Psych 156A/ Ling 150: Acquisition of Language II

Lecture 3

Sounds

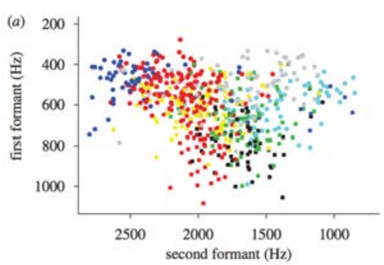
Announcements

Be working on HW1 (due 4/17/14)

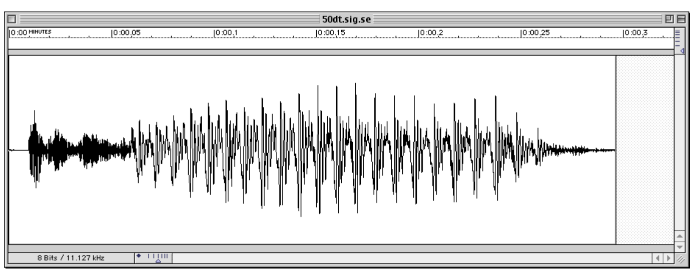
Update to HW1 (to correct an error) — please work from current version

Review questions available for sounds & sounds of words

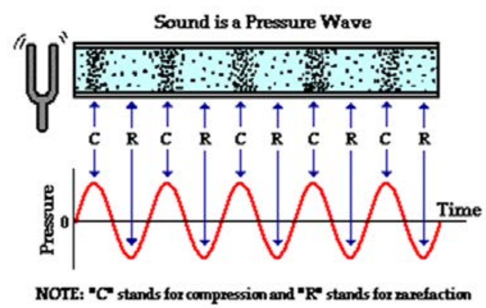
IPA sound conversion chart available



Learning sounds

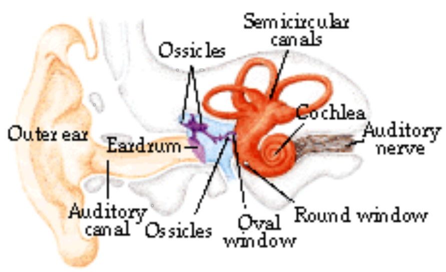


Sound waves



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

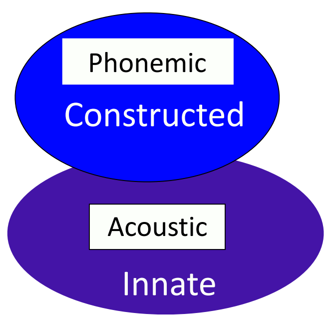
About speech perception

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.

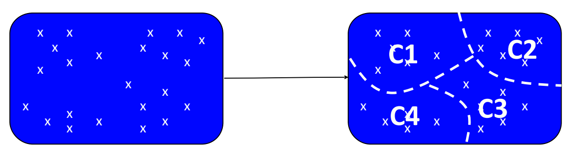
meaningful sounds in the language: "contrastive sounds" or phonemic contrasts



Speech perception: Computational problem

Divide sounds into contrastive categories (phonemes)

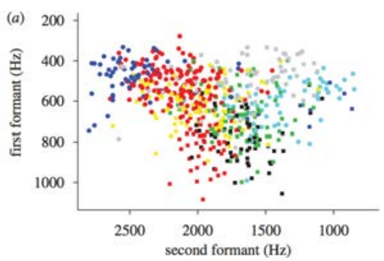
Here, 23 acoustically-different sounds are clustered into 4 contrastive categories. Sounds within categories are perceived as being identical to each other.



