

# Features in Phonology, Morphology, Syntax and Semantics: What are they?

October 31–November 1, 2013

CASTL - Center for Advanced Study in Theoretical Linguistics

A photograph of a traditional Chinese stone archway over a pond. The arch is made of large, grey stone blocks. In the background, there is a traditional Chinese building with a tiled roof and a garden with trees. The scene is reflected in the water of the pond.

*The arch not the stones:  
Universal feature theory without  
universal features*

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# Introduction

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I will propose that the phonological component of the grammar computes features, but these features are not innate.

Rather, they are created by the learner as part of the acquisition of phonology.

Further, Universal Grammar (UG) requires that these features be organized into **contrastive feature hierarchies** that reflect phonological activity and the contrasts in the lexical inventory.

# Introduction

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The talk is organized as follows:

- **Introduction**
- Part 1: The arch not the stones
  - Problems with innate features
  - Contrastive feature hierarchies
- Part 2: Example of contrast and activity:  
Classical Manchu vowels
- Part 3: The acquisition of phonological representations
- Part 4: The contrastive hierarchy and 'substance':  
Tonal organization in Chinese dialects
- Conclusion: Phonology and the Faculty of Language

# Part 1

## *The arch not the stones*



*In Invisible Cities, Italo Calvino imagines an exchange between Marco Polo and Kublai Khan.*



*Marco Polo describes a bridge, stone by stone.*

*“But which is the stone that supports the bridge?”  
Kublai Khan asks.*

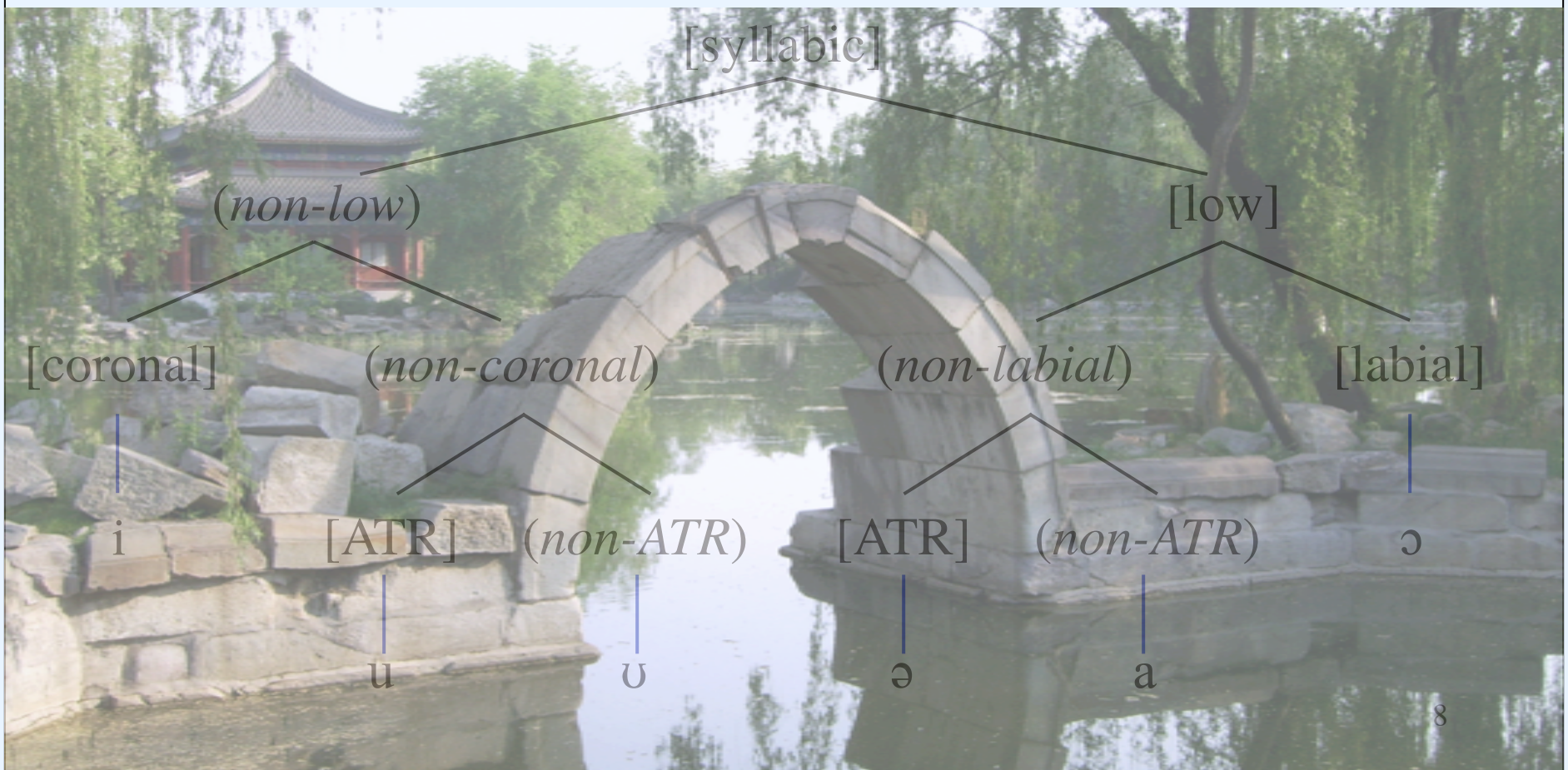


*“The bridge is not supported by one stone or another,” Marco answers, “but by the line of the arch that they form.”*



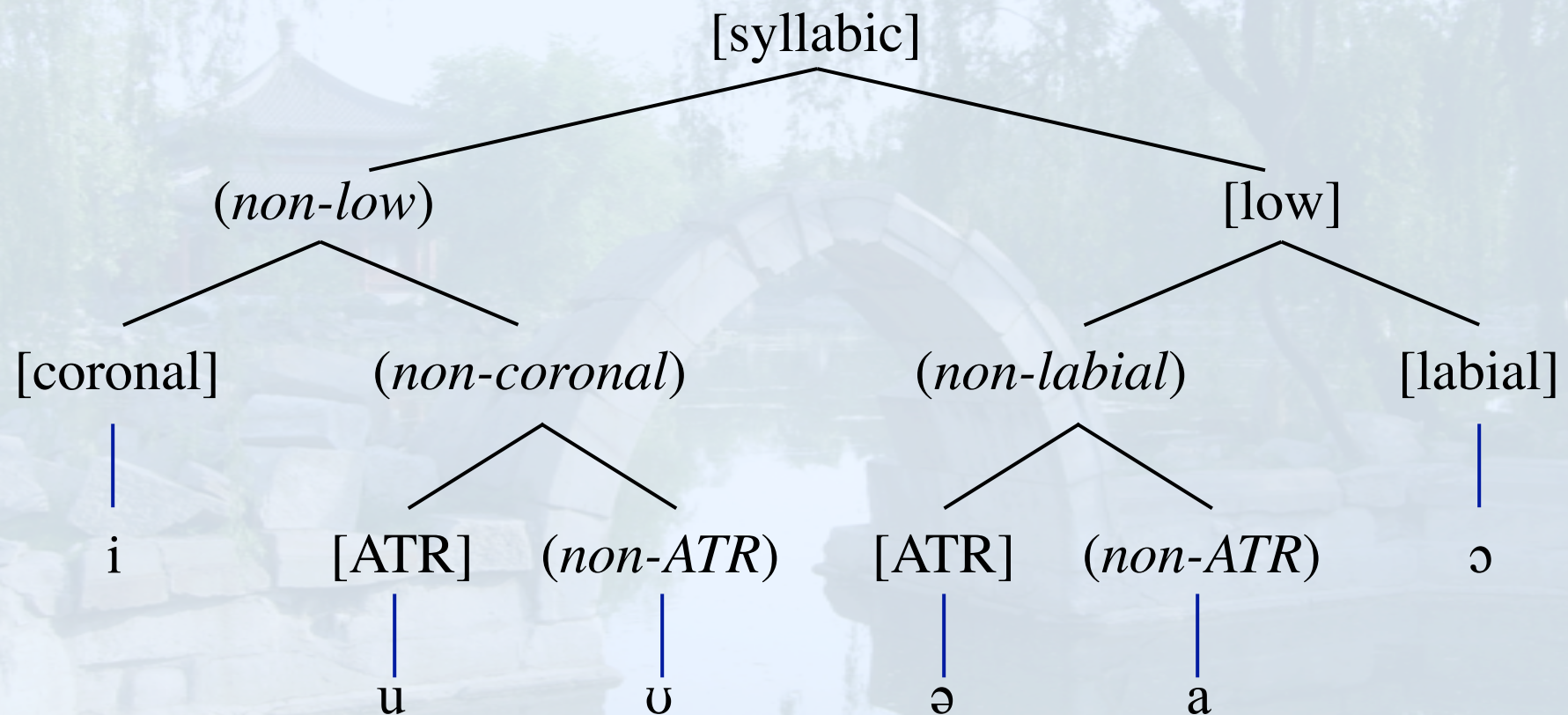
*“The bridge is not supported by one stone or another,” Marco answers, “but by the line of the arch that they form.”*

*Kublai Khan remains silent, reflecting. Then he adds:*





*“Why do you speak to me of the stones? It is only the arch that matters to me.”*



*“Why do you speak to me of the stones? It is only the arch that matters to me.”*

*Polo answers: “Without stones there is no arch.”*



# Emergent features

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

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

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

# Against innate features

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- from a biolinguistic perspective, phonological features are too specific, and exclude sign languages (van der Hulst 1993; Sandler 1993);
- empirically, no one set of features have been discovered that 'do all tricks' (Hyman 2010 with respect to tone features, but the remark applies more generally);
- since at least some features have to be acquired from phonological activity, a prespecified list of features becomes less useful in learning.

# Why do features emerge at all?

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But if features are emergent, we need to explain why they are required at all, and what UG principles account for the way they function in the phonology.

I propose that the task of the learner is to arrive at a set of features that account for the contrasts and the phonological activity in a given language.

# A theory of contrast



To implement contrast in an explicit theory, I borrow an idea from Jakobson and his collaborators (Jakobson, Fant & Halle 1952, Jakobson & Halle 1956), that was called 'branching trees' in the literature of the 1950s and 1960s:

# The contrastive hierarchy

Contrastive features are assigned by language-particular feature hierarchies.

I call it the **Successive Division Algorithm** (Dresher 1998, 2003, 2009):

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

As a first approximation I assume further that phonology computes **only** contrastive features, in keeping with the **Contrastivist Hypothesis**:

# A theory of contrast

## The Contrastivist Hypothesis (Hall 2007)

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

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

## Corollary to the Contrastivist Hypothesis

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



# Markedness

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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.

I will designate the marked value of a feature F as **[F]**, and the unmarked value as *(non-F)*.

# Phonological primes

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The working assumption here is that the phonological primes are binary features.

It is an empirical hypothesis that the learner creates binary features and not other sorts of entities, such as privative elements or dependency structures of various kinds.

As long as these other types of representations are compatible with the contrastive hierarchy and related assumptions as outlined above, we can consider them to be minor variations of the theory presented here.

# Emergent features and UG

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For the content of features (or whatever primes are assumed), learners make use of the available materials relevant to the modality:

- for spoken language, acoustic and articulatory properties of speech sounds;
- for sign language, hand shapes and facial expressions.

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

# How the contrastive hierarchy works

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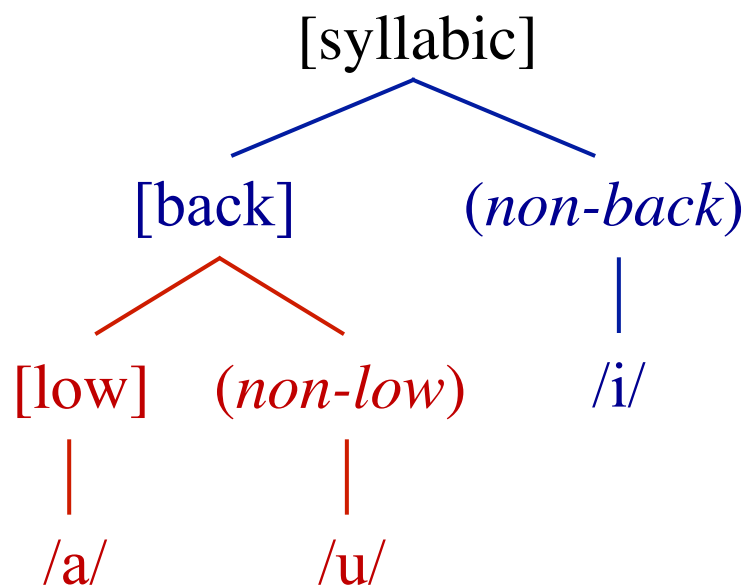
For example, if a language has three vowel phonemes /i, a, u/, and if the vowels are split off from the rest of the inventory so that they form a sub-inventory, then they must be assigned a contrastive hierarchy with two vowel features.

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

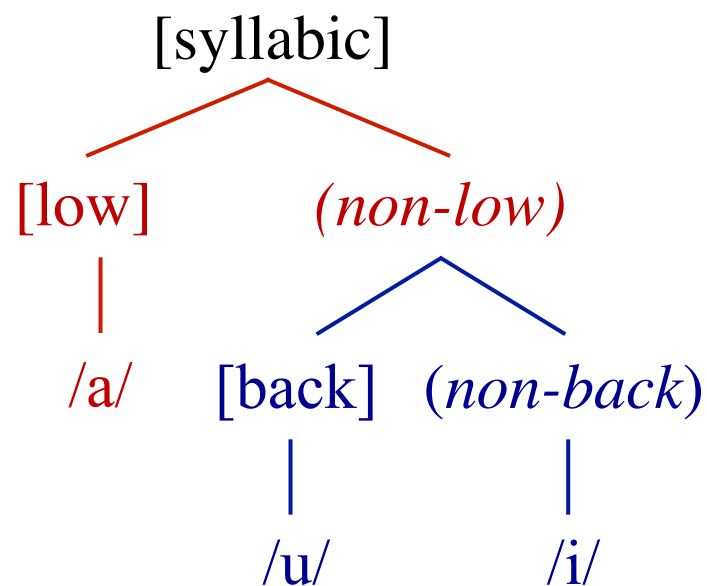
# How the contrastive hierarchy works

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

**[back]** > **[low]**



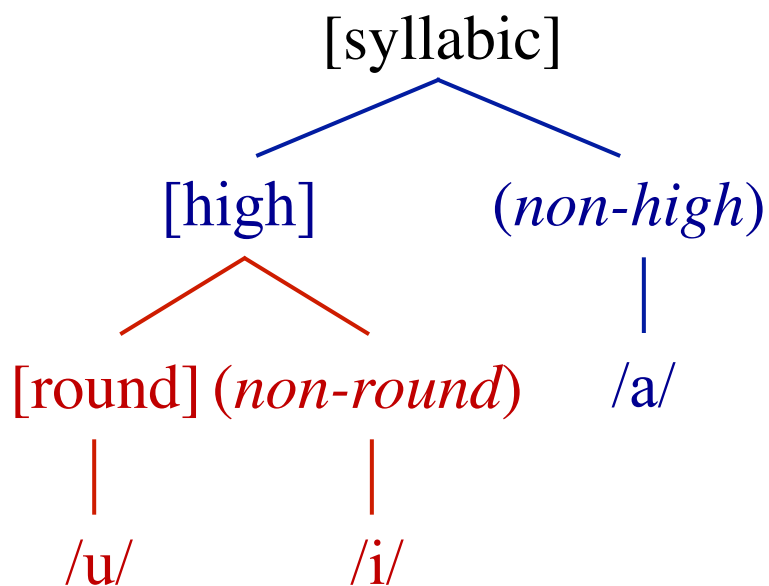
**[low]** > **[back]**



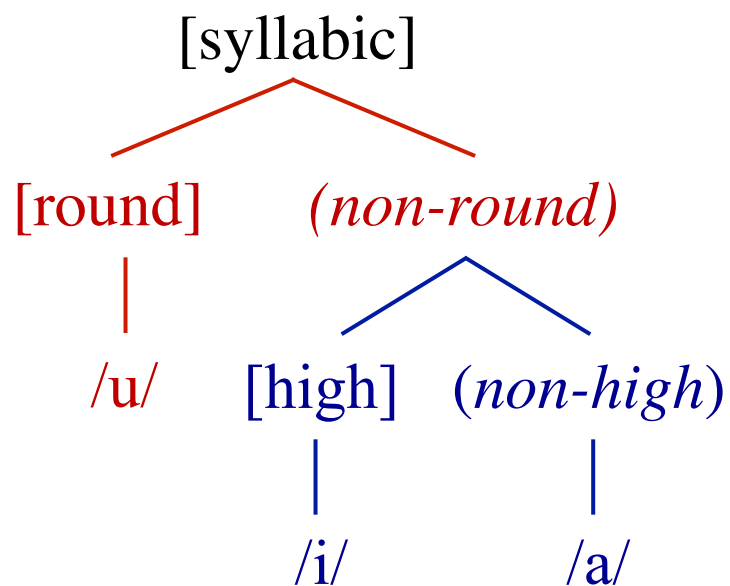
# How the contrastive hierarchy works

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

**[high]** > **[round]**



**[round]** > **[high]**

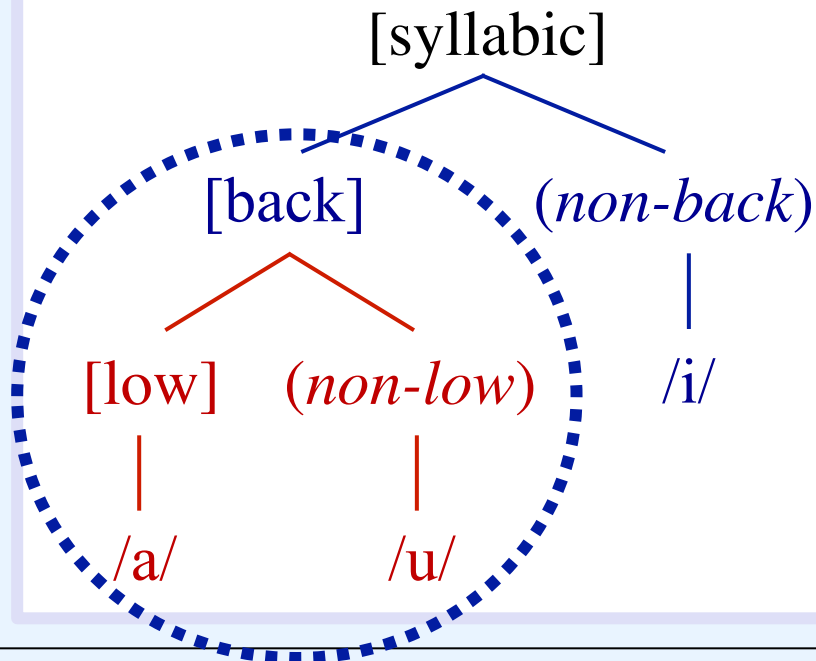


# What does the hierarchy do? Synchrony

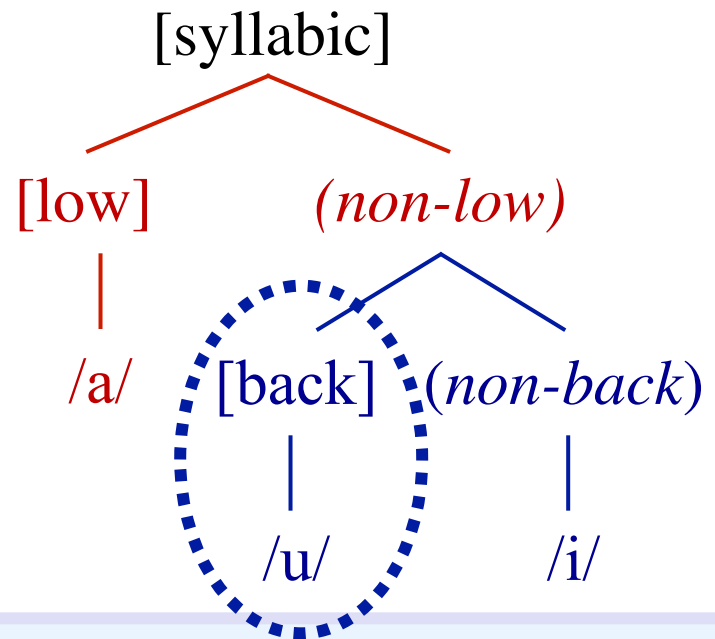
1. The hierarchy constrains phonological activity:  
Only **contrastive** features can be **phonologically active**.

*Which phonemes can trigger backing?*

**[back] > [low]**



**[low] > [back]**

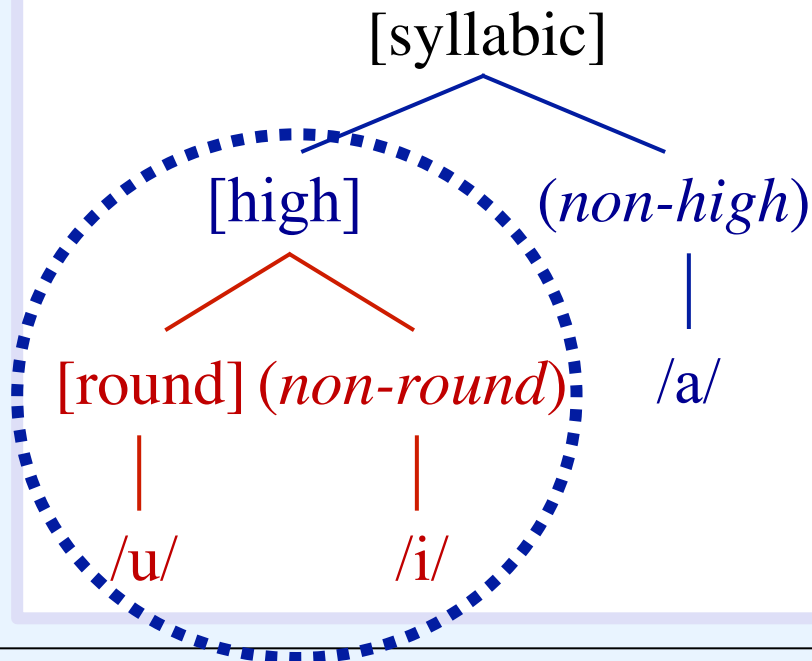


# What does the hierarchy do? Synchrony

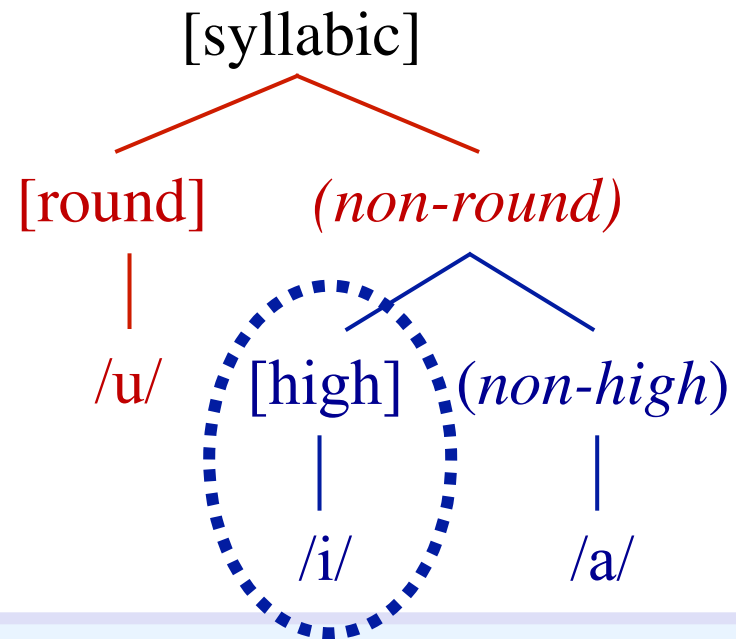
1. The hierarchy constrains phonological activity:  
Only **contrastive** features can be **phonologically active**.

*Which phonemes can trigger raising?*

**[high] > [round]**



**[round] > [high]**



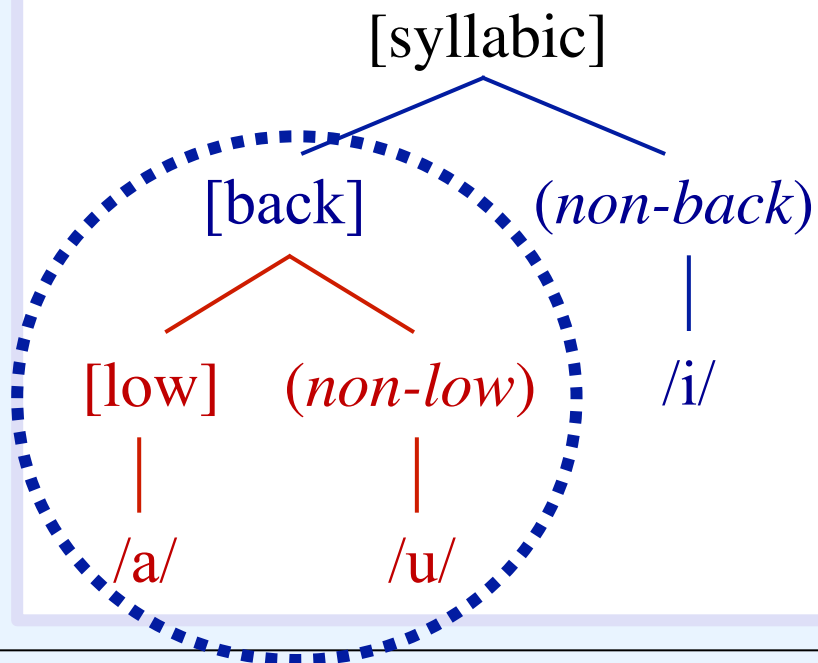


# What does the hierarchy do? Diachrony

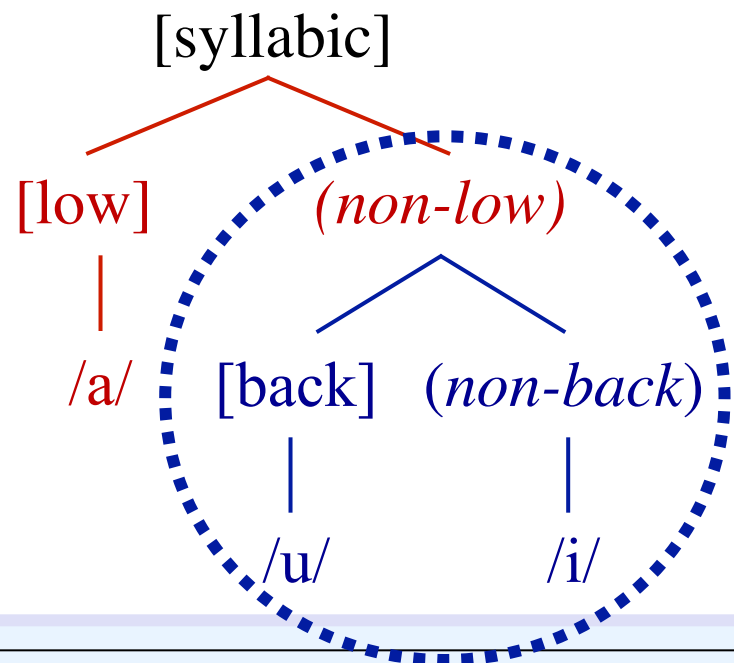
2. The hierarchy constrains neutralization and merger:  
Mergers affect phonemes that are **contrastive sisters**.

