

Lecture 10: Language Development

COGS 153

An infant's earliest sounds

Birth: burping, sighing, sucking, crying

2 months: cooing (drawn-out vowel sounds)

4 months: consonant-like sounds; sustained laughter

6 months: babbling (ba da ga)

8 months: reduplicated babbling (ba ba ba da da da)

10 months: jargon babbling (ba di bi da gu ba ni la)

Babbling reflects native language phonotactics!



Babbling: Sign Language

- Congenitally deaf babies' *vocal* babbling occurs late and is very limited
- If they are exposed to sign language, they babble manually



Babbling: cross-species comparison

- Babbling is an important part of the vocal learning process!

 SpringerLink

[Naturwissenschaften](#)

September 2006, Volume 93, [Issue 9](#), pp 451–454

Babbling behavior in the sac-winged bat



[Live Science](#) > [Animals](#)

Birds Babble Like Babies

By Rachel Mahan | May 1, 2008 11:55am ET

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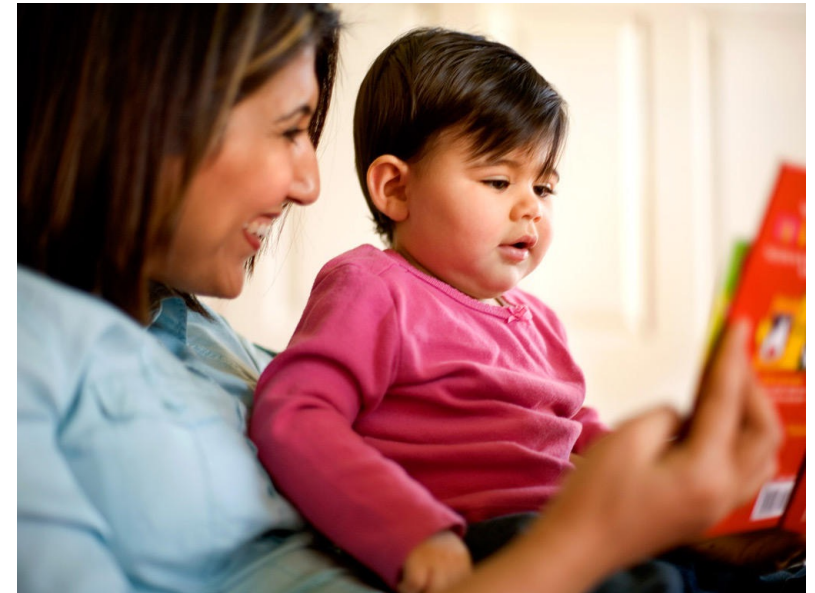


The babbling of young zebra finches (right and left) may have implications for human baby behavior.

Credit: Dmitry Aronov, MIT

Word learning timeline

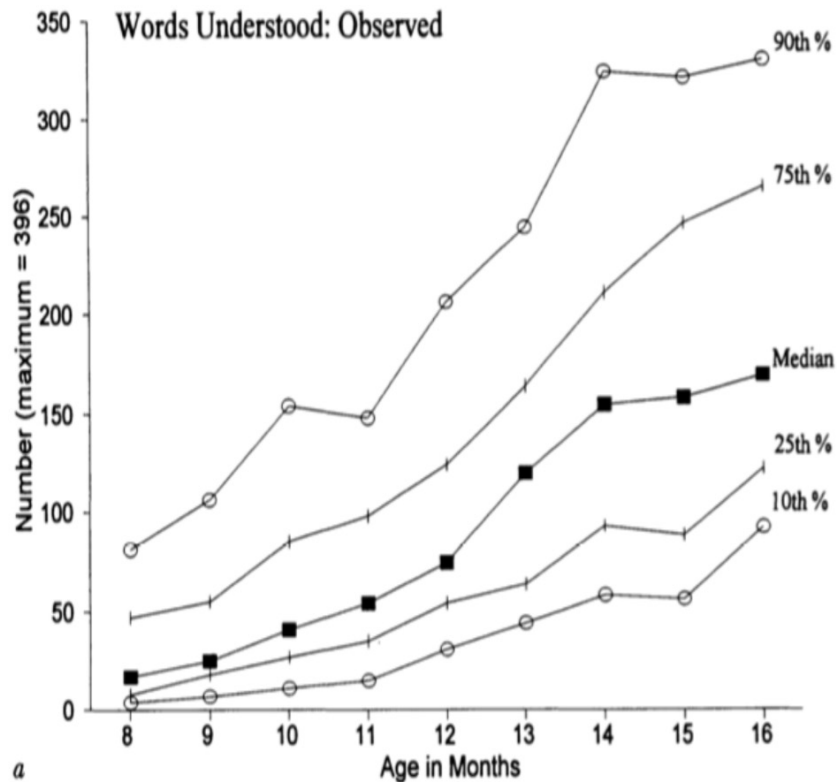
- By 6 months, babies already know some common nouns (they look toward the object when you say its name)
- 10-15 months, babies produce their first words
- At about 18 months, there is a vocabulary-learning explosion!
- Toddlers learn words FAST! By 2 years old, kids typically know 1000-2000 words!



