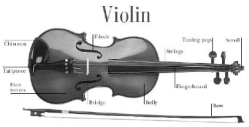
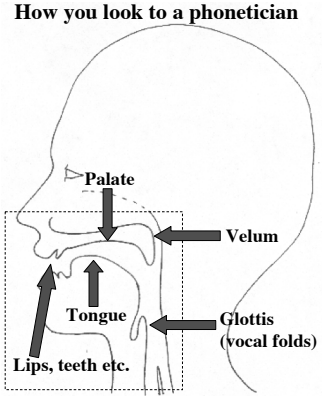
Language & the Mind
LING240
Summer Session II 2005

Lecture 5
Sounds

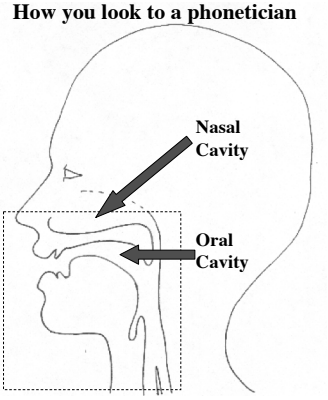
Sound Production

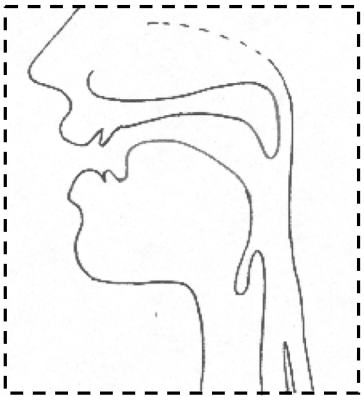


How you look to a phonetician



How you look to a phonetician





θ ‘thick’
ð ‘the’
ʃ ‘sh’
ʒ ‘azure’
tʃ ‘ch’
dʒ ‘j’
ŋ ‘thing’
ʔ ‘_uh-_oh’

Forget Spelling!

Sounds ≠ Spelling

One Sound - Many Characters

h**e**	e	s**ea**s	ea
bel**ie**ve	ie	am**oe**ba	oe
C**ae**sar	ae	k**ey**	ey
s**ee**	ee	mach**i**ne	i
p**eo**ple	eo	s**ei**ze	ei

Interantioanl **P**honetic **A**lphabet: **[i]**

One Sound - Many Characters

t**oo**	oo	thr**ew**	ew
t**o**	o	l**ieu**	ieu
cl**ue**	ue	sh**oe**	oe
thr**ough**	ough		

IPA: **[u]**

One Character - Many Sounds

d**a**me	e
d**a**d	æ
f**a**ther	a
c**a**ll	ɔ
vill**a**ge	ɪ, ə
m**a**ny	ɛ

One Sound - Multiple Letters

shoot	ʃ
ei**th**er	ð
character	k
d**ea**l	i
Thomas	t
physics	f
rou**gh**	f

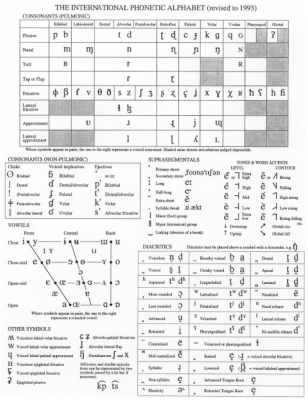
One Letter - 0, 1, 2 Sounds

mnemonic
psychology
resi**g**n
g**h**ost
i**s**land
whole
de**b**t

cute [**kj**uwt]

Differences across Languages

- English: judge, juvenile, Jesus **[ʤ]**
- Spanish: jugar, Jesus [**ɦ**]
- German: Jugend, jubeln, Jesus [**j**]
- French: Jean, j'accuse, jambon [**ʒ**]



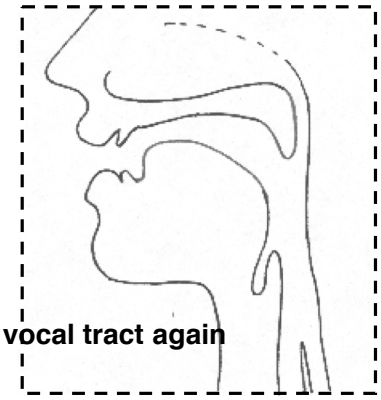
Major division: consonants vs vowels

- Consonantal sounds: narrow or complete closure somewhere in the vocal tract.
- Vowels: very little obstruction in the vocal tract. Can form the basis of syllables (also possible for some consonants).

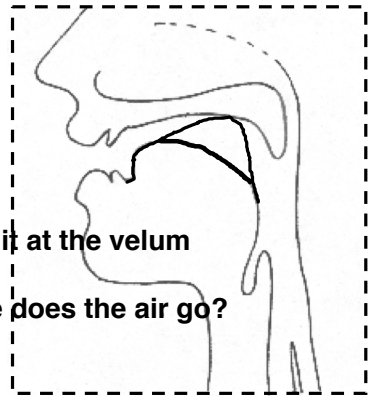
Describing Speech Sounds

- Where/how is the air flowing? *nasal/oral*, *stop*, *fricative, liquid* etc.
- Where is the air-flow blocked? *labial, alveolar, palatal, velar etc.*
- What are the vocal folds doing? *voiced* vs. *voiceless*

Where does the Air Flow?

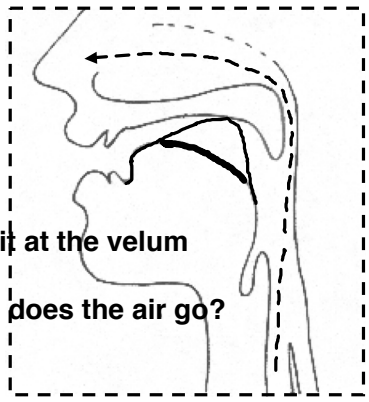


Your vocal tract again



Block it at the velum

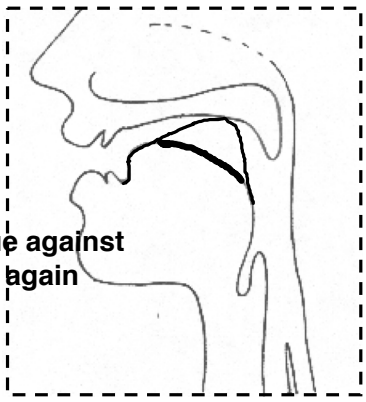
Where does the air go?



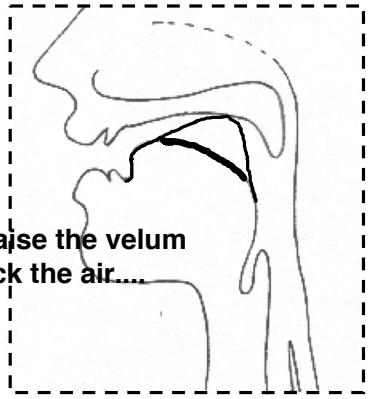
ŋ

Block it at the velum

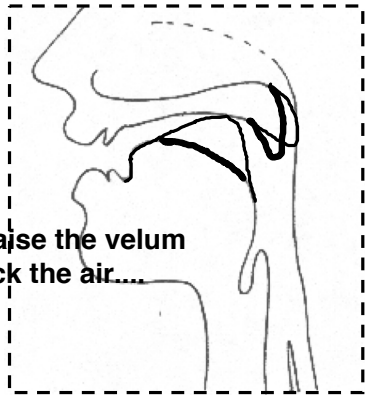
Where does the air go?



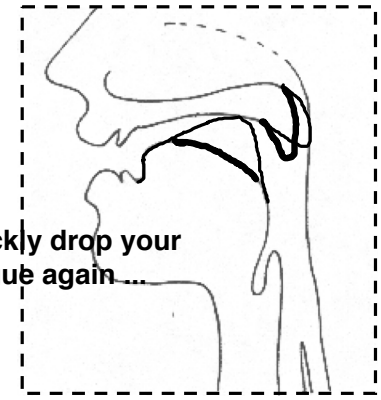
Tongue against velum again



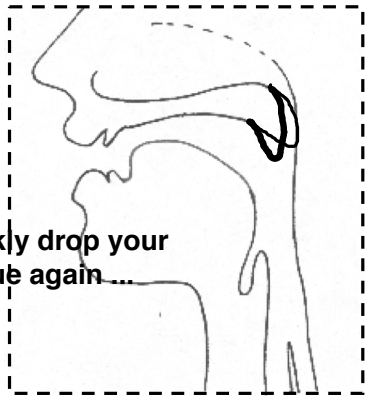
Now raise the velum to block the air....



Now raise the velum to block the air....



