Assessing Speech Processing During a fNIRS Task in Normal Hearing Listeners & Cochlear Implant Users

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Objectives

Cochlear implants (CIs) enable deaf patients to understand spoken language. However, outcomes after implantation vary considerably. There is evidence that hearing outcomes with CI correlate with plastic brain changes caused by hearing loss.

Fig. 1: Using functional near-infrared spectroscopy (fNIRS), we measure cortical brain activation during an audiovisual task. The method is non-invasive and can be performed with an active CI.

Aims of the study

• Evaluate the brain activation of individuals with normal hearing (NH) and good-performing CI users
• Clarify the role of adaptive neuroplastic changes in good-performing CI users

Methods

Participants

• 26 NH adults
• 22 good-performing CI users (monosyllables > 75%)

Multi-modal fNIRS Speech Comprehension Task [1]

• Video-version of Oldenburg Sentence Test (OLSA)
• Block design with 4 different speech modalities (Fig. 2.)
• Comprehension questions about the content

Results

fNIRS measurements during an established speech comprehension task showed distinct cortical activations [2]

(a) Temporal Region
(b) Occipital Region
(c) Behavior

Fig. 3: Grand average activation in temporal (a) and occipital (b) regions. Behavioral variables complementing fNIRS data (c).

Discussion

Good-performing CI and NH subjects show comparable temporal activity during auditory stimulations (Fig. 3a)
• Successful hearing rehabilitation in CI users
Evidence for brain plasticity
• During lipreading, CI users show focused occipital activity and further processing in speech centers (3b, 4)
The findings are reflected in the behavioral parameters (3c)

Fig. 4: Brain plasticity observed during lipreading. CI users show stronger temporal and focused occipital activity; while NH subjects show weak temporal and broad occipital activation.

References