Language development in childhood

attention to sound structure in infancy
word recognition and phonological encoding

What’s going on in the first year

innate auditory abilities govern categorization of speech
then, infants start sorting out which sounds of a particular language are meaningfully different
at the same time, infants begin building a vocabulary of words (mainly sound-forms only, no meanings)
by 10-12 months, infants say their first words

What ARE they thinking?

(A Q&D tutorial on child language methods)

What do kids say (sounds, words)?
But what if they can’t talk?
Have to ask what they pay attention to.
What seems interesting?
What seems new?
What means something’s going to happen?
What did a spoken word refer to?

What ARE they thinking?

(A Q&D tutorial on infant methods)

Headturn Preference Procedure: What seems interesting?

Play sounds out of a speaker
Some sounds of Type 1, some of Type 2
Does infant look at speaker longer (indicating more interest) for Type 1, or is there no difference?

What ARE they thinking?

(A Q&D tutorial on infant methods)

Headturn Preference Procedure: What seems interesting?

1. trial starts with green light
2. once baby’s ready, flash one side light
3. when baby turns to light, start playing sounds from speaker
4. when baby turns away, stop sounds and start new trial

dependent measure: listening time to a given kind of auditory material

What ARE they thinking?

(A Q&D tutorial on infant methods)

Habituation: What seems new?

Version 1: high-amplitude sucking (HAS)--good if v. young kid gets to hear sound with each HA suck after hearing the same sound, suck rate declines present slightly-changed sound: does sucking rate perk up again? (= renewed interest)
Version 2: visual habituation hear sound whenever kid looks at visual stimulus gradually, look length declines change sound: do looks get longer again?
What ARE they thinking?
(A Q&D tutorial on infant methods)

What means something’s going to happen?

Conditioned Head-Turn Procedure

Teach kid that whenever sound Y happens, reward usually a toy drumming bear

Then present X, X, Y, X…
do they look for reward at Y?
I.e., can they detect Y (is it different from X?)

Picture fixation: What did a spoken word refer to?

Show pictures of a ball and an apple.

Sound: “Look at the ball! Isn’t it nice?”

Videotape eyes as word is heard.

Code eye movements to given picture.
Do they look more at the ball than the apple?
(=know the word?)

innate auditory abilities

case study: Eimas et al., 1971, on [p] vs [b]--HAS

the sound [p] in, say, “a pack”:

1. stop vocal fold vibration
2. put lips together
3. release lips and let air through
4. start vocal fold vibration

time between #3 and #4: Voice Onset Time (VOT)

VOT is a primary cue listeners use to distinguish [p] from [b] at syllable onset.

Early speech development

VOT variation in English

<table>
<thead>
<tr>
<th>Voiceless</th>
<th>Voiceless</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>20 - 40</td>
<td>20 - 40</td>
</tr>
</tbody>
</table>

Thai uses all three: ba: ‘crazy”; pa: ‘aunt”; paa: ‘cloth

English speakers can distinguish synthesized b/p sounds differing only in VOT, if tested using 20 and 40 msec. But they can’t (or perform poorly) if tested using 0 and 20 or 40 and 60.

Categorical perception (strict definition): listeners can only discriminate sound pairs they can give different labels.

Categorical perception (loose definition): listeners are much better at discriminating between categories than within categories.
**How do infants perceive speech sounds?**

Eimas et al.: 1- and 4-month-olds; habituation procedure.

**VOT:** +20/+40 (ba/pa) 0/+20 Control (ba...ba...ba...ba...)

Uniquely human genetic innate language capacity!...or not

[Image of chinchilla and macaque]

**Basic auditory ability**

Further study: replications testing discrimination of many speech sounds.

Under ideal conditions, young infants can tell apart any **two speech sounds** that are used in any language for conveying different meanings.

<table>
<thead>
<tr>
<th>Some contrasts</th>
<th>Some contrasts infants discriminated in studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>big/pig</td>
<td>b/p s/z a/ã</td>
</tr>
<tr>
<td>shed/said</td>
<td>b/d s/θ E/æ</td>
</tr>
<tr>
<td>dumb/numb</td>
<td>r/l f/θ i/ɪ</td>
</tr>
<tr>
<td>flora/nora</td>
<td>b/w d/ɡ b/m a/ɪ w/j u/y</td>
</tr>
</tbody>
</table>

language-specific refinement

Werker & Tees 1984: test discrimination of Hindi dental and retroflex /t/, and discrimination of Nthlakampx velar and uvular consonants [k'] and [q'], using CHT.

