Ling 51/Psych 56L: Acquisition of Language

Lecture 7

Phonological development II

Announcements

Be preparing for the midterm on 10/27/16 (review questions, HW1, HW2, HW3)

Midterm review 10/25/16 in class

HW3 due 10/25/16 (same day as midterm review — feel free to ask questions about it!)

Prelinguistic "speech" production

Stages of prespeech vocal development

Newborns make biologically-related sounds: reflexive crying, burping, breathing, sucking

Helpful: infants' vocal cords vibrate & airflow through the vocal apparatus is stopped and started

Stages of prespeech vocal development

Around 6-8 weeks: infants start cooing (sounds that result from being happy).

First coos sound like one long vowel - but over many months, they acquire a variety of different vowel sounds.

Stages of prespeech vocal development

Around 16-30 weeks: vocal play. Infants use a variety of different consonant-like and vowel-like sounds. At the end of this stage, infants form long combinations of the sounds (marginal babbling).

Recognizable vowel sounds heard at the beginning, while recognizable consonant sounds (usually velars like k/g) are usually heard around 2-3 months. Recognizable consonant sounds occurring near the front of the mouth (n/m/p/b/d) come in around 6 months of age.

Stages of prespeech vocal development

Around 6-9 months: canonical/reduplicated babbling, with actual syllables in the sounds produced (ex: [dadada]). These syllables are often repeated in a row.

Social aspect: babies don't give any indication that they're initially babbling to communicate (no intentionality at this point) even though sometimes it may look like it. They babble in the car and their crib, showing no sign that they expect any reply.

Note: even deaf infants babble, but they tend to produce marginal babbling instead of canonical babbling.

Stages of prespeech vocal development

After canonical babbling: nonreduplicated/variegated babbling, with non-repetitive syllables and more variety in consonant and vowel sounds. Infants also incorporate prosody (the rhythm of the language) into their babbling, which makes it sound much more like they're trying to talk. However, the "words" in this kind of babbling are usually only 1 or 2 syllables.

http://www.youtube.com/watch?v=_JmA2ClUvUY

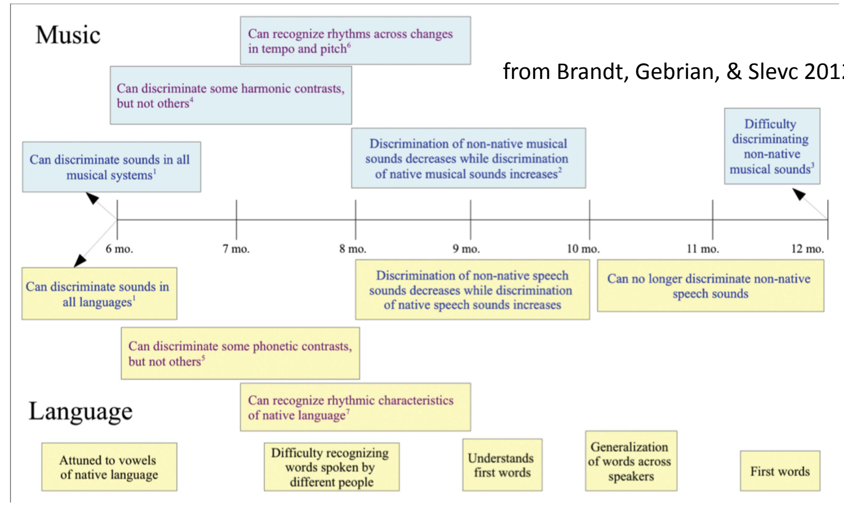
Stages of prespeech vocal development

0 weeks	reflexive crying, biological-based sounds
6-8 weeks	cooing
16 weeks	vocal play begins
36 weeks	reduplicated/canonical babbling
48 weeks	nonreduplicated babbling

First Word

Language- and culture-specific effects: Language and music

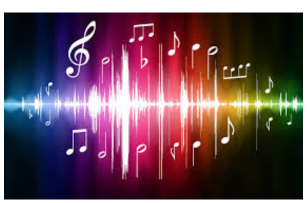
[Extra]



from Brandt, Gebrian, & Slevc 2012

Language and music: Developmental linking

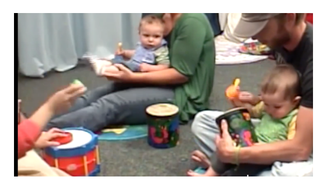
On Gordon et al. 2014:
"Though the grammatical and musical tests were quite different, Gordon found that children who did well on one kind tended to do well on the other, regardless of IQ, music experience and socioeconomic status…Perhaps children who are better at detecting variations in music timing are also better at detecting variations in speech and therefore have an advantage in learning language…"
- http://www.sciencedaily.com/releases/2014/11/141105101238.htm



