Psych 156A/ Ling 150: Acquisition of Language II

Lecture 5
Sounds of Words

Announcements
- Be working on HW1 (due 4/14/16)
- Be working on review questions for sounds and sounds of words

Word forms
Computational problem:
Map variable word signals to more abstract word forms

Word learning: mapping between concept, word, and word's variable acoustic signal

Stager & Werker 1997
Learning nonsense words that are minimal pairs (differ by one phoneme): "bih" vs. "dih". Comparing against words that are not: "lif" vs. "neem"

"Switch" Procedure: measures looking time

Habituation
Same: bih
Test
Switch: dih

Timeline
from Curtin & Zamuner 2014

Learning word forms starts pretty early (just before 6 months)
Learning word-object associations comes several months later (reliably at 12 months)
**Stager & Werker 1997**

**Experiment 1**

<table>
<thead>
<tr>
<th>'Dih'</th>
<th>'Bih'</th>
<th>'Dih'</th>
</tr>
</thead>
</table>

Habituation

**14-month-olds**

Same: bih!

Switch: dih!

No looking time difference = 14-month-olds didn’t notice the difference!

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**Stager & Werker 1997**

**Experiment 1**

<table>
<thead>
<tr>
<th>'Dih'</th>
<th>'Bih'</th>
<th>'Dih'</th>
</tr>
</thead>
</table>

8-month-olds & 14-month-olds

Habituation

Same: bih!

Switch: dih!

No difference in looking time = 14-month-olds didn’t notice the difference again!

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**Stager & Werker 1997**

**Experiment 2**

<table>
<thead>
<tr>
<th>'Bih'</th>
<th>'Bih'</th>
<th>'Dih'</th>
</tr>
</thead>
</table>

8-month-olds & 14-month-olds

But 8-month-olds did! They have a difference in looking time. They look longer at the "bih" object when it is labeled "dih" - so they must know "b" and "d" are different.

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**Stager & Werker 1997**

**Experiment 2**

<table>
<thead>
<tr>
<th>'Bih'</th>
<th>'Bih'</th>
<th>'Dih'</th>
</tr>
</thead>
</table>

14-month-olds

Habituation

Same: lif!

Switch: neem!

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**Stager & Werker 1997**

**Experiment 3**

<table>
<thead>
<tr>
<th>'Lif'</th>
<th>'Lif'</th>
<th>'Neem'</th>
</tr>
</thead>
</table>

14-month-olds

Test

Same: lif!

Switch: neem!
Here, the 14-month-olds look longer at the “lif” object when it’s labeled “neem”. They notice the difference.

Infants unlikely to associate label with checkerboard pattern (that is, to treat it like a word that has a referent/meaning)

Here, the 14-month-olds look longer at the “bih” “object” when it’s labeled “dih”. They notice the difference.

Key findings

14-month-olds can discriminate the minimally contrasting words (Expt. 4)

...but they fail to notice the minimal change in the sounds when they are paired with objects, i.e., when they are words with associated meaning (Expt. 2)

14-month-olds can perform the task, when the words are more distinct (Expt. 3)

Therefore, 14-month-olds use more detail to represent sounds than they do to represent words?

What’s going on?

They fail specifically when the task requires word-learning.

They do know the sounds...but they fail to use the detail needed for minimal pairs to store words in memory.

What’s going on?

– Is this true for all words?
– When do they learn to do this?
– What triggers the ability to do this?
What children may be doing

One idea: Encode detail only if necessary

If children have small vocabularies, it may not take so much detail to distinguish one word from another. (baby, cookie, mommy, daddy...)

Neighborhood structure idea: When a child knows two words that differ only by a single phoneme (like "cat" and "bat"), more attention to detail is required to distinguish them.

Prediction: The content of children’s vocabulary drives their ability to notice the difference between words that differ minimally (ex: by a single phoneme)

What children may be doing

One idea: Encode detail only if necessary

Some support for this idea:
Children with smaller vocabularies have more high neighborhood density words (Stokes 2010, Stokes et al. 2012a, Stokes et al. 2012b). This may help children keep the word forms separate.

Words from dense neighborhoods are produced more accurately and with less variability than words with sparse neighborhoods (Freedman & Barlow 2012, Sosa & Stoel-Gammon 2012).

Going with the neighborhood idea, look at Stager & Werker 1997

“bih” and “dih” are too close (they differ only by one phoneme), and 14-month-old kids don’t know any words close enough to motivate attention to the “b”/“d” difference when word-learning

Prediction: The content of children’s vocabulary drives their ability to notice the difference between words that differ minimally (ex: by a single phoneme)

Werker et al. 2002: Vocabulary size matters

Stager-Werker task

Test

Same: bih/

Switch: dih/

Habituation

Test

20-month-olds notice
14-month-olds don't

17-month-olds do

Those with a small vocabulary look like 14-month-olds - they can't tell the difference for a novel word they haven't heard much.

Those with a large vocabulary look like 20-month-olds - they can tell the difference for a novel word, even though they haven't heard it much.

