Title: Hidden Structure in Linguistics: The Organization of Sound Systems

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Abstract: I

will discuss some basic notions in the theory of phonology (sound systems in language). The sounds of a language are generally assumed to be composed of smaller constituents, called features. The features that make up a sound cannot be directly obtained from its pronunciation, but rather must be inferred from the system of contrasts that are at play in a particular language. How to determine which features are contrastive presents a logical and empirical puzzle that may be interesting to students of physics, who are accustomed to explaining observable events in terms of hidden structures that cannot be directly observed.

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COLLOQUIUM SERIES

January 30, 2013

Hidden Structure in Linguistics: The Organization of Sound Systems

B. Elan Dresher University of Toronto

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2

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Similarly, it is accepted that the ultimate constituents of matter are elements whose existence must be inferred from empirical evidence that is subject to differing interpretations.

I will show that the same is true in linguistics—that the grammars of languages are organized in terms of structures and elements that are not directly observable.

2

This general conclusion is true of all aspects of linguistic structure, but my particular topic will be the organization of speech sounds in language, that is, the theory of phonology.

3

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The features that make up a sound cannot be directly obtained from its pronunciation, but rather must be inferred from the patterns of activity that are at play in a particular language.

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How to determine which features are contrastive presents a logical and empirical puzzle that may be interesting to students of physics.

4

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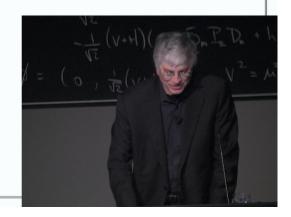
The study of contrast will lead us to discover that features are organized into language-particular hierarchies, which are, for now, among the most covert of hidden structures in linguistics.

4

Plan of the talk

The talk is divided into three parts:

Part 1 is a very brief introduction to some basic notions of phonology, enough to enable us to formulate an interesting hypothesis, whose empirical status, however, at first appears unpromising.



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5

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Part 3 is a short concluding section.

5

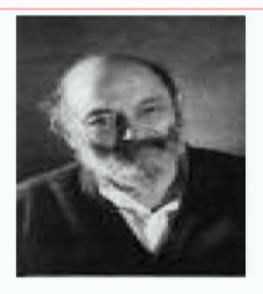
PART 1

A brief introduction to some basic notions of phonology, leading to an interesting hypothesis

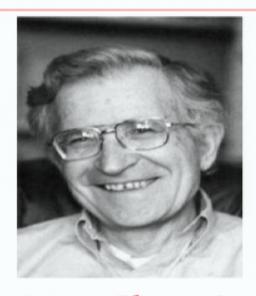
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The Goals of linguistic theory



Morris Halle



Noam Chomsky

Modern linguistics as developed by Chomsky and Halle has two major goals:

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The 1st goal of linguistic theory

1. To characterize a person's knowledge of his or her language.

C

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The 1st goal of linguistic theory

1. To characterize a person's knowledge of his or her language.

In other words, we seek to answer the question: What does a person know when he or she knows a language?

We attempt to summarize this knowledge in a grammar.

Thus, a grammar of a language is a hypothesis about what speakers know about their language.

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The 2nd goal of linguistic theory

2. To explain how speakers acquire their grammar.

This goal requires formulating a theory of the cognitive principles that language learners bring to the task of learning a language.

These principles are collectively called Universal Grammar: they are universal because they must work for any human language that a child might be exposed to;

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and the grammar part refers to the fact that these principles enable us to acquire a grammar.

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Phonology

I will be concerned with that part of the grammar that deals with phonology, the organization of sounds in a language.

10

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Phonology

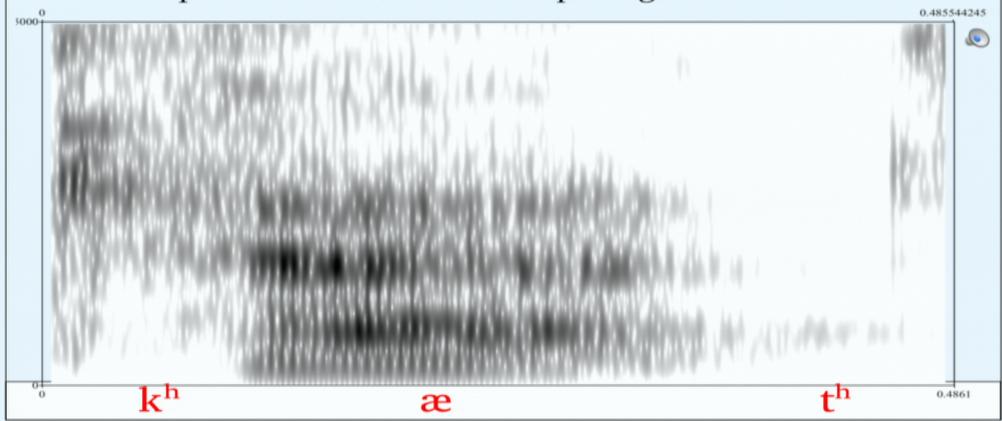
I will be concerned with that part of the grammar that deals with phonology, the organization of sounds in a language.

The study of speech sounds involves abstraction at a number of levels.

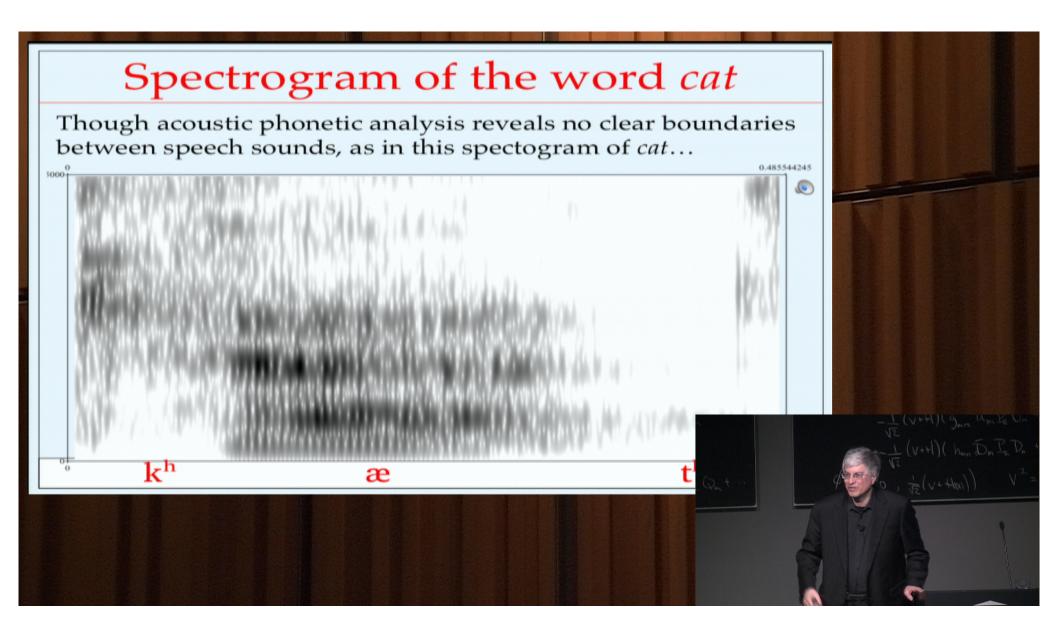
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Spectrogram of the word cat

Though acoustic phonetic analysis reveals no clear boundaries between speech sounds, as in this spectogram of *cat*...



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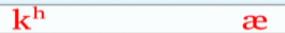
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for purposes of phonology we can consider this word to be made up of three discrete segments, as every speaker of English knows. In phonetic notation: k^h - æ - t^h = $[k^h$ æ $t^h]$.

k^h æ

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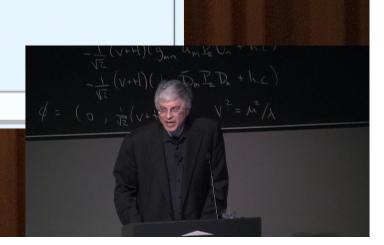




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 $m k^h$ æ



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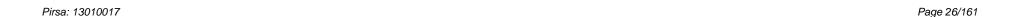
But a very detailed phonetic transcription of sounds, though quite abstract relative to the acoustics, is not yet abstract enough, in that it does not distinguish between those aspects of sounds that are distinctive, and those that are predictable.

k^h æ t^h

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For example, the first sound, k, in cat is followed by a puff of air, called aspiration, denoted h . This aspiration is obligatory in English word-initial k, and is therefore predictable.

cat: [khæth]



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If we put an *s* in front of the *k*,as in *scat*, the puff of air disappears; yet, English speakers consider the *k* sounds in *cat* and *scat* to be instances of the 'same sound' at some level.

cat: [khæth]

scat: [skæth]

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Similarly, the initial sounds in *keel* and *cool* are objectively quite different, because of the vowels that follow them; but again, to English speakers they are instances of the same sound.

cat: [khæth] keel: fronted [kh]

scat: [skæt^h] cool: retracted [kh]

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Many speech sounds that we think of as being the same turn out to have a lot of variation.

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Many speech sounds that we think of as being the same turn out to have a lot of variation.

