Plasticity of phoneme categories in speech perception and production

Shane Lindsay (1), Meghan Clayards (2), Silvia Gennari (1), & M. Gareth Gaskell (1)

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

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

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

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

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

<table>
<thead>
<tr>
<th></th>
<th>pre-test</th>
<th>post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>13.1 ms</td>
<td>16 ms</td>
</tr>
<tr>
<td>p</td>
<td>62.3 ms</td>
<td>67.1 ms</td>
</tr>
</tbody>
</table>

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

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.

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 test words to compare pre and post test (bees/peas, beer/peer, beep/peep)

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]

We gratefully acknowledge the assistance of Sunil Naran, Claire Blackmore, Elaine Tham and Hennessy-Wong.