There is no *pat* in *patting*: Acquisition of phonological alternations by English-learning 12-month-olds

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No mummy, you are wrong, its beau-di-ful!

-Lila (age 2;08)

Tapping in English

- In North American English, [t] and [d] realized as [ɾ]
  - Between two vowels
  - When the following vowel is unstressed
    - E.g. meeting [miɾing] or seed [siɾing]

- Results in many-to-one mapping between root forms and inflected forms
  - E.g., *þat* and *þad* inflected as [pæɾing]

- Infants need to learn these alternations
  - Treat physically non-identical tokens as the same phoneme

Learning phonological alternations

- Mechanisms
  - By tracking statistics of speech sounds to determine if they are in complementary distribution
    - Computational models: Peperkamp & Dupoux, 2002; Peperkamp et al., 2006a
    - 12-month-olds: K. White et al., 2008
  - Bias favoring alternations between perceptual similar segments
    - Adults: Skoruppa et al., 2011; J. White, in press
    - Computational models: J. White, 2013 (BUCLD morning session)
    - 12-month-olds: J. White & Sundara, 2012

Experiment 1

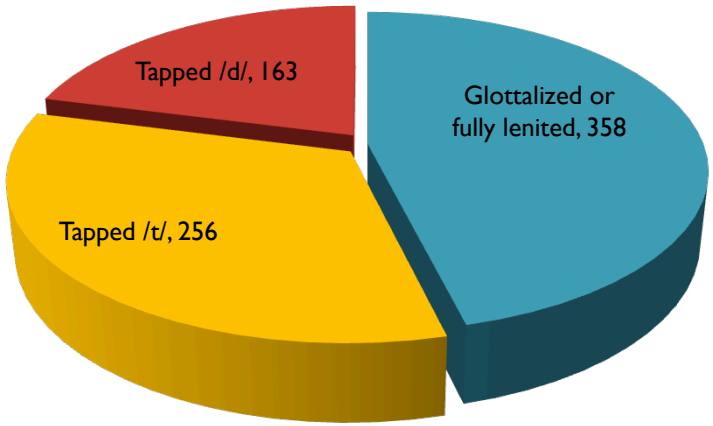
- Do infants map taps to /t/?
  - Monolingual English-learning 12-month-olds (n=20)
  - Based on detailed parental questionnaire, exposure to English > 90% (M = 99%; Range = 93:100)

- Background
  - *–ting* words more frequent that *–ding* words
  - /d/ perceptually closer to tap than /t/ (Herd et al., 2010)

Frequency of taps in *–ing* context

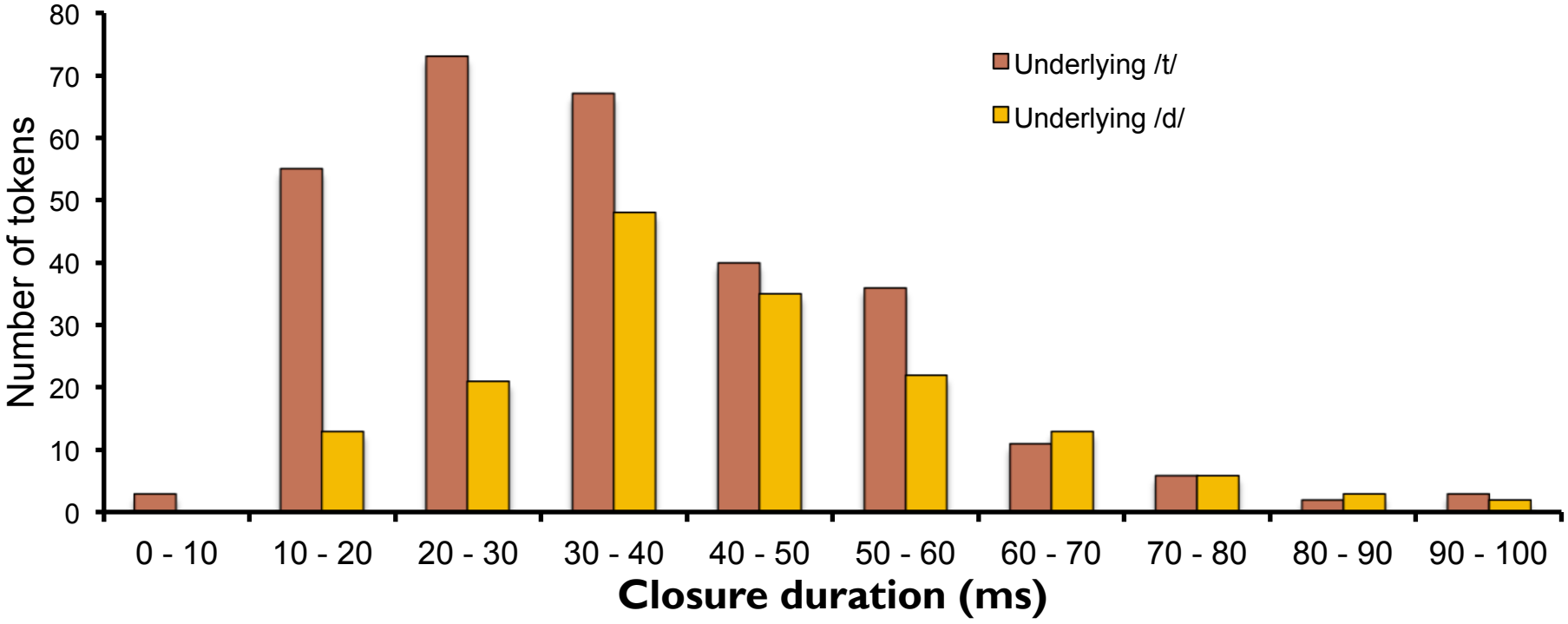
- Infants hear more *–ting* (type: 64; token: 722) than *–ding* words (type: 29; token: 233)