Consider, for example, how Canadian English *t* is pronounced in a number of different words:

top Aspirated, like k in cat [th]

stop Unaspirated, following s [t]



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<i>top</i>	Aspirated, like k in cat	[t ^h]
	**	F. 7

stop Unaspirated, following s [t]

cat Could be lightly aspirated, or unreleased [th] or [t7]

not you Palatalized due to the following y [t^j]



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top	Aspirated, like k in cat	[tʰ]
stop	Unaspirated, following s	[t]
cat	Could be lightly aspirated, or unreleased	$[t^h]$ or $[t^{\gamma}]$
not you	Palatalized due to the following y	[t ^j]
trap	Retroflexed due to the following r	[t]



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not you	Palatalized due to the following y	[t ^j]
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latter	Flapped between vowels after stress	[t]

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<i>trap</i>	Retroflexed due to the following r	[t]
latter	Flapped between vowels after stress	[r]
two	Rounded due to the following vowel	[t ^w]

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The notion 'same sound' All these sounds are phonetically different. [th] [t] [t] [tj] [t] [r] [tw] Phonetic representation

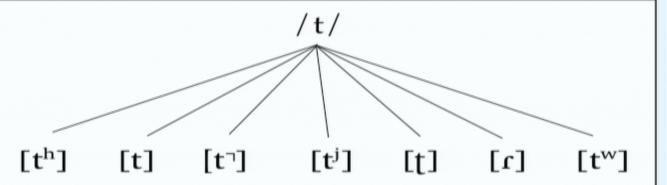
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All these sounds are phonetically different.

But at the level of mental lexical representation, they are all instantiations of the 'same sound' in English, a sound we can designate /t/.

Lexical or phonemic representation

Phonetic representation



The notion 'same sound'

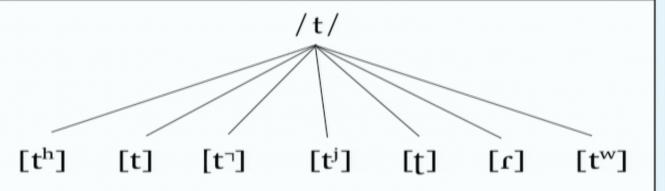
All these sounds are phonetically different.

But at the level of mental lexical representation, they are all instantiations of the 'same sound' in English, a sound we can designate /t/.

In other words, they are all allophones (variants) of a single phoneme.

Lexical or phonemic representation

Phonetic representation



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Phonemes

Phonemes are the (abstract) sounds that contrast in a language.

In English, /t/ contrasts with phonemes /d/, /k/, /s/, /n/, among others.

Some English phonemes

/t/

/d/

/k/

/s/

/n/

tick

Dick

kick

sick

Nick

bat

bad

back

bass

ban

Phonemes

Phonemes are the (abstract) sounds that contrast in a language.

In English, /t/ contrasts with phonemes /d/, /k/, /s/, /n/, among others.

These contrasts are language particular: there are languages in which some of these sounds may be allophones of a single phoneme; conversely, sounds which are allophones in English may be separate phonemes in other languages.

Some English phonemes

/t/ /d/

/k/

/s/

/n/

tick

Dick

kick

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bat

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back

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Phonemes are not irreducible primitives; groups of phonemes that share one or more properties form classes that pattern in similar ways in a language.

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Phonemes are not irreducible primitives; groups of phonemes that share one or more properties form classes that pattern in similar ways in a language.

For example, phonemes /p/, /t/, /k/, /f/, $/\theta/$ are all voiceless sounds (produced without vocal cord vibration); when a noun ends with one of these sounds, its plural is pronounced [s].

Nouns ending in voiceless phonemes take plural [s]

/p/ /t/ /k/

tips nuts sacks

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/p/ /t/ /k/ /f/ $/\theta/$

tips nuts sacks puffs baths

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Phonemes /b/, /d/, /g/, /v/, /n/ are all voiced sounds (produced with vocal cord vibration); when a noun ends with one of these sounds, its plural is pronounced [z].

The spelling here is deceptive: English spelling does not need to mark this difference, and spells all plurals with s (but note newer spellings like girlz, boyz, etc., which indicate the [z]).

Nouns ending in voiced phonemes take plural [z]

/b/

/d/

/g/

 $/\mathrm{v}/$

/n/

tabs

buds

rags

doves

pans

A third group of s-like sounds take plurals in [z] separated by a vowel called schwa, represented as [a] and written e.

Nouns ending in sibilant phonemes take plural [əz]

/s/

/z/

/ʃ/

/t∫/

/d3/

busses

mazes

rashes

batches

badges

A third group of s-like sounds take plurals in [z] separated by a vowel called schwa, represented as [a] and written e.

These sounds are called sibilants, and the plural rule shows that they act like a class in English.

Nouns ending in sibilant phonemes take plural [əz]

/s/

/z/

/ [/

/tʃ/

 d_{3}

busses

mazes

rashes batches

badges

Distinctive features

To capture the fact that phonemes pattern as members of classes, it has been supposed that phonemes are composed of distinctive features, which express contrastive properties of phonemes.

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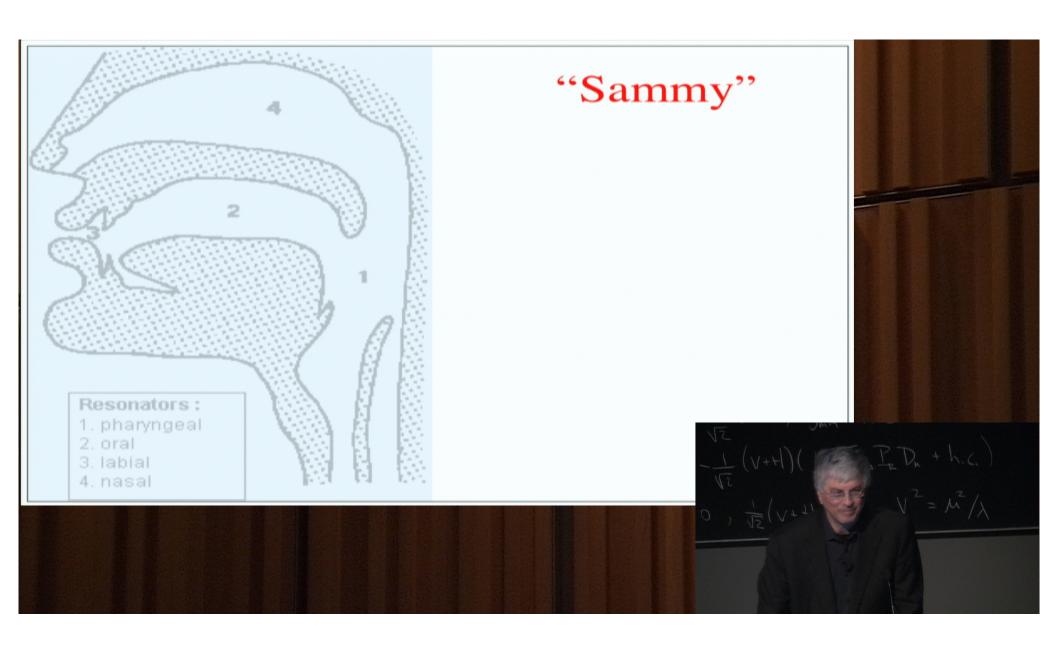
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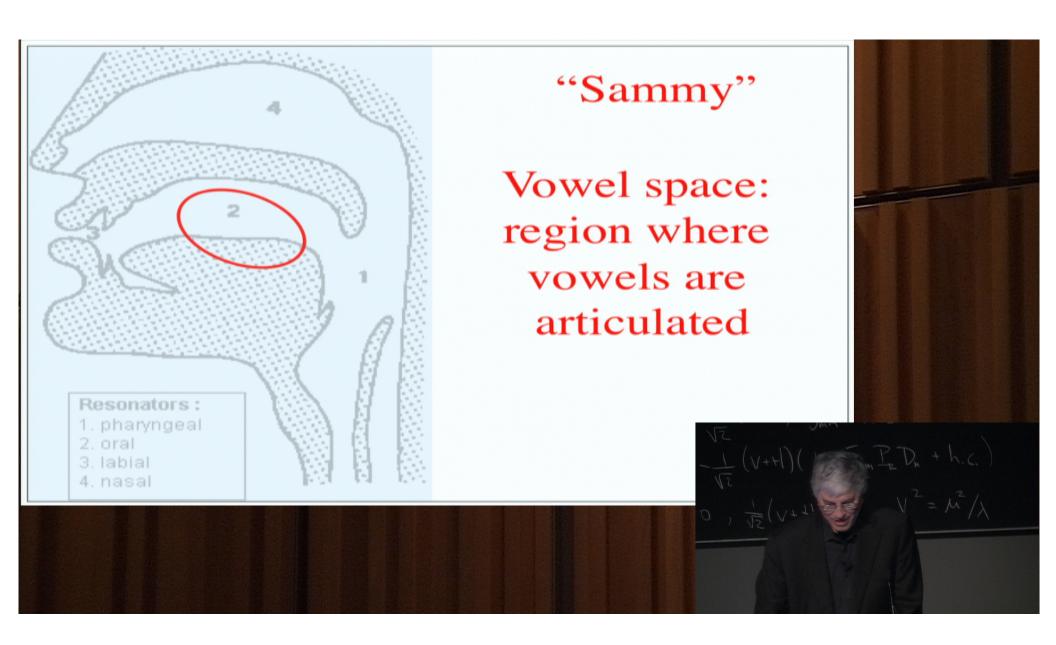
For example, the English plural suggests that the feature [voiced] is relevant, or active, in English, as is a feature or group of features that demarcate sibilants.

It is commonly assumed that features are binary, expressing the presence or absence of a property. Hence, voiced consonants have the feature [+voiced], and voiceless consonants are [-voiced].

