

# How do listeners generalise perceptual learning for phonotactics across talkers and places of articulation?

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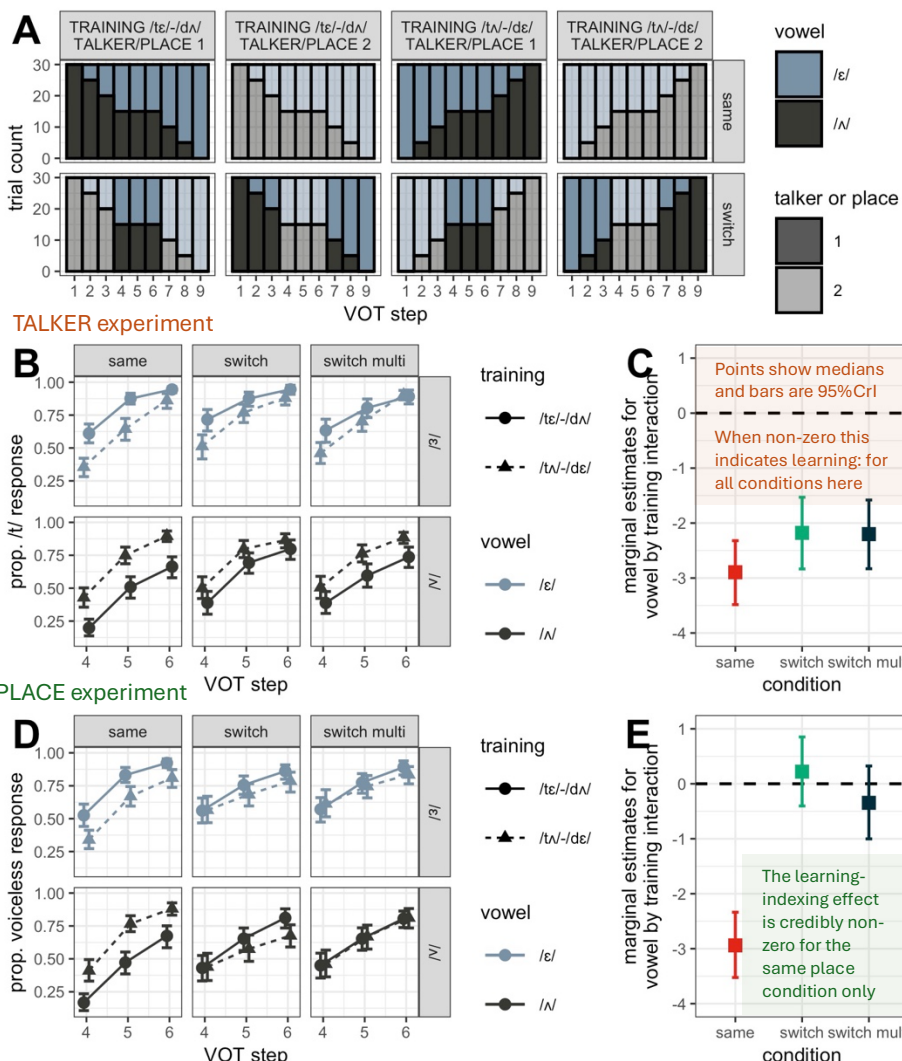
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Language experience with phonotactics influences speech processing [1]. For example, phonotactic probabilities bias perception of acoustic cues, favouring perception of higher-probability sequences [2] even with just short-term exposure in the lab [3]. Here we examine the extent to which this type of perceptual learning is generalisable. Is it represented at an abstract level, i.e., a (a) talker-general or (b) phonological featural [5] level? Or is learning contrast and talker-specific [4]? We present two sets of parallel experiments addressing talker and featural generalization. **Methods.** We created non-word stimuli along a 9-step VOT continuum: /pɛɜ/ - /bɛɜ/, /tɛɜ/ - /dɛɜ/, /kɛɜ/ - /gɛɜ/, and /pʌɜ/ - /bʌɜ/, /tʌɜ/ - /dʌɜ/, /kʌɜ/ - /gʌɜ/. Vowels were *categorically* different (via formant resynthesis). VOT steps were paired probabilistically with each vowel context in the **training stimuli**, following [3] shown in panel A. /tʌ/ - /dɛ/ training means that longer VOT (= voiceless stop) is paired with /ʌ/: /ʌ/ should increase voiceless responses if learning occurs. The opposite is predicted for /tɛ/ - /dʌ/: /ɛ/ increases voiceless responses. VOT steps 4-6 are **test stimuli** with no distributional bias. Other steps are training, with skewed biphone information (panel A). Listeners categorised the initial stop (2AFC task, all test and training trials fully randomised).

