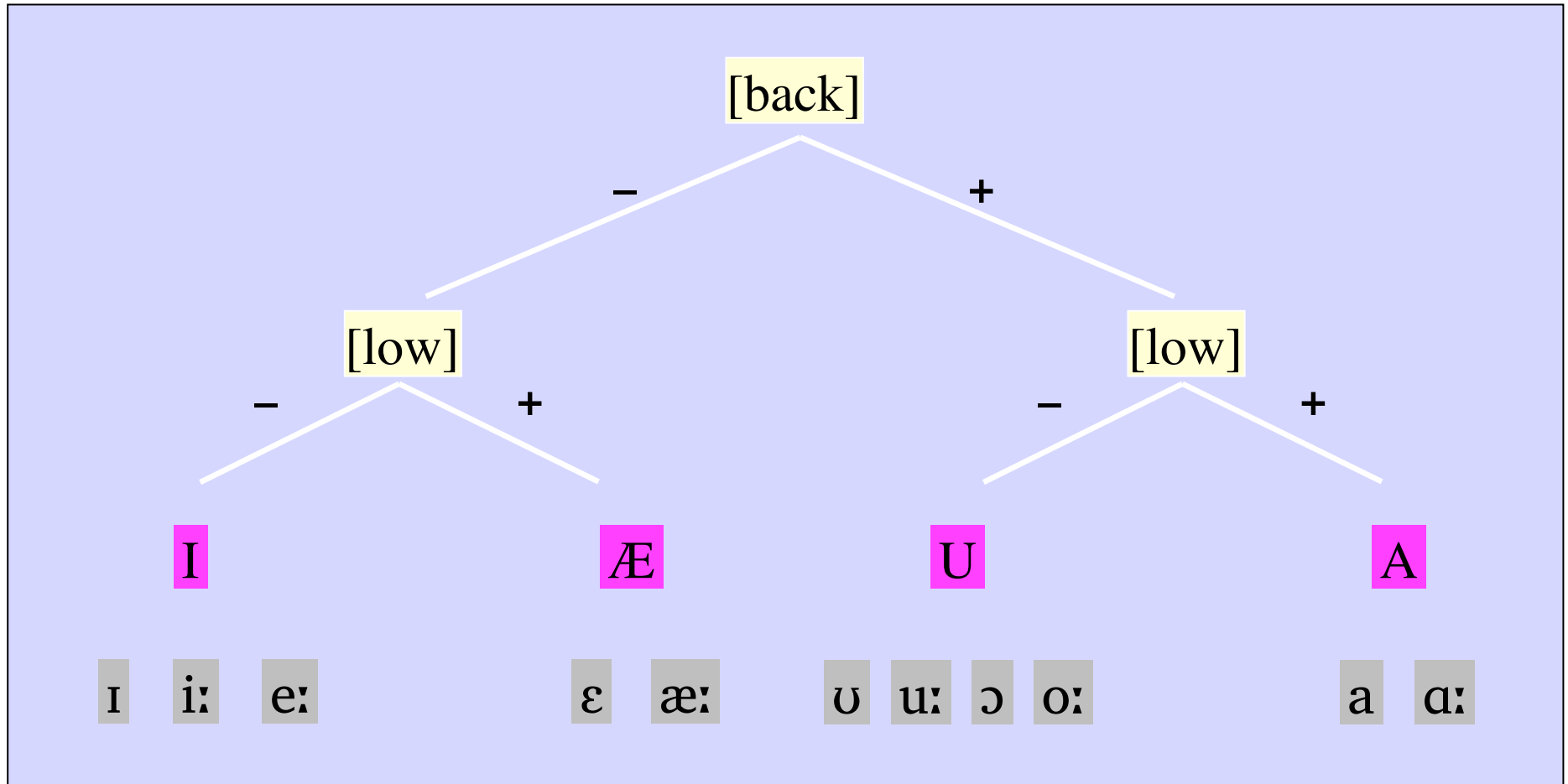
Following Dyck (1995), the order of the features in Romance vowel systems is [low] > [labial] > [high]. This explains why a phonetically high vowel must contrast with a mid vowel to receive a contrastive feature [high]. In the four-vowel system shown above, only /U/ is contrastively [+high].

Contrastive Hierarchy for Lithuanian Vowels



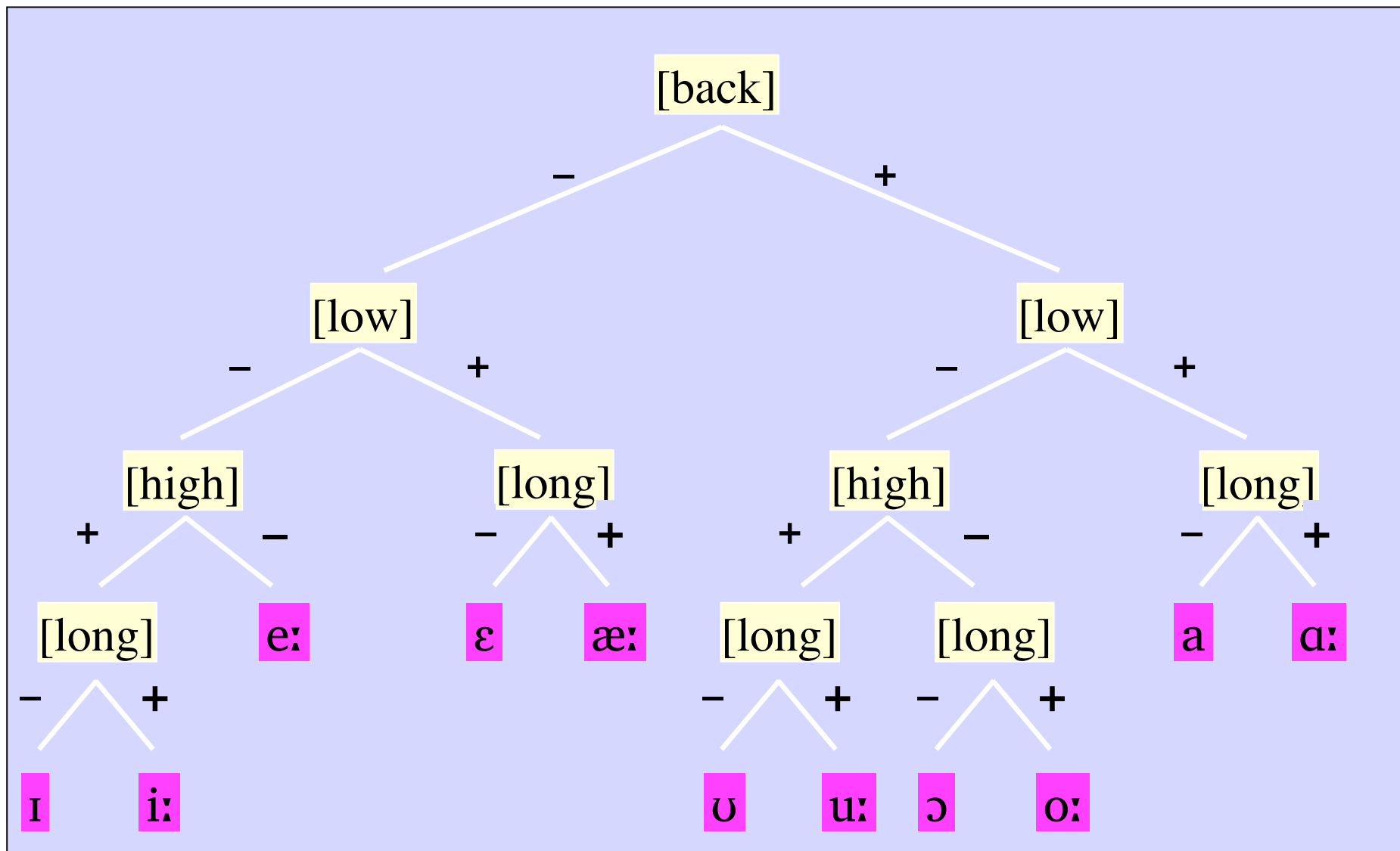
The first division of the vowels is made by [back]. At this point there are only two distinct vowels, represented as [-back] /I/ and [+back] /U/. [back] is minimally contrastive, since no other feature distinguishes these vowels.

Contrastive Hierarchy for Lithuanian Vowels



Each subset of vowels is then divided by [low]. This contrast is also minimal. Note that the addition of this contrast has the effect of making [back] no longer a minimal contrast for all vowels.

Contrastive Hierarchy for Lithuanian Vowels



Similarly, the addition of further contrastive and non-contrastive features makes earlier features non-minimally contrastive.

What Determines the Feature Order?

This approach requires us to put the features in an order, which raises the question: where does the ordering come from?

Jakobson and Halle (1956) proposed that the ordering is basically universal, with certain choices being allowed at specified points.

But the order does not appear to be entirely universal. I will adopt the following hypothesis:

Feature Hierarchy Variability Hypothesis

- Like other aspects of linguistic theory, the hierarchy of features is subject to parametric variation

It follows that the contrastive hierarchies of different languages may be different, even if their segmental inventories look similar.

How does One Know What the Order is?

So how do we know what the order is in any given language?

The Contrastivist Hypothesis suggests an answer: If only contrastive features are *active* in the phonology, then if we find an active feature, we should suppose it's contrastive.

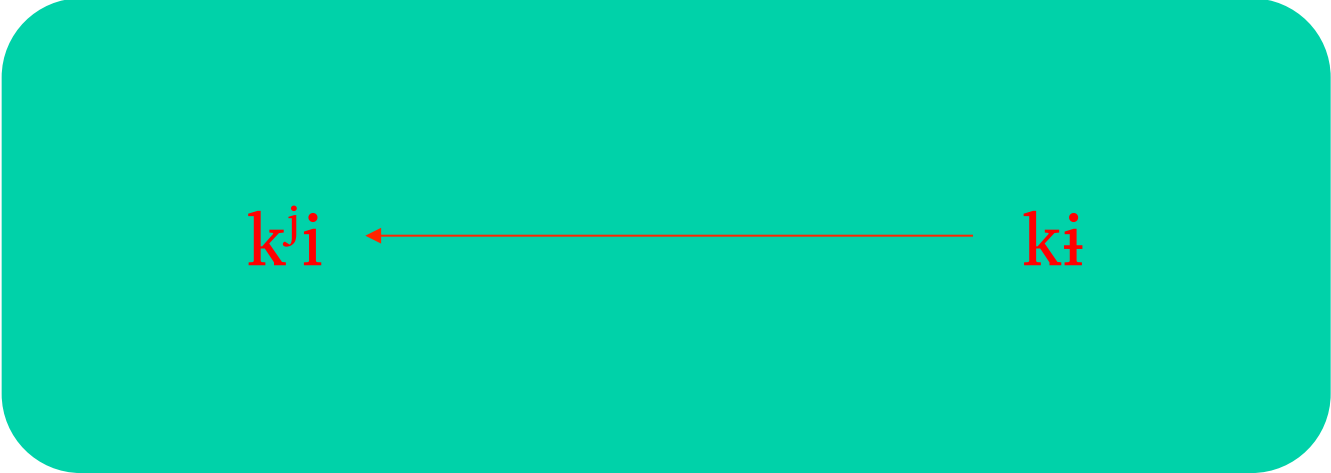
The Contrastivist Hypothesis is falsified to the extent that we find more active features than can be contrastive.

Cases

- Romance metaphony
- Lithuanian vowel contrasts
- German and Czech /h/
- East Slavic post-velar fronting

Introduction

Between the 12th and 14th centuries k_i fronted to k^j_i in East Slavic.

