Research in Sensory Science

Cochlear implants (CI)

Issue: Some individuals with unilateral deafness lack localization and speech-in-noise abilities. A CI provides degraded input; it is unclear whether that signal can be used for improved hearing.

Question: Does cochlear implantation restore binaural hearing and reduce listening effort?

Douglas Sladen, Ph.D. Mayo Clinic Audiology Collaborators: Colin Driscoll, Chuck Beaty, Brian Naft, Matt Carlson, Ann Peterson, Amy Clund, Kate Tecce, Brittany Dowling

For 16 listeners with unilateral deafness, speech understanding improves with time after implantation.

Listeners indicate significant benefits in speech, spatial hearing, and sound quality (SSQ) after implantation.

Preliminary results demonstrate that cochlear implantation for adults with unilateral hearing loss allows:

- Improved speech understanding for the implanted ear.
- Mean percent scores are lower than mean percent correct scores of adults with bilateral hearing loss
- Improved speech understanding in noise measured in diffuse noise
- Improved self-perceived benefit for tinnitus and SSQ
- Negligible benefit for listening effort

Research in Sensory Science

Enhanced aids for hearing loss

Customized amplification based on physiology

Issue: Hearing aid amplification controls for level-based residual hearing, but it may also need to control for level-induced distortions.

Question: What are physiological mechanisms driving individual variance in level-induced degradation in amplified speech perception?

Evelyn Davies-Venn, PhD, CLA, SLHS

Behavioral scores:

Speech input
- Earphones
- Hearing aids
- Sound field

In-car Acoustic Recordings

Electro-Physiology
- ABR
- PFR

Computational Modeling
- Cochlear to auditory nerve

Results

Model simulation: Basilar membrane response from auditory nerve model: similar to behavioral results; it is harder to distinguish spectral modulation or phase inversion with increase in ripple density.

- Amplified speech perception may be limited by peripheral auditory processing mechanisms at high intensities
- Computational model simulations of cochlear mechanisms related to satisfactorily predicted behavioral scores for each individual listener as well as the average for listener group
- Some but not all of the differences in performance between NH and SNHL listeners can be accounted for by neural mechanisms in auditory periphery.

Research in Sensory Science

Issue: Developing/testing an app version of the MNREAD, a continuous-text reading acuity chart.

Question: Does the app version provide reliable data acquisition and analysis?

Gordon Legge, PhD, CLA, Psychology

Collaborator: Aurelie Calabrese

Funding: NIH R01 EY025254

165 normally-sighted subjects were tested at the Minnesota State Fair on both the printed chart and the app version of the MNREAD test.

Reading parameters assessed with the two versions of the test were compared using mixed-effect models.

The MNREAD app is easier and quicker to administer than the printed chart.

The app has several new features that make it more user-friendly: data recording, automated reading parameters estimation, data storage. Tested on a large population of normally-sighted subjects, the app gave similar results as the printed chart.

Results

All participants have reduced IND thresholds after training.

Threshold of this participant was 3.48°.

Results

Visuomotor Training Improves Proxioptive Acuity by 32%

- Perceptual Threshold: individual performance was tested using a cumulative Gaussian function. Maximal difference in the forced-choice threshold test score change was considered as the null hypothesis difference (NHD) threshold.

Visuomotor Training also improves motor precision in an untrained task by 24%