Speech perception: Computational problem

Note:

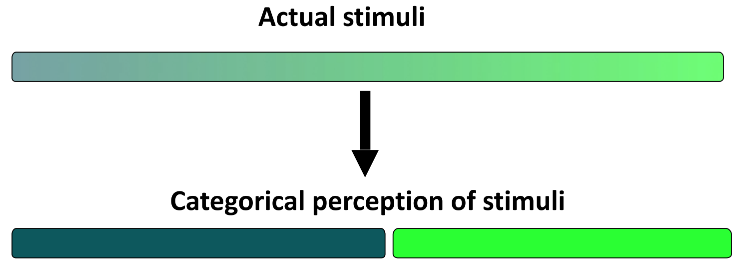
Real life sounds are actually much harder because categories overlap.



Each color represents one vowel (that is, a sound perceived by native speakers as one vowel, like “oo” or “ee”)

Categorical perception

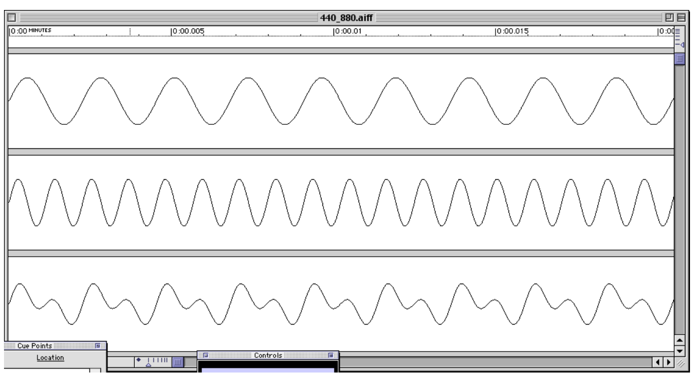
Categorical perception occurs when a range of stimuli that differ continuously are perceived as belonging to only a few categories, with no degrees of difference within a given category.



Acoustic-level information

Includes: timing and frequency

Tones: frequency (close-up)

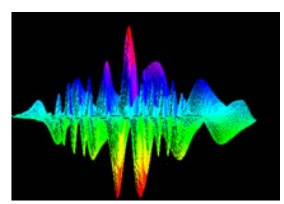


Acoustic-level information

Vowels combine acoustic energy at a number of different frequencies

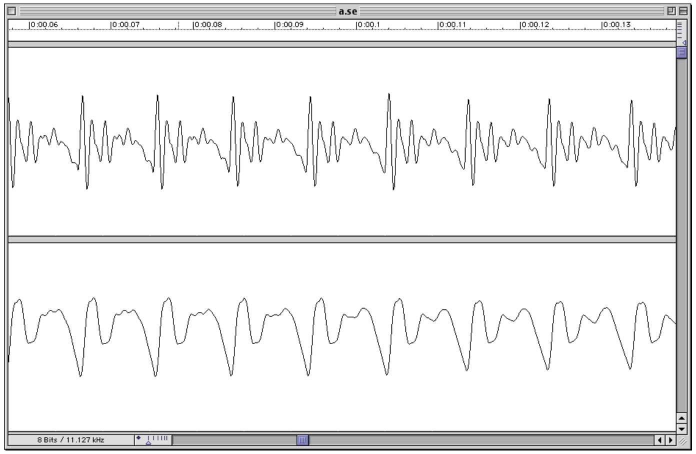
Different vowels ([a] “ah”, [i] “ee”, [u] “oo” etc.) contain acoustic energy at different frequencies

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



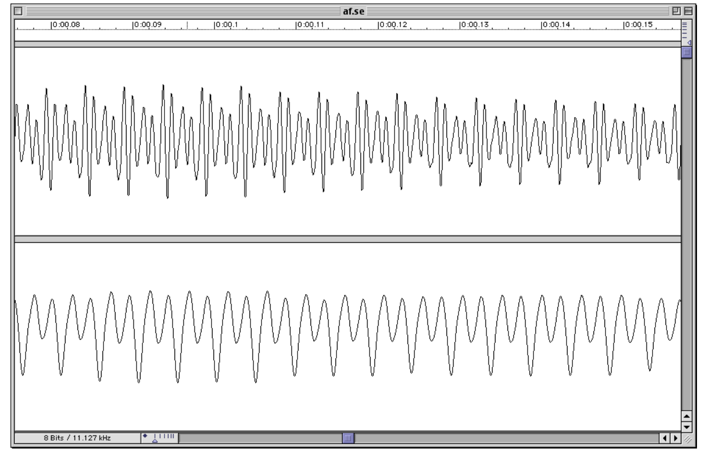
Acoustic-level information

Male Vowels (close up)



