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

Bálint A[1,2], Wimmer W[3,2], Caversaccio M[1,2] and Weder S[1,2]

[1]*Hearing Research Laboratory, ARTORG Center, University of Bern, Switzerland*
[2]*Department of ENT, Head and Neck Surgery, Bern University Hospital, Switzerland*
[3]*Technical University of Munich, TUM School of Medicine, Germany*

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

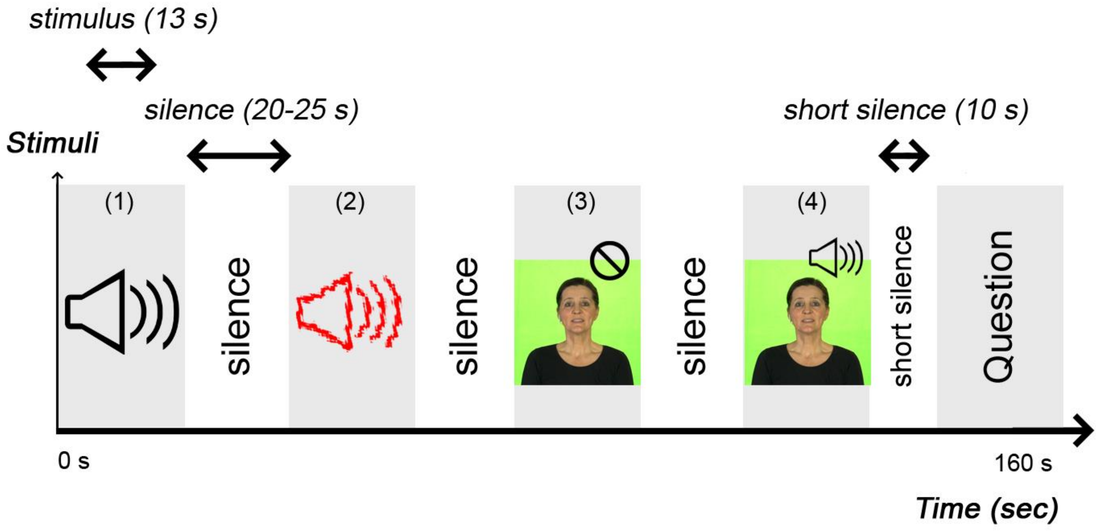

Fig. 2: We present blocks of 4 different speech modalities: Speech-in-quiet (1), Speech-in-noise (2), Visual Speech (i.e., lipreading) (3), and Audiovisual Speech (4). At random points, speech comprehension questions are asked.