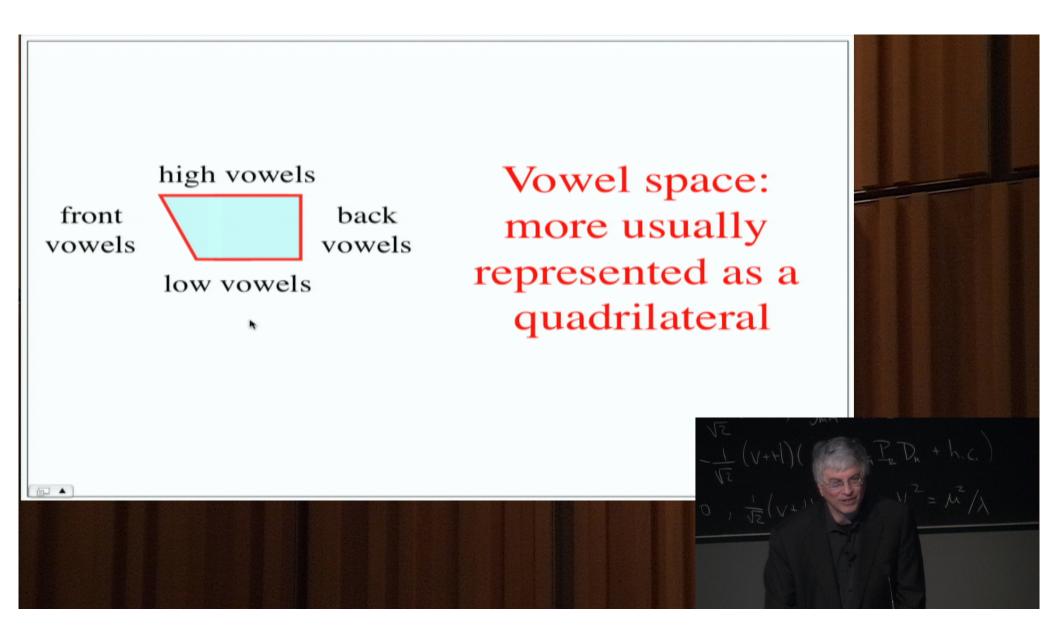
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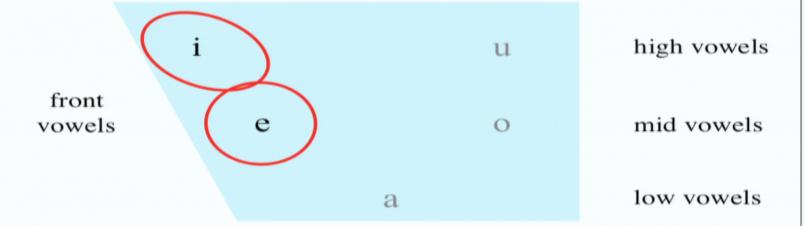
The vowel space Vowels tend to be pronounced over a region of the vowel space. i high vowels u front vowels mid vowels low vowels a

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The vowel space

Vowels tend to be pronounced over a region of the vowel space.

For example, a language might have two vowel phonemes /i/ and /e/ that can be pronounced various ways, as long as they remain distinct from each other and from other vowels.



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"dans la langue il n'y a que des différences"

The notion of contrast has been central to linguistics since Ferdinand de Saussure (late 19th–early 20th century).



Ferdinand de Saussure, Cours de linguistique générale ([1916] 1972:166)

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"dans la langue il n'y a que des différences"

The notion of contrast has been central to linguistics since Ferdinand de Saussure (late 19th–early 20th century).

He is famous for the dictum that in language, there are only differences (contrasts). Further:

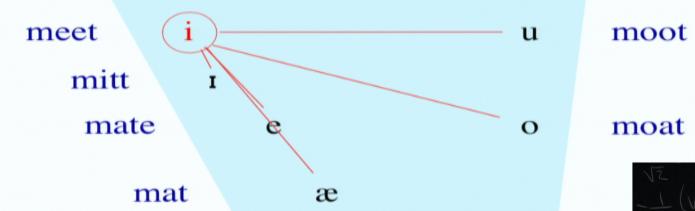


Ferdinand de Saussure, Cours de linguistique général 1972:166)



That is, a phoneme is identified not only by its positive characteristics – for example, the fact that it sounds like [i], as in *meet...*

but also by what it is **not** — that is, by the sounds it contrasts with. In English, /i/ is different from /I/, /e/, /æ/, /o/, and /u/, among other vowels.



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Many languages, such as Modern Hebrew, do not make a distinction between phonemes /i/ and /I/, as English does.

meet i mitt I

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Many languages, such as Modern Hebrew, do not make a distinction between phonemes /i/ and /I/, as English does.

Speakers of such languages tend to have a single phoneme in this region, with the result that, when speaking English, words like *meet* and *mitt* may sound the same.

meet i i



Classes of vowels

It is one thing to determine that two vowels are in contrast in a particular language; we also need to know with respect to which features they are in contrast.

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As with consonants, vowels participate in classes that are referred to by the phonology.

A simple example is the vowel system of Yowlumne Yokuts (Newman 1944, Kuroda 1967), a Native American language spoken in California.

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Yowlumne has four vowel phonemes. These vowels participate in vowel harmony, as follows:

/u/

/0/

/a/

/i/

Yowlumne has four vowel phonemes. These vowels participate in vowel harmony, as follows:

When the first vowel in a word is u, it causes a subsequent i to change to u. An example is the suffix -nit, which appears as -nut when a u precedes. Note that o does not affect i.

/i/ /u/
/o/
/a/

Future passive suffix -nit

xil-nit 'tangle'

hud-nut 'recognize'

gop-nit 'take care of'

max-nit 'procure'

Yowlumne has four vowel phonemes. These vowels participate in vowel harmony, as follows:

When the first vowel in a word is o, it causes a subsequent a to change to o. An example is the suffix -al, which appears as -ol when an o precedes. a is not affected by a preceding u.

/i/ /u/
/a/

Dubitative suffix -al

xil-al 'tangle'
hud-al 'recognize'
gop-ol 'take care of'
max-al 'procure'

Vowel harmony shows that we need to divide the vowels into two height classes: [+high], which includes /i/ and /u/, and [-high], which includes /a/ and /o/.

/i/ /u/ [+high]
/o/
[-high]

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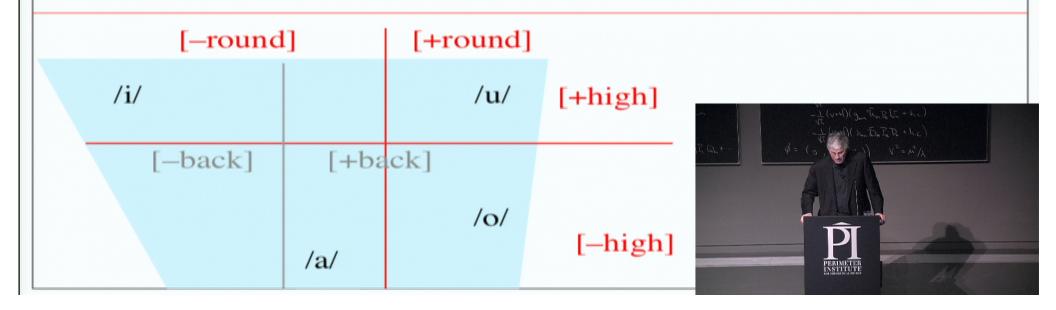
The other feature we need to describe harmony is [round]: /u/and /o/ are both [+round], characterized by lip rounding; /i/and /a/ are [-round].

It follows that the features [high] and [round] are active in this language, in the sense that the phonology refers to them.

[–roun	d] [+rou	ind]		
/i/	/	/u/	[+high]	- VZ
	/a/	/o/	[–high]	$\frac{1}{\sqrt{2}}(V+H)(V+H)(V+H)(V+H)(V+H)(V+H)(V+H)(V+H)$

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In particular, Yowlumne phonology does not refer to the feature [back], which makes a distinction between [-back]/i/and the other vowels, /a/, /o/, and /u/, which are [+back].



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In particular, Yowlumne phonology does not refer to the feature [back], which makes a distinction between [-back] /i and the other vowels, /a/, /o/, and /u/, which are [+back].

That is, [back] is not active in Yowlumne Yokuts, nor is it needed to draw contrasts between the vowels.

l.	[–round]	[+round]		
	/i/		/u/	[+high]	- 1 (V+H) (g - To b, Z Tr + h, c) - 1 (V+H) (hon Dn Tr Dr + h, c)
	[-back]	[+ba /a/	.ck] /o/	[–high]	PERIMETER INSTITUTE

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Japanese has five vowel phonemes, /i, e, a, o, u/.

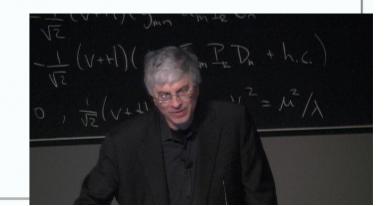
/i/ /u/
/e/ /o/



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According to Trubetzkoy (1939), lip rounding is not active in Japanese, though / u/ and / o/ are phonetically round.

/i/ /u/
/e/ /o/



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According to Trubetzkoy (1939), lip rounding is not active in Japanese, though /u/and/o/are phonetically round.

Rather, Japanese vowels are divided by [back].

[-back]	[+back]
/i/	/u/
/e/	/0/
	/a/

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According to Trubetzkoy (1939), lip rounding is not active in Japanese, though /u/and/o/are phonetically round.

Rather, Japanese vowels are divided by [back].

[-back]	[+back]	
/i/	/u/	Trubetzkoy proposes that this feature accounts for why palatalized and non-
/e/	/0/	palatalized consonants fall together (are neutralized) before /i/ and /e/ in
	/a/	Japanese.

To complete the specification of these vowels we can add two height features, which we can designate as [high] and [low].

[-back]	[+back]	
/i/	/u/	[+high]
/e/	/o/	[-high]
	/a/	[+low]

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Japanese vowels

To complete the specification of these vowels we can add two height features, which we can designate as [high] and [low].

On this analysis, the feature [round] is neither active nor contrastive in the Japanese vowel system.

