Language comprehension and sensorimotor learning with cochlear-implant simulated speech

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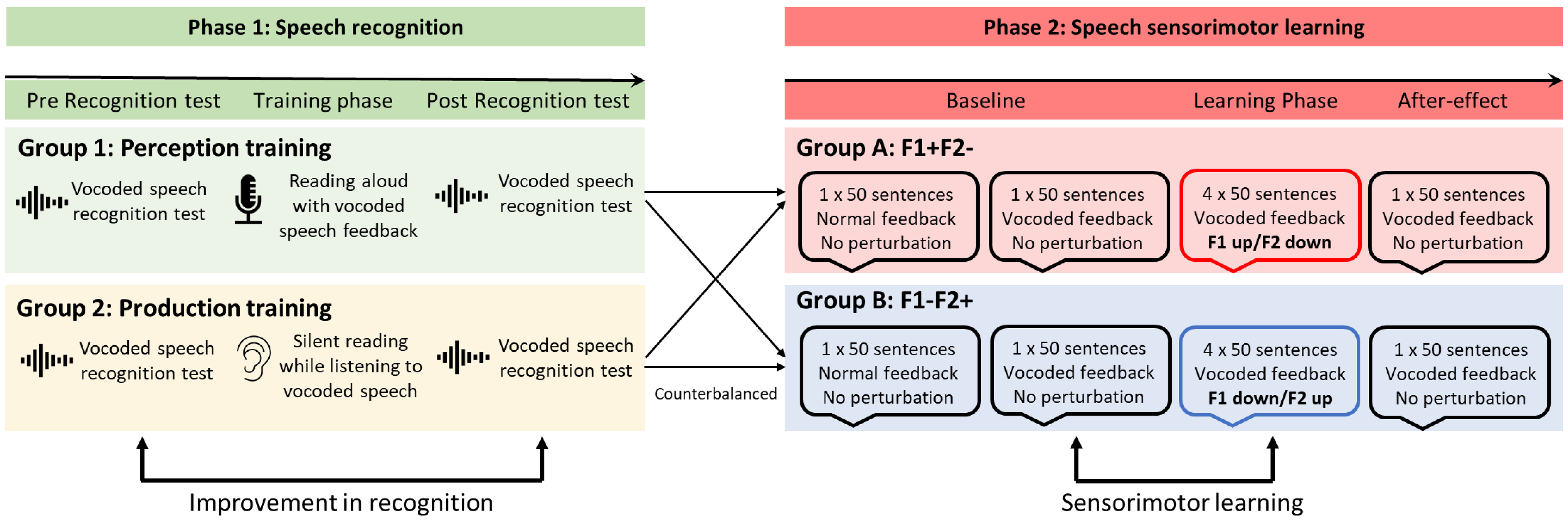
Introduction

- Cochlear implants (CIs) are devices that can enable deaf individuals to hear.
- This includes hearing auditory feedback from one's own voice during production, known to support maintenance of intelligible speech articulation.
- However, auditory input provided by CIs is degraded in quality, and learning to interpret and use this new speech auditory input takes time.
- This experiment investigated whether typical hearing participants can use CI simulated speech input for language comprehension and sensorimotor control of speech production.

Methods



- Sample: 20 native speakers of British English, no reading, language or hearing impairments.
- CI simulation for real-time and pre-recorded speech achieved using a form of spectral degradation known as noise vocoding (approx. 8 channel vocoder).
- Sensorimotor learning = changes in produced formants that oppose the perturbation.

