The view from cognitive psychology: human infants and speech learning

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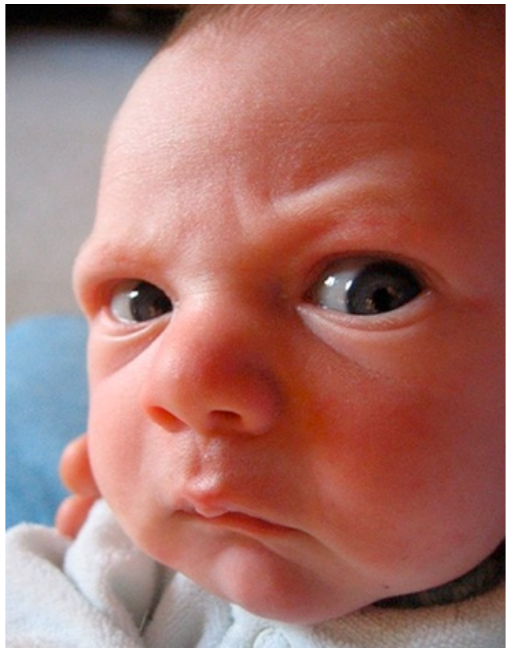
- Its phonetic categories (roughly, its consonants and vowels)
- Some (50? 500?) frequent sequences / chunks
- Some meaningful aspects of some words
- Bits and pieces relevant to grammatical word order

the **How**: What they have to work with:

- Skills of intention reading, & so some comprehension
- A medium-sized corpus
- Capacity for grouping / chunking
- Ears
- Sounds, faces, and some innate links between them



The What:
methods; discrimination and categorization

"Is this stimulus new?"

- Habituation (sucking, looking)
- Oddball (EEG)

"Does this stimulus match a trained target?"

- Conditioned Headturn
- Anticipatory eye-movements (2AFC)

Duration of training in a typical training study: 3 minutes

The What: some results

Testing VOT perception in infants:
Eimas, Siqueland, Jusczyk, &Vigorito, 1971

6 syllables ba/pa: VOT -20, 0, +20, +40, +60, +80
(Adults perceive -20, 0, and 20 as [b], others [p])

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some contrasts infants discriminated in studies

b/p	s/z	a/ã
b/d	s/θ	E/æ
r/l	f/θ	i/ɪ
b/w	d/g	
b/m	a/i	
w/j	u/y	

some contrasts that seem more difficult

- s/z (Eilers & Minifie 1975)
- f/sh (Eilers, Wilson, & Moore 1977)
- $_{\#}$n/$_{\#}$ng (Narayan, 2006)
- d/D (Polka, Colantonio, & Sundara 2001)

The What: some results

Native-language learning: decreasing attention to non-native contrasts

Werker & Tees 1984, using conditioned headturn (CHT)
Hindi dental / retroflex [t]; Nthlkampmx velar / uvular [k] vs [q]

6-8 months: distinguish the sounds; 10-12 mos did not; 8-10 intermed.

Polka & Werker 1994
German [u] vs [y] and [U] vs [Y]

CHT: 6-8 mos, ~35% reach 7/8 criterion; 10-12 mos, ~10%

Vis. Habituation: 4 mos distinguish the sounds; 6 mos did not

Bosch & Sebastián-Gallés 2003
Catalan [e] vs [E], Catalan and Spanish – native infants, visual habituation

4 mos distinguish the sounds; 8 mos only the Catalans

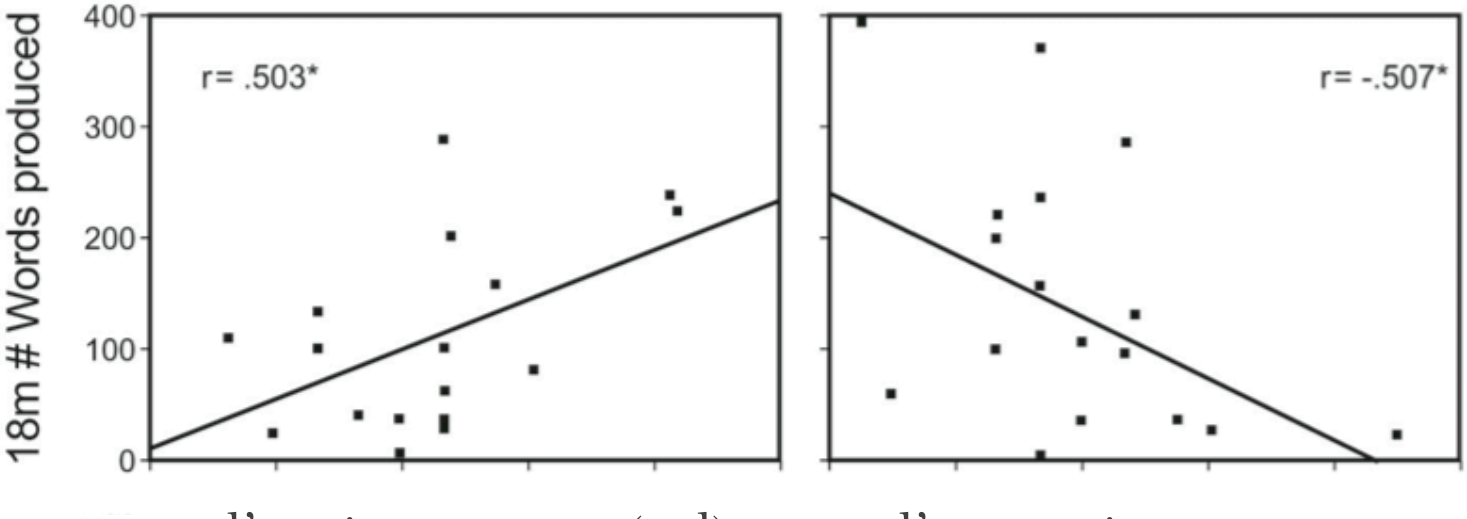
The What: some results

Native-language learning: decreasing attention to non-native contrasts

Kuhl et al., 2005, Conditioned headturn

7 month olds' [t] vs [d] discrimination is correlated (+) with vocab. at 18 mos.

/ɕi/, /tɕʰi/ *discrimination is correlated (−) with vocab at 18 mos.*



The What: the standard conclusion on consonants and vowels

Infants start by being able to distinguish clear instances of almost any contrastive speech sounds (from any language).