Quickly drop your tongue again ...



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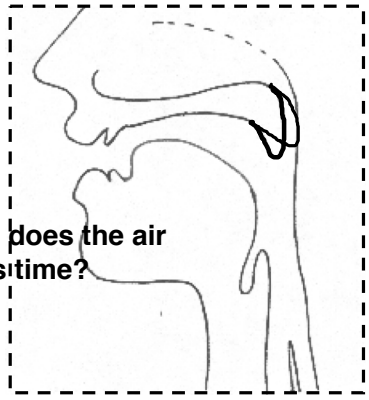
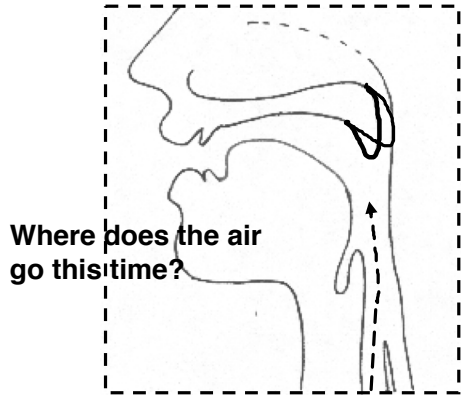
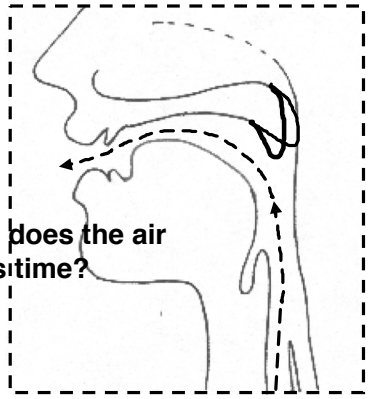


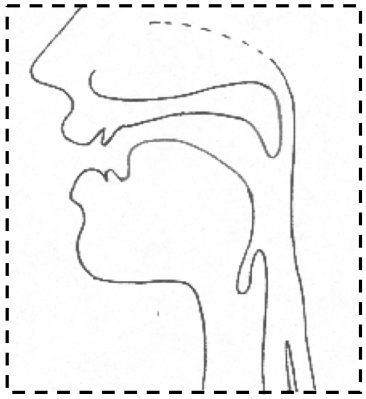


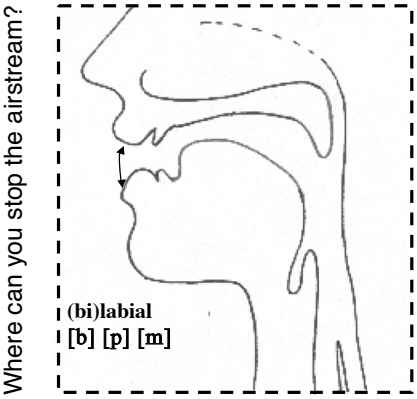


g
k

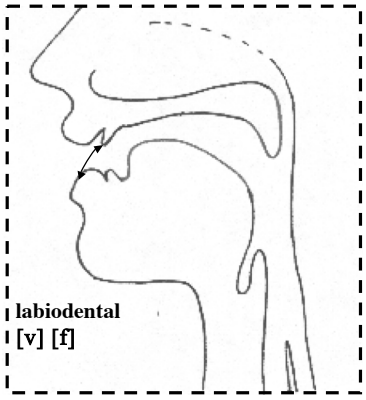
So far we have:

Nasal stop:
[ŋ]
Non-nasal (oral) stops:
[g] [k]





Where can you stop the airstream?



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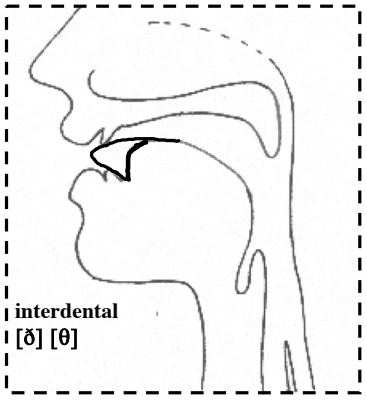

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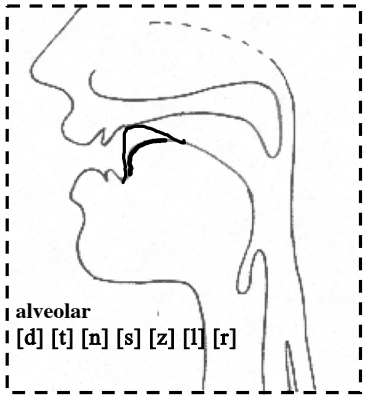

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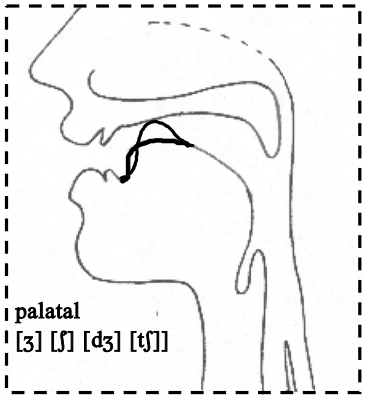

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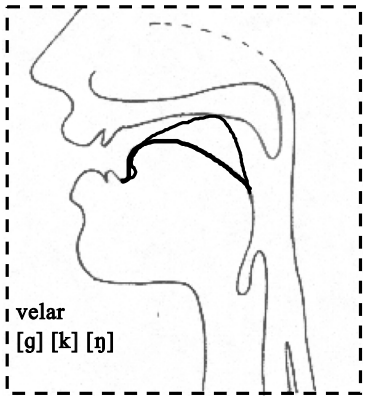

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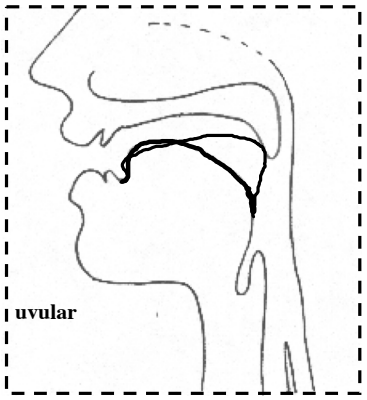

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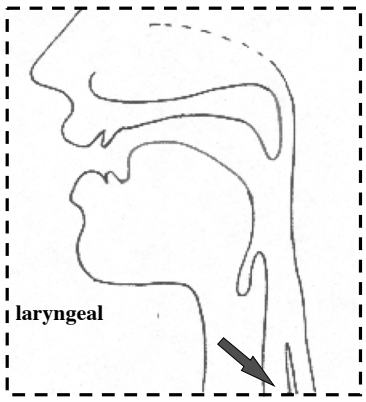


Manner - How the Air is Flowing

- Stops
  [p] [t] [k] [b] [d] [g]...
- Fricatives
  [f] [v] [θ] [ð] [s] [z]
- Approximants/Glides
  [w] [j]
- Liquids
  [r] [l]

Fricatives & Affricates

- Palatal sounds [ʒ] [ʃ] [dʒ] [tʃ]
- Palatal Fricatives - [ʒ] [ʃ]
  [note: according to IPA chart these are strictly 'post-alveolar']
- Affricates - combination of stop + fricative - [dʒ] [tʃ] , as in *judge*, *church*

Voiced & Voiceless Consonants

- Consonants either voiced or voiceless.
- English pairs:

b p	v f	d t
z s	ð θ	

Describing Consonants

- Where is the air-flow blocked?
  labial, alveolar, palatal, velar etc.
- Where/how is the air flowing?
  nasal/oral, *stop*, *fricative, liquid* etc.
- What are the vocal folds doing?
  voiced vs. *voiceless*

Features

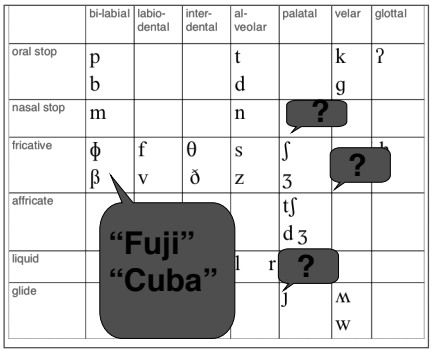
- Ways of *describing* sounds
  e.g., [t] = voiceless, alveolar, stop
- Stronger claim: features are the *smallest building blocks of language*, used to store sounds in the mind
- *Atoms of Speech*