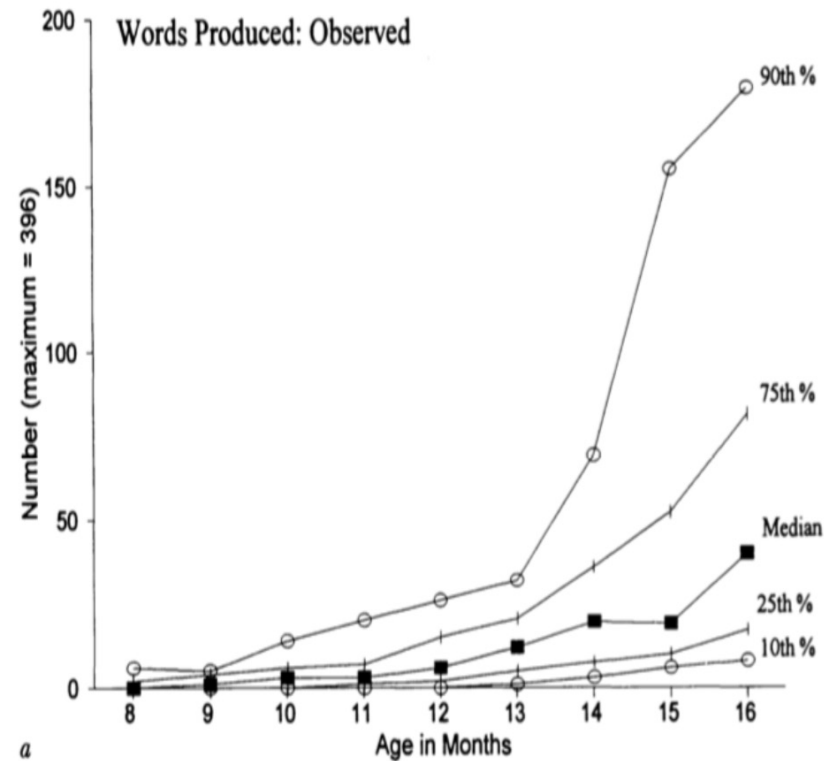
Perception before production

- At any given age, young children can comprehend much more than they can produce

Understood



Produced



Stages of word usage

At first: One-Word Utterances

- (i.e., child typically expresses a “whole phrase” with a single word)

Underextension: use a word in a narrower context than appropriate

- *doggy* only means one specific dog

Overextension: they use a given word in a broader context than is appropriate

- *Family dog's name* means any dog
- Or *doggy* means goat, sheep, cat, fox... etc.

- Represents an effort to communicate despite a limited vocabulary

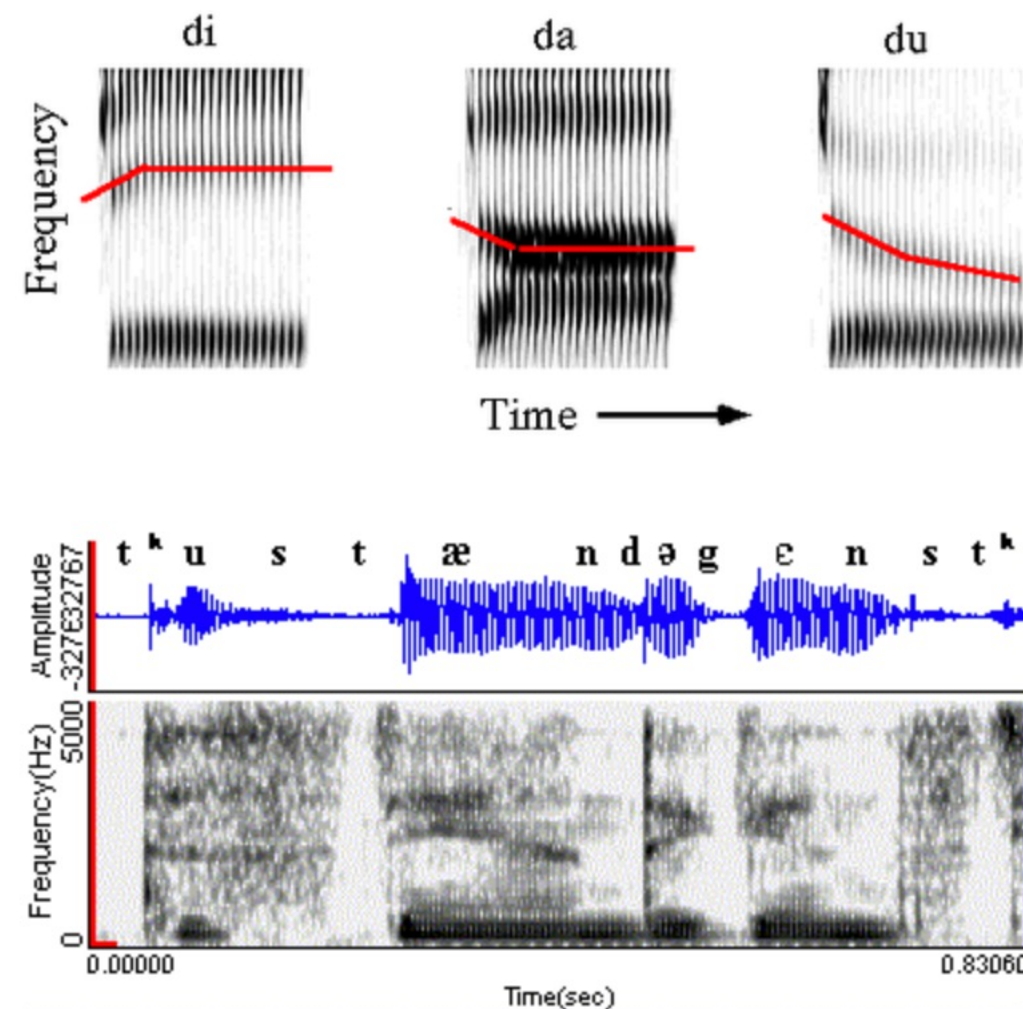
Infant Directed Speech (IDS)