[–back]	[+ba	ack]		
/i/		/u/	[+high]	
/e/	id]	[+round] /o/	[-high]	
	/a/		[+low]	

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Turkish vowels

A final example of how phonology operates on vowel classes is the eight-vowel system of Turkish (Nevins 2010).

ü i u

e ö o

a 39

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Turkish vowels

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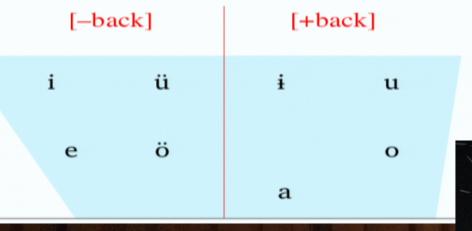
Traditional analyses posit that both the features [back] and [round] are required to characterize the phonology, as well as a single height feature [high].

	[–back] [–round] [+round]		[+back] [–round] [+round]		
[+high]	i	ü	i	u	
	e	ö		o	
[—high]			a		

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Turkish vowel harmony

The rationale for these specifications: All vowels in a word must be either [-back] or [+back] (backness harmony); therefore, all vowels must have specifications for this feature.



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Turkish vowel harmony

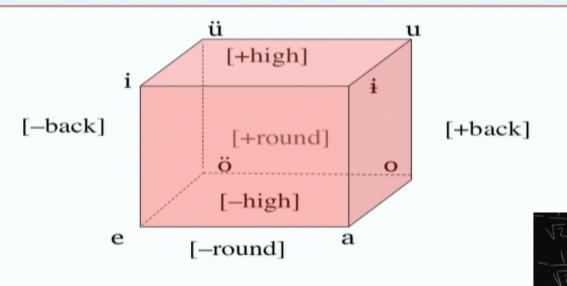
Turkish also has rounding harmony, whereby high vowels become round after round vowels. Hence, vowels must be specified for [round] and [high].

	[-round]	[+round]	[-round]	[+round]
[+high]	i	ü	i	u
[–high]	e	ö	a	О

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Turkish vowels

Each of these feature specifications is also contrastive, because the vowels completely fill the $2^3 = 8$ cell vowel space created by these 3 binary features.



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Turkish vowels

The feature [low] does not play a role in Turkish, despite the fact that /a/ is phonetically lower than the other vowels.

	[-back] [-round] [+round]		[+back] [–round] [+round	
[+high]	i	ü	i	u
[–high]	e	ö		О
			a	

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So far, I have made the following points:

 The flow of speech sounds can be segmented into discrete speech sounds, or segments (e.g. [khæth] for the word cat)

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 The evidence for features is that they organize phonemes into classes that the phonology operates on (e.g. the English plural is sensitive to the feature [voiced], round harmony targets [round], etc.).



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- Such features can be said to be phonologically active, in the sense that they play a role in phonological generalizations, rules, or constraints.
- Features are also required to make contrasts between phonemes. By definition, every phoneme in an inventory must have a unique set of feature specifications.

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Is there a relationship between contrast and activity?

At this point, you may have noticed a certain correlation between those distinctive features that are active in a language, and those that are contrastive.

Many phonological theorists over the years have had the intuition that contrastive features are particularly important to the patterning of sound systems.

Some have considered the hypothesis that only contrastive features are 'visible' to the phonology.

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Some have considered the hypothesis that only contrastive features are 'visible' to the phonology.

Hall (2007: 20) calls this Contrastivist Hypothesis:

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

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Is this hypothesis correct? It would be interesting if it were. The late G. N. Clements, an influential phonologist, reflected on this hypothesis (he didn't give it a name) as follows:

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In other words, only contrastive features can be active in phonological processes.

Is this hypothesis correct? It would be interesting if it were. The late G. N. Clements, an influential phonologist, reflected on this hypothesis (he didn't give it a name) as follows:

"This hypothesis is attractive in that, if true, it would place strong constraints on the nature of feature representation." (Clements 2001: 79)

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Clements concluded, however, that the Contrastivist Hypothesis is too strong: that there are cases where non-contrastive features can be shown to be active.

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This remains the view of many phonologists: that while active features may tend to be contrastive, not all of them are, and that there are rules that target non-contrastive features.

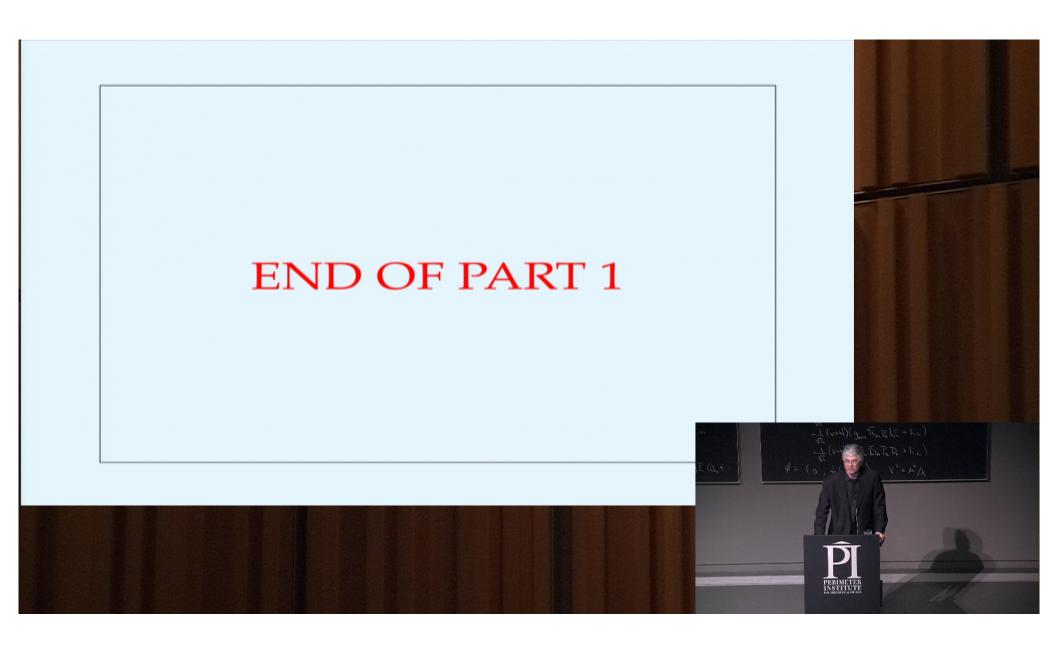
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This remains the view of many phonologists: that while active features may tend to be contrastive, not all of them are, and that there are rules that target non-contrastive features.

So, is this the end of the Contrastivist Hypothesis? Not quite,

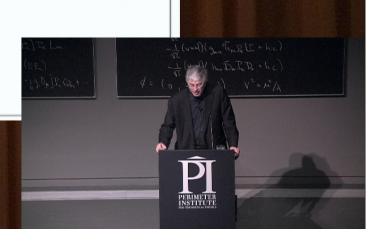
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Before we give up on the Contrastivist Hypothesis, let's consider more closely what it would take to falsify or support it.

The hypothesis states that only contrastive features can be active in phonological processes.



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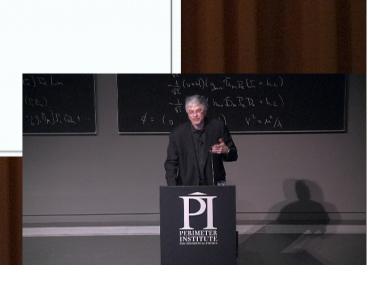
To test if this is so, we need to be able to identify which features are active in a given language, and which are contrastive, and then see if the two sets coincide.

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Identifying active features

Identifying which features are active is relatively, though not completely, straightforward.

Activity can be observed, for example, in the English plural rule and in Turkish vowel harmony.



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There is of course room to disagree about what exactly the relevant features are, and about what the mechanisms behind these processes are, and about whether certain phenomena qualify as 'activity' or as something else.

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There is of course room to disagree about what exactly the relevant features are, and about what the mechanisms behind these processes are, and about whether certain phenomena qualify as 'activity' or as something else.

Nevertheless, the basic concept of activity is reasonably well understood, enough for our purposes, at any rate.

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Let us consider now the other crucial term in the Contrastivist Hypothesis:

To see if in fact all the active features in a language are contrastive, we need to be able to identify which features are contrastive and which are non-contrastive.

How do we identify contrastive features? When we search through the literature, we find a remarkable lack of explicit answers to this fundamental question.

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Let us consider now the other crucial term in the Contrastivist Hypothesis:

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How do we identify contrastive features? When we search through the literature, we find a remarkable lack of explicit answers to this fundamental question.

Remarkable, because the notion of contrast has been at the heart of linguistic theory for over a hundred years.

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After some investigation, I found that there have been two main approaches to determining contrastive features.

Both have a certain initial intuitive appeal. However, they are not notational variants, because they yield different and incompatible results.

Therefore, they cannot both be right, and I think I can prove that one of them is certainly wrong.

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Both have a certain initial intuitive appeal. However, they are not notational variants, because they yield different and incompatible results.

Therefore, they cannot both be right, and I think I can prove that one of them is certainly wrong.

Finding the right way to determine contrast has empirical consequences; but it is, to begin with, a logical problem.

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Two Theories of Contrast

- Approach 1: Extraction of contrastive features from full specifications via *minimal pairs*, looking for *minimal contrasts*.
- Approach 2: Derivation of contrastive features by successively splitting the inventory by a *hierarchy* of features

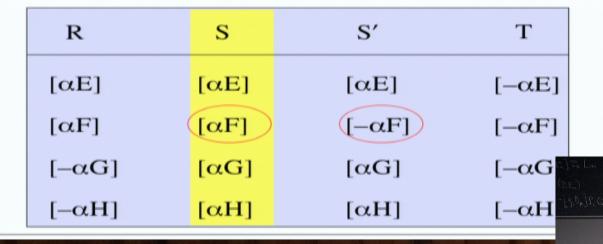
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A segment S with specification αF is *contrastive* for F if there is another segment S' in the inventory that is featurally identical to S, except that it is $-\alpha F$.