- Hear potentially more [t] → tap alternations



Acoustics of taps in *–ing* context

- Taps mapped to /t/ and /d/ differ in closure duration



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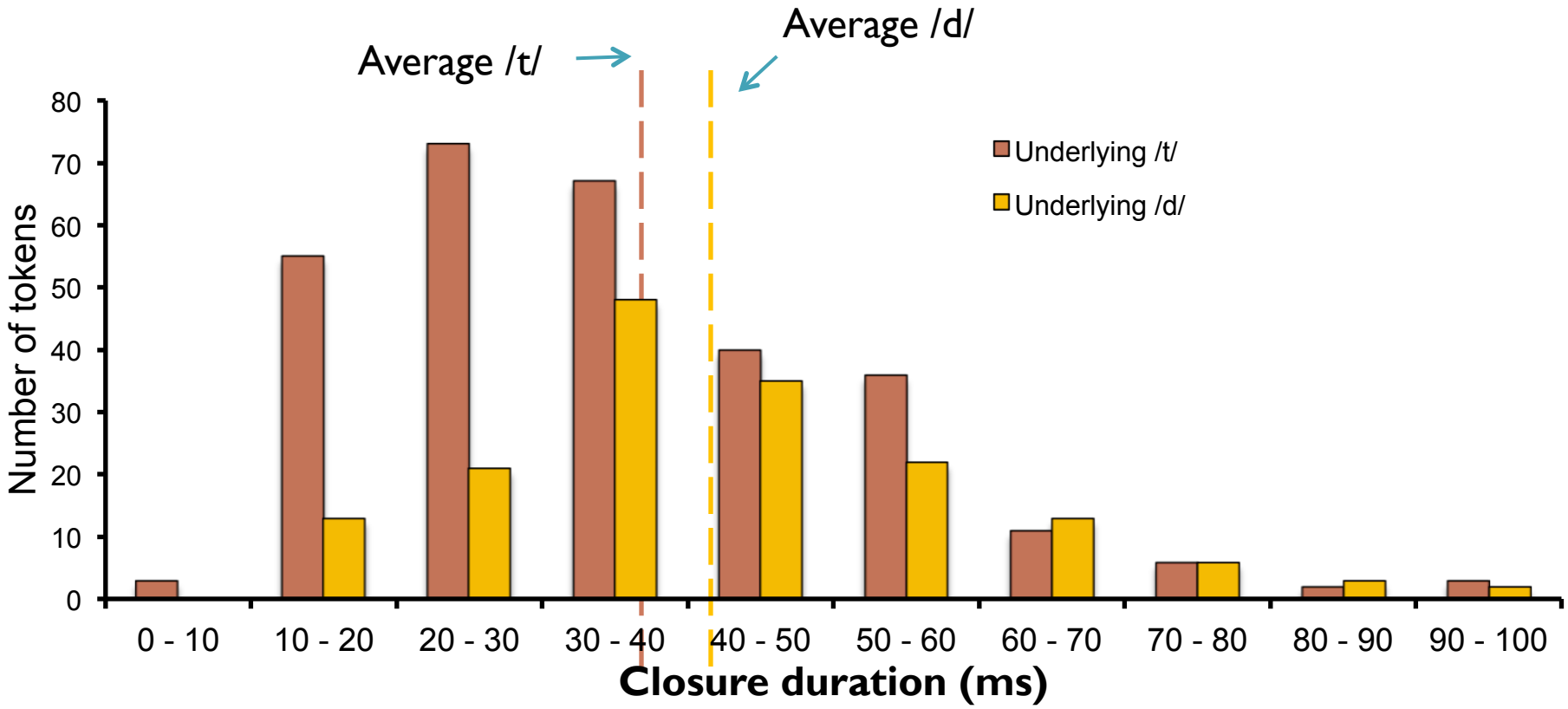
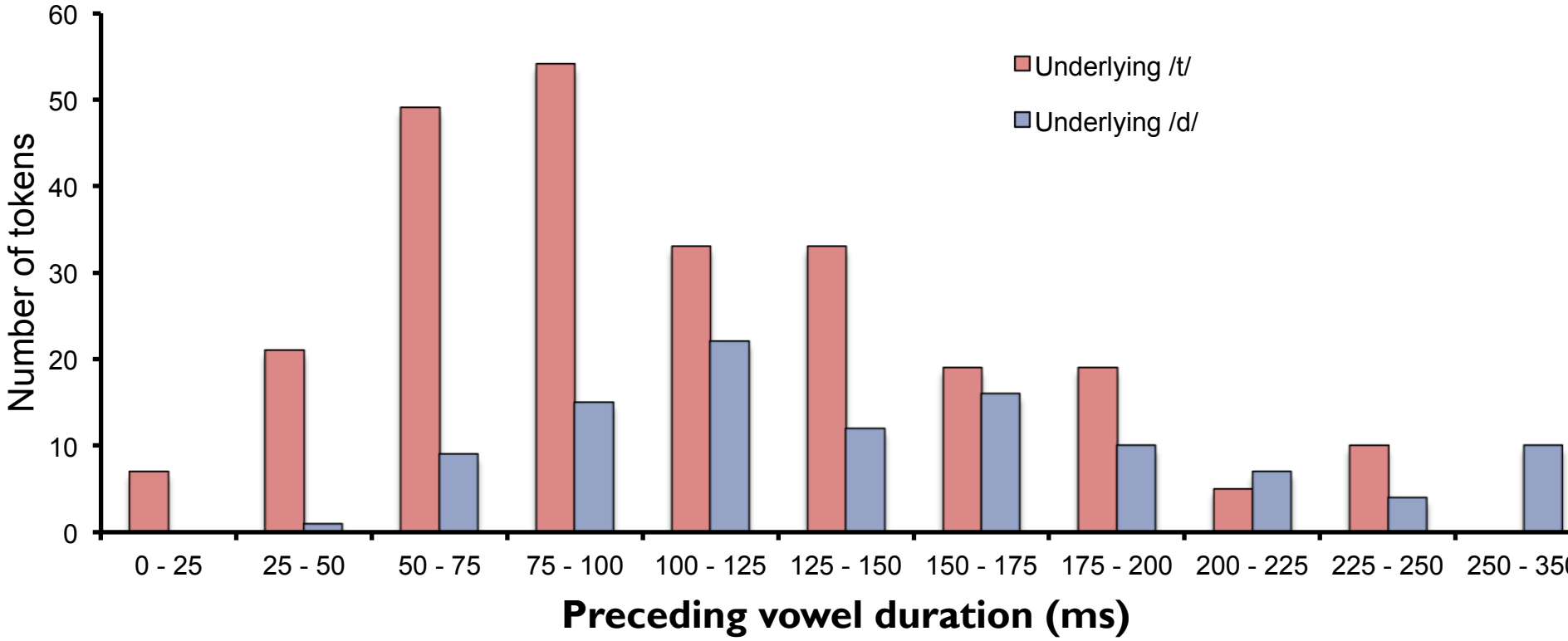