Language and music: From music to language

On Zhao & Kuhl 2016:
"Babies in the music group had stronger brain responses to the disruption in both music and speech rhythm in both the auditory and the prefrontal cortex, compared with babies in the control group. This suggests that participation in the play sessions with music improved the infants' ability to detect patterns in sounds."
- https://www.sciencedaily.com/releases/2016/04/160425161148.htm

https://www.youtube.com/watch?v=whzxMNvHBD4&feature=youtu.be
Musical stimuli example: 0:09-0:26



Language and music:
Not from language to music

On Langus et al. 2016:
"Several clues, like the fact that many of the cortical auditory regions responsible for linguistic and musical processing are the same and the existence of auditory illusions dependent on the mother tongue or dialect, have led investigators to hypothesize that native listening transfers also to non-linguistic sound stimuli such as music. [However,] Alan Langus…and other colleagues demonstrat[ed] that there is no transfer to the non-linguistic domain."
- https://www.sciencedaily.com/releases/2016/02/160224070645.htm

Language-specific effects

"From the moment of birth, babies cry in the accent of their mother's native language…" – Annie Murphy Paul, 2011 *Ted Talk: What We Learn Before We're Born*

Is all babbling the same?

Besides the differences between the vocal babbling of deaf children and non-deaf children, babies' babbling is also influenced by the language they hear.

How do we know?

(1) Test competent native speakers.

Record the babbling of babies who are learning to speak different languages (ex: French, Arabic, Chinese). See if native speakers can identify which baby's babble is from their language (ex: asking French mothers to choose between Arabic babble and French babble as French.)

De Boysson-Bardies, Sagart, and Durand (1984): recordings of 8-month-olds can be recognized by language.

Is all babbling the same?

Besides the differences between the vocal babbling of deaf children and non-deaf children, babies' babbling is also influenced by the language they hear.

How do we know?

(2) See if babbling features accord with language features

Determine which vowels and consonants appear in babbling, and how frequently they appear. Compare to target language's vowels and consonants. (Can be subtle, though.)

Ex: Japanese & French words contain more nasal sounds than Swedish & English words; Japanese & French babbles contain more nasal sounds than Swedish & English babbles.

Is all babbling the same?

Besides the differences between the vocal babbling of deaf children and non-deaf children, babies' babbling is also influenced by the language they hear.

How do we know?

(2) See if babbling features accord with language features

Determine which vowels and consonants appear in babbling, and how frequently they appear. Compare to target language's vowels and consonants. (Can be subtle, though.)

Ex: Mandarin Chinese uses tone-like pitches to distinguish meaning, and Mandarin babbles also use these tone-like pitches while English babbles do not (Meltzoff et al. 2009).

Processes underlying speech sound development

Three main factors

Physical growth & development of the vocal tract

Development of brain & other neurological structures responsible for vocalization

Experience

Processes underlying speech sound development

Physical growth & development of the vocal tract

A newborn's vocal tract is smaller & shaped differently from an adult's. (Ex: The tongue fills the entire mouth, limiting range of motion.)

"A newborn has a vocal tract like a nonhuman mammal. The larynx comes up like a periscope and engages the nasal passage, forcing the infant to breathe through the nose and making it anatomically possible to drink and breathe at the same time." – Steven Pinker, *The Language Instinct*

Processes underlying speech sound development

Physical growth & development of the vocal tract

"By three months the larynx has descended deep into the throat, opening up the cavity behind the tongue (the pharynx) that allows the tongue to move forwards and backwards and produce the variety of vowel sounds used by adults."
– Steven Pinker, *The Language Instinct*

As the facial skeleton grows, the tongue gets more room. This happens during the vocal play stage, and the exploration of this new vocal freedom may be the cause of the vocal play itself.

Processes underlying speech sound development

Development of brain & other neurological structures responsible for vocalization

Later neurological developments in higher brain structures correlate with developments in vocalization.