*Which phoneme can /u/ merge with?*

**[back] > [low]**



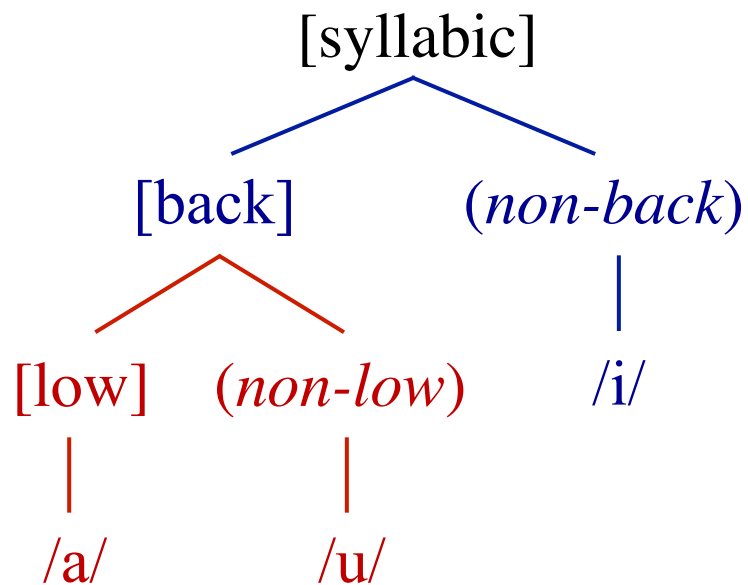
**[low] > [back]**



# Where can we find typological generalizations?

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

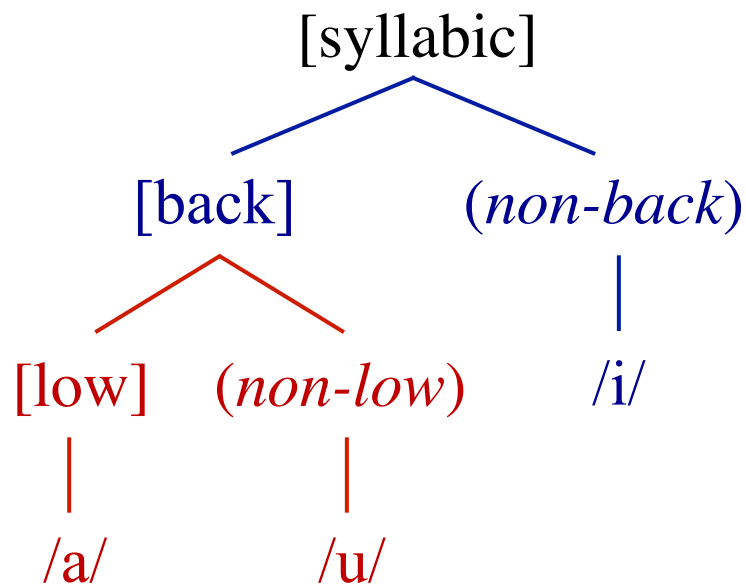
**[back] > [low]**



# Phonological features are cognitive entities

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

**[back]** > **[low]**



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

# Phonological features are cognitive entities

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

**[back]** > **[low]** ?



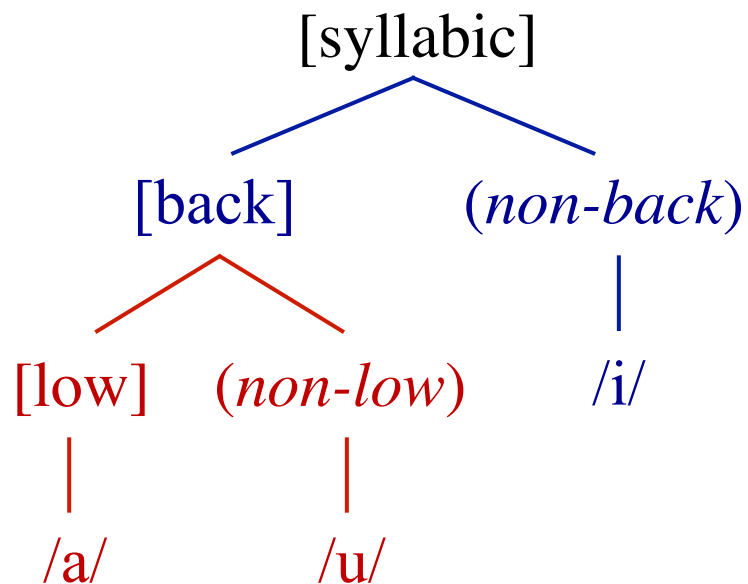
Thus, the contrasts indicated by [back] and [low] may be cross-linguistically common because we have neurons sensitive to formant transitions.

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

# Underspecified features

Notice that on this view, lexical specifications are limited to contrastive features, so are not pronounceable.

**[back]** > **[low]**



In this example, the phoneme designated /u/ has only two features: [back] and (*non-low*).

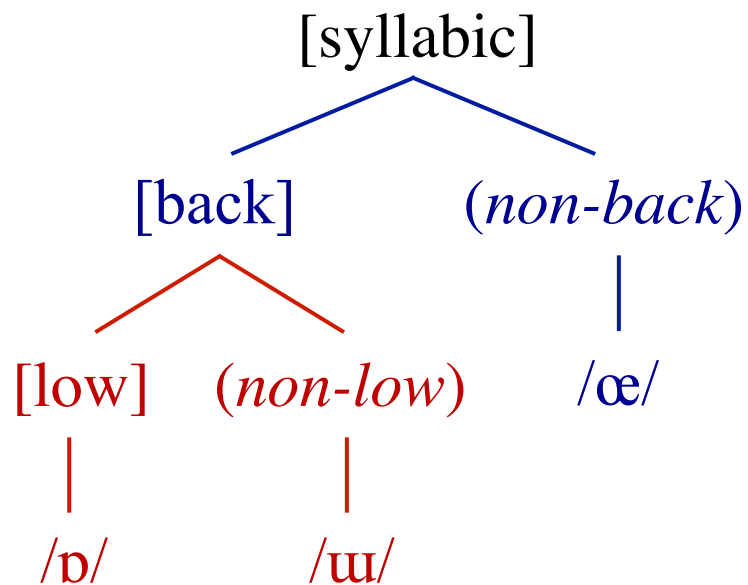
Why, then, is it designated /u/ and not /ʊ/, /ʌ/, /ɯ/, /ɪ/ or /o/, among other choices?

As far as its contrastive status goes, any of these alternatives would be equally appropriate.

# Underspecified features

We could indicate the phonemes as below, for example, though these symbols are typographically less convenient.

**[back]** > **[low]**

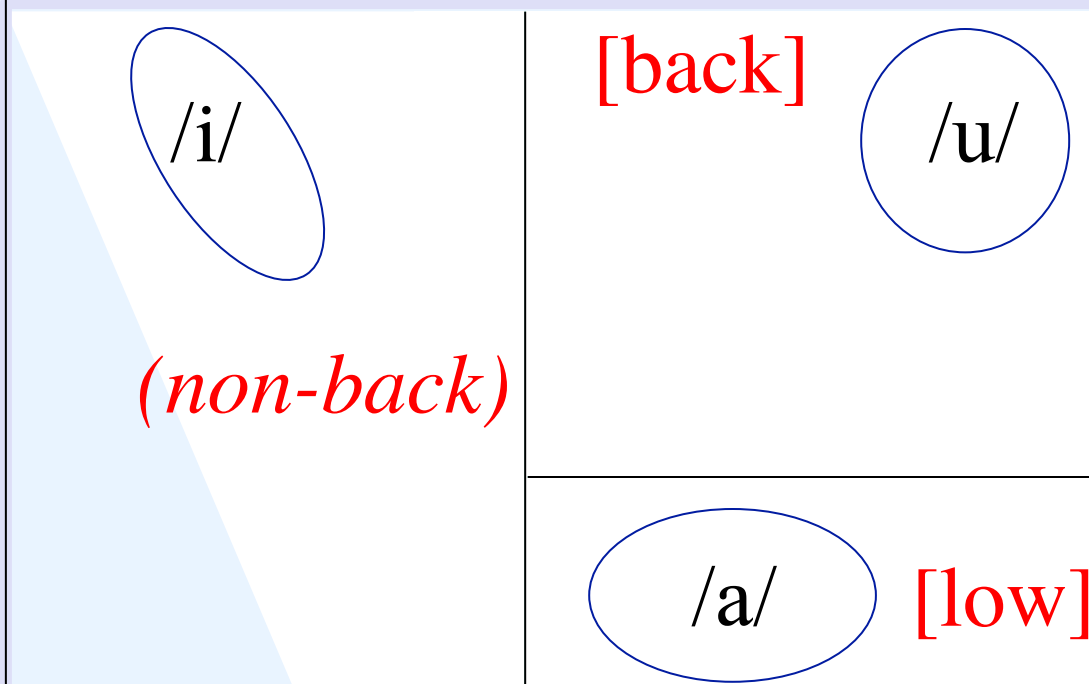


Unless the vowels are further specified in the phonology by other contrastive features (originating in the consonants, for example), they are made more specific only in a post-phonological component.

# Enhancement of underspecified features

Stevens, Keyser & Kawasaki (1986) proposed that feature contrasts can be **enhanced** by other features that have similar acoustic effects.

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



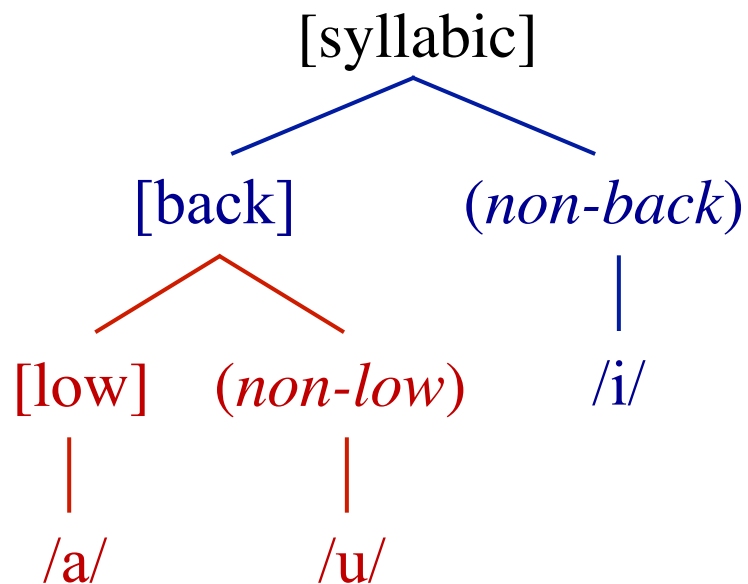
Thus, a non-low back vowel can enhance these features by being round and high, that is, /u/.

These enhancements are not necessary, however, and other realizations are possible.

# The arch not the stones

It is thus the contrastive hierarchy, not the features, that is native to UG, the thing that ‘matters’ to us (Kublai Khan, *op. cit.*). In the words of Jakobson, Fant & Halle (1952: 9):

**[back] > [low]**



“The dichotomous scale is the pivotal principle of the linguistic structure. The code imposes it upon the sound”

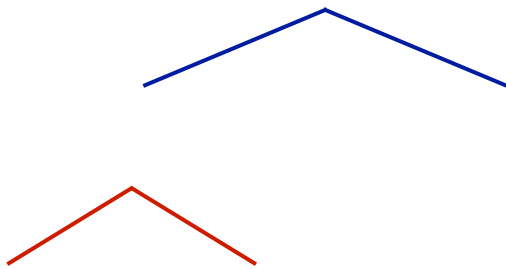
So why should we concern ourselves with features at all?



# The arch not the stones

Because without features there is no hierarchy.

[ ] > [ ]



## *Part 2*

*The connection between  
contrast and activity:  
The Classical Manchu  
vowel system*

# Classical Manchu vowel system (Zhang 1996)

Classical Manchu has 6 vowel phonemes:

/i/

/u/

/ʊ/

/e/

/ɔ/

/a/

# Classical Manchu vowel system (Zhang 1996)

Even if there were innate universal features, there would be considerable ambiguity as to how they apply to this system.

/i/

/u/

/ʊ/

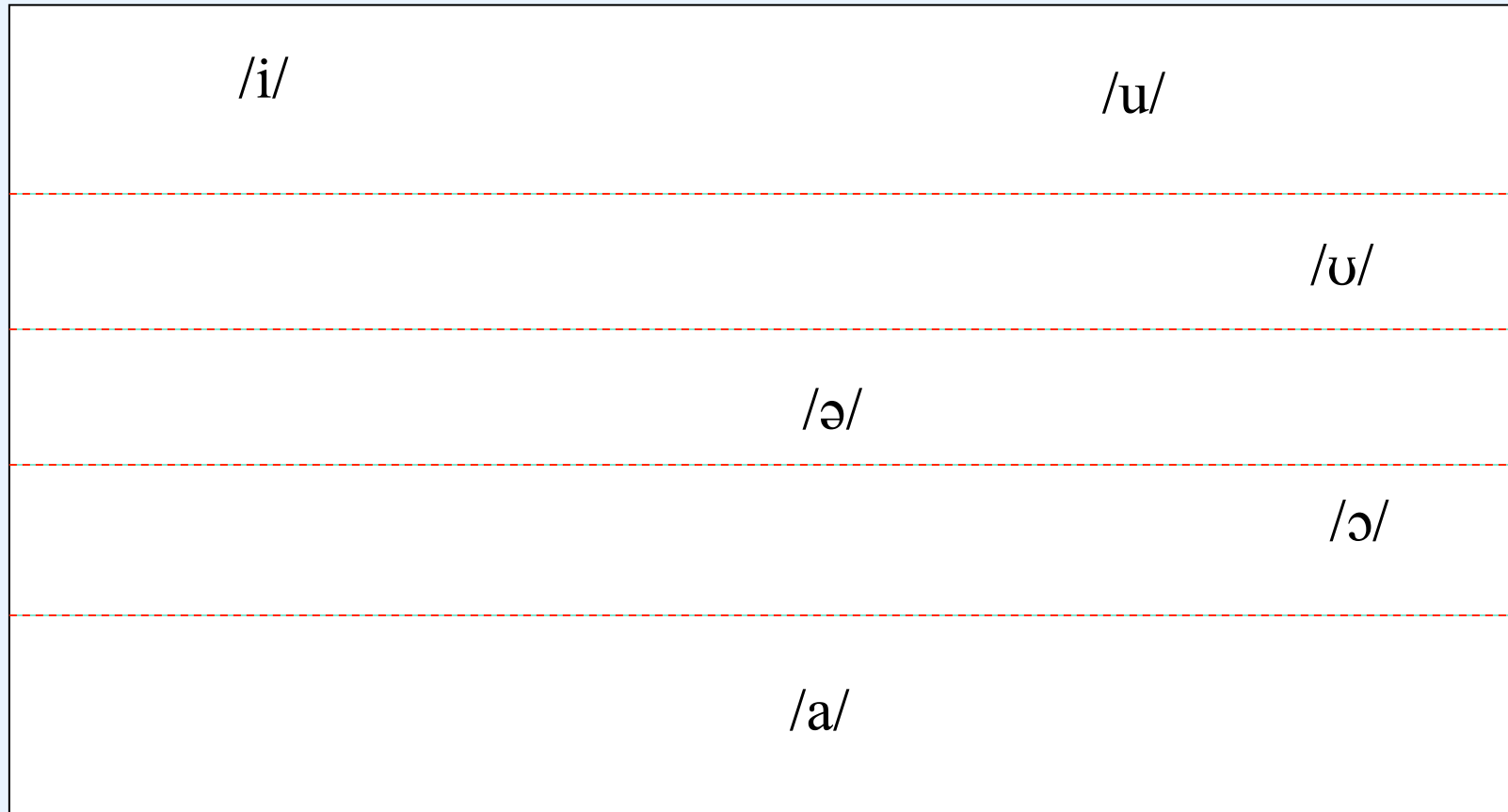
/ə/

/ɔ/

/a/

# Classical Manchu vowel system (Zhang 1996)

For example, where is the boundary between the low vowel(s) and the rest? How many heights should we distinguish: 2, 3, 5?



# Classical Manchu vowel system (Zhang 1996)

For further insight, we need to look at how the vowels pattern, that is, at the types of phonological activity they exhibit.

/i/

/u/

/ʊ/

/ə/

/ɔ/

/a/

# Activity in Classical Manchu

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The three most notable kinds of phonological activity involving vowels are:

- ATR harmony
- Labial (rounding) harmony
- Palatalization

# ATR harmony

The vowels /ə/ and /u/ trigger ATR harmony within a word: /ə/ alternates with /a/ and /u/ alternates with /ʊ/

/ə/ alternates with /a/

[ATR]	xəxə	‘woman’	xəxə-ŋgə	‘female’
(non-ATR)	aGa	‘rain’	aGa-ŋGa	‘of rain’

/u/ alternates with /ʊ/

[ATR]	xərə-	‘ladle out’	xərə-ku	‘ladle’
(non-ATR)	paqt’a-	‘contain’	paqt’a-qu	‘internal organs’



# ATR harmony

An apparent exception is caused by the fact that /**ʊ**/ changes to [**u**] everywhere except after dorsal (velar ~ uvular) consonants:

## Underlying /**ʊ**/: ATR harmony

[ATR]	s <b>u</b> sə	‘coarse’	s <b>u</b> sə-tə-	‘make coarsely’
[ATR]	xət' <b>u</b>	‘stocky’	xət' <b>u</b> -kən	‘somewhat stocky’

## Underlying /**ʊ**/: non-ATR vowels

( <i>non-ATR</i> )	t <b>u</b> lpa	‘careless’	t <b>u</b> lpa-ta-	‘act carelessly’
( <i>non-ATR</i> )	tat'ʂ <b>u</b> n	‘sharp’	tat'ʂ <b>u</b> -qan	‘somewhat sharp’

# ATR harmony

The vowel /i/ is neutral:

/ə/ ~ /a/ suffix

[ATR]	pəki	‘firm’	pəki-lə	‘make firm’
(non-ATR)	paqtʂin	‘opponent’	paqtʂi-la-	‘oppose’

/u/ ~ /ʊ/ suffix

[ATR]	sitərə-	‘hobble’	sitərə-sxun	‘hobbled/lame’
(non-ATR)	panjin	‘appearance’	panji-sxun	‘having money’

/i/ suffix

[ATR]	əmtə	‘one each’	əmtə-li	‘alone; sole’
(non-ATR)	taxa-	‘follow’	taxa-li	‘the second’

# ATR harmony

When /i/ is in a position to trigger harmony, it occurs only with **non-ATR** vowels:

/ə/ ~ /a/ suffix

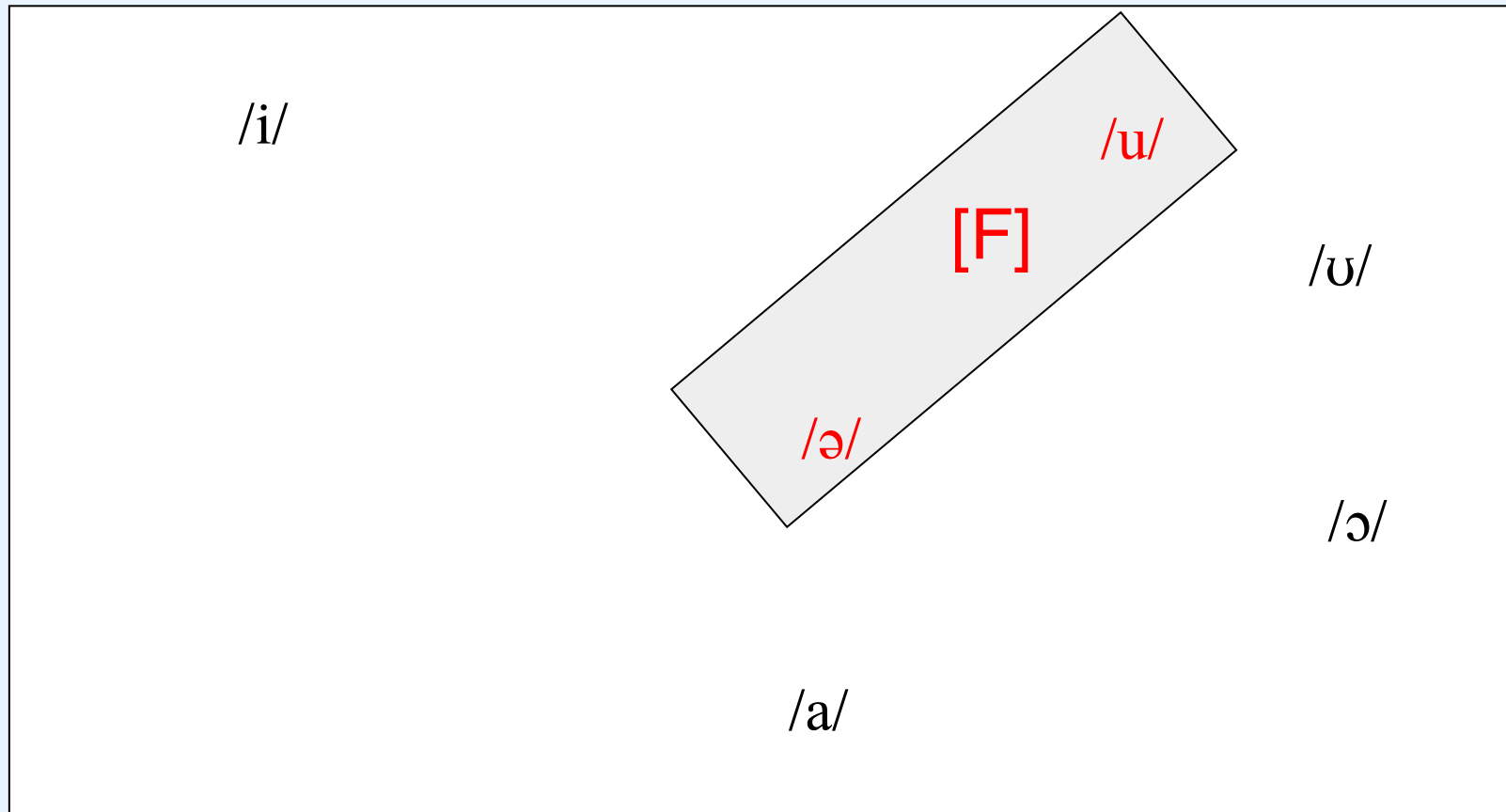
( <i>non-ATR</i> )	<b>ili-</b>	‘stand’	<b>ili-χa</b>	‘stood’
( <i>non-ATR</i> )	<b>fili</b>	‘solid’	<b>fili-qan</b>	‘somewhat solid’

/u/ ~ /ʊ/ suffix

( <i>non-ATR</i> )	tɕ' <b>ili-</b>	‘to choke’	tɕ' <b>ili-qu</b>	‘choking’
( <i>non-ATR</i> )	<b>sifi-</b>	‘stick in the hair’	<b>sifi-qu</b>	‘hairpin’

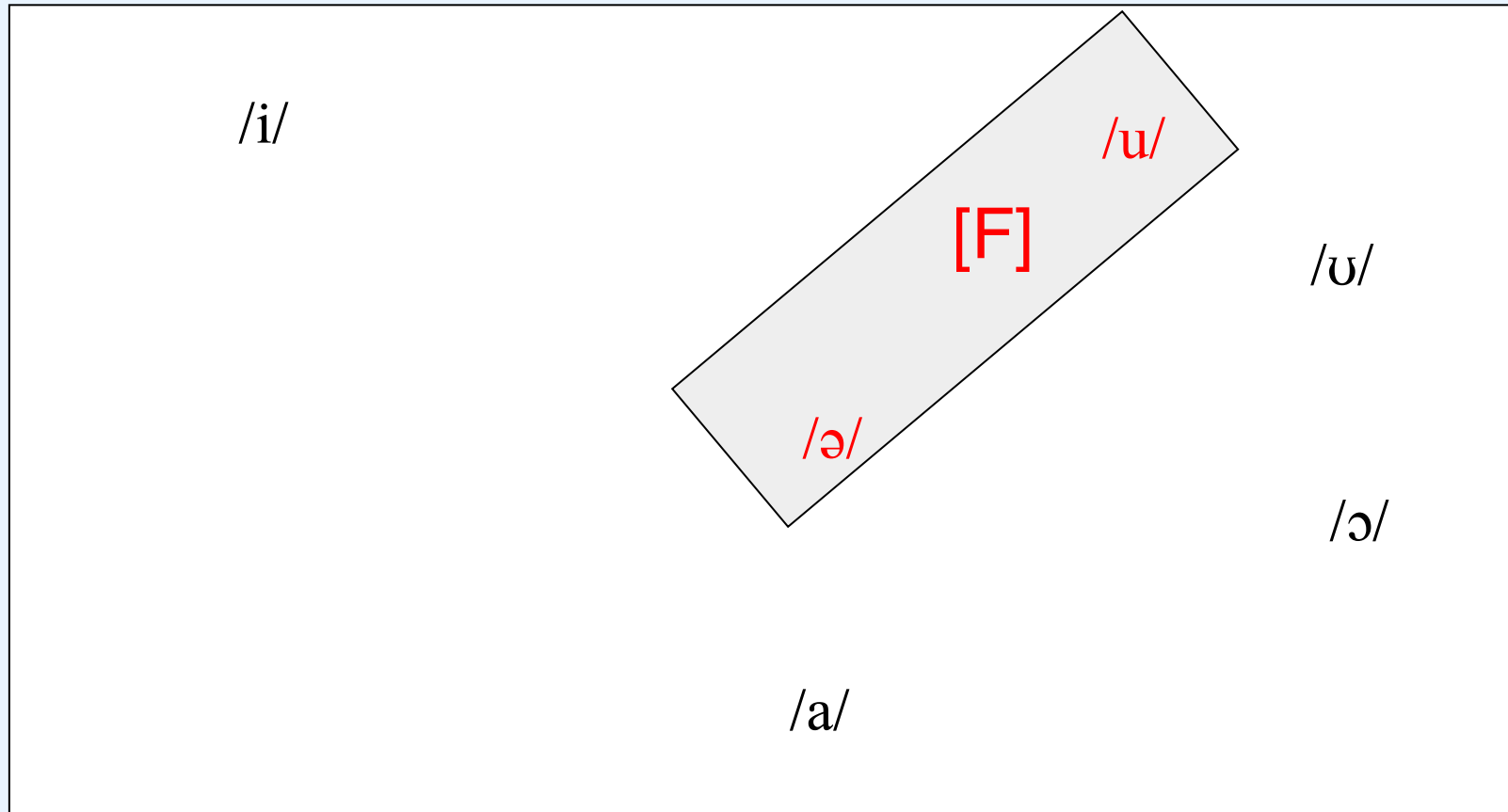
# ATR harmony

The evidence from activity, therefore, is that /ə/ and /u/ have an active feature in common that is not shared by the other vowels; by hypothesis, this feature must be contrastive.



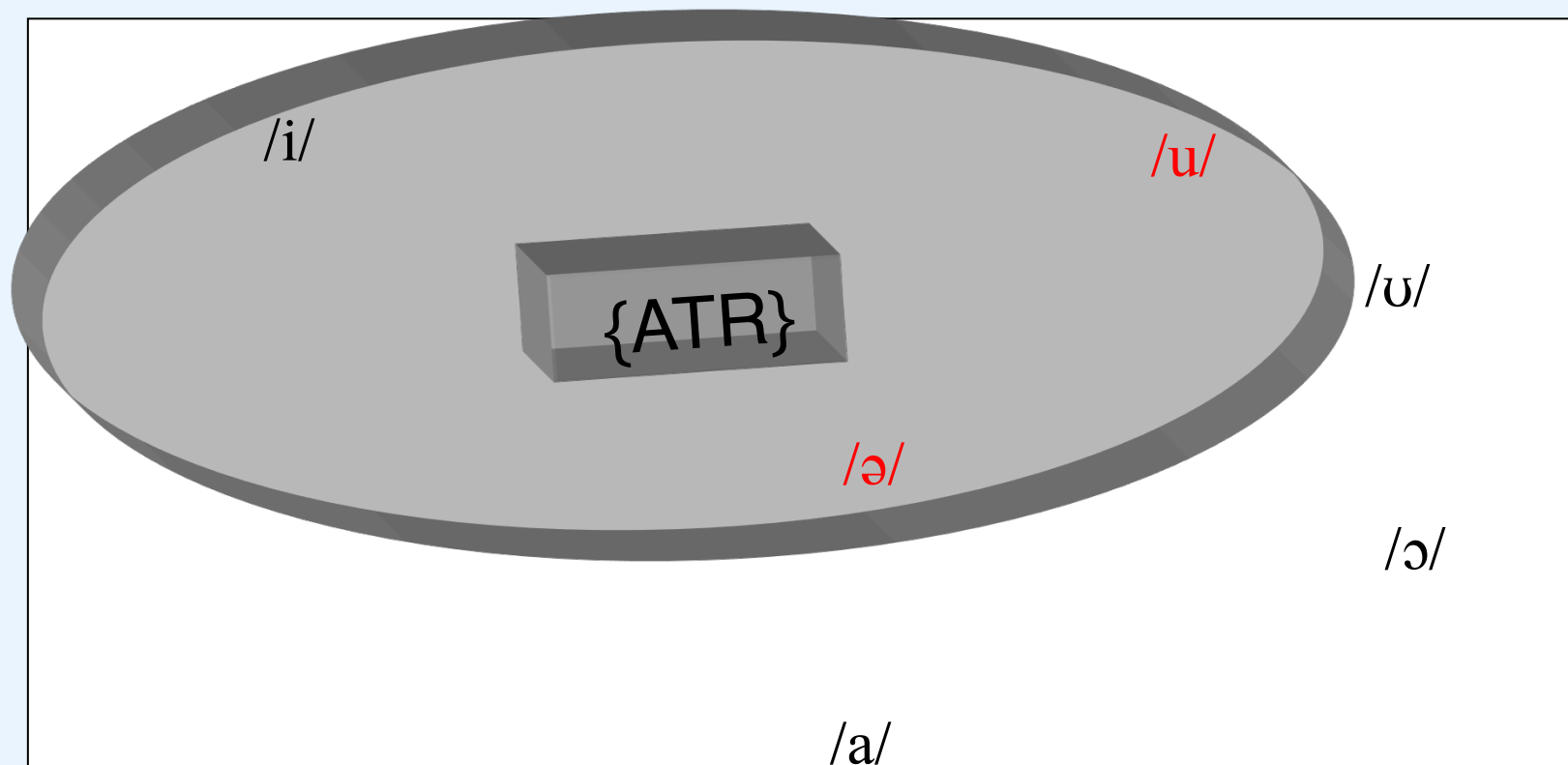
# ATR harmony

What feature could this be? I have already given away that it is [ATR].