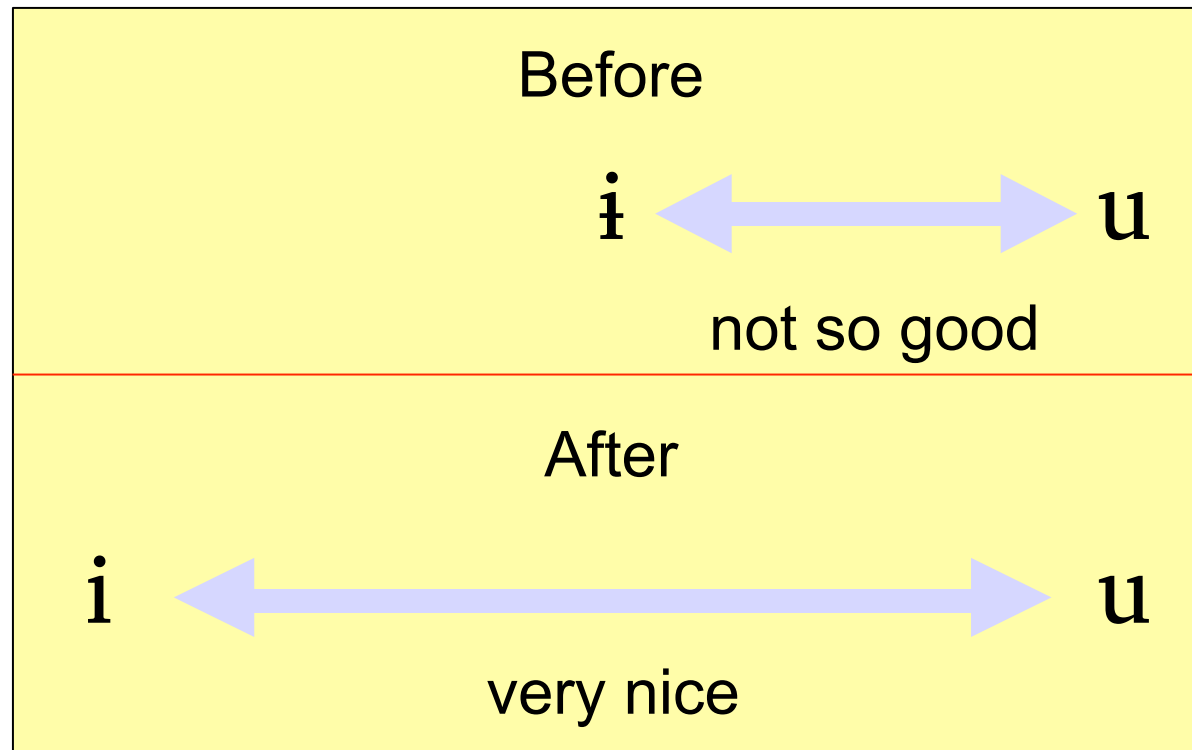


k^j_i ← k_i

What caused this fronting? Everyone agrees that the lack of contrast at the time between k and k^j is crucial to accounting for this change.

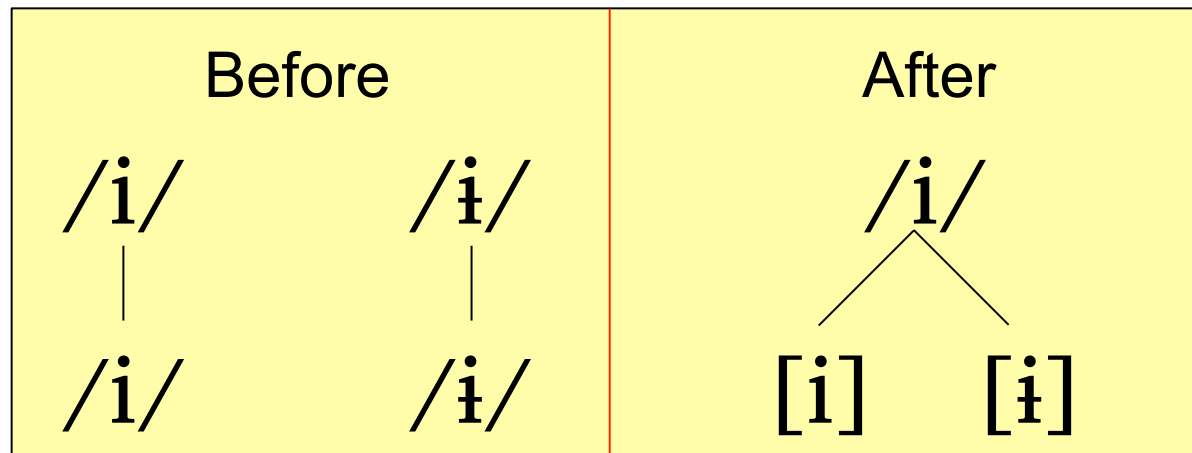
Introduction

Padgett (2003) argues that it was motivated also by the **surface** distance between **i** and **u**.



Introduction

I argue, following Jakobson (1929), that the trigger was the reanalysis of **underlying** vowel contrasts, whereby the phoneme /i/ became a positional allophone of /i/.



Introduction

At issue is the proper way to incorporate contrast into phonology. I will argue for the following positions:

- **Which features** does the phonology compute?
NOT **all features** but only **contrastive features**
- **How** is contrast assessed?
NOT by **minimal pairs** but by a **contrastive feature hierarchy**
- **Where** does phonology access contrast?
NOT at the **surface** but at the **underlying form**

Introduction

I will begin by giving a fairly standard account of some changes in the history of Slavic that led up to this change.

Then I will discuss both analyses and argue in favour of my approach, which adheres to the framework of Modified Contrastive Specification (Toronto phonology)

Some Slavic Diachrony

Slavic Sound Changes

Underlying

pi pĭ pu ki kĭ ku

Surface

pi pĭ pu ki kĭ ku

Prior to Changes

/i/, /i̯/, and /u/ are separate phonemes.

/p/ and /k/ occur before all vowels.

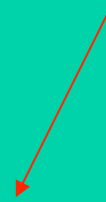
Slavic Sound Changes

Underlying

pi pĭ pu ki kĭ ku

Surface

pi pĭ pu tʃi kĭ ku



First Velar Palatalization (Common Slavic)

Velar [k] mutates to palatoalveolar [tʃ] before /i/.

This begins as a phonetic change.

Slavic Sound Changes

<i>Underlying</i>	pi	pĭ	pu	tʃi	□	kĭ	ku
<i>Surface</i>	pi	pĭ	pu	tʃi		kĭ	ku

First Velar Palatalization (Common Slavic)

At some point [tʃ] is reanalyzed as /tʃ/,

losing its connection to /k/.

This left a gap in the phonotactics, as now there was no /kĭ/.

Slavic Sound Changes

Underlying

pi

pĭ

pu

tʃi

kĭ

ku



Surface

pʲi

pĭ

pu

tʃʲi

kĭ

ku

Palatalization of Consonants Before Front Vowels (Post-Common Slavic)

This change begins as a predictable allophonic palatalization.

Consequences of the Fall of the Jers (Early East Slavic)

Underlying

p^ji pi pu tʃ^ji ki ku

Surface

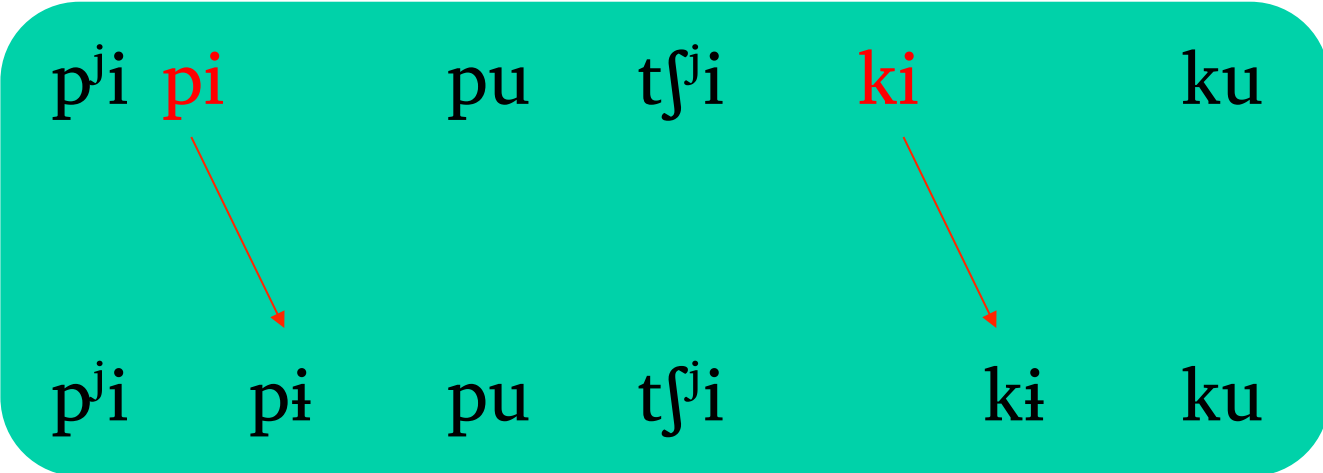
p^ji pi pu tʃ^ji ki ku

Palatalized consonants become phonemic

The surface loss of short high front and back vowels (*jers*) made palatalization opaque and led to a reanalysis of palatalized consonants as underlying.

Consequences of the Fall of the Jers (Early East Slavic)

<i>Underlying</i>	p ^j i	pi	pu	ts ^j i	ki	ku
<i>Surface</i>	p ^j i	p ^ɨ i	pu	ts ^j i	k ^ɨ i	ku



/i/ becomes an allophone of /i/

Due to the above and other changes,
[ɨ] occurs only after non-palatalized consonants,
in complementary distribution with [i].

Why Post-Velar fronting?

Underlying

p^ji pi pu tʃ^ji ki ku

Surface

p^ji pⁱ pu tʃ^ji k^ji < ki ku

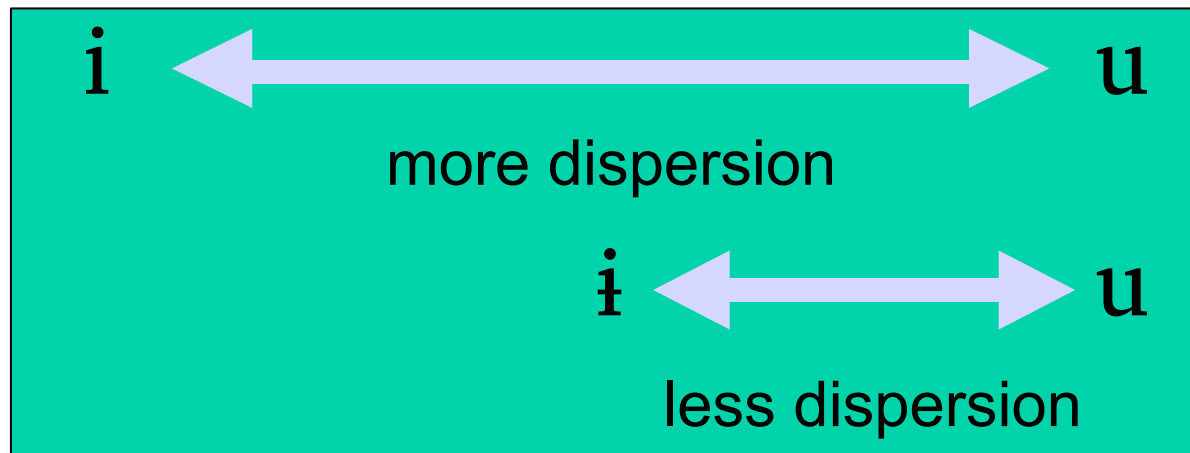
Post-Velar Fronting (East Slavic)

What caused [ki] to front to [k^ji]?

A Dispersion Theory Analysis (Padgett 2003)

A Dispersion Theory Analysis (Padgett 2003)

Padgett (2003) looks at **surface phonetic contrasts** and proposes that the key to the change of k_i to k^j_i is that k^j_i makes a better **perceptual** contrast with ku than does k_i .



Formal Implementation of the DT Analysis

The formal implementation of this analysis requires elaborate and problematic machinery.

Padgett follows Flemming (1995/2004) in assuming that possible inputs and candidate forms within OT can include not only individual forms, but **sets of forms**.

In Ní Chiosáin and Padgett's (2001) interpretation, the objects of analysis are taken to be **entire languages**.

Padgett (2003: 51) writes that 'this daunting prospect is made manageable by means of extreme idealization.'

Set of East Slavic 'words' (Padgett 2003)

The idealization starts by limiting the set of relevant 'words' to the ones below:

pi

p̣i

pu

pau

p^ji

p̣^ji

p^ju

p^jau

tʃi

tʃ̣i

tʃu

tʃau

tʃ^ji

tʃ̣^ji

tʃ^ju

tʃ^jau

ki

ḳi

ku

kau

k^ji

ḳ^ji

k^ju

k^jau

Formal Implementation of the DT Analysis

Padgett posits a family of **SPACE** constraints that penalize sets of forms that do not allow for sufficient perceptual contrast along designated dimensions

As part of the extreme idealization of his analysis, Padgett restricts attention to the **colour** dimension, that is the properties of backness and roundness that are primarily signalled by the second vowel formant:

$SPACE_{\text{COLOR}} \geq 1/2$: Potential minimal pairs differing in vowel color differ by at least 1/2 of the full vowel color range.

A **potential minimal pair** is a pair of words having the same number of segments, and all but one of whose corresponding segments are identical.

Prior to post-velar fronting

p_i_1 p_i_2 pu_3
 ki_5 ku_6
 $tʃ_i_4$

Padgett supposes that prior to post-velar fronting, underlying forms were essentially the same as the surface forms that obtained after the First Velar Palatalization. (He omits the palatalization in word 1, $[p_i_1]$, though he agrees with standard accounts that it was palatalized).