Ex: Onset of cooing at 6-8 weeks coincides with development of limbic system (associated with expression of emotion in both humans and other animals).

Ex: Maturation of areas in the motor cortex may be required for the onset of canonical babbling.

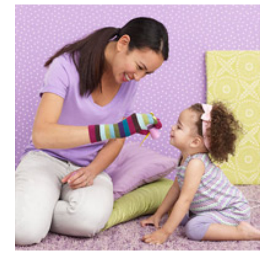
Processes underlying speech sound development

Experience

Experience 1: Hearing the speech adults produce (influences the sounds children choose to babble and prosodic character of later babbling)

From Curtin & Zamuner 2014 (Box 1):

The amount of time 12-month-olds spend listening to speech is related to vocabulary size at 18 months (Newman et al. 2006).



Processes underlying speech sound development

Experience

Experience 1: Hearing the speech adults produce (influences the sounds children choose to babble and prosodic character of later babbling)

https://www.sciencedaily.com/releases/2016/05/160523141552.htm

Value for learning words later on:

"…we show that experience is essential in guiding infants, with increasing precision, to single out which signals from the initially privileged set they will continue to link to meaning and which they will tune out." — Sandra Waxman

"…merely exposing 6-month-old infants to nonhuman primate vocalizations permits them to preserve, rather than sever, their early link between these signals and categorization."

Processes underlying speech sound development

Experience

Experience 1: Hearing the speech adults produce (influences the sounds children choose to babble and prosodic character of later babbling)

Important: There appears to be a social component involved.

(1) Infants increase the complexity of their vocal output when their mother provides immediate social feedback (Goldstein, King, & West 2003).

Processes underlying speech sound development

Experience

Experience 1: Hearing the speech adults produce (influences the sounds children choose to babble and prosodic character of later babbling)

Important: There appears to be a social component involved.

(2) 8-month-old infants increase their consonant-vowel vocalizations (canonical & non-canonical babbling) when their mother responds to what she thinks they're saying. The babies also learn to direct more of their babbling to their mothers. (Gros-Louis, West, & King 2014).

http://www.sciencedaily.com/releases/2014/08/140827122632.htm

Processes underlying speech sound development

Experience

Experience 1: Hearing the speech adults produce (influences the sounds children choose to babble and prosodic character of later babbling)

Important: There appears to be a social component involved.

(3) Infants learn foreign sounds (ex: American infants learning Mandarin phonemes) only when the input comes from a live speaker interacting with them (and not from a television broadcast of that same speaker, for example). (Kuhl, Tsao, & Liu 2003)

Processes underlying speech sound development

Experience

Experience 1: Hearing the speech adults produce (influences the sounds children choose to babble and prosodic character of later babbling)

Important: There appears to be a social component involved.

(4) Adults also seem to pick up sounds more easily when they're engaged socially with the input source.
http://www.sciencedaily.com/releases/2013/09/130910121523.htm
(Stuart-Smith, Timmins, & Gunter 2013)

Processes underlying speech sound development

Experience

Experience 2: Hearing their own vocal output motivates infant vocalizations (also allows for calibration - matching what they produce to what they hear).
(Fagan 2014, 2015)

Links to early word forms:
Infants tend to use the sounds that they've babbled in their first words rather than the sounds that are most common in the speech that adults use with them.

Processes underlying speech sound development

Experience

Experience 2: Hearing their own vocal output motivates infant vocalizations (also allows for calibration - matching what they produce to what they hear).

(Fagan 2014, 2015)

Absence of auditory feedback may explain why deaf infants produce less elaborate vocal play than hearing infants, and reach the canonical babbling stage later.

Processes underlying speech sound development

Experience

Fagan (2014, 2015): Infants with profound hearing loss who received cochlear implants to help correct their hearing soon reached the vocalization levels of their hearing peers. Among other things, the infants with cochlear implants are able to reach the canonical babbling stage with reduplicated sounds (like "baba").

http://www.sciencedaily.com/releases/2014/09/140923182138.htm

https://www.sciencedaily.com/releases/2015/10/151022125740.htm

Prelinguistic speech perception

Infant hearing

Infant hearing is not quite as sensitive as adult hearing - but they *can* hear quite well and remember what they hear.

Ex 1: Fetuses 38 weeks old

A loudspeaker was placed 10cm away from the mother's abdomen. The heart rate of the fetus went up in response to hearing a recording of the mother's voice, as compared to hearing a recording of a stranger's voice.

