Infant learning of phonological alternations is biased by phonetic similarity

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Introduction

- Infants are excellent at **statistical learning:**
  - Discriminating speech sounds (Anderson et al., 2003; Maye et al., 2002)
  - Phonotactics (Chambers et al., 2003)
  - Word segmentation (Saffran et al., 1996)
- Tracking statistics likely plays a role in learning **phonological alternations** as well.
  - Computational work (Peperkamp et al., 2006)
  - Experimental work with infants (K. White et al., 2008)
- Evidence mounting that learners are **biased by phonetic similarity** – they prefer alternations between phonetically similar sounds.
  - Typology (Steriade, 2001; Hayes & J. White, sub.)
  - Adult artificial language studies (Skoruppa et al., 2011; J. White, 2014)
  - Computational modeling (Peperkamp et al., 2006; Wilson, 2006; J. White, 2013)
- Virtually no work with **infant** learners!!

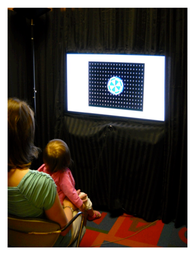
Research questions:

1. Are 12-month-olds biased by phonetic similarity when **generalizing** newly learned alternations in an **artificial language**? **(Study 1)**
2. Are 12-month-olds biased by similarity when **learning** alternations in their **first language**? **(Study 2)**

Study 1 (White & Sundara, 2014)

Question:
Does 12-month-olds' generalization of newly learned alternations depend on phonetic similarity?

Participants:
40 monolingual English-learning 12-month-olds at UCLA.



Procedure:
Visual Fixation Procedure

1. Familiarization: Phrases providing evidence for an alternation.
   - 'Function' element (*na* or *rom*) + CVCV 'content' word (e.g. *rom poli…na timu…*)
   - 16 phrases, repeated twice per trial
   - 3 trials (45s each, 135s total exposure)
2. Test: Novel pairs of CVCV words (e.g. *buni…vuni…*)

BIAS condition - [p ~ v] or [t ~ z]

Labials Alternating		Coronals Alternating	
rom poli	*na voli*	*rom poli*	*rom voli*
rom poli	*na voli*	*na poli*	*na voli*
rom timu	*rom zimu*	*rom timu*	*na zimu*
na timu	*na zimu*	*rom timu*	*na zimu*

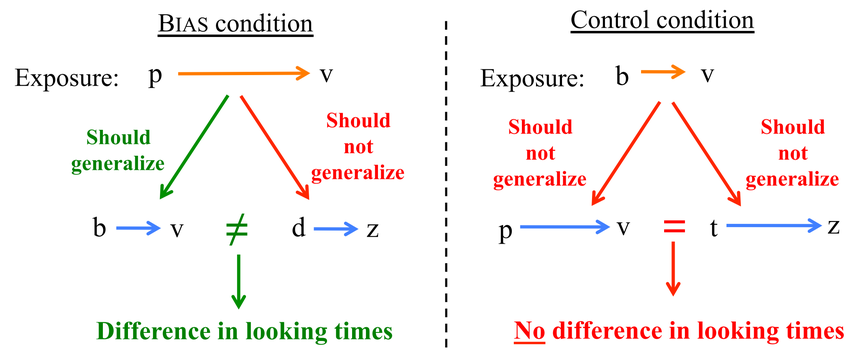
Test pairs: buni/vuni, bagu/vagu, dilu/zilu, dari/zari

CONTROL condition – [b ~ v] or [d ~ z]

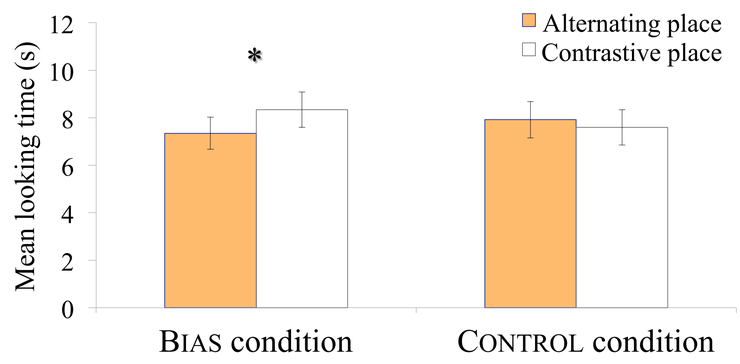
Labials Alternating		Coronals Alternating	
rom boli	*na voli*	*rom boli*	*rom voli*
rom boli	*na voli*	*na boli*	*na voli*
rom dimu	*rom zimu*	*rom dimu*	*na zimu*
na dimu	*na zimu*	*rom dimu*	*na zimu*

Test pairs: puni/vuni, pagu/vagu, tilu/zilu, tari/zari

Predictions (if biased by similarity):



Results:



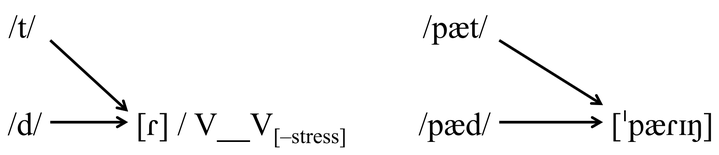
→ **12-month-olds generalized the alternations to new pairs of sounds that were more similar, but not to ones that were less similar.**

→ Similar results found with adult learners in a previous study. (J. White, 2014)

Study 2 (Sundara, Kim, White, & Chong, submitted)

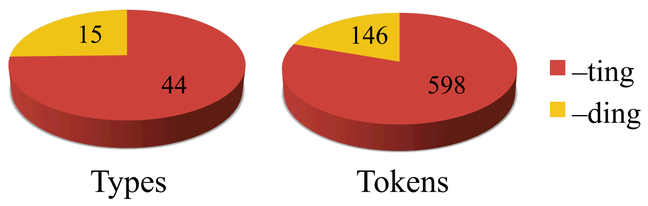
Question:
Do 12-month-olds depend solely on input statistics when learning phonological alternations in their first language, or is this learning biased by phonetic similarity?

Tapping in American English:
/t/ and /d/ (partially) neutralized to [ɾ] in certain contexts:



Corpus search of infant-directed speech:
- Brent corpus (Brent & Siskind, 2001)
- 9 infant-mother dyads chosen (infant ages 0;9–2;2).
- All words ending in –ting/–ding extracted.

–ting/–ding words (tapping contexts only)

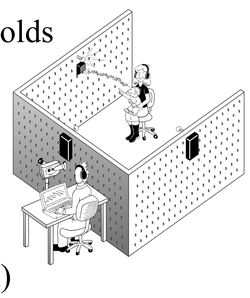


→ Infants hear far **more –ting words** than –ding words in IDS.

Phonetic similarity:
- [d] and [ɾ] more similar than [t] and [ɾ] (Herd et al., 2010)

Predictions:
Based solely on input statistics: [t ~ ɾ] learned first.
Bias based on phonetic similarity: [d ~ ɾ] learned first.

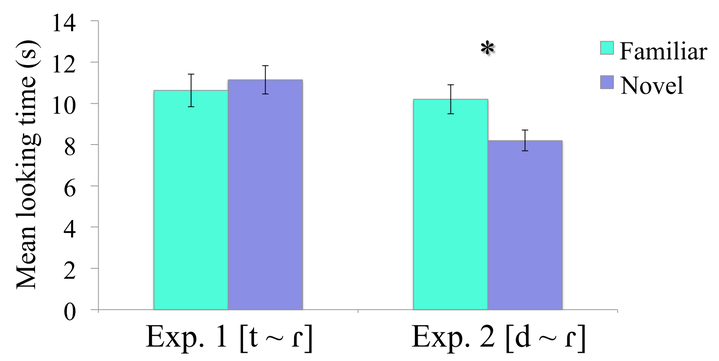
Participants:
48 monolingual English-learning 12-month-olds (24 in each exp.)



Procedure:
Headturn Preference Procedure (HPP)

1. Familiarization: 2 passages (45s to each)
   - E.g. ***Cutting*** papers with scissors is a lot of fun… Mommy is really good at ***cutting*** tofu…
   - Target word appeared 6 times/passage.
   - 2 groups (cutting/meeting or patting/shooting, counterbalanced)
2. Test: 4 wordlists, 2 familiar and 2 novel (4 trials x 2 blocks).
   - Exp. 1: *cut…cut…cut…* (also: *meet, pat, shoot*)
   - Exp. 2: *cud…cud…cud…* (also, *meed, pad, shood*)

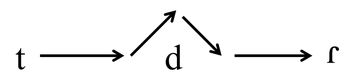
Results:



→ **12-month-olds know [d ~ ɾ], but not [t ~ ɾ], despite greater evidence for [t ~ ɾ] in the input.**

→ **Exp. 3**: Confirmed that 12-month-olds **can discriminate** [d] and [ɾ] perceptually.

→ Note: if [t ~ ɾ] learned first, this would be a **saltatory alternation**:



- Particularly egregious P-map violation.
- Poses theoretical difficulties. (Hayes & J. White, sub.)
- Disfavoured by learners (J. White, 2014).

General Discussion

- **Input statistics are not sufficient** for explaining infants' learning and generalization of phonological alternations.
  - Instead, this learning is **biased by phonetic similarity**.
- Previous experimental work with adults (J. White, 2014) and computational modeling (J. White, 2013) suggests that this bias is a **substantive bias favouring alternation between perceptually similar sounds** (i.e. a **P-map bias**, Steriade 2001).
  - Future infant work will look more into the type of bias (e.g. perceptual vs. features).
- **Prediction**: alternations between similar sounds learned first, all else being equal.

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