Prior to post-velar fronting

IDENT(COLOR) >> SPACE

pi_1 pi_2 pu_3 ki_5 ku_6 $tʃi_4$	Ident-Color	Space-Color	<p>At this stage it was more important to retain underlying values of [back] and [round] (IDENT_{COLOR})...</p>
a. pi_1 pi_2 pu_3 ki_5 ku_6 $tʃi_4$		***	

Prior to post-velar fronting

IDENT(COLOR) >> SPACE

		Ident-Color	Space-Color	
	pi_1 pi_2 pu_3 ki_5 ku_6 $tʃi_4$			
☞ a.	pi_1 pi_2 pu_3 ki_5 ku_6 $tʃi_4$		***	<p>At this stage it was more important to retain underlying values of [back] and [round] (IDENT_{COLOR})... than to maximize the separation along the color dimension (SPACE_{COLOR}).</p>
b.	pi_1 pi_2 pu_3 k^ji_5 ku_6 $tʃi_4$	*!	**	


Post-velar fronting

SPACE >> IDENT(COLOR)

<p>pi_1 pi_2 pu_3 ki_5 ku_6 $t^j i_4$</p>	Space- Color	Ident- Color	Padgett proposes that what precipitated post-velar fronting was a reranking of the SPACE and IDENT constraints.

Post-velar fronting

SPACE >> IDENT(COLOR)

	Space-Color	Ident-Color	<p>Padgett proposes that what precipitated post-velar fronting was a reranking of the SPACE and IDENT constraints.</p> <p>Now the 'faithful' candidate (a) loses to the candidate, (b), that better satisfies SPACE.</p>
$pi_1 \quad pi_2 \quad pu_3$ $\quad \quad \quad ki_5 \quad ku_6$ ts^ji_4			
a. $pi_1 \quad pi_2 \quad pu_3$ $\quad \quad \quad ki_5 \quad ku_6$ ts^ji_4	***!		
 b. $pi_1 \quad pi_2 \quad pu_3$ $\quad \quad \quad k^ji_5 \quad ku_6$ ts^ji_4	**	*	

Problems with the DT Analysis

Padgett's DT analysis runs into a number of conceptual and technical problems.

Limiting the set of 'words'

First, Padgett presents no principle that could justify limiting the analysis to the 'words' below. Choosing a different set would lead to a different analysis with a different outcome.

pi

p̄i

pu

pau

p^ji

p̄^ji

p^ju

p^jau

t̄si

t̄s̄i

t̄su

t̄sau

t̄s^ji

t̄s̄^ji

t̄s^ju

t̄s^jau

ki

k̄i

ku

kau

k^ji

k̄^ji

k^ju

k^jau

Limiting the set of 'words'

Note in particular the **unprincipled** decision to designate all labials and coronals apart from **tʃ** as **p**, while velars are designated as **k**.

pi

p̥i

pu

pau

pʲi

p̥ʲi

pʲu

pʲau

tʃi

tʃ̥i

tʃu

tʃau

tʃʲi

tʃ̥ʲi

tʃʲu

tʃʲau

ki

k̥i

ku

kau

kʲi

k̥ʲi

kʲu

kʲau

Limiting the set of 'words'

It is stretching the meaning of 'idealization' to apply it to this type of case.

pi

p̄i

pu

pau

p^ji

p̄^ji

p^ju

p^jau

t̄si

t̄s̄i

t̄su

t̄sau

t̄s^ji

t̄s̄^ji

t̄s^ju

t̄s^jau

ki

k̄i

ku

kau

k^ji

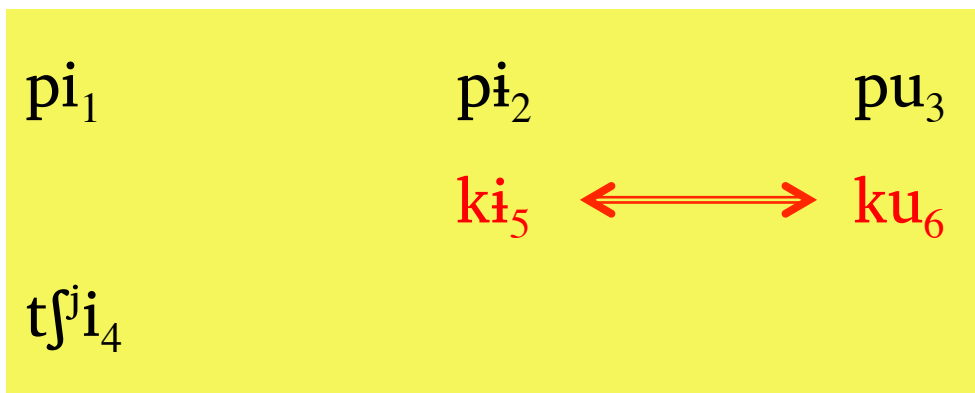
k̄^ji

k^ju

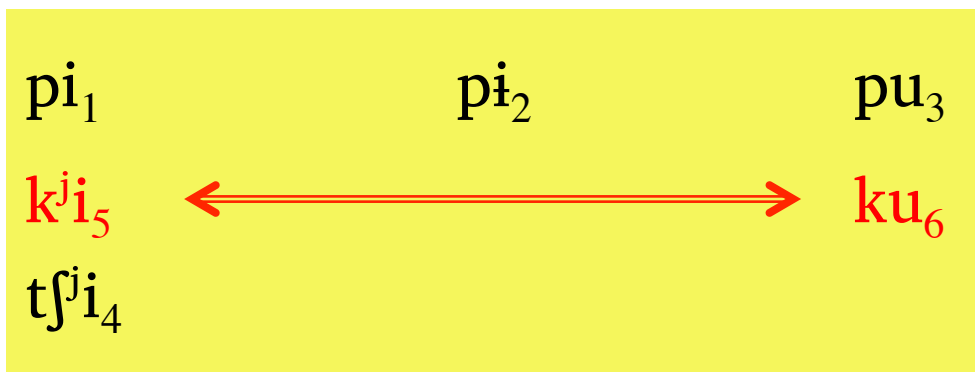
k^jau

Limiting the Space dimensions

Second, the DT analysis also imposes an arbitrary limitation on which space dimensions are evaluated for dispersion.

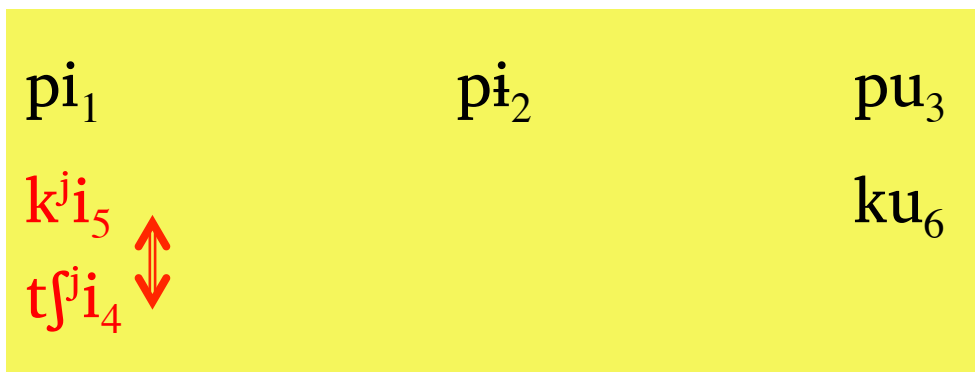
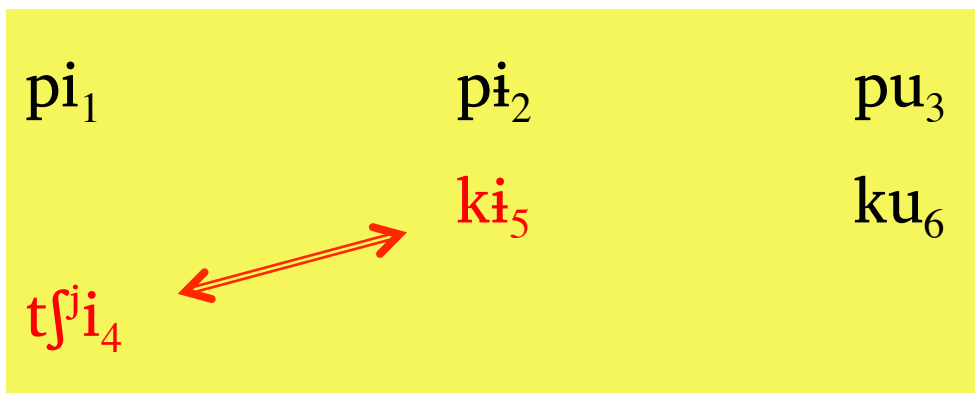


Only the distance between vowels on the color dimension (front/back and round/unround) is considered.



Limiting the Space dimensions

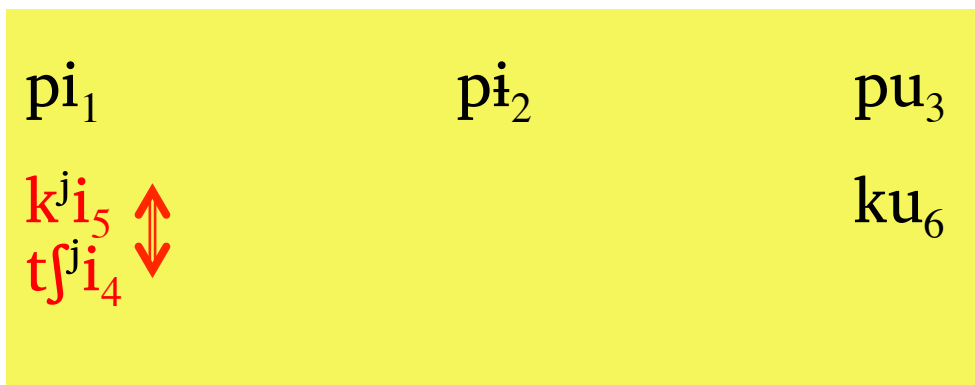
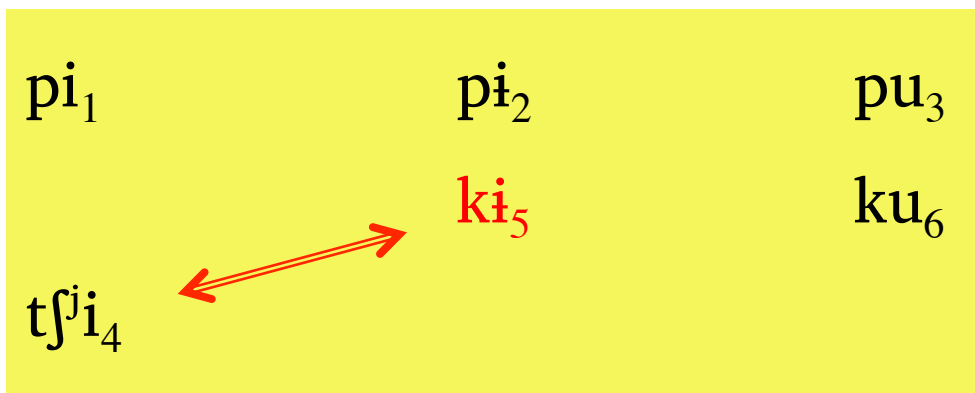
Second, the DT analysis also imposes an arbitrary limitation on which space dimensions are evaluated for dispersion.



But the distance between the consonants is not considered. In fact, the second candidate, though having better vowel dispersion, does much worse in the consonants.

Limiting the Space dimensions

Second, the DT analysis also imposes an arbitrary limitation on which space dimensions are evaluated for dispersion.



We can't argue that this contrast is somehow not salient or important; on the contrary, we know with certainty that / k^ji / can be confused with / $tʃi$ /: this actually happened in the First Velar Palatalization!

Problems with Minimal Pairs

Third, there is a technical problem with the notion of 'minimal pair'. Recall that space constraints only value the dispersion of potential minimal pairs.

pi_1	pi_2	pu_3
	ki_5	ku_6
ts^ji_4		

pi_1	pi_2	pu_3
k^ji_5		ku_6
ts^ji_4		

A potential minimal pair is defined as a pair of words having the same number of segments, and *all but one* of whose corresponding segments are identical.

Problems with Minimal Pairs

Third, there is a technical problem with the notion of 'minimal pair'. Recall that space constraints only value the dispersion of potential minimal pairs.

pi ₁	pi ₂	pu ₃
	ki ₅	ku ₆
tʃi ₄		

By this definition **ki** and **ku** are a minimal pair, differing only in the vowel;

pi ₁	pi ₂	pu ₃
k ^j i ₅		ku ₆
tʃi ₄		

But **k^ji** and **ku** differ in the vowel and in the consonant, and so are not a minimal pair. Therefore, the SPACE constraint should not apply.

