First Language Acquisition - Sounds

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COGS 4780

Acquisition of sounds

- Acquisition of speech sounds seems to take place before acquisition of anything else in language
- In order to get meaning/sentences you need words, and in order to get words you need sounds
- The building blocks must come first

Acquisition of sounds

- Comprehension precedes production
- Internal knowledge of sounds is present significantly before infants ever start to produce words, which allows them to know:
  - The sounds of their language (differentiated from any other sounds)
  - Specific sound differences that are meaningful in their language
  - How streams of sound get distributed into different words
  - How sounds can be combined into words in their language (phonotactics)

- Why is it difficult to study infant language skills?

Methods

- One way is to measure pacifier-sucking amplitude
- Training: special pacifier measures sucking amplitude, when amplitude increases a new sound is played
  → conditioning to associate new sounds with high-amplitude sucking
- With that established, can play series of sounds to see whether infants can detect the change
  - If they can, that means they can tell the sounds apart

- Infants as young as 1 month old can do this (Eimas et al. 1971)

Methods

- Another way to do it is with a conditioned head-turn experiment

Acquisition of sounds

- **Werker et al (1981)** and Werker & Tees (2002) used the procedure to compare different age groups' ability to distinguish sounds

- Three groups: English-speaking adults, Hindi-speaking adults, 7 month old infants
  - [ba] vs [da] (place of articulation)
  - [ta] vs [ʈa] (place of articulation)
  - [tʰa] vs [dʰa] (voicing [~10ms])

- No significant difference between infants and Hindi adults
- Both significantly better than English adults (with or without training)

Acquisition of sounds

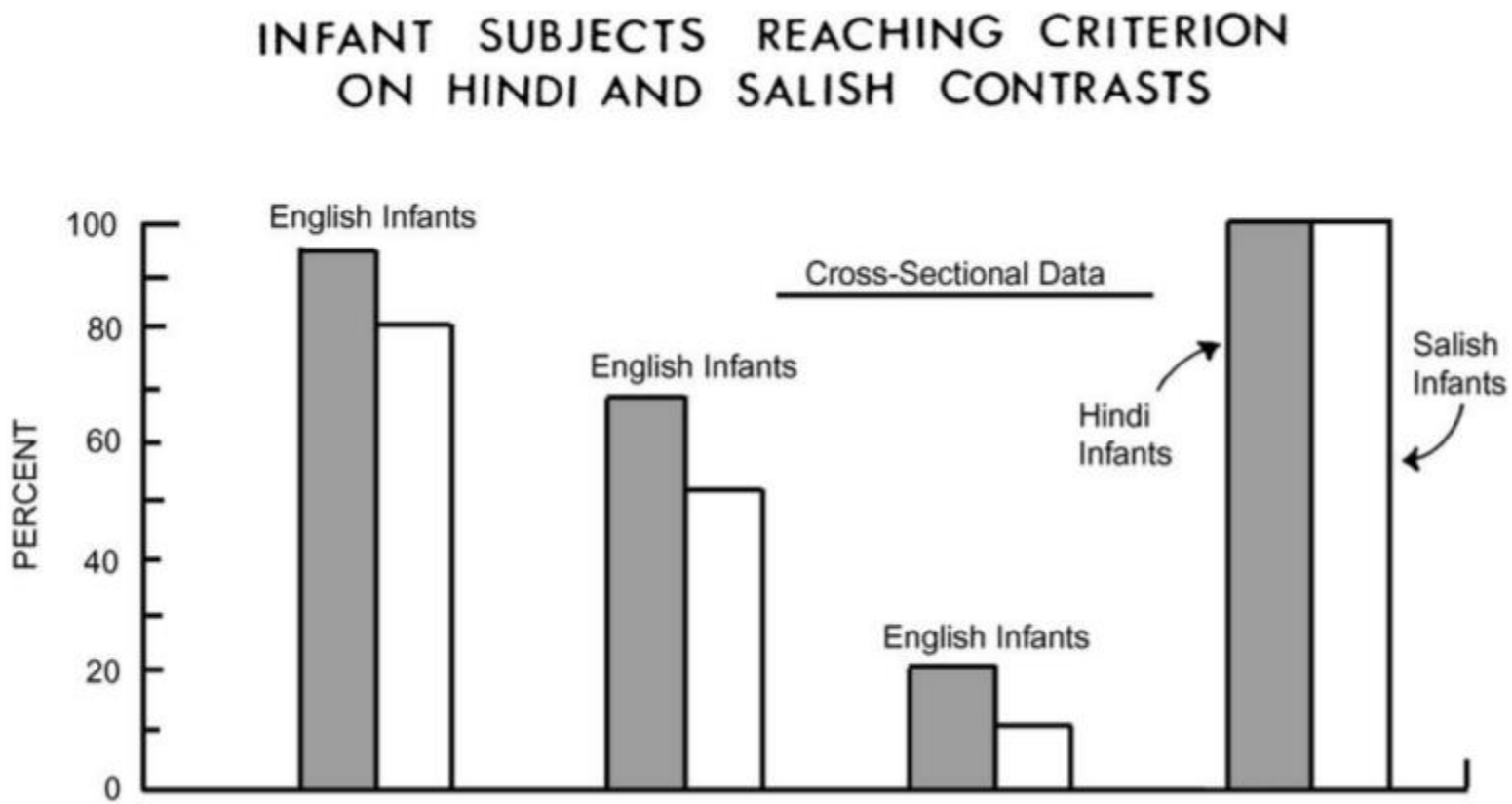
- Werker et al (1981) and **Werker & Tees (2002)** used the procedure to compare different age groups' ability to distinguish sounds

