Long-term high-variability training for adult cochlear implant users
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Introduction
Although cochlear implants have been demonstrated to be effective surgical treatments for deafness, new implant users must undergo an intense period of perceptual learning and adaptation to learn to hear with their prostheses. Few adult CI users receive any formal training following implantation, and as a result, the perceptual skills that they develop are highly variable. This study assessed the efficacy of a new training program for adult CI users.

The goal of our interactive, adaptive, high-variability training program is to 1. provide empirically-based, adaptive and interactive perceptual training to new CI users to help them adjust to their prostheses; 2. develop a common set of robust and adaptive cognitive auditory skills in CI users that will help them to hear in real world situations; 3. Establish baseline levels of performance for experienced CI users to evaluate successful implant use by new users.

Method

Participants
- Normal Hearing Listeners (n=68)
- Age 21.14 years (Range 18-23 years), no reported speech, Bimodal CI users performed lower than Bimodal CI users, while the Unilateral CI users performed best overall
- Experienced CI Users (n=23)
- Average Age 59.13 years (Range 25-78 years)
- New CI User (n=11)
- Age 46 years, Prelingually Deafened, Bimodal

Materials
- Talker Identification (Clopper & Pisoni, 2006)
- Focused attention on the acoustic indexical features of the voice
- Generalizes to speech perception (Loebach, Bent & Pisoni, 2008)
- Ex. The steady drum was more than the drenching rain
- Anomalous Harvard sentences (Herman & Pisoni, 2000)
- Focused attention on the letter and word sounds themselves, and prevents overreliance on sentence context, but are more difficult
- Generalizes to meaningful sentences transcription and word recognition (Loebach & Pisoni, 2008)
- Ex. Sh. the hint was firm on the dusty smile
- Phonetically Balanced Words (Egan, 1948)
- Promote lexical access in isolation, easier due to fewer phonological neighbors
- Ex. charge, bought, cloud, mute
- MRT words (House, Williams, Hecker & Kryter, 1963)
- Promote phoneme identification and discrimination
- Ex. lake, lye, lace, lance, lane
- Environmental sounds (Marcell et al., 2002)
- Focused attention on complex acoustic nonlinguistic information
- Generalizes to speech (Loebach & Pisoni, 2008)
- Ex. dog barking, car horn, accordion, door slamming
- Subjects made open-set typed responses or spoke their responses aloud
- Received orthographic and auditory feedback irrespective of their answer

Results

Talker Identification Increases as Talkers Increase
- Performance improved across days demonstrating that participants were able to learn to identify talkers by voice
- As the number of talkers increased (from 4 to 6 to 8), accuracy initially decreased, but stabilized over sessions

Environmental Sound and Phoneme Identification
- Talker Identification Stabilizes Across Weeks
- Performance accuracy improves across days
- Adaptive training increases task difficulty across sessions by using less intelligible talkers, foreign accented English, and less commonly encountered environmental sounds

Discussion
- Perceptual learning is influenced by training materials
- All types of training generalize to easy materials (meaningful sentences, PB words)
- Training specificity is observed for difficult materials (anomalous sentences, environmental sounds), and only similar stimuli will generalize (Loebach & Pisoni, 2008; Loebach, Pisoni & Svirska, 2010)
- A desirable level of difficulty (Bjork, 1994) is needed to promote robust perceptual learning and should ensure generalization to hearing in real world environments
- If the task is too easy, learning does not occur
- If the task is too difficult, learning does not occur
- Generalization of perceptual learning depends on the depth of processing required during training
- Tasks that require deeper analysis generalize to sentence transcription
- Tasks that require shallow analysis do not (Loebach, Bent & Pisoni, 2008; Bent, Loebach, Phillips & Pisoni, 2011)
- Manipulation of depth of processing (Craig & Lockhart, 1972) will foster robust generalization to difficult tasks
- Highly variable stimulus sets require deeper levels of analysis and promote robust perceptual learning
- Targeted training in cochlear implant users may
- Reduce variability in outcome by standardizing the perceptual learning process across individuals
- Provide better assessment of gains and expectations
- Enhance neurocognitive coping skills in a variety of real world listening situations
- Challenge listeners to do better and give them a framework in which they can improve
- Future directions
- Recruit additional experienced, postlingually deafened adult CI users to provide normalization data
- Implement the training program in additional new CI users
- Finish an online version of the training program so users can train from home more easily

Acknowledgements

References