Infant hearing

Infant hearing is not quite as sensitive as adult hearing - but they *can* hear quite well and remember what they hear.

Ex 2: Newborns

Pregnant women read a passage out loud every day for the last 6 weeks of their pregnancy. Their newborns showed a preference for that passage over other passages read by their mothers.

Infant hearing

Infant hearing is not quite as sensitive as adult hearing - but they *can* hear quite well and remember what they hear.

Ex 3: Newborns (Moon, Lagercrantz, & Kuhl 2012)

Swedish and English newborns heard different ambient languages while in the womb (Swedish and English, respectively), and were surprised when they heard non-native vowels only hours after birth.

Studying infant speech perception

http://www.thelingspace.com/episode-16

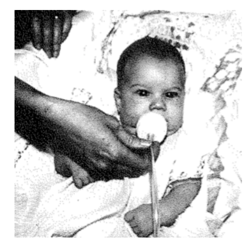
https://www.youtube.com/watch?v=3-A9TnuSVa8

beginning through 3:34: High Amplitude Sucking Procedure (HAS)

Studying infant speech perception

Researchers use indirect measurement techniques.

High Amplitude Sucking (HAS)



Infants are awake and in a quietly alert state. They are placed in a comfortable reclined chair and offered a sterilized pacifier that is connected to a pressure transducer and a computer via a piece of rubber tubing. Once the infant has begun sucking, the computer measures the infant's average sucking amplitude (strength of the sucks).

Studying infant speech perception

Researchers use indirect measurement techniques.

High Amplitude Sucking (HAS)

A sound is presented to the infant every time a strong or "high amplitude" suck occurs. Infants quickly learn that their sucking controls the sounds, and they will suck more strongly and more often to hear sounds they like the most. The sucking rate can also be measured to see if an infant notices when new sounds are played.

Studying infant speech perception

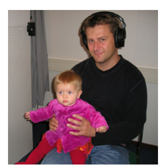
http://www.thelingspace.com/episode-16

https://www.youtube.com/watch?v=3-A9TnuSVa8

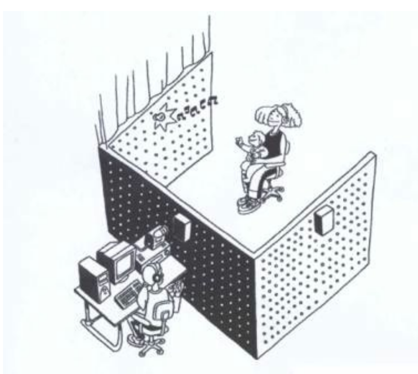
3:34 - 5:48: Head-Turn Preference Procedure

Studying infant speech perception

Researchers use indirect measurement techniques.



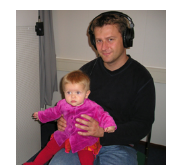
Head-Turn Preference Procedure



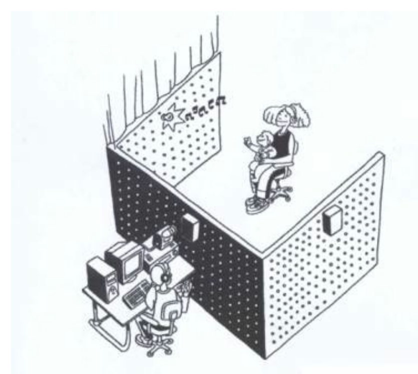
Infant sits on caretaker's lap. The wall in front of the infant has a green light mounted in the center of it. The walls on the sides of the infant have red lights mounted in the center of them, and there are speakers hidden behind the red lights.

Studying infant speech perception

Researchers use indirect measurement techniques.



Head-Turn Preference Procedure

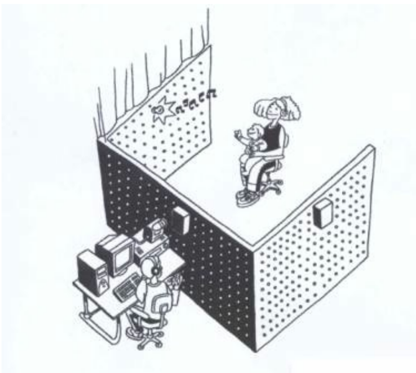


Sounds are played from the two speakers mounted at eye-level to the left and right of the infant. The sounds start when the infant looks towards the blinking side light, and end when the infant looks away for more than two seconds.