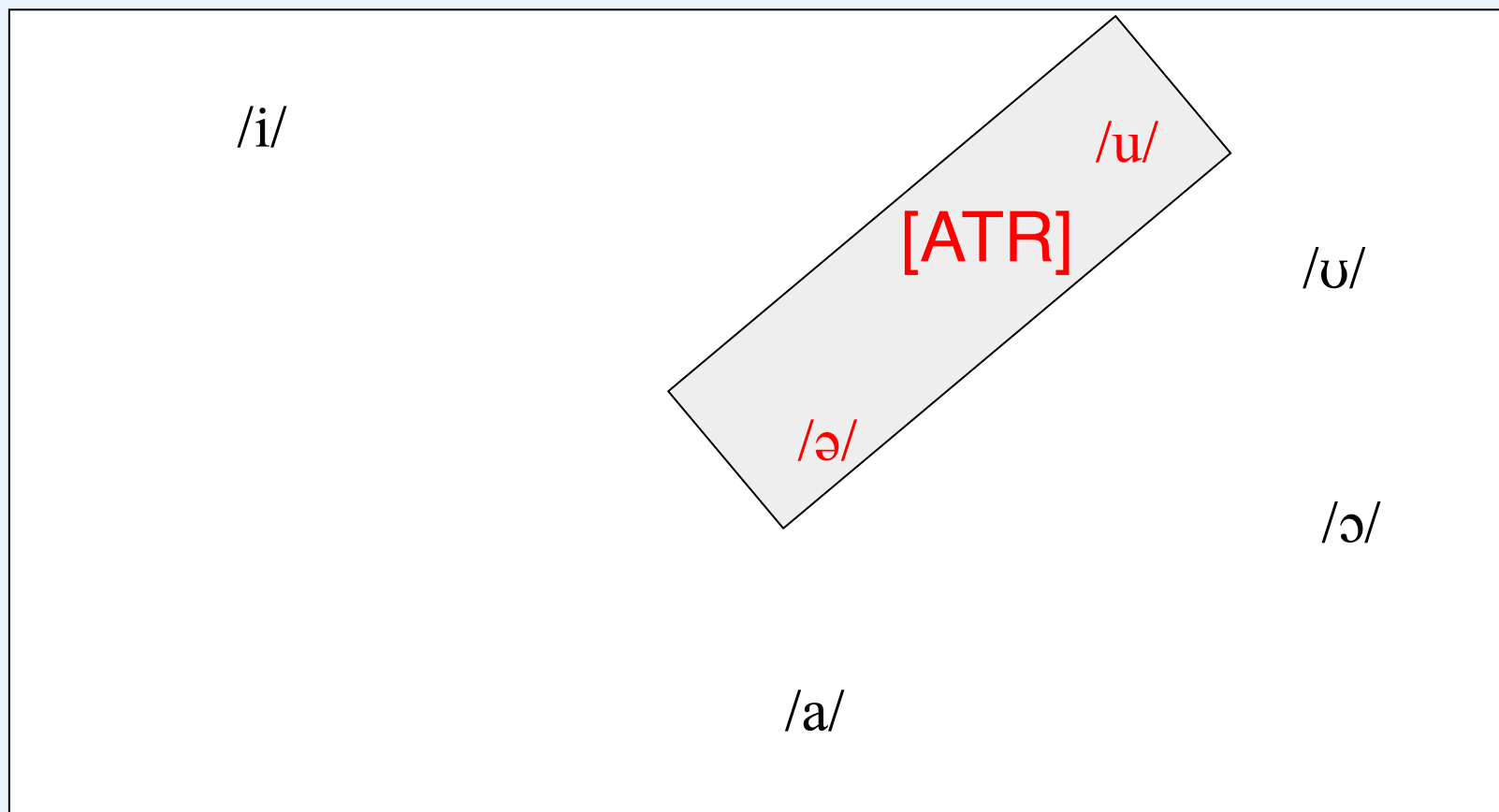
# ATR harmony

What feature could this be? I have already given away that it is [ATR]. But this is not obvious right away, because though /ə/ and /u/ are phonetically ATR (= {ATR}), so is /i/.



# ATR harmony

But there is no obvious alternative, so we can designate the feature as **[ATR]**. The learner will have to find a feature ordering in which the feature applies to /ə/ and /u/, but not /i/.



# Labial (rounding) harmony

Two successive /ɔ/ vowels cause  
a suffix /a/ to become /ɔ/:

Two successive /ɔ/ vowels trigger labial harmony

ɔ...ɔ	pɔtʂ'ɔ 'colour'	pɔtʂ'ɔ-ŋGɔ 'coloured'
Compare	aGa 'rain'	aGa-ŋGa 'of rain'

A single /ɔ/, short or long, does not suffice

Single ɔ	tɔ- 'alight (birds)'	tɔ-na- 'alight in swarm'
Single ɔɔ	tɔɔ- 'cross (river)'	tɔɔ-na- 'go to cross'



# Labial (rounding) harmony

Note that /u/ and /ʊ/ do **not** trigger labial harmony:

/u/

gulu ‘plain’  
kumun ‘music’

gulu-kən ‘somewhat plain’  
kumu-ŋgə ‘noisy’

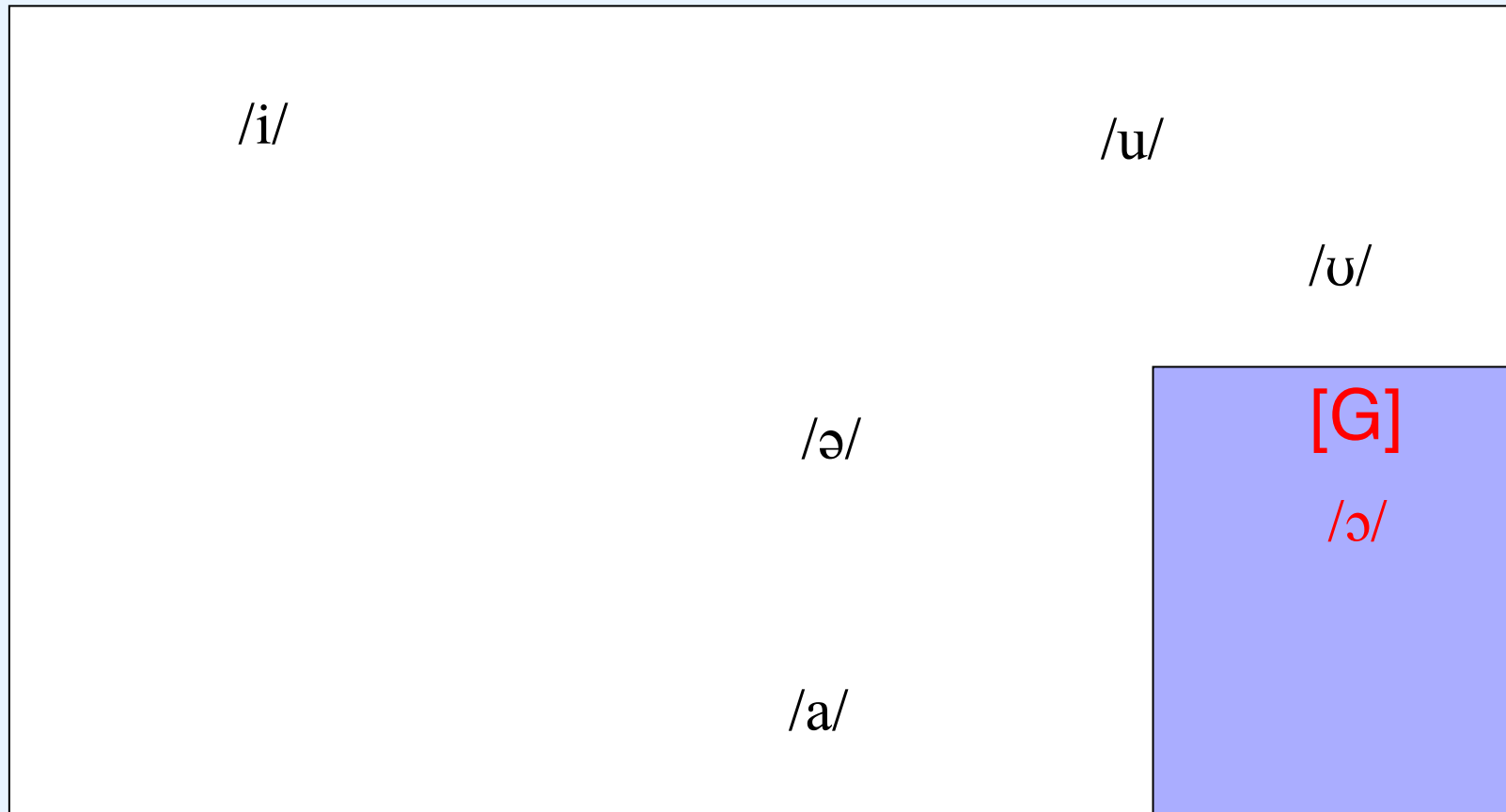
/ʊ/ (/ʊ/ becomes [u] except after a back consonant)

χʊtun ‘fast’  
tʊrsun ‘form’

χʊtʊ-qan ‘somewhat fast’  
tʊrsʊ-ŋGa ‘having form’

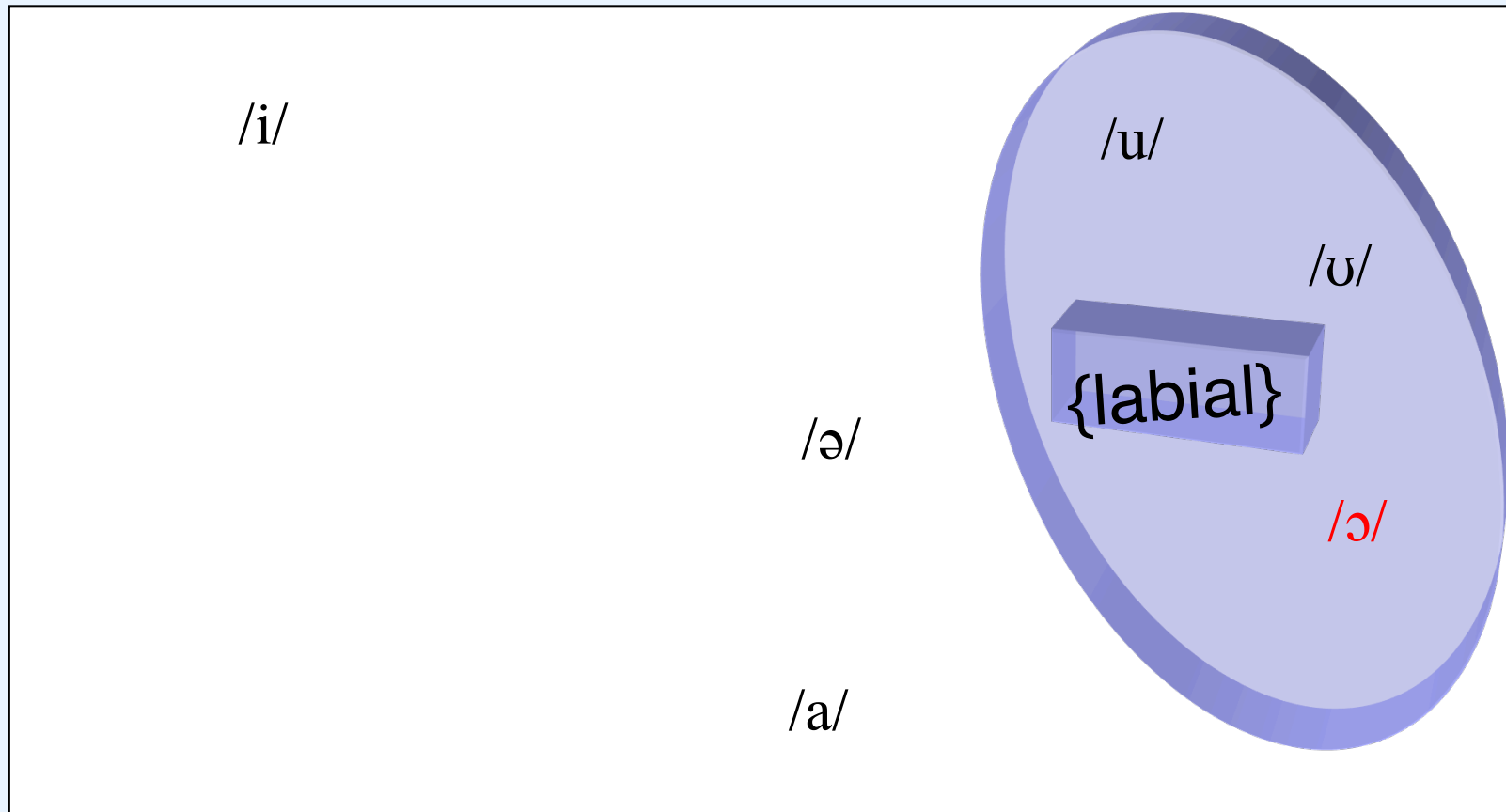
# Labial (rounding) harmony

The evidence from activity here, then, is that /ɔ/ must have an active, therefore contrastive, feature that causes rounding. [labial] is an obvious candidate.



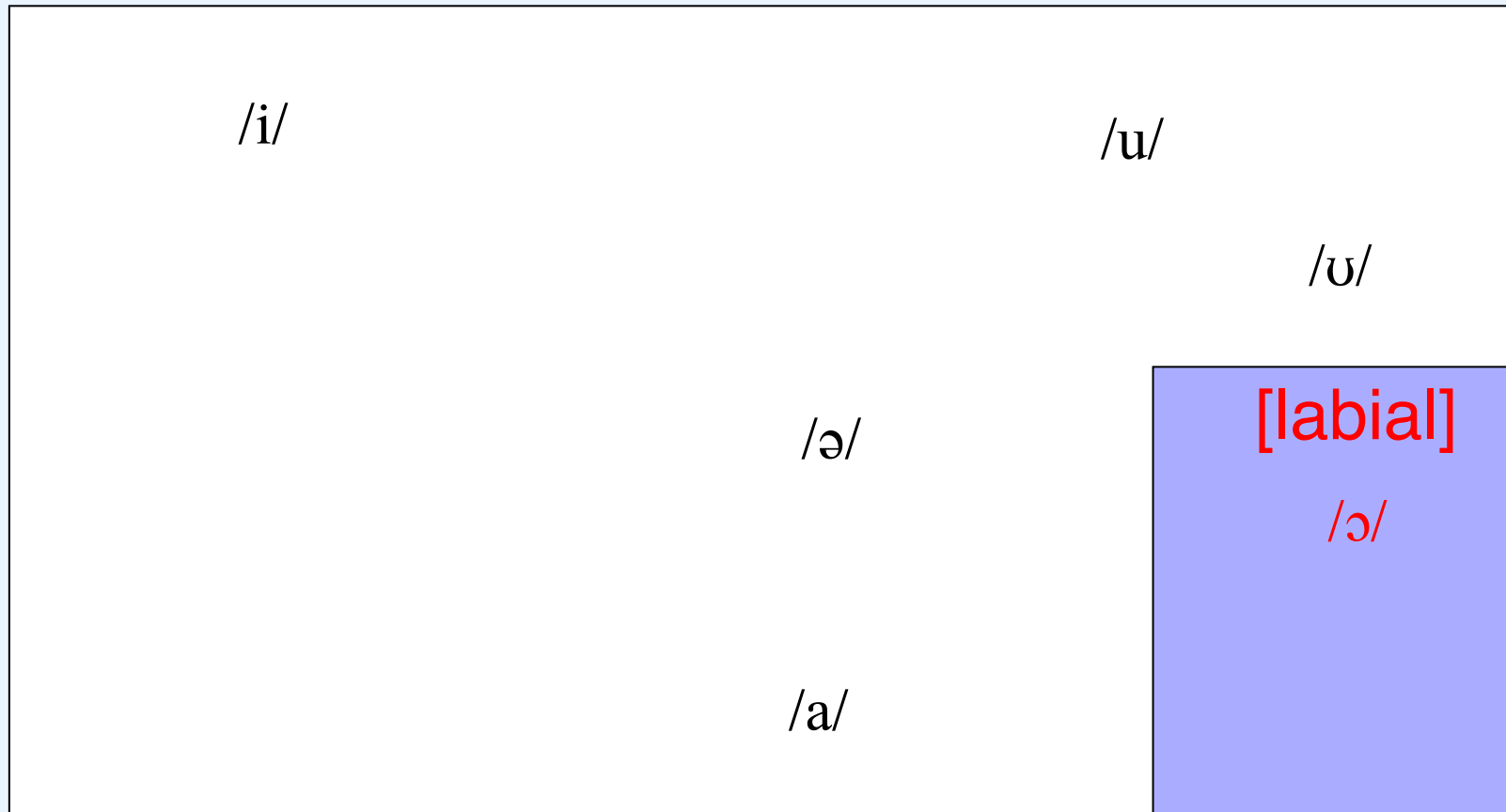
# Labial (rounding) harmony

But /u/ and /ʊ/ are also phonetically {labial}, though there is no evidence that that they have an active [labial] feature.



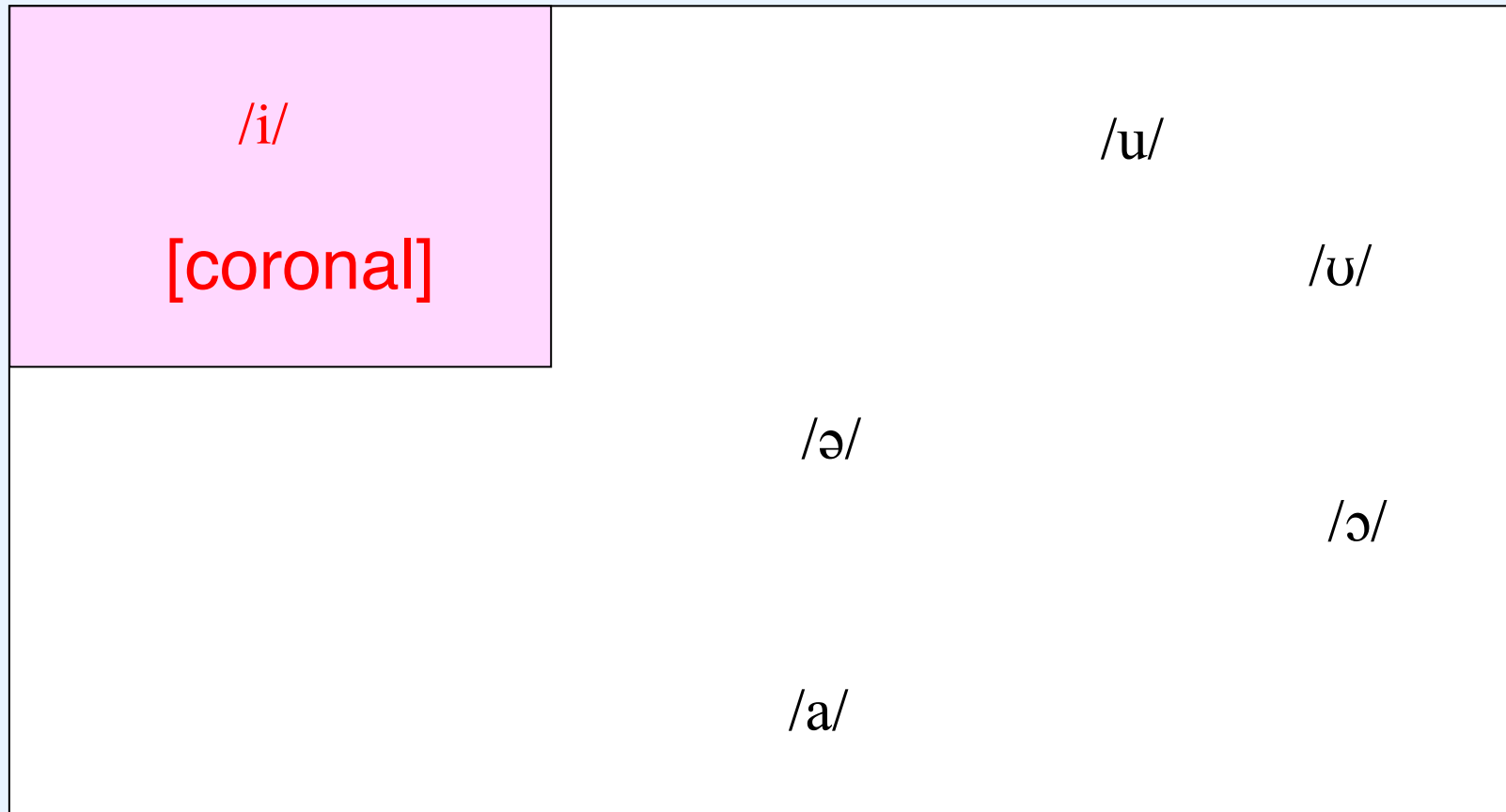
# Labial (rounding) harmony

Here, the preferred analysis is one where contrastive [labial] is restricted to /ɔ/, and excludes /u/ and /ʊ/.



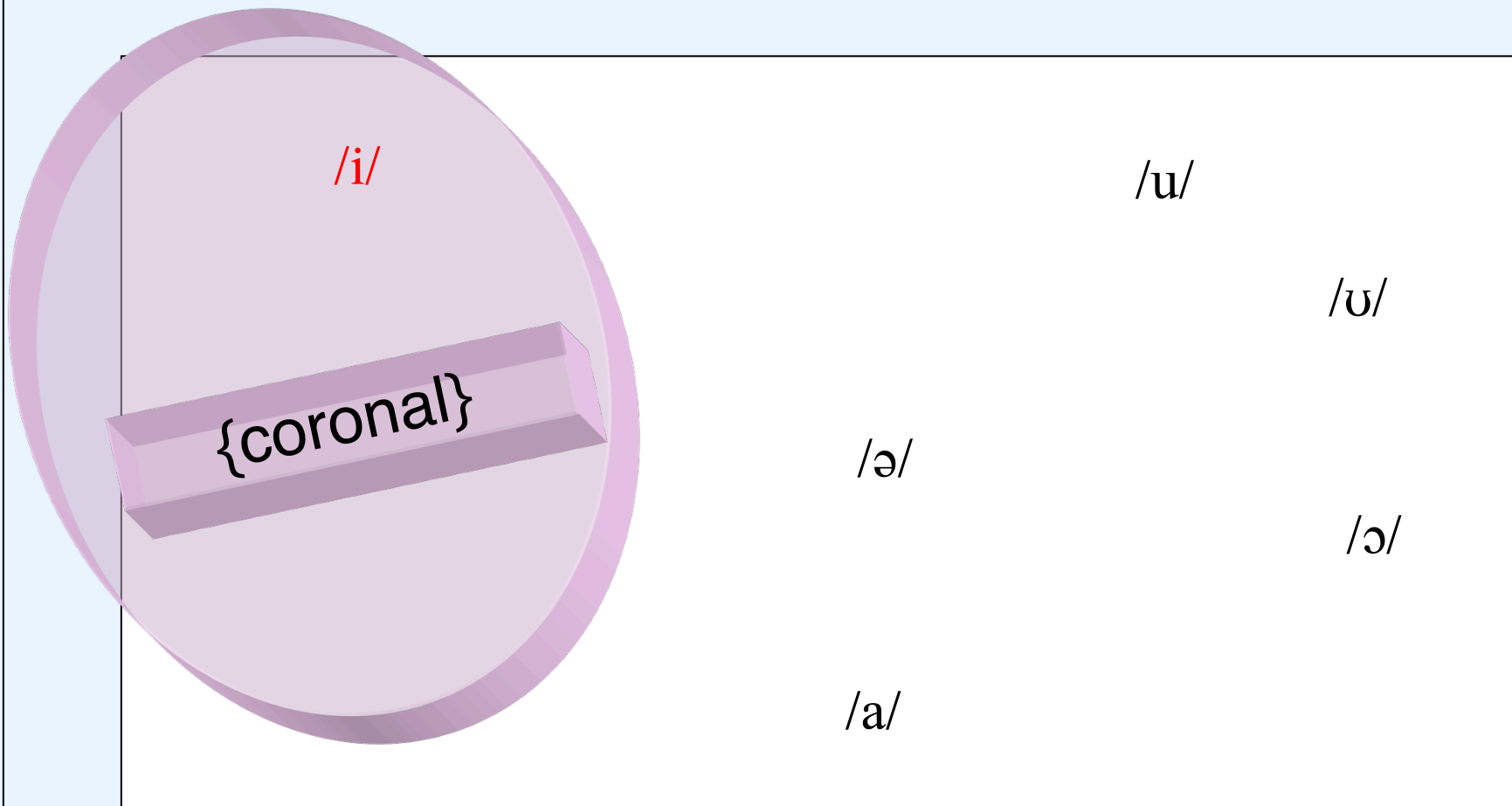
# Palatalization

The vowel /i/ uniquely causes palatalization of a preceding consonant, which suggests it alone has a contrastive triggering feature we call [coronal].



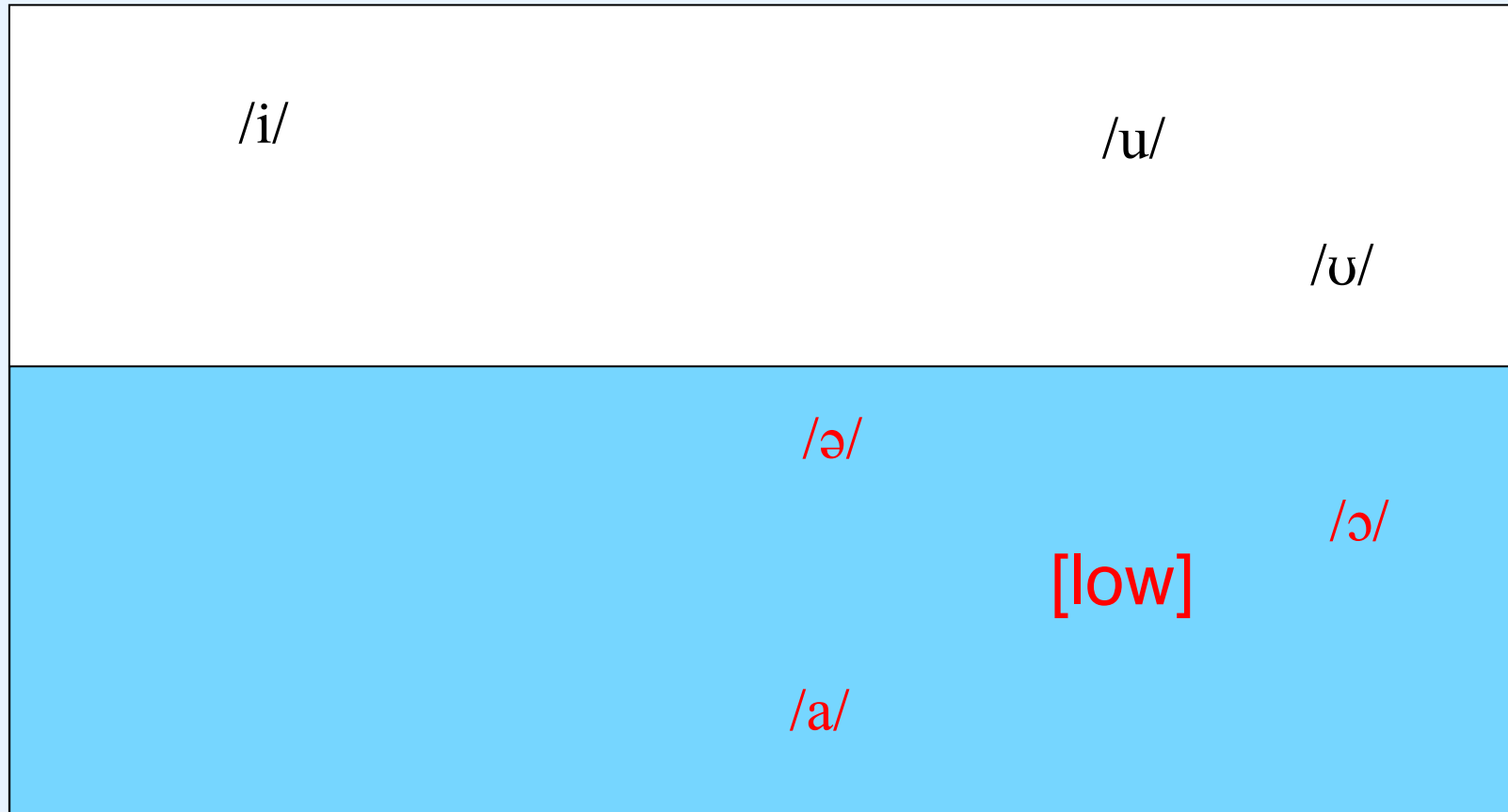
# Palatalization

In this case */i/* is the only vowel that falls in the space of the phonetic percept {coronal}.