- The distinctive mode of speech that adults adopt when talking to very young children (aka 'motherese' or 'parentese')
- Warm and affectionate tone, high pitch, extreme intonation, slower speech, exaggerated facial expressions
- Common throughout the world (although not universal)



Challenges for infant learners

- The **Lack of Invariance** Problem is a huge challenge for infants
 - **Coarticulation**: Phonemes sound different in different environments. More than one sound is articulated at once, so each of them is partly shaped by the sounds surrounding it. The articulators move from sound to sound, so the acoustic structure of each phoneme depends a lot on its phonetic 'neighbours'
 - **Individual differences**: Phonemes sound different when spoken by different speakers
- **Word Segmentation**
 - Where are the word boundaries? There aren't pauses in the speech stream

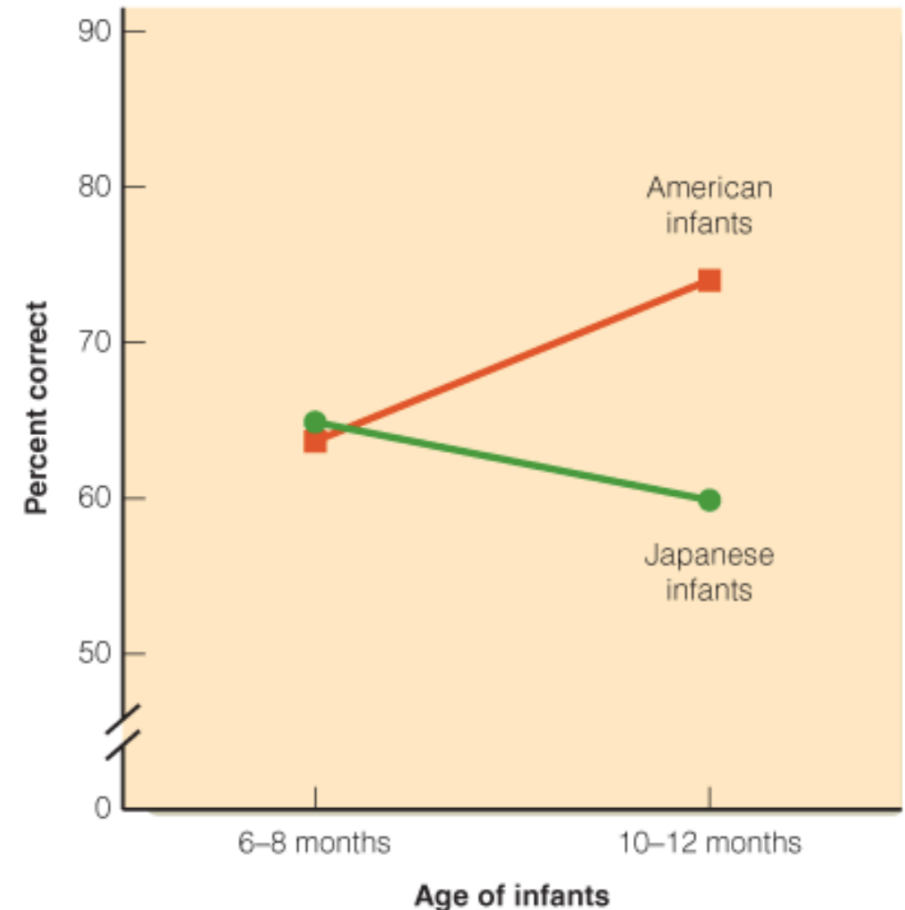


Categorical perception

- **Categorical perception:** a phenomenon by which people perceive entities differently after learning to categorize them: differences within categories are compressed, and differences across categories are expanded.
 - When items that range along a continuum are perceived as being either more or less similar to each other than they really are because of the way they are categorized
- Speakers have categorical perception of the phonemes of their native language ...and speakers of a language literally *lose the ability to hear* allophonic variation

Phonemes and categorical perception

- /r/and/l/ are different speech sounds in English, but the same sound in Japanese
- At 6 months old, all infants hear the difference
- By 12 months old, Japanese infants have learned to ignore that difference



Quine's "Gavagai" Problem



Quine's "Gavagai" Problem

Gavagai could mean infinite things:

- Rabbit
- This rabbit (it's name)
- Some property (fluffy, brown)
- Some part (the head or the ears)
- The scene (the rabbit on the ground)
- The action (Scurrying)
- Some plan for the rabbit (let's catch it and cook it for dinner~!)