Implication: Performance on Stager-Werker task with novel words does depend (somehow!) on how many words the child knows.
More vocabulary =
more necessary distinctions?

Werker et al. 2002: Performance on Stager-Werker task with novel words depends on how many words the child knows.

Implication: The content of children’s vocabulary drives their ability to notice the difference between words that differ minimally (ex: by a single phoneme)

Prediction: This should apply to familiar words too. Specifically, children with small vocabularies should have trouble noticing phonemic differences in familiar words.

Swingley & Aslin 2002: Familiar word tests

But English 14-month-olds noticed the difference between correct pronunciations and mispronunciations when the words were familiar!

<table>
<thead>
<tr>
<th>CP</th>
<th>MP-close</th>
<th>MP-distant</th>
</tr>
</thead>
<tbody>
<tr>
<td>apple (/æpl/)</td>
<td>opal (/əpl/)</td>
<td>opal (/əpl/)</td>
</tr>
<tr>
<td>ball (/bɔl/)</td>
<td>gawl (/gəl/)</td>
<td>shawl (/ʃəl/)</td>
</tr>
<tr>
<td>cat (/kæt/)</td>
<td>kard (/kər/)</td>
<td>kier (/kɪər/)</td>
</tr>
<tr>
<td>dog (/dɔɡ/)</td>
<td>tug (/tʌɡ/)</td>
<td>mag (/mæɡ/)</td>
</tr>
<tr>
<td>kitty (/ˈkɪti/)</td>
<td>pty (/pti/)</td>
<td>yiny (/jɪni/)</td>
</tr>
</tbody>
</table>

Maybe these 14-month-olds just happen to have large vocabularies?

Swingley 2005: Familiar words for younger children

(Dutch) 11-month-olds noticed the difference between correct pronunciations and mispronunciations when the words were familiar (Headturn Procedure: tests ability to hear sound differences)

<table>
<thead>
<tr>
<th>Familiar</th>
<th>Newword</th>
<th>Close-MP</th>
</tr>
</thead>
<tbody>
<tr>
<td>bed</td>
<td>baːd</td>
<td>deːd</td>
</tr>
<tr>
<td>ben</td>
<td>baːn</td>
<td>deːn</td>
</tr>
<tr>
<td>boyk</td>
<td>boːn</td>
<td>koyk</td>
</tr>
<tr>
<td>abhi</td>
<td>aːbi</td>
<td>eːbi</td>
</tr>
<tr>
<td>b ʃt</td>
<td>b ʃt</td>
<td>s ʃt</td>
</tr>
<tr>
<td>baːf</td>
<td>baːf</td>
<td>saːf</td>
</tr>
<tr>
<td>host</td>
<td>hoːt</td>
<td>foːt</td>
</tr>
<tr>
<td>kus</td>
<td>kus</td>
<td>kuːs</td>
</tr>
<tr>
<td>moʊst</td>
<td>moʊst</td>
<td>moʊst</td>
</tr>
<tr>
<td>neɪk</td>
<td>nɛk</td>
<td>nɛk</td>
</tr>
<tr>
<td>paːt</td>
<td>paːt</td>
<td>daːt</td>
</tr>
<tr>
<td>pas</td>
<td>pas</td>
<td>tas</td>
</tr>
<tr>
<td>staːlp</td>
<td>staːlp</td>
<td>staːlp</td>
</tr>
<tr>
<td>teʃt</td>
<td>teʃt</td>
<td>teʃt</td>
</tr>
<tr>
<td>v ʃt</td>
<td>vaːʃt</td>
<td>v ʃt</td>
</tr>
<tr>
<td>vot</td>
<td>veʃt</td>
<td>vot</td>
</tr>
</tbody>
</table>

Swingley 2005: Familiar words for younger children

(Dutch) 11-month-olds noticed the difference between correct pronunciations and mispronunciations when the words were familiar (Headturn Procedure: tests ability to hear sound differences)

But this is before they've likely learned many words...so it probably isn't just the number of words they know (and which words they know) that drives the detailed representations of the sounds in the words.

Point: Vocabulary can't be the only thing determining children’s ability to distinguish the sounds of words. So what's the problem with the 14-month-olds in the Stager-Werker task?

Was the task too hard for 14-month-olds?

Yoshida, Fennell, Swingley, & Werker (2009)

Maybe the problem with the 14-month-old infants was that the switch task was too hard - they have to be very confident that the close mispronunciation of the new word (dih for novel word bih) is not actually close enough.

What would happen if we habituated 14-month-old children the usual way for the Switch procedure, but then tested them a different way that didn’t require them to be as confident about the correct pronunciation of a word’s form?

The Visual Choice Task

“Preferential looking”

Golinkoff, Hirsh-Pasek, Cauley & Gordon 1987

A two-alternative forced choice looking task that compares visual fixations to target and distractor objects

“Where's the dog?”

Familiar object better match for familiar word
The Visual Choice Task
“Preferential looking”
Golinkoff, Hirsh-Pasek, Cauley & Gordon 1987

A two-alternative forced choice looking task that compares visual fixations to target and distractor objects

“Where’s the tog?”