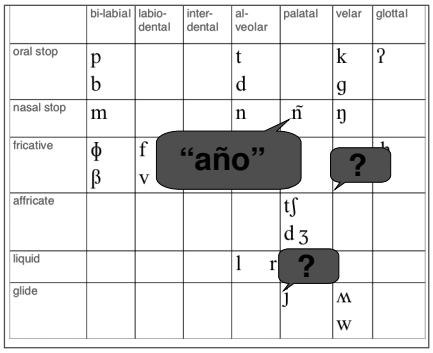
Roman Jakobson, 1896-1982

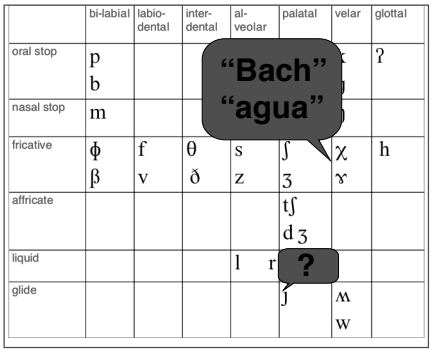
Features

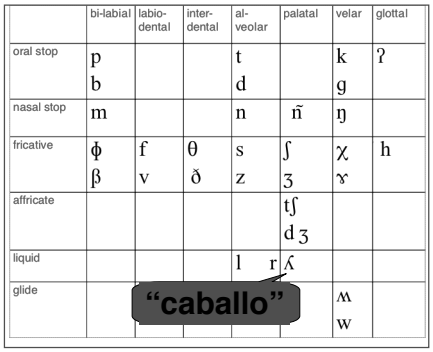
- Prediction: by combining a small number of atomic features, it should be possible to create a larger number of speech sounds
- Goal: a set of universal features should make it possible to describe the speech sounds of all of the languages of the world
- Different languages choose different feature combinations

	bi-labial	labio-dental	inter-dental	al-veolar	palatal	velar	glottal
oral stop	p b			t d		k g	ʔ
nasal stop	m			n		ŋ	
fricative		f v	θ ð	s z	ʃ ʒ		h
affricate					tʃ dʒ		
liquid				l r			
glide					j	ʍ w	





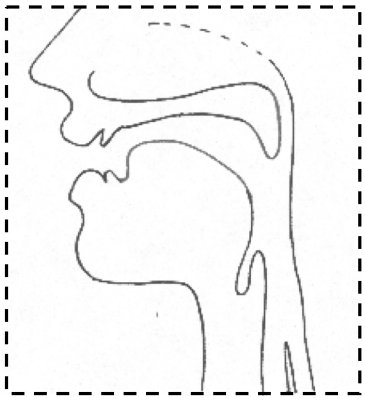




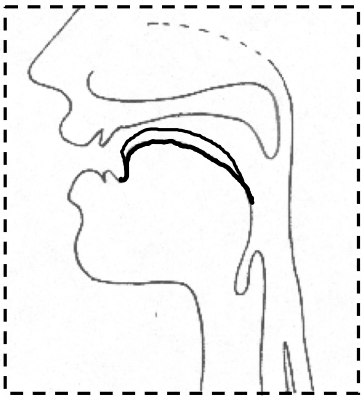
	bi-labial	labio-dental	inter-dental	al-veolar	palatal	velar	glottal
oral stop	p b			t d		k g	ʔ
nasal stop	m			n	ɲ	ŋ	
fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	χ ʁ	h
affricate					tʃ dʒ		
liquid				l r	ʎ		
glide					j	ʍ w	

VOWELS

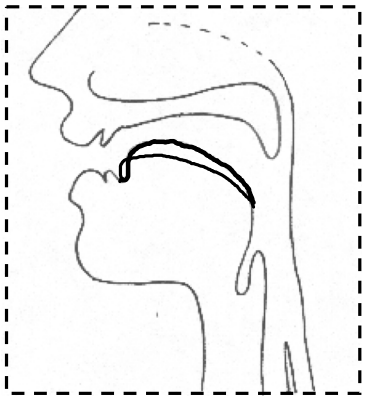
What can you do to alter the shape of your vocal tract?



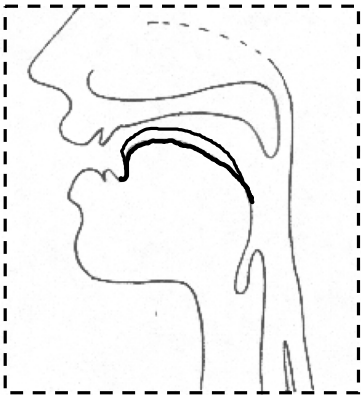
[i]



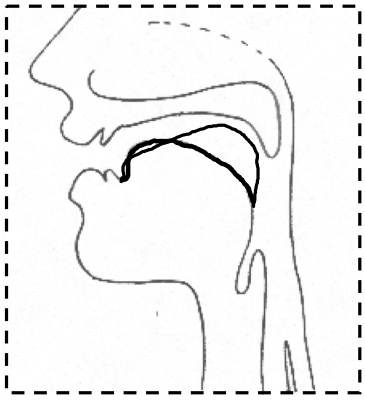
[æ]



[ɪ]



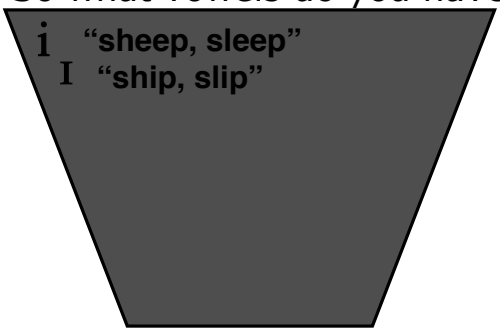
[u]



You can....

- Raise or lower your tongue
- Advance or retract your tongue
- Round or spread your lips
- Tense or not tense your mouth

So what vowels do you have?



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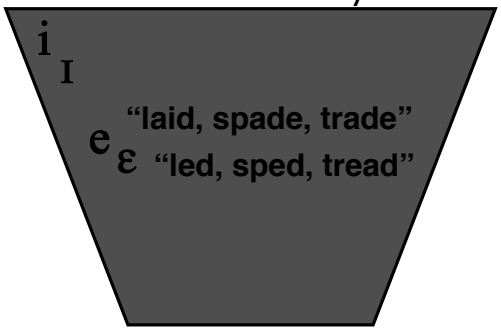

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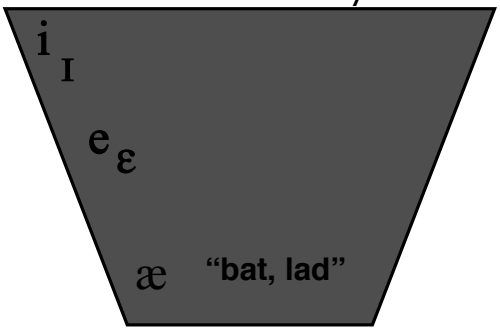

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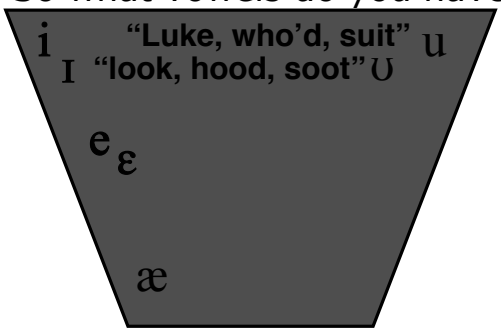

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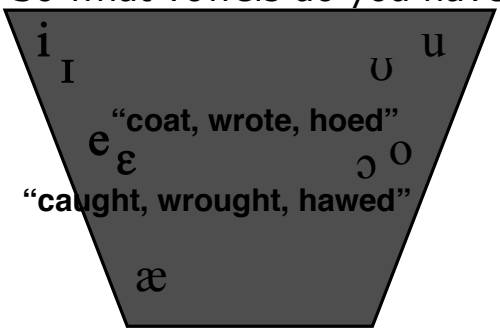

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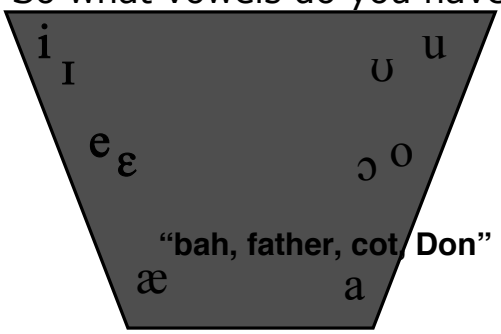

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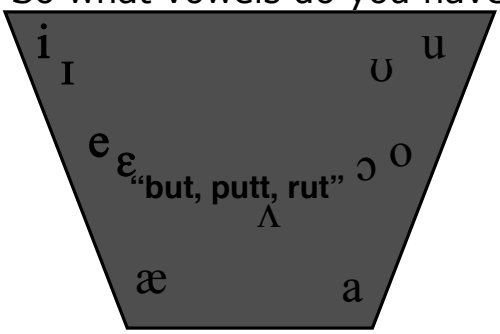