Over the first year they begin to conflate similar sounds that are not used contrastively in their native language.

The What: **words**

Infants prefer listening to words, rather than sequences that are not words

Hallé & de Boysson-Bardies, 1994
Words presented in lists, either potentially familiar, or rare:

Familiar	Rare
bonjour, gâteau, biberon,	busard, cobaye, berline,
lapin, poupée, ballon,	licence, diffus, caduc,
voiture, canard, chaussure,	soudard, tangage, enzyme,
encore, chapeau, oiseau	bigot, volute

Result: 11-month-olds (sometimes 8-mos) listen longer to familiar words

Replications: Vihman et al., 2004 (Engl.), Hallé & de. B-B, 1996 (Fr.), Swingley, 2005 (Dutch); 8 months: Jusczyk & Hohne, 1997

Caution: Ngon et al., (2011): freq. syllable pairs just as good as bisyll words

The What: words

Infants know what some words mean (at least roughly)

Bergelson &
Swingley, 2012

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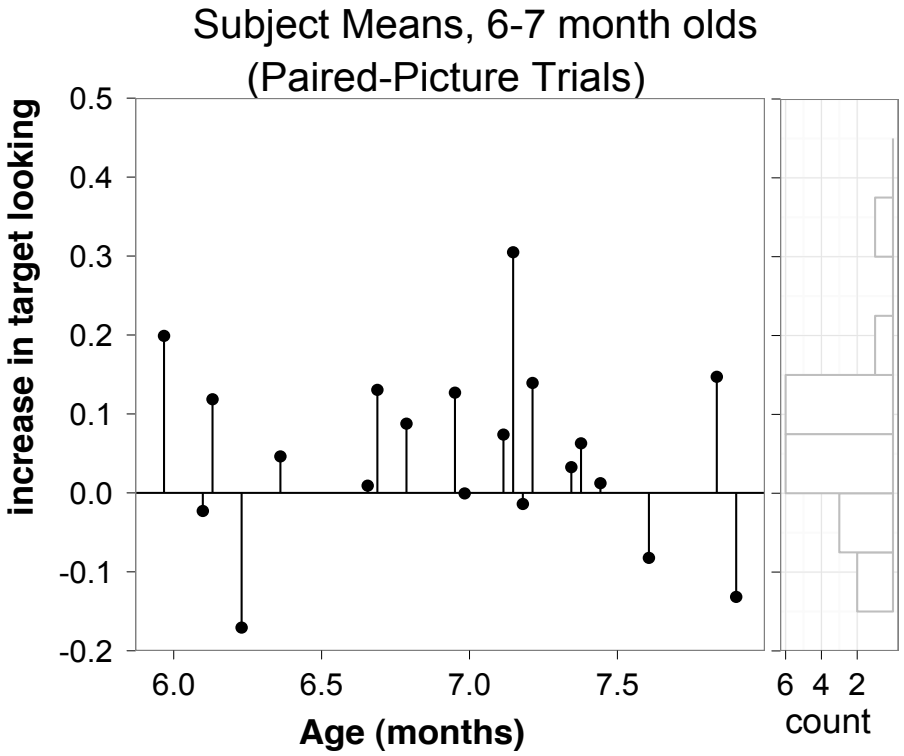