Quine's "Gavagai" Problem

- It's a problem of reference:
 - A word may refer to a number of referents (large potential meaning space)
 - A single object/events has many features or parts that can be referred to



Word learning biases

For word learning to be possible, maybe children make some default assumptions...

Biases/Constraints that help word learning:

- Whole Object Bias
- Shape Bias
- Mutual Exclusivity Bias

Whole Object Bias

- Children assume that words refer to whole objects (not parts, actions, or properties)

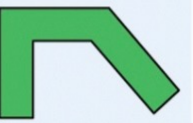

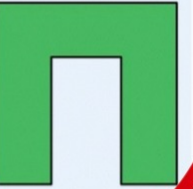


Shape Bias

- Children think a new word refers to objects of the same shape



“Which one is a dax?”

Shape change	 .50
Texture change	 .76
Size change	 .82

Mutual Exclusivity Bias

- Children make the assumption that each thing will have only one name
- Children can deduce what a new word means by ruling out objects they already know



Can you show me a
Blicket?



One-Shot Word Learning (fast mapping)

- Children often learn words after just one exposure! Even if it's only referred to indirectly

Test: Can you find the **koba**?

(Immediately, one week later, and one month later...kids remember!)

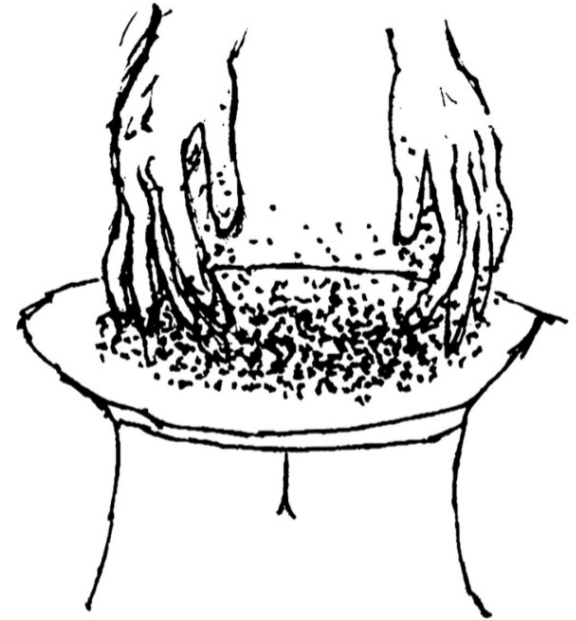
Can you find the koba?



Linguistic context can help

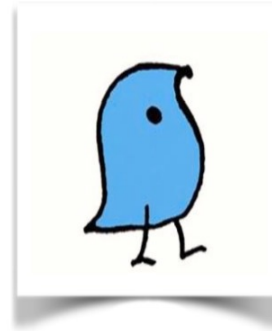
Syntactic/morphological features of words can help children figure out what the word refers to:

- This is a “**sib**” = object
- He is “**sibbing**” = the action
- This is some “**sib**” = the substance

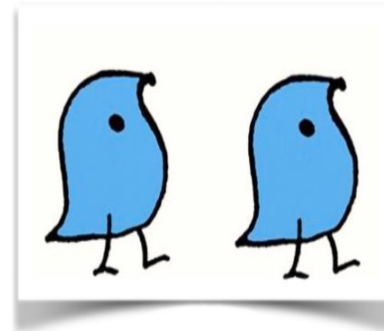


The Wug Test

- Children by 4 years of age will generate the morphological correct endings for novel words!



“This is a **Wug**”



“Now there is another one.
There are two of them.
There are two ____”