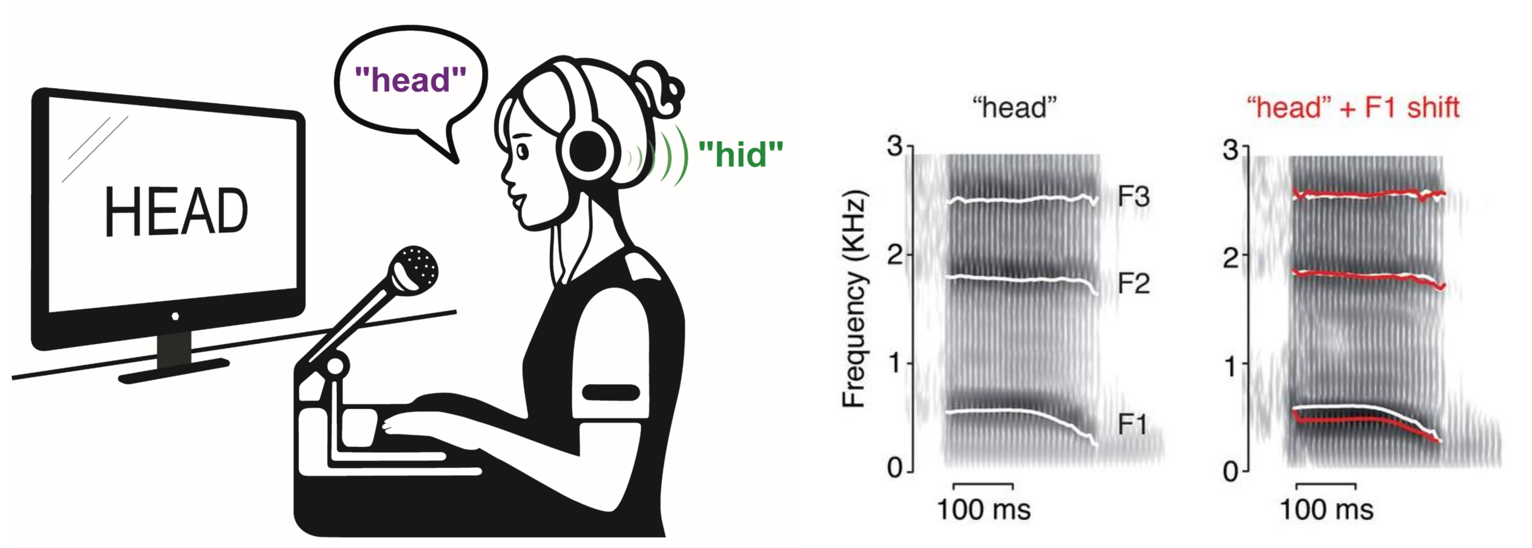


Figure 1: Sensorimotor Learning Set-up. *Participants read aloud sentences while hearing their voice played back through headphones, with or without a formant perturbation.*

