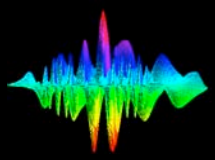
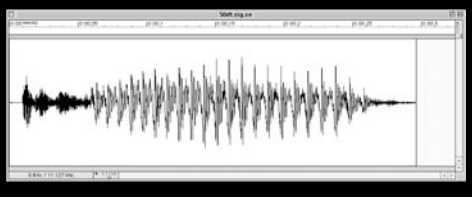
Psych 215: Language Sciences (Language Acquisition)

Lecture 4

Speech Perception I



Learning Sounds



Sounds of Language (Speech Perception)

Learner's job: parse continuous stream of speech into sentences, clauses, words, syllables, and phonemes

big vs. dig

Phonemes are language-specific - r/l is a phonemic contrast (changes word's meaning) 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

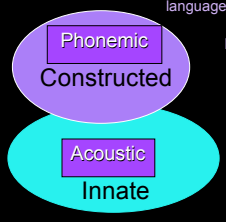
Important: Not all languages use the same sounds.

Languages draw from a common set of sounds.

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

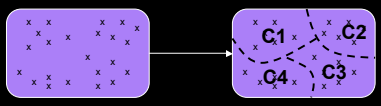
meaningful sounds in the language: "contrastive sounds"

phonemic contrasts



Speech Perception: Computational Problem

Divide sounds into contrastive categories

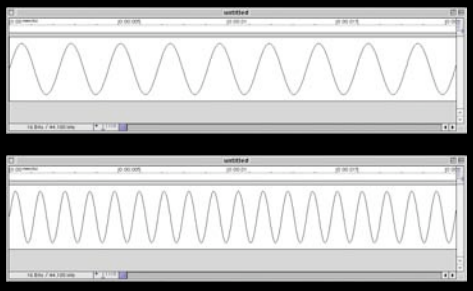


Acoustic-Level Information

Includes: timing and frequency
Tones: frequency

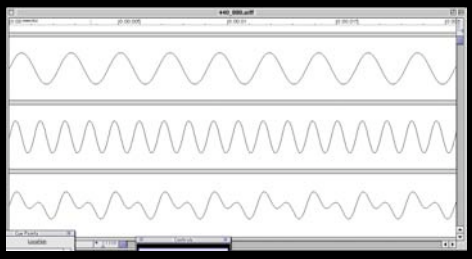
Acoustic-Level Information

Includes: timing and frequency
Tones: frequency (close-up)



Acoustic-Level Information

Includes: timing and frequency
Tones: frequency (close-up)



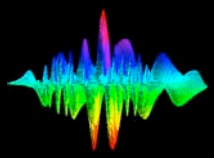
Acoustic-Level Information

Language sounds

Vowels combine acoustic energy at a number of different frequencies

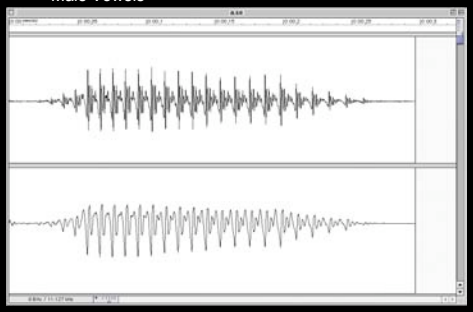
Different vowels ([a] “ah”, [i] “ee”, [u] “oo” etc.) contain acoustic energy at different frequencies

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



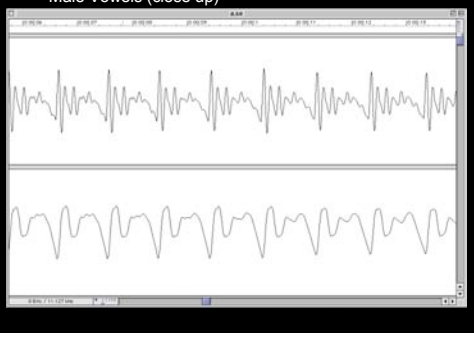
Acoustic-Level Information

Language sounds
Male Vowels



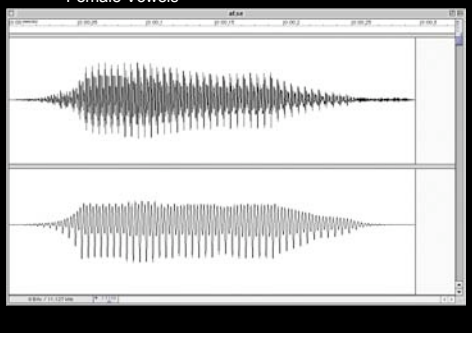
Acoustic-Level Information

Language sounds
Male Vowels (close up)



