Psych 156A/ Ling 150: Acquisition of Language II

Lecture 3
Sounds

Announcements

Be working on HW1 (due 4/19/12)

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)

phonemes are language-specific - /r/ 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.

Actual stimuli

Categorical Perception of stimuli

Acoustic-Level Information

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

Language sounds

Vowels combine acoustic energy at a number of different frequencies
Different vowels (i.e. “ah”, “ee”, “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

Language sounds
Male Vowels (close up)

Synthesized Speech

Allows for precise control of sounds

Valuable tool for investigating perception: Praat

www.praat.org

Acoustic-Level Information

Language sounds
Female Vowels (close up)

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)

Perception of stimuli: 2 categories

Perceiving VOT
'Categorical Perception': dQ vs. tQ

More uncertainty/ error at category boundary

Time to make decision
Decision between d/t
Identification task: "Is this sound d or t?"
Discrimination Task
“Are these two sounds the same or different?”

<table>
<thead>
<tr>
<th>Same/Different</th>
<th>0ms</th>
<th>60ms</th>
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<tbody>
<tr>
<td>Same/Different</td>
<td>0ms</td>
<td>10ms</td>
</tr>
<tr>
<td>Same/Different</td>
<td>40ms</td>
<td>40ms</td>
</tr>
</tbody>
</table>

Why is this pair difficult?
(i) Acoustically similar?
(ii) Same Category?

Cross-language Differences

<table>
<thead>
<tr>
<th>D</th>
<th>0ms</th>
<th>20ms</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>20ms</td>
<td>40ms</td>
<td>T</td>
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<tr>
<td>T</td>
<td>40ms</td>
<td>60ms</td>
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</tbody>
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Across-Category Discrimination is Easy
Within-Category Discrimination is Hard
Cross-Language Differences

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

Miyawaki et al. 1975

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

Cross-Language Differences

Hindi

dental [d]
(tip of tongue touches back of teeth)

retrolflex [D]
(tongue curled so tip is behind alveolar ridge)

English [d] is usually somewhere between these

Cross-Language Differences

Salish
(Native North American language):
glottalized 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.

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
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.

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.

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

A useful indirect measurement

Head Turn Preference Procedure

A useful indirect measurement

Head Turn Preference Procedure
Head Turn Preference Procedure Movies

Head Turn Preference Procedure

http://psych.rice.edu/mtbmlanguage/sPerception/infantHeadturn_h.html

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

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

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.

Kidd, Piantadosi, & Aslin (2010) provide some evidence that this may have to do with the informational content of the test stimulus. There may be a “Goldilocks” 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
Comparing perceptual ability

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

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

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

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=GS1wU_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

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

Testing ability to distinguish Salish & Hindi contrasts

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

English 6-8 month-olds do well

English 8-10 month-olds do less well

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.

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 4 on HW1.