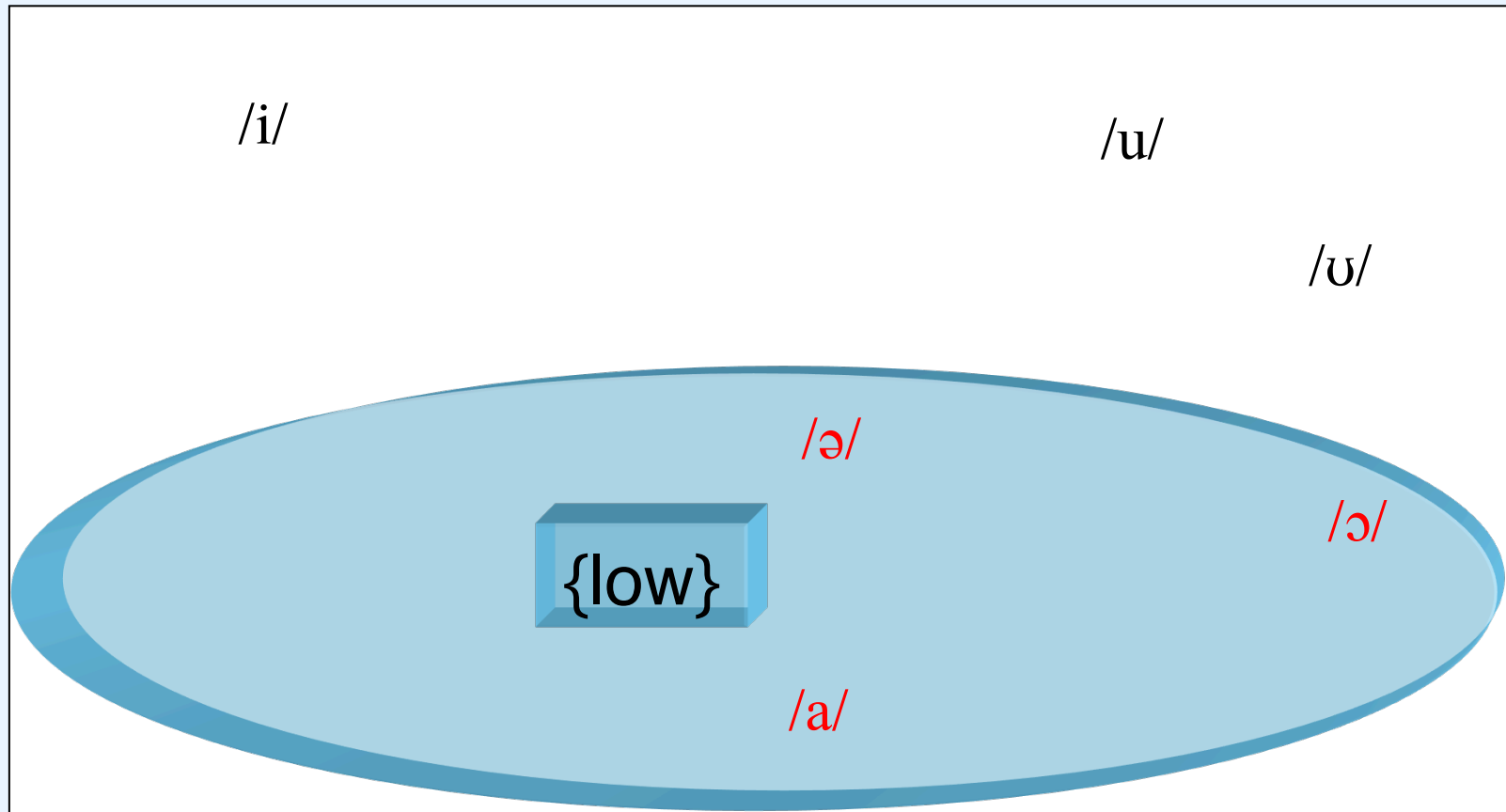
# One height contrast

The alternations /ə/ ~ /a/ ~ /ɔ/ and /u/ ~ /ʊ/ are limited to a height class, and we still need to distinguish /ə/ from /u/ and /a/ from /ʊ/. It is simplest to assume one height contrast, which we call [low].



# One height contrast

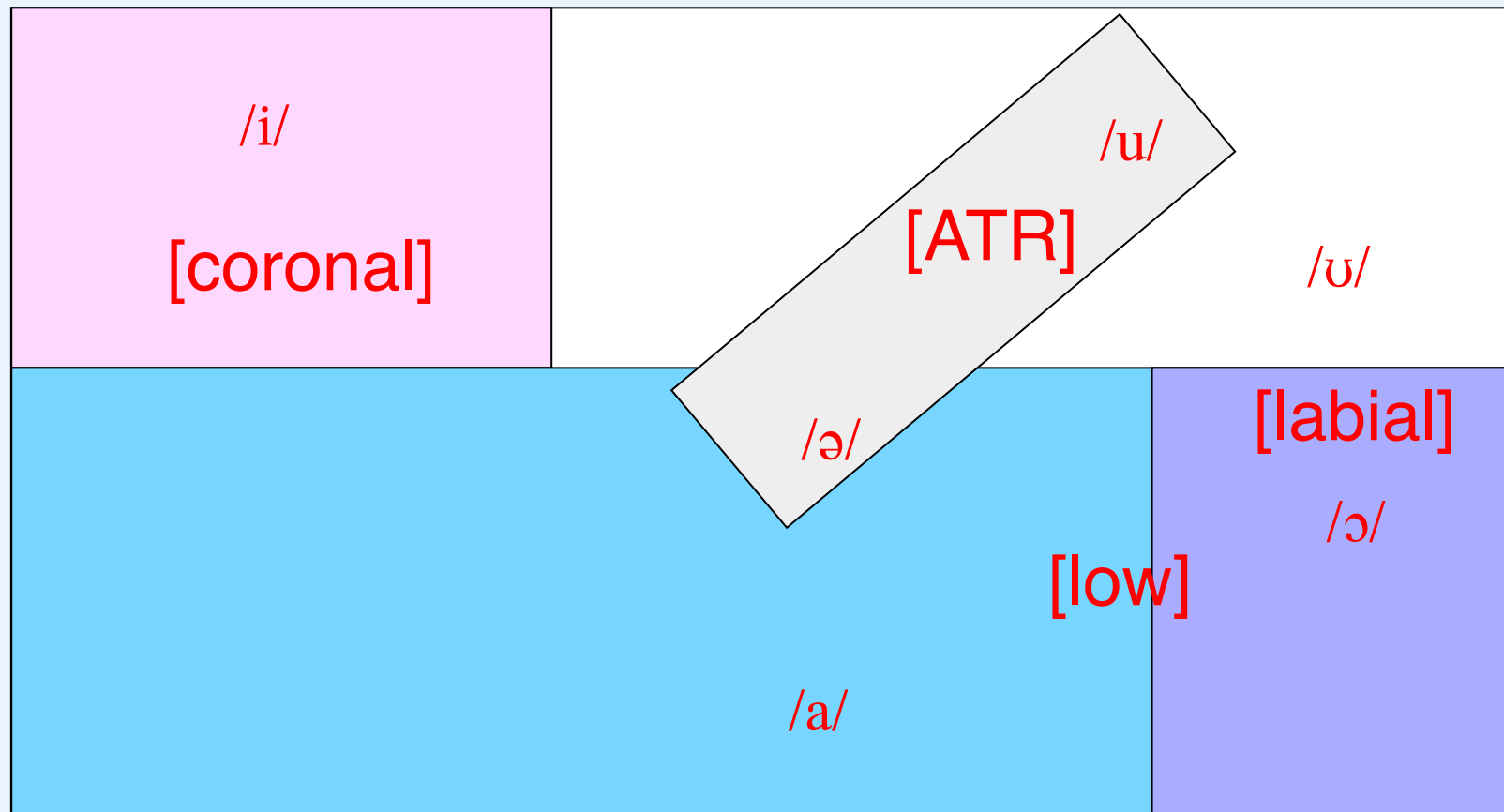
Since height is a relative property, it is not a problem to base the contrastive feature on a perceptible phonetic difference based on relative height or sonority. [high] would also be possible here.





# Classical Manchu contrastive features

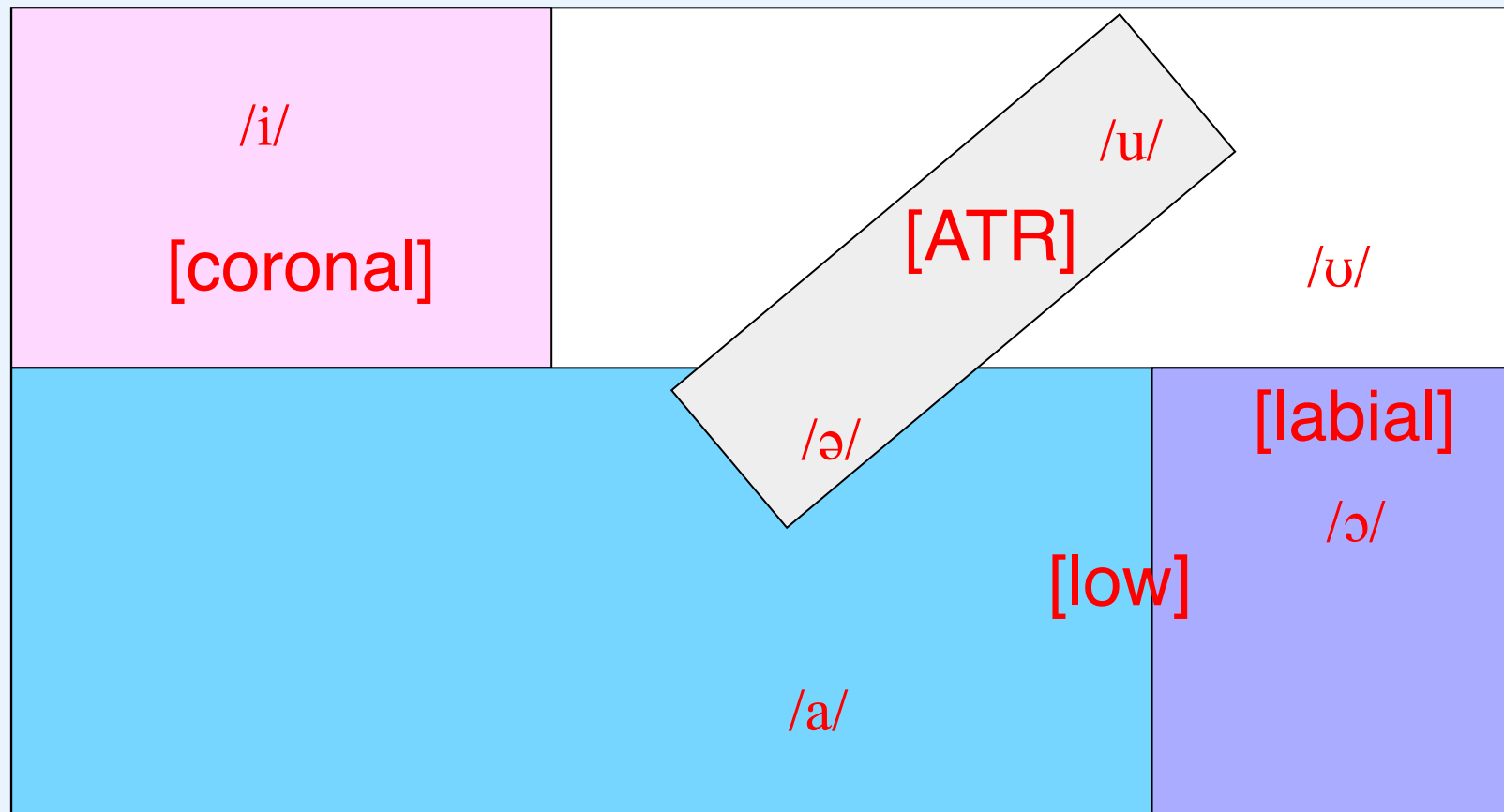
Putting together the evidence of phonological activity surveyed to here, we need to arrive at a feature hierarchy that yields the values below.



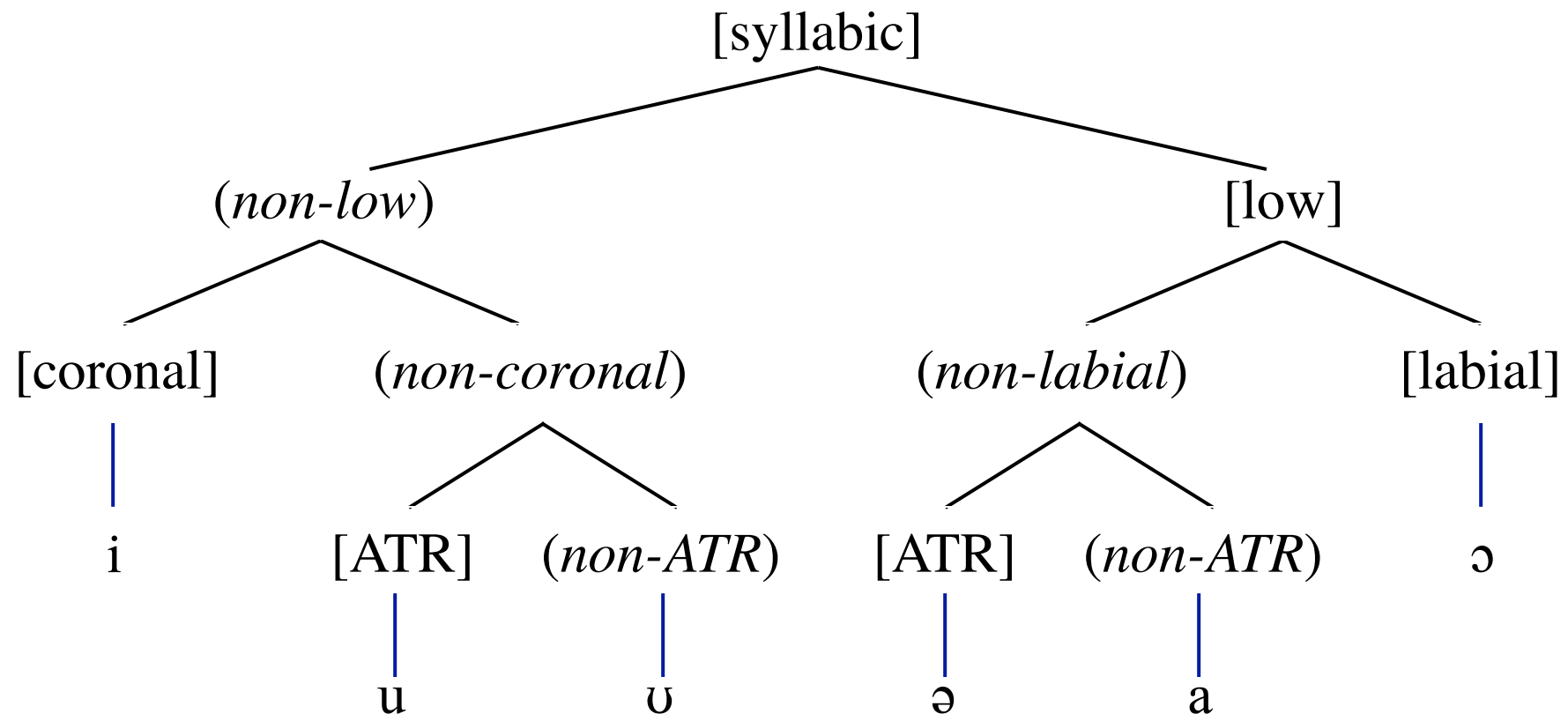
# Classical Manchu contrastive features

Zhang (1996) proposes the hierarchy:

[low] > [coronal] > [labial] > [ATR]



# Classical Manchu contrastive hierarchy (Zhang 1996)



[low] > [coronal] > [labial] > [ATR]

# Classical Manchu vowels

## Contrastive featural representations

*/i/*  
[coronal]

*/u/*  
[ATR]

*/ʊ/*

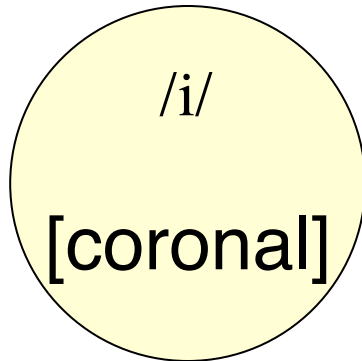
*/a/*  
[low]

*/ə/*  
[low]  
[ATR]

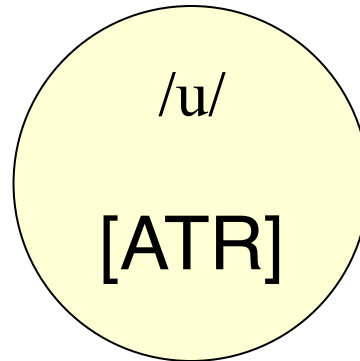
*/ɔ/*  
[low]  
[labial]

# Classical Manchu vowels

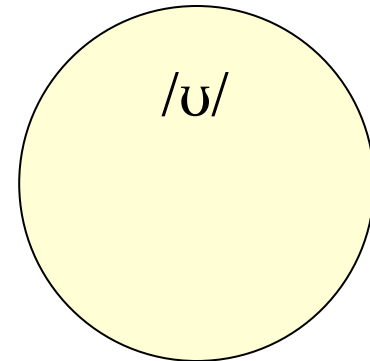
## Contrastive featural representations



Though phonetically {ATR}, /i/ lacks contrastive feature [ATR], so does not participate in ATR harmony.



Though phonetically {labial}, /u/ and /ʊ/ lack a contrastive feature [labial], so they do not participate in rounding harmony



## *Part 3*

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*The contrastive  
hierarchy and the  
acquisition of  
phonological  
representations*

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# Implications of the contrastive hierarchy for acquisition

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The **phonological contrastive features** that must be acquired are not identical to the **acoustic percepts** that can be detected in the signal by an early learner.

We have already seen that the phonetic ranges of the acoustic percepts on which the Manchu features are based are not co-extensive with the phonological representations of the vowels:

# Classical Manchu vowels and features: Acoustic percepts

---

[i]

[u]

[ʊ]

[ə]

[ɔ]

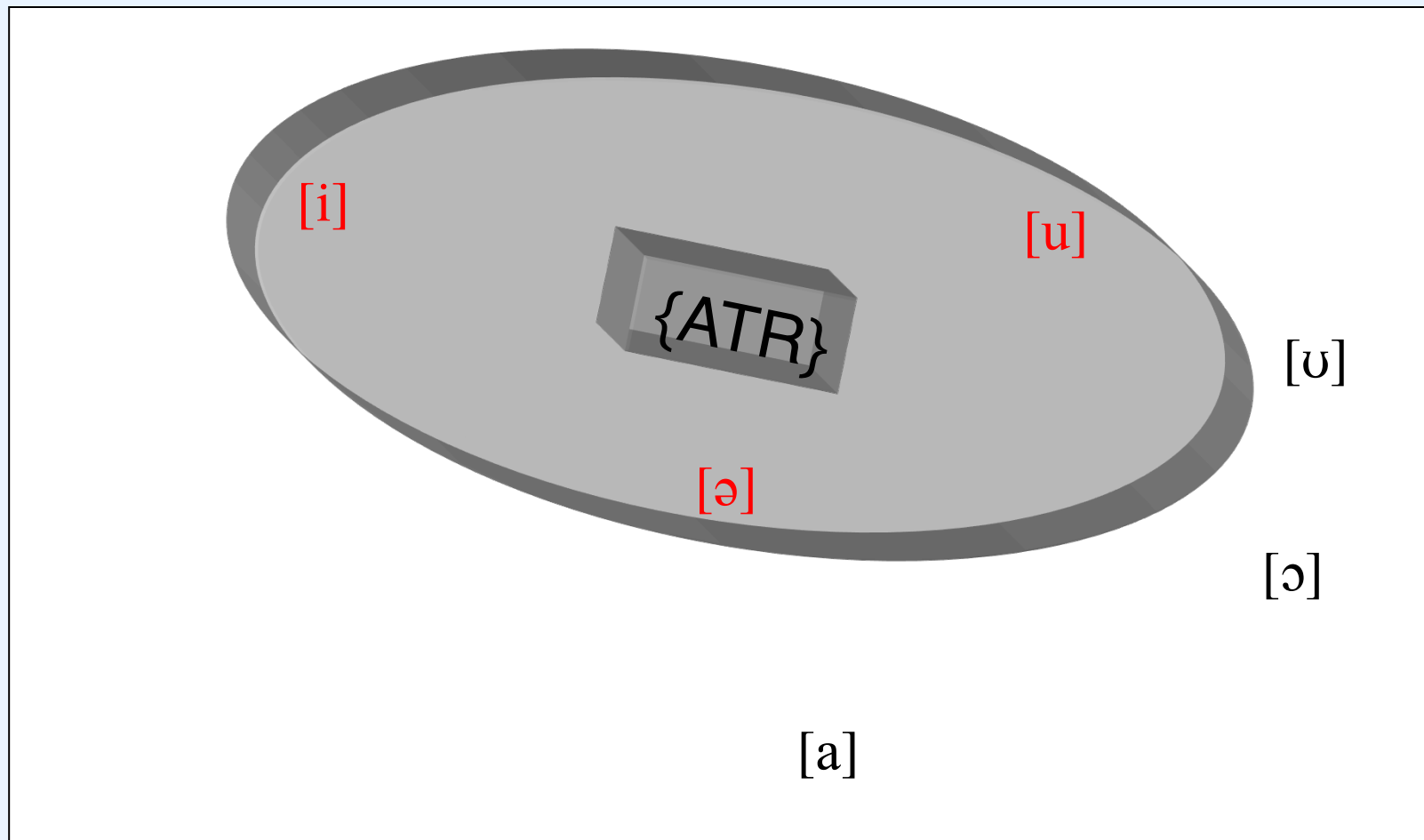
[a]