- Nlaka'pamuctsin/Thompson River Salish [k'i] vs [q'i]
- Hindi [ta] vs [ʈa]

- Infants of 6-8, 8-10, 10-12 compared cross-sectionally

Table 1
Infant discrimination performance on two non-English speech contrasts

Reached criterion	6–8 months	8–10 months	10–12 months
	The retroflex/dental contrast /*ṭa*/-/*ta*/		
Yes	11	8	2
No	1	4	8
	The velar/uvular contrast /*ǩi*/-/*q̀i*/		
Yes	8	8	1
No	2	6	9

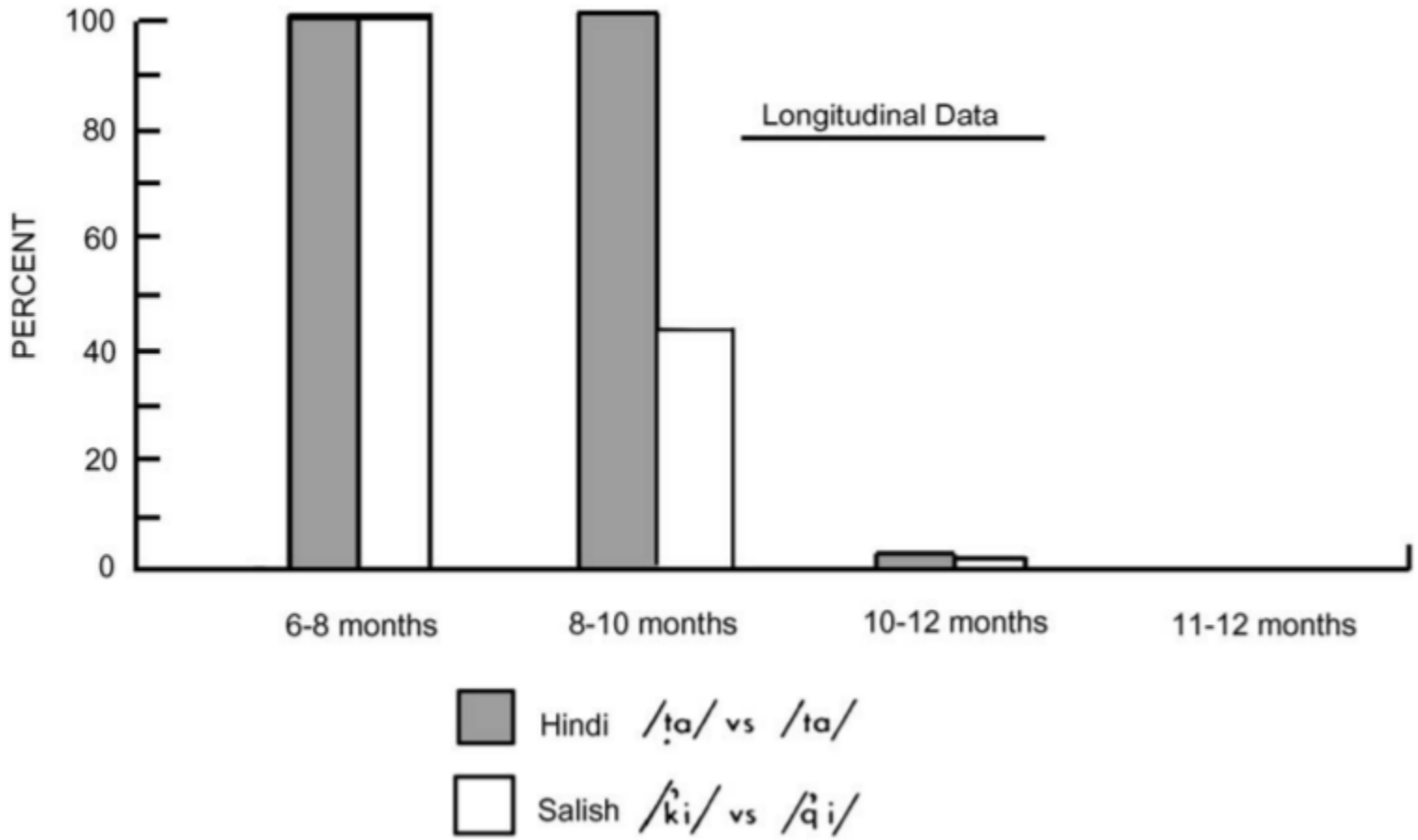

INFANT SUBJECTS REACHING CRITERION
ON HINDI AND SALISH CONTRASTS
PERCENT
100
80
60
40
20
0
English Infants
English Infants