Acoustic-level information

Female Vowels (close up)

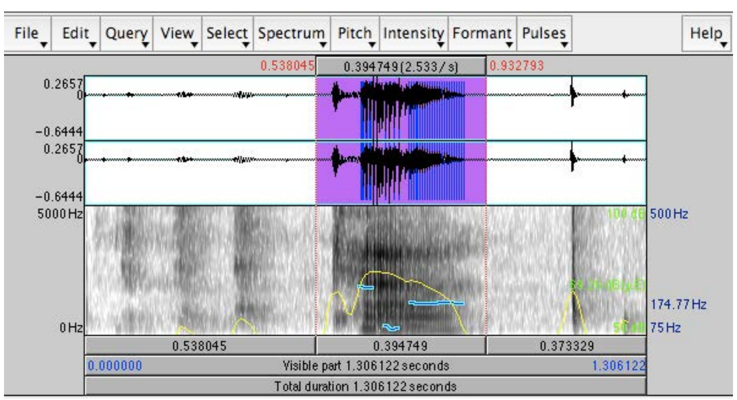


Synthesized speech

Allows for precise control of sounds

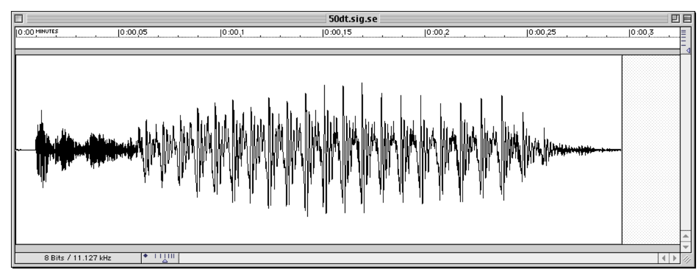
http://www.fon.hum.uva.nl/praat/
www.praat.org

Valuable tool for investigating perception: **Praat**



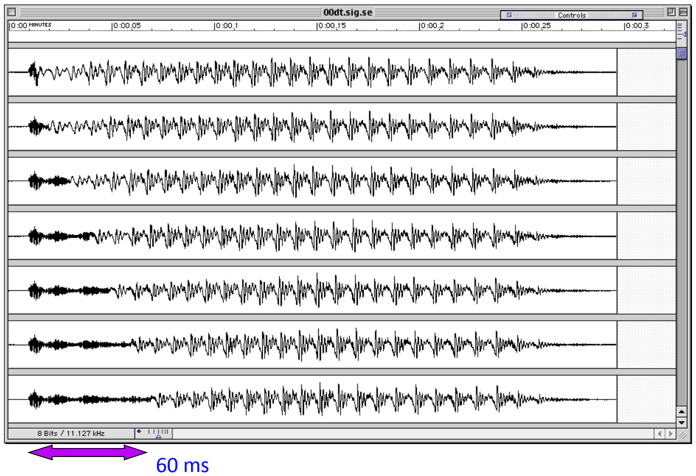
Acoustic-level information

Timing: Voicing



Acoustic-level information

Timing: Voice Onset Time (VOT)



