Psych 156A/ Ling 150: Psychology of Language Learning

Lecture 3
Sounds II

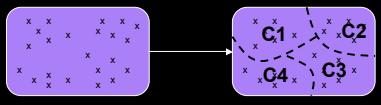
Announcements

Reminder: HW1 is due 1/15/09 (hand in during class)

Review questions are available for sounds

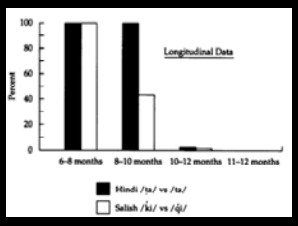
What Happens

Divide sounds into contrastive categories (phonemes)



When It Happens

Between 8-10 months



Werker & Tees (1984), testing English infants

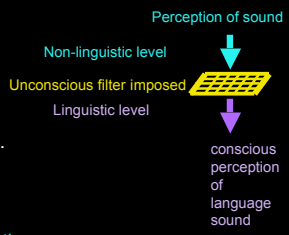
How it happens

Idea 1: Maintenance & Loss
Data distributions determine which boundaries are maintained and which ones are lost/ignored

Problem: Doesn't seem to be permanent loss, and doesn't seem to affect sounds if processed as non-language

How it happens

Idea 2:
Functional Reorganization
Unconscious filter imposed when sounds are processed as language. Data distributions determine what the boundaries are in the filter.



Common theme: data distributions determine construction of relevant category boundaries for language

More about contrastive sounds

There are a number of acoustically salient features for sounds. All it takes for sounds to be contrastive is for them to have "opposite" values for one feature.

Example:
English sounds "k" and "g" differ only with respect to voicing. They are pretty much identical on all other features. Many contrastive sounds in English use the voicing feature as the relevant feature of contrast (p/b, t/d, s/z, etc.). However, there are other features that are used as well (air flow, manner of articulation, etc.).

Task for the child: Figure out which features are used contrastively by the language. Contrastive sounds for the language will usually vary with respect to one of those features.

Experimental Study: Dietrich, Swingley & Werker (2007)

Testing children's perception of contrastive sounds

Dutch and English contrastive features differ.

In English, the length of the vowel is not contrastive

"cat" = "caat"

In Dutch, the length of the vowel is contrastive

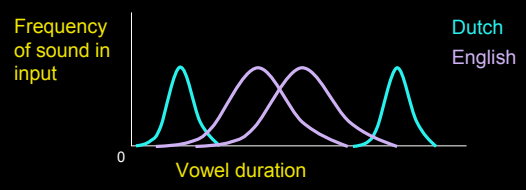
"cat" ≠ "caat"

(Japanese also uses this feature)

Does the data distribution show this?

Dutch and English vowel sounds in the native language environment also seem to differ

"…studies suggest that differences between the long and short vowels of Dutch are larger than any analogous differences for English."



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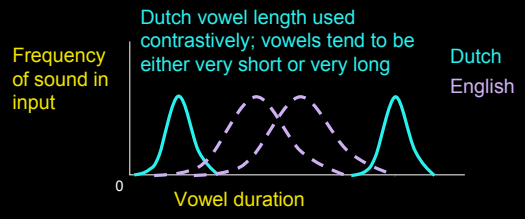

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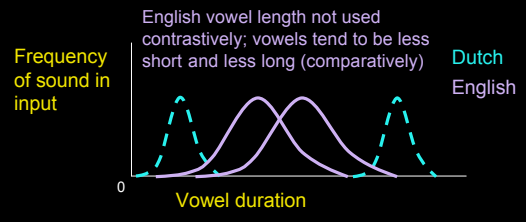

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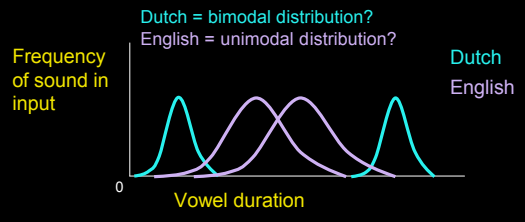