Studying infant speech perception

Researchers use indirect measurement techniques.

Head-Turn Preference Procedure



Thus, the infant essentially controls how long s/he 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.

Studying infant speech perception

Researchers use indirect measurement techniques.

Head-Turn Technique

https://www.youtube.com/watch?v=WvM5bqUsbu8

Especially 0:31-1:15

Studying infant speech perception

Researchers use indirect measurement techniques.

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.

Studying infant speech perception

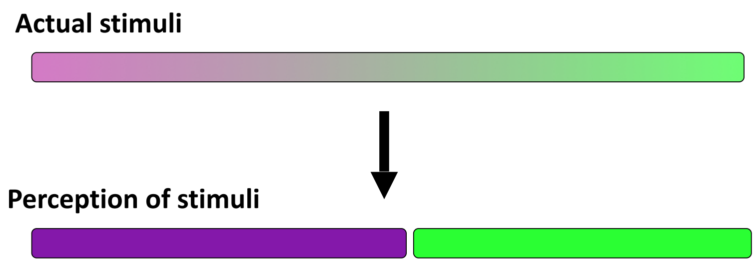
Researchers use indirect measurement techniques.

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.

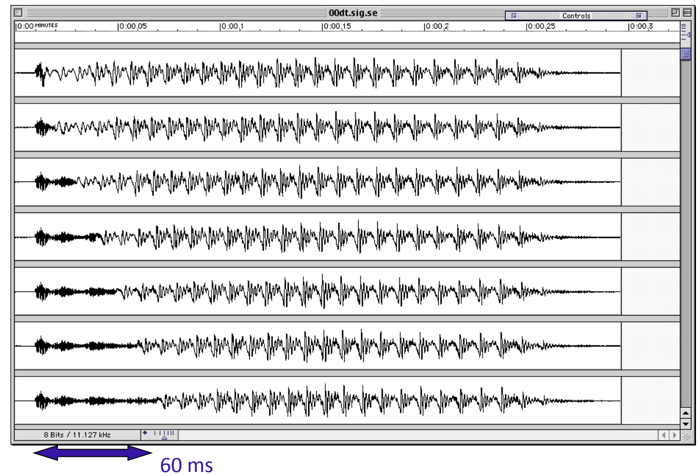
Categorical perception

One feature of infants' speech perception: 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 those categories.



Categorical perception

Adult categorical perception: Voice Onset Time (VOT)



Categorical perception

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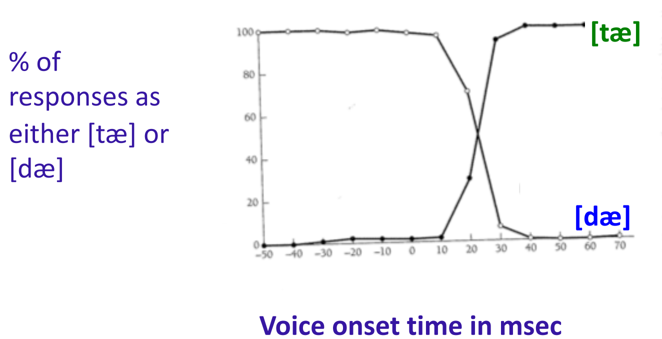
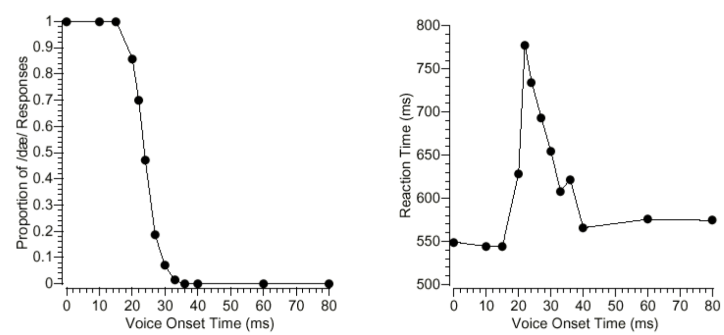


Categorical perception

Adult categorical perception: Voice Onset Time (VOT)

