

# Psych 229: Language Acquisition

## Lecture 9 Speech Perception

### Gerken & Aslin (2005): Jusczyk Speech Perception Research Review

Prosodic markers can help, but can't be all there is - specific linguistic units are difficult for young learners to locate in fluent speech (Gerken, Jusczyk, & Mandel, 1994)

Still prosody is something noted early by children (2-6 months) and stored in memory (Mandel et al. 1994; Mandel et al. 1996; Nazzi et al. 2000)



Newborns discriminate mother's native language from another language based on prosodic information (Mehler et al., 1988; Nazzi et al. 2000)

### Gerken & Aslin (2005): Jusczyk Speech Perception Research Review

Prosody for word segmentation: trochaic bias for English (Jusczyk, Cutler, & Redanz (1993) with 9-month olds)

Metrical phonology:

trochee: **ba** by  
          **strong** weak  
iamb:  gui **tar**  
          weak **strong**



Turk, Jusczyk, & Gerken (1995): Infants sensitive to syllable weight when discerning stress patterns

syllable weight:  
VV(C) = **knee, noon, baste**  
          Heavy  
V(C) = **plot, deft**  
          Light

### Gerken & Aslin (2005): Jusczyk Speech Perception Research Review

Statistical tracking for phonotactics at 9 months

Infants track consonant sequences (blick vs. \*bnick)

Jusczyk et al. 1993: 9-month old American & Dutch infants

Infants sensitive to frequency of consonant sequences = evidence of statistical learning

Jusczyk, Luce, & Charles-Luce 1994

Support for highly specific acoustic information in memory for infants  
Jusczyk & Aslin (1995) with 7.5 month olds: Infants have fine acoustic detail for words heard in fluent speech ("dog" is not "tog")

### Gerken & Aslin (2005): Jusczyk Speech Perception Research Review

Prosodic cues to word segmentation: more work with the trochaic bias  
7-months: Infants can't extract words in iambic form  
11-months: infants have overcome initial strong trochaic bias (Houston et al. 2004)

The interplay between prosodic cues and statistical cues

Johnson & Jusczyk (2001): 8-month olds prefer prosodic information over statistical information

Mattys et al. (2001): 9-month olds use phonotactic information

Thiessen & Saffran (2003): 6-month olds prefer statistics to prosody

Johnson et al. (2003): 12-month olds are biased to segment fluent speech based on their knowledge of what a viable auditory word form is for the language

### Gerken & Aslin (2005): Jusczyk Speech Perception Research Review

Tracking non-adjacent dependencies: predecessor for syntactic complexity

Santelman & Jusczyk 1998: 16-18 month olds can track non-adjacent dependencies from fluent speech (*is...ing* in English)



A note on how to conduct language acquisition research

Despite his sophisticated approach to these domains, Peter was convinced that a proper appreciation of development required researchers to consider the perspective of the infant, as a learner who is exposed to a complex set of inputs and as a participant in experiments, so that such work is designed to optimally assess the infant's underlying capacities

## Werker (1995): 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

Dental T vs. retroflex t is a distinction in Hindi, but not in English

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

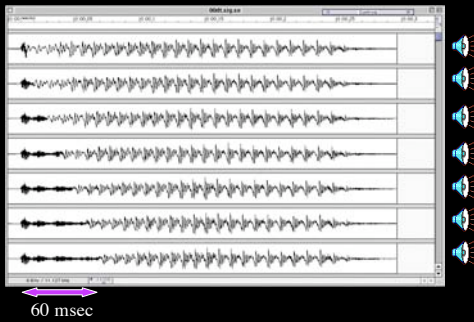


## A Brief Foray into Phonemes & Categorical Differences

How do the acoustic signals of phonemes vary?

How "categorical" are the sounds of a language?