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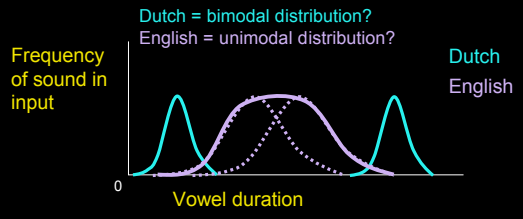


Learning from real data distributions

Prediction if children are sensitive to this distribution

Dutch children interpret vowel duration as a meaningful contrast because the distribution is more bimodal

Implication: Change to vowel duration = new word

English children should not interpret vowel duration as a meaningful contrast because the distribution is more unimodal

Implication: Change to vowel duration = same word as before

Dietrich, Swingley, & Werker (2007)

Tests with 18-month-old children who know some words (and so have figured out the meaningful sounds in their language)

"Switch" Procedure: measures looking time

…this is a *tam*…look at the *tam*

Habituation

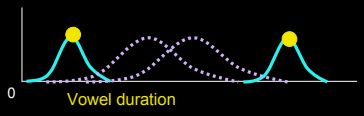
Test

Same: look at the *tam!*

Switch: look at the *taam!*

Dietrich, Swingley, & Werker (2007)

Experiment 1: Testing English and Dutch kids on Dutch vowel durations



Dutch kids

5.04 sec 9.23 sec difference

English kids

6.66 sec 7.15 sec no difference

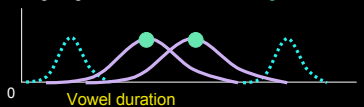
Test

Same: look at the *tam!*

Switch: look at the *taam!*

Dietrich, Swingley, & Werker (2007)

Experiment 1: Testing English and Dutch kids on English vowel durations



Dutch kids

5.92 sec 8.16 sec difference

English kids

7.34 sec 8.04 sec no difference

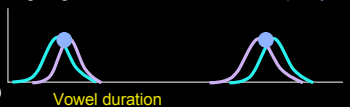
Test

Same: look at the *tam!*

Switch: look at the *taam!*

Dietrich, Swingley, & Werker (2007)

Experiment 1: Testing English and Dutch kids on vowel quality contrast (a/e)



(This is a control condition to make sure English kids can do the task when the sound is contrastive for them)

Dutch kids

4.08 sec 5.72 sec difference

English kids

6.31 sec 9.31 sec difference

Test

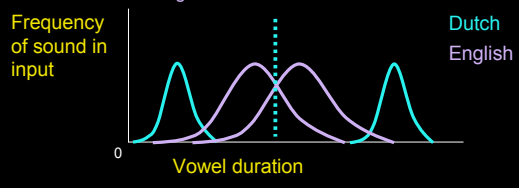
Same: look at the *tam!*

Switch: look at the *tem!*

Dietrich, Swingley, & Werker (2007)

Implications of experiments 1, 2, and 3: Dutch children recognize vowel duration as contrastive for their language while English children do not. This can only be due to the data encountered by each set of children in their language.

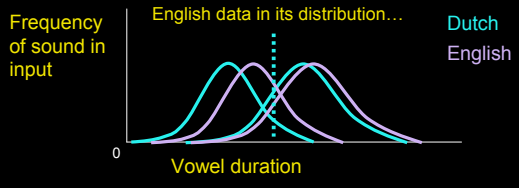
Dutch children have a category boundary approximately here. English children do not.



Dietrich, Swingley, & Werker (2007)

One small caveat: It turns out that Dutch vowel duration data isn't as bimodally distributed as previously believed. So, the Dutch data probably isn't as informative to Dutch children by itself…Dutch children must also use other cues in the data. (Research still under way to identify those cues and how children use them.)

Dutch children have a category boundary approximately here. But Dutch data looks more like English data in its distribution…



Discovering contrastive sounds: What's the point of it again?

The idea is that once children discover the meaningful sounds in their language, they can begin to figure out what the words are.