Acoustics of taps in *–ing* context

- Taps mapped to /t/ and /d/ differ in preceding vowel duration



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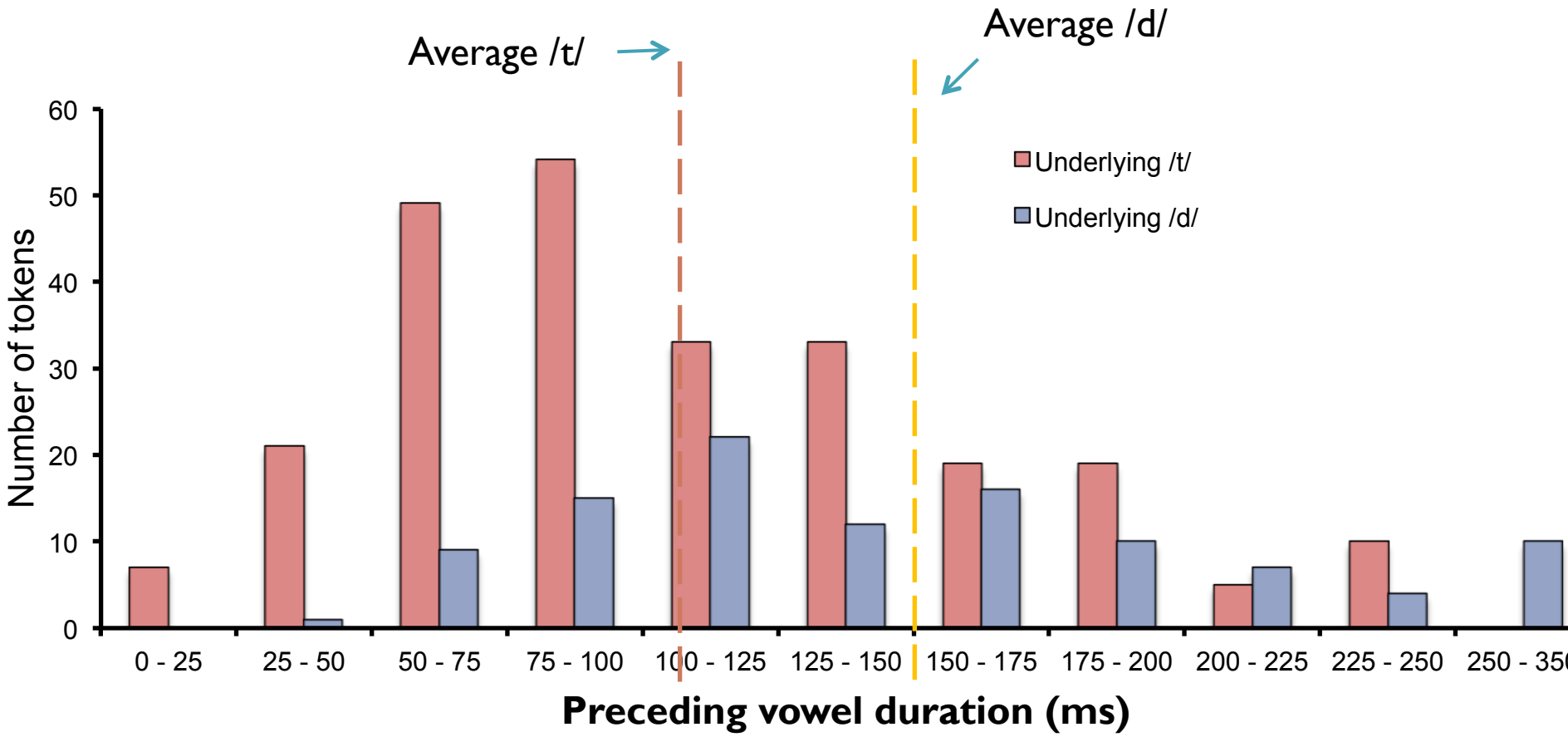
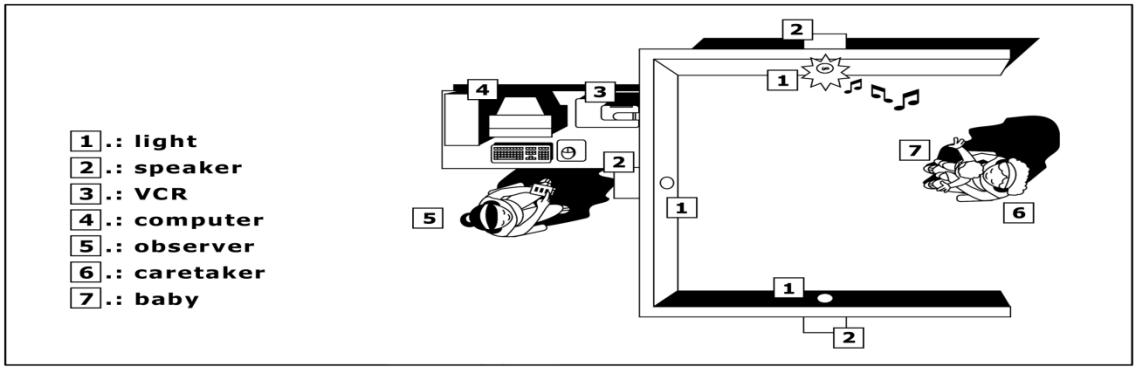