## Voice Onset Time (VOT)



## English VOT production

Not uniform  
(2 categories)

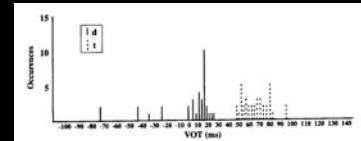
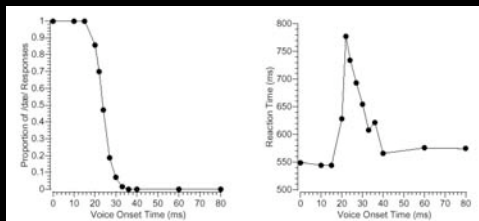


Figure 5-3. VOT productions of a single normal adult speaker of American English for words beginning with /d/ and /t/. (Figure adapted with permission from Blumstein, Cooper, Goodglass, Stender, & Gottlieb, (1990). Production Deficits in Aphasia: A Voice Onset-Time Analysis. *Brain and Language*, 9, 153-170. Copyright 1990 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 [speaker icon] [speaker icon] 20ms D

D 20ms [speaker icon] [speaker icon] 40ms T

T 40ms [speaker icon] [speaker icon] 60ms T

Within-Category Discrimination is Hard

### Cross-language Differences

[speaker icon]

R

[speaker icon]

L

[speaker icon]

R

[speaker icon]

[speaker icon]

[speaker icon]

[speaker icon]

[speaker icon]

[speaker icon]

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 listeners. American listeners show the characteristic step-like discrimination at the phonetic boundary. Japanese listeners do not. (From McClelland & Rumelhart, 1981)

### Cross-Language Differences

English vs. Hindi

alveolar [d]

retroflex [ɖ]

[speaker icon]

[speaker icon]

[speaker icon]

[speaker icon]

[speaker icon]

[speaker icon]

[speaker icon]

?

### Cross-language Differences

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

[speaker icon] [d<sup>1</sup>a]

[speaker icon] [d<sup>2</sup>a]

DIFFERENT

Imsri & Idsardi (2001)

### Werker (1995): Speech Perception

1-4 month olds can distinguish ba vs. pa

pa

Voice Onset Time

ba

Note: Jusczyk & Derah (1987) and Bertoncini et al. (1988) showed syllable is salient linguistic unit for infants (newborns & 2-month olds)

But only if it's a categorical difference (can't distinguish within-category differences)

pa

Voice Onset Time

ba

within category

across category

## Werker (1995): Speech Perception

Kids...

This ability extends to phonemic contrasts that are non-native. (Japanese infants can discriminate contrasts used in English but not in Japanese.) 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?

## Werker (1995): Speech Perception

Comparing perceptual ability

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

### Conditioned Head Turn Procedure

A method of testing was adopted that can be implemented in very similar forms with infants (5 1/2 months or older), children, and adults to ensure that subjects of different ages are tested in an equally sensitive procedure. The procedure used with infants is called the Conditioned Head Turn, and the adult procedure is a close variant. Basically, this is a category change task in which the subject has to monitor a continuous background of syllables from one phonetic category (for example, /ba/), and signal when the stimuli change to a contrasting phonetic category (for example, /da/). Infants are conditioned to turn their head toward the speaker when a change is presented. Correct head turns are reinforced with interesting, lighted toys (such as drumming beads) and verbal praise from the experimenter. Adults and children signal detection of this change by pressing a button. Their correct responses are reinforced with a flashing light. Incorrect responses are not reinforced.

ba...ba...ba...ba... da...



## Werker (1995): Speech Perception

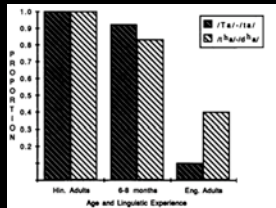


Figure 6.3 Proportion of subjects reaching criterion as a function of age and language contrast. Adapted from Werker et al. 1981.

## Werker (1995): Speech Perception

But when after 6-8 months is the ability to lost?

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

To test for this critical 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 and were unable to discriminate the Hindi non-English phonemes. The study was extended to 4-year-old children, who actually performed much worse than all on the nonnative contrasts. Importantly, their poor performance was not due to task difficulties as they performed well on an English /ba/-/da/ distinction, and as 4-year-old Hindi-speaking children performed well on the Hindi contrasts (Werker and Tees 1983). These findings revealed that experience must begin to influence speech perception long before age 4, certainly well before the critical period suggested by Lenneberg.



## Werker (1995): Speech Perception

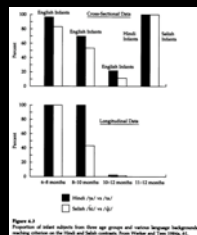


Figure 6.2 Proportion of subjects reaching criterion as a function of age group and contrast. Adapted from Werker and Tees (1983).