Words and sounds in infants’ language learning

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What a competent language user knows

speech sounds, prosody

words

how to convey meaning using the arrangement of words;
how to inflect / modify words

how to integrate meaning and intention, discourse goals
What a competent language user knows

phonology

lexicon

syntax and morphology

pragmatics
Learning one’s language: the standard “bottom-up” view

phonology

lexicon

syntax and morphology

pragmatics
Learning one’s language: the standard “bottom-up” view

- Phonology
- Lexicon
- Syntax and morphology
- Pragmatics

0-24 months
Learning one’s language: the standard “bottom-up” view

phonology

lexicon

syntax and morphology

pragmatics

1-3 years
Learning one’s language: the standard “bottom-up” view

phonology

lexicon

syntax and morphology

pragmatics

1

2

3

4

3+ years
Why this view of infants? (0 – 12 months)

1. *methodological and historical accidents*
   
   perception researchers found babies first;
   techniques not applied to *interpretation*
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1. *methodological and historical accidents*
   perception researchers found babies first;
techniques not applied to *interpretation*

   Eimas  →
   Kuhl, Werker  →
   Jusczyk
Why this view of infants? (0 – 12 months)

2. *Informational dependence:*
   no words without sounds;
   no syntax without words;
   no pragmatics without … theory of mind?

… But our primitives may not be the baby’s primitives

Ours: acoustics, perceptual features, solid objects
Babies’: emotions, movements, intentions (?)
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   no words without sounds;
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Is phonology → lexicon → syntax/pragmatics really “bottom-up”?
birth
1 year
2 years
3 years
more sequential

more interactive
Interactions between words and sounds: how sounds are learned

By 12 months, infants ignore similar non-native sound distinctions

Werker & Tees, 1984; Kuhl et al., 1992; Polka & Werker, 1994; Pegg & Werker, 1997; Bosch & Sebastián-Gallés, 2003; Mattock et al., 2008
How do infants learn which sounds their language uses?

**Semantic** route, through minimal pairs:

- keys
- peas.

Thus $[k] \neq [p]$.

This theory has long been considered unlikely, given 12-month-olds’ vocabularies (an *informational dependence* problem)
How do infants learn which sounds their language uses?

**Distributional** route, through phonetic clustering

“distributional learning”
discovering categories by detecting clusters of experienced instances in a perceptual space

e.g. Goudbeek, Swingley, & Smits *JEP:HPP*, 2009
Distributional route, for learning vowels

P. Kuhl et al., 1997, Science
1500 monophthongs spoken by one mother to her 10 month old (English, Brent corpus)
Duration contrasts

Dutch short, long vowels
raw data: Levelt & Fikkert
analysis: Swingley, 2006

Japanese short, long vowels
Bion, Miyazawa, Kikuchi, & Mazuka, ICIS conf. 2012
Is a pure “bottom up” solution feasible?

We don’t know.
  • maybe other phonetic features make these problems easy.
  • maybe infants pay more attention to “better” instances.

But if not: here’s an idea
thought experiment: how to use words, without minimal pairs
2 preconditions concerning speech to infants

1. The early vocabulary mustn’t have too many vowel minimal pairs (like “teeth-tooth”)

2. These word forms have to specify their categories (i.e., words should exemplify their canonical vowels)
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2. These word forms have to specify their categories (i.e., words should exemplify their canonical vowels)

1 precondition concerning infants

1. Infants must actually use such a strategy when it’s available
raw speech

data: Brent & Siskind, 2001
frequent orthographic words, mean vowel locations
most frequent words: orthographic

- kitTY, teeth, see, me, we, reaDY
- /l/ & /E/ here, it, DIIlon, there, YEllow...
- black, back, yeah, cat, DAddy, that...
- you, do...
- misc doing, good, so, Gonna
- oh, hold, helLO, no, go, yellow, ...
- hug, love, up, humpty, some...
- not, all, frog, talking, on

first formant (Hz)

second formant (Hz)
Analysis: frequent consonantal frames

Convert all vowels to neutral “vowel” character
compute trimmed mean of F1 and F2 over each frequent (n > 4) “frame”

The risk: “nightmare scenario” sets like
  mV (me 54%, my 38% ...)
  hV (huh 28%, how 22%, he 22%, hey 11%, hi, ...)
  jV (you 62%, yeah 19%, your 11%, ...)
Using words to find categories: evaluation

Some categories are easy to find this way. Others seem harder, particularly mid-front vowels.