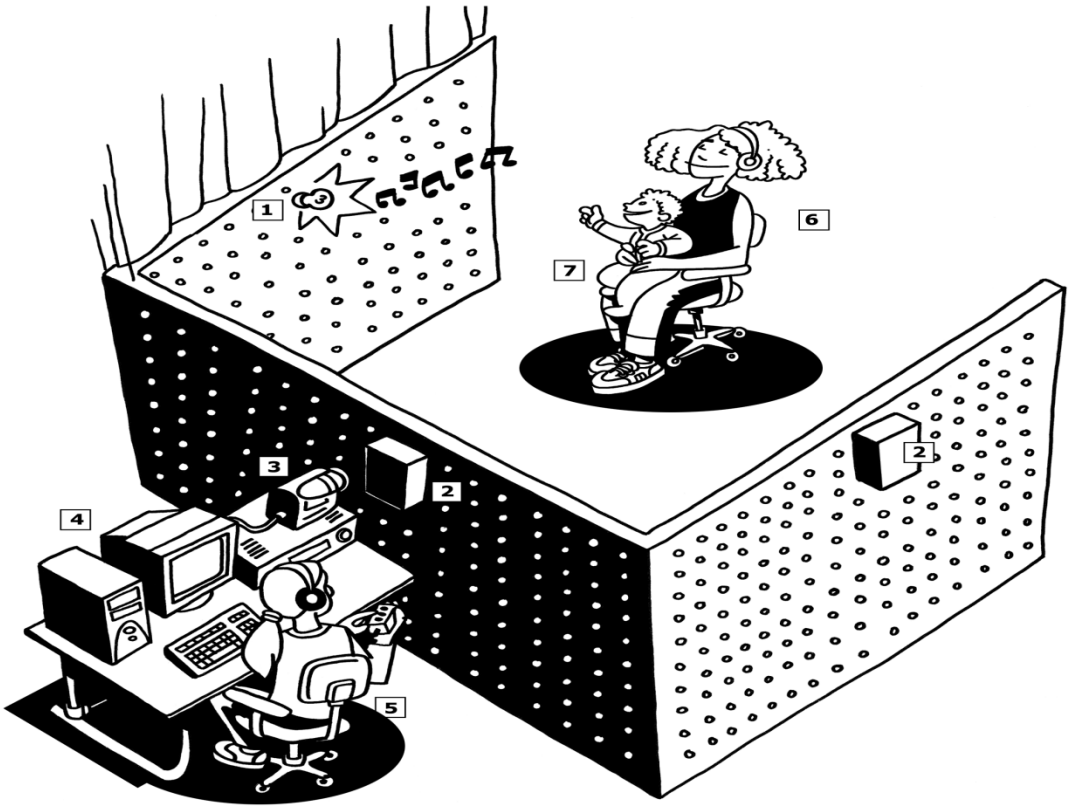
Experiment 1

- Do infants map taps to /t/?
  - Monolingual English-learning 12-month-olds (n=20)
  - Based on detailed parental questionnaire, exposure to English > 90% (M = 99%; Range = 93:100)

- Used Headturn Preference Procedure

ILUSTRATION OF THE HEAD-TURN PREFERENCE PROCEDURE (HPP)



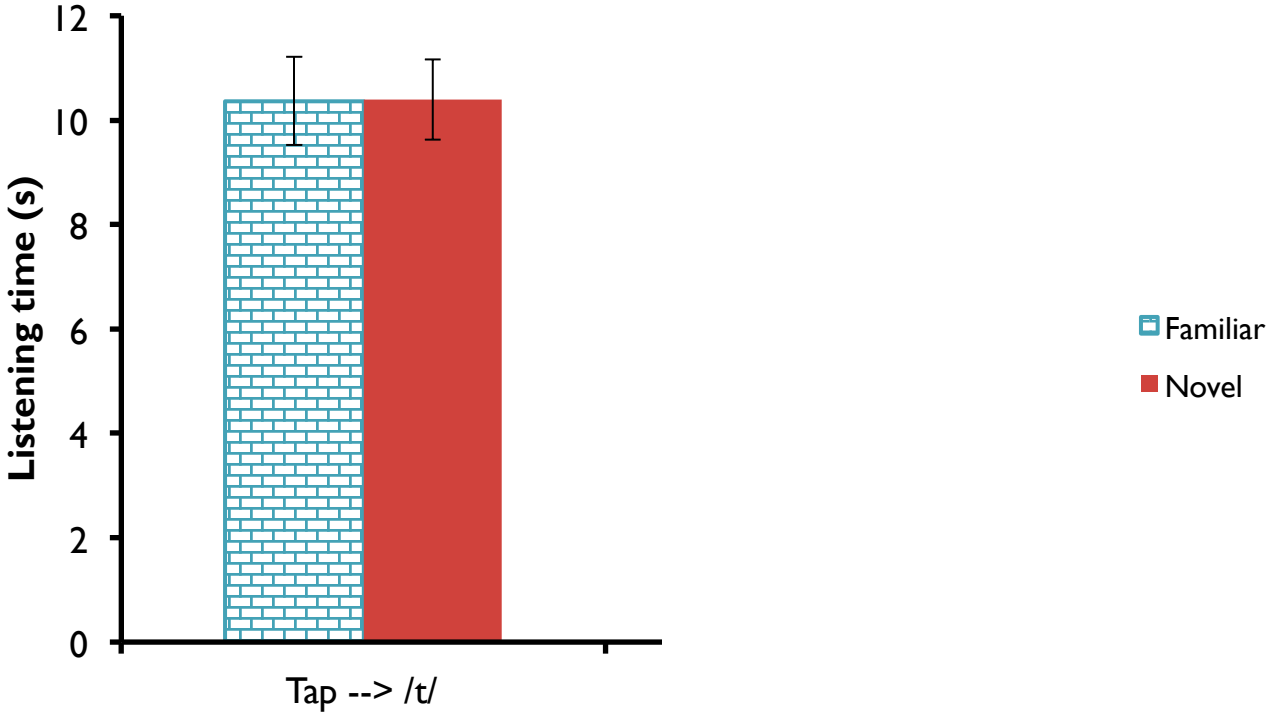


HPP testing

- Familiarization phase (45 s each)
  - 2 passages
    - E.g. Patting animals always relaxes me. My dog gets angry when he sees me patting cats. Please wash your hands before patting the baby. …….
    - Shooting an arrow is hard when it's windy. Shooting a movie is my favorite hobby. I had fun at the carnival shooting balloons..…

- Test phase (4 trials X 2 blocks)
  - 2 familiar & 2 novel word lists
    - pat…..pat……pat….pat…..
    - shoot…. shoot …shoot…..shoot….
    - cut….cut…cut…cut….
    - meet….meet…meet……meet….