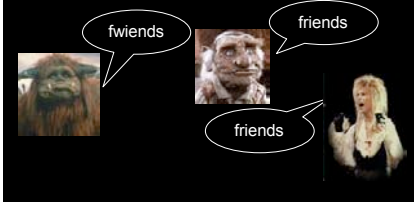
Ex: An English child will know that "cat" and "caat" are the same word (and should have the same meaning).

As adults, we can look at a language and figure out what the contrastive sounds are by looking at what changes a word's meaning. But children can't do this - they figure out the contrastive sounds *before* they figure out words and word meanings.

Learning Words

Word Forms

Computational Problem:
Map variable word signals to more abstract word forms

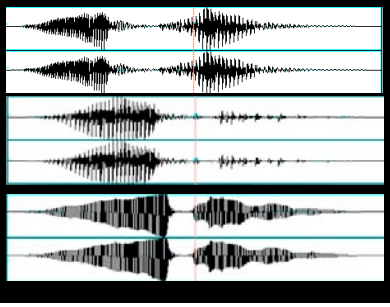


"friends"

What's Involved in Word Learning

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

"goblin"



Word Learning Experiment (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

…this is a ***bih***…look at the ***bih***

Habituation 

Test

Same: look at the ***bih!*** 

Switch: look at the ***dih!*** 

Word Learning Experiment (Stager & Werker 1997)

14-month-olds

…this is a ***dih***…look at the ***dih***

…this is a ***bih***…look at the ***bih***

Habituation  

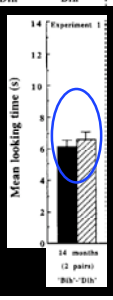
Test

Same: look at the ***bih!*** 

Switch: look at the ***dih!*** 

Word Learning Experiment (Stager & Werker 1997)

14-month-olds



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

Word Learning Experiment (Stager & Werker 1997)

8-month-olds & 14-month-olds

…this is a ***bih***…look at the ***bih***

Habituation 

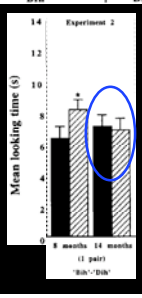
Test

Same: look at the ***bih!*** 

Switch: look at the ***dih!*** 

Word Learning Experiment (Stager & Werker 1997)

8-month-olds & 14-month-olds

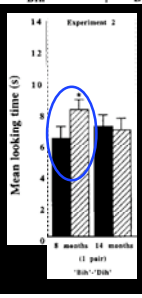


No difference in looking time = 14-month-olds didn't notice the difference again!

Word Learning Experiment (Stager & Werker 1997)

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.



Word Learning Experiment (Stager & Werker 1997)

14-month-olds

…this is a ***lif***…look at the ***lif***

Habituation

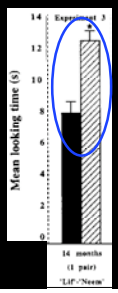
Test

Same: look at the ***lif!***

Switch: look at the ***neem!***

Word Learning Experiment (Stager & Werker 1997)

14-month-olds



Here, the 14-month-olds look longer at the "lif" object when it's labeled "neem". They notice the difference.

Word Learning Experiment (Stager & Werker 1997)

14-month-olds

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

…this is a ***bih***…look at the ***bih***

Habituation

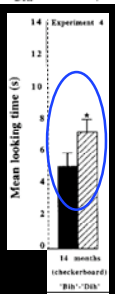
Same: look at the ***bih!***

Switch: look at the ***dih!***

Test

Word Learning Experiment (Stager & Werker 1997)

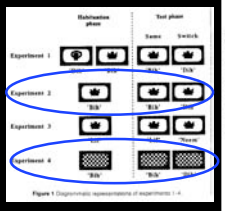
14-month-olds



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

Word Learning Experiment (Stager & Werker 1997)

Key: Experiment 2 vs 4



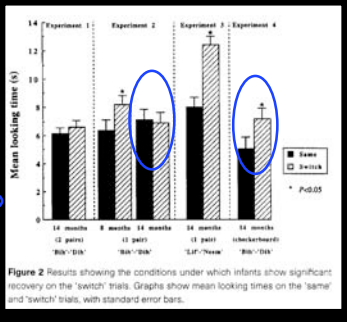


Figure 2 Results showing the conditions under which infants show significant recovery on the 'switch' trials. Graphs show mean looking times on the 'same' and 'switch' trials, with standard error bars.