Acoustic-Level Information

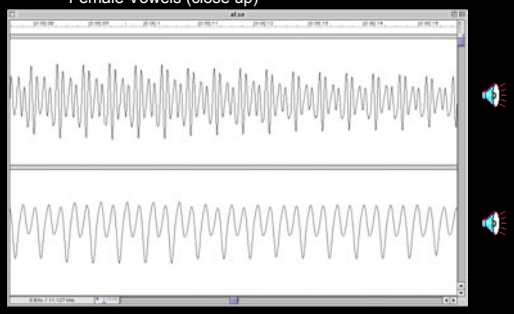
Language sounds
Female Vowels



Acoustic-Level Information

Language sounds

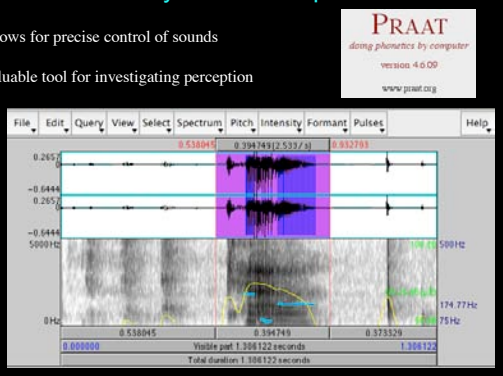
Female Vowels (close up)



Synthesized Speech

Allows for precise control of sounds

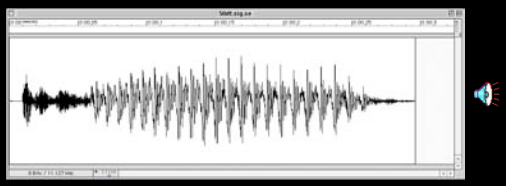
Valuable tool for investigating perception



Acoustic-Level Information

Language sounds

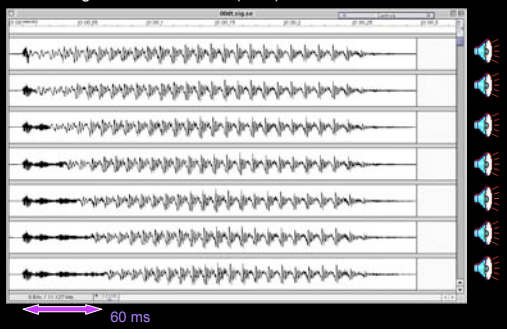
Timing: Voicing



Acoustic-Level Information

Language sounds

Timing: Voice Onset Time (VOT)



English VOT production

Not uniform - there are 2 categories

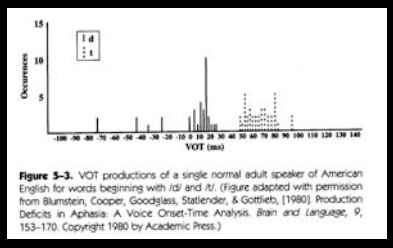
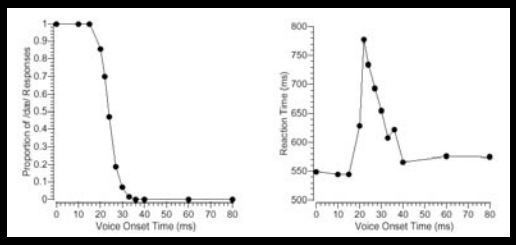


Figure 5–3. VOT productions of a single normal adult speaker of American English for words beginning with /d/ and /t/. (Figure adapted with permission from Blumstein, Cooper, Goodglass, Statlender, & Gottlieb, [1980]. Production Deficits in Aphasia: A Voice Onset-Time Analysis. *Brain and Language, 9*,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

Perceiving VOT

'Categorical Perception': dæ vs. tæ



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

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

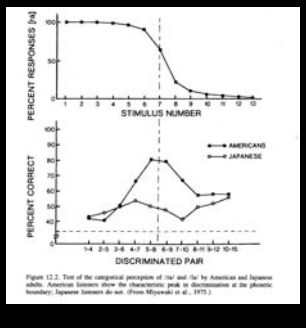
Cross-language Differences

R L

R L

Cross-Language Differences

English vs.
Japanese R-L



Cross-Language Differences

English vs. Hindi

alveolar [d]

retroflex [D]

?

Human and Non-Human Perception

Perceptual biases shared with other animals:

Discriminate native language rhythm only when played forward, not backward

Categorical discrimination of some contrasts

(ex: voice onset time “d” vs. “t”)

Human and Non-Human Perception

Perceptual biases possibly shared with other animals:

Preference for speech over acoustically matched non-speech sounds

Sensitivity to cues that indicate word boundaries

(From cognitive neuroscience studies): unique cortical activation to forward speech vs. backward speech

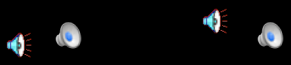
Infant Speech Perception

How do we tell what infants know, or use, or are sensitive to?