English VOT production

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

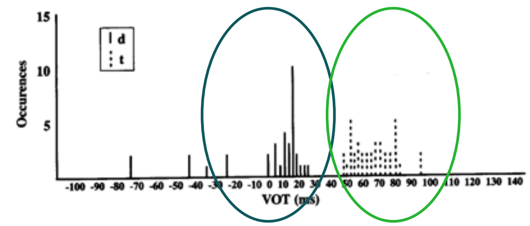
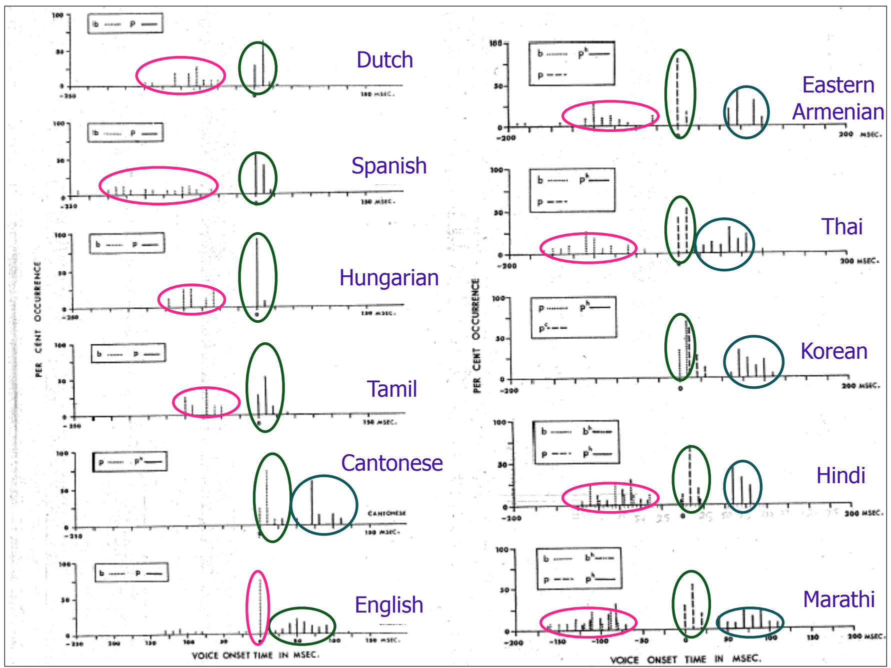


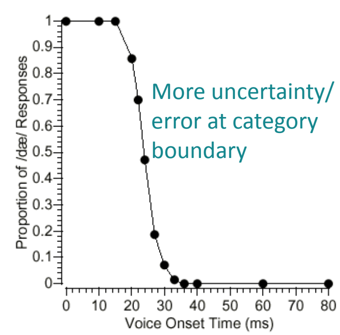
Figure 5–3. VOT productions of a single normal adult speaker of American English for words beginning with /d/ and /t/. (Figure adapted with permission from Blumstein, Cooper, Goodglass, Statlender, & Gottlieb, [1980]. Production Deficits in Aphasia: A Voice Onset-Time Analysis. *Brain and Language*,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

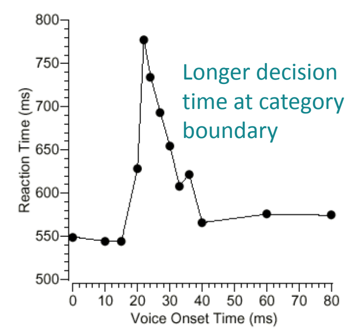
Perception of stimuli: 2 categories



Perceiving VOT

'Categorical Perception': dæ vs. tæ





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

Why is this pair difficult?

(i) Acoustically similar?

(ii) Same Category?

Same/Different
40ms 40ms

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

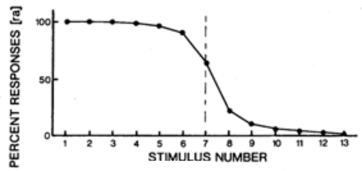
R L

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



R -----------------------> L

Cross-language differences

Discrimination task:

English speakers have higher performance at the r/l category boundary, where one sound is perceived as r and one sound is perceived as l. Japanese speakers generally perform poorly (at chance), no matter what sounds are compared because r and l are not contrastive for them.