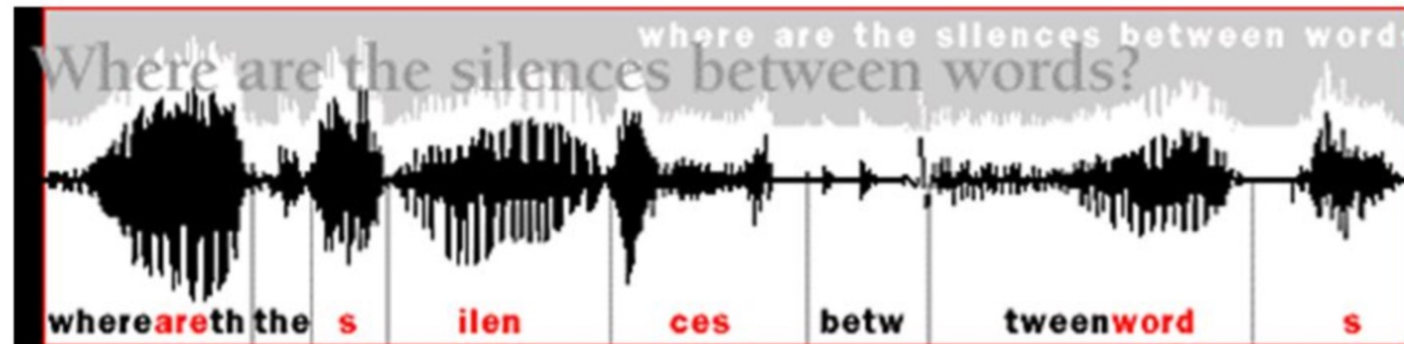
Other cues in word learning

- Kids pay attention to where the speaker is attending
 - Toddlers use the speaker's **gaze** to determine what novel words refers to
 - 16 month olds will apply a new word to a novel object the experimenter is looking at even if the child cannot see the object at the time
- Use of language in context – Sarcasm, intonation, etc



But what about word segmentation?

- Statistical Learning in 8-month olds
 - Infants seem to detect and make use of a variety of probabilistic cues to determine word boundaries
 - Considerable evidence that this ability develops in infants between 7.5 and 10.5 months of age



Transitional probabilities: the likelihood that one sound will follow another

PRETTY BABY

$$\frac{(\text{freq}) \text{ pretty}}{(\text{freq}) \text{ pre}}$$

.80

versus

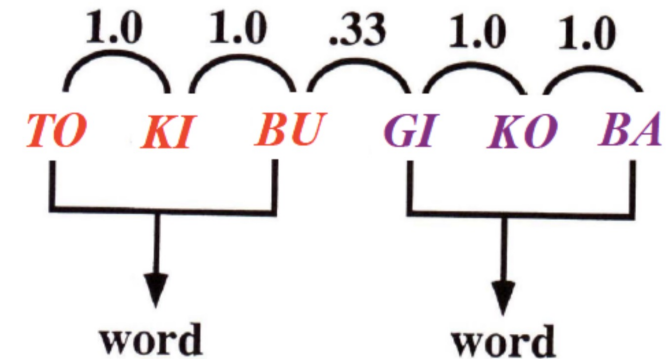
$$\frac{(\text{freq}) \text{ tyba}}{(\text{freq}) \text{ ty}}$$

.0002

tokibugikobagopilatipolutokibu
gopilatipolutokibugikobagopila
gikobatokibugopilatipolugikoba
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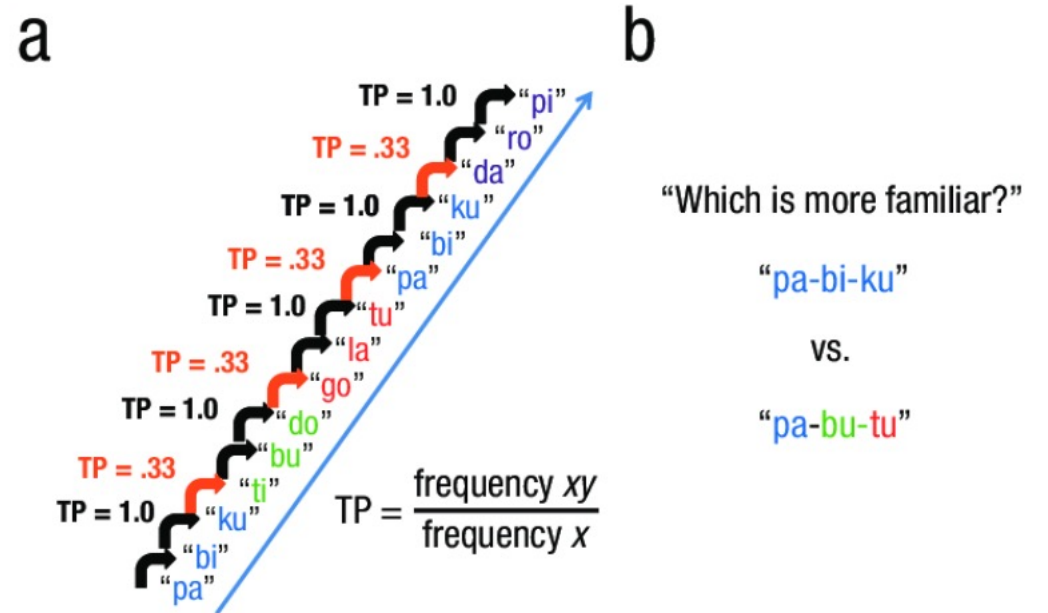
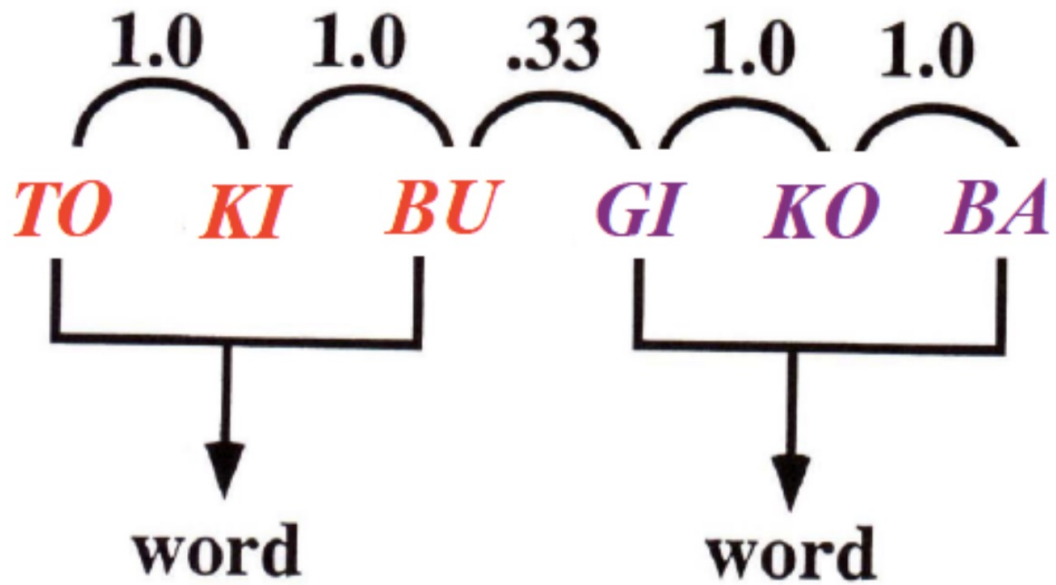
- Experiment: manipulate the transitional probabilities between syllables and words
 - Transitional probability of 1 between syllables in a word
 - Transitional probability of 0.33 between words
 - So certain syllables within a word always follow each other, but the next presented word will be different most of the time (for test words)



