Psych 156A/ Ling 150: Acquisition of Language II

Lecture 3

Sounds

Announcements

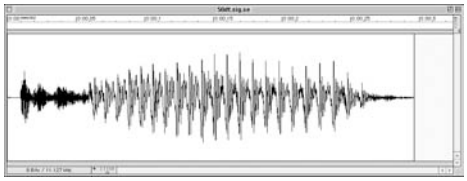
Be working on HW1 (due 4/13/10)

Review questions available for sounds & sounds of words

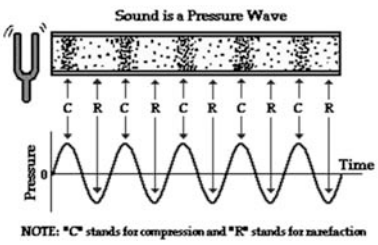
IPA chart available

Read Stager & Werker (1997) for next time

Learning Sounds

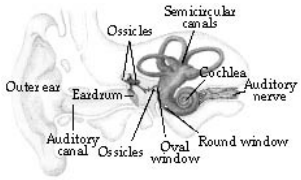


Sound Waves



A wave is a disturbance of a medium which transports energy through the medium without permanently transporting matter.

Listening



Hearing Frequency:
20 Hz and 20000 Hz
Speech:
200-8000 Hz
Most sensitive to
1000-3500 Hz
Phones (speech sounds):
300-3400 Hz

Sounds of Language (Speech Perception)

Learner's job: Identify phonemes (contrastive sounds that signal a change in meaning)

big vs. pig

Phonemes are language-specific - r/l is a phonemic contrast in English but not in Japanese

Lisa = Risa for some of my Japanese friends

Kids of the world require knowledge of phonemes before they can figure out what different words are - and when different meanings are signaled by different words

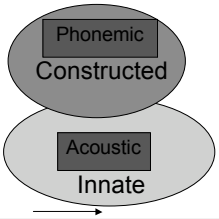
About Speech Perception

Important: Not all languages use the same contrastive sounds.

Languages draw from a common set of sounds (which can be represented by the International Phonetic Alphabet (IPA)), but only use a subset of that common set.

Child's task: Figure out what sounds their native language uses contrastively.

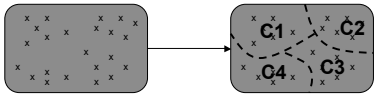
meaningful sounds in the language: "contrastive sounds" or phonemic contrasts



Speech Perception: Computational Problem

Divide sounds into contrastive categories (phonemes)

Here, 23 acoustically-different sounds are clustered into 4 contrastive categories. Sounds within categories are perceived as being identical to each other.



Categorical Perception

Categorical perception occurs when a range of stimuli that differ continuously are perceived as belonging to only a few categories with no degrees of difference within a given category.

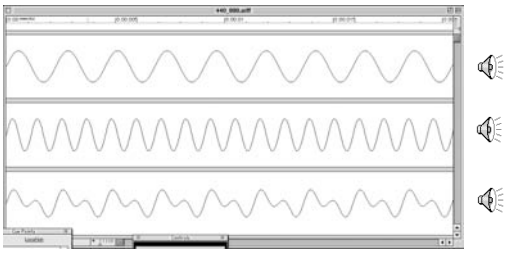
Actual stimuli

Categorical Perception of stimuli

Acoustic-Level Information

Includes: timing and frequency

Tones: frequency (close-up)



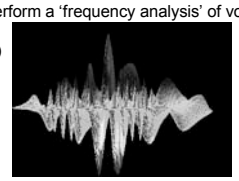
Acoustic-Level Information

Language sounds

Vowels combine acoustic energy at a number of different frequencies

Different vowels ([a] “ah”, [i] “ee”, [u] “oo” etc.) contain acoustic energy at different frequencies