# Classical Manchu vowels and features:

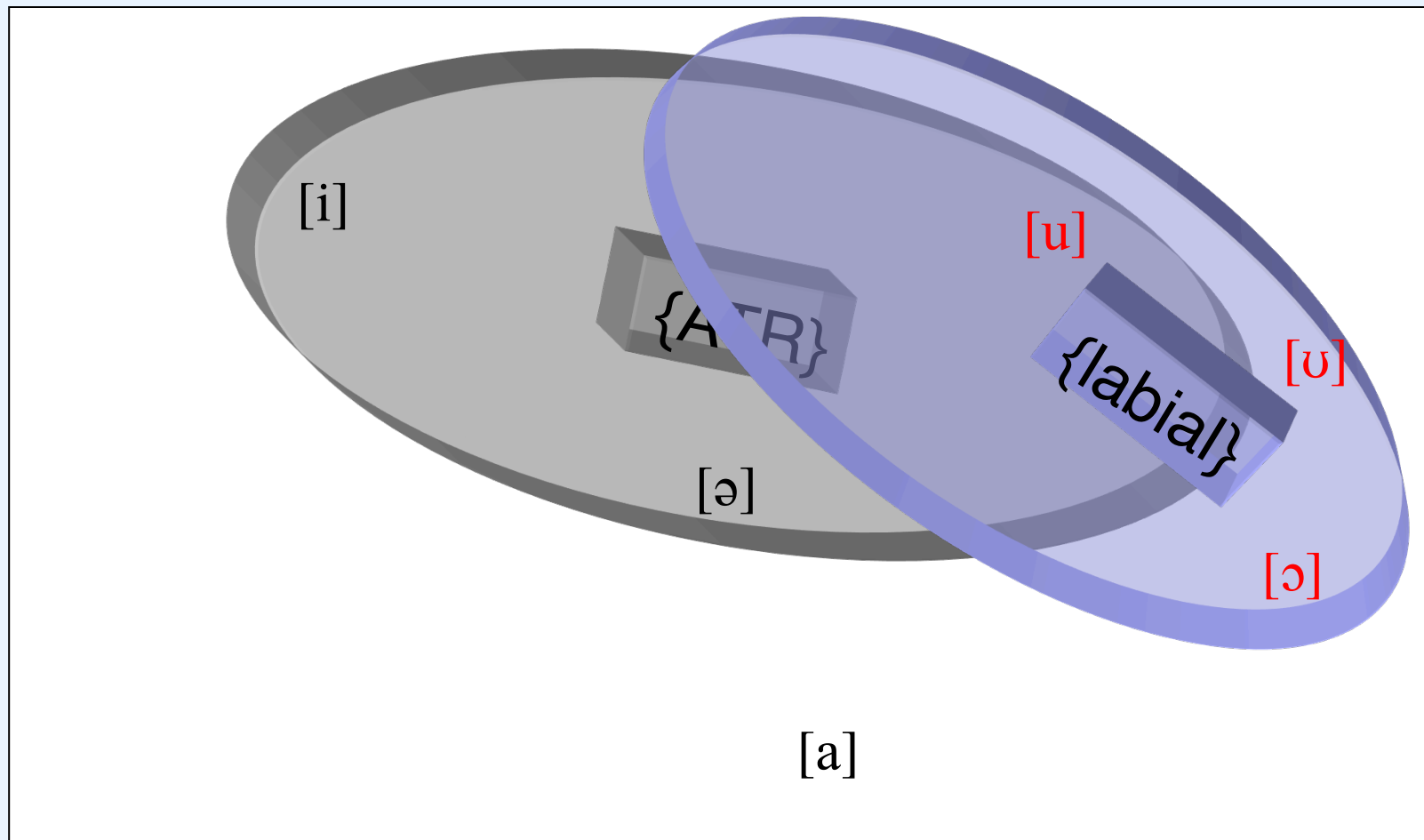
## Acoustic percepts

{ATR}



# Classical Manchu vowels and features: Acoustic percepts

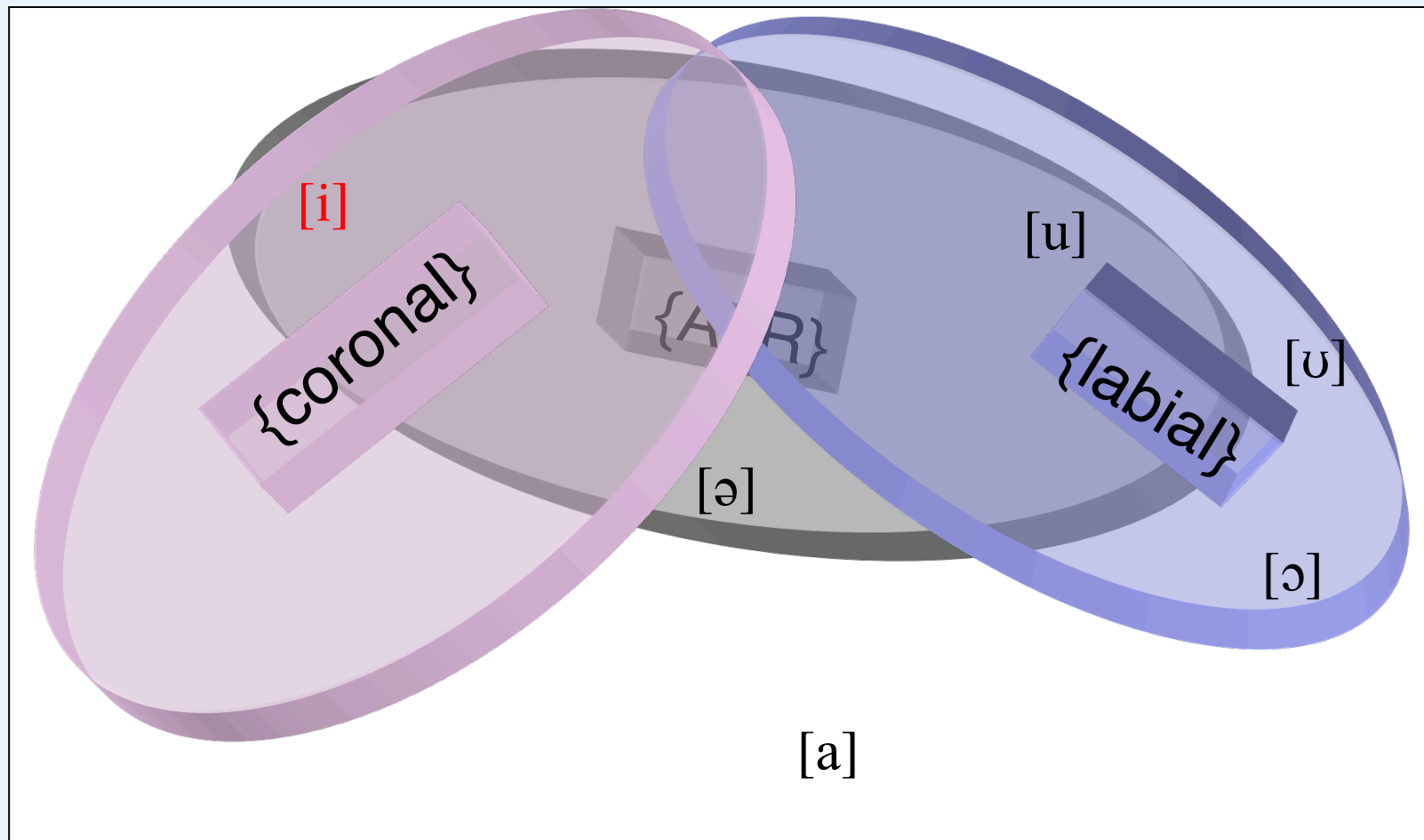
{labial}



# Classical Manchu vowels and features:

## Acoustic percepts

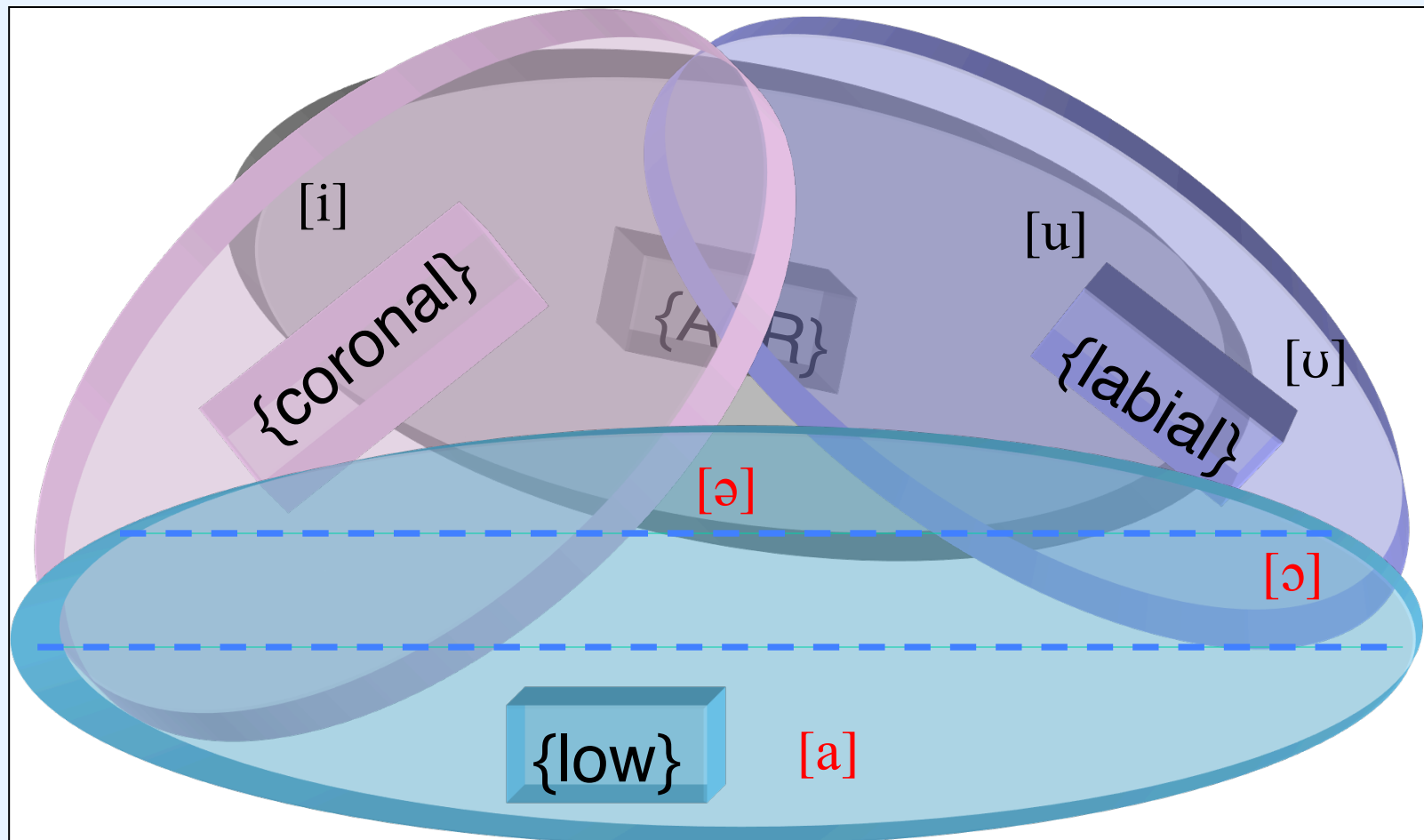
{coronal}



# Classical Manchu vowels and features:

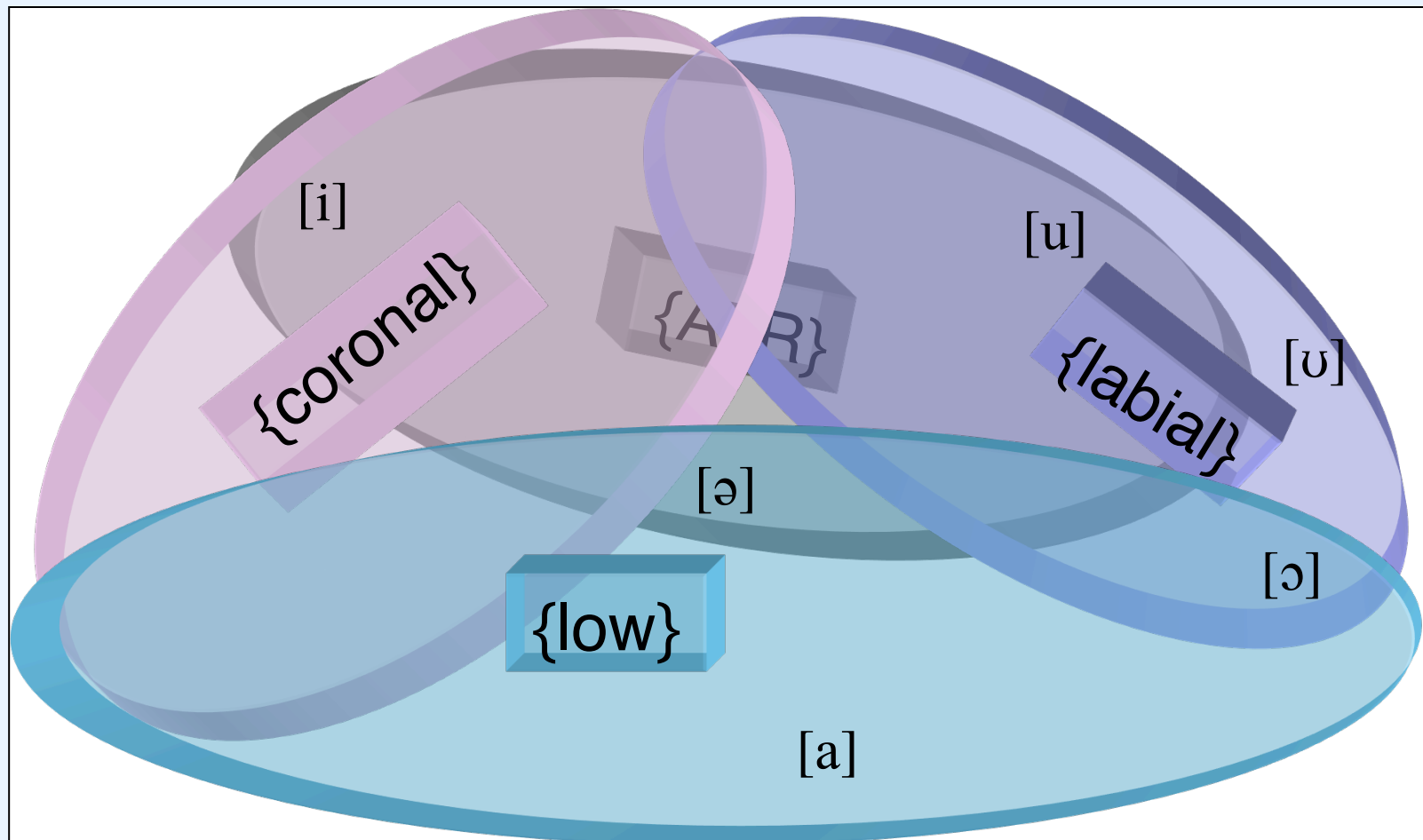
## Acoustic percepts

{low} (ambiguous)



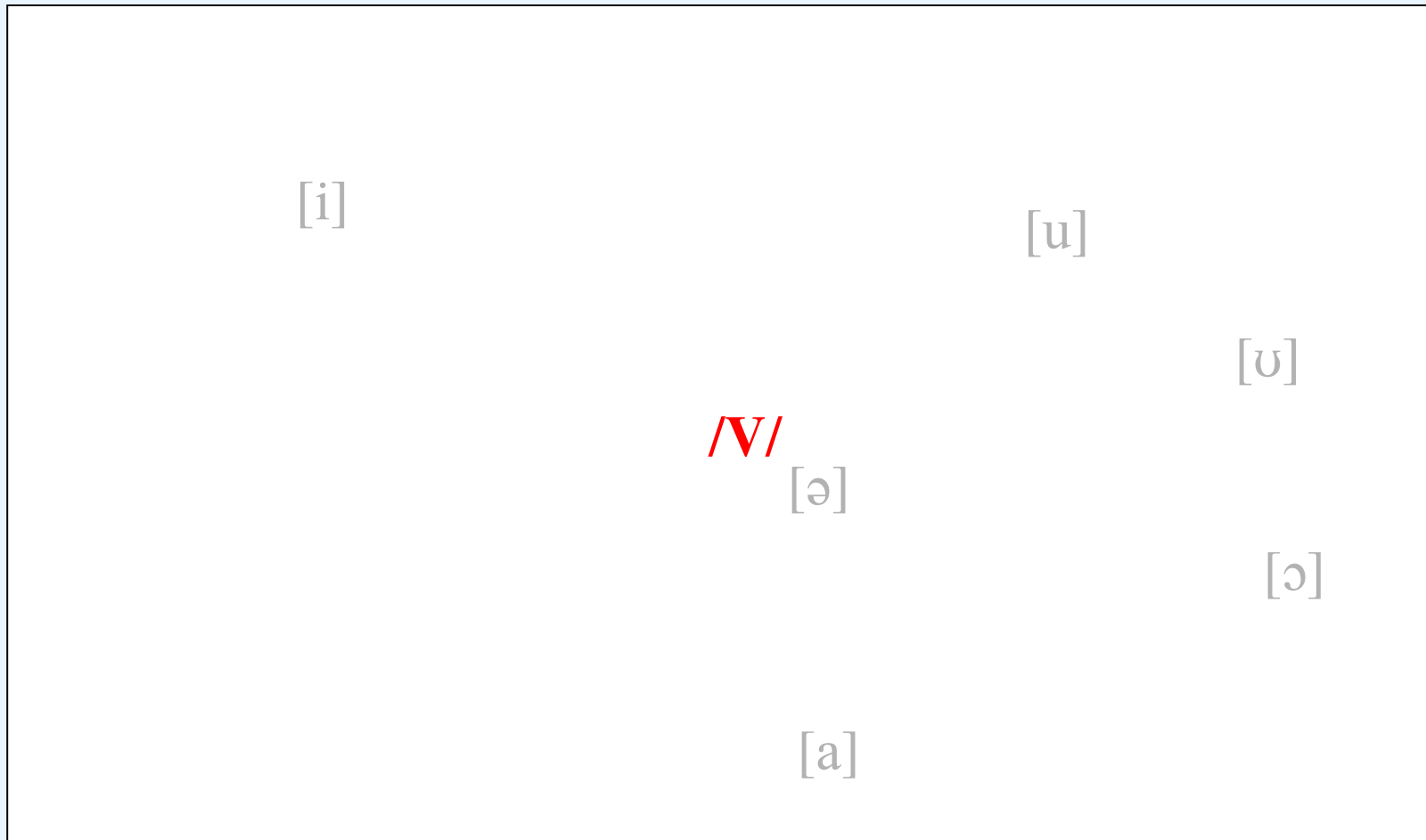
# Classical Manchu representations

These percepts are not **representations**. The learner has not yet identified any contrasts in the vowel system.



# Classical Manchu vowels

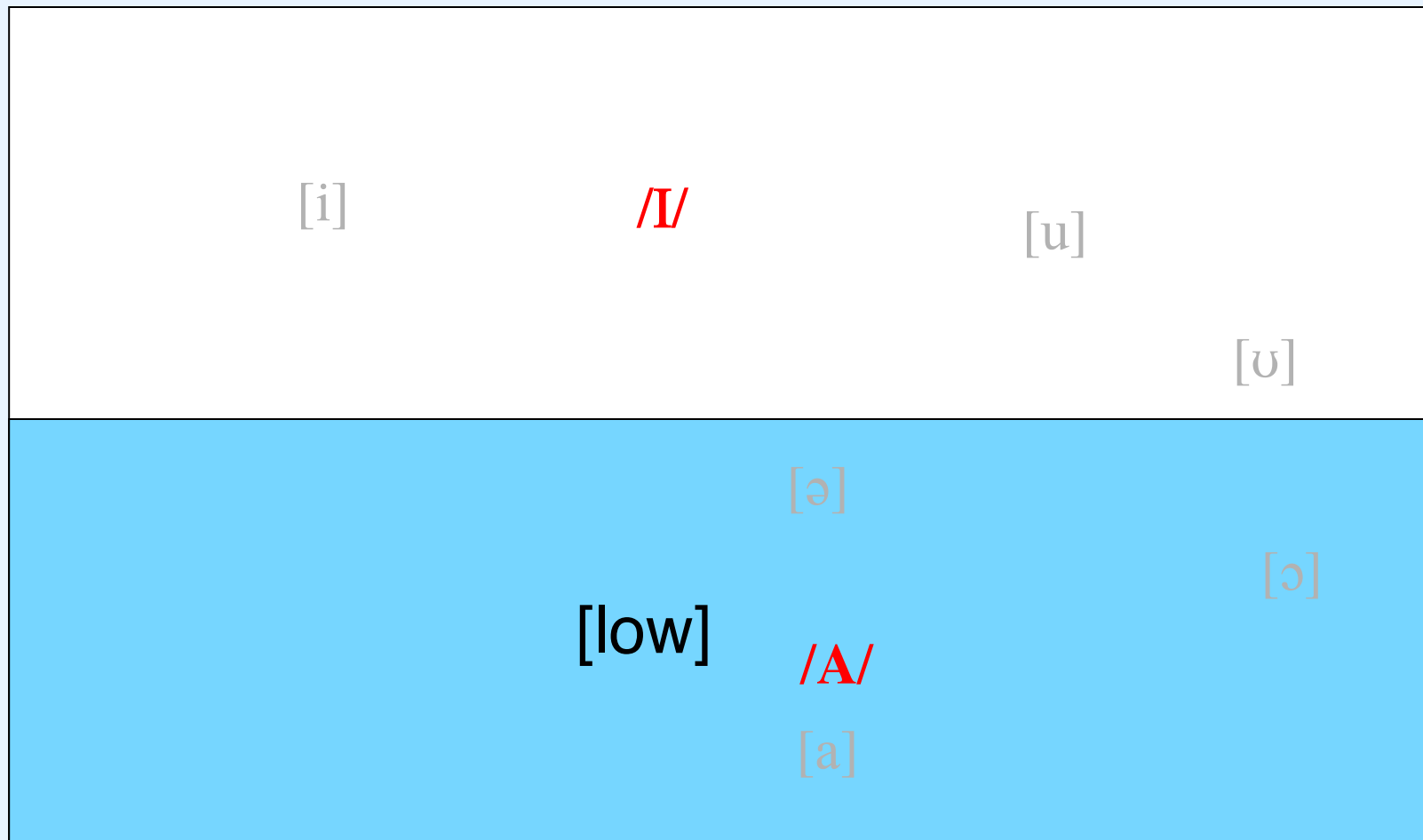
Assume contrastive features are determined in order:  
At the outset, assume one undifferentiated phoneme /V/.



# Classical Manchu vowels

The learner discovers a contrast between a [low] vowel /A/ and a non-low vowel /I/ (the symbols are for convenience only).

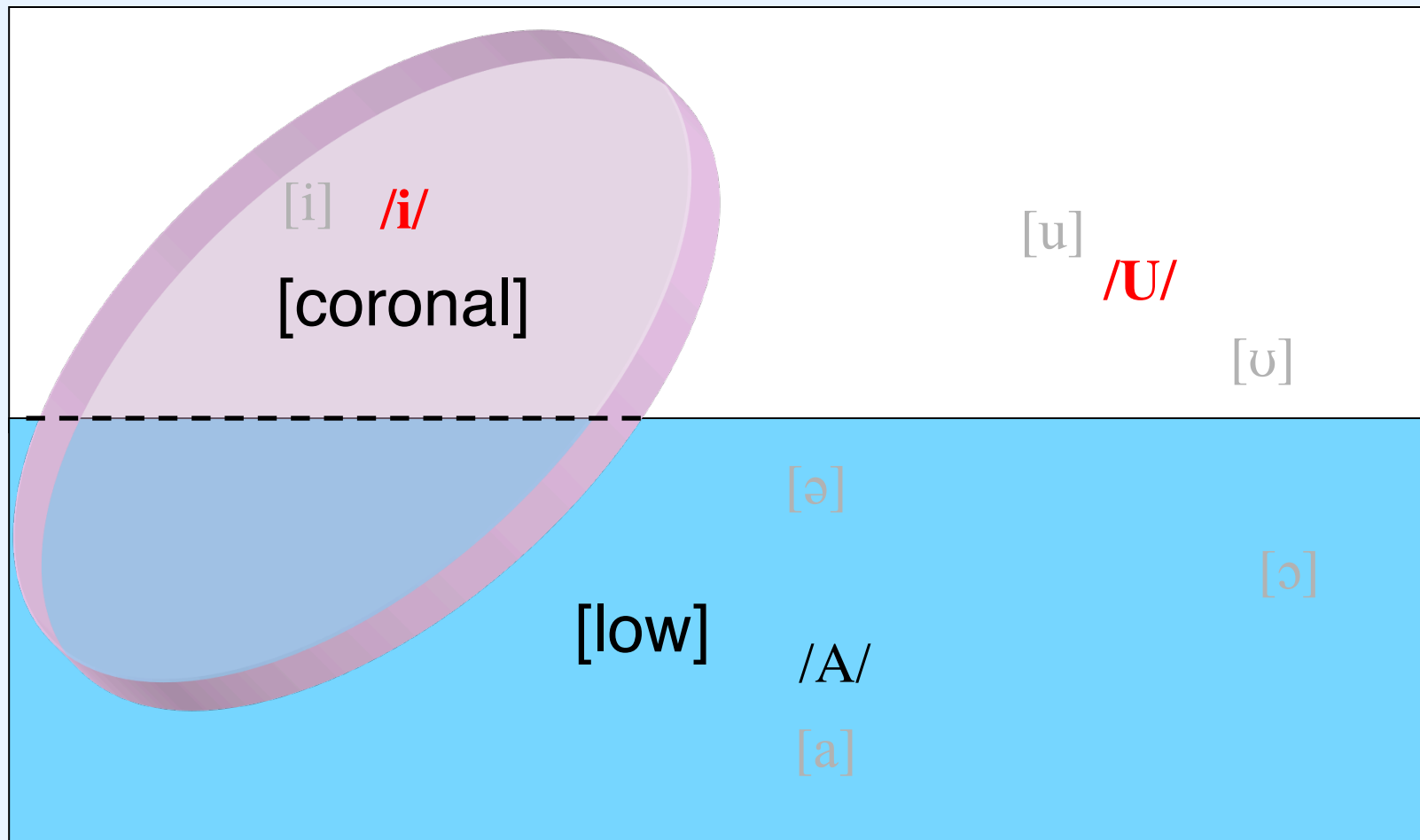
[low]



# Classical Manchu vowels

The non-low vowels split into a [coronal] vowel /i/ and a non-coronal vowel /U/.

[low] > [coronal]

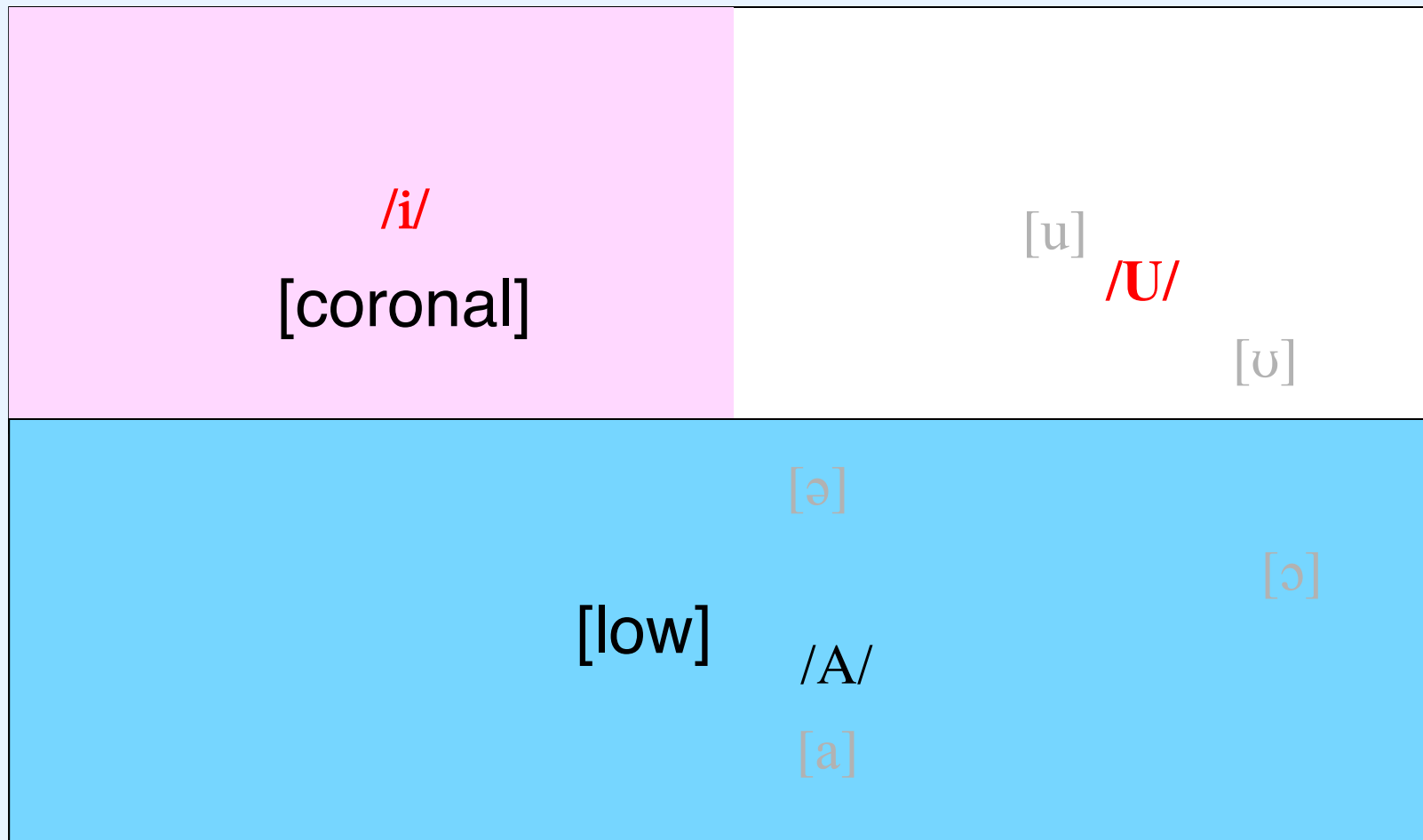




# Classical Manchu vowels

The non-low vowels split into a [coronal] vowel /i/ and a non-coronal vowel /U/.

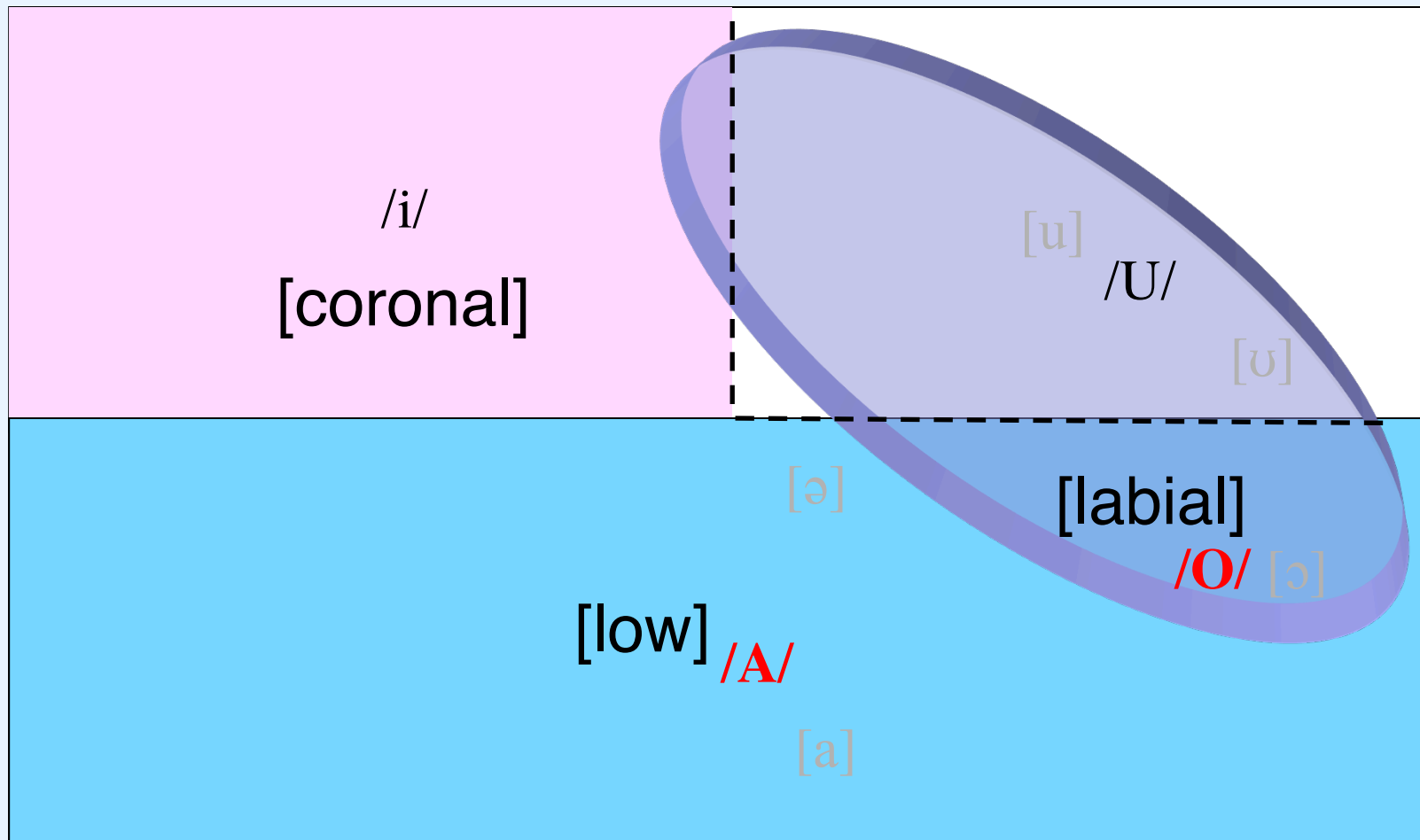
[low] > [coronal]



# Classical Manchu vowels

The low vowels split into a [labial] vowel /O/ and a non-labial vowel /A/.