Results

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

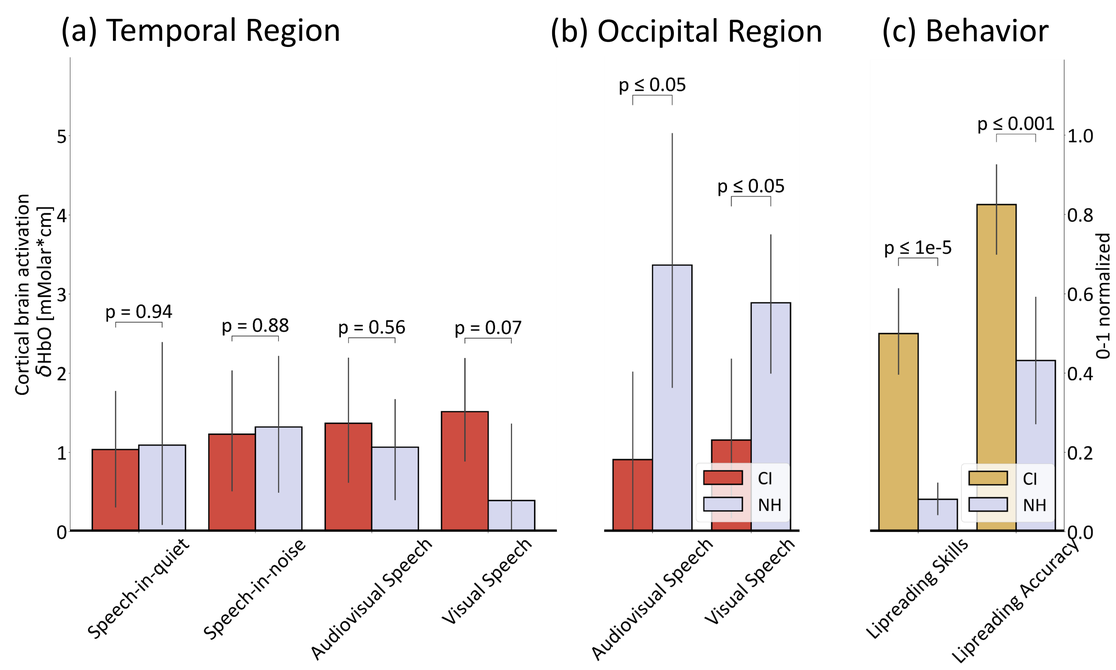

Fig. 3: Grand average activation in temporal (a) and occipital (b) regions. Behavioral variables complementing fNIRS data (c).

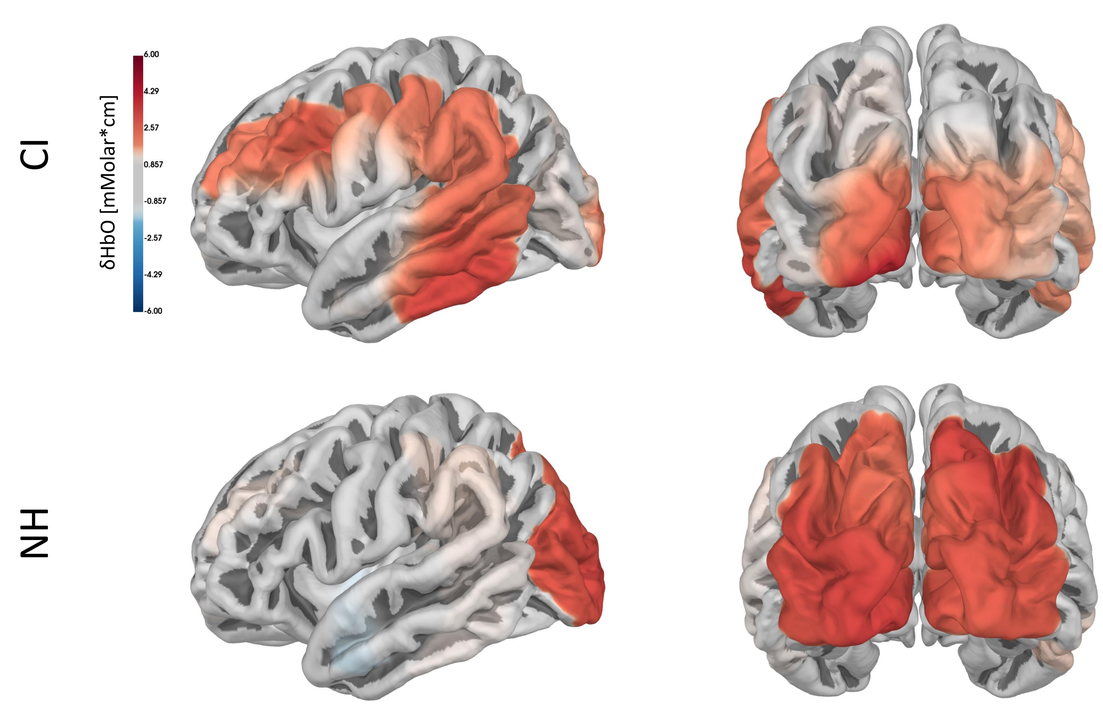

Fig. 4: Brain plasticity observed during lipreading. CI users show stronger temporal and focused occipital activity; while NH subjects show weak temporal and broad occipital activation.

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)

References

[1] Bálint A, Wimmer W, Caversaccio M, Weder S., Neural Activity during Audiovisual Speech Processing: Protocol for a Functional Neuroimaging Study. *JMIR Research Protocols,* 03/06/2022:38407
[2] Bálint A, Wimmer W, Caversaccio M, Rummel C., Weder S., Multi-modal fNIRS Speech Comprehension Task Reveals Brain Activation Patterns in Normal Hearing Adults. *Frontiers in Neurology,* (in review)

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Hearing Research Laboratory
Murtenstrasse 50
3008 Bern, Switzerland
Tel +41 31 632 7614
Mail andras.balint@unibe.ch