Novel object is a better match for novel word form and importantly familiar object is a poor match - infant knows familiar word.

Yoshida, Fennell, Swingley, & Werker 2009

Novel labels “bin” “din”

Test: 14-month-olds “Where’s the bin?”

14-month-old infants look significantly more at the correct novel object - they do have detail for words!

The problem with the Stager-Werker Task

Maybe the problem with the 14-month-olds in the Stager-Werker task was that they encoded the phonetic forms with low confidence. So, when tested on the original switch task, they didn’t have enough confidence in their representation of the novel form to realize it was the wrong label for the novel object.

Yoshida et al. 2009: “Calling a din object by the word bin is not good pronunciation to the 14-month-old, but neither is it categorically incorrect.”

Another methodological check

Fennell & Waxman 2010: 14-month-olds can pass this switch task if the communicative purpose of the novel word label is made more salient.

Fennell & Waxman 2010: 14-month-olds can pass this switch task if the communicative purpose of the novel word label is made more salient.

Non-issue: bih is definitely a label for the object.

Look at the dih...
(This is definitely strange, given the habituation.)

The communicative intent of the novel word can also be made clear by training items that show familiar objects and labels.

Fennell & Waxman 2010

Kitty! Carl! Shoe! Bih!

When there’s clear intent for the novel word to be a label, 14-month-olds can pass the Switch task just fine.
Another methodological check

Fennell & Waxman 2010: 14-month-olds can pass this switch task if the communicative purpose of the novel word label is made more salient.

When it’s not clear the novel word is intended as a label (in fact, it seems to be more of an exclamation like “wow”), 14-month-olds look just like they did in the Stager & Werker (1997) experiment.

Why does having a familiar word help?

Idea: Children build up more confidence in the word form the more times they hear it.

\[ (p/b/d/g)(a/o/u)(I/r) = “pall”, “dor” \]
\[ “gull”, “ball” \]
\[ (p/b)(a)(I/r) = “pall”, “ball”, \]
\[ “bar”, “par” \]
\[ (b)(a)(l) = “ball” \]

Building up an abstract representation from many samples

Thiessen & Yee 2010: Early word form representations retain contextual and perceptual features associated with children’s prior experience with words.

15-month-olds learned novel names for objects that began with either [t] or [d].

This was meant to draw attention to the difference between these phonemes.

Building up an abstract representation from many samples

Thiessen & Yee 2010: Early word form representations retain contextual and perceptual features associated with children’s prior experience with words.

Similar to the 14-month-olds in Stager & Werker 1997, when this name was switched to yat, they didn’t notice.
Building up an abstract representation from many samples

Thiessen & Yee 2010: Early word form representations retain contextual and perceptual features associated with children’s prior experience with words.

15-month-olds learned novel names for objects that began with either [t] or [d].

dawbow vs. tawgaa

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Thiessen & Yee 2010: Early word form representations retain contextual and perceptual features associated with children’s prior experience with words.

If they were able to represent the [d] vs. [t] distinction abstractly, dawbow and tawgaa should help remind them that [d] and [t] are distinct. So, if the other novel object’s name is switched from yad to yot, they should notice.

But they didn’t…probably because this is a different acoustic context (word-initial vs. word-final).

Building up an abstract representation from many samples

Thiessen & Yee 2010: Early word form representations retain contextual and perceptual features associated with children’s prior experience with words.

This suggests they’re representing a lot of extra contextual and perceptual detail about the [d] and [t] examples they heard, which causes them not to recognize those sounds (and the important differences between them) when they’re used in the third novel word.

Building up an abstract representation from many samples

Thiessen & Yee 2010: Early word form representations retain contextual and perceptual features associated with children’s prior experience with words.

Check: When they’re habituated to novel words that use the same acoustic context as the test word...

boeyad vs. gooyat

This suggests that they are detecting the difference between [d] and [t], but not at the abstract level that would allow them to recognize that difference in different acoustic contexts.

They haven’t yet abstracted to the phonemic level adults use.

Building up an abstract representation from many samples

Thiessen & Yee 2010: Early word form representations retain contextual and perceptual features associated with children’s prior experience with words.

Now they do better at telling that this contrast is relevant in the same context.

Same Switch

yad vs. yat

Building up an abstract representation from many samples

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This suggests that they are detecting the difference between [d] and [t], but not at the abstract level that would allow them to recognize that difference in different acoustic contexts.

They haven’t yet abstracted to the phonemic level adults use.
Recap: Sounds, words, and detail

Word-learning is very hard for younger children, so detail seems to be initially missed when they first learn words.

When children are tested with a visual choice task, they show more knowledge of detailed word forms than when they are tested with a Switch procedure task.

Many exposures are needed to learn detailed word forms at the earliest stages of word-learning, so that the word forms are represented at the appropriate abstract level.

Questions?

You should be able to do all the questions on HW1 and all the review questions for sounds & sounds of words.