Multiple sources of information contribute to novel category formation

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Introduction
The acquisition challenge
Adult learners of a second language often struggle with the acquisition of phonemes in the target language, especially when they overlap with or crosscut phonemic categories in the native language [1, 2, 3].

Native attractors
One way to frame this difficulty is in terms of attractors: native categories act as stable, well-trained attractors that pull incoming acoustic information towards these familiar representations [2, 4]. Without intervention, non-native tokens may reinforce and strengthen these native categories [5], rather than be recognized as separate categories.

Pathways to learning
To break away from native representations, a number of interventions have been tested in laboratory training paradigms, including performance feedback [5, 6], the manipulation of attention [7, 8], cue enhancement [5, 9, 10] and high stimulus variability [8, 11, 12].

The current study
This study consists of a multi-day training paradigm targeted at teaching new learners several non-native contrasts in Hindi. It introduces multiple sources of cues to help learners form new categories, and tests the integration of perceptual and articulatory information in the learning process.

Study questions
1. Can native phoneme category biases be overcome with a combination of perceptual interventions in a short-term training paradigm?
   - Feedback: explicit information about performance
   - Adaptive fading: Transition from clear to less-distinct tokens
   - Repeated exposure
2. Do different non-native contrasts differ in learnability?
3. What does articulatory training [13] contribute to perceptual category formation in a short-term, integrated training design?

Methods
Experiment design
Tasks: AX-discrimination, repetition
Perception training: adaptive fading, feedback on performance, repeated exposure to targets
Production training: explicit instruction about tongue/larynx control
Average days to complete: 12.7 (s.d. 9.4)

Subjects
11 native English speakers
No prior experience with Hindi or languages with phonemic contrasts similar to the target contrasts

Stimuli
VCV and CV syllables recorded by a native speaker of Hindi
Contrast types: voicing (e.g. /t/ - /ɗʱ/), place (/j/ - /ɡ̥/), place-voicing (/j/ - /dʱ̥/), same (/j/ - /ɡ̥/)

Results: Individual differences
Performance accuracy varied across subjects, and initial performance did not necessarily predict end-of-study performance.

Range of performance on “different trials”:
- pre-test: 42.8% - 79.8%
- post-test: 73.3% - 92.6%
- re-test: 66.2% - 95.1%

Correlation of performance across sessions:
pre-test ↔ post-test: r = 0.544, p = 0.08
post-test ↔ re-test: r = 0.751, p = 0.008
pre-test ↔ re-test: p = n.s.

Results: Reaction Time
Question: Can learning be indexed by speed of response?
Analysis: Mixed-effects model of reaction time in all “correct” trials
Model terms: contrast type, session, session * contrast type, vowel, trial

Findings:
- Speed increases: over the course of a session
- in /a/ trials more than other vowels
- after training for all trill trials (post-hoc test, Tukey correction)

Discussion
• Improvement is possible in short-term training.
• Initial performance relates to, but does not determine, final outcomes.
• Speed may signal improvement once accuracy hits a near-ceiling.
• Production training does not add benefit at the end of perceptual training.

Future directions
• Production training: beneficial as stand-alone training?
• Benefit of perceptual training on quality of production data?
• EEG MMN study: is improvement detectable at a neural level before behavioral evidence is clear?

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References