Learning Phonology

LINGUIST 397LH

Oiry/Hartman

Learning phonology

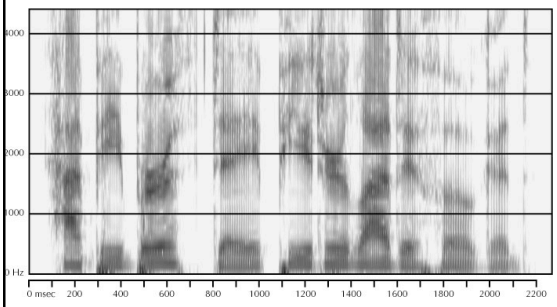
- Language learning starts in the womb.
- Auditory system is fully developed by the beginning of third trimester.
- A fetus can hear, but it doesn't hear what we hear.
- Womb acts as a low pass filter (only allows lower frequencies)

What speech sounds like in the womb

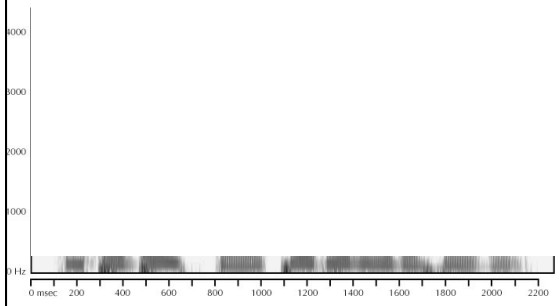
Low pass filter

Unfiltered

Spectrogram



Spectrogram after 250 Hz Low Pass Filter



What we know at (and before) birth

- A fetus can distinguish:
  - Language vs. non-language
  - Mother's voice vs. someone else's voice
- A newborn can distinguish:
  - Their native language vs. another language
  - A rhythmically similar language (English/Dutch) vs. a rhythmically dissimilar language (English/ Japanese)

Techniques for assessing early linguistic development

Fetuses: kicking, fetal heart rate

Newborns: High-Amplitude Sucking

Babies and Toddlers: Head Turn Preference, Looking Time

Age ~3 onward: Elicited production, comprehension tasks, eyetracking, etc.

Head Turn Preference

High-Amplitude Sucking

Acquiring phonemic inventories

- Languages differ widely in their phonemic inventories.
- Some languages, e.g., distinguish [p] and [b], but others don't.
- Kids eventually come to know the phonemic inventory of their language. How?

Distinguishing Phonemes

- What does having the ability to recognize [p] as a distinct phoneme from [b] consist of?
- In 1964, Arthur Abramson and Leigh Lisker of Haskin Laboratories determined that the acoustic difference between [p] and [b] (and voiceless stops and voiced stops in general), is…
- … the amount of time that elapses between when the closure that makes the stop is released and the voicing for the sound that follows begins.
- The time between when a stop is released and when the sound that follows begins is called the Voice Onset Time (VOT).
  - Voiceless stops in English have a VOT of more than ~30 ms .
  - Voiced stops in English have a VOT of less than ~30 ms.

Distinguishing Phonemes

- Adult speakers of languages that do not treat voiced and voiceless stops as phonemes cannot distinguish stops with a VOT of less than 30 ms from a stop with a VOT of more than 30 ms.
- The perceptual apparatus of speakers whose languages make this distinction are different than the perceptual apparatus of speakers of languages that do not.
- When is this ability to distinguish phonemes acquired?

Acquisition of Phonemic Contrasts

- It looks like it's not acquired!
- In 1971, Peter Eimas and colleagues used the Abramson and Lisker materials to test whether 1 month and 4 month old infants could discriminate voiced and voiceless sounds.
- They could!

Eimas et al. (1971)

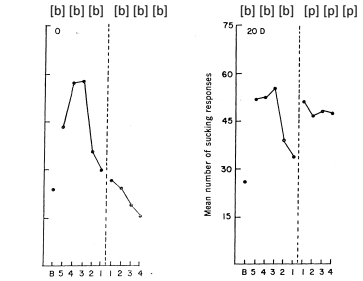


Fig. 2. Mean number of sucking responses for the 4-month-old infants, as a function of time and experimental condition. The dashed line indicates the occurrence of the stimulus shift, or in the case of the control group the time at which the shift would have occurred. The letter *B* stands for the baseline rate. Time is measured with reference to the moment of stimulus shift and indicates the 5 minutes prior to and the 4 minutes after shift.

What about *non-native* phonemic contrasts?

- Janet Werker and her colleagues were among the first to investigate this.
- In a series of studies in the early 1980's she showed that children learning English could discriminate the Hindi voiceless retroflex alveolar stop from the voiceless dental stop in their first few months, but lost this ability between the 10th and 12th month!
- In a follow up study, she showed the same thing for the Nthlakampx (Salish) distinction between voiceless velar stops and voiceless uvular stops.

From Werker and Tees (1984)

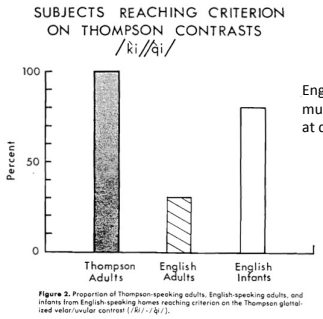


Figure 2. Proportion of Thompson-speaking adults, English-speaking adults, and infants from English-speaking homes reaching criterion on the Thompson glottalized velar/uvular contrast (/ki/–/qi/).