Problems with Minimal Pairs

Third, there is a technical problem with the notion of 'minimal pair'. Recall that space constraints only value the dispersion of potential minimal pairs.

pi_1	pi_2	pu_3
	ki_5	ku_6
$tʃi_4$		

The same problem arises with /pⁱ/, once we restore the missing palatalization that Padgett omits from his tableaux.

pi_1	pi_2	pu_3
k^ji_5		ku_6
$tʃi_4$		

Problems with Minimal Pairs

Third, there is a technical problem with the notion of 'minimal pair'. Recall that space constraints only value the dispersion of potential minimal pairs.

$p^j i_1$	$p i_2$	$p u_3$
	$k i_5$	$k u_6$
$tʃ i_4$		

The same problem arises with $/p^j i/$, once we restore the missing palatalization that Padgett omits from his tableaux.

$p^j i_1$	$p i_2$	$p u_3$
$k^j i_5$		$k u_6$
$tʃ i_4$		

$/p^j i/$ differs from $/p i/$ and $/p u/$ in both the vowel and consonant.

Disregard of Phonemic Status

A fourth problem with Padgett's approach is its total disregard for the phonemic status of segments.

Padgett (2003) writes that his analysis is inspired by Jakobson (1929); but the key to Jakobson's analysis is a change in the phonemic status of the vowel **i**.

In Padgett's surface-oriented approach it makes no difference if **i** is an independent phoneme or an allophone of /**i**/.

Richness of the Base

Padgett (2003) does not want to rely on the phonemic status of [i] because of his understanding of the concept of **richness of the base** (Prince and Smolensky 2004).

Padgett's reasoning can be reconstructed along the following lines: If [i] derives from the phoneme /i/, then according to richness of the base we require a solution that works no matter which allophone we put in the input; in particular, the solution should work if [i] corresponds to input /i/.

Therefore, he rejects any analysis (like Jakobson's) that crucially depends on [i] deriving from underlying /i/, that is, a vowel specified [-back].

Richness of the Base

Ironically, it turns out that in order to account for a sequence of historical changes, Padgett himself must abandon richness of the base.

This is because he wants to guarantee the stability of a historical change: for example, that when [k^ji] changes to [tʃ^ji], that subsequently the input to [tʃ^ji] will remain /tʃ^ji/, and will not revert to /k^ji /.

Therefore he adopts, 'as an expository convenience', the *synchronic base hypothesis* (Hutton 1996, Holt 1997), which holds that the input at each historical stage is the output of the previous stage.

Rejection of Structuralism

The synchronic base hypothesis is a rejection not only of richness of the base; it amounts to a reversion to pre-structuralist 19th century neogrammarian theory.

Jakobson argued that historical change is influenced by the phonemic status of segments, a position elaborated on in generative grammar, notably by Kiparsky.

On this view, diachronic changes are the surface reflection of changes to the grammar, and the cause of any particular change must be understood with respect to the grammar as a whole.

Modified Contrastive Specification




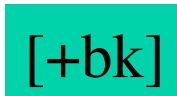


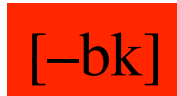
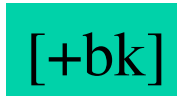
The theory of the contrastive hierarchy suggests a different solution to post-velar fronting, one that does not require the problematic selection of sets of inputs, and which is closer to the spirit of Jakobson's (1929) analysis. In keeping with generative grammar, it requires paying attention to the succession of *grammars*, not just to changing surface forms.

Based on the traditional chronology given earlier, I assume the following sequence of grammars, starting with Common Slavic, after First Velar Palatalization (FVP) but before the East Slavic post-velar fronting:

Stage 1: Vowels, not consonants, are contrastively [back]

Underlying	/p i/	/p i/	/tʃ i/	/k i/
	[-bk]	[+bk]	[-bk]	[+bk]









Stage 1: [-back] vowels cause preceding consonants to palatalize allophonically.

Underlying	/p i/	/p i/	/tʃ i/	/k i/
	 [-bk]	 [+bk]	 [-bk]	 [+bk]
Palatalization	p ^j i	p i	tʃ ^j i	k i
	 [-bk]	 [+bk]	 [-bk]	 [+bk]
Phonetic	[p ^j i]	[p ^ɨ i]	[tʃ ^j i]	[k ^ɨ i]

Stage 2: There were two ultra-short vowels called jers: one was a front vowel and the other was a back vowel.

Underlying	/p ĭ/	/p ĥ/	/tʃ ĭ/	/k ĥ/
	[-bk]	[+bk]	[-bk]	[+bk]

Stage 2: The front jer palatalized like other front vowels, the back one did not.

Underlying	/p ĭ/	/p ĥ/	/tʃ ĭ/	/k ĥ/
				
Palatalization	p ^j ĭ	p ĥ	tʃ ^j ĭ	k ĥ
				

Stage 2: The fall of the jers made palatalization opaque and led to the reanalysis of palatalized consonants as underlying.

Underlying	/p ĭ/	/p ǐ/	/tʃ ĭ/	/k ǐ/
	[-bk]	[+bk]	[-bk]	[+bk]
Palatalization	p ^j ĭ	p ǐ	tʃ ^j ĭ	k ǐ
	[-bk]	[+bk]	[-bk]	[+bk]
Jers delete	[p ^j]	[p]	[tʃ ^j]	[k]

Stage 3: Vowels and *paired* consonants are contrastively [back].

Underlying	/p ^j	i/	/p	i/
	[-b]	[-b]	[+b]	[+b]
Palatalization	—		—	
Phonetic	[p ^j i]		[pi]	

Stage 3: Some coronals, like /tʃ^j/, are unpaired, but function as contrastively [-back].

Underlying	/p ^j /	i/	/p/	i/	/tʃ ^j /	i/
	[-b]	[-b]	[+b]	[+b]	[-b]	[-b]

Palatalization	—		—		—	
----------------	---	--	---	--	---	--

Phonetic	[p ^j i]		[pi]		[tʃ ^j i]	
----------	--------------------	--	------	--	---------------------	--

Stage 3: Velars are unpaired, but they are *not* contrastively [back]. Why the difference between /tʃ^j/ and /k/?

Underlying	/p ^j	i/	/p	i/	/tʃ ^j	i/	/k	i/
	[-b]	[-b]	[+b]	[+b]	[-b]	[-b]	[+b]	
Palatalization	—		—		—		—	
Phonetic	[p ^j i]		[pi]		[tʃ ^j i]		[ki]	

Stage 3: The contrastive status of unpaired consonants depends on the contrastive hierarchy.

Underlying	/p ^j	i/	/p	i/	/tʃ ^j	i/	/k	i/
	[-b]	[-b]	[+b]	[+b]	[-b]	[-b]	[+b]	
Palatalization	—		—		—		—	
Phonetic	[p ^j i]		[pi]		[tʃ ^j i]		[ki]	

Stage 3: I will show why unpaired coronals are contrastive for [back] while velars are not contrastively [+back].

Underlying	/p ^j	i/	/p	i/	/tʃ ^j	i/	/k	i/
	[-b]	[-b]	[+b]	[+b]	[-b]	[-b]	[+b]	
Palatalization	—		—		—		—	
Phonetic	[p ^j i]		[pi]		[tʃ ^j i]		[ki]	

Stage 3: For now let us assume this result.

Underlying	/p ^j	i/	/p	i/	/tʃ ^j	i/	/k	i/
	[-b]	[-b]	[+b]	[+b]	[-b]	[-b]	[+b]	
Palatalization	—		—		—		—	
Phonetic	[p ^j i]		[pi]		[tʃ ^j i]		[ki]	

Stage 4: The regularity whereby [ɨ] followed back consonants and [i] occurred elsewhere led to a reanalysis:

Phonetic

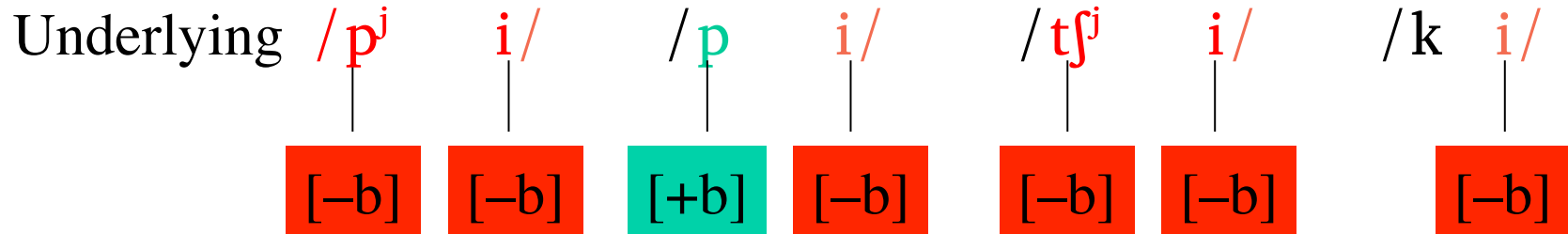
[p^ji]

[pɨ]

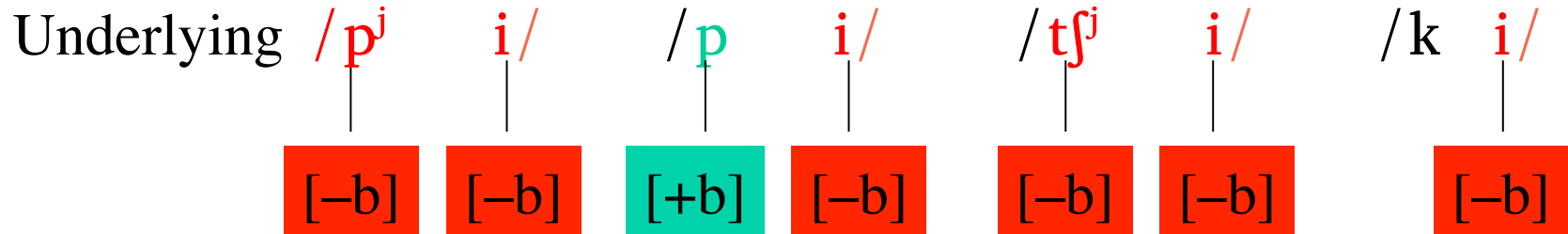
[tʃ^ji]

[kɨ]

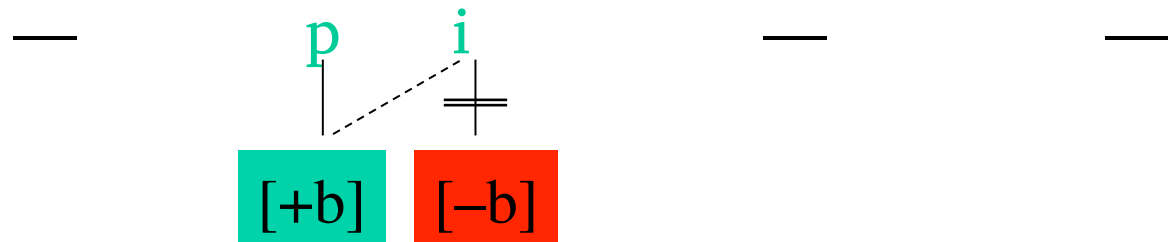
Stage 4: /i/ is reanalyzed as a [+back] allophone of [-back] /i/



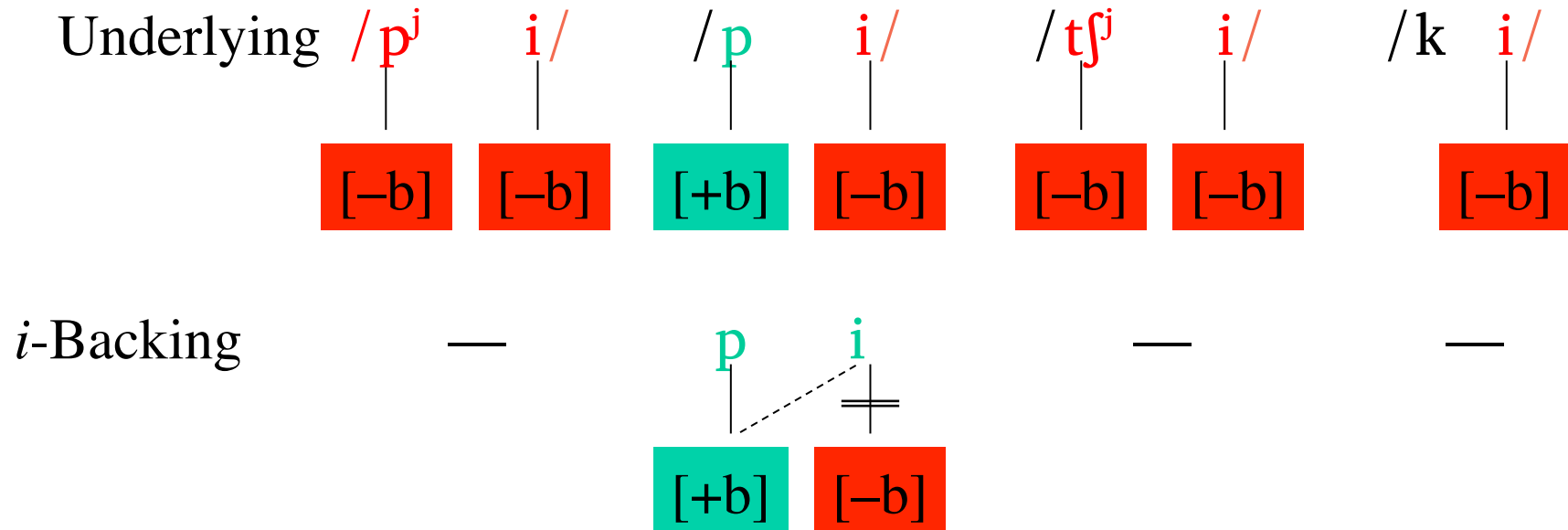
Stage 4: The reanalysis requires a rule that backs /i/ to [ɨ] after a [+back] consonant.