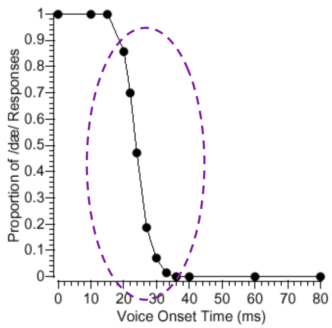


Decision between dæ/tæ **Time to make decision**

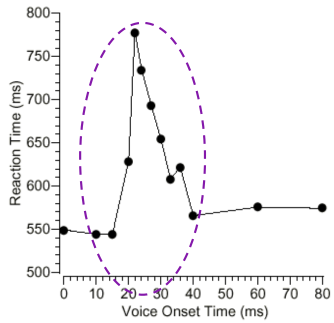
Categorical perception

Adult categorical perception: Voice Onset Time (VOT)

Uncertainty at category boundary



Decision between dæ/tæ



Time to make decision

Categorical perception

Adult categorical perception: Voice Onset Time (VOT)

Within-category discrimination is hard, across-category discrimination is easy

D 0ms 20ms D

D 20ms 40ms T

T 40ms 60ms T

Categorical perception

http://www.thelingspace.com/episode-4

https://www.youtube.com/watch?v=dtf8zGQj9GY

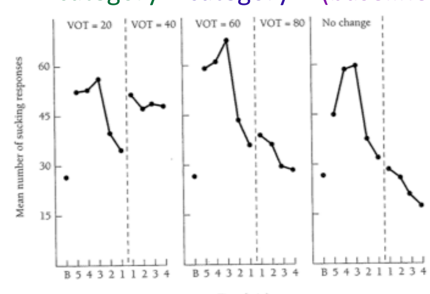
5:39-6:59

Categorical perception

Infant categorical perception: Voice Onset Time (VOT)

Eimas et al. 1971: HAS technique

across category | within category | control (baseline)



Categorical perception

Infant categorical perception: Voice Onset Time (VOT)

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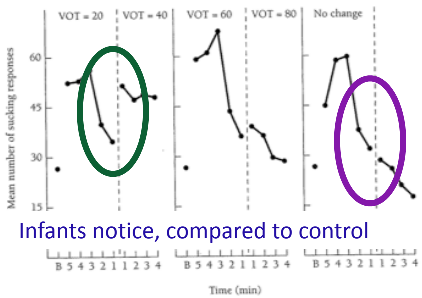


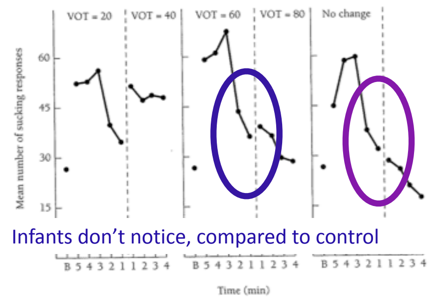
Infants notice, compared to control

Categorical perception

Infant categorical perception: Voice Onset Time (VOT)

Eimas et al. 1971: HAS technique

across category | within category | control (baseline)



Infants don’t notice, compared to control

Categorical perception

Infant categorical perception: Impact on later language development

From Curtin & Zamuner 2014 (Box 1):

Infant ability to discriminate two acoustically distinct vowels (/u/ and /y/) at six months is correlated with language abilities at 13–24 months of age (Tsao et al. 2004).

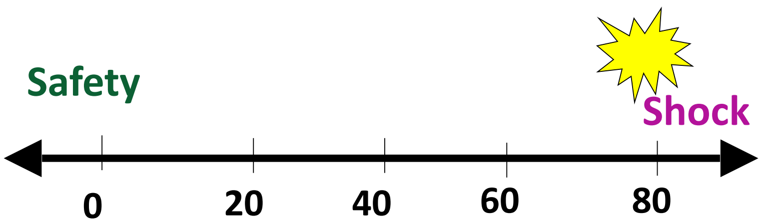
Categorical perception

Categorical perception: a special human ability?

Categorical perception is not specific to the human ear, though - it’s a feature shared with other mammals like chinchillas (tested with an Avoidance Conditioning Procedure)!