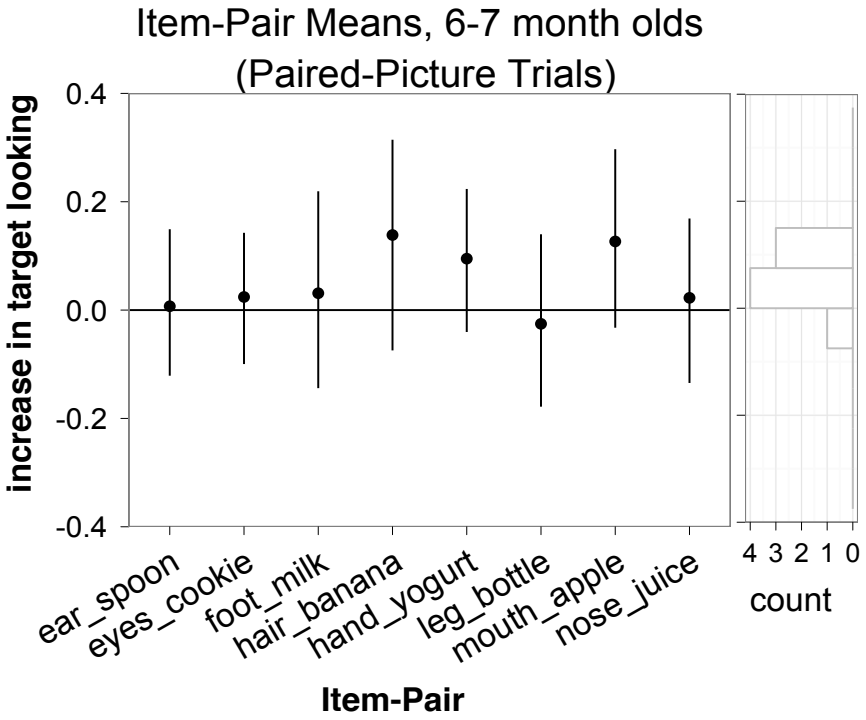

Bergelson & Swingley, 2012

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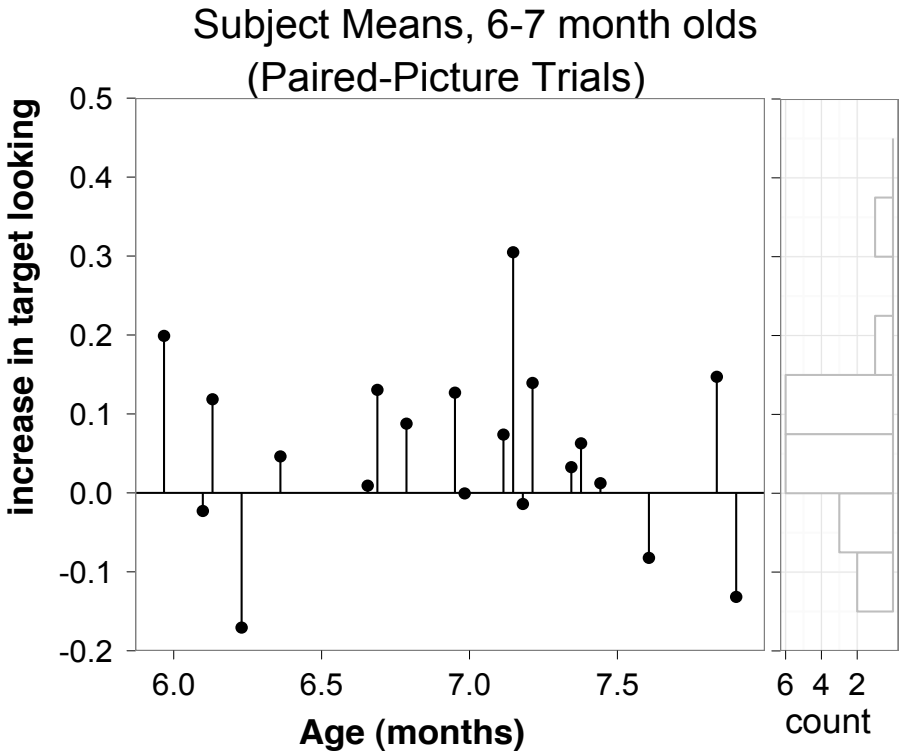
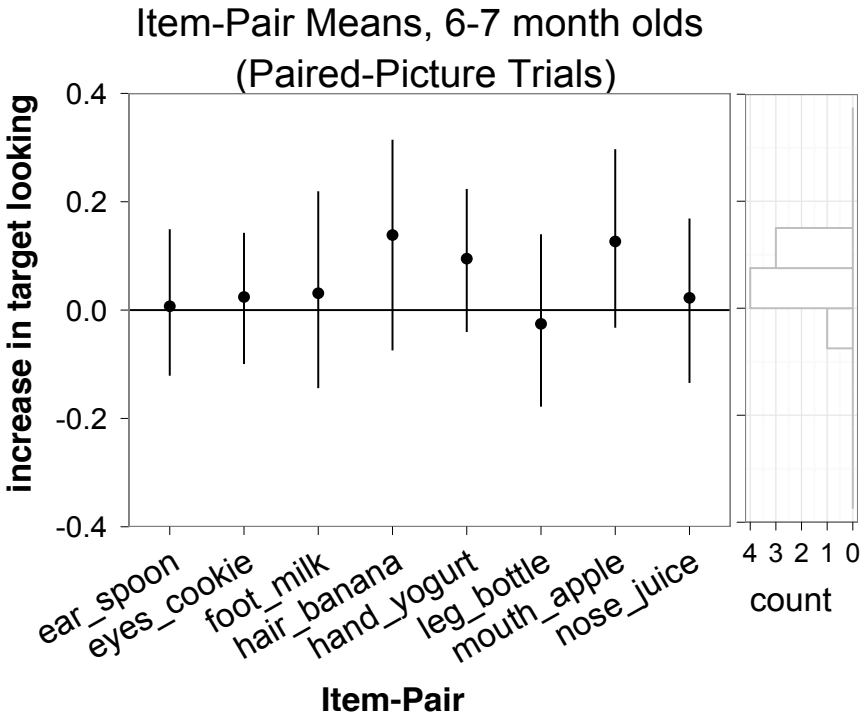
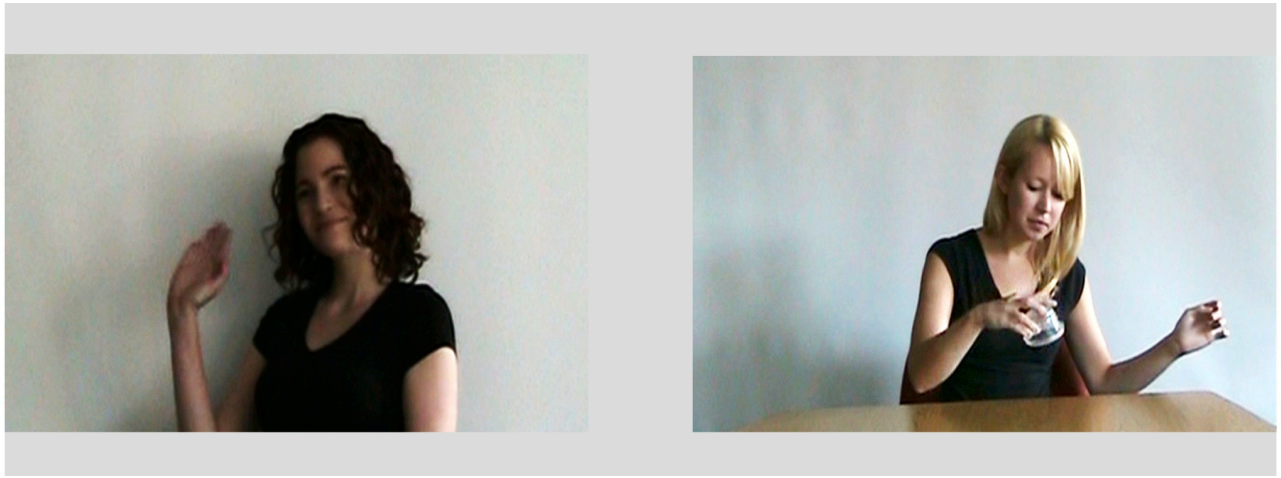




n.b. non-mom talker? Same result (in progress)

Bergelson & Swingley, 2012

abstract words (i.e., not objects)



"hi"
"all gone"

"eat"
"hug"

Bergelson & Swingley, u.r.