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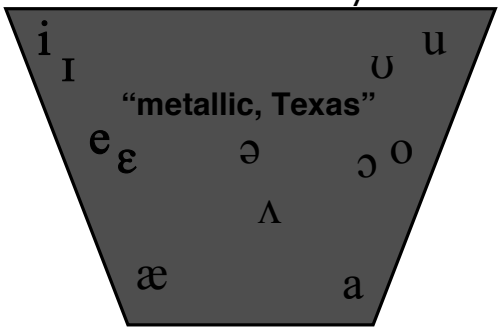
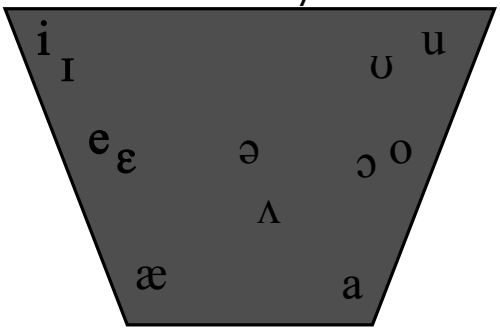


So here they are!



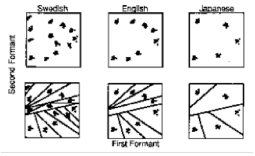
Some dialectal differences

- caught/cot [Mid back lax vowel and mid back tense vowel]: many American speakers do not have both of these.
- pot/father: some British and (fewer) American dialects have different vowels in these words ("pot" has a low back rounded vowel [ɒ]).

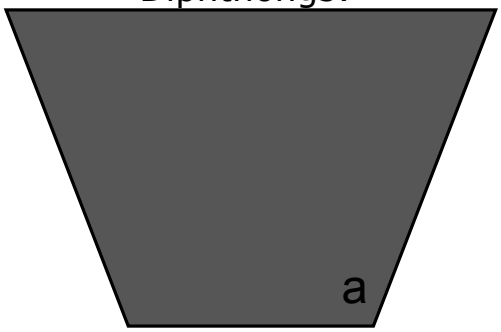
Cross-language Differences

- Feature Combinations
  - English: back vowels are rounded, others are not
  - German/French has high, front, rounded vowel [y]
  - Russian has high back unrounded vowel [ɯ]
  - Many languages don't make the tense/lax distinction found in English (ex: Spanish [i])
  - Many languages distinguish short and long vowels (unlike English), ex: Japanese

Cross-language Differences



Diphthongs:



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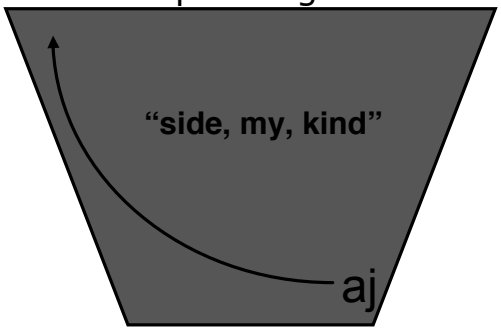

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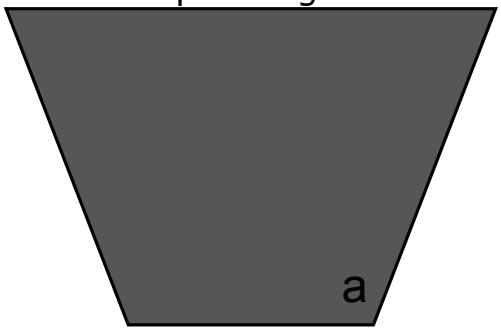
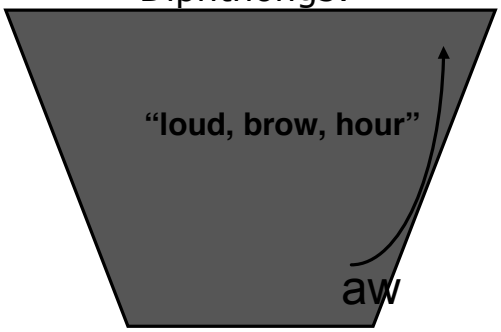
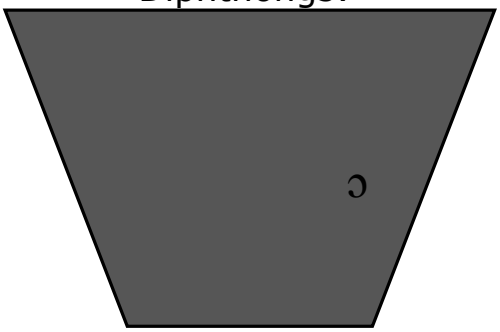


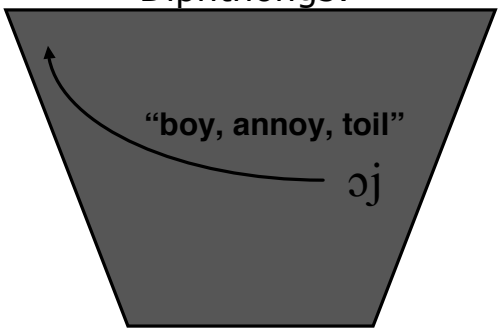
Diphthongs:



Diphthongs:



Diphthongs:



Speech Production - Summary

- Airflow set in vibration by vocal folds
  Airflow modified by vocal tract
- Vowels: shaping of oral cavity
- Consonants: narrowing or blocking of oral/nasal cavity
- Different languages choose different selections of articulatory gestures

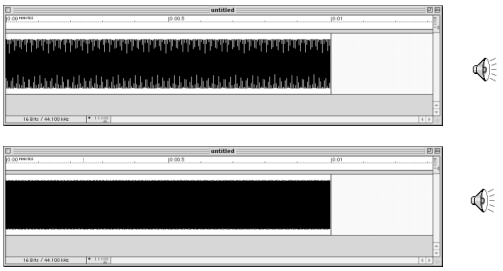
Speech Perception

- Speech production processes must be *undone* by the ear
- Motions of articulators must be *reconstructed* from patterns of air vibration
- Requires extremely precise hearing, possibly a system specialized for hearing speech
- Substantially developed at birth

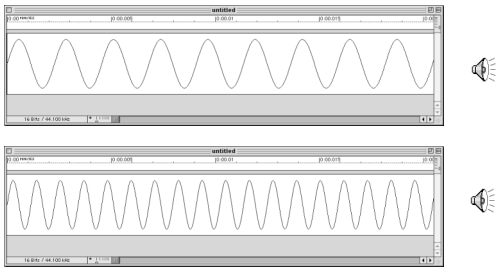
Acoustic Information

- Frequency
- Timing

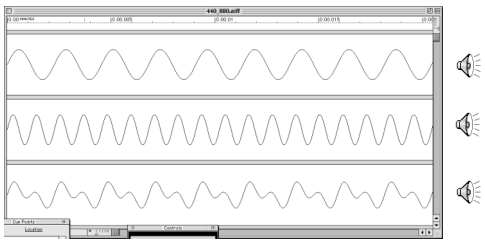
Frequency - Tones



Frequency - Tones (Close Up)



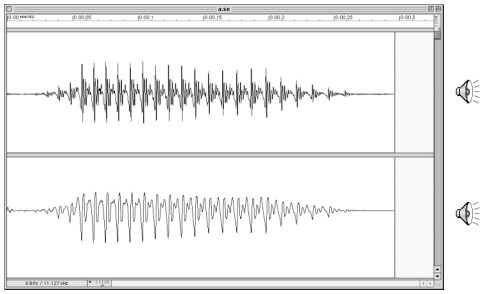
Frequency - Tones



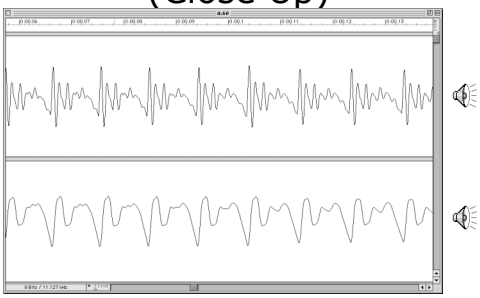
Frequency - Vowels

- Vowels combine acoustic energy at a number of different frequencies
- Different vowels ([a], [i], [u] etc.) contain acoustic energy at different frequencies
- Listeners must perform a 'frequency analysis' of vowels in order to identify them (*Fourier Analysis*)