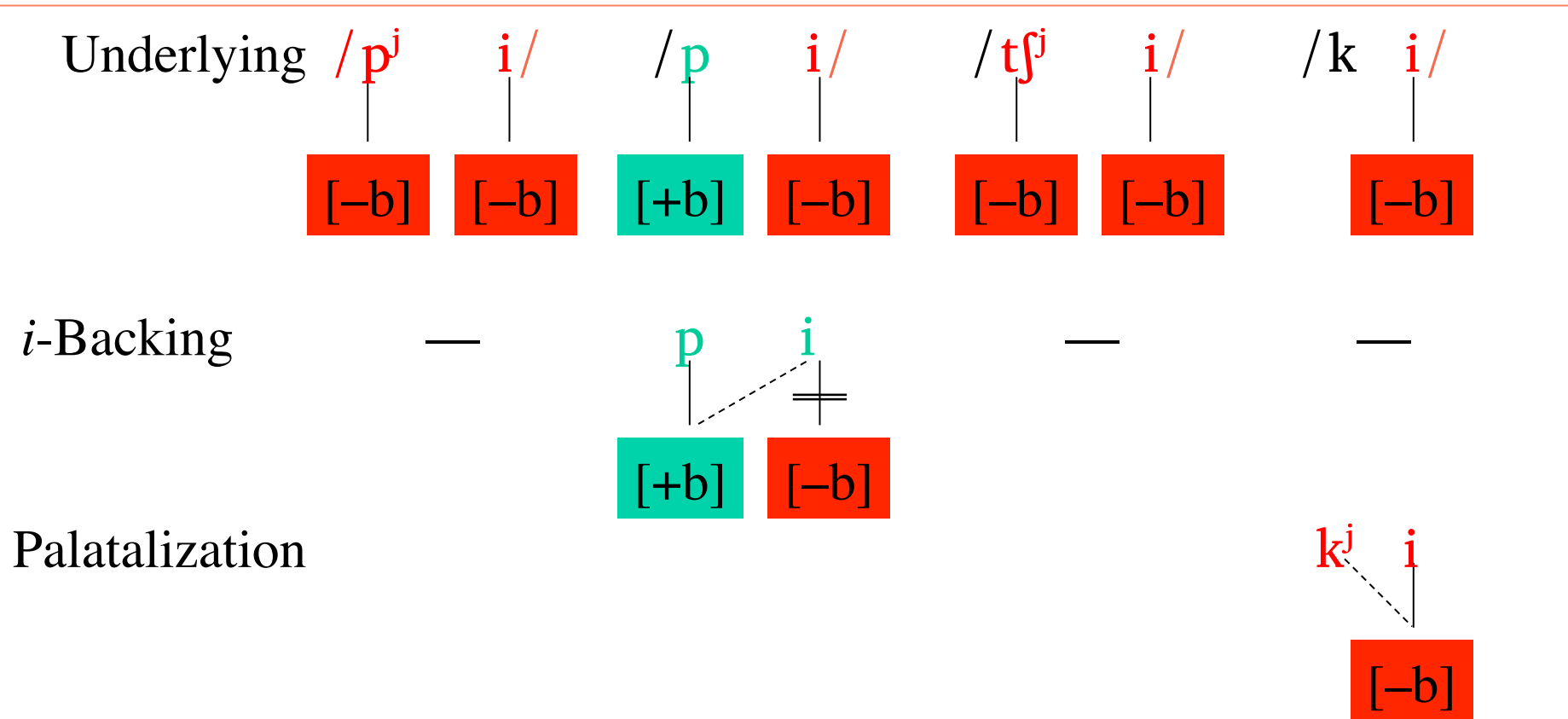
i-Backing



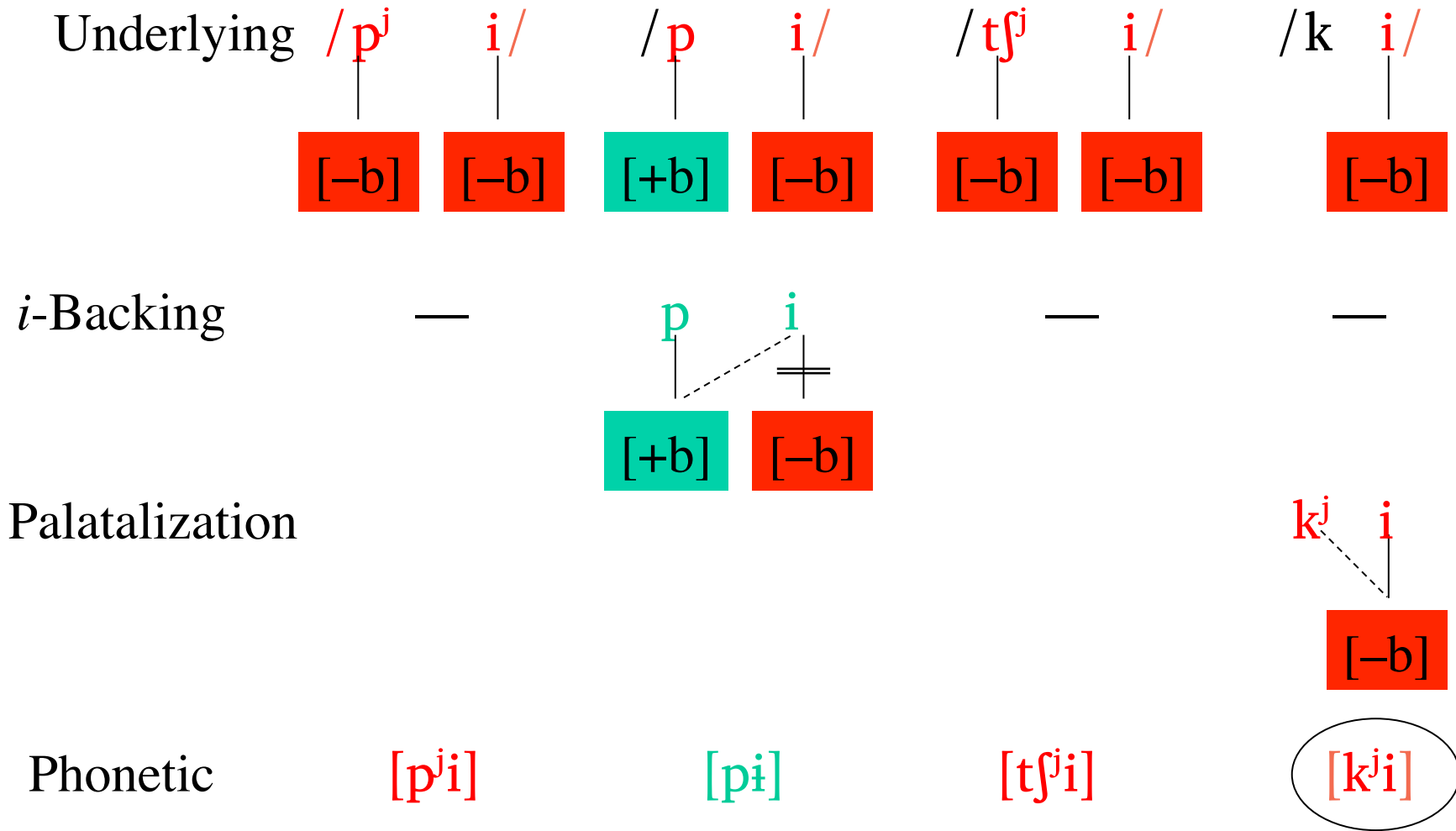
Stage 4: But /k/ has no contrastive [+back] feature that can affect the vowel.



Stage 4: Instead, /i/ palatalizes the /k/.



Stage 4: The consequence is post-velar fronting: it appears that [kʲi] > [kʲi].

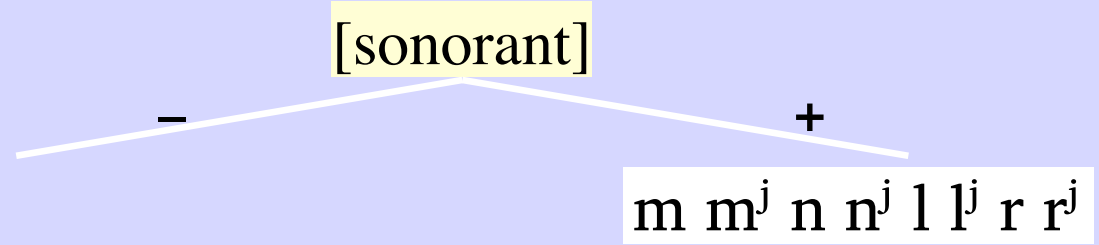


A Contrastive Hierarchy Analysis

This is essentially Jakobson's (1929) analysis, in which the crucial event that provoked post-velar fronting was the reanalysis of [i] as an allophone of /i/, not the lack of dispersion between [i] and [u].

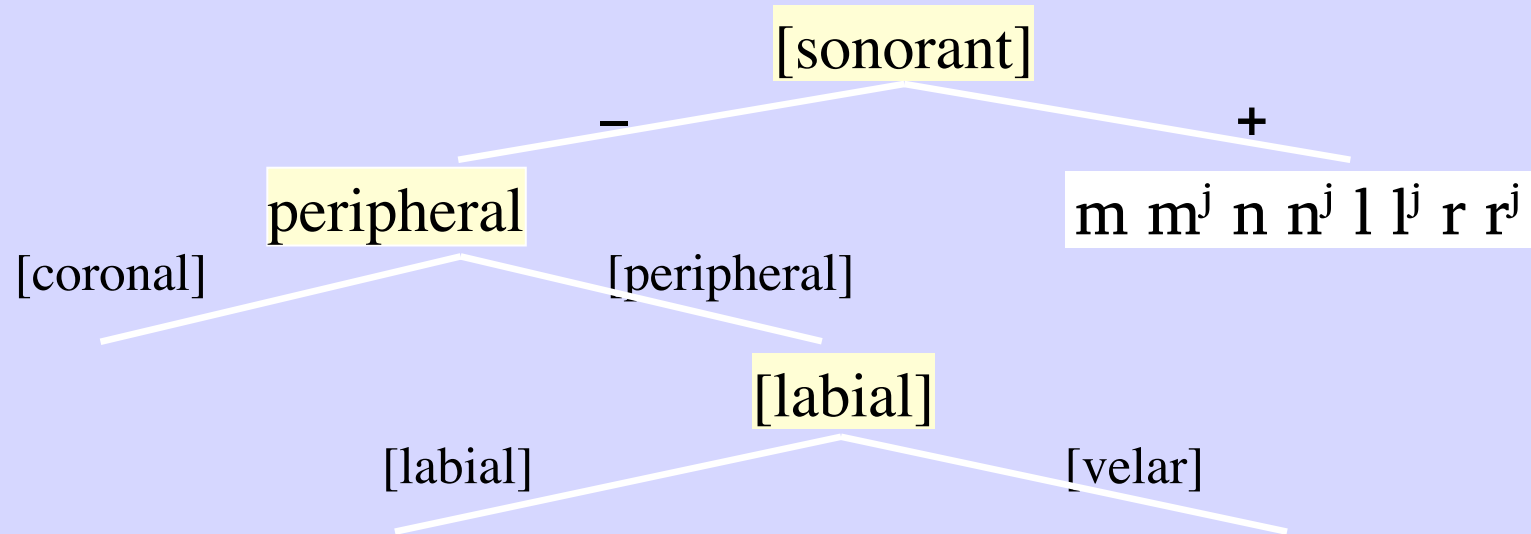
Rather than an arbitrary selection of 'words' and arbitrary restriction of the dimensions of contrast for this problem alone, this analysis is based on a contrastive feature hierarchy for Russian that should apply to other aspects of Russian phonology, such as voicing:

Contrastive Hierarchy for Early Russian Consonants



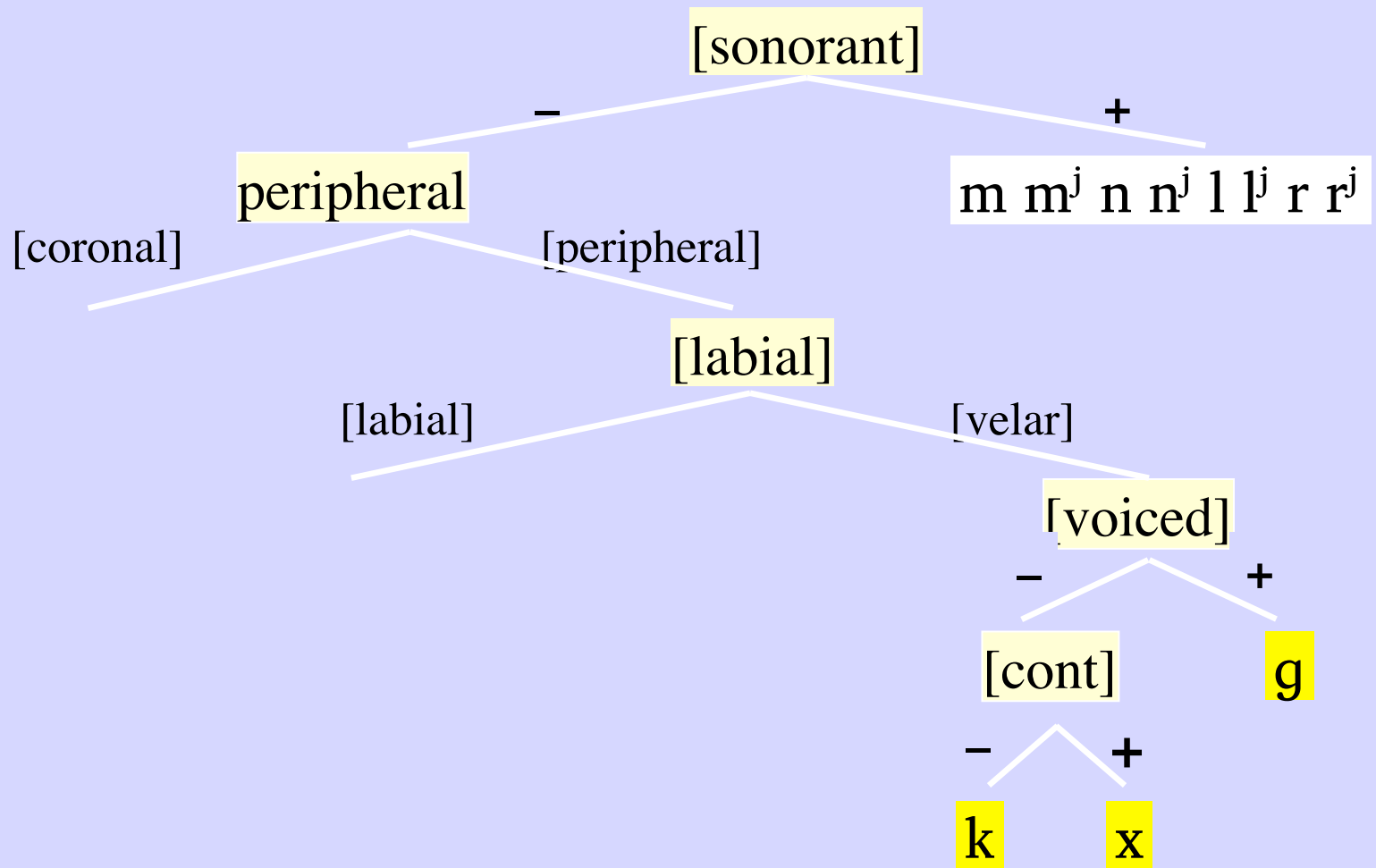
The first contrast is between sonorants and obstruents. Voicing is now not contrastive among the sonorants, which are all voiced.

Contrastive Hierarchy for Early Russian Consonants



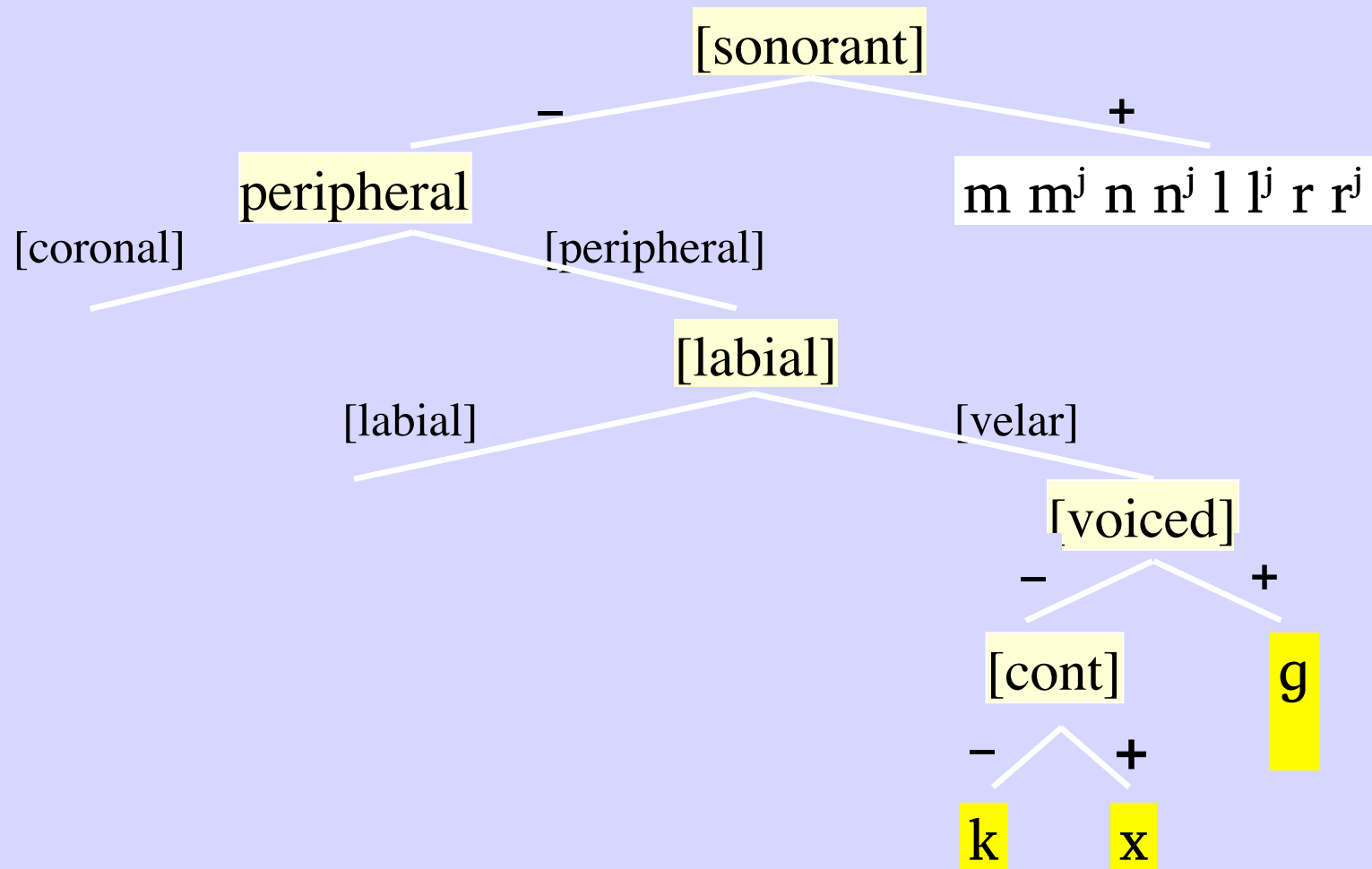
I assume that the place features [peripheral] and [labial] come next. [-peripheral] = [coronal] and [-labial] = [velar].

Contrastive Hierarchy for Early Russian Consonants



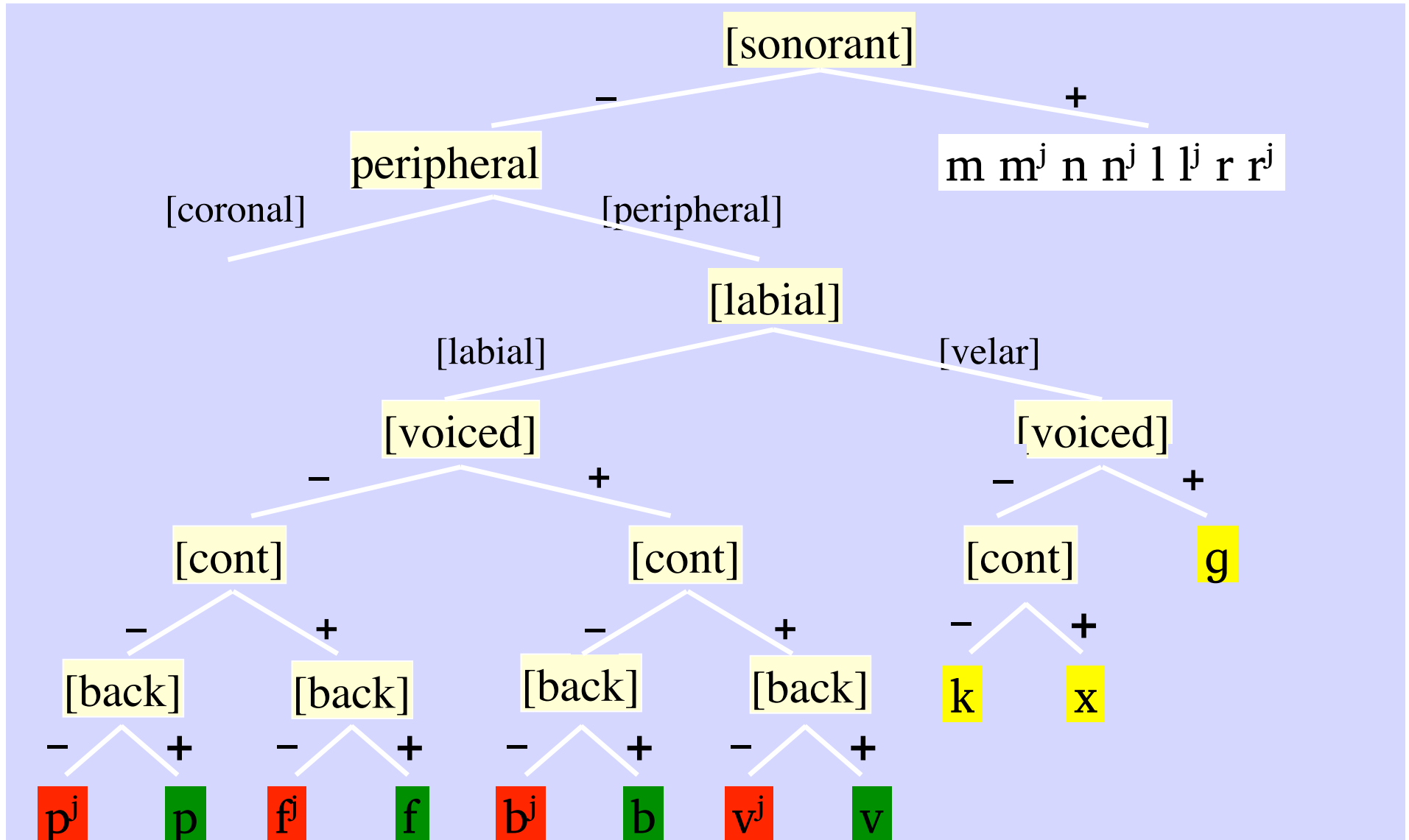
We know that the velars have contrastive specifications for [voiced] and [continuant]. They receive no further features.