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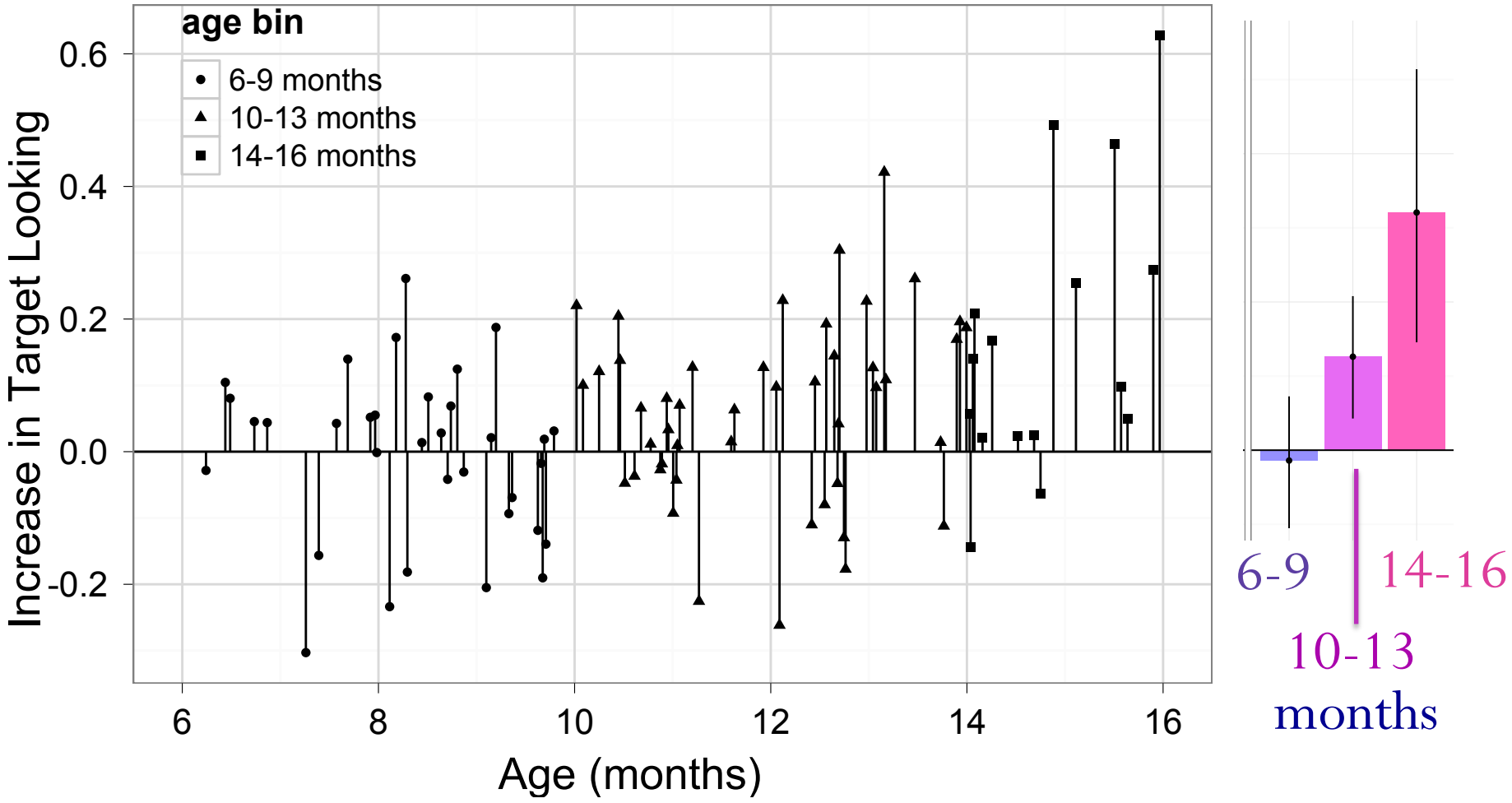

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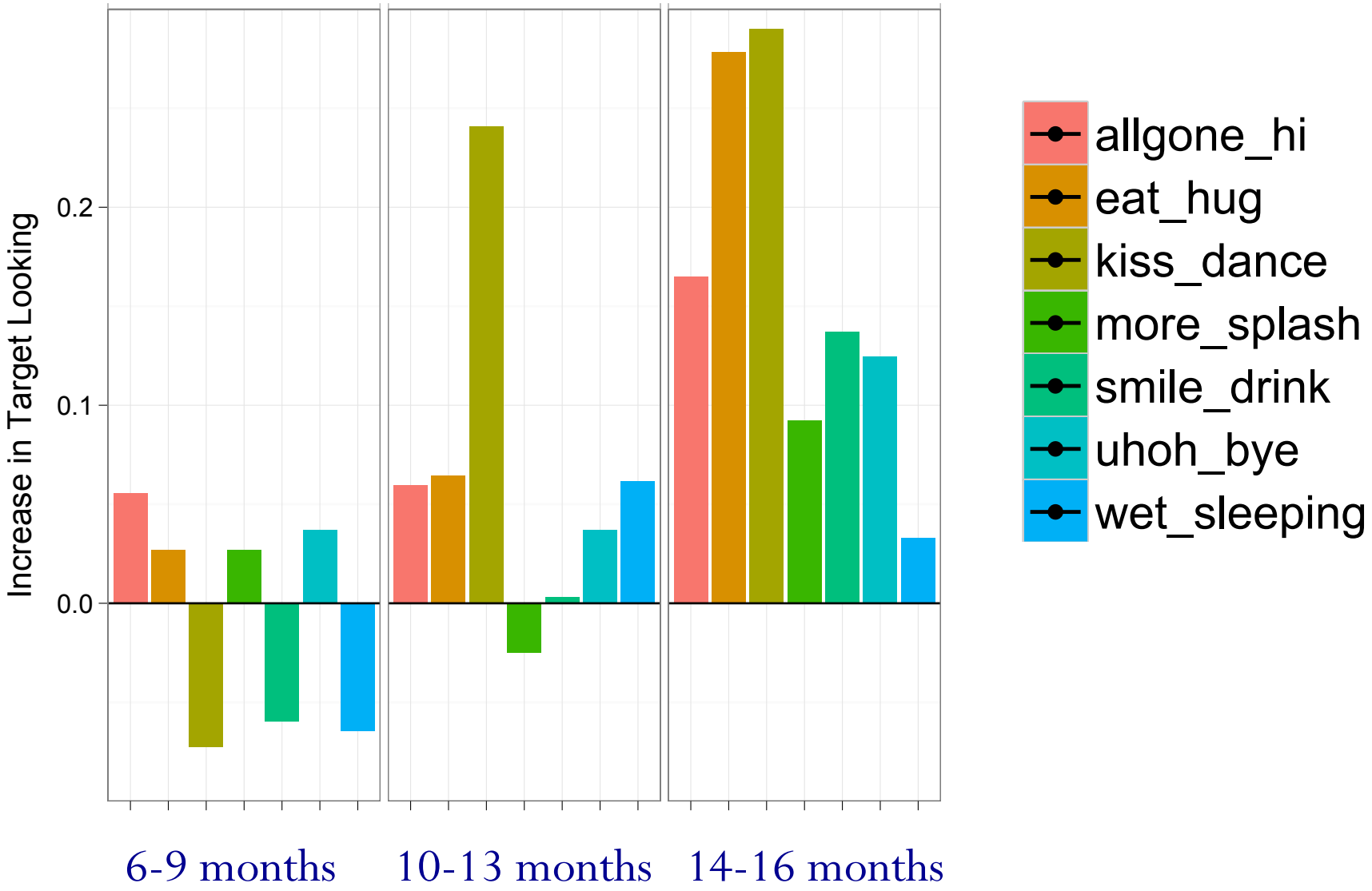

knowledge relevant to grammar

- frequent syllables or sounds are "dissociable" from their contexts

  nouns are identified in article+noun pairs (but not for made-up articles). Likewise verb+inflection lists.