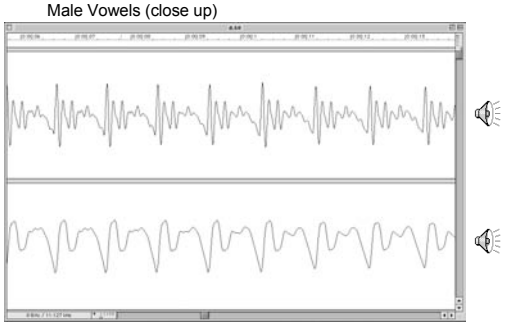
Listeners must perform a ‘frequency analysis’ of vowels in order to identify them (*Fourier Analysis*)



Acoustic-Level Information

Language sounds

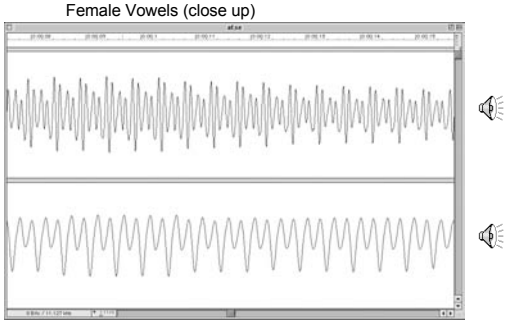
Male Vowels (close up)



Acoustic-Level Information

Language sounds

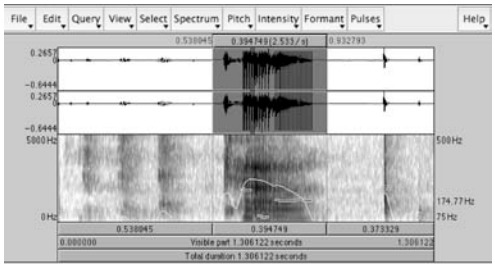
Female Vowels (close up)



Synthesized Speech

Allows for precise control of sounds

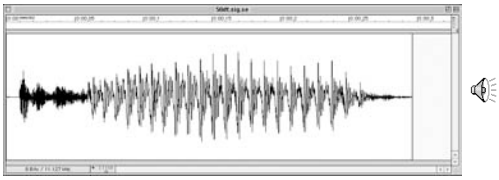
Valuable tool for investigating perception



Acoustic-Level Information

Language sounds

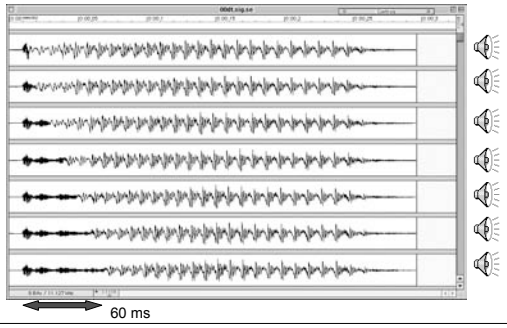
Timing: Voicing



Acoustic-Level Information

Language sounds

Timing: Voice Onset Time (VOT)



English VOT production

Not uniform - there are 2 categories (distribution is bimodal)

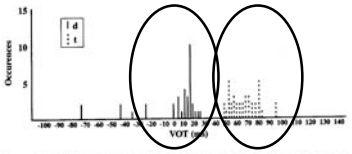
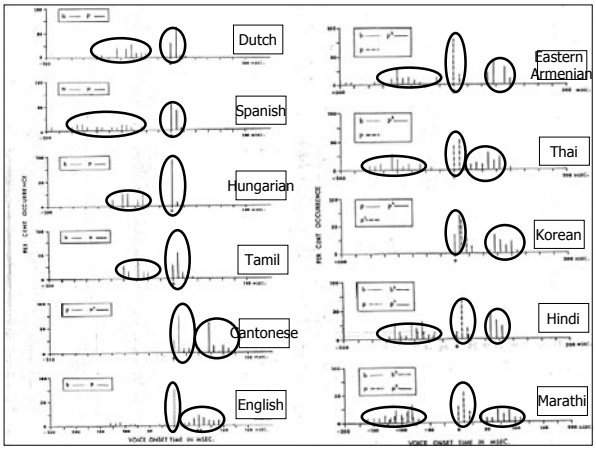