Test: TOKIBU vs. BUGIKO

Word

Part	Word
1	the
2	the
3	the
4	the
5	the
6	the
7	the
8	the
9	the
10	the
11	the
12	the
13	the
14	the
15	the
16	the
17	the
18	the
19	the
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97	the
98	the
99	the
100	the



^^ showing same idea, just different syllables/words

What is the sensitive/critical period in language development?

The **critical period or sensitive period**: A window in time when children seem to have a special aptitude for learning language

- So maybe you have a limited window to learn language and if you don't, it's too late and you never will?

How would you test this?

- To test this idea experimentally... get a group of children & isolate them, then compare a test group that gets no language exposure and a control group that does ('the forbidden experiment')

To test this idea (more ethically)...:

- Test animals – experiments that isolate songbirds
- Find 'natural cases' of language-deprived humans ('feral' or abused children, Deaf children born to hearing parents)
- Look at second language acquisition

Language-deprived children

- Isabelle: abused child found at age 8. She rapidly acquired language abilities & matched her peers
- Genie: abused child found at age 13. She learned a large vocabulary, but never developed normal syntax & morphology
- Chelsea: deaf & language-deprived but not physically abused, found at age 31. She learned large vocabulary, but never developed normal syntax & morphology

Genie: Social & Linguistic Deprivation



<https://www.youtube.com/watch?v=6H2PONmzbPo>

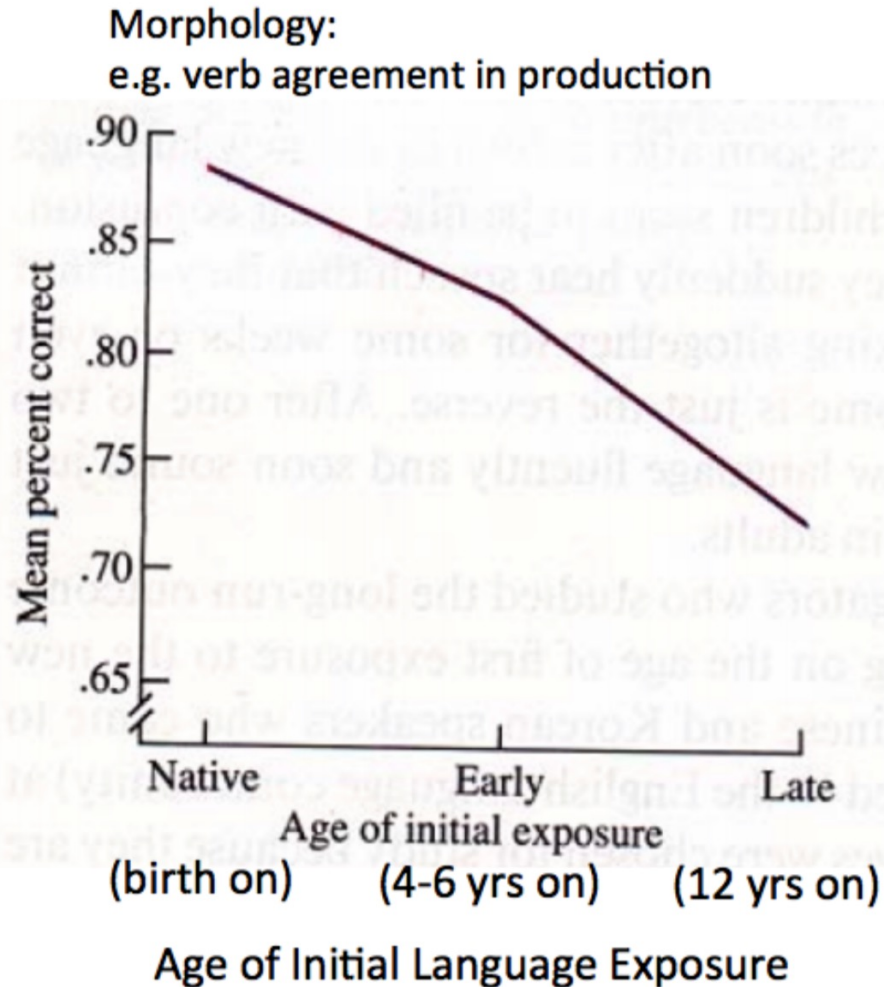
Importance of quality input



Importance of quality input

- **Homesign** is the gestural communication system developed by a deaf child who lacks input from a language model in the family
 - This is a common experience for deaf children with hearing parents who are not part of a sign language community
- Characteristics of homesign systems
 - Slow signing rate, compared to established sign languages
 - Variability in signs/not fully conventionalized - a concept may be communicated with different gestures across utterances
 - Heavy use of pointing and iconicity
 - Children use conventionalization that their mothers don't understand
 - Children use more complex gesture strings than their mothers

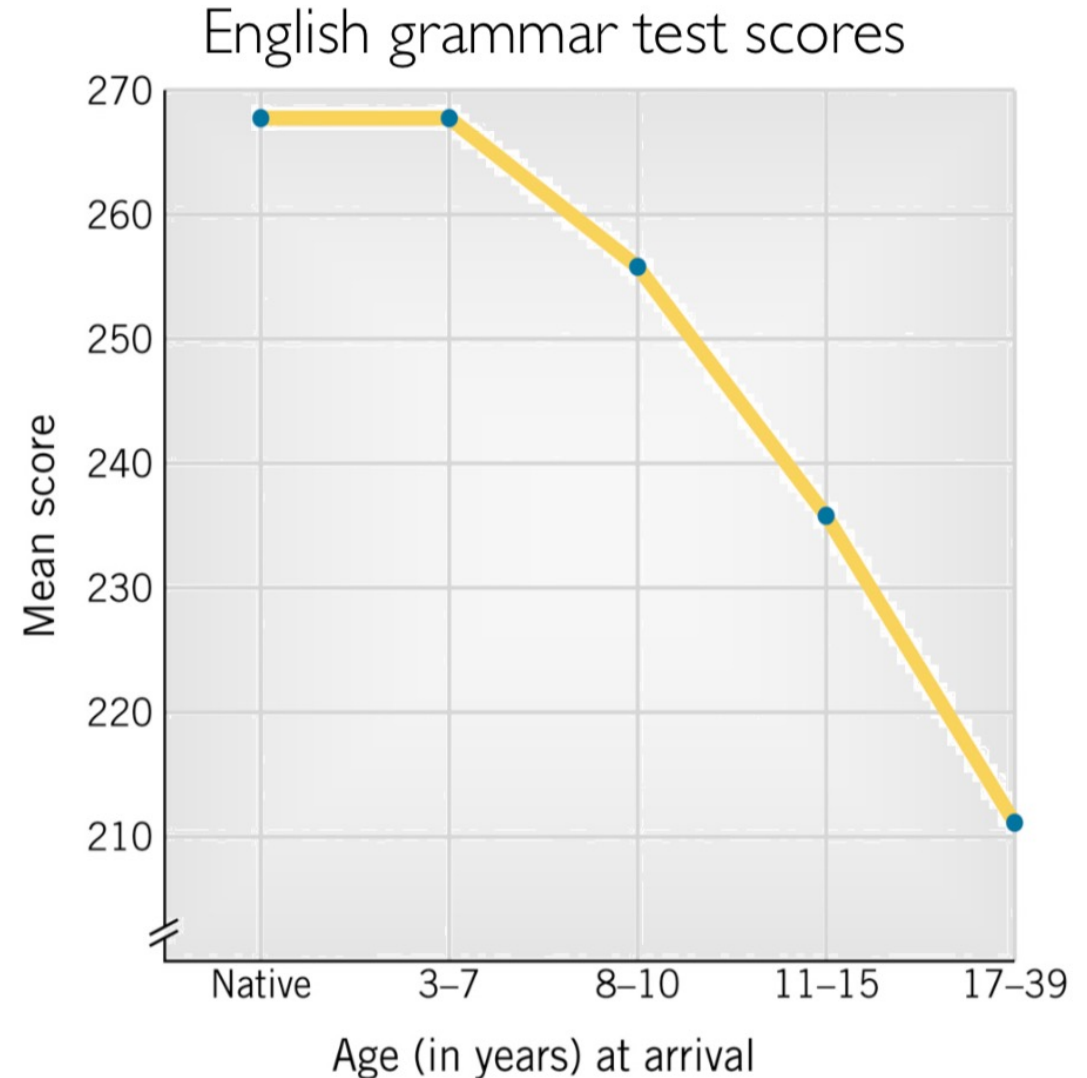
Importance of early experience



- Deaf children born to hearing parents: late exposure to sign language affects mastery of morphological processes