  e.g. Hallé, Durand, & de Boysson-Bardies, 2008; Marquis & Shi, 2012

- frequency and unit grouping:

  Given streams of alternating frequent and infrequent syllables, Japanese 8 month olds parse them as infreq-freq, Italian 8 month olds as freq-infreq

  Gervain et al., 2008

knowledge relevant to grammar

Familiarization Phase

within-category

This one is *blickish*. Do you like the *blickish* one?
This one is a *blick*. Do you like the *blick*?
Look here. Look at this. Do you like this?

adjective
noun
no-word

Test Phase

"See what I have?"

Q: how much touching of novel-property toy

Result: greater attention to novel-property item, only Adjective condition
Interpretation: hearing adjective guides attention to property of object (more than object kind).

Waxman, 1999: 13 month olds (with 3+ words)

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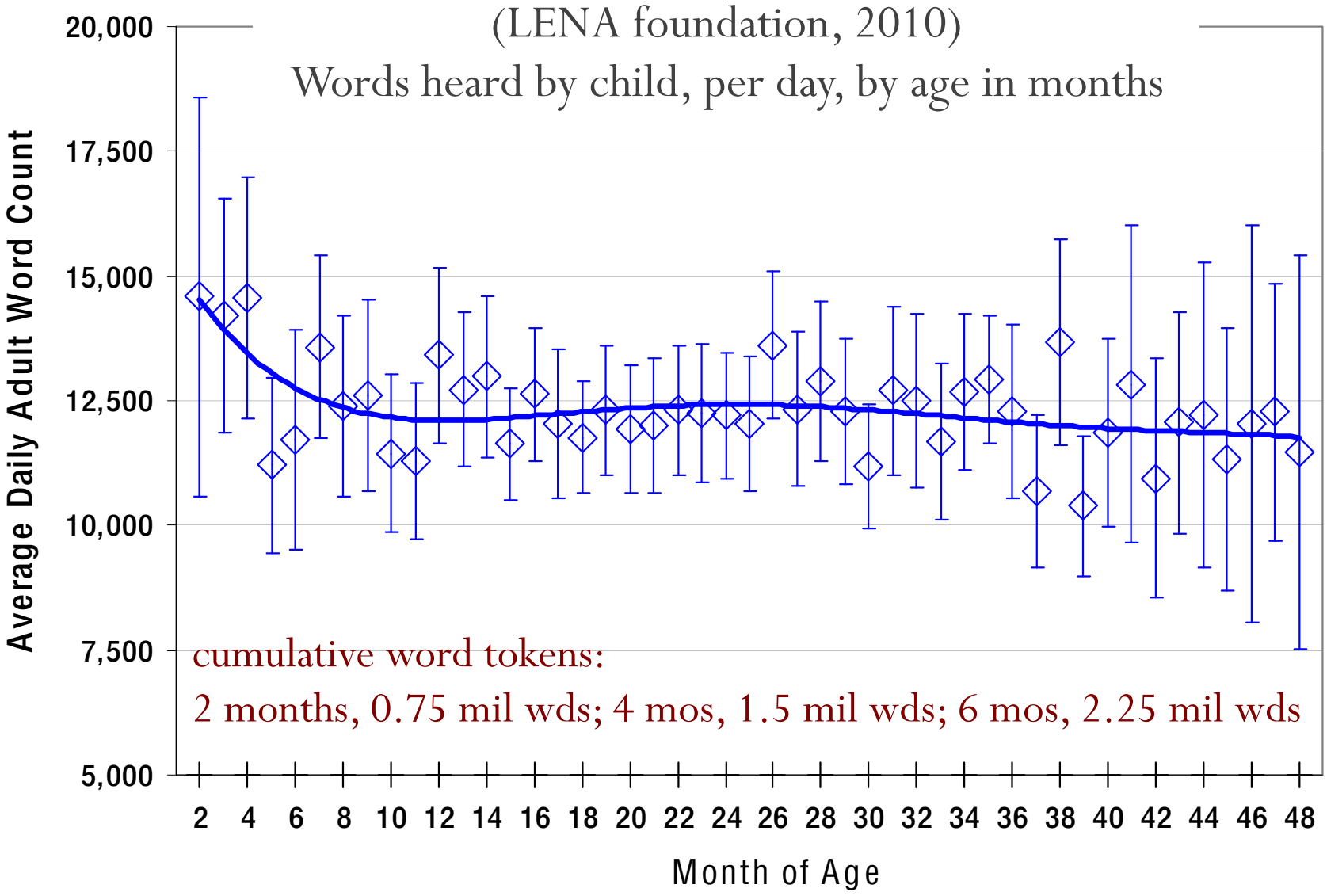
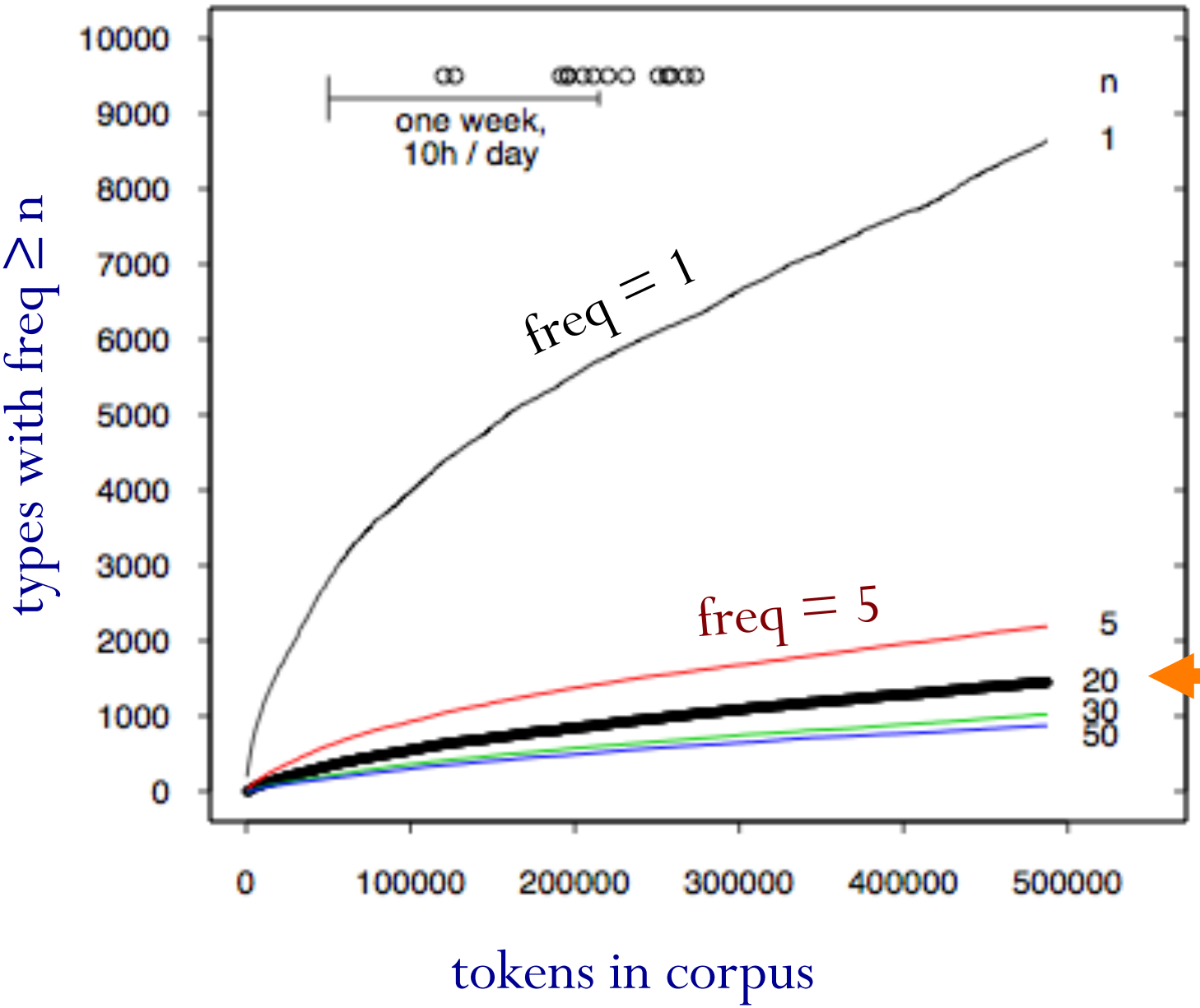
The baby's dataset