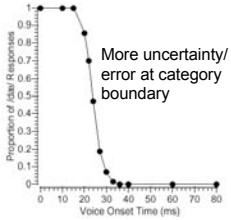
Figure 3–3. VOT productions of a single normal adult speaker of American English for words beginning with /d/ and /t/. (Figure adapted with permission from Blumstein, Cooper, Goodglass, Statlender, & Gottlieb, [1980]. Production Deficits in Aphasia: A Voice Onset-Time Analysis. *Brain and Language, 9*,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

Perception of stimuli: 2 categories

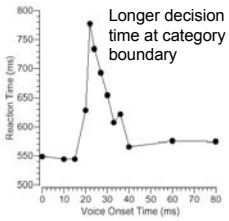


Perceiving VOT

'Categorical Perception': dæ vs. tæ



More uncertainty/ error at category boundary



Longer decision time at category boundary

Decision between d/t **Time to make decision**

Identification task:"Is this sound dæ or tæ?"

Discrimination Task

"Are these two sounds the same or different?"

Same/Different
0ms 60ms

Same/Different
0ms 10ms

Same/Different
40ms 40ms

Discrimination Task
"Are these two sounds the same or different?"

Same/Different
0ms 60ms

Same/Different
0ms 10ms

Same/Different
40ms 40ms

Why is this pair difficult?

(i) Acoustically similar?

(ii) Same Category?

Discrimination Task
"Are these two sounds the same or different?"

D 0ms 20ms D

D 20ms 40ms T

T 40ms 60ms T

Across-Category Discrimination is Easy

Within-Category Discrimination is Hard

Cross-language Differences

R L

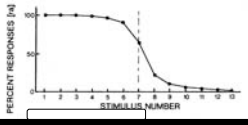
R L

Cross-Language Differences

Miyawaki et al. 1975

Identification task:

English speakers can discriminate r and l, and seem to show a similar pattern of categorical perception to what we saw for d vs. t



Cross-Language Differences

Discrimination task:

English speakers have higher
where one sound is perceived
Japanese speakers generally p
sounds are compared because

Miyawaki et al. 1975

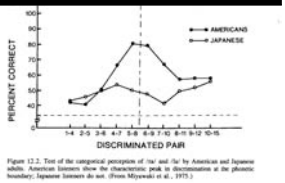


Figure 12.2. Test of the categorical perception of /ra/ and /la/ by American and Japanese adults. American listeners show the characteristic peak in discrimination at the phonetic boundary; Japanese listeners do not. (From Miyawaki et al., 1975.)

Cross-Language Differences

Hindi

dental [d]

(tip of tongue touches back of teeth)

retroflex [D]

(tongue curled so tip is behind alveolar ridge)

English [d] is usually somewhere between these

?

Cross-Language Differences

Salish
(Native North American language):
glotalized voiceless stops

Uvular – tongue is raised against the velum

Velar – tongue is raised behind the velum

(they are actually ejectives - ejective is produced by obstructing the airflow by raising the back of the tongue against or behind the velum)

Perceiving sound contrasts

Kids…

This ability to distinguish sound contrasts extends to phonemic contrasts that are non-native. (Japanese infants can discriminate contrasts used in English but that are not used in Japanese, like r/l.) This goes for both vowels and consonants.

…vs. adults

Adults can't, especially without training - even if the difference is quite acoustically salient.

So when is this ability lost?

And what changes from childhood to adulthood?

A useful indirect measurement

High Amplitude Sucking (HAS) Procedure

- Infant given a pacifier that measures sucking rate
- Habituation – Infant sucks to hear sound (e.g. ba) until bored.
- Test – Play sound (e.g., ba or pa). Is there *dishabituation*?
  - Infants will suck to hear sound if the sound is no longer boring.