Contrastive Hierarchy for Early Russian Consonants



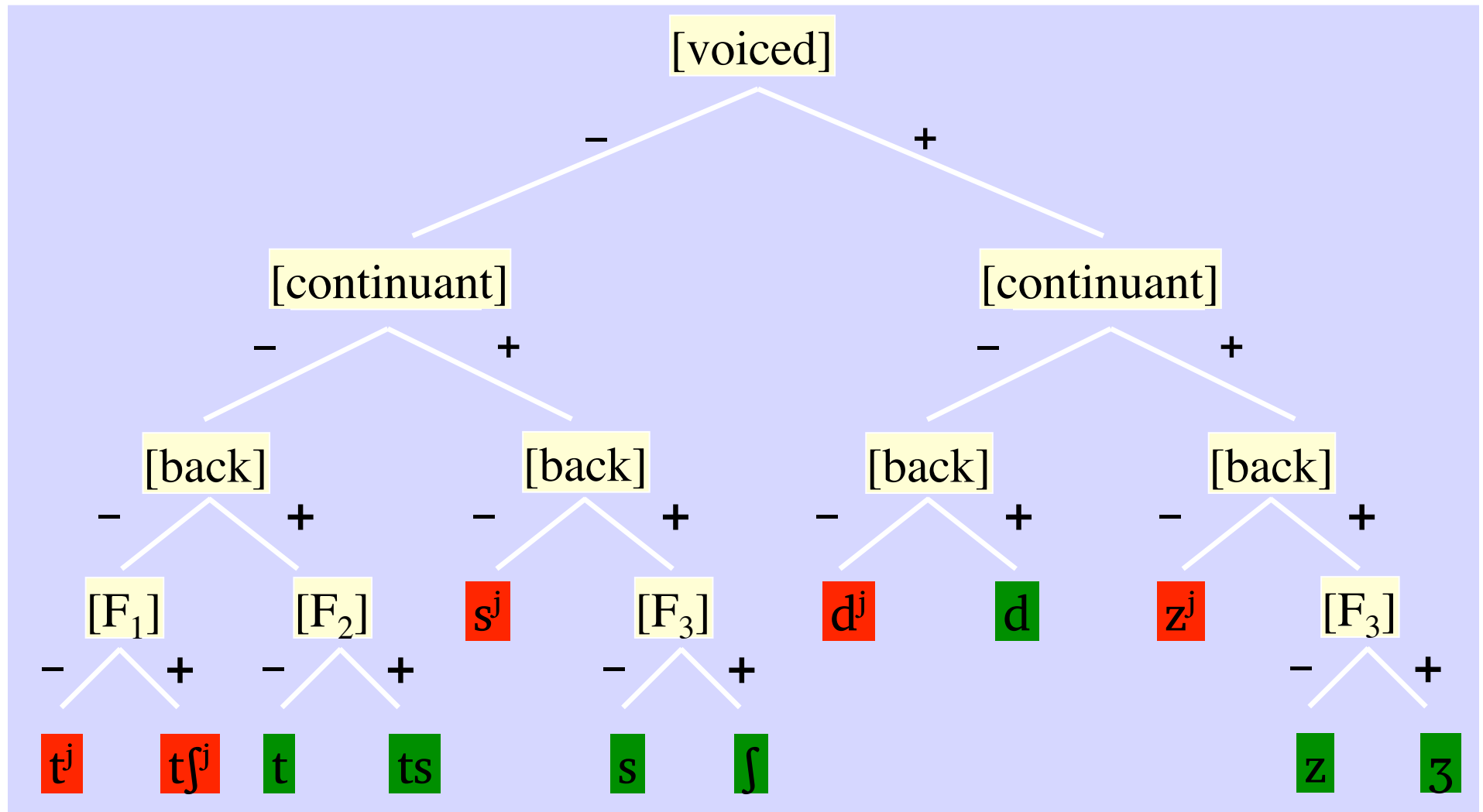
In particular, they receive no contrastive specifications for [back].

Contrastive Hierarchy for Early Russian Consonants



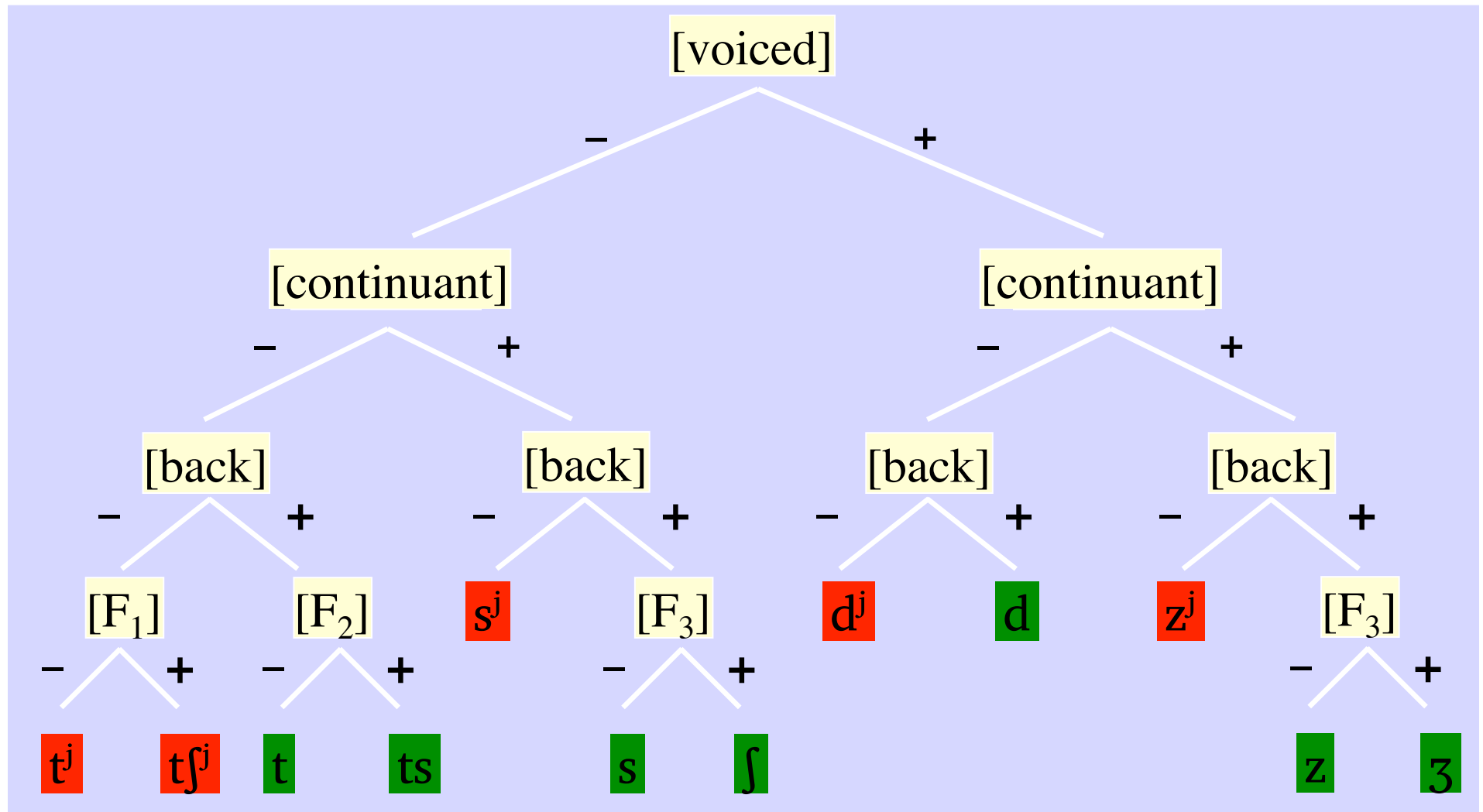
The same ordering applies in the labials. Since they are all paired, they all receive contrastive values of [back].

Contrastive Hierarchy for Early Russian Coronals



The coronals are more interesting. There are more contrasts in the coronals than in the velars; if we assume that the feature [back] is ordered ahead of some other features, designated here as [F_i],

Contrastive Hierarchy for Early Russian Coronals



the result is that **all** the coronals receive contrastive values of [back]. This explains why the ‘unpaired’ coronals act as if they are contrastively palatalized or nonpalatalized, unlike the velars.

Russian 'Paired Consonants'

Russian has two types of 'paired' consonants: palatalized ~ nonpalatalized (involving the feature [back]); and voiced ~ voiceless ([voiced]).

Paired consonants are contrastive for the relevant feature in any theory: /t/ ~ /d/ contrast only in voicing, and /t/ ~ /tʲ/ contrast only in palatalization.

Russian 'Unpaired Consonants'

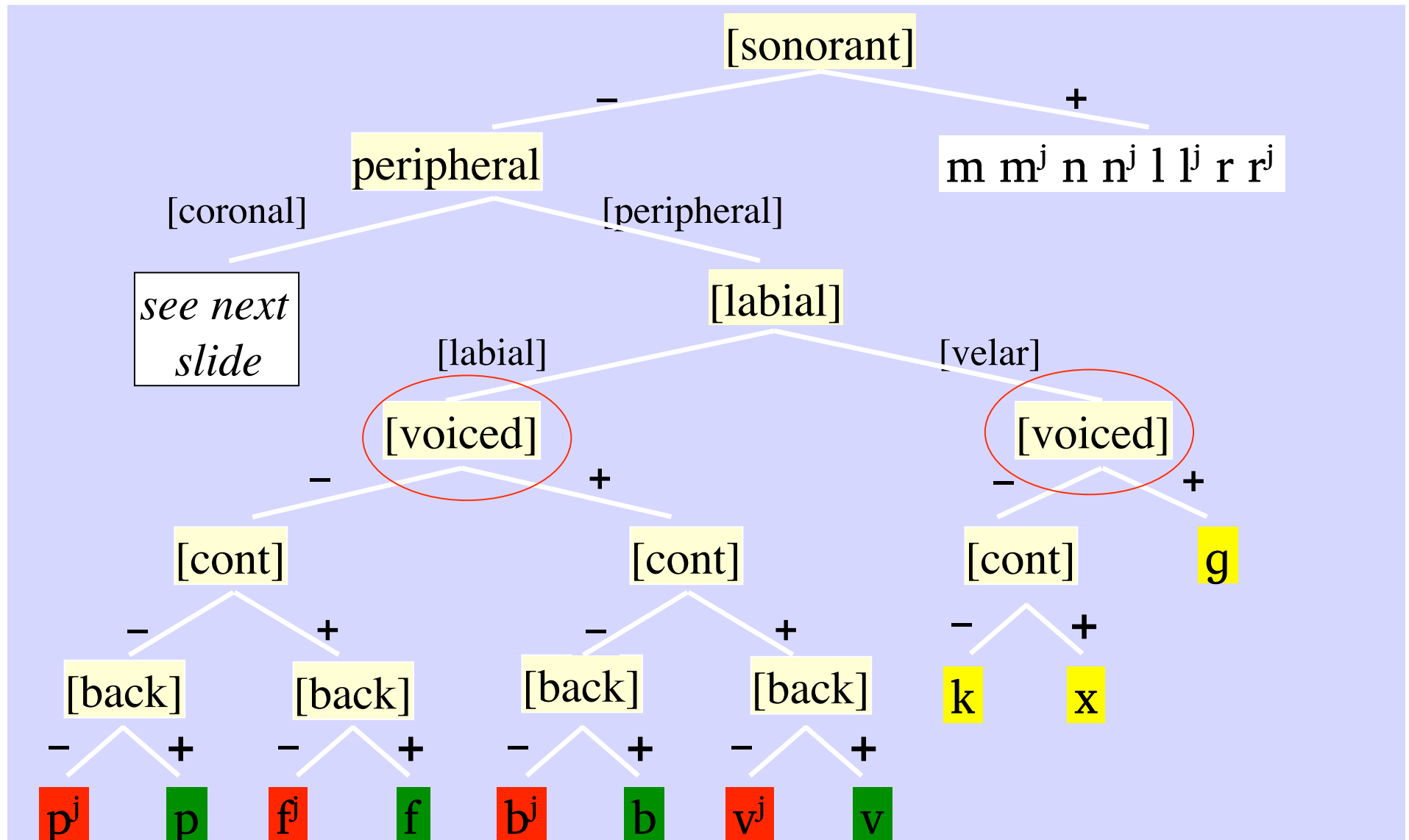
But the unpaired consonants are *not* all noncontrastive for each feature.

In the case of voicing, the famous unpaired voiceless consonants /ts, tʃ, x/ all act as if they are contrastively voiceless.

In the case of palatalization, the unpaired velars are not contrastive, but the unpaired coronal consonants act as if they *are*.