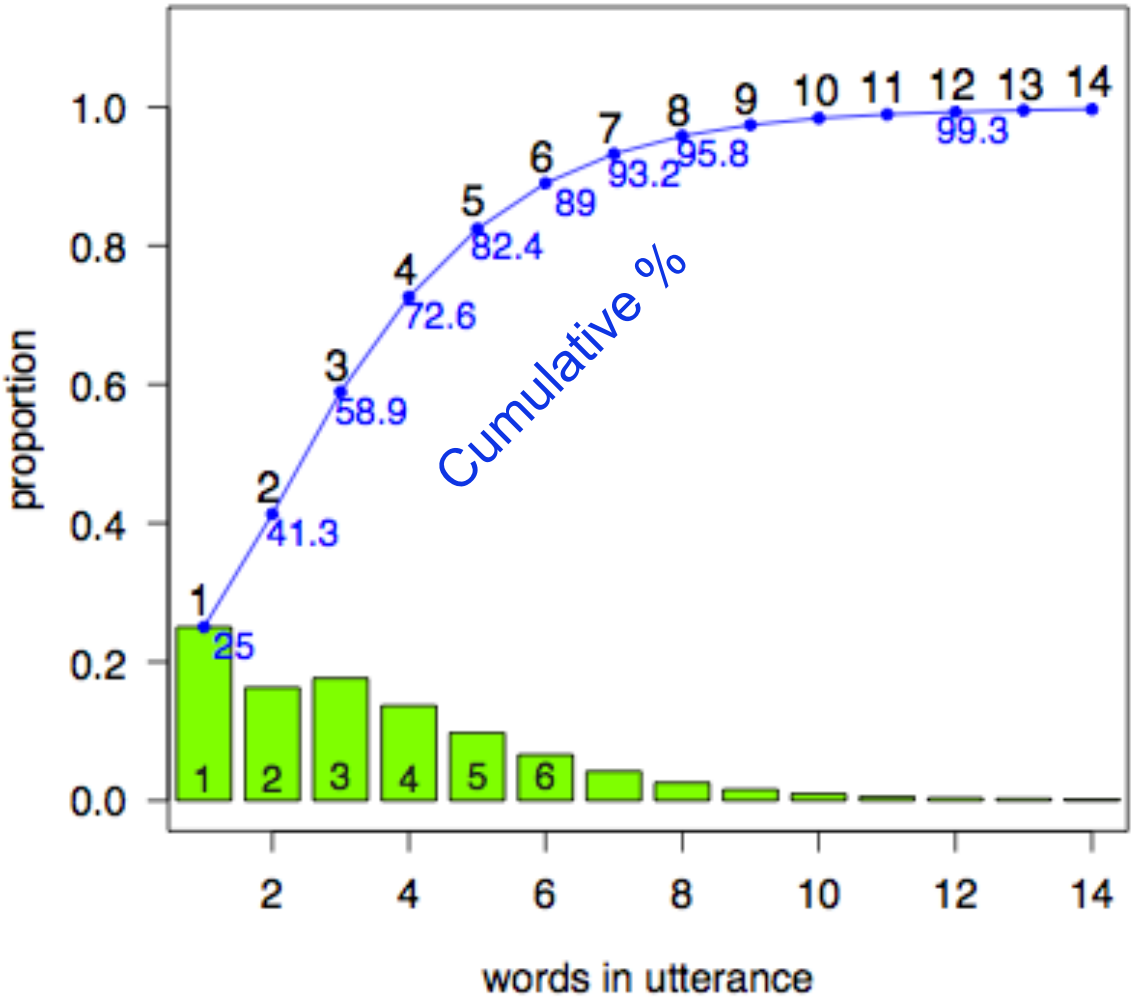
Google: 87 000 hours = 24 years of 10-hour days

how many very-frequent words do infants hear?