Nevins (2010: 98)

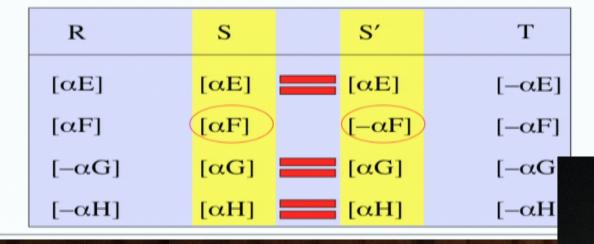


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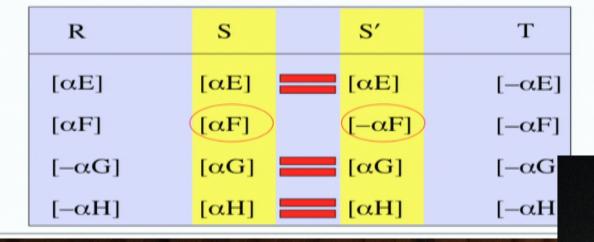


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French /pb m/ (Martinet 1964: 64)

This is how Martinet arrived at contrastive specifications for the French bilabial consonants. Assume that the relevant features are [voiced] and [nasal].

Begin with their full specifications for these features:

p b m
voiced - + +
nasal - - +

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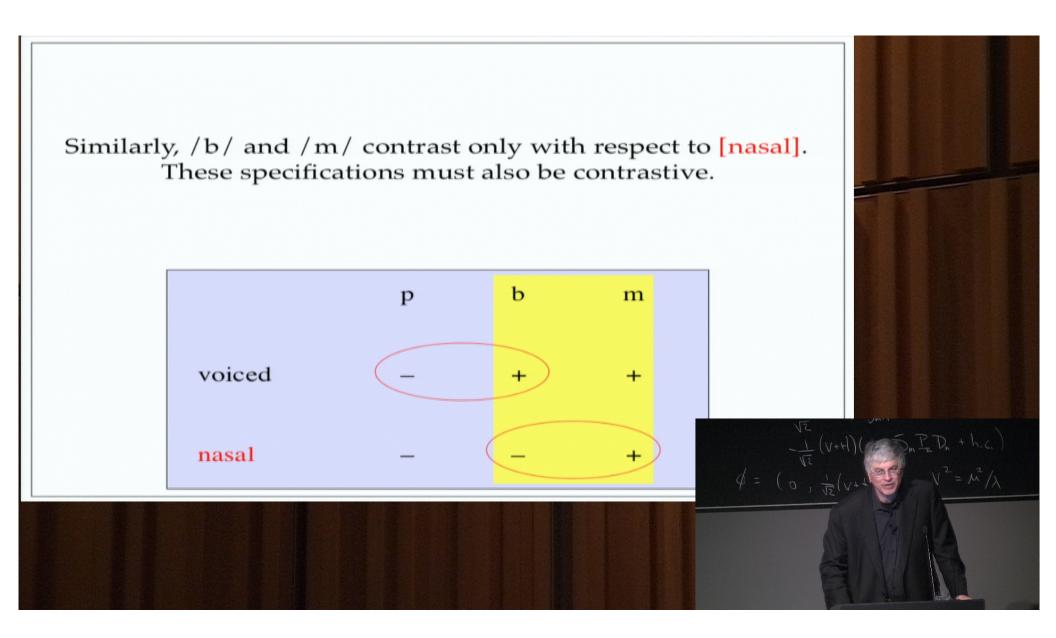
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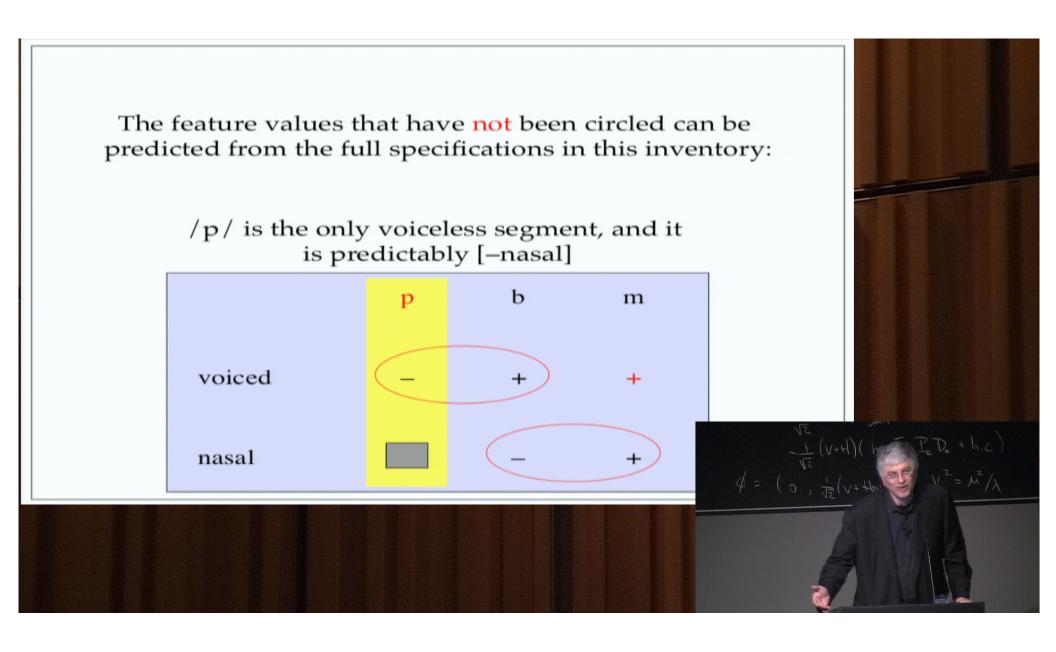
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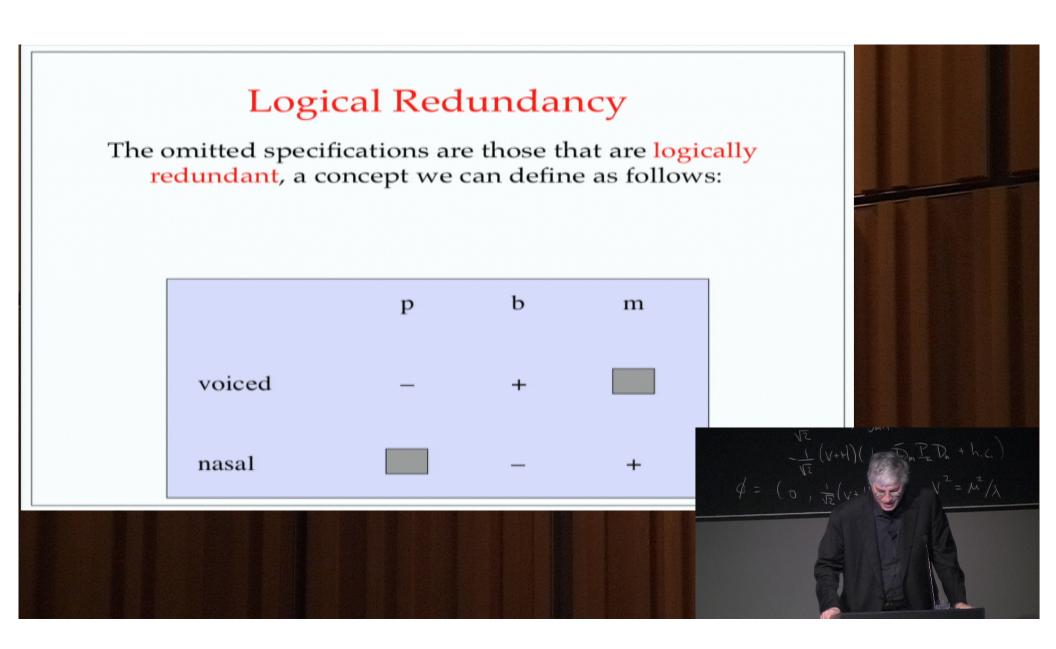
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Logical Redundancy

The omitted specifications are those that are logically redundant, a concept we can define as follows:

If Φ is the set of feature specifications of a member, M, of an inventory, then the feature specification [f] is logically redundant iff it is predictable from the other specifications in Φ .

	M	N	О	P	Q
	a	ь	с	d	e
0	f	g	h	i	j
	k K	1	m	n	О
	p	q	r	s	t

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Minimal pairs approach: Problems

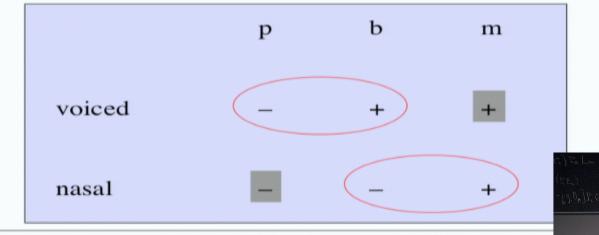
 Logical redundancy is an insufficient foundation upon which to base a general theory of contrast.



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The problem with relying on logical redundancy is that in many cases it does not provide a contrastive specification, because there are not enough minimal pairs in the inventory.