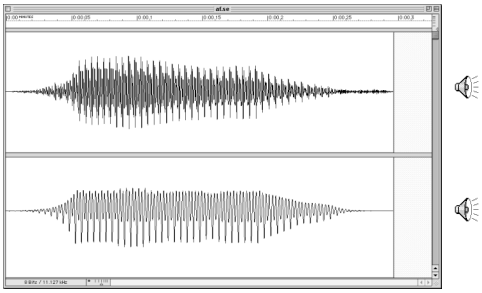
Frequency - Male Vowels



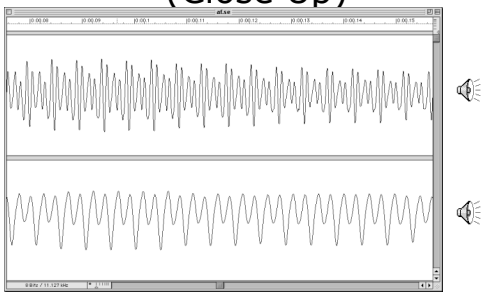
Frequency - Male Vowels (Close Up)



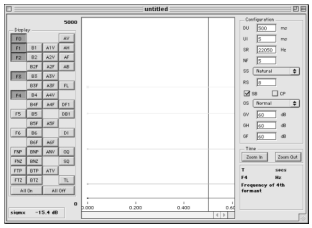
Frequency - Female Vowels



Frequency - Female Vowels (Close Up)

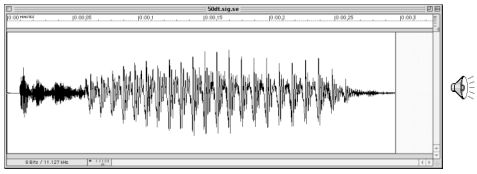


Synthesized Speech

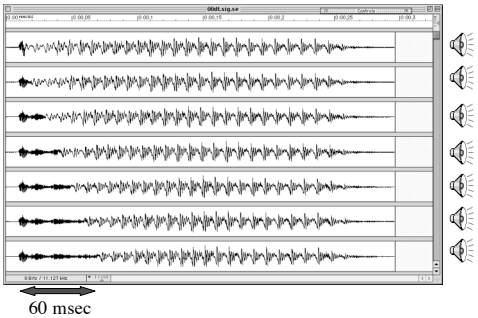


- Allows for precise control of sounds
- Valuable tool for investigating perception

Timing - Voicing



Voice Onset Time (VOT)



English VOT production

- Not uniform
- 2 categories

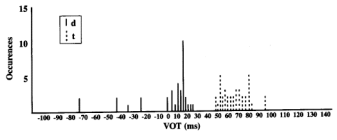
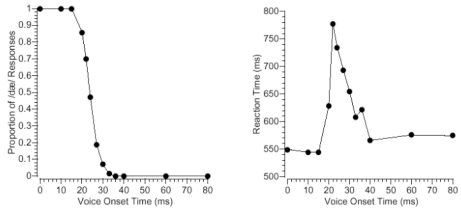


Figure 5–3. VOT productions of a single normal adult speaker of American English for words beginning with /d/ and /t/. (Figure adapted with permission from Blumstein, Cooper, Goodglass, Statlender, & Gottlieb, [1980]. Production Deficits in Aphasia: A Voice Onset-Time Analysis. *Brain and Language, 9,* 153–170. Copyright 1980 by Academic Press.)

Perceiving VOT



'Categorical Perception'

Discrimination

Same/Different
0ms 60ms

Same/Different
0ms 10ms

Same/Different
40ms 40ms

Why is this pair difficult?

(i) Acoustically similar?

(ii) Same Category?

Discrimination

Same/Different
0ms 60ms

Same/Different
0ms 10ms

Same/Different
40ms 40ms

A More Systematic Test

D 0ms 20ms D

D 20ms 40ms T

T 40ms 60ms T

Within-Category Discrimination is Hard

Cross-language Differences

R L

R L

Cross-Language Differences

English vs.
Japanese R-L

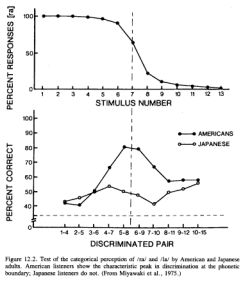


Figure 12.2. Test of the categorical perception of /ra/ and /la/ by American and Japanese adults. American listeners show the characteristic peak in discrimination at the phonetic boundary; Japanese listeners do not. (From Miyawaki et al., 1975.)

Cross-Language Differences

English vs. Hindi

alveolar [d]

retroflex [D]

?

Cross-language Differences

Participants: Thai – native
English- second (>3 years in the US)

[d¹a] [d²a] **DIFFERENT**

Imsri & Idsardi (2001)

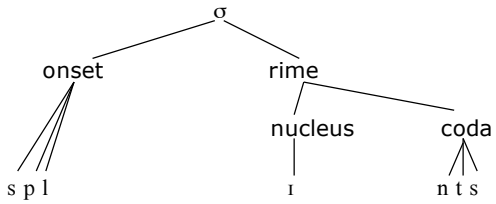
Japanese Syllables

- English Pronunciation
[m æ k d a n ə l d z]

- Japanese Pronunciation
[m æ k **ɯ** d o n a r **ɯ** d **o**]

What's a Syllable?

- Another phonological unit of words
- Every vowel is at the center of a syllable
- Syllables have hierarchical structure



Phonotactic Constraints: Constraints on Syllable Structure

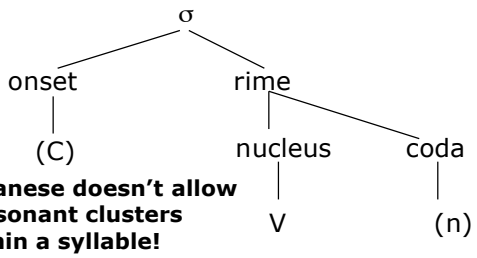
- Every language has restrictions on what sequences of phonemes may occur (*ktleem)
- These constraints are *language specific*

English: *zleem Polish: *zlev* 'sink'

- Illegal sequences are illegal *within a single syllable*

English: *[kspl] [ɛk splɪ sɪt]

Japanese Phonotactic Constraints



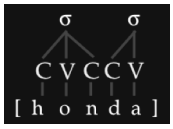
Japanese doesn't allow consonant clusters within a syllable!

Toyota, Honda…

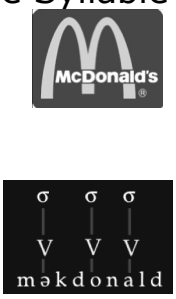
Japanese Syllable Structure

- Toyota

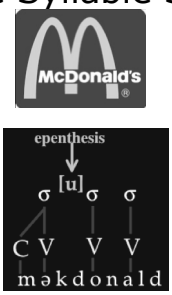
- Honda



Japanese Syllable Structure



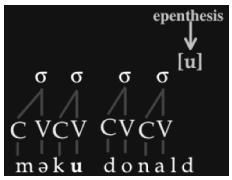
Japanese Syllable Structure



Japanese Syllable Structure

Japanese Syllable Structure

Japanese Syllable Structure



Japanese Syllable Structure

Japanese Syllable Structure

Japanese Syllable Structure

Japanese Syllable Structure

Phonemic Level: /m æ k d o n a l d/

Phonetic Level: [m æ k u d o n a l u d o]

Behavioral Results

- Japanese speakers have trouble hearing the difference

[eb**u**zo]

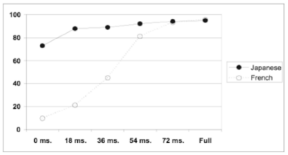


Figure 1: Percept [u] vowel judgments as a function of vowel duration (adapted from Dupoux et al., 1999).

Dupoux et al. 1999

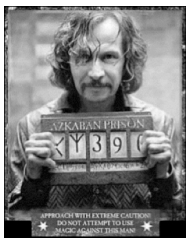
Additional Findings

Language	RT	SE	Err	RT	SE	Err
	Vowel Length Contrast *ebuzo-ebuuzo*			Epenthesis Contrast *ebuzo-ebzo*		
Japanese	1082	45	7.5%	1187	75	32%
French	1173	73	21%	1002	54	5.8%

Table 1
Mean reaction time (ms), standard error, and error rate in ABX judgments on an epenthesis contrast and a vowel length contrast in French and Japanese participants (Experiment 3).

Speech Perception

It seems that a language speaker is a prisoner of his/her language phonemic alphabet



A Puzzle…

- Korean speakers use the sounds [r] and [l]
  e.g. *Korea*
  Seoul
- Korean babies hear the difference between [ra] and [la] … they don't know Korean yet
- Korean adults know Korean … but they have difficulty hearing the [ra] vs. [la] contrast

Developmental Questions

- How does the native/non-native difference emerge?
- Does native-language discrimination improve as a result of native language input?