about 1500 words

Lots of short sentences



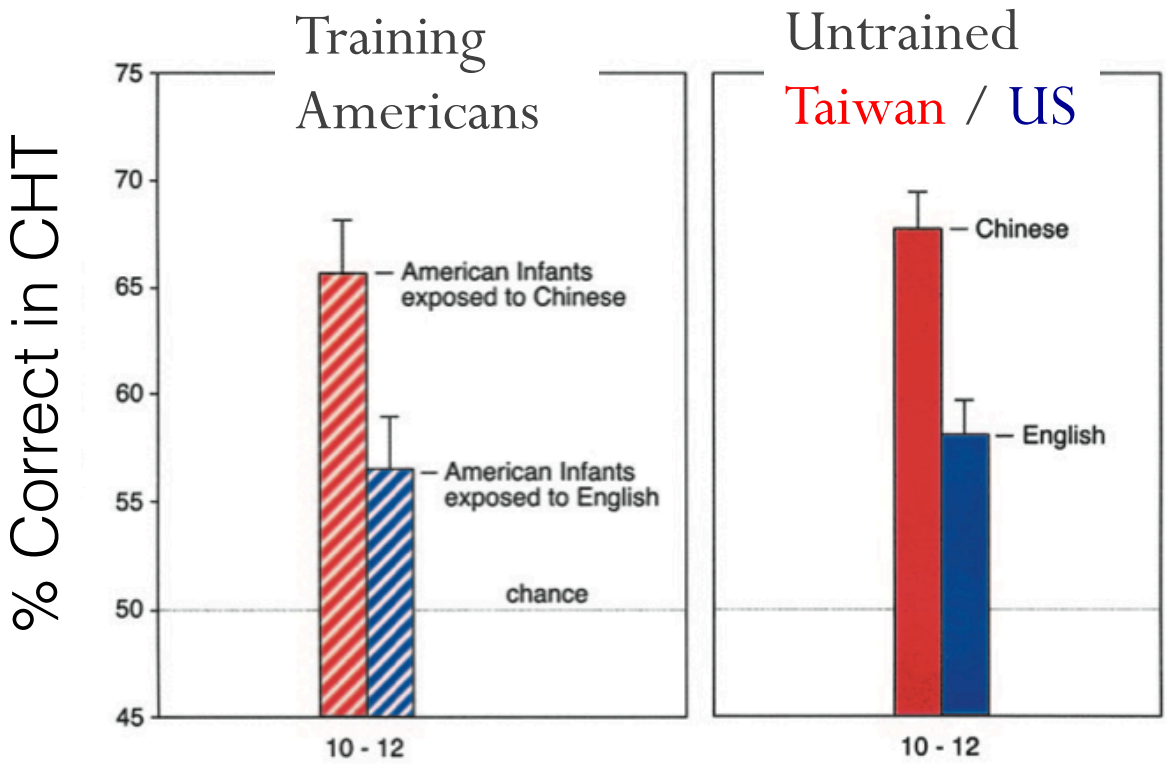
Words per utterance,
Brent corpus

How much exposure needed to retain a consonant contrast?

12 sessions over 4 weeks, starting at 9 months; 4 talkers (men & women).

Mandarin speaker talks to, plays with infant 15 min; book reading 10 min

About 2150 instances (total) of /ɕi/, /tɕʰi/



Conditioned headturn test on /ɕi/, /tɕʰi/

Kuhl, Tsao, & Liu 2003

Grouping / chunking

Language A

Torno a **casa** con le **bici** cariche di frutta in **bi**lico sulla sella.
La zia **Ca**rola si e` esi**bi**ta in una **fuga** colla **bici** verde.
Se porti il **melo** sulla **bici** forse **ca**li un po' di chili.
La **bici** ha su**bi**to un danno dentro la c**a**s**a** del **ca**po di Lara.
La **ca**via **Bi**da e` in **fuga** da **casa** per aver gio**ca**to con le **bi**lie blu.
La **bi**scia in lenta **fuga** dal giardino **ca**pita in **casa** mia.
Il tuo **melo** ar**ca**no **fuga** l'afa che de**bi**lita la folla.
[…]

fuga, melo, bici, casa: occur 6 times each.

Lang. A: *fu, ga, me, lo* only occur in *fuga, melo*

bi, ca occur in other contexts; thus p(*sa* | *ca*) = .33

Lang. B: *bi, ci, ca, sa* only occur in *bici*, *casa*, […]


Lg A


Lg B

Result: preference for high trans. prob. words, p<.001

Pelucchi, Hay, & Saffran, 2009: 8.5 mos.

Having ears

Eimas & Miller 1980

[b] and [w] differ, in part, in how speedy the transition is

Fast transition: [b]
Slow transition: [w].

But "fast" vs "slow" are not absolute; they depend on speaking rate (or syllable duration)

80 ms duration syllable: transition 16 ms = b, 40 ms = w
296 ms duration syllable: transition 40 ms = b, 64 ms = w

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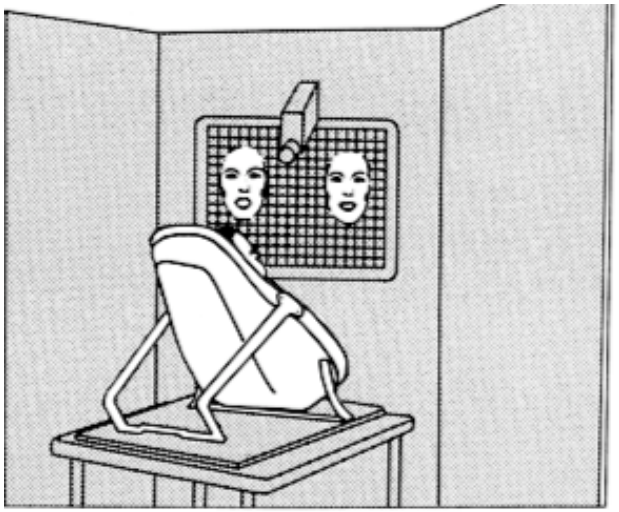
5 groups:		Change in sucking rate after switch
• short syll, 16ms -> 40ms **[b-w]**	....	**+4.0 ***
• short syll, 40ms -> 64 ms [w-w]		-2.5
• long syll, 16 ms -> 40 ms [b-b]		-3.8
• long syll, 40ms -> 64 ms **[b-w]**	....	**+4.3 ***
• control: no change		-4.6

sounds and faces

Kuhl & Meltzoff, 1982



One face says /i/ … /i/ ….
Other face says /a/ … /a/ …

Infant hears either /i/ or /a/

19-week-olds (~4.4 months)