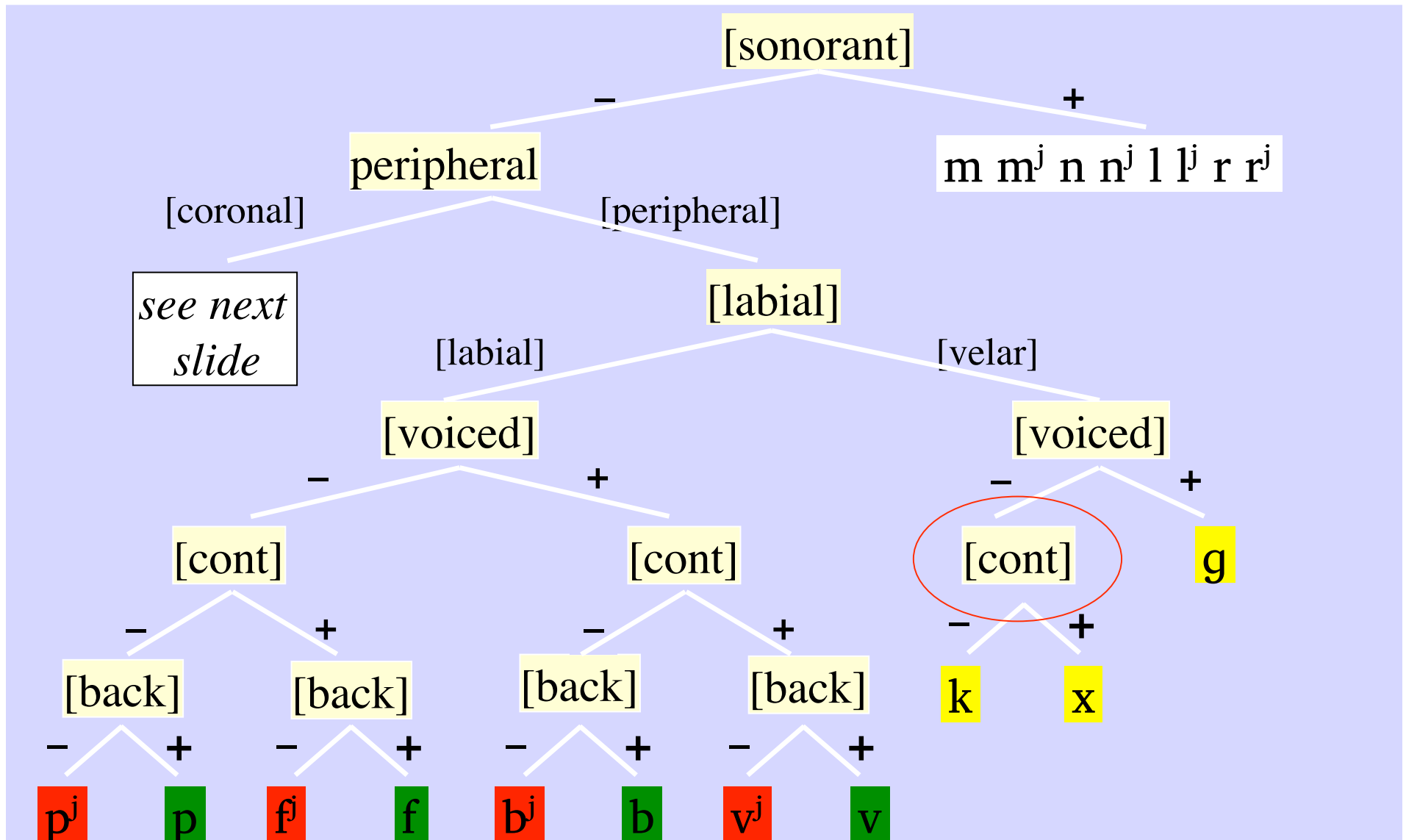
'Minimal pairs' cannot explain this, but the contrastive hierarchy for Russian shows why this is so.

Contrastive Hierarchy for Early Russian Consonants



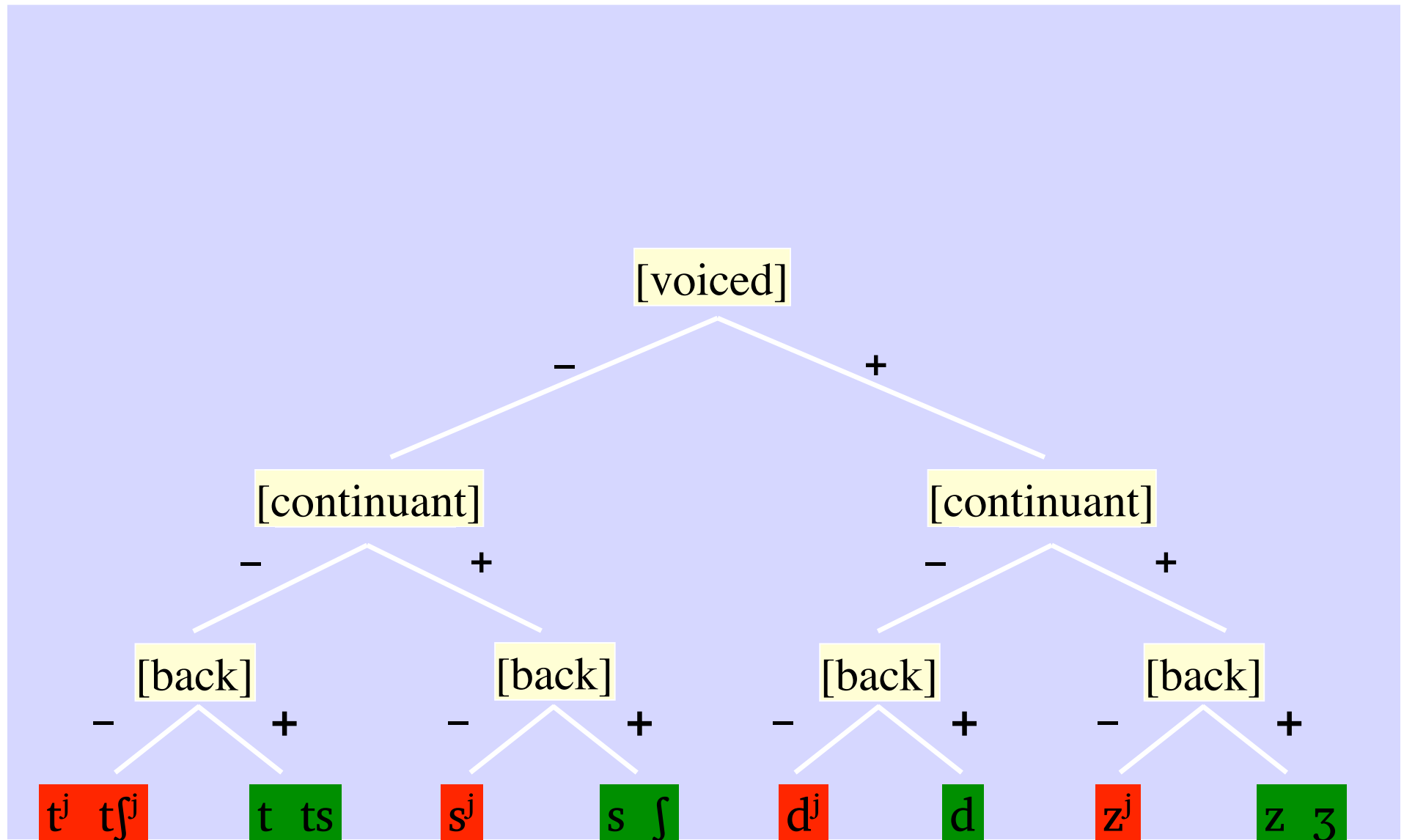
[voiced] is sufficiently high in the order to take scope over all obstruents, so paired and unpaired consonants function alike.

Contrastive Hierarchy for Early Russian Consonants



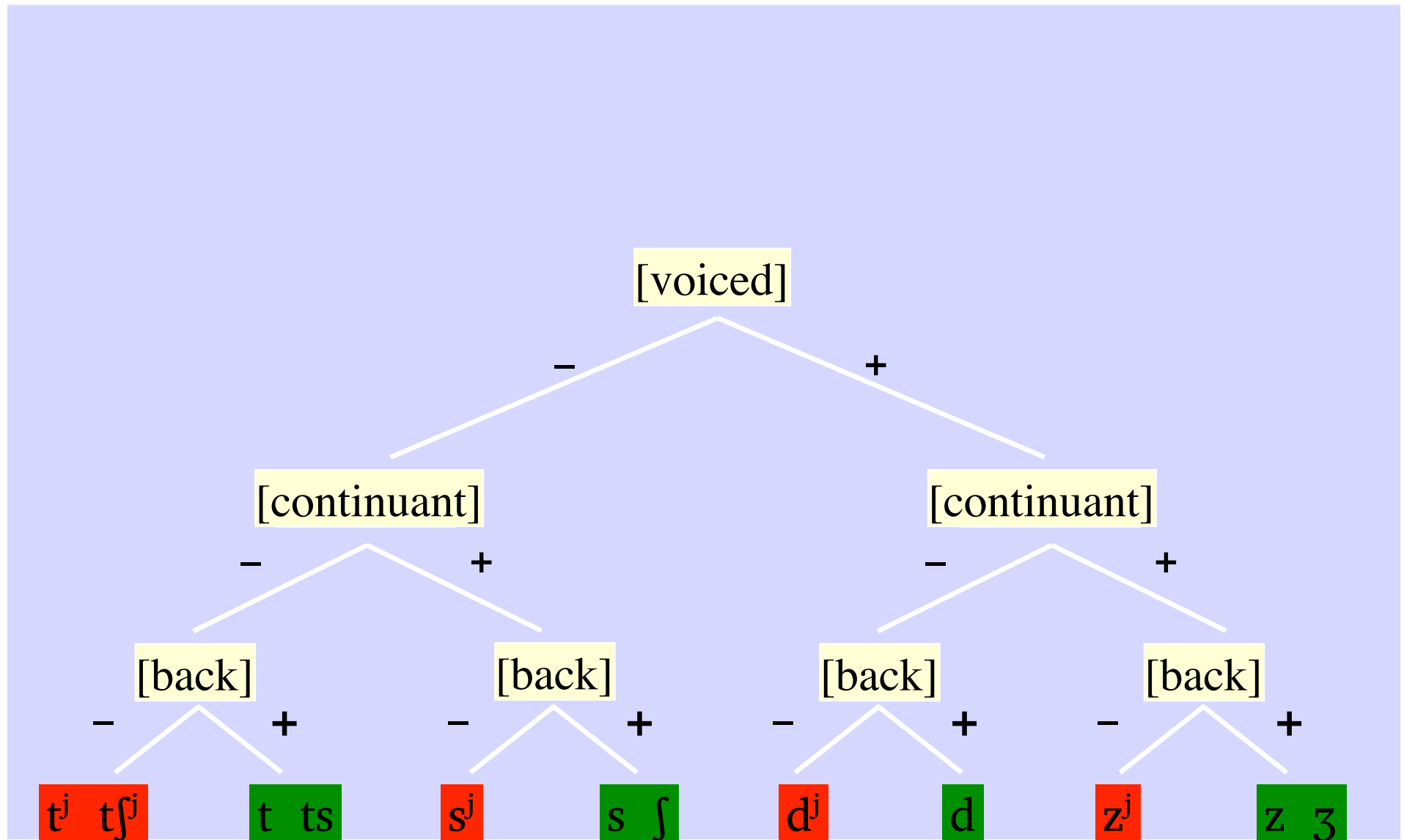
But [cont] is lower. In the velars, 'unpaired' /g/ has no contrastive value for this feature.

Contrastive Hierarchy for Early Russian Coronals



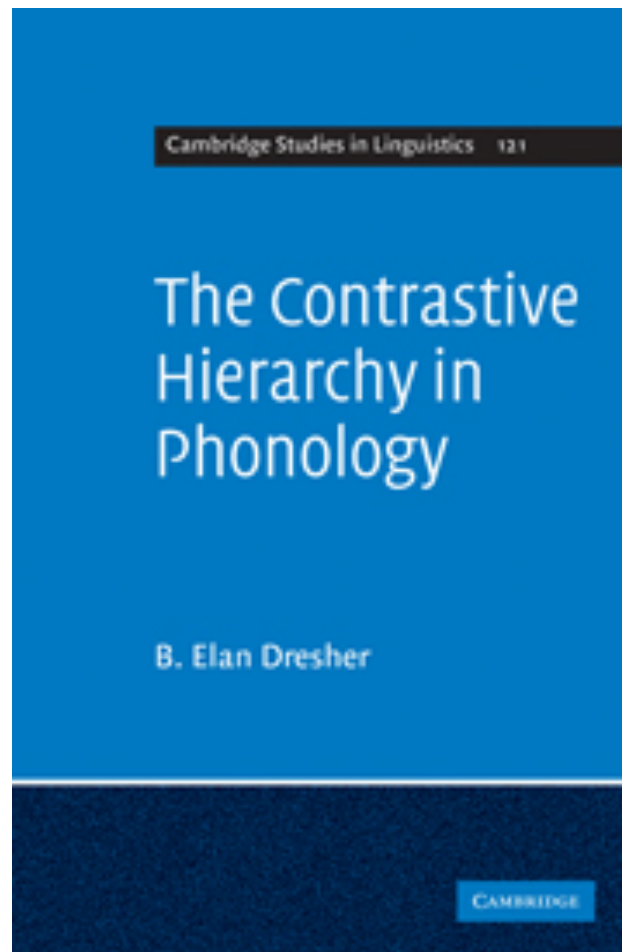
There are more coronals, so all three of these features are contrastive in all coronals.

Contrastive Hierarchy for Early Russian Coronals



The evidence from different phonological processes converges on a single consistent feature hierarchy.

For a more complete account please see:



I am grateful to members of the project on
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www.chass.utoronto.ca/~contrast/

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