Researchers use indirect measurement techniques.

Some information from the High Amplitude Sucking (HAS) paradigm

Infants have sophisticated discrimination abilities, but they don't abstract sounds into categories the way that adults do.



Infant Speech Perception

How do we tell what infants know, or use, or are sensitive to?

Researchers use indirect measurement techniques.

Some information from the High Amplitude Sucking (HAS) paradigm

Infants have sophisticated discrimination abilities, but they don't abstract sounds into categories the way that adults do.

Adult perception

Infant Speech Perception

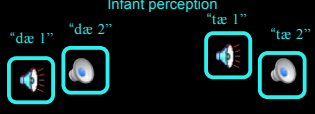
How do we tell what infants know, or use, or are sensitive to?

Researchers use indirect measurement techniques.

Some information from the High Amplitude Sucking (HAS) paradigm

Infants have sophisticated discrimination abilities, but they don't abstract sounds into categories the way that adults do.

Infant perception



Infant Speech Perception

How do we tell what infants know, or use, or are sensitive to?

Researchers use indirect measurement techniques.

Some information from the High Amplitude Sucking (HAS) paradigm

Infants have sophisticated discrimination abilities, but they don't abstract sounds into categories the way that adults do.

Infant Speech Perception

How do we tell what infants know, or use, or are sensitive to?

Researchers use indirect measurement techniques.

Some information from the High Amplitude Sucking (HAS) paradigm

Infants have sophisticated discrimination abilities, but they don't abstract sounds into categories the way that adults do.

Adult perception

"dæ" "tæ"

phonemic category phonemic category

Infant Speech Perception

How do we tell what infants know, or use, or are sensitive to?

Researchers use indirect measurement techniques.

Some information from the High Amplitude Sucking (HAS) paradigm

Infants have sophisticated discrimination abilities, but they don't abstract sounds into categories the way that adults do.

Infant perception

"dæ 1" "dæ 2" "tæ 1" "tæ 2"

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 not in Japanese, like r/l.) This goes for both vowels and consonants.

…vs. adults

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

So when is this ability lost?

And what changes from childhood to adulthood?

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 English & Hindi contrasts

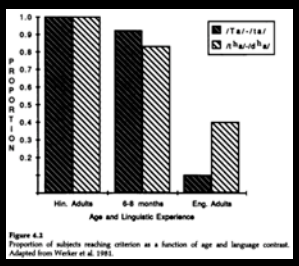


Figure 4.3
Proportion of subjects reaching criterion as a function of age and language contrast. Adapted from Werker et al. 1981.

Conditioned Head Turn Procedure

Werker (1995): Speech Perception

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

Key into "critical period" hypothesis for language (Lenneberg 1967) - when language can be learned natively

"To test for this critial period, children of 12 and 8 years were tested, with the expectation that the 8-year-olds but not the 12-year-olds would be able to discriminate nonnative contrasts. English-speaking children of both ages, however, performed like English-speaking adults…study was extended to 4-year old children, who actually performed most poorly of all on nonnative contrasts….findings revealed that experience must begin to influence speech perception long before 4, certainly well before the critical period suggested by Lenneberg."

Speech Perception of Non-Native Sounds

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

Salish & Hindi contrasts

Change happens somewhere around 8-10 months, depending on the sound contrast.

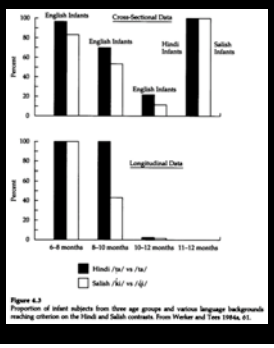


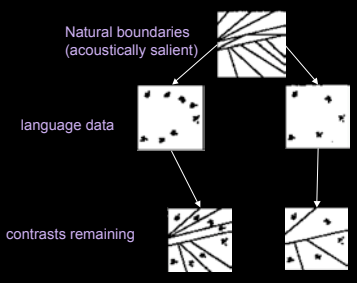
Figure 4.5
Proportion of infant subjects from three age groups and various language backgrounds reaching criterion on the Hindi and Salish contrasts. From Werker and Tees 1984a, 61.

How change happens

Maintenance & Loss Theory

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

Patricia Kuhl



"Perceptual Magnet"

How change happens

Maintenance & Loss Theory

Predictions for performance on non-native contrasts over time

Loss of discrimination ability is permanent and absolute

"…appears that the role of experience is to "maintain" those perceptual sensitivities that are already evident in the young infant. Without such exposure, initial abilities will be lost."