A useful indirect measurement

High Amplitude Sucking (HAS) Procedure

http://psych.rice.edu/mmtbn/language/sPerception/video/sucking_h.mov

Testing categorical perception in infants: Eimas et al. (1971)

- BA vs. PA
- Vary Voice Onset Time (VOT): time between consonant release and vocal cord vibration

VOT in milliseconds

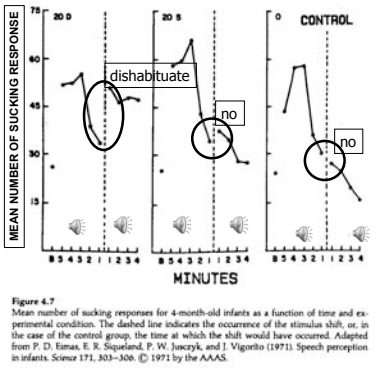
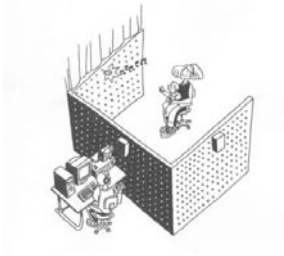


Figure 4.7
Mean number of sucking responses for 4-month-old infants as a function of time and experimental condition. The dashed line indicates the occurrence of the stimulus shift, or, in the case of the control group, the time at which the shift would have occurred. Adapted from P. D. Eimas, E. R.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

A useful indirect measurement

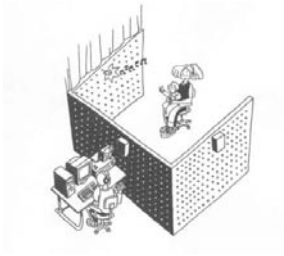
Head Turn Preference Procedure



Infant sits on caretaker's lap. The wall in front of the infant has a green light mounted in the center of it. The walls on the sides of the infant have red lights mounted in the center of them, and there are speakers hidden behind the red lights.

A useful indirect measurement

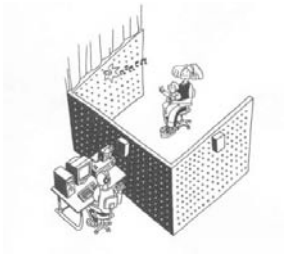
Head Turn Preference Procedure



Sounds are played from the two speakers mounted at eye-level to the left and right of the infant. The sounds start when the infant looks towards the blinking side light, and end when the infant looks away for more than two seconds.

A useful indirect measurement

Head Turn Preference Procedure



Thus, the infant essentially controls how long he or she hears the sounds. Differential preference for one type of sound over the other is used as evidence that infants can detect a difference between the types of sounds.

Head Turn Preference Procedure Movies

"How Babies Learn Language"
(first part, up to about the 2 minute mark)

http://www.youtube.com/watch?v=mZAuZ--Yeqo

http://psych.rice.edu/mmtbn/language/sPerception/infantHeadturn_h.html

Speech Perception of Non-Native Sounds

Comparing perceptual ability

Werker et al. 1981: English-learning 6-8 month olds compared against English & Hindi adults on Hindi contrasts

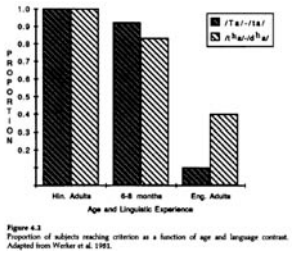


Figure 4.3
Proportion of subjects reaching criterion as a function of age and language contrast.
Adapted from Werker et al. 1981.

Speech Perception of Non-Native Sounds

Comparing perceptual ability

Werker et al. 1981: English-learning 6-8 month olds compared against English & Hindi adults on Hindi contrasts

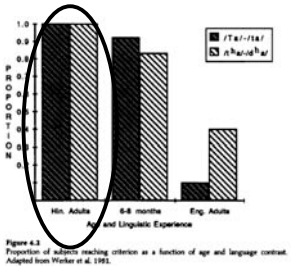


Figure 4.3
Proportion of subjects reaching criterion as a function of age and language contrast.
Adapted from Werker et al. 1981.