English infants are actually much *better* than English adults at discriminating [k] and [q]!

From Werker and Tees (1984)

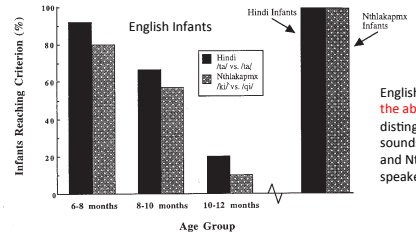
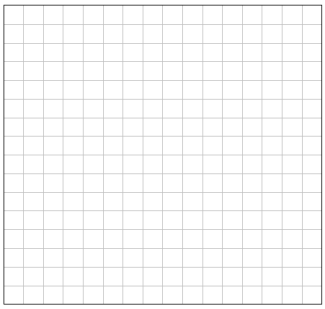


Figure 2 The proportion of infants at each age reaching discrimination criterion on the Hindi and Nthlakampx contrasts. (*Far right*) The performance of infants 11 months old raised in either a Hindi or a Nthlakampx environment. (Adapted from Werker & Tees 1984a.)

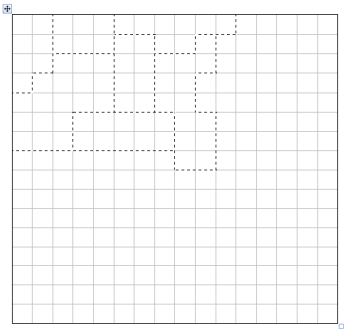
English infants lose the ability to distinguish these sounds, while Hindi and Nthlakapmx speakers retain it!

In a sense, children are learning which phonemic contrasts *not* to make!

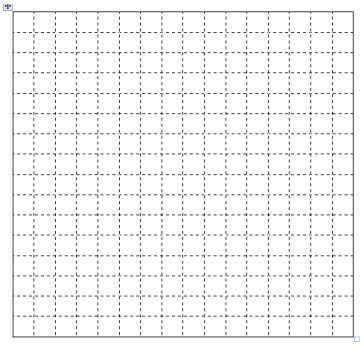
How to learn phonemic inventories "Blank Slate" Model



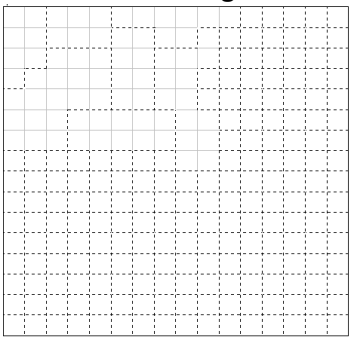
How to learn phonemic inventories "Blank Slate" Model



How to learn phonemic inventories Innate knowledge Model



How to learn phonemic inventories
Innate knowledge Model



Beginning to *produce* sounds

- Unlike auditory system, articulatory system *undergoes significant development* throughout infancy.
- Physiological changes in articulators
  - Larynx descends
  - Teeth develop
  - Palate elevates and arches
- Development of motor control, procedural memory in motor learning ("muscle memory")
- Articulation: *extremely* complex motor task
  - At typical adult speaking rate: ~14 phonemes/sec.
  - 140,000 neuromuscular events/second

Typical stages in articulatory development

Birth to ~6 months:	pre-babbling sounds (e.g., crying)
~6-12 months:	babbling (e.g., "ba ba goo ga")
~10-18 months:	first words

Pre-babbling stage

- Typical pre-babbling sounds:
  - Crying
  - Grunting
  - Burping
  - Squealing / "Cooing"
- Generally do not require use of articulators (lips, tongue, palate, teeth)

Babbling Stage

- Some striking similarities in babbling across languages.
- Early in the babbling stage, certain sounds are quite common, while other sounds are quite uncommon.
- In later babbling stage, language-specific differences begin to emerge:
  - Relative frequency of sounds begins to resemble frequency in target language.

Typical babbling sounds

Common and uncommon sounds during the babbling phase[10]

Frequently found consonants	Infrequently found consonants
p b m	f v th
t d n	sh ch j
k g	l r ng
s h	
w y	

- Common babbling vowels: [a],[i],[u],[ə]
- What characterizes the common babbling sounds vs. the uncommon ones?

Development of phonemic inventory in production

- We saw that children are able to *perceive* phonetic distinctions essentially from birth.
- *Producing* these distinctions is another matter.
- Example from O'Grady reading:

A telling example:

From the O'Grady reading:

> One of us . . . spoke to a child who called his inflated plastic fish a *fis*. In imitation of the child's pronunciation, the observer said: "This is your *fis*?" "No," said the child, "my *fis*." He continued to reject the adult's imitation until he was told, "That is your fish." "Yes," he said, "my fis."[19]

- In phonemic development, as elsewhere in language development:
  - **comprehension precedes production**.

Early phonemic inventories

Typical consonant inventory at age two

p	b	m	f	w
t	d	n	s	
k	g			

Typical consonant inventory at age four

p	b	m	f	**v**	**ch**	**j**	w	**y**
t	d	n	s	**z**			**l**	**r**
k	g	**ng**	**sh**					

Some early production errors

- Substitution
  - liquids -> glides
  - nasal stops -> oral stops
  - Postalveolar fricatives -> alveolar fricatives
- Deletion (of segment, of syllable)
  - Consonant cluster simplification