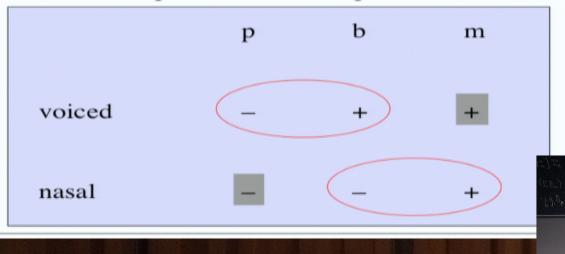


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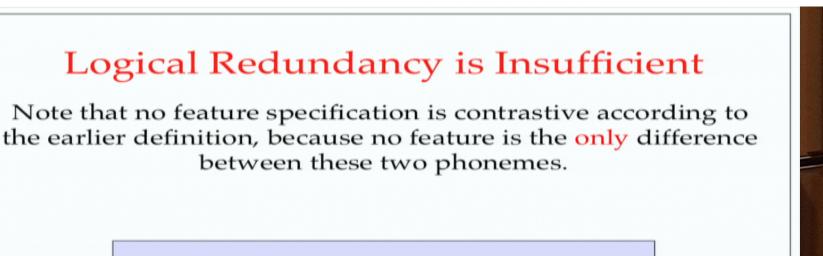


The problem with relying on logical redundancy is that in many cases it does not provide a contrastive specification, because there are not enough minimal pairs in the inventory.

In this inventory /b/ participates in a minimal pair with both /p/ and /m/:



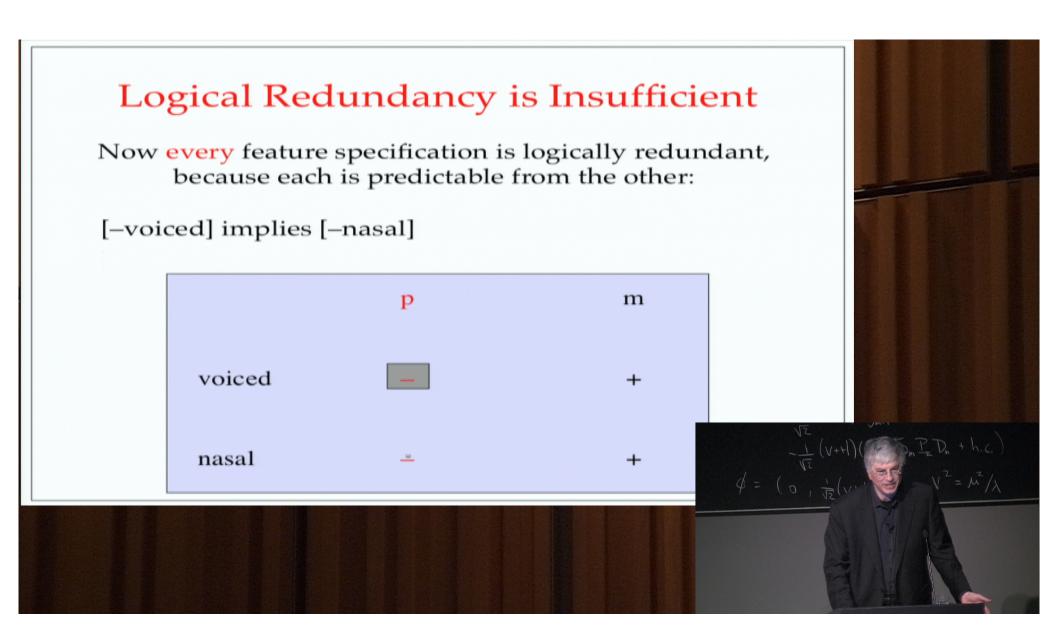
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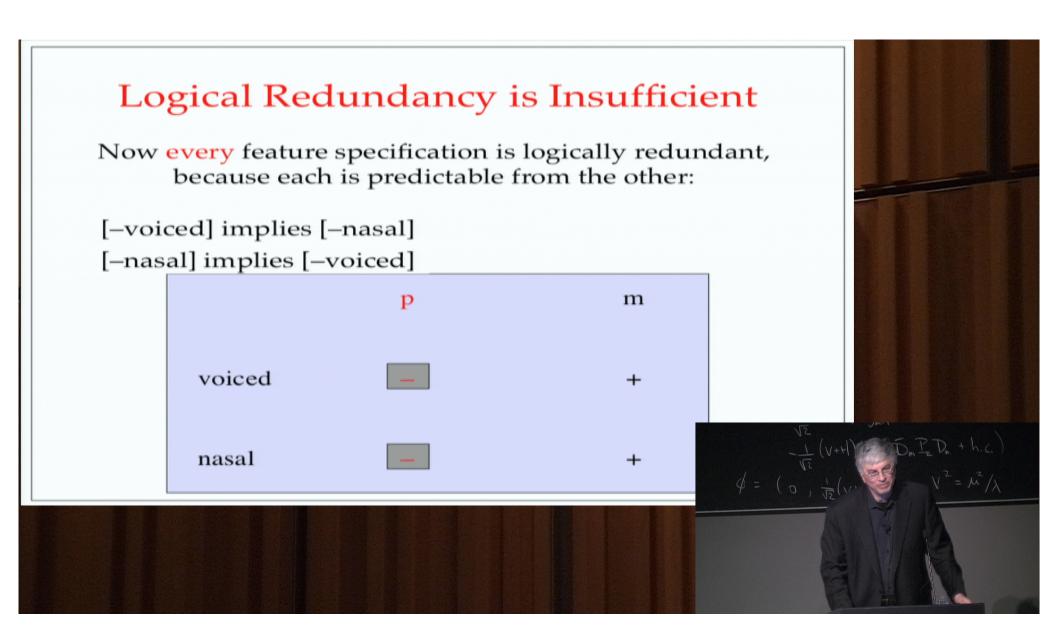
p m
voiced – +



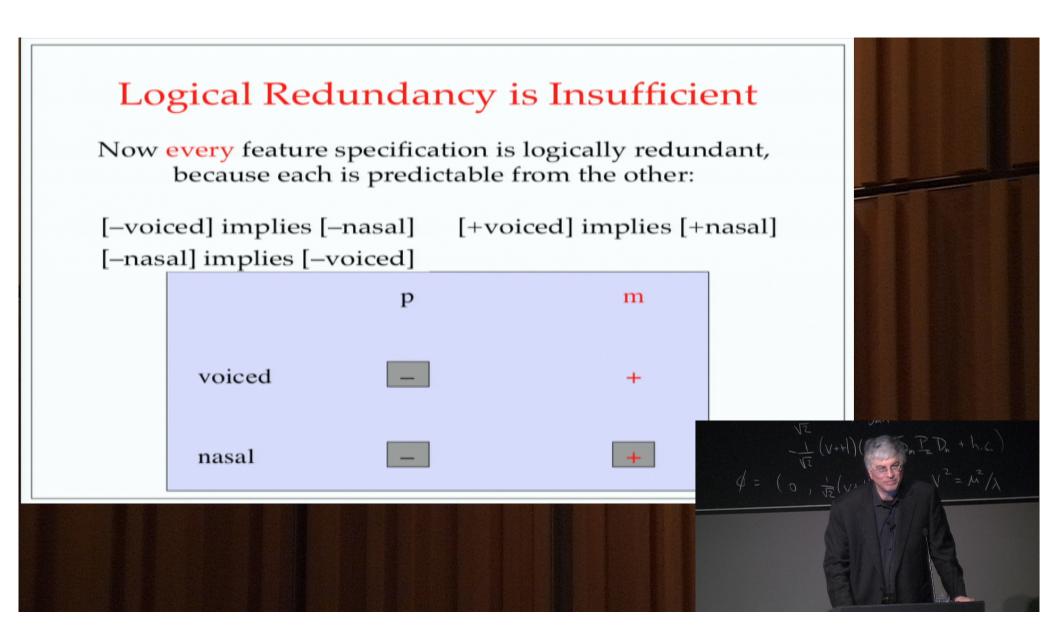
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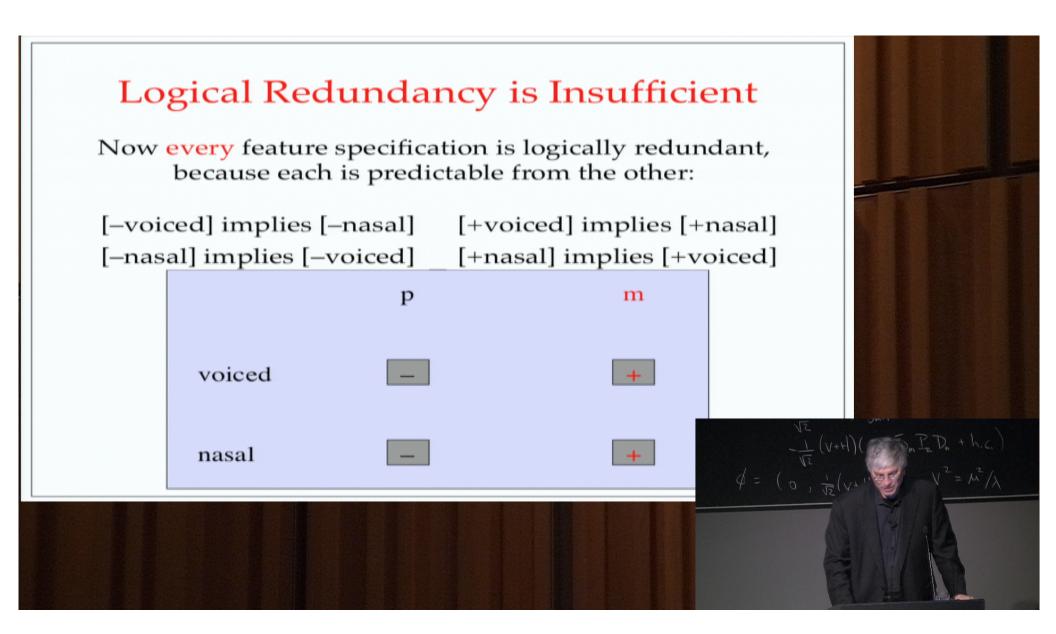
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Logical Redundancy is Insufficient

Now every feature specification is logically redundant, because each is predictable from the other.