Hindi adults can easily distinguish sounds that are used contrastively in their language

Speech Perception of Non-Native Sounds

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Werker et al. 1981: English-learning 6-8 month olds compared against English & Hindi adults on Hindi contrasts

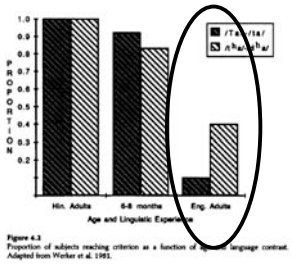


Figure 4.3
Proportion of subjects reaching criterion as a function of [illegible] language contrast.
Adapted from Werker et al. 1981.

English adults are terrible (below chance), though there is some variation depending on which sounds are being compared

Speech Perception of Non-Native Sounds

Comparing perceptual ability

Werker et al. 1981: English-learning 6-8 month olds compared against English & Hindi adults on Hindi contrasts

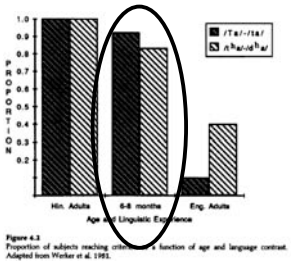


Figure 4.3
Proportion of subjects reaching criterion as a function of age and language contrast.
Adapted from Werker et al. 1981.

English infants between the ages of 6-8 months aren't quite as good as Hindi adults - but they're certainly much better than English adults! They haven't yet learned to ignore these non-native contrasts.

Sound-Learning Movie

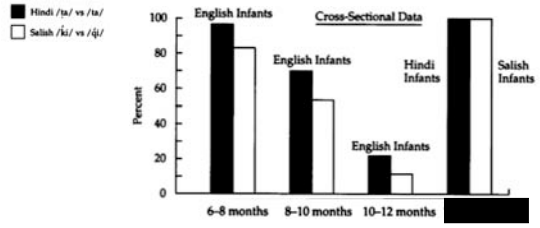
Infant Speech Discrimination

http://www.youtube.com/watch?v=GSIwu_Mhl4A

When Change Happens

But when after 6-8 months is the ability to lost? Werker & Tees (1984)

Testing ability to distinguish
Salish & Hindi contrasts



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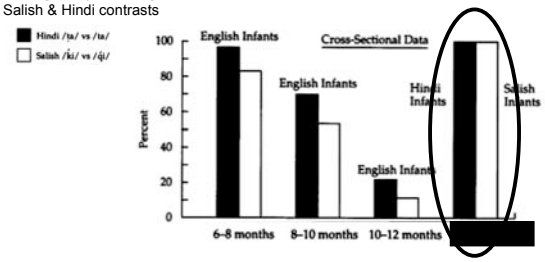

Control (make sure experiment is doable by infants):
Hindi and Salish infants do perfectly

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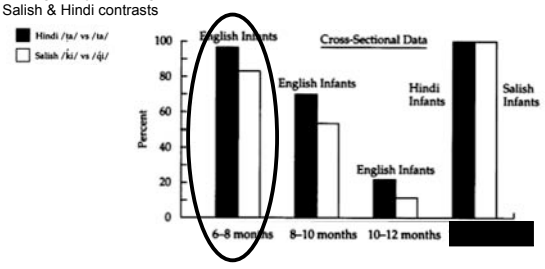