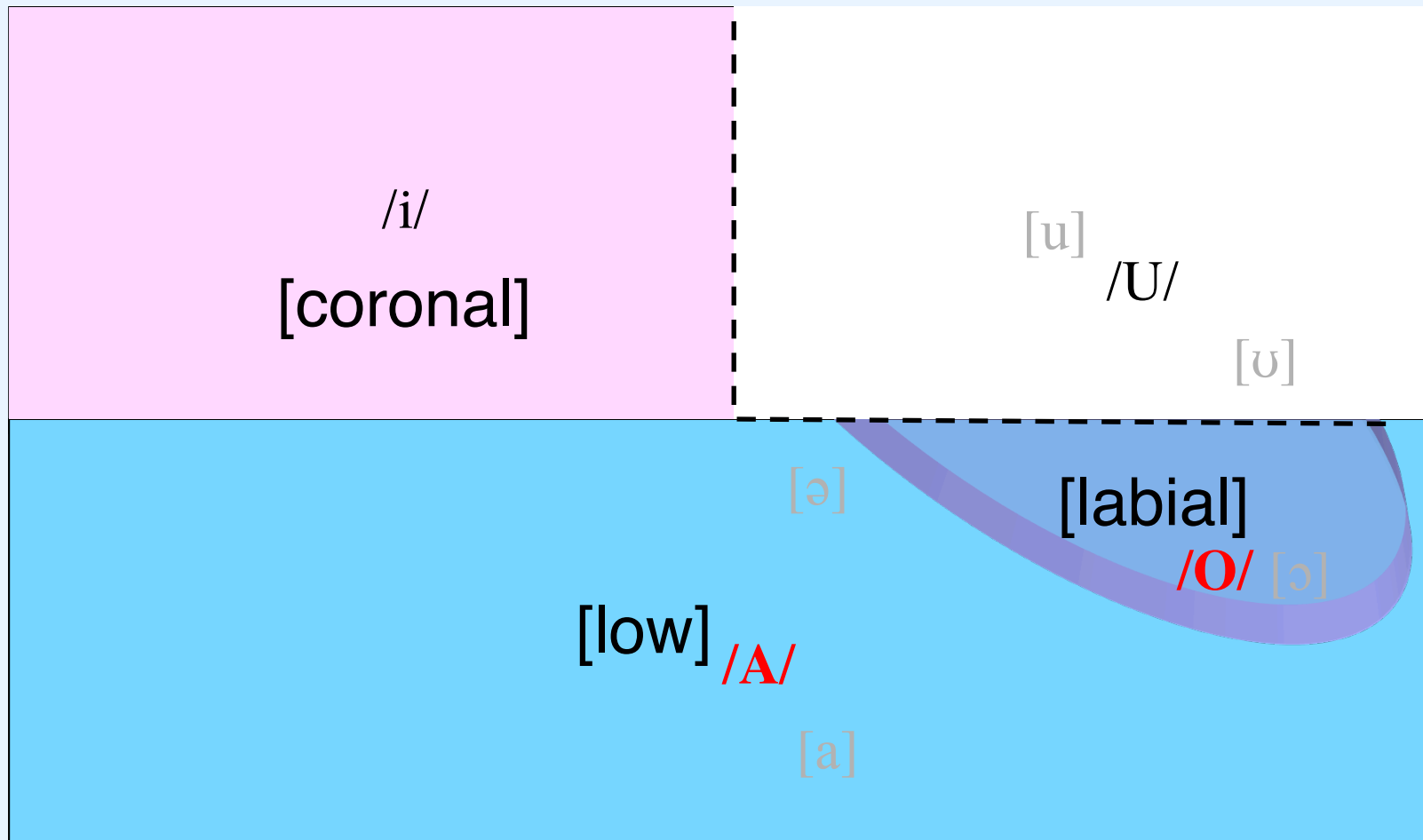
[low] > [coronal] > [labial]



# Classical Manchu vowels

[labial] has nothing to do in the non-low vowels, where [coronal] has arrived first.

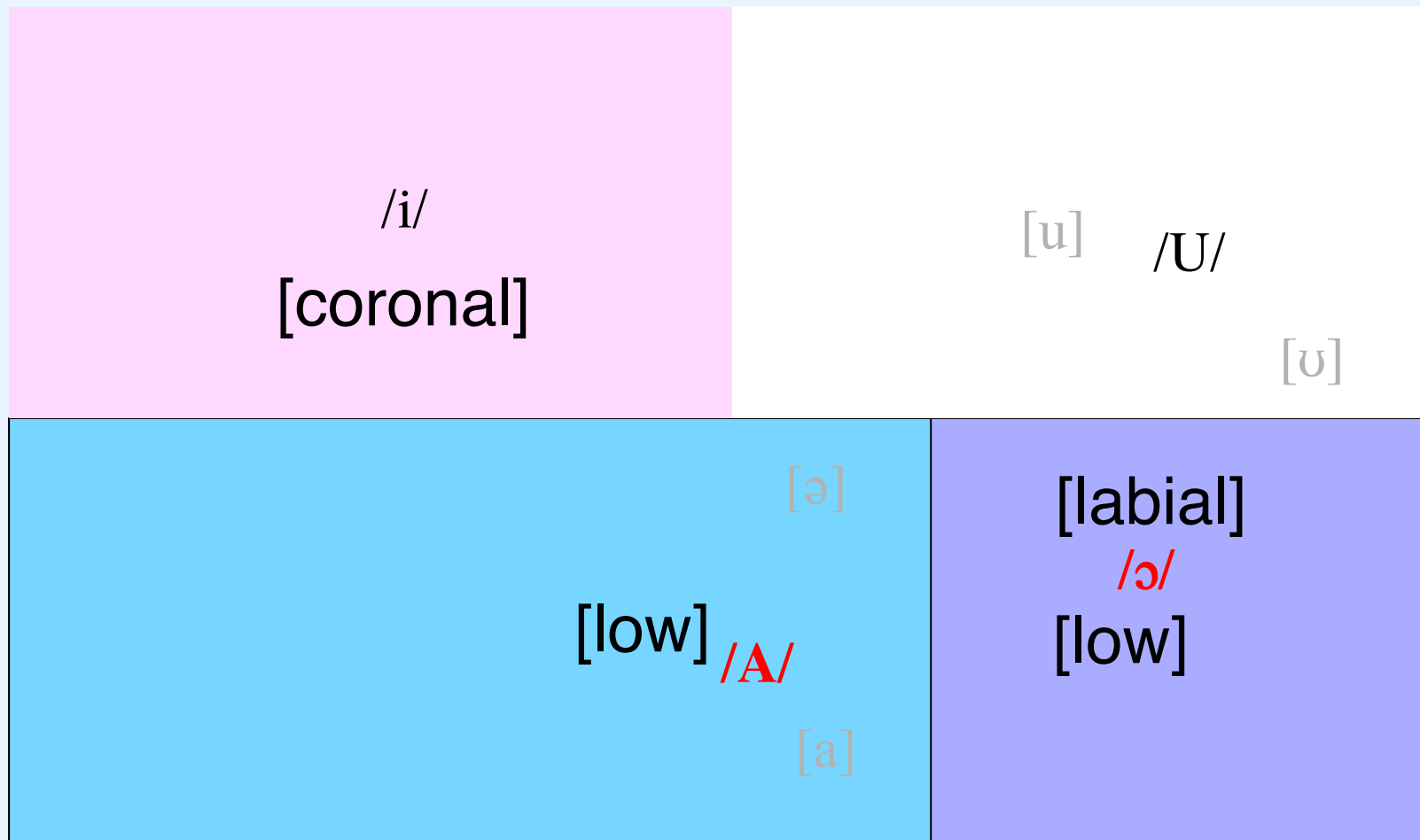
[low] > [coronal] > [labial]



# Classical Manchu vowels

[labial] has nothing to do in the non-low vowels, where  
[coronal] has arrived first.

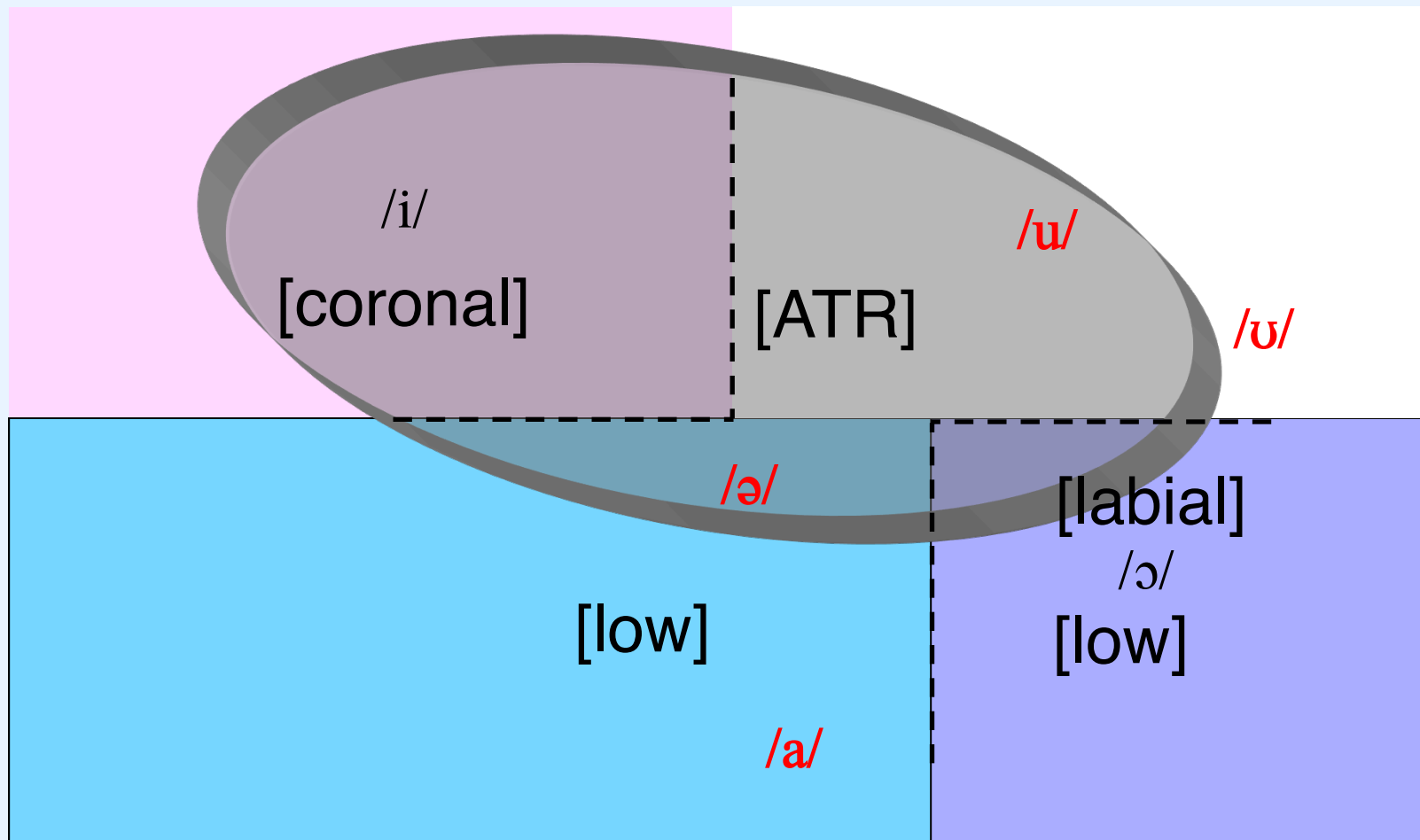
[low] > [coronal] > [labial]



# Classical Manchu vowels

Finally, [ATR] makes the final set of contrasts.

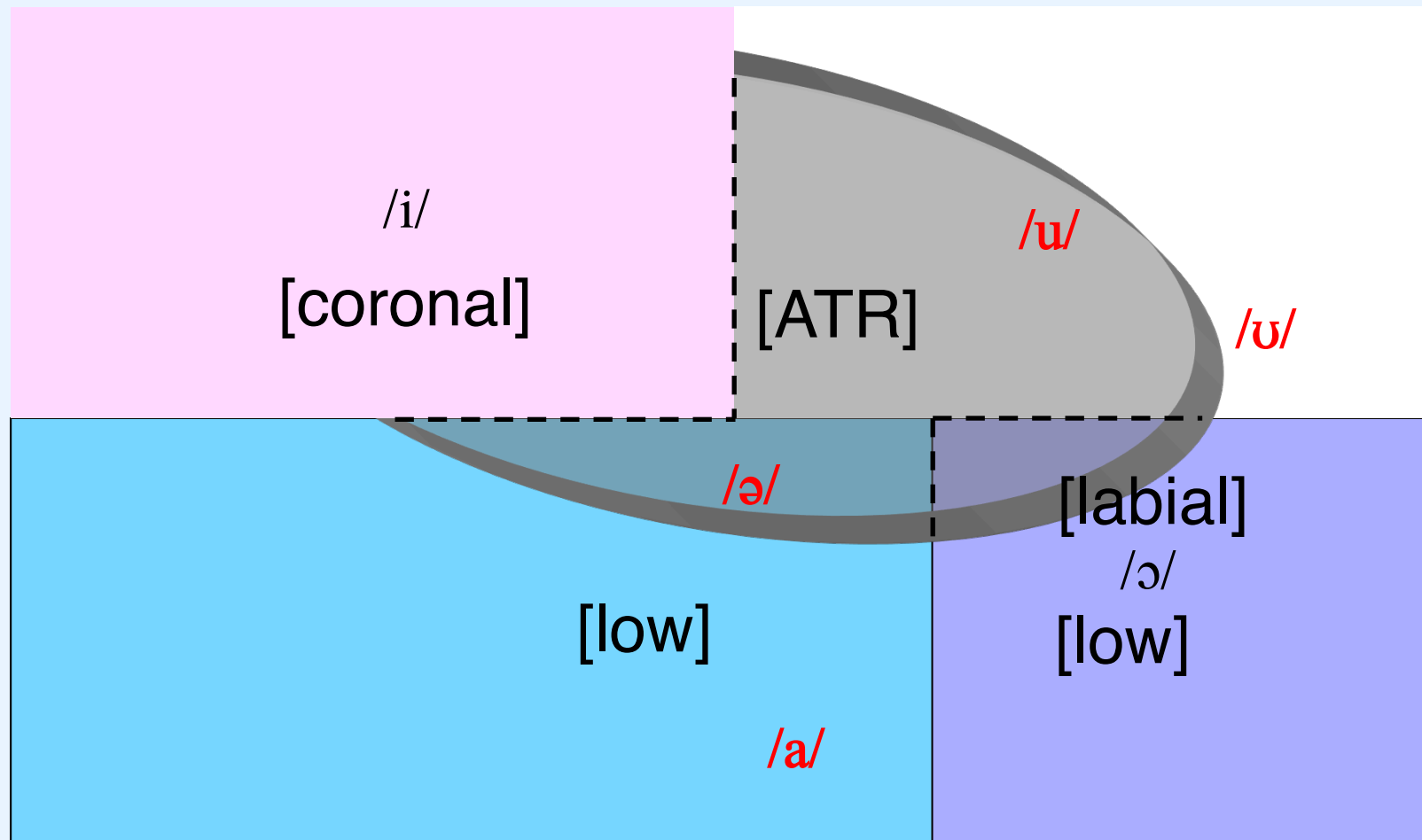
[low] > [coronal] > [labial] > [ATR]



# Classical Manchu vowels

[ATR] cannot apply to the [coronal] vowel which is already uniquely specified.

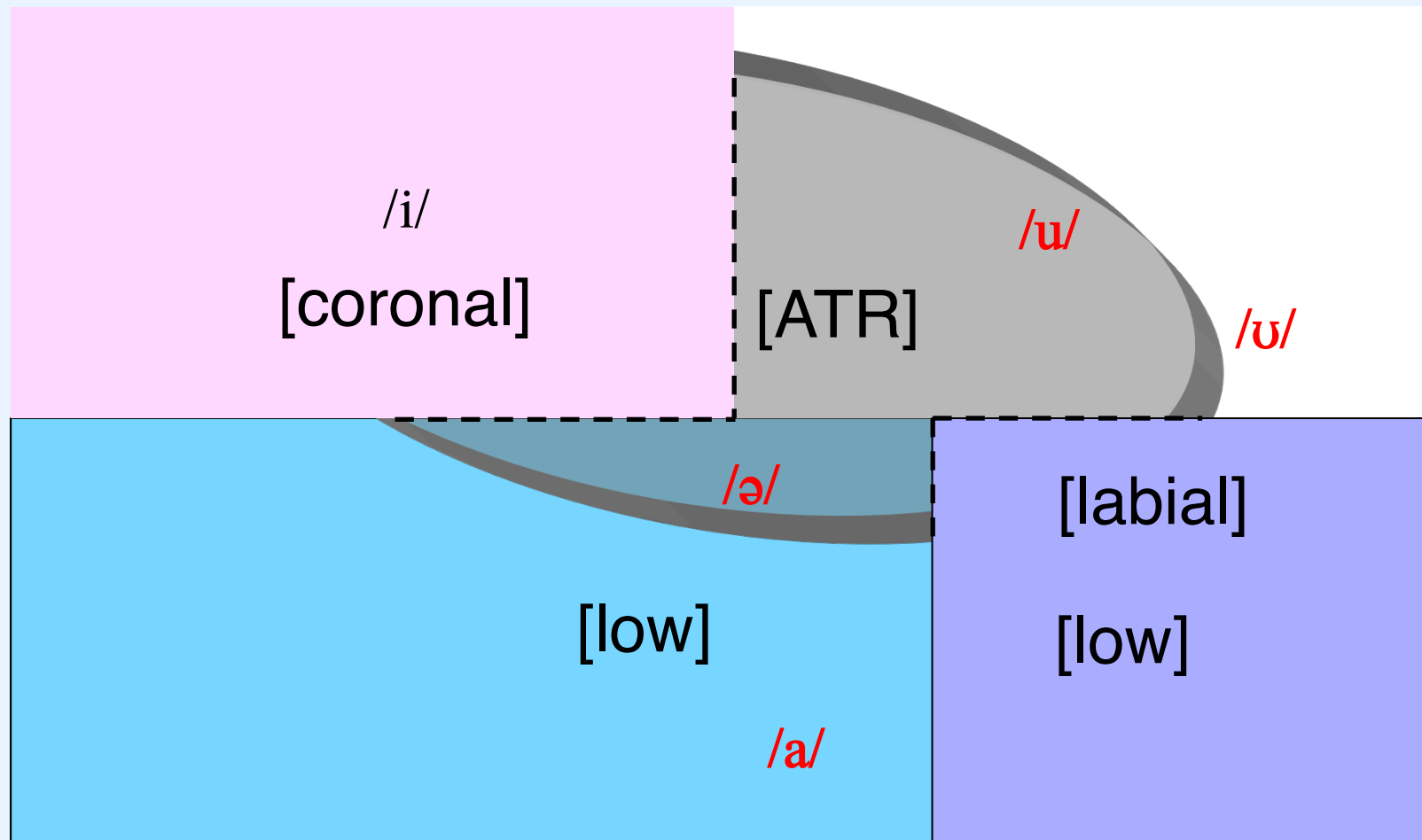
[low] > [coronal] > [labial] > [ATR]



# Classical Manchu vowels

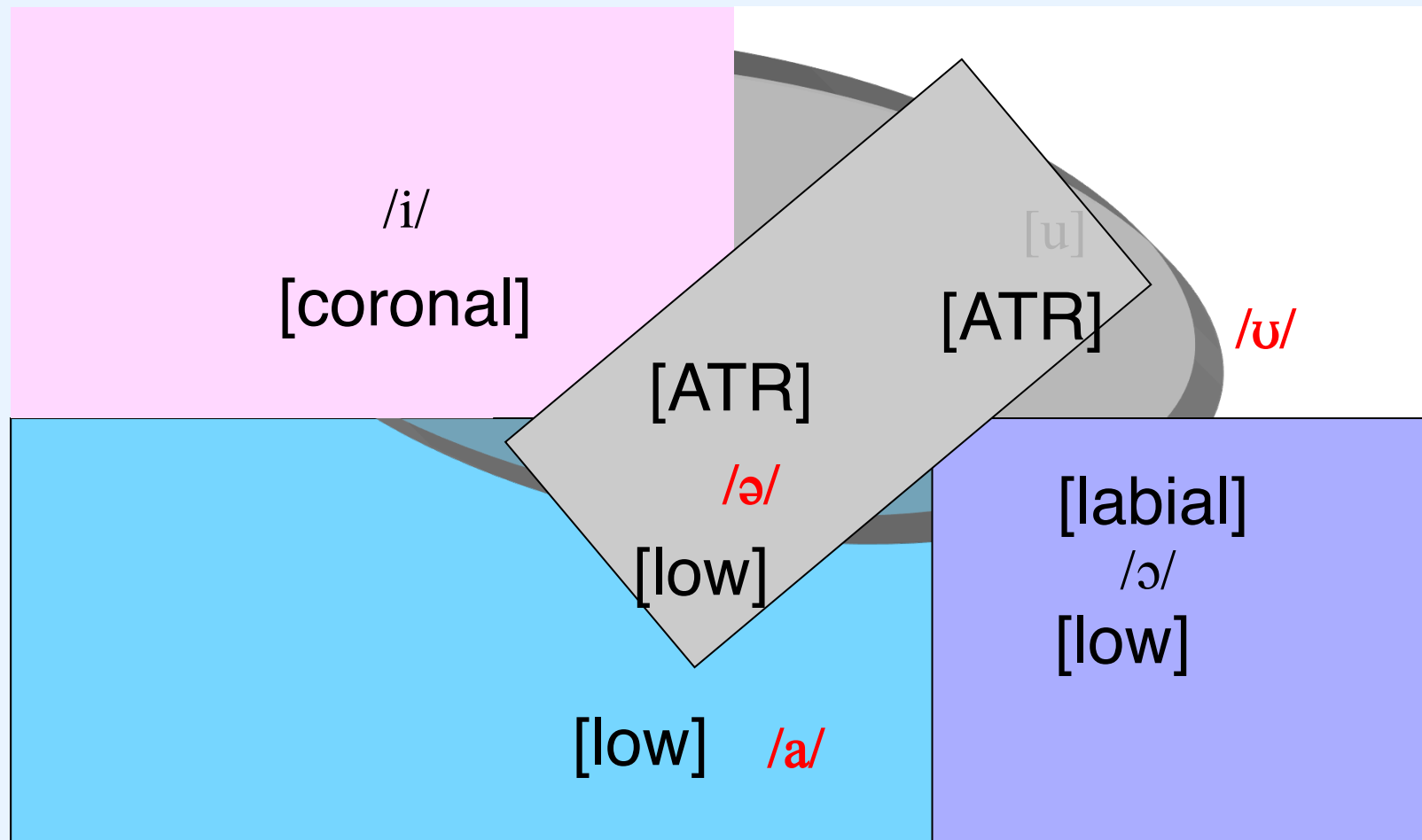
Nor can it apply to the [labial] vowel, which is not even phonetically {ATR}.

[low] > [coronal] > [labial] > [ATR]



# Classical Manchu vowels

[low] > [coronal] > [labial] > [ATR]

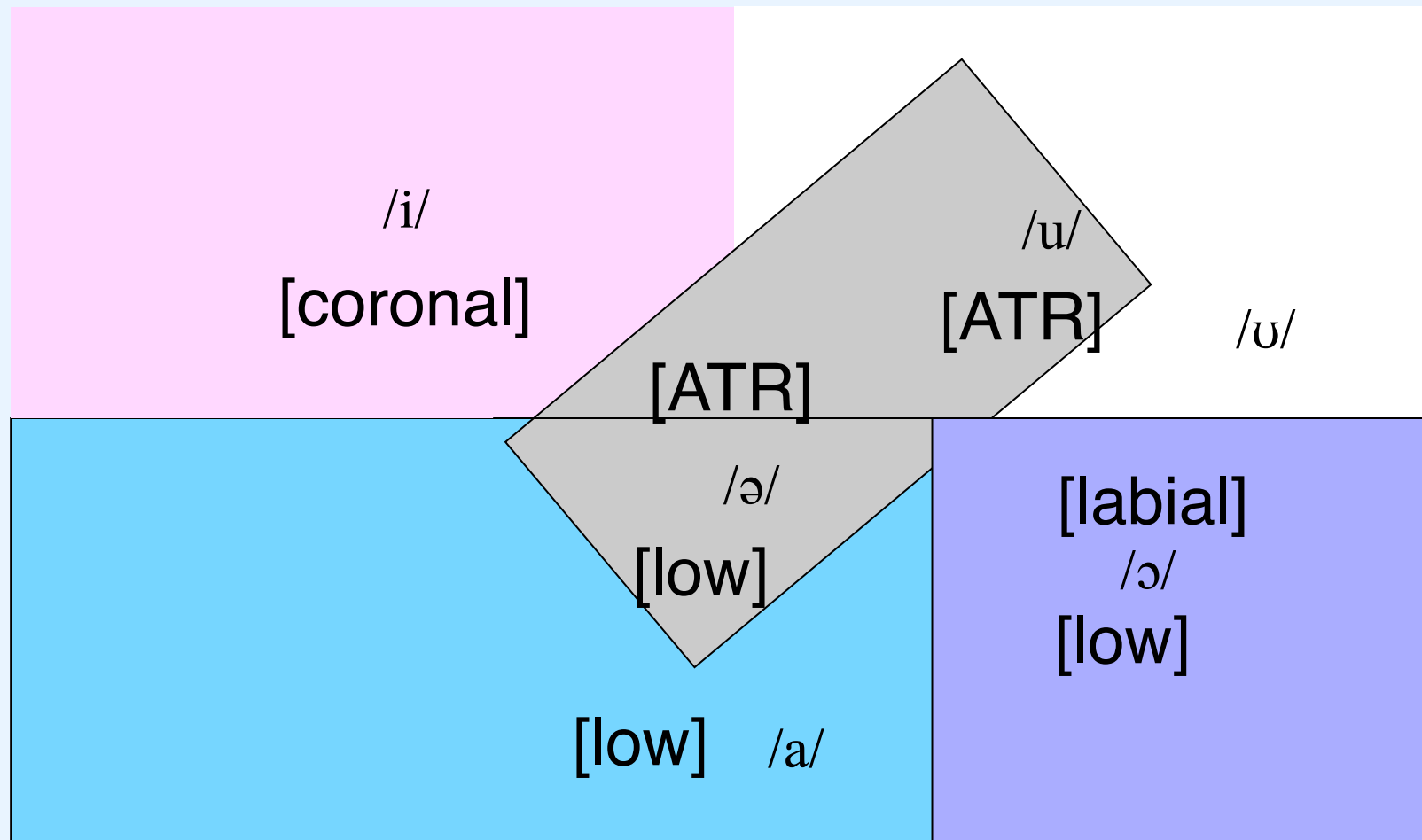




# Classical Manchu vowels

At this point there are no further contrasts to find in this language, and the hierarchy is complete.

[low] > [coronal] > [labial] > [ATR]



# Acquisition of contrasts

---

The preceding was a hypothetical sequence showing the order that contrasts in Manchu vowels would be acquired if the order of acquisition mirrors the feature hierarchy of the adult system.

This idea stems from Jakobson (1941) and is a natural way to describe developing phonological inventories (Pye, Ingram and List 1987; Ingram 1988; 1989; Levelt 1989; Dinnsen et al. 1990; Dinnsen 1992; 1996; see Dresher 1998a for a review).

# Acquisition of onset contrasts in Dutch



In the formulation of Rice and Avery (1995), phonological representations are built into systems of increasing complexity, based on the input from phonetic perception together with evidence from the grammar, which itself becomes more complex and removed from the initial percepts.

# Acquisition of onset contrasts in Dutch



In the formulation of Rice and Avery (1995), phonological representations are built into systems of increasing complexity, based on the input from phonetic perception together with evidence from the grammar, which itself becomes more complex and removed from the initial percepts.