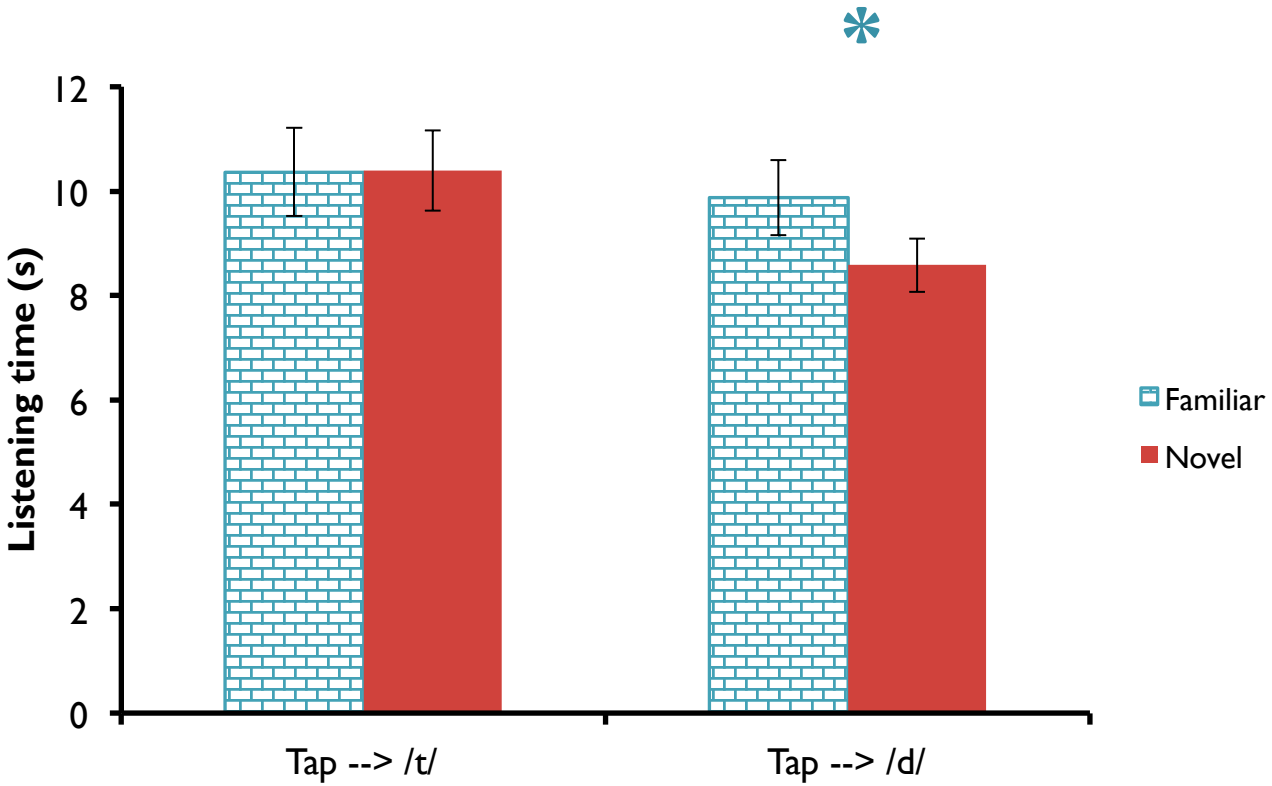
Results: tap → /t/



Experiment 2

- Do infants map taps to /d/?
  - Monolingual English-learning 12-month-olds (n=20)
  - Based on detailed parental questionnaire, exposure to English > 90% (M = 99%; Range = 95:100)
- Used Headturn Preference Procedure
- Test phase
  - 2 novel & 2 familiar word lists
    - pad…..pad……pad….pad…..
    - shood…. shood …shood…..shood….
    - cud….cud…cud…cud….
    - meed….meed…meed……meed….