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)

They *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?

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

Swingley & Aslin (2002)

Maybe the problem with the younger infants was that these were *novel* words

What would happen if we tested children on familiar words, like "baby"? Would they notice if they were mispronounced (like "vaby")?

Swingley & Aslin 2002: Familiar Word Tests

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

Table 1. *Correctly pronounced (CP) target words and their mispronounced (MP) versions*

CP	MP-close	MP-distant
apple (/æpl̩/)	opple (/apl̩/)	opal (/opl̩/)
baby (/beˈbi/)	vaby (/veˈbi/)	raby (/ɹeˈbi/)
ball (/bɔl/)	gall (/gɔl/)	shawl (/ʃɔl/)
car (/kaɹ/)	cur (/kɜ˞/)	kier (/kiɹ/)
dog (/dɔg/)	tog (/tɔg/)	mog (/mɔg/)
kitty (/kɪti/)	pity (/pɪti/)	yitty (/jɪti/)

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 are similar (like "cat" and "bat"), more attention to detail is required to distinguish them.

Prediction: Children's vocabulary drives their ability to notice the difference between words that differ minimally (ex: by a single phoneme)

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

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

…this is a ***bih***…look at the ***bih***

Habituation

Test

Same:
look at the ***bih!***

Switch:
look at the ***dih!***

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)

Familiar	Nonword	Onset-MP
beɦ	baɬ	deɦ
beʃ	bøɬ	deʃ
bœyk	bœyn	kœyk
eɦt	eɸ	eɦt
h nt	hak	x nt
haʃ	heɦ	saʃ
hont	ho	font
ku	kus	xu
mont	maɦt	nont
nøɬ	nut	møɬ
paɦt	pøɦt	daɦt
pus	purt	tus
sxaɸ	sxeʃ	ɬaɸ
teɦ	to	peɦ
v s	vaɦt	v s
vut	veɦt	but

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

Why does having a familiar word help? Another Idea

Idea: Maybe phonetic detail involves hearing the word a number of times, and getting a little more detail each time…so vocabulary size doesn't really matter.

{p/b/d/g}{a/o/u}{l/r} *"ball"*

…

(p/b}{a}{l/r}

…

{b}{a}{l}

If it's a novel word, kids haven't heard it enough yet.

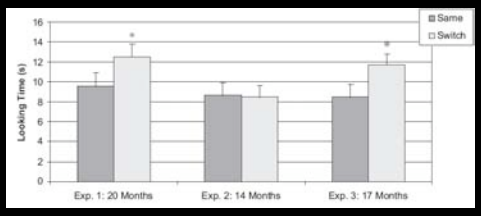
(Stager & Werker, 1997 used novel words with only 7 repetitions)

Werker et al. 2002: Vocabulary Size Matters

Stager-Werker task
Test

Same: look at the ***bih!***

Switch: look at the ***dih!***



Werker et al. 2002: Vocabulary Size Matters

Stager-Werker task
Test

Same: look at the ***bih!***

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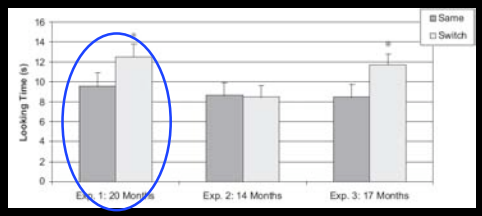