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

# Development of Dutch onset consonants

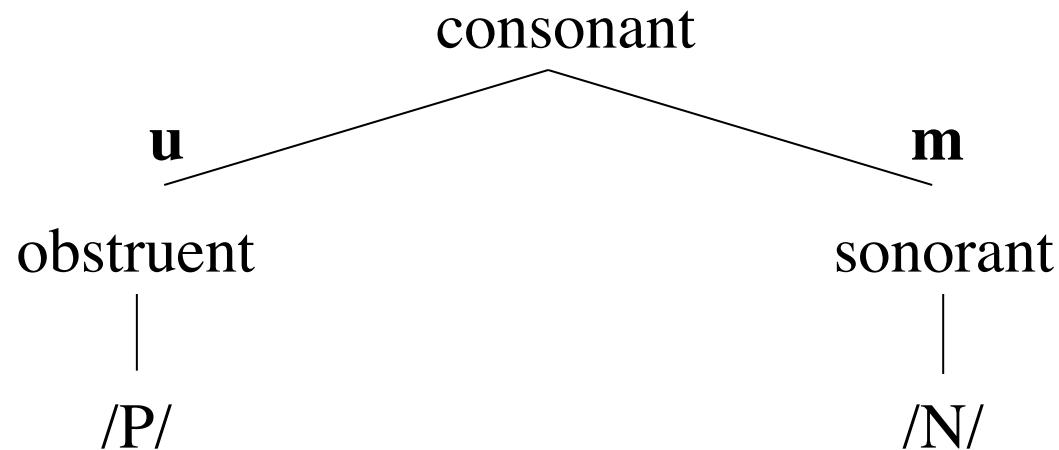
consonant

/P/

## Stage 1

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

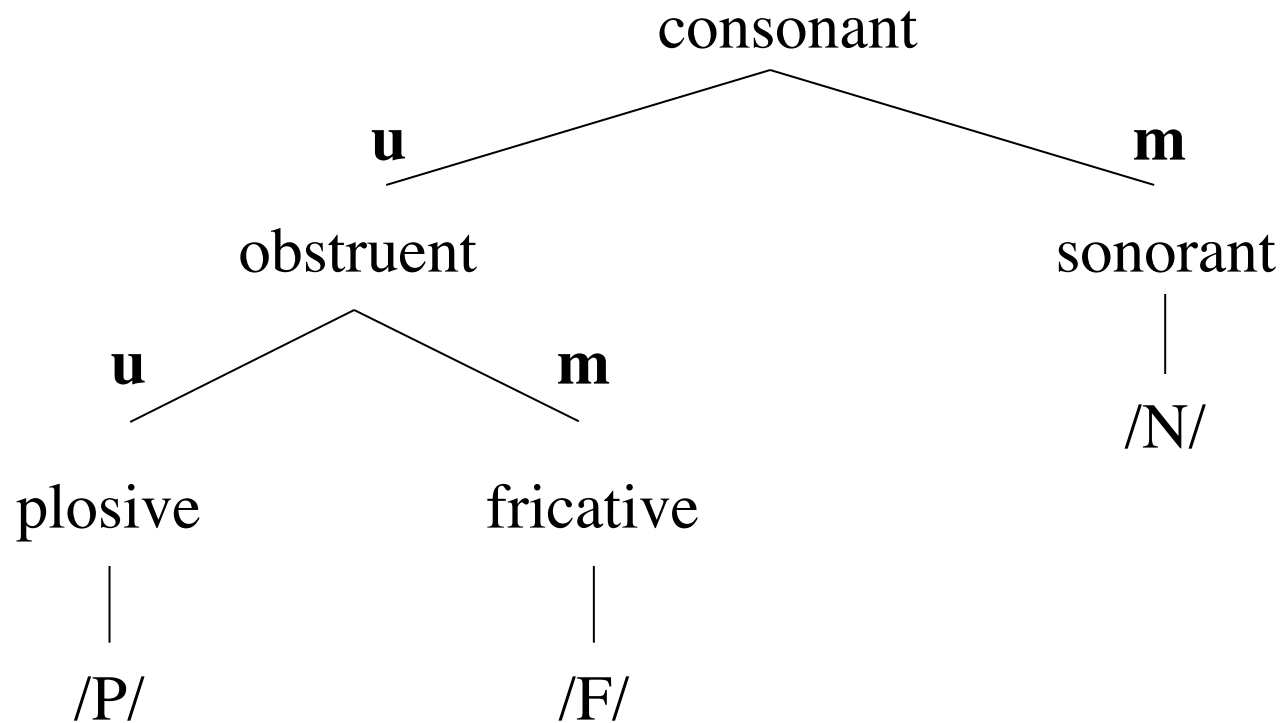
# Development of Dutch onset consonants



## Stage 2

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

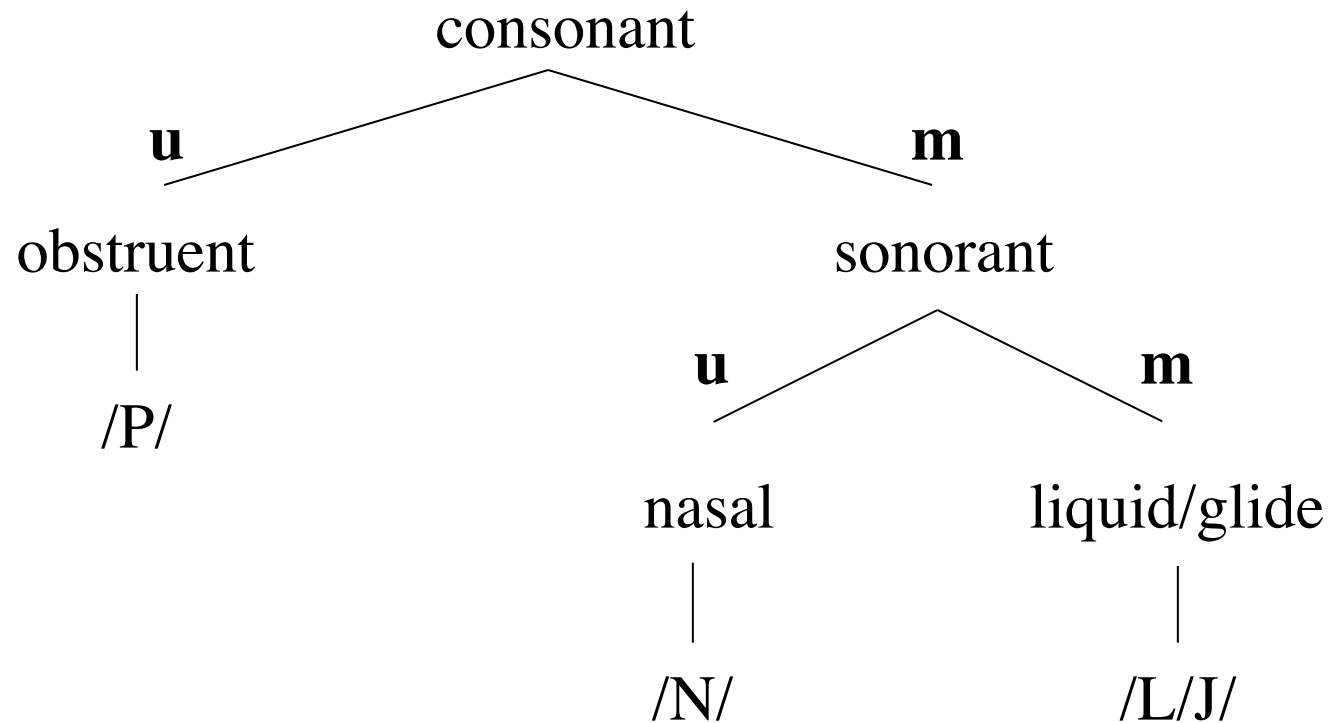
# Development of Dutch onset consonants



## Stage 3a

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

# Development of Dutch onset consonants

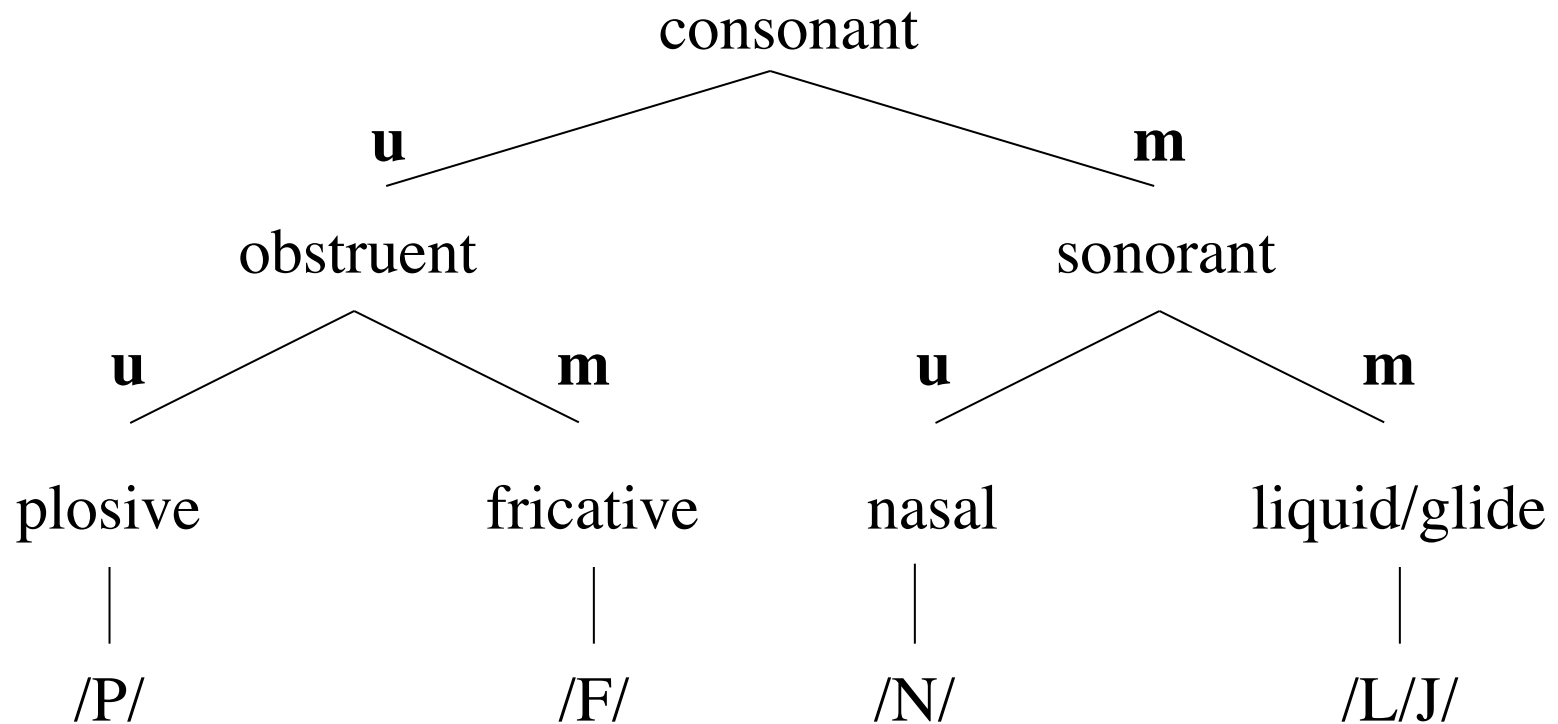


## Stage 3b

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



# Development of Dutch onset consonants



## Stage 4

Continuing in this way we will eventually have a tree that gives all and only the contrasting features in the language.

# An acquisition paradox?

---

The scenario presented here has been criticized by Hale & Reiss (2008) and Samuels (2009).

Hale & Reiss (2008: 39–42) argue that the ‘traditional model’ set out by Rice & Avery (1995), and adopted here, cannot be accepted:

# An acquisition paradox?



“We believe that such a learning path is not possible given standard assumptions about the language faculty...Rice and Avery’s theory, and those like it, must be rejected as unpar-simonious, incompatible with the generative program, and incapable of modeling a successful learning path.”

## An acquisition paradox?

To illustrate their argument, imagine a 5-vowel language /i, e, a, o, u/, and suppose that a learner has reached a stage that distinguishes only 3 vowels with the features shown below.

The learner has not yet made a distinction between /i/ ~ /e/ and /u/ ~ /o/; i.e., the feature [high] has not yet been acquired.

<i>(non-back)</i>	[back]
/i/	/u/
/ɪ/	/ʊ/
/e/	/o/
/a/ [low]	

Thus, words like [pit] and [pet] are both represented /pɪt/; for the child, the vowels in both have the identical representation (*non-low, non-back*).

# An acquisition paradox?

How do learners get to the 5-vowel stage? Hale & Reiss argue that they can't get there from here!

“[A]ny vowel that the child is presented with must be parsed as one of the three, or else it will not be parsed at all.”

“A representation can only be assigned using the available representational apparatus.”

*(non-back)*

/i/

/ɪ/

/e/

[back]

/u/

/ʊ/

/o/

/a/

[low]

# An acquisition paradox?

How do learners get to the 5-vowel stage? Hale & Reiss argue that they can't get there from here!

“[A]ny vowel that the child is presented with must be parsed as one of the three, or else it will not be parsed at all.”

<i>(non-back)</i> /i/	[high]	[back] /u/
/e/	<i>(non-high)</i>	/o/
	/a/	[low]

“A representation can only be assigned using the available representational apparatus.”

Thus, a learner that can distinguish [i] from [e] must *already* have access to the feature [high], contrary to what is assumed here.

## An acquisition paradox?

Our answer is that learners can discriminate sounds for which they have no phonological representations using their innate perceptual system, but Hale & Reiss do not accept this explanation either.

They argue that the grammar should not make use of two types of representation: “a phonological representation, which starts out with access to a minimal set of features, and a phonetic or acoustic representation, which makes use of fully specified phonetic feature matrices.”

But we are not proposing that what I have called ‘acoustic percepts’ are part of the grammar, or make use of feature matrices.

# An acquisition paradox?



Hale & Reiss, however, reject the notion that learners can make use of “raw acoustic images” that are outside the grammar.

They assert that any discrimination of speech sounds must be in terms of innate phonological features.



# An acquisition paradox?



But recall the evidence that ferrets have neurons that can discriminate fine details of speech sounds.

Presumably we have them, too, before and after they enable us to acquire phonological representations.

## A contrary acquisition path

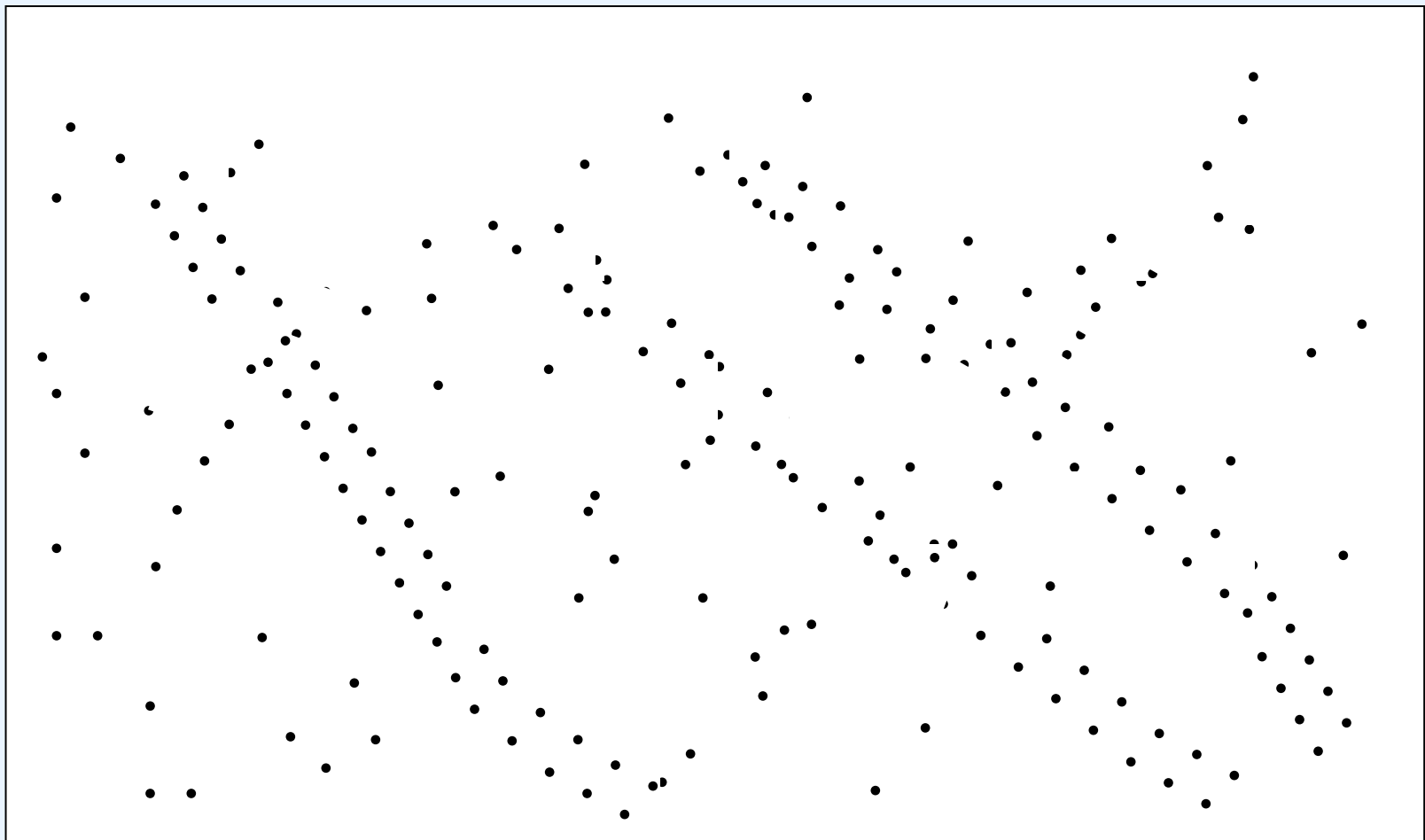
Hale & Reiss's view is that phonological representations begin as very detailed and become simpler in the course of acquisition.

This theory requires that phonological features are innate, universal, and unambiguous, an untenable position.

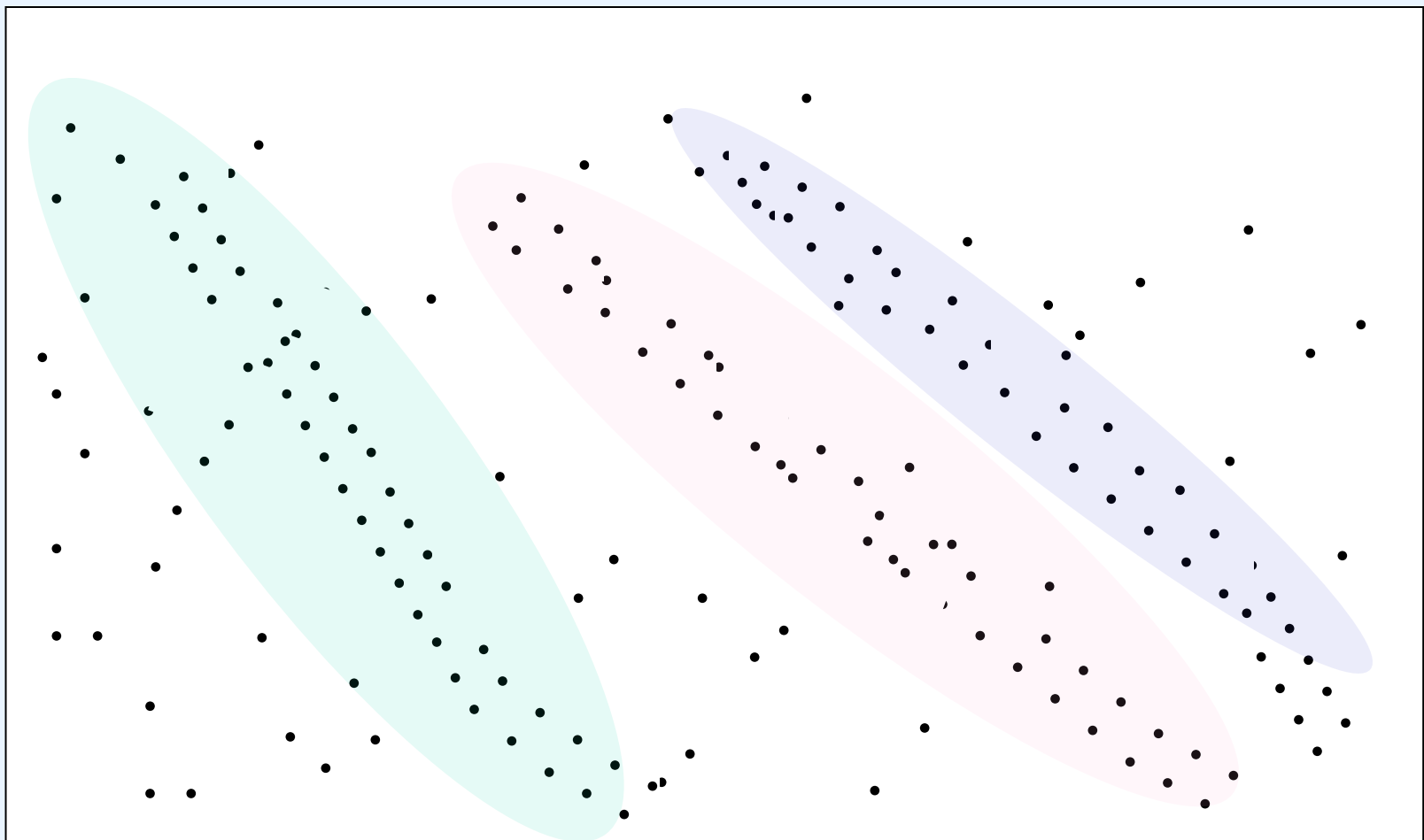
In support of their view, they cite evidence that infants begin by attending to many potential sources of contrasts, and are more able than adults to discriminate sounds not used in the ambient language (Eimas et al. 1987, Werker et al. 1981).

That is, acquisition of the native language requires that they 'tune' their perceptual system to the contrasts used in their language, while learning to disregard contrasts that are not used (Werker and Tees 1984).

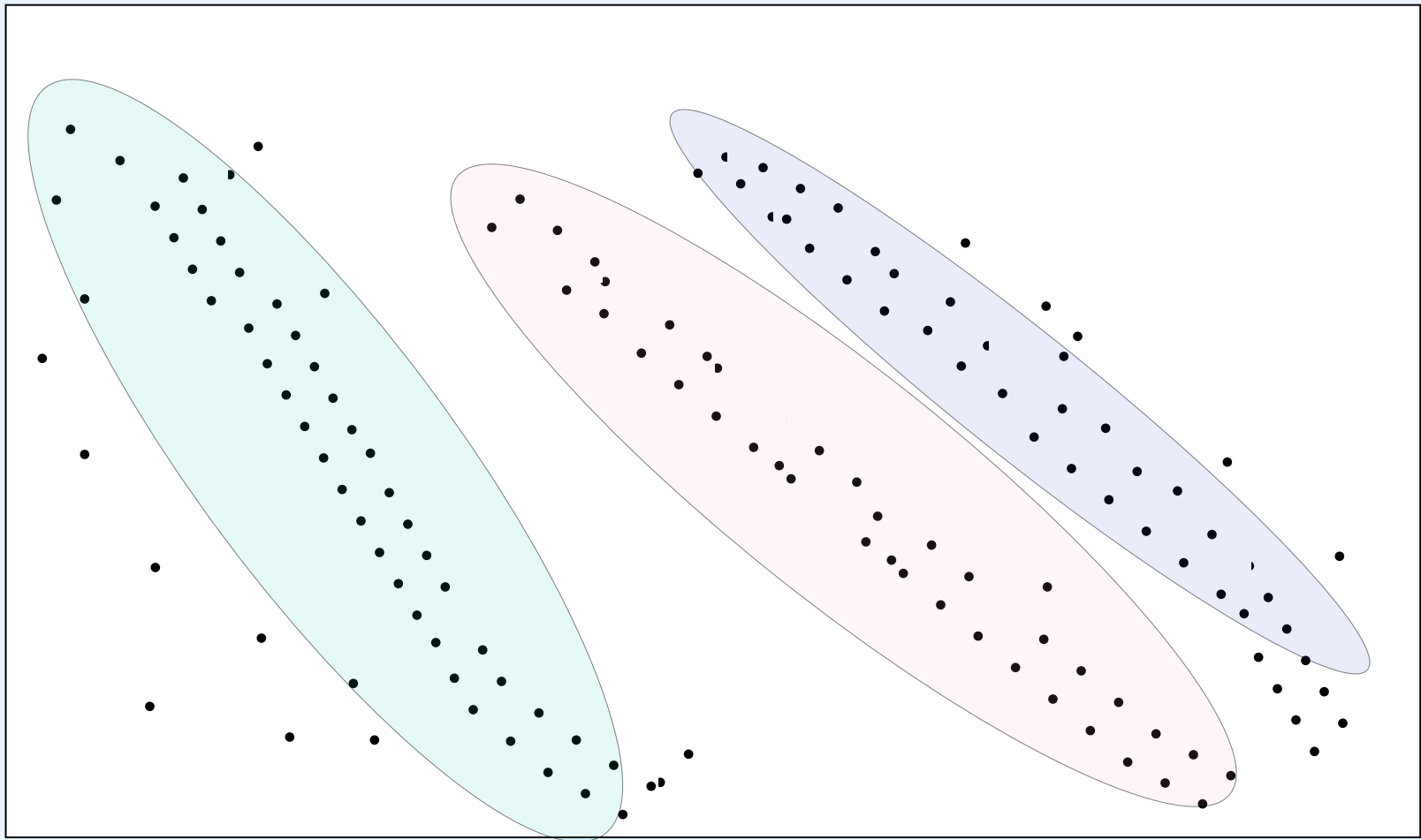
# Pruning the perception of phones: Schematic depiction



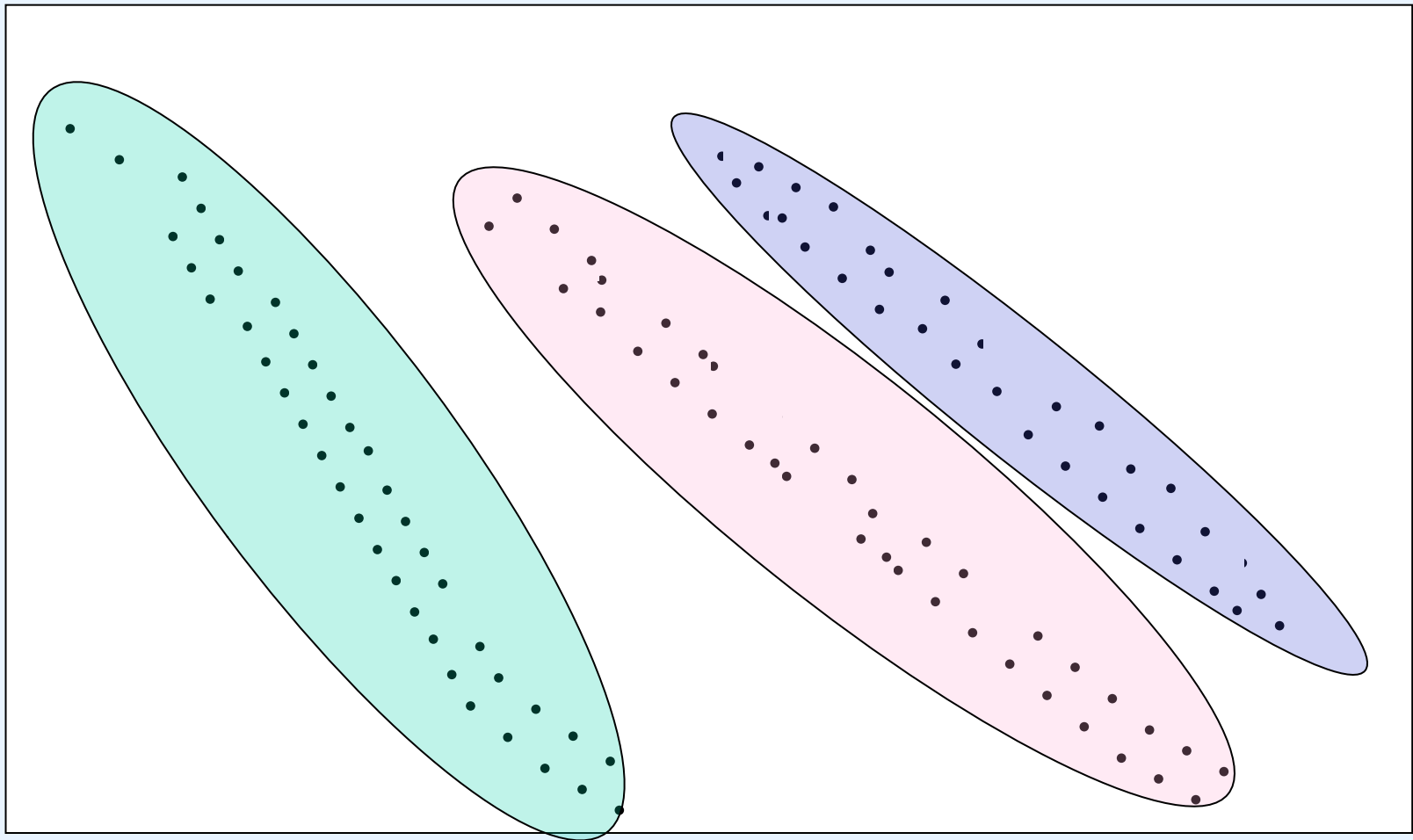
# Pruning the perception of phones: Schematic depiction



# Pruning the perception of phones: Schematic depiction



# Pruning the perception of phones: Schematic depiction



# Pruning of Perceptual Contrasts

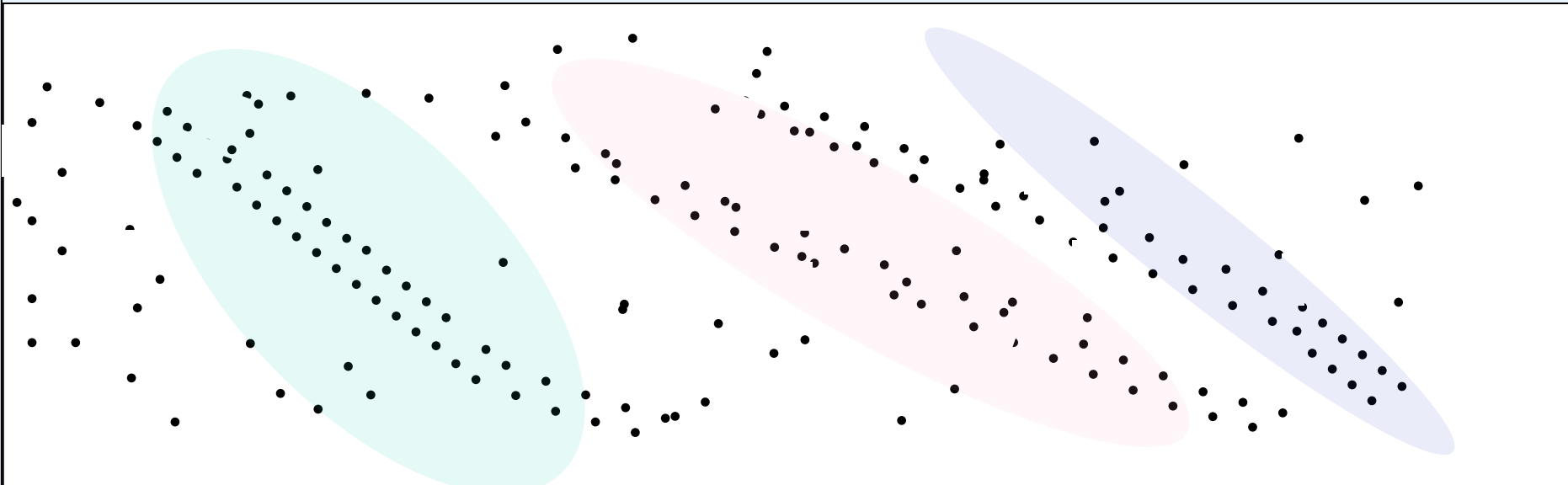
However, there is no evidence that this 'tuning' applies to phonological **representations**.