We have to decide by some other means which feature takes precedence, whether voicing or nasality is more important.

p m
voiced – +
nasal – +

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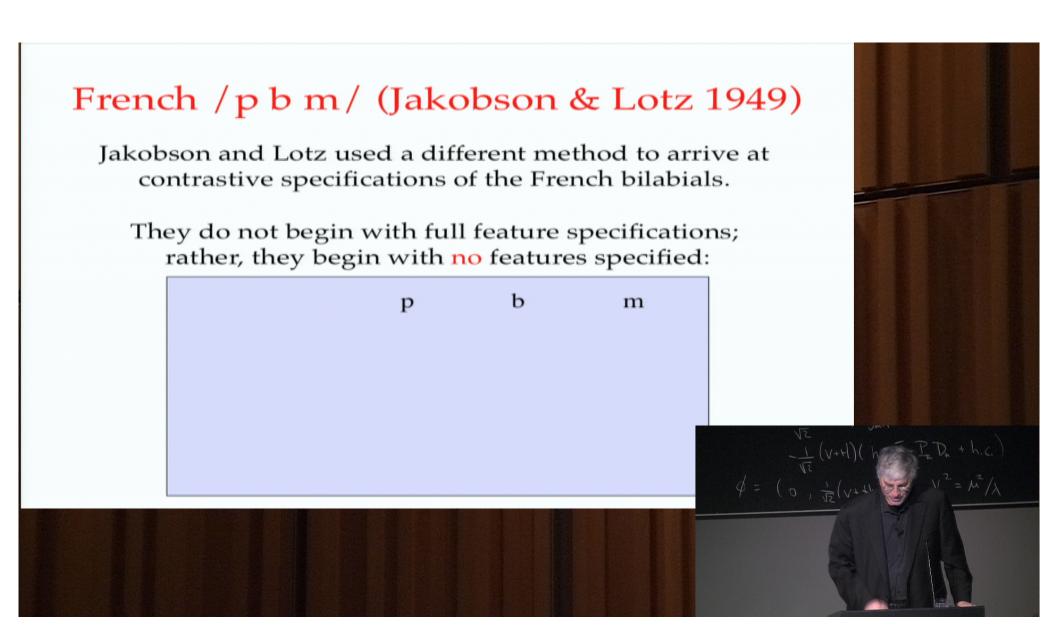
p m
voiced – +
nasal – +

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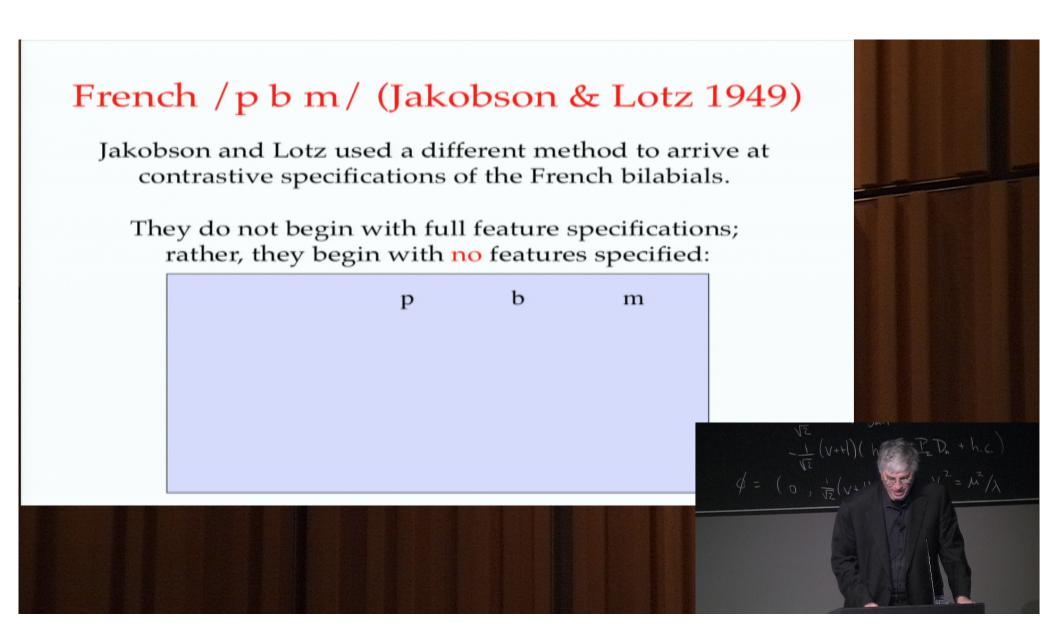
Contrastive specification by a hierarchy of features

The second main approach to determining contrastive features takes precedence as its main property. This approach assigns precedence relations by ordering the features.

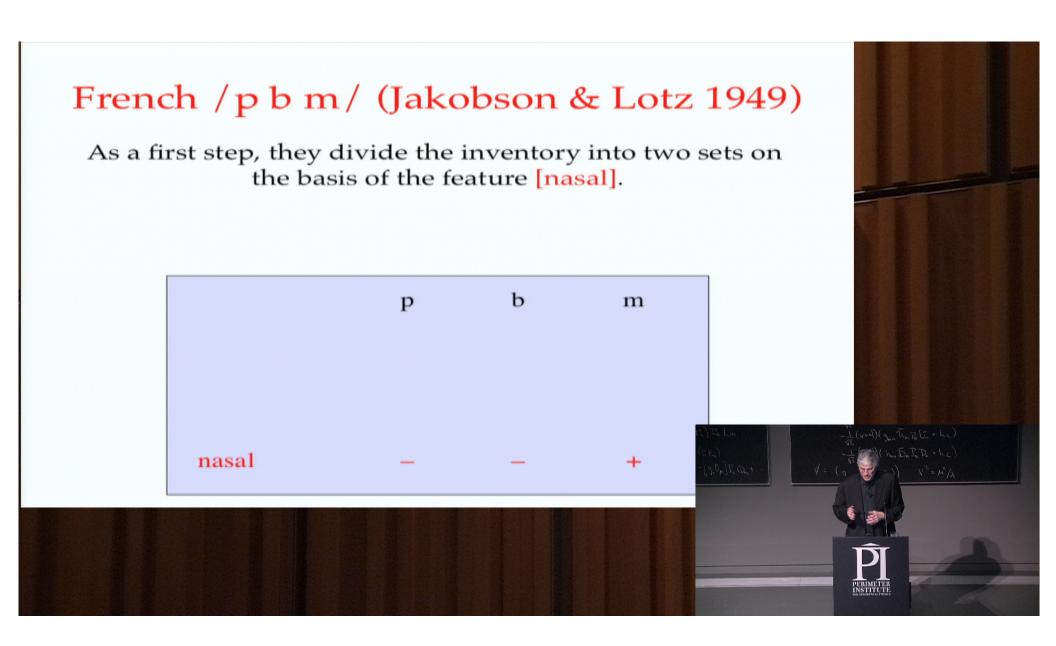
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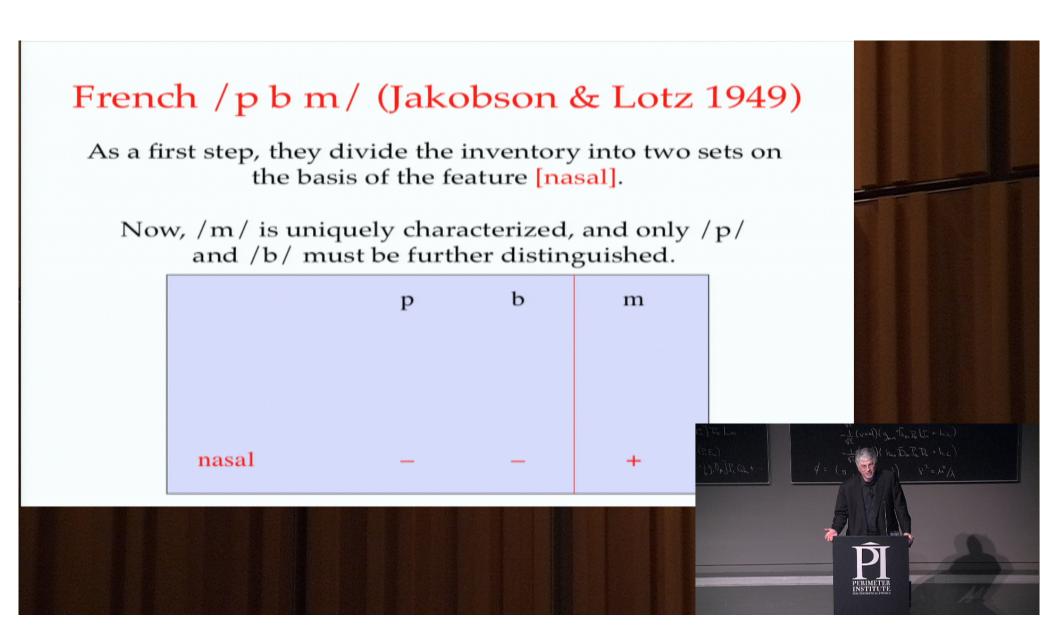
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In this approach, the ordering of the features is crucial. The specifications below are the result of ordering [nasal] ahead of [voiced]. In other words, [nasal] has wider scope than [voiced].

Ordering: [nasal] > [voiced]

p b m

voiced - +

nasal - - +



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Contrast by Feature Ordering

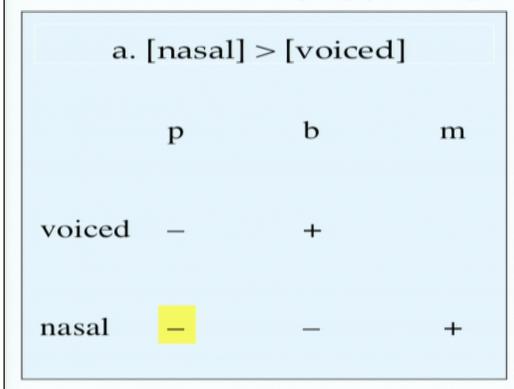
[nasal] would then be relevant only to the [+voiced] set.