Miyawaki et al. 1975

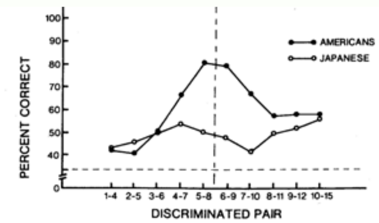


Figure 12.2. Test of the categorical perception of /ra/ and /la/ by American and Japanese adults. American listeners show the characteristic peak in discrimination at the phonetic boundary; Japanese listeners do not. (From Miyawaki et al., 1975.)

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.

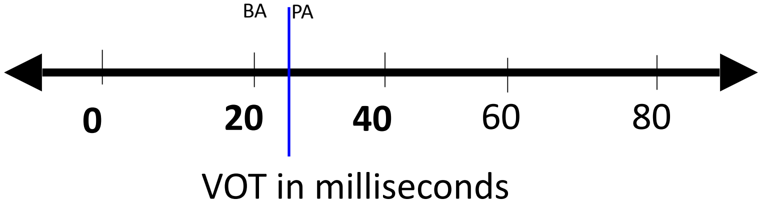
A useful indirect measurement

High Amplitude Sucking (HAS) Procedure

video ~4 minutes long

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



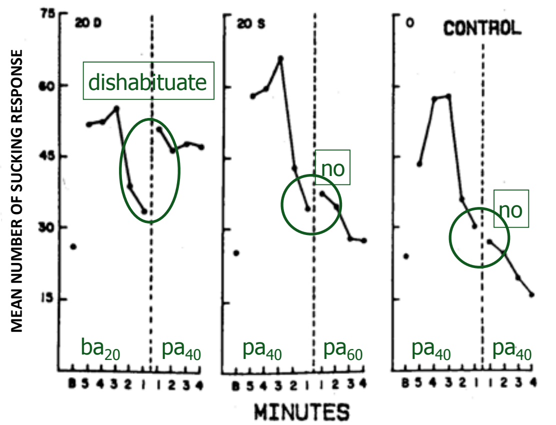
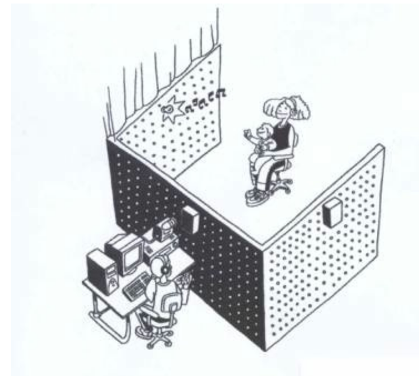


Figure 4.7
Mean number of sucking responses for 4-month-old infants as a function of time and experimental condition. The dashed line indicates the occurrence of the stimulus shift, or, in the case of the control group, the time at which the shift would have occurred. Adapted from P. D. Eimas, E. R.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

A useful indirect measurement

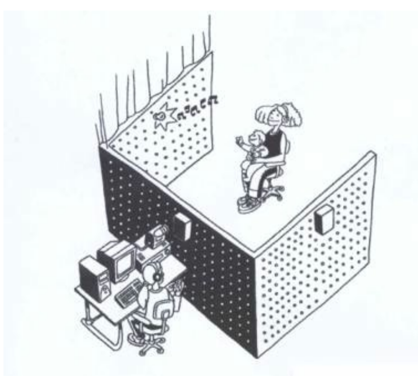
Head-Turn Preference Procedure



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

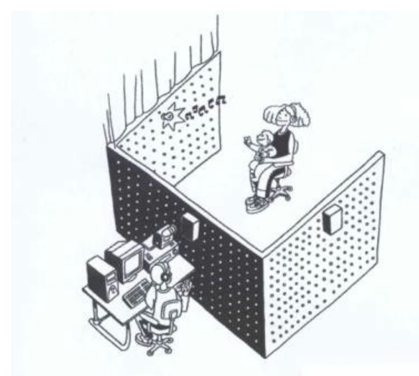
Head-Turn Preference Procedure

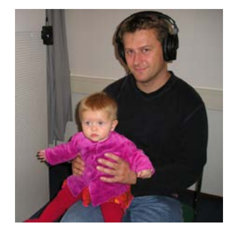


Sounds are played from the two speakers mounted at eye-level to the left and right of the infant. The sounds start when the infant looks towards the blinking side light, and end when the infant looks away for more than two seconds.