- velar
- uvular

Canadian babies: discriminated at 6-8 months only some did at 8-10 months almost none at 10-12 months

Infants get worse at discriminating sounds that aren’t contrastive in their language.

language-specific refinement: vowels

similar results, perhaps even earlier development

Polka & Werker 1994, using visual habituation procedure

German /u/ vs /y/

4 months discriminate

6 months don’t

10-12 months don’t

language-specific refinement: vowels

Catalan and Spanish

Catalan: has /e/ and /E/ (like “bait” and “bet”) Spanish: just something in between, near /e/;

Bosch & Sebastian-Gallés, using habituation procedure:

all 4.5 month olds discriminate /e/ and /E/;
Catalan 8.0 month olds discriminate them too;
Spanish 8.0 month olds don’t.
Once infants recognize phonetic categories, they’re all set, right?

No! They still have to find words: the segmentation problem

Sometimes word boundaries are clear.

Sometimes word boundaries are not clear.

This is essentially what infants are faced with!

What about actual speech to infants?

In general, parents don’t do much to mark where linguistic units (words, phrases) begin and end. The baby has to figure that out.

Start by learning words in isolation?

Word-teaching experiment (see Aslin, 1993)

Get parents to teach word (e.g. "rist") to infants
Parents rarely produced in isolation…
Even though trying to teach kids the word!

Infants’ learning of word-forms from speech

Infants remember words from stories after two weeks. Shown by preference for hearing those words rather than other words. (Jusczyk & Hohne 1997)

Jusczyk & Hohne (1997)

1. Visit home of 8-month-olds 10 times over 2 weeks.

On each visit, sit infant in a seat, and play a tape-recording of someone reading a story. Meanwhile flip through a book with pictures relating to story.

3 stories total, 30 min. per visit, 5 talkers each story.

Jusczyk & Hohne (1997)

2. Wait 2 more weeks.
Use headturn-preference procedure to test word lists.

**In stories**
- sneeze
- elephant
- gray
- python

**Fails**
- aches
- apricot
- sloth
- jaunt
- lanterns

In-stories words occurred ~13 times per story visit.

Results (HPP): Infants preferred the familiar-word lists.

But not in a control study of infants with the same test, but no familiarity with the stories.

8-month-olds remember at least some words they've heard (even if they don't know what the words mean yet)

How do infants know which things might be words?

**Distributional analysis:** which things tend to go together. Sound sequences that appear together in various environments are more likely to be words.

- thatsaprettybabysinit
- doyoulikeyourbabybrother
- thebabys spitupagain

**Transitional probability:**

- ba-->by 100%
- ty-->ba 33%
- hy-->is 33%

Saffran, Newport & Aslin 1996, 8-mo-olds (HPP):

- bidaku, dotigolabu bidaku labu…
- thatsaprettypabiesnит
- doyoulikeyourbabybrother
- thebabys spitupagain

Listened longer to "novel" (low transitional probability) sequences ku-pado than to bidaku

So how do they find the words?

Statistics

Biases

Also works with tones, sequences of visual objects--not a language-specific learning mechanism
infants’ learning of word-forms from speech

Similar results are found with shorter training and testing just after the training.

These studies show that children are biased in what words they extract and remember.

-- extract strong-weak (berry), not weak-strong (beret)
  [French infants do the reverse.]
  Most English words are strong-weak.
  French words (arguably) are weak-strong.

Puzzle: how do you know what language you’re in to know what bias to have?

Learning word forms

statistics

biases (from what?)

12-month-olds know a stock of word-forms, possibly quite large (150-350 words), some of which are connected to some meaning.

These words, first learned only as sounds, form the basis of the early vocabulary.

speech and babbling--developments in the first year

(some variability--see next few slides)

around 6-8 weeks: cooing (contented vowel sounds)

around 2-3 months: some consonantlike sounds, often velars like [g] and [k]

around 6 months: other consonantlike sounds with labial or alveolar constriction ([m], [n], [b], [p], [d])

around 6-9 months: canonical babbling (dadada or nanana)

around 11 months: variegated babbling (dababi with prosody)

Also, throughout (and beyond) the first year, words gradually approach adult pronunciation

onset of canonical babbling: age distribution

Figure 5.7. Age of onset of babbling in nine hearing-impaired (filled symbols) and twenty-one normally hearing (open symbols) infants.

Oller & Eilers, 1988

Acquisition of the vocabulary:

Words produced, shown by age, 8-16 months

Words produced, shown by age, 16-30 months
Word learning

Are children’s word meanings fundamentally like ours?

Maybe not: some words may be context bound

Bloom: car only for particular viewpoint
Barrett: duck only for duck bath game
Bates: words used only in the presence of their referent

But this phase is limited (only children’s very first words), and may refer only to production tendencies, not weird denotations.

Mostly, children’s words refer to categories, where the sorts of categories are comprehensible (even if they’re not quite the right meanings).

What do children talk about?

Why are children talking? -- Not only requests; many comments too.