Results: tap → /d/

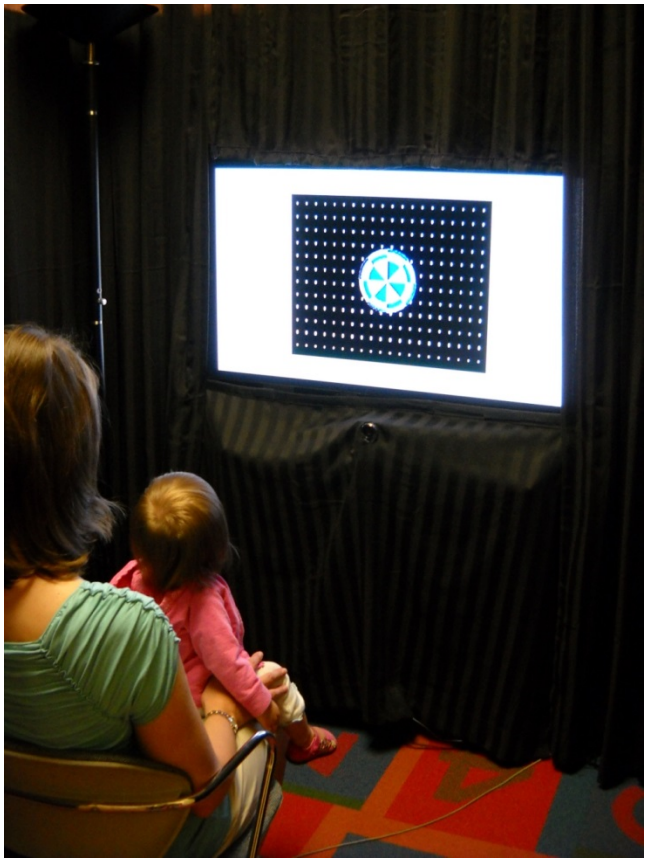


Experiment 3

- Do infants discriminate tap and /d/?
  - Monolingual English-learning 12-month-olds (n=18)
  - Based on detailed parental questionnaire, exposure to English > 90% (M = 99%; Range = 95:100)

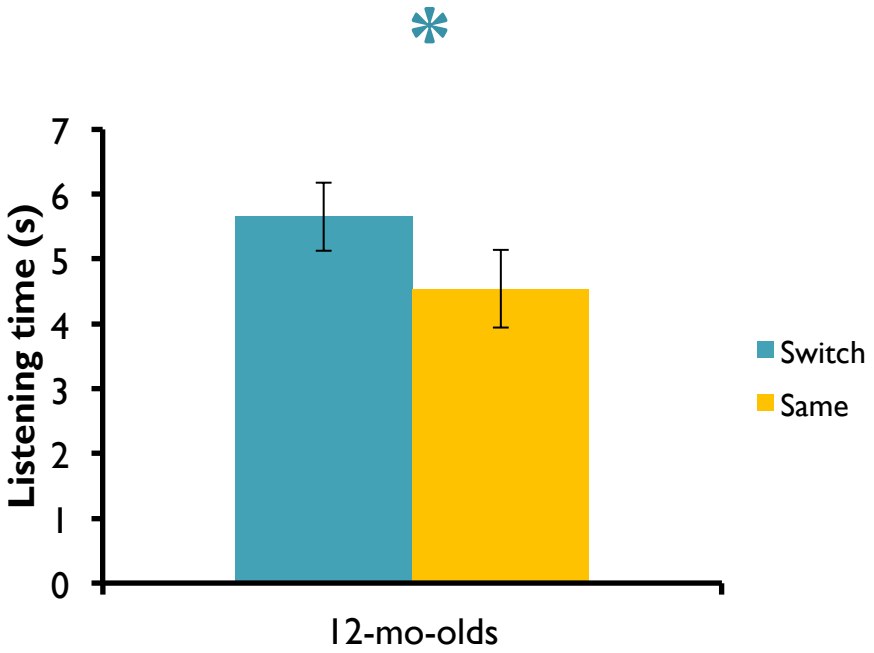
- Used the visual fixation procedure

Visual Fixation Procedure



- Stimuli
  - Multiple tokens
  - Female American English speaker
  - Tap and /d/ in [ˈaCə] context
- Design
  - Habituation Phase
    - Repeated presentation of English /ˈadə/ (or /ˈaɾə/)
    - Terminated when infant's listening time reduced by 50%
  - Test Phase
    - Same
    - Switch
    - Post-test trial [pok]

Results: Discrimination of tap & /d/



#subjects : **15/18 Switch > Same**

Findings & Implications

- 12-month-olds map taps to /d/ not /t/
  - Distributional learning of alternations is constrained by perceptual similarity
- Morphological decomposition of verbs in place at 12-months
- Coda consonants fully specified for voicing in "protolexicon"
  - 12-month-olds treat /d/ and /t/ differently

Future directions

- What is learned first?
  - Morphological decomposition (YunJung Kim's dissertation)
  - Learning of alternations (ongoing)
    - Findings should generalize to a low frequency morpheme

- Predictions
  - If two segments are neutralized,
    - infants will first learn the alternation between the neutralized segment and base segment that is more perceptually similar to it