The observations about infants apply to **phones**, not to phonemes.

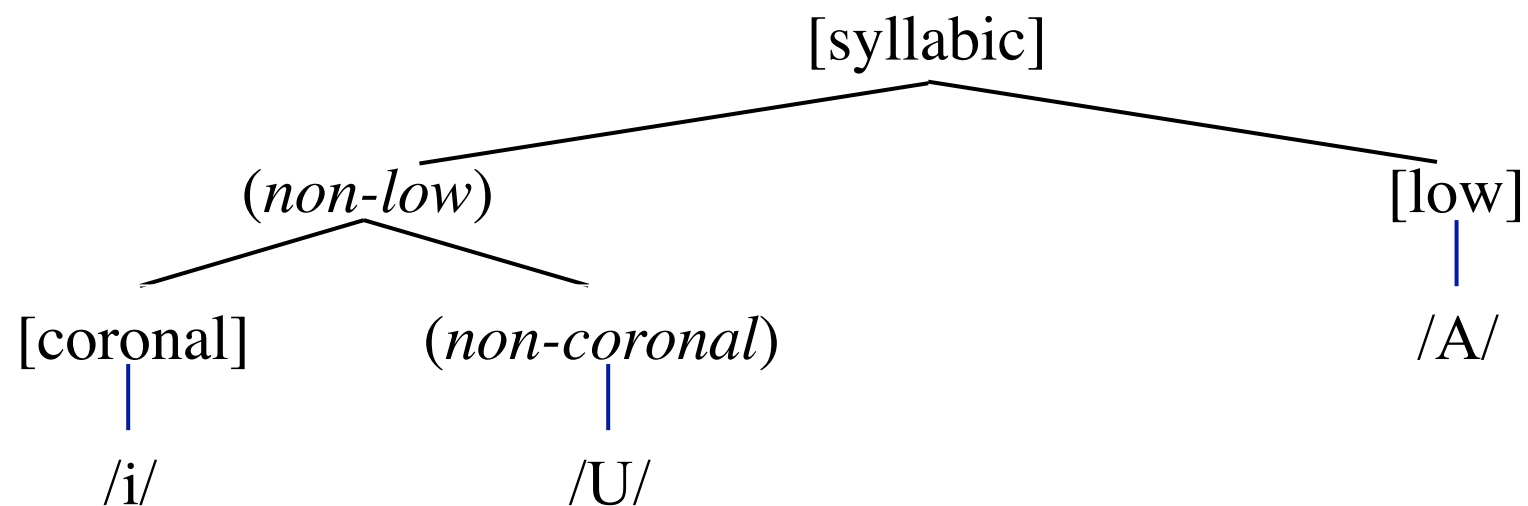
Learning to ignore sounds and distinctions that are not relevant to their native language is obviously helpful in eventually acquiring phonological features, but it is not the same process.

In fact, if we combine the studies of infants tuning phonetic perceptions with phonological studies of the role of contrast in phonological inventories, we obtain a picture of a learner going in two contrary directions simultaneously:

The perceptual system is learning to ignore irrelevant contrasts,



while phonological representations are becoming more complex.





# An untenable acquisition path

In sum, the learning path proposed by Hale & Reiss is untenable because it requires an innate and universal set of features, and it further assumes that learners can immediately assign the correct featural representations to any surface sound they hear (that is, features must also be unambiguous).

None of these prerequisites are met by phonological features, given the problems with assuming innate features, and the ambiguity of many features: How low qualifies as [low]? What height differences can be tolerated in segments of the same height? Where is the boundary between [back] and (*non-back*)?

# Perception beyond the grammar

---

It appears that there is no alternative but to suppose that learners must be able to perceive distinctions that are not yet encoded in their grammar.

It follows that perception is not limited by the current grammar.

For that matter, adults are able to perceive unfamiliar phonetic distinctions in a foreign language if they focus on them.

## No acquisition paradox!

---

I conclude that Hale & Reiss's (2008) arguments against Rice & Avery (1995), and by implication the account presented here, do not go through, and that the alternative acquisition path they propose is not tenable.

Thus there is no obstacle to adopting the 'traditional' view that phonological representations become more complex in the course of acquisition, and that learners acquire the contrasts of their language in stages.

The contrastive hierarchy provides a way of connecting accounts in the acquisition literature of developing inventories with synchronic and diachronic phonology.

# *Part 4*

---

*The contrastive  
hierarchy and  
'substance'*

# Deriving features from activity

Krekoski (2013) constructs contrastive trees for the tone systems of a number of languages that descend from Middle Chinese.

He bases the trees not on the phonetics of the tones, but on the patterns of activity they display in the form of tone sandhi.

Thus, Beijing Mandarin has the 4 tones shown, which participate in 2 robust sandhi rules:

## Beijing Mandarin tones

/55/ high level

/35/ rising

/214/ low concave

/51/ high falling

## Beijing Mandarin tone sandhi

/214/ → 35/\_\_\_\_\_/214/

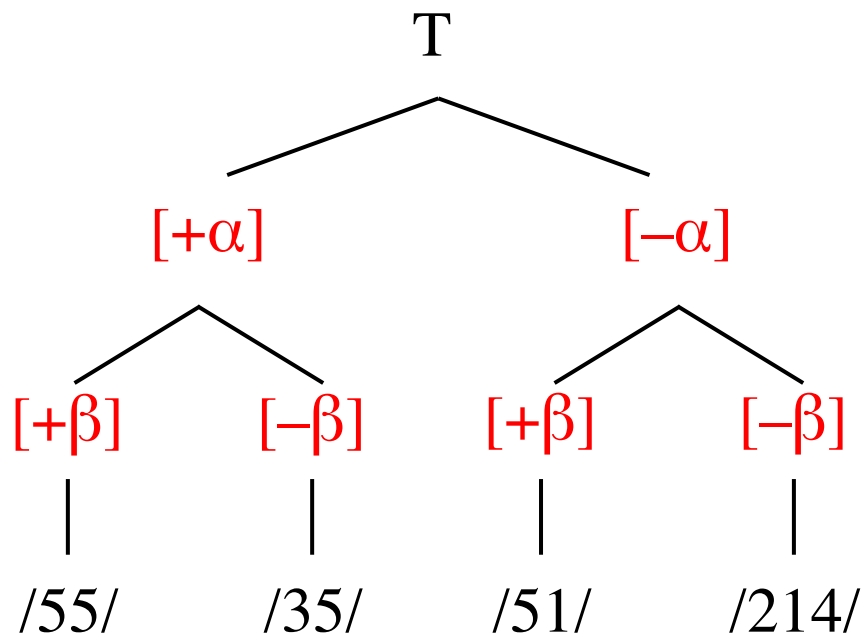
/35/ → 55/\_\_\_\_T

(T = any tone)

# Beijing Mandarin contrastive hierarchy

Krekoski (2013) assumes that, where possible, tones related by a sandhi rule differ minimally, that is by only one feature.

Thus, tone /35/ differs by 1 feature from /214/ and from /55/. Below is a tree satisfying these constraints:



[α] and [β] are placeholders for features which will be given a phonetic interpretation.

## Beijing Mandarin tone sandhi

1. /214/ → 35/\_\_\_\_\_/214/

2. /35/ → 55/\_\_\_\_\_/T

(T = any tone)

## Pingyao (Jin) tone system

Pingyao is a Jin language with 4 underlying tones. Though two of them have merged at the surface, they can be distinguished by the way they participate in tonal alternations.

Krekoski identifies 9 tone sandhi rules in Pingyao. Their inputs and outputs are summarized below. I omit alternations that are purely allotonic.

Though the two [13] tones sound the same, Krekoski gives arguments for associating them with either /13a/ or /13b/.

### Pingyao tones

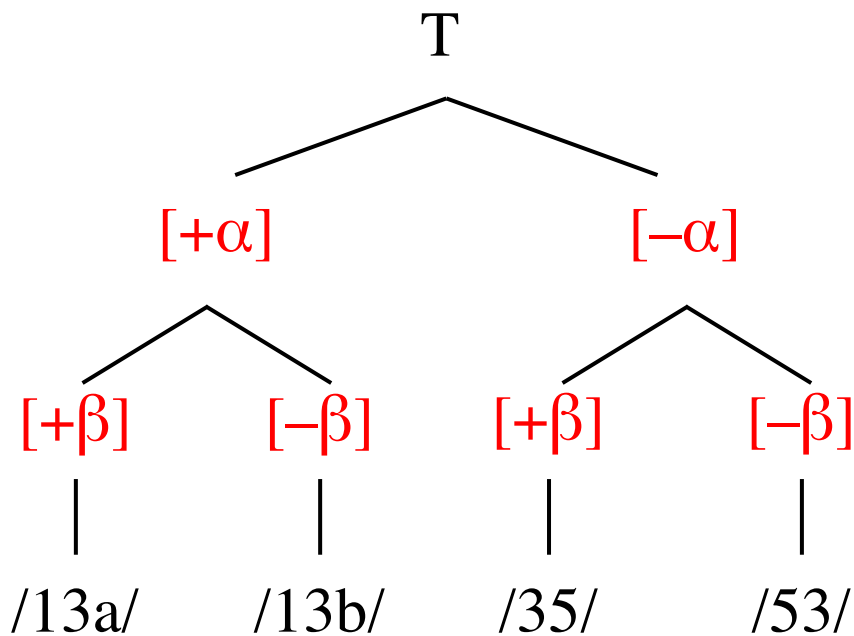
/13a/	low rising
/13b/	low rising
/53/	high falling
/35/	high rising

### Pingyao tone sandhi

Input	Outputs
/13a/	35
/35/	13 [= 13a], 53
/53/	35, 13 [= 13b]

# Pingyao (Jin) contrastive hierarchy

Following the same procedure as for Beijing, Krekoski arrives at a tree for Pingyao whereby each of the tonal alternations involves a change of only 1 feature.



## Pingyao tone sandhi

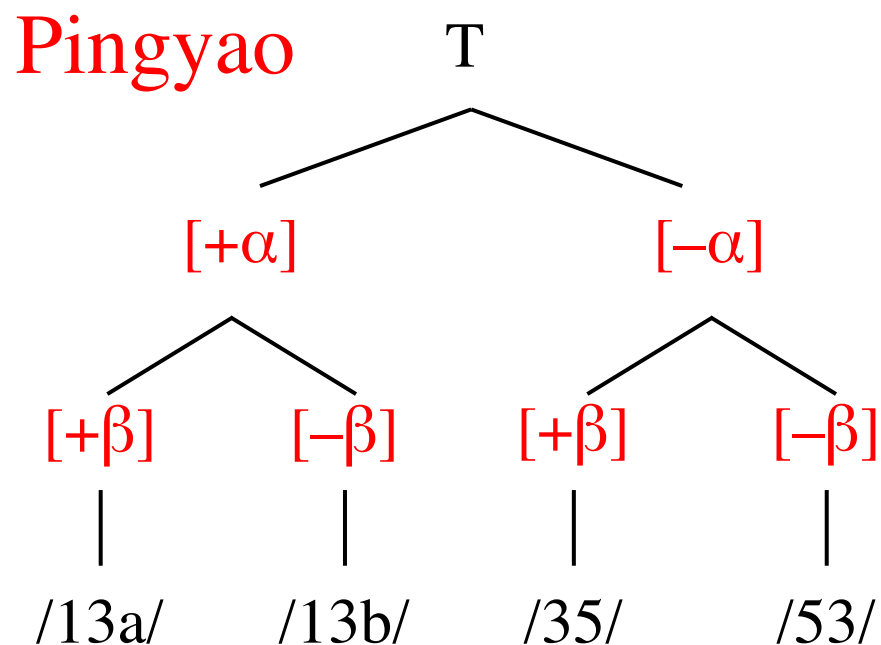
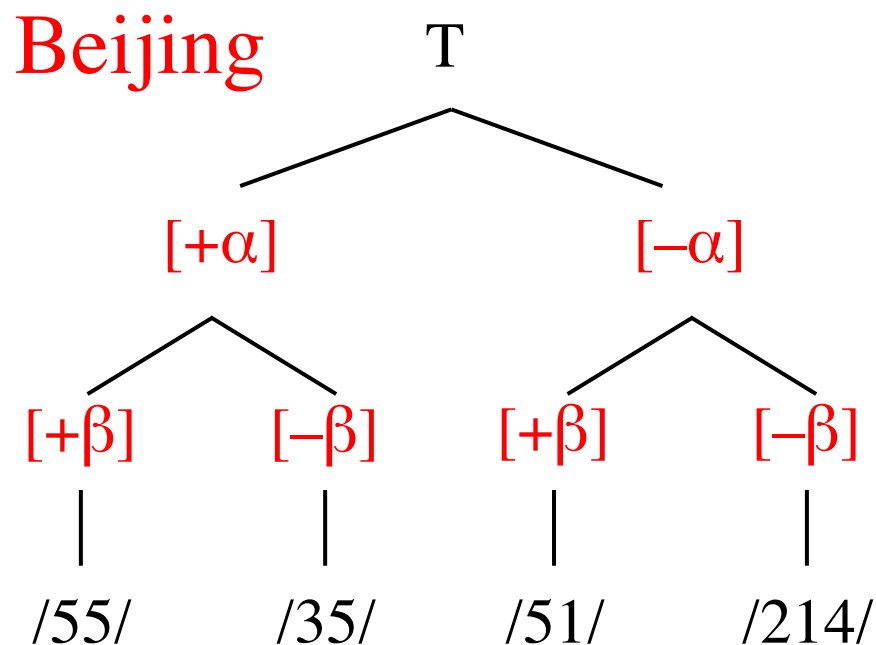
Input	Outputs
/13a/	35
/35/	13 [= 13a], 53
/53/	35, 13 [= 13b]



# Beijing and Pingyao cognate tones

Krekoski observes that Beijing and Pingyao tones in corresponding positions in the trees are cognates, and descend from the same Middle Chinese tone.

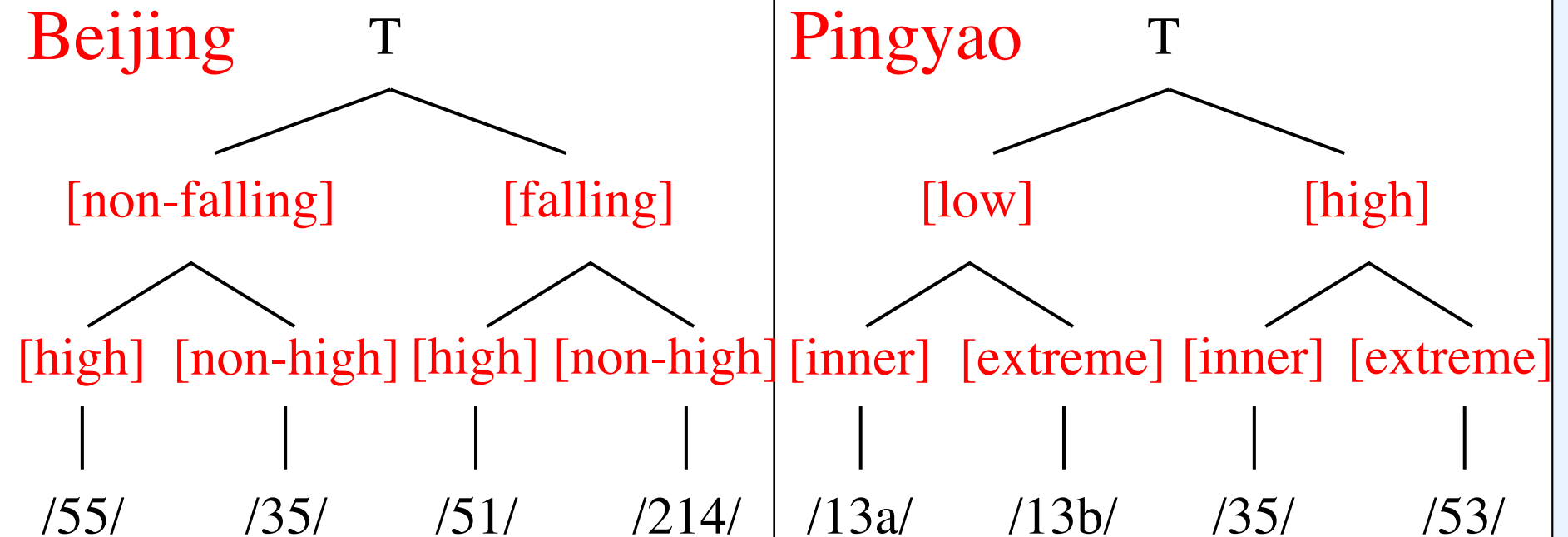
That is, despite extensive changes in their phonetics, the tones retain the same positions in the contrastive hierarchy.



# Beijing and Pingyao tone features

Up to here we have not tried to give the features phonetic interpretations; however, features are not purely abstract entities.

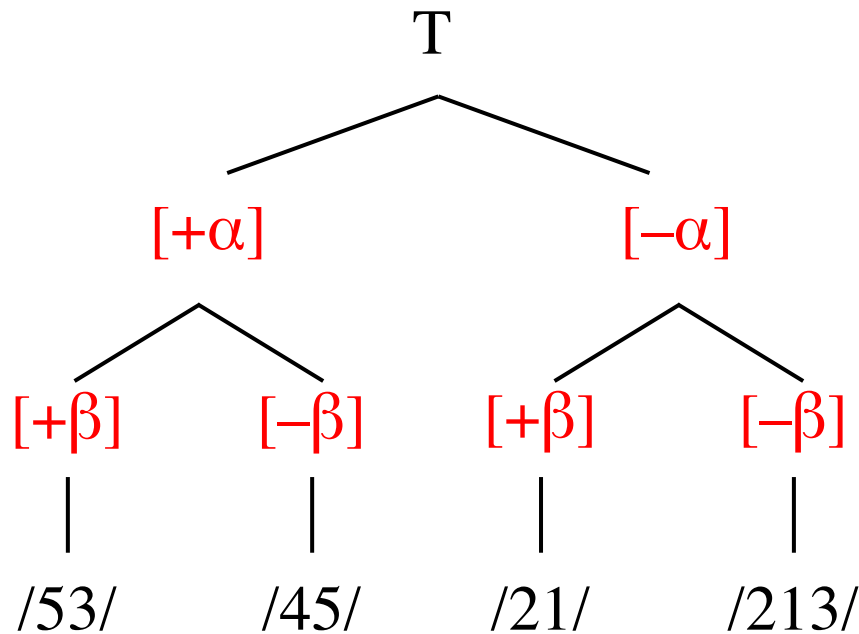
Krekoski (2013) suggests correlates for the features; I do not attempt to assign markedness. [extreme] refers to the periphery of a tonal space, [inner] to a more central region of the space.



# Substance strikes back: Tianjin Mandarin

Following the same methodology, Krekoski posits the tree below for Tianjin Mandarin.

Surprisingly, these tones do **not** correspond as expected with their cognates in Beijing and Pingyao.



Tones /21/ and /53/ are in the 'wrong place' relative to the other dialects that descend from Middle Chinese.

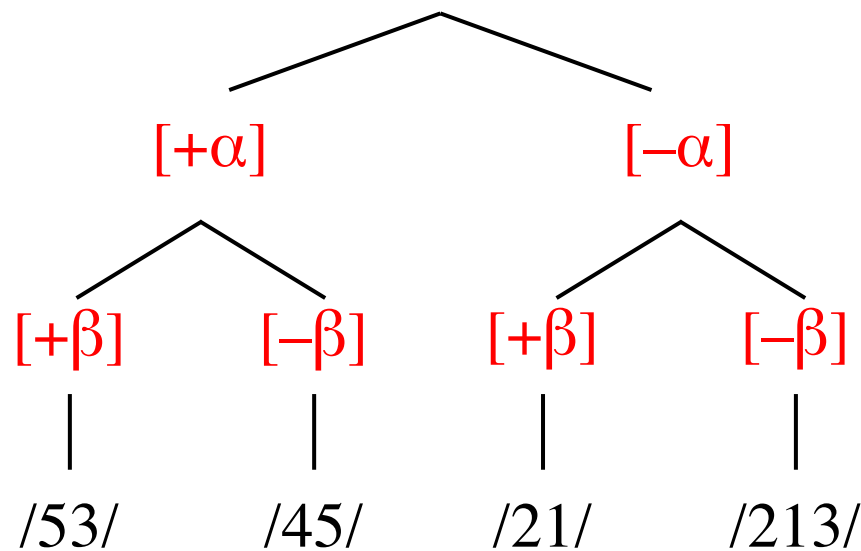
# Substance strikes back: Tianjin Mandarin

Tracing the tones from Middle Chinese, Krekoski proposes that an earlier stage of Tianjin (\*Proto-Tianjin) must have had the hierarchy on the right.

Why did a contrastive shift occur in the history of Tianjin? An answer can be found in the phonetics of the tones.

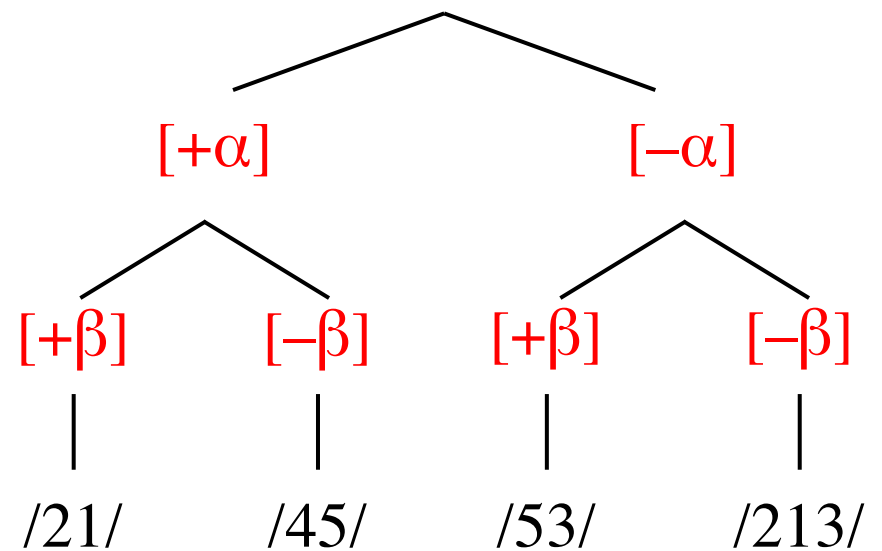
**Modern**

T



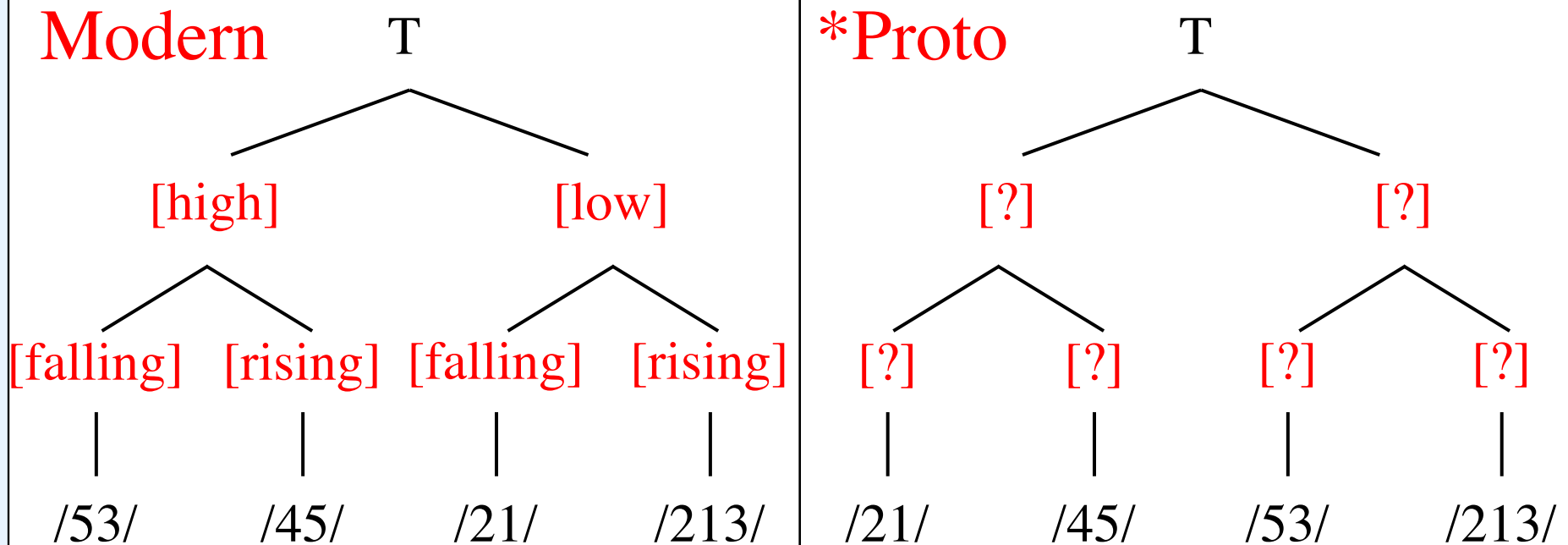
**\*Proto**

T



# Substance strikes back: Tianjin Mandarin

Krekoski observes that it is difficult to find plausible phonetic correlates for the features in \*Proto-Tianjin; whereas the Modern system clearly groups the tones by height. He proposes that “Tonal drift likely accreted changes in height values until the system of contrasts reached some critical inflection point which precipitated the reanalysis of specifications.”



# Substance strikes back: Tianjin Mandarin

---

What this example illustrates is that features may be suggested by patterns of phonological activity, but that phonetic substance has a say also.

Contrastive trees for tonal features can remain stable even as the phonetic realizations of the tones change; but the feature tree is restructured when it gets too out of sync with the phonetics.

Without such a mechanism, we would expect a much greater proliferation of 'crazy rules' than we actually find.

# The hierarchy influences substance

---

While phonetic substance influences the contrastive feature hierarchy, the influence is not all in this direction.

I argued above that the contrastive hierarchy serves as an organizing principle for synchronic phonology, and influences the direction of diachronic changes, such as mergers.

The conclusion is that influence runs in **both** directions.

*Conclusion:*

*Phonology and the  
Faculty of Language*



# Conclusion

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While the approach presented here shares with ‘substance-free’ theories the idea that features are emergent, some of these theories go too far, in my view, in shifting the explanation for phonological patterning to external factors.

In his review of Samuels (2011), Hall (2012: 738) comments:

“the substance-free and the substance-based views are alike in that they both posit functional phonetic explanations for substantive phonological patterns...the two lines of thought, in their different ways, both turn away from the practice of constructing formal explanations for substantive patterns.”

The contrastive feature hierarchy restores the balance between functional and formal explanations, to the extent that it serves as a formal organizing principle of the phonology.

# Conclusion

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More generally, it has been suggested that only syntactic recursion is part of the narrow faculty of language (FLN; Hauser, Chomsky & Fitch 2002), and that phonology is outside FLN.

However, the contrastive hierarchy has a recursive digital character, like other aspects of FLN.

Like syntax, phonology takes substance from outside FLN and converts it to objects that can be manipulated by the linguistic computational system.

The parallels between phonology and syntax may go even further, if it turns out that syntax, too, is in the business of creating contrastive hierarchies of morphosyntactic features (Cowper & Hall, this conference).

# THANK YOU!

For discussions, ideas, and analyses I would like to thank Elizabeth Cowper, Daniel Currie Hall, Paula Fikkert, Ross Godfrey, Christopher Harvey, Ross Krekoski, Will Oxford, Keren Rice, Christopher Spahr, and Zhang Xi, and other members of the project on *Markedness and the Contrastive Hierarchy in Phonology* at the University of Toronto (Dresher and Rice 2007):

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

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October 31–November 1, 2013

CASTL - Center for Advanced Study in Theoretical Linguistics