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

“How Babies Learn Language”
(first part, up to 2:04)

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

A useful indirect measurement

Head-Turn Technique

Babies tend to be interested in moving toys. Using the presentation of a moving toy as a reward, babies are trained to turn their heads when they hear a change in the sound being presented.

A useful indirect measurement

Head-Turn Technique

A sound is played over and over, and then the sound is changed followed immediately by the presentation of the moving toy. After several trials, babies turn their heads when the sounds change even before the moving toy is activated.

A useful indirect measurement

Head-Turn Technique

http://www.youtube.com/watch?v=dAU5CAl1U6M
Especially 1:54-4:02

Note on infant attention:

Familiarity vs. novelty effects

For procedures that involve measuring where children prefer to look (such as head turn preference), sometimes children seem to have a "familiarity preference" where they prefer to look at something similar to what they habituated to. Other times, children seem to have a "novelty" preference where they prefer to look at something different to what they habituated to.

This may have to do with the Goldilocks effect (Kidd et al. 2010, 2012), effect where children prefer to look at stimuli that are neither too boring nor too surprising, but are instead "just right" for learning, given the child's current knowledge state.

Speech perception of non-native sounds

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

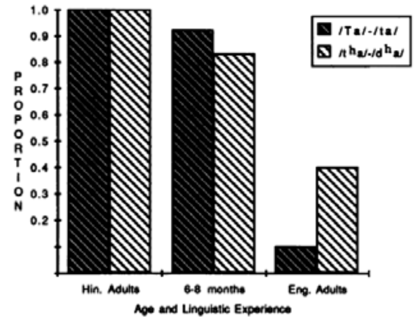


Figure 4.2
Proportion of subjects reaching criterion as a function of age and language contrast. Adapted from Werker et al. 1981.

Speech perception of non-native sounds

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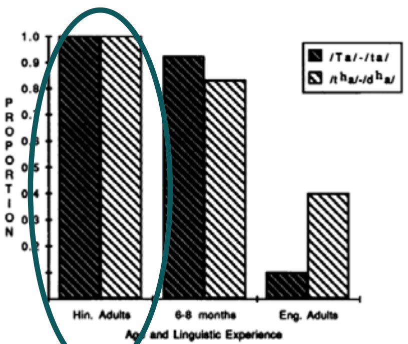


Figure 4.2
Proportion of subjects reaching criterion as a function of age and language contrast. Adapted from Werker et al. 1981.

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

Speech perception of non-native sounds

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

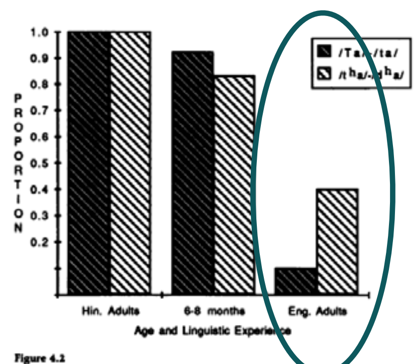
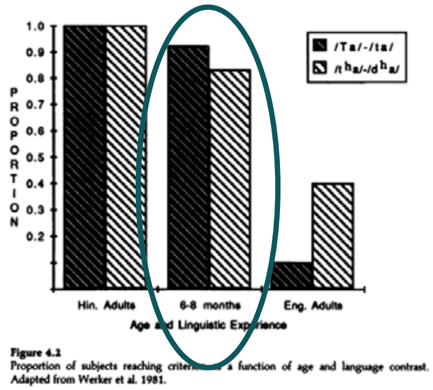


Figure 4.2
Proportion of subjects reaching criterion as a function of language contrast. Adapted from Werker et al. 1981.