English 6-8 month-olds do well

When Change Happens

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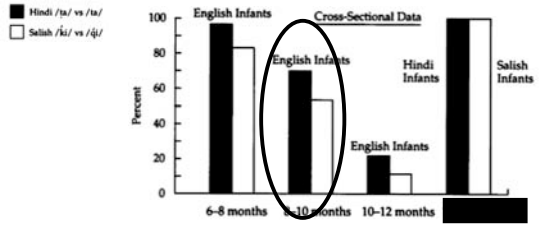
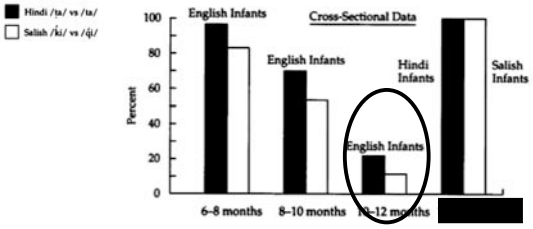


English 8-10 month-olds do less well

When Change Happens

But when after 6-8 months is the ability to lost? Werker & Tees (1984)

Testing ability to distinguish
Salish & Hindi contrasts

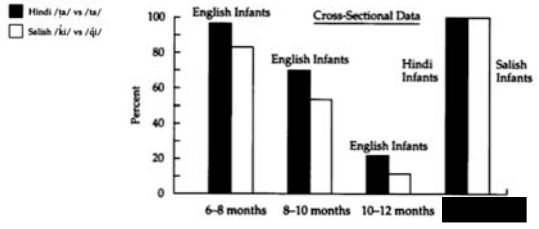


English 10-12 month-olds do very poorly

When Change Happens

But when after 6-8 months is the ability to lost? Werker & Tees (1984)

Testing ability to distinguish
Salish & Hindi contrasts



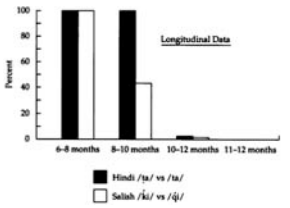
Implication: The ability to distinguish non-native contrasts is lost by 10-12 months. Change seems to be happening between 8-10 months.

When Change Happens

But when after 6-8 months is the ability to lost? Werker & Tees (1984)

Testing ability to distinguish
Salish & Hindi contrasts

Doing a longitudinal study with English infants (where the same infants are tested over time), change seems to happen somewhere around 10-12 months, depending on the sound contrast.



How Change Happens

Maintenance & Loss Theory **"Use it or lose it"**

Infants maintain contrasts being used in their language and lose all the others.

Structure-changing

Phonology

Phonetics

Acoustics

Patricia Kuhl

"Perceptual Magnet"

How Change Happens

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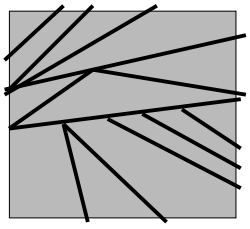
Natural boundaries
(acoustically salient)



Patricia Kuhl

"Perceptual Magnet"

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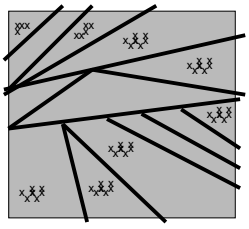
Sounds from Language 1



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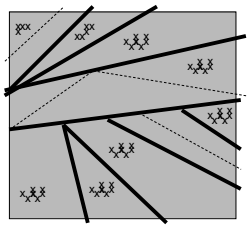
Infants maintain contrasts being used in their language and lose all the others.

Category boundaries that are maintained to keep these sound clusters distinct

Patricia Kuhl



"Perceptual Magnet"

How Change Happens

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Sounds from Language 2

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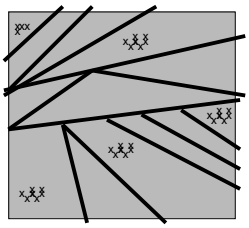

"Perceptual Magnet"

How Change Happens

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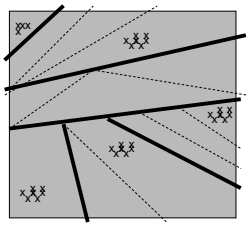
Category boundaries that are maintained to keep these sound clusters distinct

Patricia Kuhl



"Perceptual Magnet"

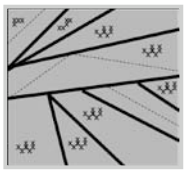
How Change Happens

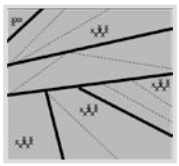
Maintenance & Loss Theory **"Use it or lose it"**

Infants maintain contrasts being used in their language and lose all the others.