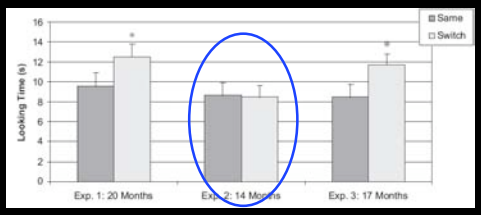
20-month-olds notice

Werker et al. 2002: Vocabulary Size Matters

Stager-Werker task
Test

Same: look at the ***bih!***

Switch: look at the ***dih!***



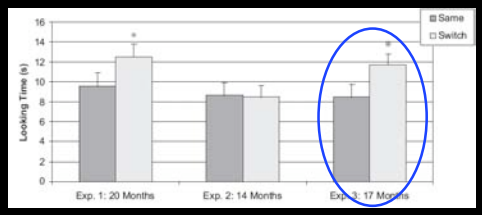
14 month-olds don't

Werker et al. 2002: Vocabulary Size Matters

Stager-Werker task
Test

Same: look at the ***bih!***

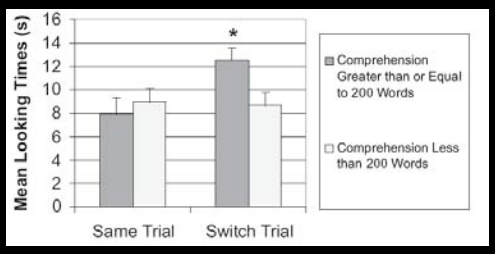
Switch: look at the ***dih!***



17-month-olds do

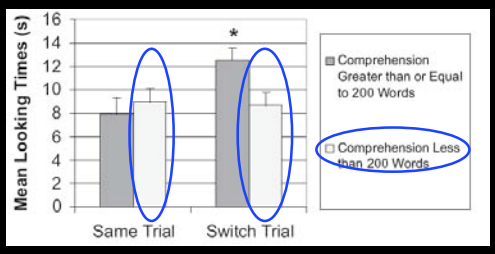
Werker et al. 2002: Vocabulary Size Matters

Zoom in on the 17-month-olds



Werker et al. 2002: Vocabulary Size Matters

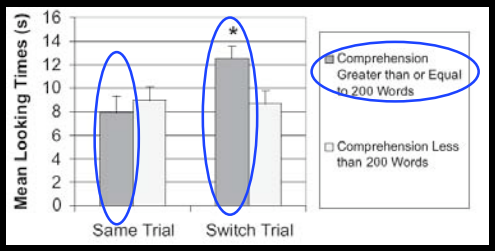
Zoom in on the 17-month-olds



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.

Werker et al. 2002: Vocabulary Size Matters

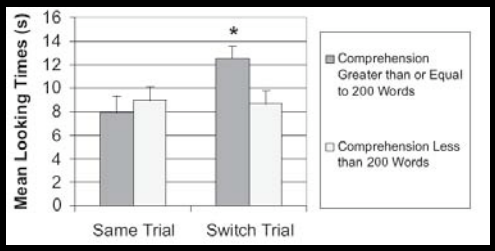
Zoom in on the 17-month-olds



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.

Werker et al. 2002: Vocabulary Size Matters

Zoom in on the 17-month-olds



Implication: Performance on Stager-Werker task with novel words *does* depend on how many words the child knows.

Why does having a familiar word help? Revising another Idea

Idea: Maybe phonetic detail involves hearing the word a number of times - children get a little more detail each time and remember which sounds are phonemic in the language so these phonemes can be recognized in novel words

{p/b/d/g}{a/o/u}{l/r}

…

(p/b}{a}{l/r}

…

{b}{a}{l} -------> *{b}{ih}* vs. *{d}{ih}*

If it's a novel word with a sound contrast children haven't encountered often enough, they will not recognize it as contrastive.

Recap: Sounds, Words, and Detail

Children figure out the contrastive, meaningful sounds (phonemes) in their language before they know words. They use the language data to help decide what features are likely to be contrastive in their language.

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

Many exposures are needed to learn detailed word forms at the earliest stages of word-learning.

Success on the Stager-Werker task, which uses novel words heard only a few times, seems to be related to the number of words children know.

Questions?