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

Speech perception of non-native sounds

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



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

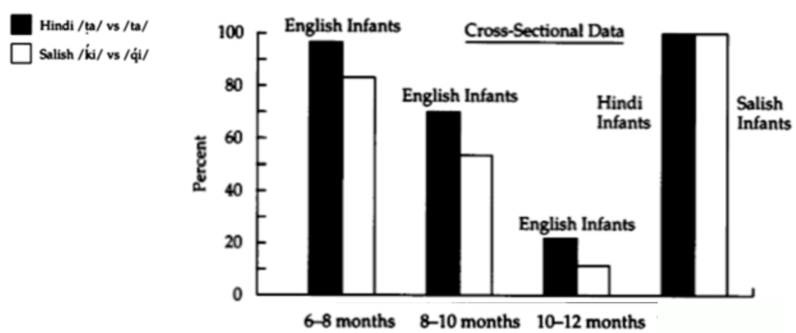
Infant speech discrimination

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



When change happens

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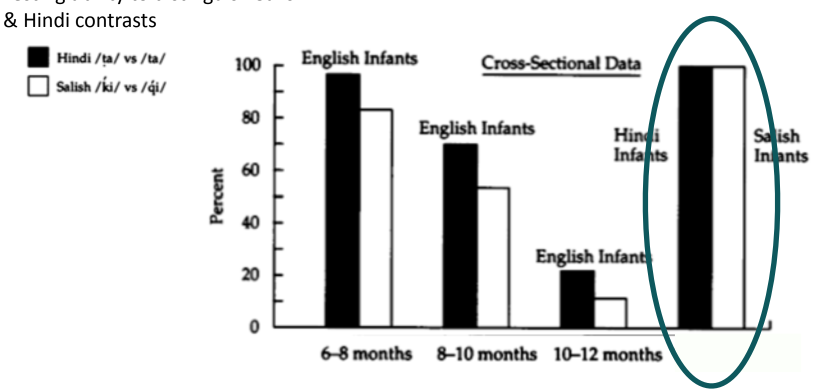
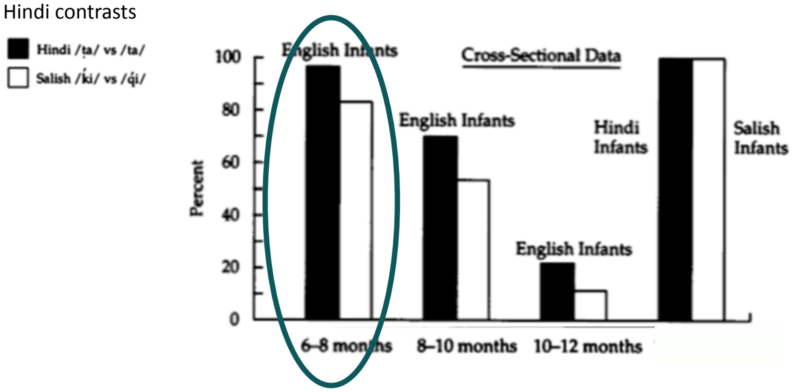


Control (make sure experiment is doable by infants): Hindi and Salish infants do perfectly