Possibility #1: Adding Features

- Children learn the *feature contrasts* of their language
- Children learn gradually, adding features over the course of development

Roman Jakobson, 1896-1982

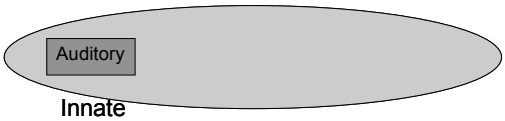
Predictions of Possibility #1

- Poor discrimination at birth
- Better and better with age

Roman Jakobson, 1896-1982

What's innate?

- Auditory abilities



Evidence from neonates?

- How do we know babies can hear differences in speech?
- What can babies do?
- High-amplitude sucking

English VOT Perception

To Test Adults

Simply ask:
same or different?

or

Is it a [b] or a [p]?

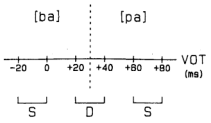


Figure 4.6
Experimental design of infant discrimination study. Based on P. D. Eimas, E. R. Siqueland, P. W. Jusczyk, and J. Vigorito (1971). Speech perception in infants. *Science* 171, 303–306. © 1971 by the AAAS.

English VOT Perception

To Test Children

Not so easy!

High Amplitude Sucking

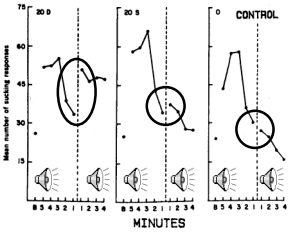


Figure 4.7
Mean number of sucking responses for 4-month-old infants as a function of time and experimental condition. The dashed line indicates the occurrence of the stimulus shift, or, in the case of the control group, the time at which the shift would have occurred. Adapted from P. D. Eimas, E. R. Siqueland, P. W. Jusczyk, and J. Vigorito (1971). Speech perception in infants. *Science* 171, 303–306. © 1971 by the AAAS.

Reality Check for Possibility #1

- Infants show *Categorical Perception* of speech sounds - at 2 months and earlier
- Discriminate a wide range of speech contrasts
- Discriminate *Non-Native* speech contrasts
  e.g., Japanese babies discriminate r-l
  e.g., Canadian babies discriminate d-D

Universal Listeners

- Infants may be able to discriminate all speech contrasts from the languages of the world!

How can they do this?

- Innate speech-processing capacity?

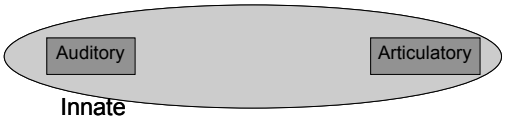
- General properties of auditory system?

What About Non-Humans?

- Chinchillas show categorical perception of voicing contrasts!

What's innate?

- Auditory abilities
- Articulatory rudiments
  - Not developed
  - Desire to coo and babble even in deaf infants



Connecting Hearing & Speaking

McGurk Effect

Auditory [ba] + Visual [ga] = Perceptual [da]

Connecting Hearing & Speaking

Auditory [ba] + Visual [ga] = Perceptual [da]

Evidence for connection

- Infants know connection between visual and auditory speech stimuli
- Mix and match [a] vs. [i]

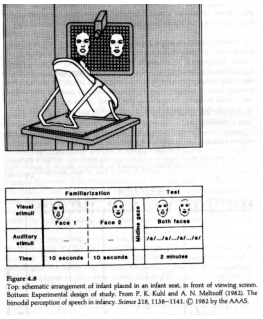
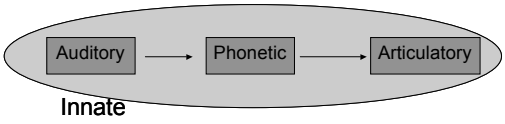


Figure 4.8
Top: schematic arrangement of infant placed in an infant seat, in front of viewing screen. Bottom: Experimental design of study. From P. K. Kuhl and A. N. Meltzoff (1982). The bimodal perception of speech in infancy. *Science* 218, 1138–1141. © 1982 by the AAAS.

What's innate?

- Auditory abilities
- Articulatory rudiments
- Connection between them
  - Phonetic level
  - Universal Grammar (UG)



When does change occur?

When Does Change Occur?

- About 10 months

Janet Werker

U. of British Columbia

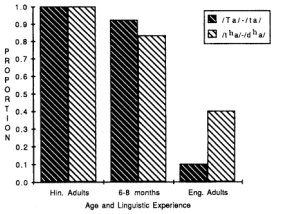


Figure 4.2
Proportion of subjects reaching criterion as a function of age and language contrast. Adapted from Werker et al. 1981.

When Does Change Occur?

- Hindi and Salish contrasts tested on English kids
- Change at 8-10 months

Janet Werker

U. of British Columbia

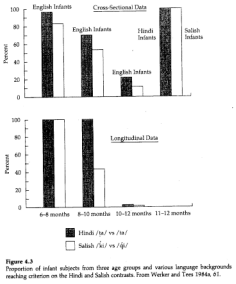
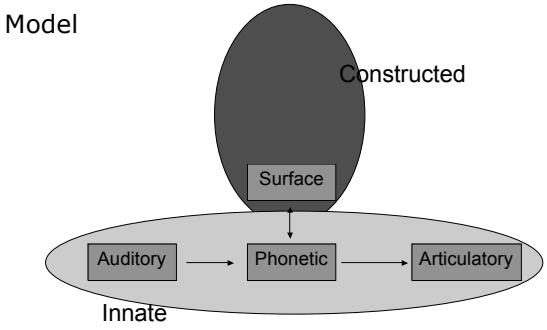


Figure 4.3
Proportion of infant subjects from three age groups and various language backgrounds reaching criterion on the Hindi and Salish contrasts. From Werker and Tees 1984a, 61.

What has Werker found?

- Is this the beginning of memory?
- Are the infants learning words?
- …Or something else?

Learning the surface

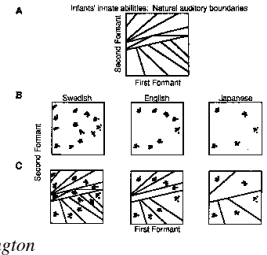


Possibility #2: Maintenance & Loss

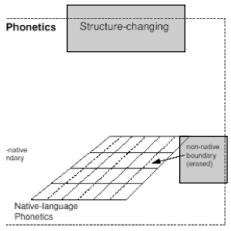
- Infants maintain features being used in their language
- They lose all others

Patricia Kuhl

University of Washington



Possibility #2: Schematic



Possibility #2: Predictions

- Loss of discriminability should be **permanent** and absolute

But…

- Training improves adult performance

ened portions. Furthermore, adults can be "taught" to discriminate the full syllables if given enough training trials, or if tested in sensitive procedures with low memory demands (Pisoni et al. 1982; Werker and Logan 1985).

But…

- Some non-native contrasts are easy for adults to distinguish

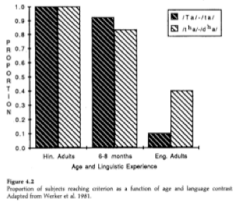


Figure 4.2
Proportion of subjects reaching criterion as a function of age and language contrast. Adapted from Werker et al. 1981.

But…

- Adults perform better at non-native contrasts if they think the sounds are not language sounds

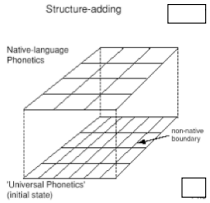
strated. In one of the more intriguing demonstrations, it was shown that if the critical acoustic information in the speech contrast is presented alone so that the syllables no longer sound like speech, adults can discriminate nonnative contrasts. To illustrate, Werker and Tees (1984b) presented adult English speakers with either the ejective portion alone from the Nthlakampx /k'i/-/q'i/ contrast (telling listeners that it was water dropping into a bucket and that they should signal when the bucket was switched) or a truncated portion of the Hindi retroflex/dental (/Ta/-/ta/) contrast. In each case adult English speakers discriminated the shortened pairs with ease, but they still failed to distinguish the full syllables even when tested on them immediately after being presented with the shortened portions. Furthermore, adults can be "taught" to discriminate the full

Possibility #2: Reality Check

- **Loss of discriminability is neither permanent nor absolute!**

Possibility #3: Functional Reorganization

- Changes in performance with development do not reflect changes in the hard-wiring of the brain



Janet Werker
University of British Columbia

What does Development Involve?

- Change - non-native categories *lost* (structure-changing)
- Growth - non-native categories *hidden* (structure-adding)

What does Development Involve?