Looking to match: 73.6%, 24/32 Ss

Extension to 2 month olds: *Patterson & Werker 2003*

Extension to more contrasts (2 mos): *Baier, Idsardi, & Lidz 2007 (Int. Conf. Aud-Vis. Speech. Proc.)*

/a/ vs /u/, /i/ vs /u/, /i/ vs /wi/

sounds and faces

Chen, Striano, & Rakoczy, 2004, 1- to 7-day-olds

Model says: aaahhh … aaahhh … (4x / trial, 8 trials); then,
model says: mmmm … mmmm … (4x, 8 trials) {or reverse order}

Q: does infant make like mouth movements?

Figure 1a *Mouth opening.*

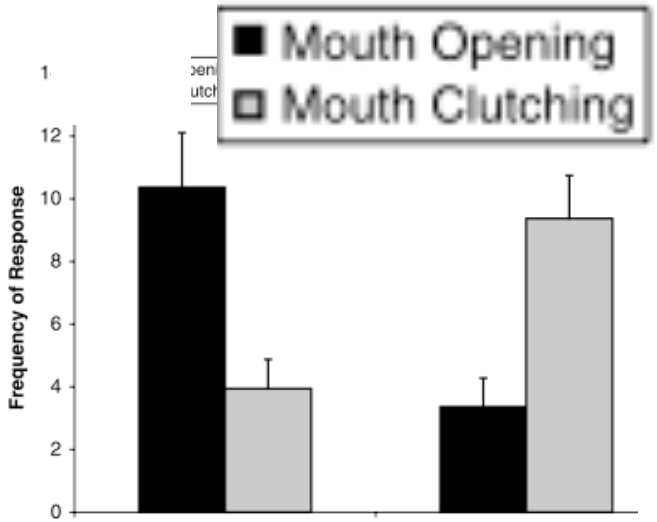
Figure 1b *Mouth clutching.*

sounds and faces

Chen, Striano, & Rakoczy, 2004

Figure 1a *Mouth opening.*

Figure 1b *Mouth clutching.*



model: /a/ /m/

13 infants who kept eyes *closed*:

	behavior	
model	opening	clutching
/a/	**9.5**	5.1
/m/	1.5	**10.4**

6 infants who kept eyes *open*:

	behavior	
model	opening	clutching
/a/	**12.3**	1.5
/m/	7.5	**7.2**

All model /a/ vs /m/ comparisons $p < .05$

Language differentiation from visual information

Weikum,Vouloumanos, Navarra, Soto-Faraco, Sebastián-Gallés, & Werker, 2007

4, 6, 8 months old, English background

Videos of 3 bilingual French/English speakers reading sentences;
No audio presented to infants

1. Show clips from each speaker, 1 language, till visual habituation.
2. Switch language (expt) or not (control).

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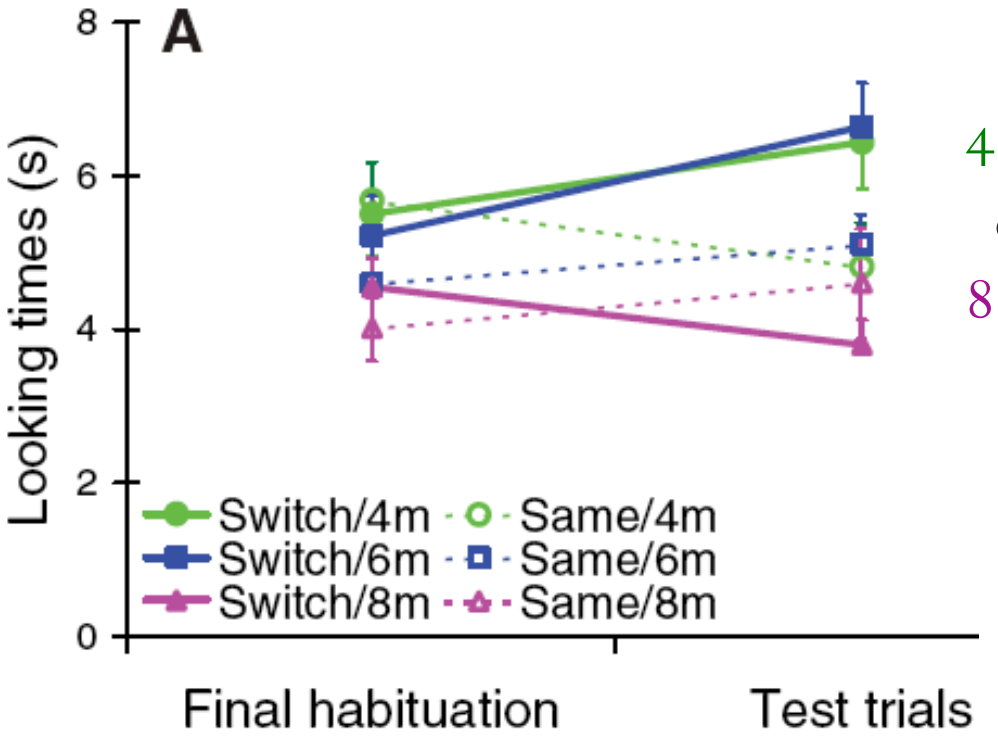

4, 6 mos: increase to switched lang., decrease to same language

8 mos: no significant difference

(But: Fr/Eng *bilingual* 6, 8mos did dishabituate to change.)

So, what information have infants got, beyond the acoustic signal?

• **a lexicon**, or at least the start of one. Meanings, at least for some words, that may anchor some phonetic variation. And word-forms, that may provoke "acquired equivalence" effects for speech sounds.

• **your face**, as you talk, and the correlated acoustic data.
[plus some complex "see you, I do" intermodal skills]