Cross-Sectional Data
English Infants
Hindi
Infants
Salish
Infants

Acquisition of sounds

- Werker et al (1981) and **Werker & Tees (2002)** used the procedure to compare different age groups' ability to distinguish sounds

- Thompson River Salish [k'i] vs [q'i] and the Hindi [ta] vs [ʈa]

- Infants of 6-8, 8-10, 10-12 compared cross-sectionally
  - and then longitudinally

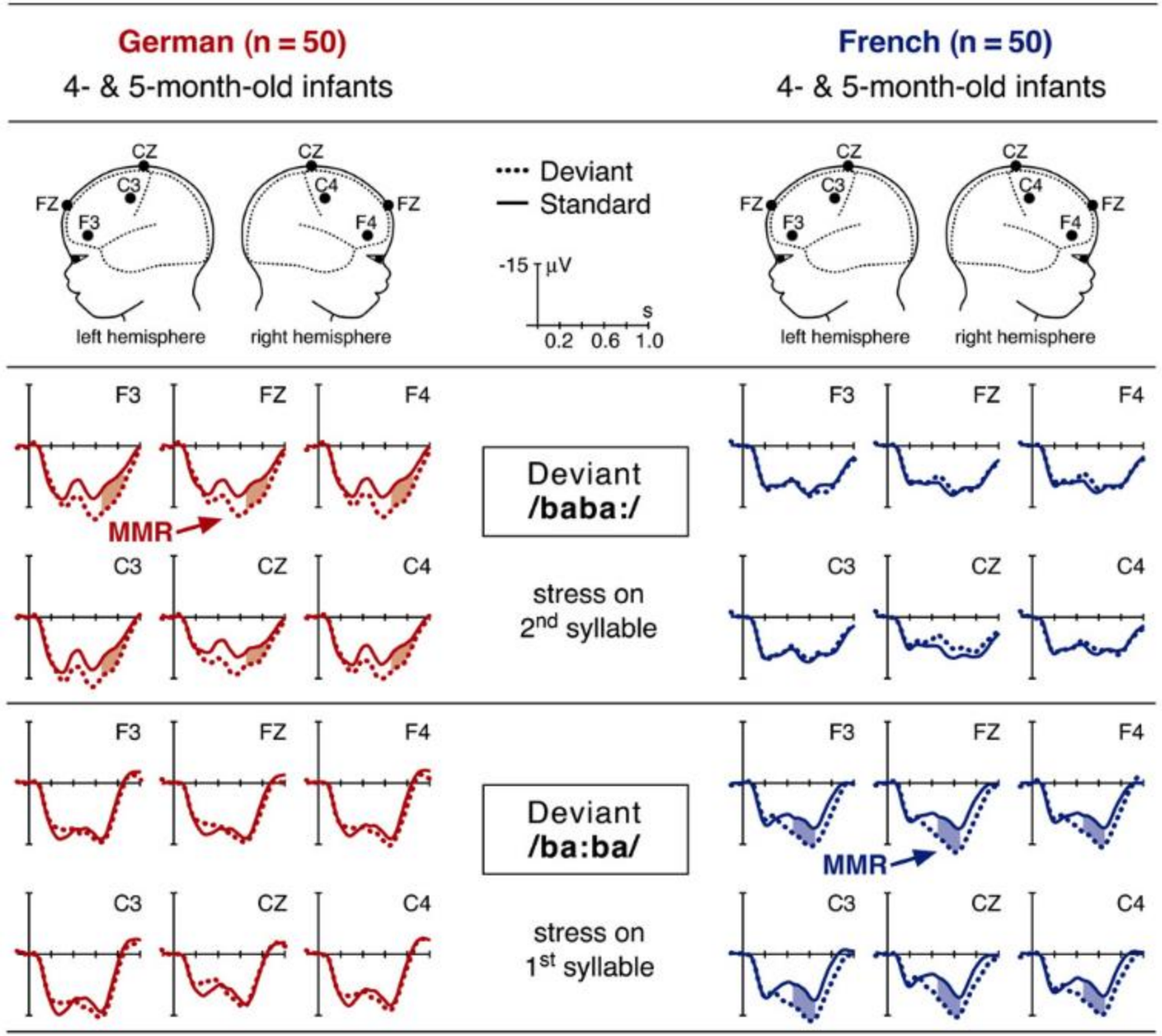

100
80
60
40
20
0
PERCENT
Longitudinal Data
6-8 months
8-10 months
10-12 months
11-12 months
Hindi /ṭa/ vs /ta/
Salish /k̓i/ vs /q̓i/