**Talker generalisation.** We used just /tɛɜ/ - /dɛɜ/ in the TALKER study. In the *same* conditions, the same talker (one of two) produced all trials. In the *switched* conditions, one talker produced the training trials, the other produced the test trials. If learning is talker-general, then it should be present in the switched condition. In the *switch multi condition* (not shown in panel A) a third talker was added producing the training trials (only) with talker 1 or talker 2. We crossed training (two patterns), target talker (counterbalancing the two talkers) and same/switch (same vs. switch vs. switch multi). 30 British English speaking participants were recruited for each condition (2 × 2 × 3 = 12), 360 total. Using Bayesian mixed-effects regression we examine if there is evidence for a critical **training by vowel** interaction which would show asymmetrical uses of vowel context based on training, evidencing learning. **Results:** We find robust evidence for learning in each same/switch condition (panel C), and credible differences between each vowel and training combination for each switch condition (panel B) with only weak evidence for a difference based on same/switch/switch-multi conditions. In other words, learning readily generalises across talkers, and is not boosted by multiple talkers as compared to just one. **Place generalisation.** Using just one talker's voice we used the same logic as the preceding experiment, this time switching *place of articulation* (360 additional participants). We tested /tɛɜ/ - /dɛɜ/, /kɛɜ/ - /gɛɜ/ for same and switch conditions, adding /pɛɜ/ - /bɛɜ/ as an additional training place for the *switch multi condition*. Here we find robust same place learning in the two-way interaction and no evidence for switched placed learning (panel E), even with multiple training places; there is no difference between training groups in switch and switch multi conditions. Learning is thus place-specific and does not generalise across contrasts.



Results will be discussed in terms of their bearing on perceptual learning, phonotactic representations, and talker adaptation.

Figure A: Training distributions for same/switched conditions, with the number of trials paired with each context, and VOT step. Shading indicates talker/place. B: Training effect for each vowel (rows) and VOT step, showing the between-subject training effect. Same/switch TALKER is indicated by column.

If learning has occurred groups should show opposite effects for each vowel. C: Marginal two-way interaction indexing learning for the TALKER experiment. D: Responses in the PLACE experiment. E: Marginal two-way interactions in the PLACE experiment.

**Refs** [1] Vitevitch, M. S., & Luce, P. A. (1999). Probabilistic phonotactics and neighborhood activation in spoken word recognition. *JML*, 40(3), 374-408. [2] Pitt, M. A., & McQueen, J. M. (1998). Is compensation for coarticulation mediated by the lexicon?. *JML* 39(3), 347-370. [3] Steffman, Jeremy, and Megha Sundara. "Short-term exposure alters adult listeners' perception of segmental phonotactics." *JASA EL* 3.12 (2023). [4] Cummings, S. N., & Theodore, R. M. (2022). Perceptual learning of multiple talkers: Determinants, characteristics, and limitations. *APP*, 84(7), 2335-2359. [5] Linzen, T., & Gallagher, G. (2017). Rapid generalization in phonotactic learning. *Lab. phonology*, 8(1).