Which words? -- a variety:

- proper nouns (Mommy);
- common nouns and pronouns (dog, this)
- action words (go, up, look)
- modifiers (all-gone, mine, big)
- social words (no, want,)
- function words (what, for, is)

--K. Nelson 1973

As vocabulary expands, the proportion of nouns balloons.

Why so many nouns?

Some crosslinguistic variation; noun bias not universal

Mandarin: children produce more verbs than nouns.
(a) verbs more likely to be sentence-final
(b) verbs vary less in their realization in M. than in Eng.
(c) parents simply say more verbs in M.

But the general pattern favors nouns, and in particular object labels.

Why?
- maybe the concepts are simpler
- maybe the concepts are easier to identify

Problems in word learning

phonological encoding: what sounds did you say?

present-referent identification: what are you talking about now?

category identification: how can a word be extended?
**Phonological encoding: production**

Children’s speech: often hard to understand
“squirrel” (skwrl) --> /ga/

- **simplify** consonant cluster skw --> k (“cluster reduction”)
- liquids /l/ and /r/ often omitted
- voiceless stop consonants often **voiced**
- vowels often **undifferentiated**

Does children’s speech reflect their knowledge of words, or just what they can do with their vocal apparatus?

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**Phonological encoding: perception**

To find out what children know about sound forms, try testing their word recognition with correct pronunciations and mispronunciations.

If children know how words should sound, mispronunciations should be **harder to understand** than correct pronunciations.

If children only have a vague idea how words should sound, they **shouldn’t care** how words are said.

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A small caveat: doesn’t work so well for new words

Stager & Werker, 1997, habituation w/14-m-o

"bih"
Test: "dih"
No dishabituation!
Fine with lif/neem

"dih"
Kids have less precise representations of new word-object pairings

My work: long time to get to adult performance

"Click on the candle"

Problems in word learning

phonological encoding: what sounds did you say?

present-referent identification: what are you talking about now?

category identification: how can a word be extended?

present referent identification

Saint Augustine, bishop of Hippo, AD 397
They say, I look: “the natural language of all nations”

W.V.O. Quine
but you never know -- “gavagai” problem

How can you really know what someone else is talking about?
Even if they point and say a single word, they could mean many different things.

3 views on Quine’s problem

1. just store a correlation matrix
2. linguistic constraints on hypothesis space
3. St. Augustine was right: intention reading carries the day

1. just store a correlation matrix

<table>
<thead>
<tr>
<th></th>
<th>brown</th>
<th>huge</th>
<th>animal</th>
<th>right-here</th>
<th>long-nose</th>
</tr>
</thead>
<tbody>
<tr>
<td>brown</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Just store a correlation matrix—but what about…

- What are the features in the matrix?
  okay for object labels, but what about “all-gone” or “think”
- Lots of things are present when a word is heard (for example, the child), yet children home in on the right meaning
- What about fast mapping?
  relatively error free learning, w/few trials

Fast mapping example:
“Give me the chromium one, not the green one, the chromium one.” (for colors, shapes, or textures)
2, 3, and 4 year olds better than chance in later choosing the right color/shape/texture from a set of 4.
Carey & Bartlett, 1978; Heibeck & Markman, 1987

Success in fast mapping suggests that “brute-force correlation”—gathering lots of information over lots of different exposures—is not the way children learn words.

2. linguistic constraints on hypothesis space

Maybe children are biased against certain word meanings, simplifying the learning problem.
Ellen Markman: constraints on object labels

- whole object assumption
- mutual exclusivity constraint

Experiments:  

More complex situation:  

“Hold the handle.”  
Here, mutual exclusivity outranks whole-object assumption

2. linguistic constraints on hypothesis space

Linguistic context as an aid in word learning

Roger Brown (1957), 3-4 year olds
“sibbing” vs. “some sib”
sibbing → verb interpretation
some sib → substance interpretation

Katz, Baker, & Macnamara (1974), 17 month olds
“a dax” vs. “Dax”
object
animate critter

3. St. Augustine was right

That is, maybe children are really good at figuring out what their parents are probably talking about, so word learning isn’t so hard after all.

Lots of social cues—joint attention
**category identification: how should a word be extended?**

Often, shape most important

- “This is a dax.” (i.e. this has the non-obvious property of being called a dax.)
- “Is this a dax?”
- “Is this a dax?”
- “Is this a dax?”

Landau, Smith, & Jones 1988 (2- and 3-year-olds)

**category identification: how should a word be extended?**

Shape not always the most important factor

Soja, Carey, & Spelke 1991, 2-year-olds

Show children (a) novel object or (b) heap of substance

Test: “Find another bicket.”

(a) group: Picked same shape (b) group: Picked same substance

- “This is a bicket.”

In general, children use whatever information they think is most relevant for identifying the category denoted by a word.

**for object labels:**
- shape
- material composition
- function
- intended category or intended function