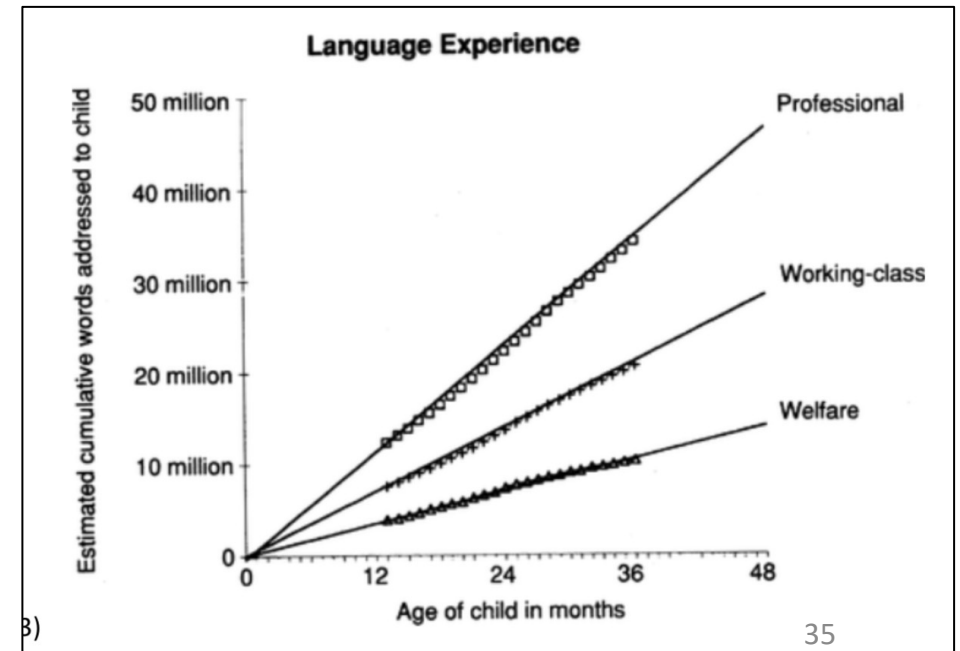
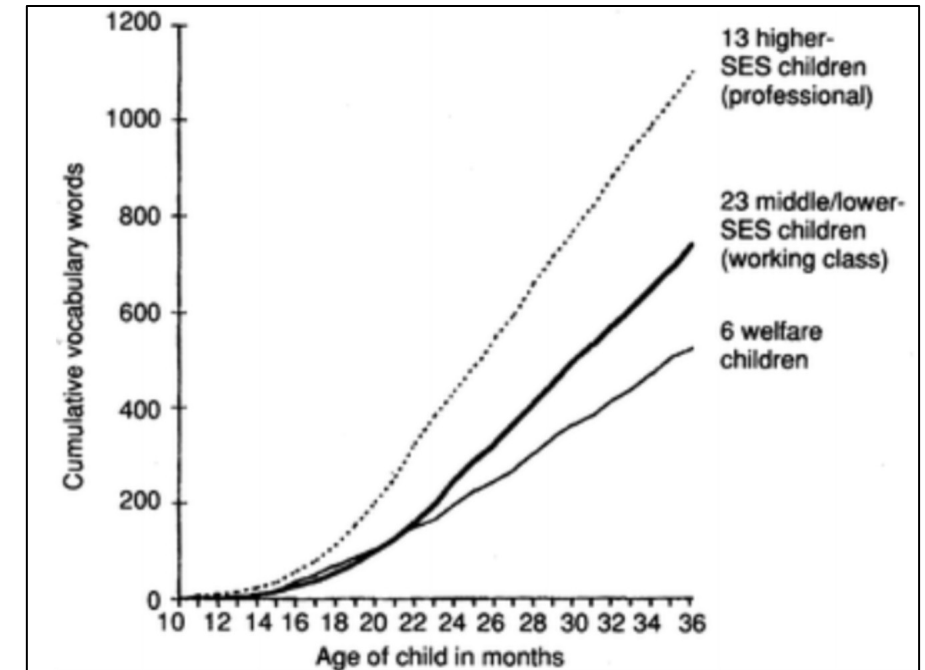
Evidence from second language learners

- Testing immigrants from Korea and China that came to U.S. (and started learning English) at different ages
 - Performance on a test of English grammar correlated with age of arrival in U.S.
 - If they arrived before the age of 7, grammar performance is just as good as that of native English speakers



Importance of early experience

- The number of words children know is closely connected to the number of words they hear
- Vocabulary is correlated with SES (Socio-Economic Status)
 - Children from higher SES households have larger vocabularies than children from lower SES households
 - Longitudinal study (2.5 yrs) of 1 - 2 year olds from families of different SESs
 - Up to a 30-million-word gap in words addressed to children between families
 - Hart & Riley (1995, 2003)



So is there a critical period? It depends

- Speech Perception: Sensitive period is about 12 months
- Pronunciation: Sensitive period is about 7 years
- Morpho-syntax: Some say sensitive period is about 15 years
- Word Order: Learned well at any age
- Vocabulary: Learned better by older learners