**Predicting and optimising speech perception outcomes in cochlear implantation using brain-imaging techniques**

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**Abstract**

There is substantial variability in individual speech understanding outcomes after cochlear implant (CI) implantation. In particular, CI users have been found to struggle with speech-in-noise understanding, contributing to increased difficulty in social settings. Therefore, there is a need for predicting these outcomes before implantation, assisting clinical decision making, rehabilitation and managing patients' expectations.

Loss of auditory input due to hearing loss is thought to induce cortical changes or "reorganisation" in the auditory and visual brain regions. Subsequent "restoration" of auditory input with a CI and the impact of this restoration on the reorganised brain regions has been proposed as a contributing factor to the wide variability in speech understanding outcomes. Coherence, which is a measure of similarity in activity between brain regions, has been used to quantify these cortical changes, and can be measured using functional near-infrared spectroscopy (fNIRS). A study by Fullerton et al. (2023) found that the coherence between auditory and visual brain regions in experienced CI users was correlated with improved speech-in-noise understanding. This project aims to evaluate how well the auditory–visual coherence metric predicts post-CI implantation speech-in-noise outcomes in cochlear implant candidates. For this we will need to:

1. Replicate and adapt Fullerton et al.'s study in Australia as Fullerton et al., was conducted in the UK.
   - Recruit participants: 1) 40 x typical hearing, and 2) 40 x CI candidates
   - Collect fNIRS, EEG, and speech-in-noise understanding data over three sessions (pre-implantation, 2-months and 12-months post-implantation)
2. Analyse data using statistical and machine learning methods.
3. Assess the predictive capability of coherence values found using fNIRS for speech-in-noise understanding.