When change happens

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

Testing ability to distinguish Salish
& Hindi contrasts

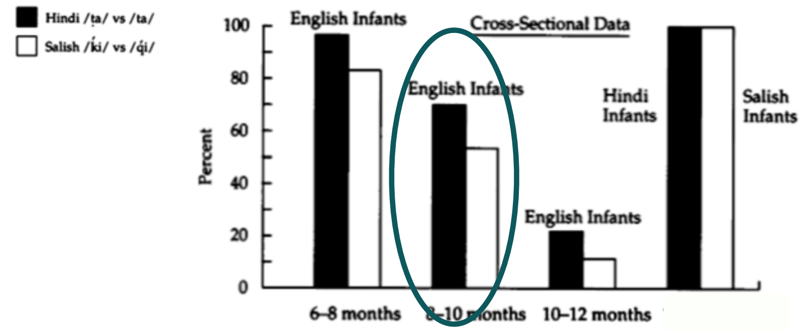


English 6 to 8-month-olds do well

When change happens

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

Testing ability to distinguish Salish
& Hindi contrasts

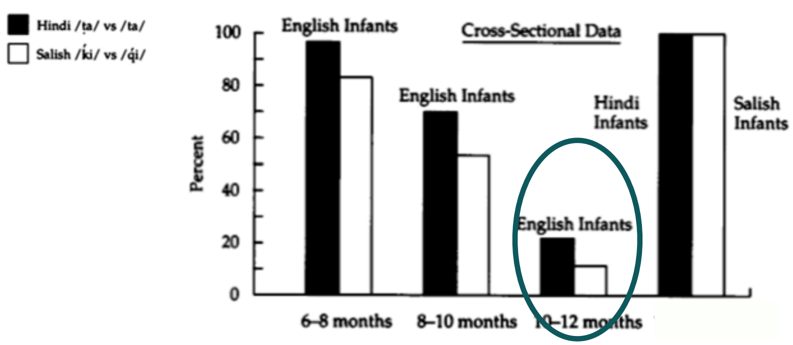


English 8 to 10-month-olds do less well

When change happens

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

Testing ability to distinguish Salish
& Hindi contrasts

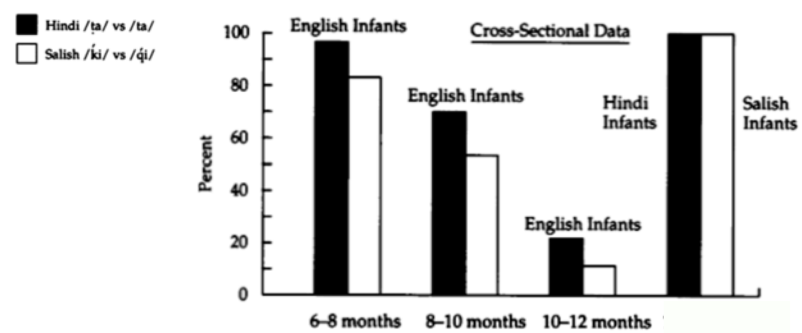


English 10 to 12-month-olds do very poorly

When change happens

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

Testing ability to distinguish Salish
& Hindi contrasts

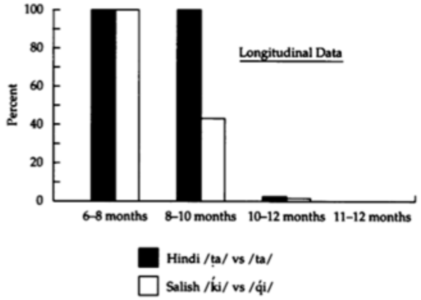


Implication: The ability to distinguish non-native contrasts is lost by 10-12 months. Change seems to be happening between 8-10 months.

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.

Yoshida et al. (2010) suggest that infants have some malleability still at 10 months, but it's much less than at 6 or 8 months.

Recap: Speech perception

One task for children is to figure out the contrastive sound categories (phonemes) for their language.

Categorical perception will occur once sounds are grouped into these contrastive sound categories - even though the sounds within a category differ acoustically, these language sounds will be perceived as being the same.

Infants seem to figure out their native language phonemes around 10-12 months.

Next time: How do children do this?

Questions?

You should be able to do up through question 10 on the sounds review questions, and up through question 6 on HW1.