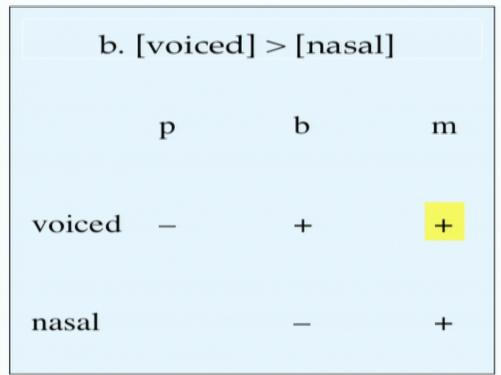
Ordering: [voiced] > [nasal]

	р	ь	m
voiced	_	+	+
nasal		_	+

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Two Contrastive Hierarchies



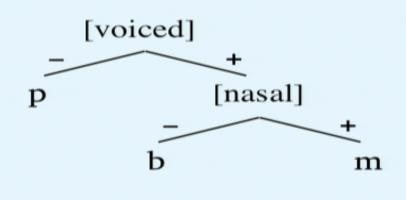


Though every omitted specification is of necessity logically redundant, neither ordering omits all logically redundant specifications. On this approach, logical redundancy is simply not the definition of phonological redundancy.

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Two Contrastive Hierarchies

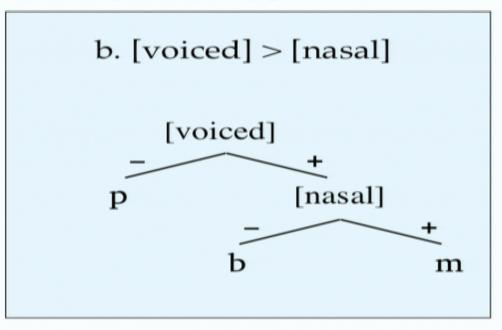
b. [voiced] > [nasal]



Another way to represent these different orderings is in terms of trees. The two orders suggest different phonemic organizations:

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Two Contrastive Hierarchies



Another way to represent these different orderings is in terms of trees. The two orders suggest different phonemic organizations:

In (a), /p/ and /b/ are more closely related to each other than to /m/; in (b), /b/ and /m/ are grouped together. We might expect that these differences will be reflected in the phonology.

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Contrastive specification by a hierarchy of features

- The same simple example
- No problem with this method

Unlike the first approach, this method is guaranteed to yield a well-formed set of contrastive representations, in which every segment is distinct from every other one.

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Contrastive specification by a hierarchy of features

- The same simple example
- No problem with this method
- But it does pose a question

However, this method requires us to put the features in an order, which raises the question: where does the ordering compercine?

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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.

A solution is suggested by the Contrastivist Hypothesis:

If only contrastive features can be active in phonological processes, then it follows from this that a heuristic principle for identifying contrastive features is: Assume that active features are contrastive.

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If only contrastive features can be active in phonological processes, then it follows from this that a heuristic principle for identifying contrastive features is: Assume that active features are contrastive.

Therefore, for each language, we should try to construct contrastive feature hierarchies that give the best account of phonological activity in that language.

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The Contrastivist Hypothesis again

What about the fact that many phonologists think that the Contrastivist Hypothesis is too strong?

My contention is that the hypothesis has not been put to a fair test, because of wrong assumptions about what the contrastive features are.

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The Contrastivist Hypothesis again

What about the fact that many phonologists think that the Contrastivist Hypothesis is too strong?

My contention is that the hypothesis has not been put to a fair test, because of wrong assumptions about what the contrastive features are.

The Minimal Contrast approach based on logical redundancy, despite its flaws, is still employed by many phonologists. It is relevant to note that this method systematically designates too few features as contrastive, where it works at all.

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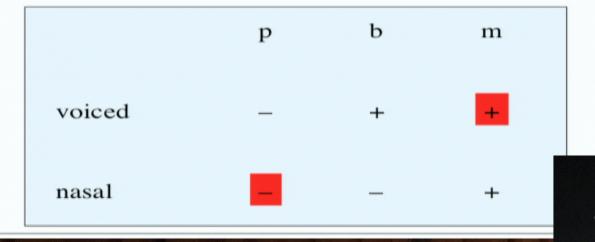
Recall that Minimal Contrast identifies the four features shown below as being contrastive in this inventory; the two blacked out features are considered non-contrastive.

p b m
voiced - + +

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If one of the features in red is active, a phonologist following Minimal Contrast would interpret it as a non-contrastive feature, hence a counterexample to the Contrastivist Hypothesis.



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Yowlumne Yokuts vowels

The contrastive hierarchy can account for the patterning of Yowlumne Yokuts vowels by ordering the features [high] and [round] at the top of the hierarchy.

[–round]	[+round]	
/i/ [+high]	/u/	[high]
[—high] /a/	/o/	-/-\t

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Yowlumne Yokuts vowels

The contrastive hierarchy can account for the patterning of Yowlumne Yokuts vowels by ordering the features [high] and [round] at the top of the hierarchy.

We now predict that no other features should be active in this language.

[-round]	[+round]	
/i/ [+high]	/u/	[high]
[—high] /a/	-/	-/////

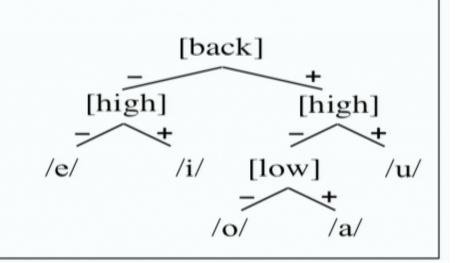
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Japanese vowels

Minimal Contrast would treat every five-vowel system in the same way, but evidence from activity shows considerable variation.

The Japanese pattern can be represented by ordering the features [back] > [high] > [low].

[-back]		[+back]
/i/		[+high] /u/
	/e/	[–high] /o/ [–low]
		/a/ [+low]



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Ordering in Turkish Vowels

Ordering is also implicit in the traditional analysis of Turkish vowels.

The features [high], [back], and [round] are ordered ahead of [low] and other possible features.

	[-back]		[+back]		
	[-round]	[+round]	[–round]	[+round]	
[+high]	i	ü	i	u	
[–high]	e	ö	a	О	97

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I have argued the following points:

- Phonologists have not been clear about how to determine which features are contrastive in any given case.
- Of the two methods for determining contrast, the Minimal Contrast method is logically flawed and can be shown to fail in many types of situations.

99

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I have argued the following points:

- Phonologists have not been clear about how to determine which features are contrastive in any given case.
- Of the two methods for determining contrast, the Minimal Contrast method is logically flawed and can be shown to fail in many types of situations.
- The other method, which assigns contrast by means of a feature hierarchy, appears to be logically sound.

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The above conclusions about contrast have interesting consequences for the Contrastivist Hypothesis:

 Feature hierarchies designate more features as contrastive than the other method; therefore, a large class of apparent counterexamples to the hypothesis disappear.



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The above conclusions about contrast have interesting consequences for the Contrastivist Hypothesis:

- Feature hierarchies designate more features as contrastive than the other method; therefore, a large class of apparent counterexamples to the hypothesis disappear.
- This does not mean that the hypothesis is correct; but it leads us to reconsider how well it does when paired with a hierarchical approach to contrast.

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The 1st goal of linguistic theory

 To characterize a person's knowledge of his or her language.

Returning to the goals of linguistic theory, I conclude that contrastive feature hierarchies are part of the phonological grammars that speakers internalize.

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The 2nd goal of linguistic theory

2. To explain how speakers acquire their grammar.

How speakers learn the hierarchy for their language is a more difficult question, though I can mention some ingredients of an answer.

I propose that the notion of features is universal, part of Universal Grammar, as is the notion of ordering features into hierarchies.

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The 2nd goal of linguistic theory

2. To explain how speakers acquire their grammar.

Moreover, it is clear that in acquiring the features of their language, learners must pay attention to phonological processes, andnot just to the local phonetics of a sound.

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The 2nd goal of linguistic theory

2. To explain how speakers acquire their grammar.

Moreover, it is clear that in acquiring the features of their language, learners must pay attention to phonological processes, andnot just to the local phonetics of a sound.

For example, we have seen that a sound pronounced [u] is phonetically both back and round; but whether it has one or both of these properties as contrastive features depends on the type of activity it exhibits.

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Hidden structures

With respect to the main theme, most of the concepts we have looked at—phonemes, features, hierarchies—are hidden, in that they are not directly observable in the signal.



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Their reality must be based on the extent to which they provide illuminating analyses of the data.



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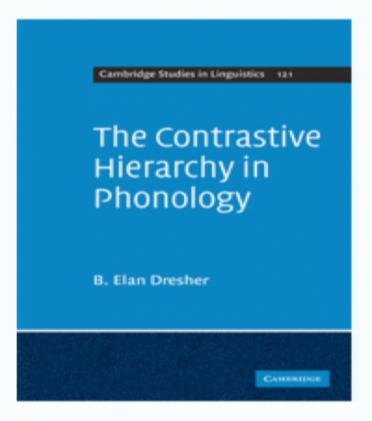
Their reality must be based on the extent to which they provide illuminating analyses of the data.

Feature hierarchies remain controversial in phonological theory. However, I think we are only starting to understand their potential to account for phonological patterns.

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For a more complete account of the topics discussed today, please see:



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THANK YOU!

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

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