Difficult categories had many “minimal pairs” like red/road, me/my, nose/nice, were/where.

Minimal pairs should be okay, though, if the child knows what they mean. But <12 month olds don’t know what words mean, right?
Using words to find categories: evaluation

Early semantic knowledge may help avoid some minimal-pair errors (Yeung & Werker, 2009)
Do “prelinguistic” infants know meanings of words?

Bergelson & Swingley, 2012
Do “prelinguistic” infants know meanings of words?

Bergelson & Swingley, 2012
Do “prelinguistic” infants know meanings of abstract words?
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“hi”
“all gone”

“eat”
“hug”

Bergelson & Swingley, u.r.
Do “prelinguistic” infants know meanings of abstract words?
Do “prelinguistic” infants know meanings of abstract words?

<table>
<thead>
<tr>
<th>Item-Pair Means by Age Bin</th>
<th>6-9 mo. mean</th>
<th>10-13 mo. mean</th>
<th>14-16 mo. mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>allgone_hi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>eat_hug</td>
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<td>kiss_dance</td>
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<td>smile_drink</td>
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<td>uhoh_bye</td>
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<td></td>
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<tr>
<td>wet_sleeping</td>
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</tr>
</tbody>
</table>

Increase in Target Looking
6 months: earliest evidence for changes in phonetic categories (Polka & Werker, 1994)

First sounds, then words?

6 months: earliest evidence for knowledge of word meaning (Bergelson & Swingley, 2012)

10 months: learning of more abstract words
back to the “bottom up” : what sound categories are for
back to the “bottom up”: what sound categories are for

- children recognize words best when words are spoken with their normal phonological constituents
back to the “bottom up” : what sound categories are for

- these phonological constituents vary by language at 1-2 years

  - Catalans, not Spanish, slowed by changes E/e
    Ramon-Casas et al., 2009

  - Dutch, not Canadians, learn word pairs varying in vowel duration
    Dietrich, Swingley, & Werker, 2007

  - Americans taught a word with a big pitch contour did not care if the contour was changed
    Quam & Swingley, 2010
The simple “bottom-up” story about receptive phonology:

1. learn phonetic categories
2. encode words using those categories
3. know that categorical distinctions are linguistically significant

birth
1 year
2 years
The simple “bottom-up” story about receptive phonology:

1. learn phonetic categories
2. encode words using those categories
3. know that categorical distinctions are linguistically significant

Thus, $[t] \neq [d]$. Thus,
Testing children’s interpretation of phonological variation

“Touch the shang.” or,
“Touch the vish.”

“vish”: 2- to 2.5-year-olds usually choose the fish
Testing children’s interpretation of phonological variation

“This is called a vish, not a fish.
This is a vish.”

“vish”: 2- to 2.5-year-olds usually choose the fish

“Touch the shang.” or,
“Touch the vish.”

“vish”: 2- to 2.5-year-olds usually choose the fish

Give us a hint: teach 5 words in introduction
Testing children’s interpretation of phonological variation

“This is a tog. Tog. A tog.” (20x)

“Where’s the tog?”
“Where’s the meb?”

19 month olds: Swingley & Aslin, 2007
Pitch in explicit interpretation of emotions

Carolyn Quam
Quam & Swingley, 2012
Body-language Group

Pitch-contour Group

Proportion Correct

Age in Years

Body-language

Pitch
Conclusion: words and sounds

- Phonetic learning affects discrimination
-Lexical categorization (may) affect phonetic learning

Phonetic categorization affects differentiation of words

But lexical competition can interfere with word learning
Conclusion

Development of all areas of language takes a long time: it extends late for phonology, and starts early for the lexicon.

Different levels may interact in unanticipated ways.
(supplementary slides follow)
What about allophones?

**Allophony**: sounds are phonetically a bit different, but phonologically “the same”. Basis: phonetic similarity, and contextual *difference*.

**My lexical proposal**: sounds are phonetically similar, therefore phonologically the same. Basis: phonetic similarity, and contextual *similarity*.

What makes allophones the same?

- contexts very consistent – even obligatory
- contexts very local – adjacent sounds
- phonetic basis: allophonic variants overlap more than \ non-allophonic pairs
purity of clusters, no lexical grouping, n=12

purity of clusters, frame grouping, n=12