- Evidence for *Growth*
- (i) Some discrimination retained when sounds presented close together (e.g. Hindi d-D contrast)
  (ii) Discrimination abilities better when people hear sounds as non-speech
  (iii) Adults do better than 1-year olds on some sound contrasts
- All evidence comes from *consonants*

What does Development Involve?

- Evidence for *Change*
  (i) No evidence of preserved non-native category boundaries in vowel perception (non-native vowel *discrimination* is pretty good in any case)
- Best evidence for *change* comes from vowels and vowel-like categories

What yearlings can't do

- Recognize minimal pairs while relating them to real words
  - "bear" versus "pair"
  - "Piglet" versus *"Biglet"
- More Werker experiments

Word Learning

- Stager & Werker 1997

  'bih' vs. 'dih' and 'lif' vs. 'neem'
- Procedure: familiarize with sound-object pairs, then test using same or different pairings

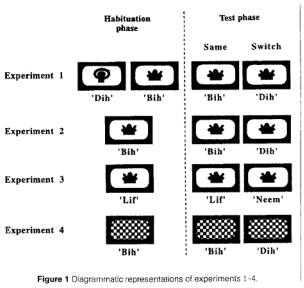
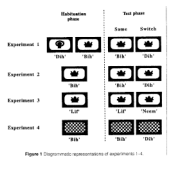


Figure 1 Diagrammatic representations of experiments 1–4.

Word learning results

- Exp 2 vs 4



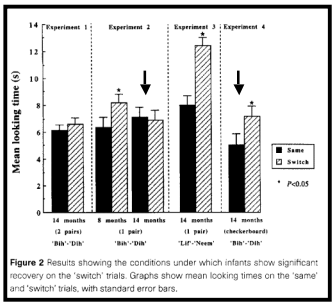


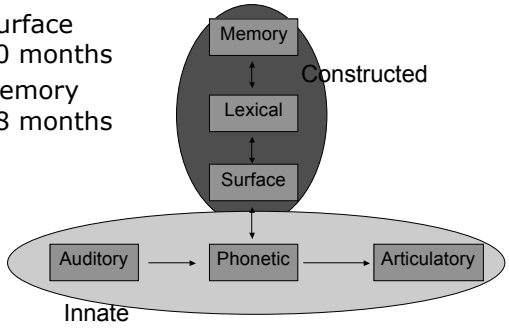
Figure 2 Results showing the conditions under which infants show significant recovery on the 'switch' trials. Graphs show mean looking times on the 'same' and 'switch' trials, with standard error bars.

Key Findings

- 14 month olds can discriminate the minimally contrasting words (Expt. 4)
- But they fail to notice the minimal change in the sounds when they are paired with objects, i.e., when they are *words* (Expt. 2)
- They *can* perform the task, when the words are more distinct (Expt. 3)
- Therefore, 14-month olds use more detail to represent sounds than they do to represent words

Approximate Ages

- Surface 10 months
- Memory 18 months



Why Yearlings Fail on Minimal Pairs

- They fail specifically when the task requires word-learning
- They *do* know the sounds
- But they fail to use the detail needed for minimal pairs to store words in memory
- What is going on?
  - Is this true for all words?
  - When do they learn to do this?
  - What triggers the ability to do this?

Swingley & Aslin, 2002

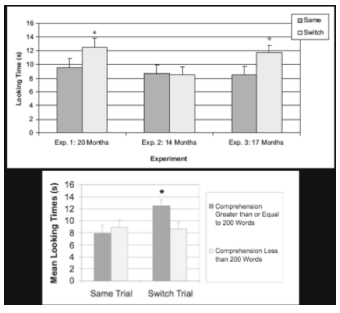
- 14-month year olds *did* recognize mispronunciations of familiar words

Table 1. *Correctly pronounced (CP) target words and their mispronounced (MP) versions*

CP	MP-close	MP-distant
apple (/æpl/)	opple (/apl/)	opal (/opl/)
baby (/beᵎbi/)	vaby (/veᵎbi/)	raby (/ɹeᵎbi/)
ball (/bɔl/)	gall (/gɔl/)	shawl (/ʃɔl/)
car (/kaɹ/)	cur (/kɜ/)	kier (/kiɹ/)
dog (/dɔg/)	tog (/tɔg/)	mog (/mɔg/)
kitty (/kɪɾi/)	pity (/pɪɾi/)	yitty (/jɪɾi/)

Note. International Phonetic Alphabet transcriptions are provided in parentheses. Bisyllabic words were stressed on the first syllable.

Werker et al., 2002



Possibility #1 Again…

- Children learn the *feature contrasts* of their language
- Children may learn gradually, <u>adding</u> features over the course of development
- *Phonetic* knowledge does not entail *phonological* knowledge

Roman Jakobson, 1896-1982

Word-learning & phonological detail

- Word-learning is very hard for younger children, so detail is initially missed when they first learn words
- Many exposures are needed to learn detailed word forms at earliest stages of word-learning
- Success on the Werker/Stager task seems to be related to the ***vocabulary spurt***, rapid growth in vocabulary after ~50 words

Back to 1-year olds

- 1-year olds know the *surface sound patterns* of the language
- 1-year olds do not yet know which sounds are used *contrastively* in the language (which sound variations affect meaning and which don't)
- 1-year olds still need to learn ***contrasts***

Phonology
(Yet Another Level!)

Vowels Same or Different?

light	**lied**
tight	**tied**
site	**sighed**
life	**live**
knife	**knive(s)**
lice	**lies**
dice	**dies**

Some people have this system:

light	**lajt**	**lied**	**lajd**
tight	**tajt**	**tied**	**tajd**
site	**sajt**	**sighed**	**sajd**
life	**lajf**	**live**	**lajv**
knife	**najf**	**knive(s)**	**najvz**
lice	**lajs**	**lies**	**lajz**
dice	**dajs**	**dies**	**dajz**

Some people have this one:

light	**l ʌ j t**	**lied**	**lajd**
tight	**t ʌ j t**	**tied**	**tajd**
site	**s ʌ j t**	**sighed**	**sajd**
life	**l ʌ j f**	**live**	**lajv**
knife	**n ʌ j f**	**knive(s)**	**najvz**
lice	**l ʌ j f**	**lies**	**lajz**
dice	**d ʌ j s**	**dies**	**dajz**

What's the pattern?

light	l ʌ j t	**lied**	lajd
tight	t ʌ j t	**tied**	tajd
site	s ʌ j t	**sighed**	sajd
life	l ʌ j f	**live**	lajv
knife	n ʌ j f	**knive(s)**	najvz
lice	l ʌ j f	**lies**	lajz
dice	d ʌ j s	**dies**	dajz

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knife	n ʌ j f	**knive(s)**	najvz
lice	l ʌ j f	**lies**	lajz
dice	d ʌ j s	**dies**	dajz

What's the pattern?

voiceless alveolar stop	t	voiced alveolar stop	d
	t		d
	t		d
voiceless labiodental fricative	f	voiced labiodental fricative	v
	f		v
voiceless alveopalatal fricative	s	voiced alveopalatal fricative	z
	s		z

So these speakers have a rule ...

Before a voiceless consonant
a j --> ʌ j

Isn't it just two sets of words?

Nope, it's a rule ...

Nope, it's a rule ...

[stajd]

[st ʌ jt]

Two "levels" of speech sounds

/lajt/

/lajd/

The sounds you "store" in your head

Two "levels" of speech sounds

[l ʌ jt]

[lajd]

The sounds you actually produce

Terminology

/lajt/

/lajd/

"phonemes"

The sounds you "store" in your head

Terminology

"phones"

[l ʌ jt]

[lajd]

The sounds you actually produce

1 <u>phoneme</u>; more than 1 <u>phone</u>

/aj/

[ʌ j]

[aj]

We call the phones <u>allophones</u> of the phoneme

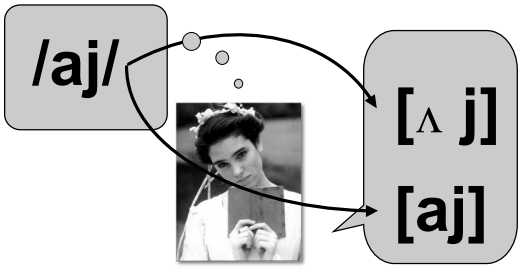
So…

- In some dialects of English, the phoneme **/aj/** has two allophones: [aj] and [ʌ j] .
- The allophone [ʌ j] occurs whenever the phoneme precedes a voiceless sound

The whole rule:

aj --> ʌ j /_____ [-voice]

1 phoneme 2 phones



sound(s) actually produced

Another rule:

t --> d /V_____V

Another rule:

- "sit" [sɪt]
- "sitter" [sɪdər]
- "heat" [hit]
- "heater" [hidər]
- "at" [æt]
- "attic" [ɑdɪk]

What about these?