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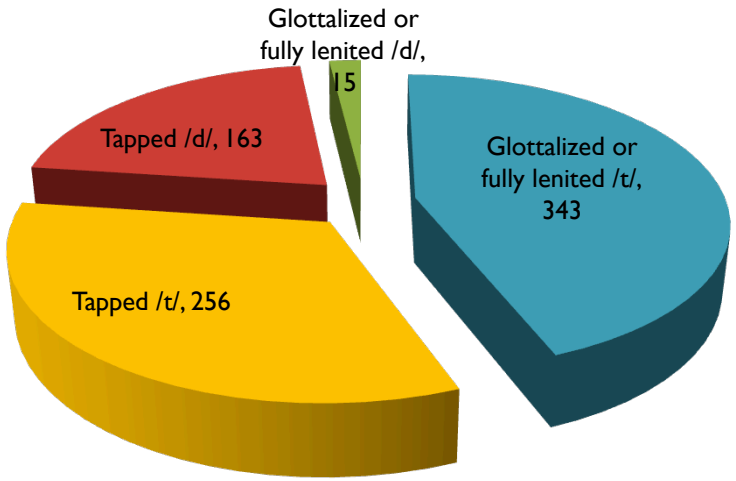
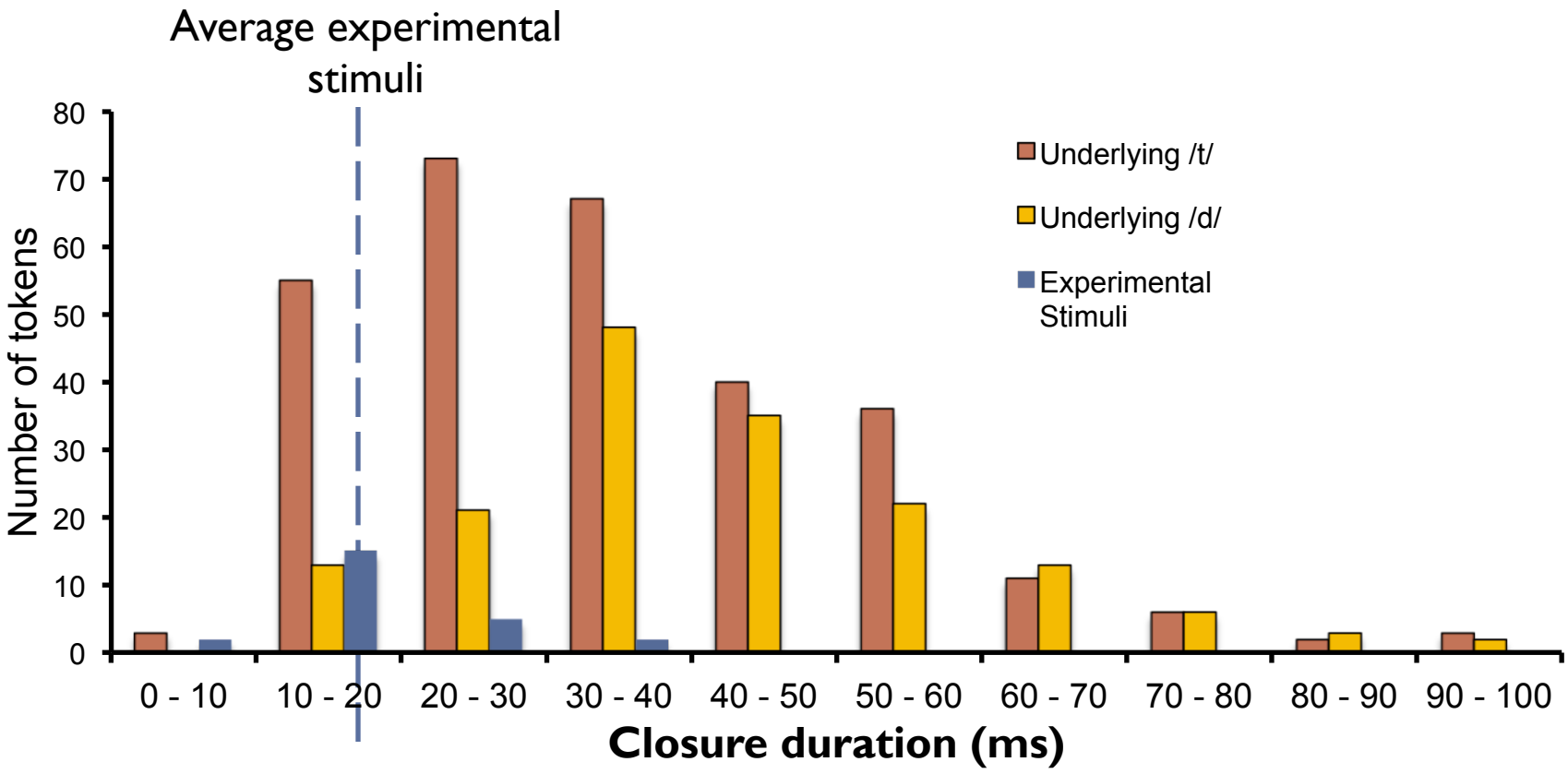
More allophones of /t/



Experimental stimuli tap durations



Ambiguity in determining underlying forms