Results

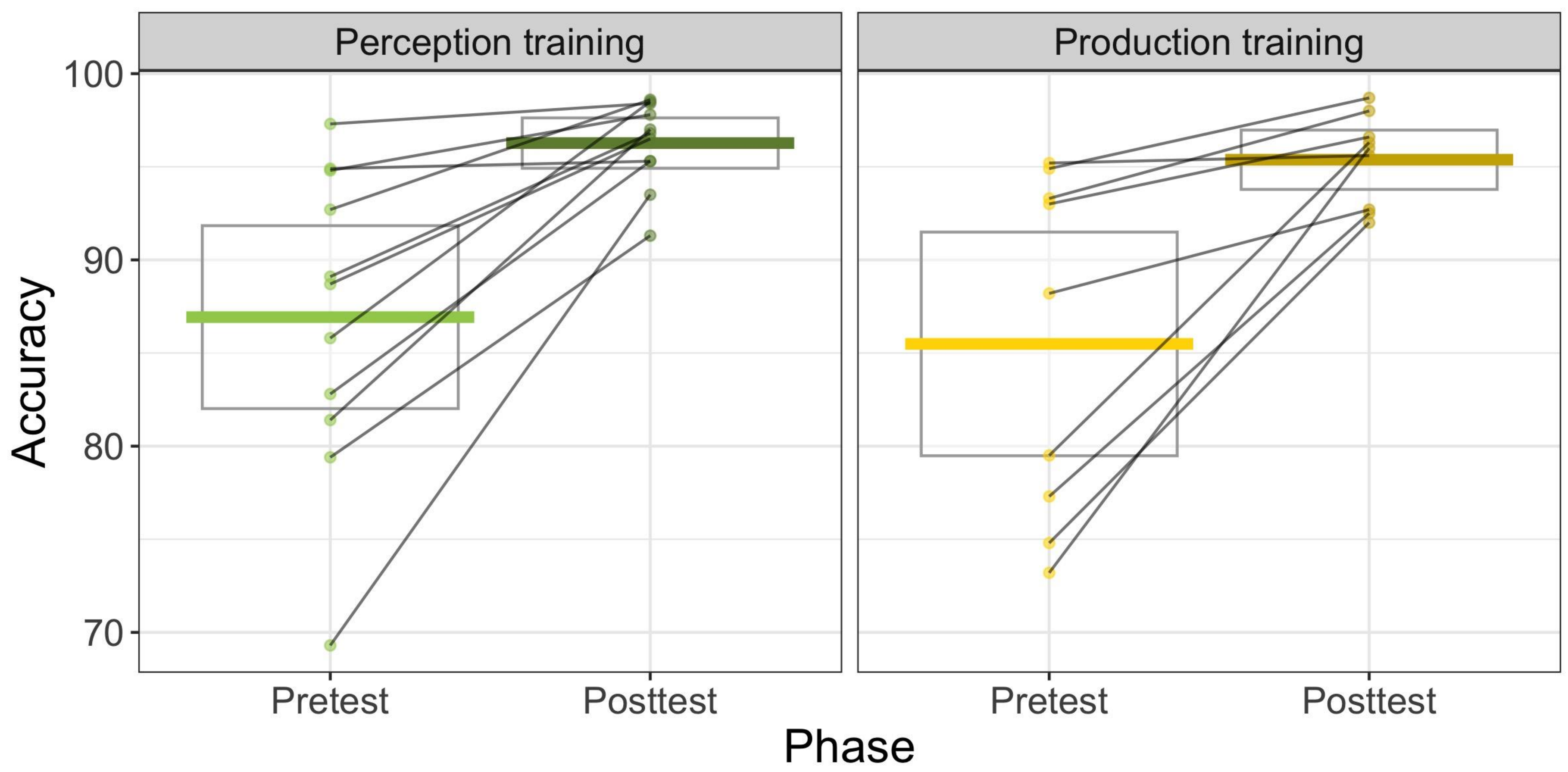


Figure 2: Phase 1 *Sentence report accuracy pre- and post-training.*

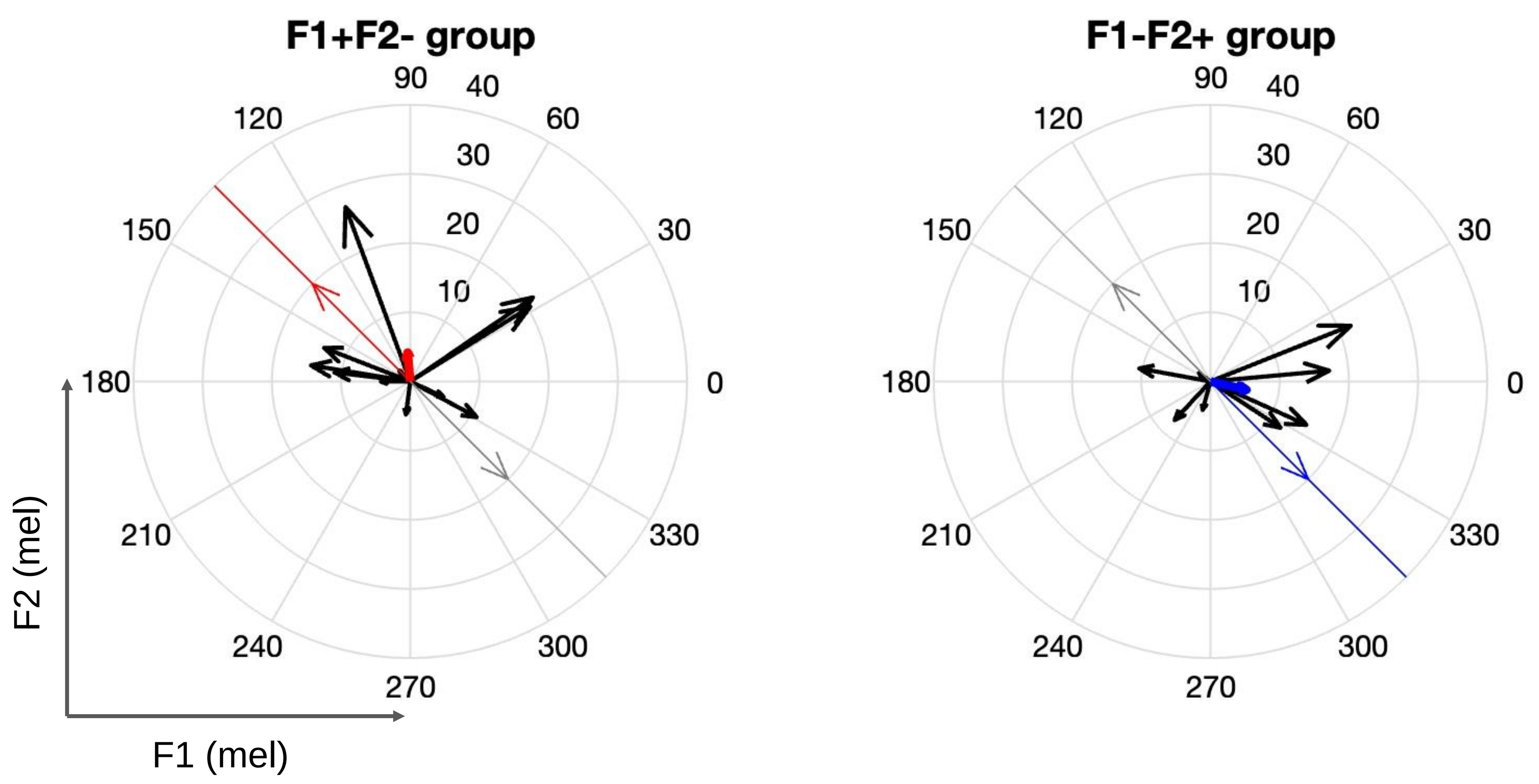


Figure 3: Phase 2 *Sensorimotor learning responses (changes in formants from baseline in block 6). Thin grey arrows show direction of perturbation.*

Phase 1

- Prediction: Improvement in recognition of noise vocoded speech pre- to post-training will be significantly greater in the production training group compared to the perception training group.
- Significant increase in accuracy from pre- to post-training in both perception (n = 9) and production (n = 11) training groups (LMM analysis).
- No significant interaction between phase and training group.

Phase 2

- Prediction: Participants in both groups will show sensorimotor learning i.e. changes in their produced formants in the direction opposite to the formant perturbation they experienced (indicated by thin blue and red arrows on Fig. 2).
- No significant change in produced formants was found in block 6 relative to baseline, in either Group A (n = 11) or Group B (n = 9) (LMM analysis).

Discussion

- Experience of speaking with CI simulated speech auditory feedback appears just as effective at improving recognition of CI speech as experience of passively listening to CI speech with matching text.
- However, typical hearing participants were not able to use this CI speech feedback to drive sensorimotor learning during production; this could be due to difficulties in perceiving the perturbation, or in sense of agency over the vocoded voice.

This study was pre-registered on OSF prior to data collection.

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