Avoidance conditioning procedure

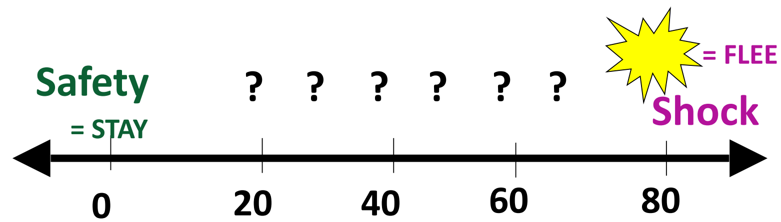
- Speech sound at one end of the continuum paired with shock
- Other end paired with safety



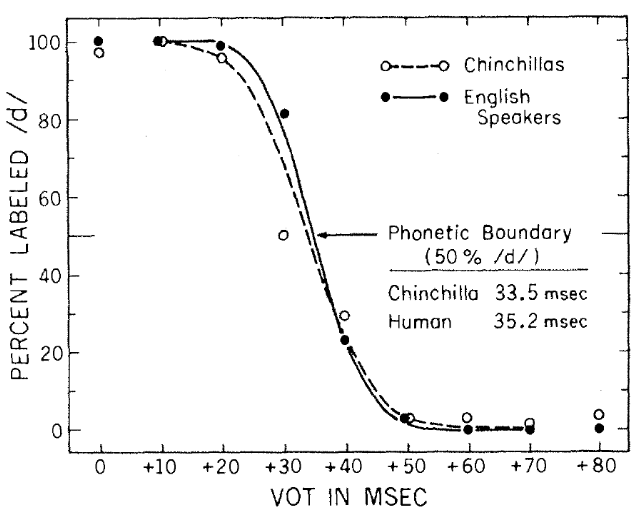
Avoidance conditioning procedure

Animals learn to “avoid” shock.

What will they do for between cases?



Kuhl & Miller (1978)



Infant-directed speech

The nature of infant-directed speech

Motherese/infant-directed speech/child-directed speech

Intonational contour is greatly exaggerated:

- higher-pitched voice, wider range of pitches, longer pauses, shorter phrases, slower tempo (vowels are prolonged)

Motherese could be helpful for language learning: likely to highlight important features of speech, and provide more prototypical examples of a language's speech sounds

How motherese helps

Greater discriminability of phonemes (contrasting sounds in a language) in child-directed speech may help children establish phonemic categories (that signal meaning contrasts)

[b] and [p] are distinct phonemic categories in English.
We know because "big" is a different word from "pig".

Support: Mothers who produce more discriminable vowels in their infant-directed speech have infants who demonstrate better speech perception skills in laboratory tests.

How motherese helps…adults?

Golinkoff & Alioto 1995: adults learned words in a foreign language better if the words were presented in infant-directed rather than adult-directed speech

But not motherese for everyone…

While motherese may be very useful, it can't be *required* for language acquisition (even if it's really helpful) since not all cultures use it. Some cultures (ex: Samoans, Papua New Guineans, Mayans, US African Americans in the rural south) do not address speech to prelinguistic children at all - so those children must learn some other way.

Links between social cues and sound learning [Extra]

Conboy, Brooks, Meltzoff, & Kuhl 2015: 10-month-olds who engaged in more gaze shifting (when a baby makes eye contact and then looks at the same object that the other person is looking at) during sessions with a foreign language tutor showed a boost in a brain response that indicates language learning.

https://www.sciencedaily.com/releases/2015/07/150727100024.htm

What this means: Sound learning may be greatly facilitated by these kind of social cues in a communicative context.

Recap: Speech sound development

Infants go through different stages of pre-speech production, which allows them to develop the motor skills to produce the speech sounds in their native language.

There are several experimental techniques that can be used to examine infant speech perception. One useful ability infants seem to have is categorical perception.

Infant-directed speech (motherese) tends to have several properties that make it helpful for learning the sounds of the language.

Questions?

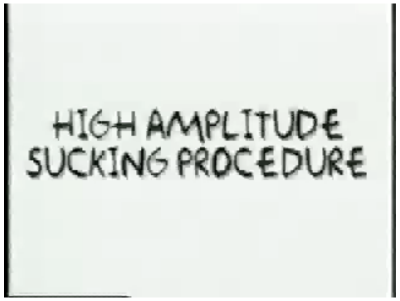
You should be able to do up through question 14 on the phonological review questions and up through question 14 on HW3.

Extra Material

Studying infant speech perception

Researchers use indirect measurement techniques.

High Amplitude Sucking (HAS)



video ~4 minutes long