Acquisition of sounds

- Evidence that sound familiarity may even be represented neurally as early as 4 months (Friederici et al. 2007)

- ERP study of German and French infants while they heard a 2-syllable word repeated
  - German features first-syllable stress e.g., *pápa*
  - French features second-syllable stress e.g., *papá*

- Significant mismatch response emerged for both sets of infants but in opposite conditions


German (n = 50)
4- & 5-month-old infants
French (n = 50)
4- & 5-month-old infants
CZ
C3
C4
FZ
F3
F4
left hemisphere
right hemisphere
Deviant
Standard
-15 µV
s
0.2 0.6 1.0
MMR
Deviant /baba:/
stress on 2nd syllable
Deviant /ba:ba/
stress on 1st syllable

Acquisition of sound patterns

- So by age 1, children are selectively responsive to sound distinctions that matter in their language
  - An English-exposed infant will not be able to reliably distinguish between [ta] and [t̪a]
  - A Hindi-exposed infant will be able to reliably distinguish between [ta] and [t̪a]

- How do they learn what distinctions are meaningful?

White et al. (2008)

na bevi	na zuma	na suma
na bogu	na zobi	na sobi
na dula	na veda	na feda
na dizu	na vadu	na fadu
rot pevi	rot zuma	rot suma
rot pogu	rot zobi	rot sobi
rot tula	rot veda	rot feda
rot tizu	rot vadu	rot fadu

White et al. (2008)

- The stops are in complementary distribution
  - na + voiced stop
  - rot + voiceless stop
- The fricatives are in contrastive distribution
  - na + voiced fricative
  - na + voiceless fricative
  - rot + voiced fricative
  - rot + voiceless fricative

White et al. (2008)

- “Data from seven additional infants were not included (five for squirminess and two for significant non-English exposure).”

White et al. (2008)

- 8.5 month olds understood the predictive relationship regarding stops and understood that there was no such relationship regarding fricatives

- 12 month olds understood this relationship even without the “determiners” included
  - Sensitive to the pattern in a list of only the nouns

- This seems to be possible through statistical learning

Statistical Learning

- Statistical learning utilized heavily in learning how to segment and distinguish words

- This ability is typically present at ~7.5 months
  - but not at 6 months
  - Jusczyk & Aslin (1995) trained children to recognize a target word and tested to see if they could identify it in sentences

her bike could go very fast
the bell on the bike was really loud
the boy had a new red bike
your bike always stays in the garage

Statistical Learning

- Statistical learning utilized heavily in learning how to segment and distinguish words

- Infants have been shown to track **transitional probabilities**
  - The likelihood that one specific syllable will be followed by another specific syllable
    - *prettybaby*
  - Transitional probabilities are significantly higher for syllable pairs that belong to the same word than those that belong to different words

$$TP = P(Y|X) = (XY)/(X)$$

Statistical Learning

- Saffran, Aslin, & Newport (1996)
- Saffran, Newport, Aslin, Tunick, & Barrueco (1997)

Statistical Learning

- Separating out words winds up being extremely easy in a language you know and extremely difficult in a language you don’t know

- And gets increasingly easy as you start to learn more words

Constraints on statistical learning

- This sort of learning sensitivity doesn’t emerge to just any pattern
- Infants are good at picking up *realistic* patterns
  - Ones that align with natural classes
- Infants are worse at picking up unrealistic patterns
  - Ones that are random and ignore natural classes
- When trained on 2 minutes of speech with natural sound patterns, 9 month olds could extract generalizations and use them to learn new words; when trained on 2 minutes of speech with unnatural sound patterns, they could not (Saffran & Thiessen, 2003)

Animal replications?

- Rats (Toro & Trobalón, 2005) – success! (in simple cases)

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- “Our results demonstrate that rats can segment the streams using the frequency of co-occurrence (not transitional probabilities, as human infants do) among items, showing that some basic statistical learning mechanism generalizes over nonprimate species. Nevertheless, rats did not differentiate among test items when the stream was organized over more complex regularities that involved nonadjacent elements and abstract grammar-like rules.”

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- Cotton-top tamarins (Hauser et al. 2001) – success! (in simple cases)

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Statistical learning

- What we've documented so far is that statistical learning exists and is robust
- But questions still remain…
- The existence of statistical learning does not exclude the existence of Universal Grammar

- Why is phonology probably not the best domain in which to investigate the existence of Universal Grammar?