- "attack"
- "atone"
- "determine"
- "detect"

Is there a pattern?

[sɪdər]	[ətæk]
[hidər]	[ətɔn]
[ædɪk]	[ditɛkt]

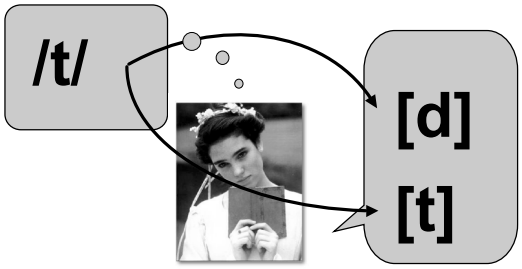
Is there a pattern?

[sídər]	[ətǽk]
[hídər]	[ətɔ́n]
[ǽdɪk]	[ditɛ́kt]

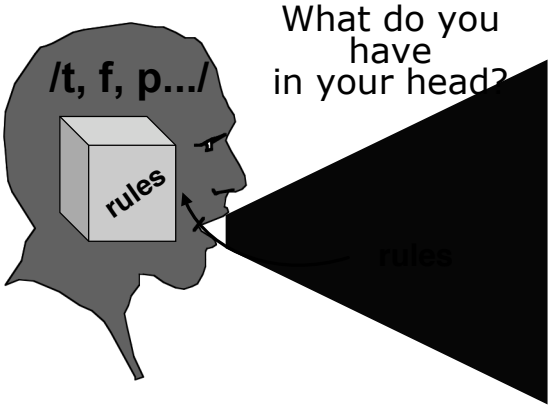
So we need a slight revision

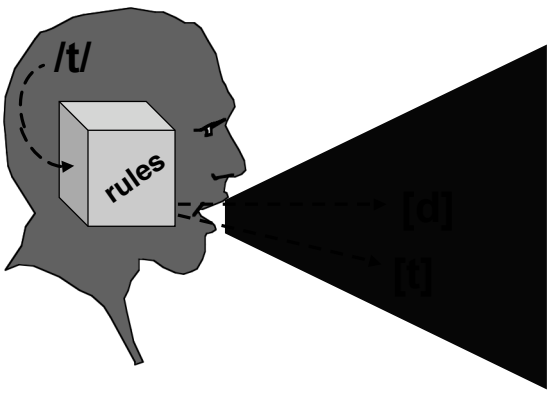
t --> d /V́_____ V

1 phoneme 2 allophones



sound(s) actually produced





Points to note:

- Sequence becomes "easier to say"

BUT

- This process is a specific rule of a particular dialect of English

In what sense a specific rule?

- doesn't apply to all instances of "t" between vowels
- isn't a part of the grammar of other dialects of English
- is only one way to make sequencesof vowels and voiceless consonants easier to say

Moral:

The rules that we discover are often "natural" in that one can find an explanation for many of them in terms of ease of articulation, but they are not inevitable/innate: they are specific rules of particular dialects or languages, and had to be learned.

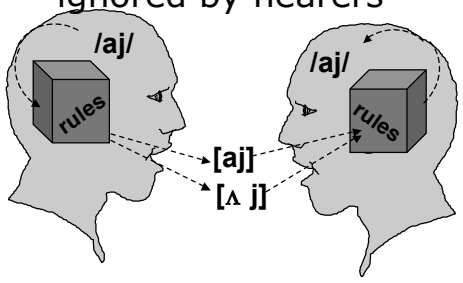
How much detail do you have to remember about the sound of each word?

If you can predict something by a rule, you don't have to remember it

Just remember:

- the rule
- the things that can't be predicted

Allophonic differences ignored by hearers



Varying Pronunciations

- Voiceless stops /p, t, k/

pit	🔊	tack	🔊
spit	🔊	stack	🔊
spit	🔊	stack	🔊
bit		dack	

- Aspirated at start of syllable; unaspirated after [s]
- 6 month olds easily distinguish bottom 2 rows; 1 year olds do not (adults aren't great either)

Languages can differ in what is predictable

Korean has [l] and [r] ...

[rupi]	"ruby"
[kiri]	"road"
[saram]	"person"
[irɯmi]	"name"
[ratio]	"radio"
[mul]	"water"
[pal]	"big"
[səul]	"Seoul"
[ilkop]	"seven"
[ipalsa]	"barber"

But [r] doesn't show up everywhere ...

[rupi]	"ruby"
[kiri]	"road"
[saram]	"person"
[irɯmi]	"name"
[ratio]	"radio"
[mul]	"water"
[pal]	"big"
[səul]	"Seoul"
[ilkop]	"seven"
[ipalsa]	"barber"

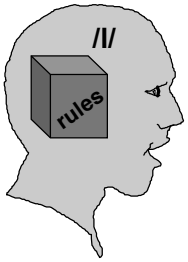
[r] is *always* in front of a vowel

And nor does [l] ...

[rupi]	"ruby"
[kiri]	"road"
[saram]	"person"
[irɯmi]	"name"
[ratio]	"radio"
[mul]	"water"
[pal]	"big"
[səul]	"Seoul"
[ilkop]	"seven"
[ipalsa]	"barber"

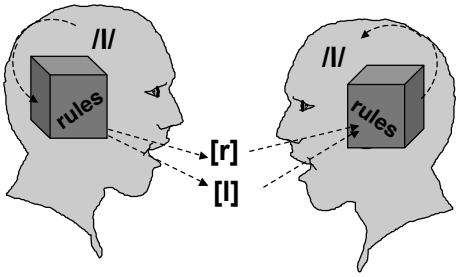
[l] is *never* in front of a vowel

So: Korean has only 1 liquid phoneme



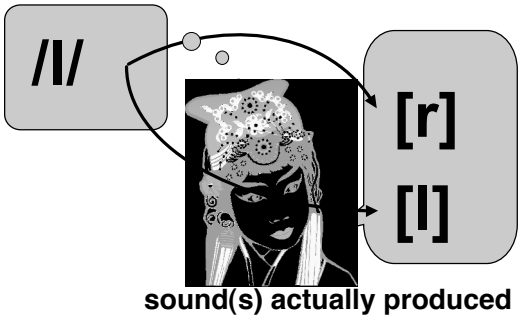
(Koreans don't have to remember if a word has [l] or [r])

So in Korean, [l] and [r] are "the same"



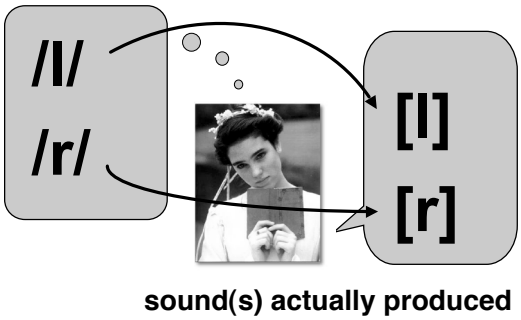
So Korean works like this:

1 phoneme 2 allophones

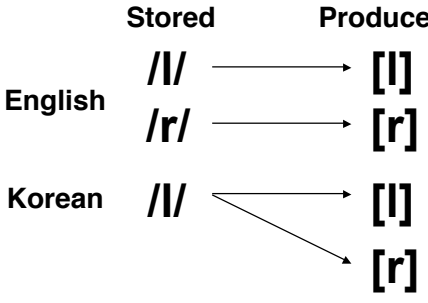


While English works like this:

2 phonemes 2 phones



Even more schematically:



Minimal Pairs

- In English, [r] and [l] can occur in the same position in a word

rake	*lake*
ramp	*lamp*
rim	*limb*
ripper	*ripple*

- In English, [r] and [l] can be used to mark a *meaning contrast*
- In English, /r/ and /l/ are two *phonemes*

Minimal Pairs

- Korean works differently

Minimal Pairs

- Korean works differently
- [r] and [l] are two allophones of a *single phoneme* in Korean
- It's impossible to create minimal pairs which contrast r/l in Korean
- [r] and [l] cannot be used *contrastively* in Korean

Puzzle Solved!

but not contrastively!

so they don't know that they are pronunciations of the *same* phoneme

- Korean speakers use the sounds [r] and [l] e.g. *Korea* *Seoul*
- Korean babies hear ~~the difference between~~ [ra] and [la] … ~~they don't know Korean yet~~
- Korean adults know Korean … ~~but~~ they have difficulty hearing the [ra] vs. [la] contrast

phonemic contrasts are easier to hear