



Plasticity of phoneme categories in speech perception and production

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Introduction: Existing evidence shows considerable plasticity in perception of speech categories, e.g., short-term changes to the distributions of acoustic cues (Kraljic & Samuel, 2006; Maye, Aslin, & Tanenhaus, 2008; Norris, McQueen, & Cutler, 2003; Clayards, Tanenhaus, Aslin, & Jacobs, 2008)

However, plasticity in perception does not always lead to changes in production (Kraljic, Brennan, & Samuel, 2008, (Delvaux & Soquet, 2007; Nielsen, 2007)

Our goal: investigate the relationship between plasticity in perception and production by exposing participants to a shifted distribution of phonetic cues. This artificial distribution was designed to shift the typical /b/ distribution towards longer VOTs, with a consequent shift in the boundary between /b/ and /p/

Experiment 1: Same speaker / same test words

pre-test

PRODUCTION TASK

Baseline task. Participants read aloud 3 minimal pairs 3 times pairs heard in the in the exposure task, along with 2 filler pairs

BA/PA PERCEPTION TASK

Baseline task. Categorisation of 68 token /ba-/pa/ VOT continuum (6 repetitions x 13 steps)

EXPOSURE TASK

Participant categorise 504 tokens of an artificial bimodal VOT continuum, over 3 blocks, without feedback

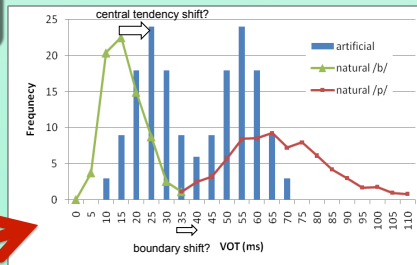
post-test

BA/PA PERCEPTION TASK

Same as above

PRODUCTION TASK

Same as above



Stimuli	
beach	peach
beak	peak
beat	peat

Minimal pair exposure words heard in isolation in Exp. 1 and spoken by same female talker as in /ba-/pa/ perception task. Burst and aspiration portions were cross-spliced so identical for both words and syllables.

Experiment 2: Different speaker / additional test words

Same as Exp 1. with a few changes:

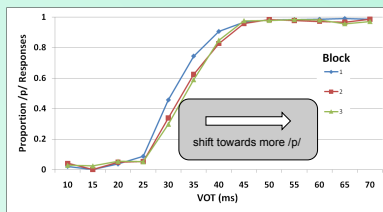
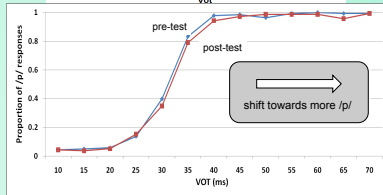
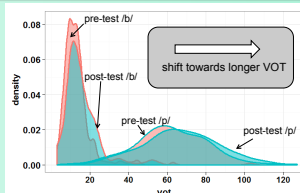
Do perceptual shifts transfer to a new speaker?

- Same burst and aspiration portions from Exp.1 spliced onto words spoken by a different female talker embedded in 1 of 3 neutral carrier sentences during perception task, e.g.: "This one is beach"

Do production shifts transfer to different words?

- Production stimuli to include 3 additional minimal pairs to compare pre and post test (bees/peas, beer/peer, beep/peep)

Results Experiment 1 = N23



PRODUCTION SHIFT

Following exposure, mean VOTs were longer for both /b/ and /p/ initial words [F(1,22)=10.20, p<.01]

	before	after
b	13.1 ms	16 ms
p	62.3 ms	67.1 ms

BA/PA PERCEPTION SHIFT

Following exposure, there was a marginally significant shift in category boundaries [F(1,21),p=.057]

EXPOSURE PERCEPTION SHIFT

Within the course of the exposure task, categorisation was significantly shifted to more /p/ responses [F(2,44)=8.14, p<.001], indicating a plasticity in perception

Results Experiment 2 = N23

PRODUCTION SHIFT

Significantly longer VOT productions were elicited following exposure [F(5.56), p=.028], for exposure stimuli and additional words, indicating generalisation

BA/PA PERCEPTION SHIFT

We found a highly significant shift in perception following exposure, with a boundary shift for longer VOTs, even though the speaker was different from that heard during exposure [F(1,22)=12.36, p<.01]

EXPOSURE PERCEPTION SHIFT

As in Exp. 1, we found exposure to the distribution shifted categorisation across the 3 blocks of trials to more /p/ responses [F(2,44)=21.89,p<.001]

Discussion

- Perceptual plasticity in category boundaries as a result of listening to spoken words can generalise to perception of syllables from the same and different talkers (Exp. 2) and to production, even when cues to category boundaries are only signalled by distributional information
- We argue that these data are consistent with models in which speech perception and production are closely linked, and where statistical learning allows constant retuning of phonetic categories

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Clayards, M., Tanenhaus, M. K., Aslin, R. N., & Jacobs, R. A. (2008). Speech perception reflects optimal use of probabilistic speech cues. *Cognition*, 108, 804-809.

Delvaux, V., & Soquet, A. (2007). The influence of ambient speech on adult speech productions through unintentional imitation. *Phonetica*, 64(2-3), 145-173.

Kraljic, T., Brennan, S. E., & Samuel, A. G. (2008). Accommodating variation: Dialects, idiolects and speech processing. *Cognition*, 107, 54-81.

Kraljic, T., & Samuel, A. (2006). Generalization in perceptual learning for speech. *Psychonomic Bulletin & Review*, 13(2), 262.

Maye, J., Aslin, R. N., & Tanenhaus, M. K. (2008). The weekend witch of the west: Lexical adaptation to a novel accent. *Cognitive Science: A Multidisciplinary Journal*, 32(3), 543-562.

Nielsen, K. (2007). Implicit phonetic imitation is constrained by phonemic contrast. In *Proceedings of the International Congress of Phonetic Sciences* (Vol. 16, pp. 1981-1984). Saarbrücken, Germany.

Norris, D., McQueen, J. M., & Cutler, A. (2003). Perceptual learning in speech. *Cognitive Psychology*, 47(2), 204-238.