Cross-linguistic variation in which contrasts are maintained, depending on language input

Patricia Kuhl





"Perceptual Magnet"

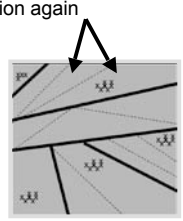
How Change Happens

Maintenance & Loss Theory **"Use it or lose it"**

Prediction for performance on non-native contrasts over time:

Loss of discrimination ability is permanent and absolute

Should never be able to hear this distinction again



How change happens

Problems with the Maintenance & Loss Theory

If it doesn't sound like speech, adults can tell the difference. Werker & Tees (1984) showed this with truncated portions of syllables of non-native contrasts. They told subjects the sounds were water dropping into a bucket, and to tell them when the bucket changed. Adults who could not perceive the difference when they heard the entire syllable could perceive the difference when they processed the consonant sounds separately as a non-linguistic sound - like water dropping into a bucket.

Non-linguistic perception

How change happens

Problems with the Maintenance & Loss Theory

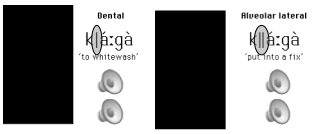
Pisoni et al. (1982), Werker & Logan (1985): adults can be trained if given enough trials or tested in sensitive procedures with low memory demands.

Maintenance & Loss would predict that this ability should be irrevocably lost - and it shouldn't matter how much training adults receive, or how the task is manipulated to help them.

How change happens

Problems with the Maintenance & Loss Theory

Some non-native contrasts are easy for older infants and adults to discriminate, even though these sounds are never heard in their own languages. (Click languages (Zulu) - click sounds like "tsk tsk" nonspeech)



http://hctv.humnet.ucla.edu/departments/linguistics/VowelsandConsonants/course/chapter6/zulu/zulu.html

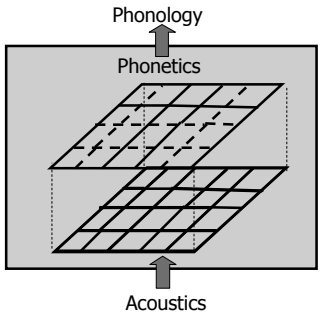
How change happens

Another theory: Functional reorganization

Janet Werker

Structure-building

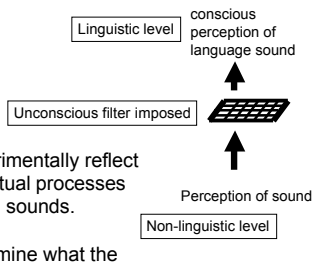
Native language phonemes built from universal phones



How change happens

Another theory: Functional reorganization

Janet Werker



Changes attested experimentally reflect operation of postperceptual processes that kick in for language sounds.

Data distributions determine what the category boundaries are in the filter. Importantly, constructing this filter does not affect base-level sound perception.

How change happens

Another theory: Functional reorganization

Explanatory power: the whole story

Very young infants respond to any detectable variation - so they can pick up any salient contrasts in surrounding language. Adults have a bias for phonemic contrasts since those are the ones relevant to language. If they're in a non-language setting, adults can distinguish non-native contrastive sounds.

Learning Sounds: Recap

One of the things children must do is figure out what the meaningful contrastive sounds (phonemes) in their native language are.

Phonemes vary from one language to another.

Children initially can hear many contrastive sounds, even non-native ones. However, they seem to have lost this ability by 10-12 months and instead only consciously hear the contrastive sounds of their native language.

Evidence suggests that this perceptual change is a specialized unconscious filter that is only active when the brain believes it is processing language sounds.

Questions?

Use the remaining time to work on HW1 and look over the sound review questions.