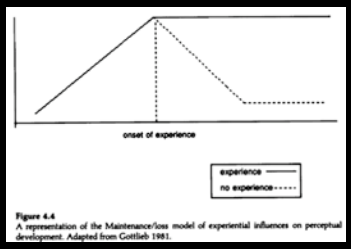


Figure 4.4
A representation of the Maintenance/loss model of experiential influences on perceptual development. Adapted from Gottlieb 1981.

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.

Non-linguistic perception

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

Can be taught

Decline and then recovery (after 4 years old) should never happen if this theory is correct….

But there's improvement for older speakers

How change happens

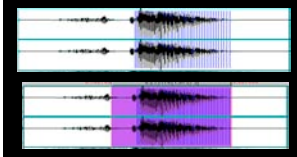
And another problem

Some non-native contrasts are easy for older infants and adults to discriminate. (Click languages (Zulu) - click sounds like "tsk tsk" nonspeech)

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

Is it just about hearing examples in the input?

Pegg & Werker (1994): adult English speakers to English 6-8 month olds and 10-12 month olds on systematic allophonic distinctions in English ("t" in top vs. "t" in stop)



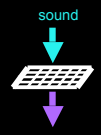
Conditioned Head Turn Procedure: adults & 6-8 month olds notice difference, but 10-12 month olds don't

Apparently not just about having the sounds in the input…

How change happens

Another theory: functional reorganization
Changes attested experimentally reflect operation of postperceptual processes that kick in for language

Janet Werker



How change happens

Another theory: functional reorganization
Changes attested experimentally reflect operation of postperceptual processes that kick in for language

Janet Werker

Explanatory power: the whole story
Very young infants respond to any detectable variation - so they can pick up any salient ones in surrounding language. Adults have bias for phonemic information since those are the ones relevant to language. If in non-language setting, adults can tell the nonphonemic differences.

Open question: but why can't 12 month olds (up to 4 year olds) do the same?

Perceptual Ability Links

The effect of early exposure to sounds in a language:

Links with later language proficiency

Vowel discrimination at 6 months predicts vocabulary size at 13-24 months

Reading proficiency correlated with sound discrimination as neonate

Bilingual evidence: don't have true bilingual discrimination if exposed to sound system after 3-4 years of age

Word Learning & Back to the Critical Period

The connection with word-learning
"Starting at around 1 year of age, infants are poised to begin to learn words, a task they will devote considerable energy to…a language-specific bias to attend to only those differences that are used to contrast meaning in the native language will help the child…sensitivity to too much variation could result in [mapping] errors."

Adults already have their vocabularies fairly stable
"Adults…have the cognitive "distance" and strategic skills to listen for whatever information is required in a particular task. Thus, if the task requires listening to nonnative phonetic distinctions, the adults will - with varying amounts of practice or training - be able to demonstrate such an ability."

Linking to the critical period?
"Similarly, young children moving to a new linguistic environment would have the auditory sensitivity to listen to the relevant phonetic detail to acquire words in their new language."

More on Critical Periods…

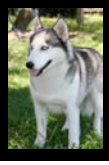
But a slight problem, with respect to the critical period…there *is* one
Functional reorganization would imply continued flexibility throughout life. Maybe the problem is that there's a difference between perceptual accent (ability to perceive non-native differences) and productive accent (ability to produce non-native differences).

Could be a separate critical period for each.

Also a problem with word-learning connection - kids don't seem to show phonetic distinction when word-learning
12-18 month olds treat "dog" and "bog" as the same.

More on this later…

"dog" or "bog"



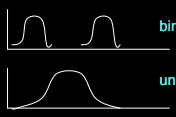
How change happens

Possible Mechanism: Statistical Learning

9 month infants are sensitive to the frequency and distribution of perceptual input in speech.

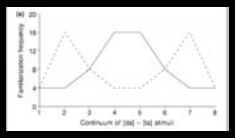
Highly frequent distinctions are learned earlier.

Life's easier when the distribution is bimodal, though



Distributional learning

Possible Mechanism: Statistical Learning

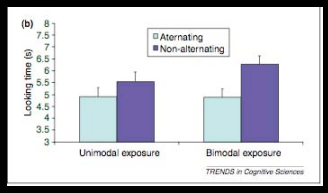


Infants exposed to either unimodal or bimodal distribution

Alternating test: stimuli 1 and 8

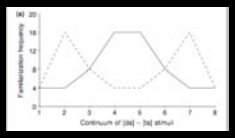
Non-alternating baseline: stimuli 3 or stimuli 6

Maye et al. 2002



Distributional learning

Possible Mechanism: Statistical Learning



Infants exposed to either unimodal or bimodal distribution

Alternating test: stimuli 1 and 8

Non-alternating baseline: stimuli 3 or stimuli 6

Maye et al. 2002

Bimodal children are sensitive to the presence of two categories