Elitenetzwerk Bayern

Einblicke in die Forschungsarbeit

FORSCHUNGSPROJEKT

„Restoring senses with neuroprostheses“

AUGUSTE SCHULZ

Elitestudiengang Neuroengineering

Technische Universität München, Dezember 2018

Restoring senses with neuroprostheses

Fascinated by the possibility to restore lost function in humans through neurotechnologies Auguste Schulz joined the Elite Masters Program in Neuroengineering (MSNE) at the Technical University Munich after studying physics in Heidelberg and London. She conducted a 9-week research project at the Munich School of Bio-Engineering with the Bio-Inspired Information Processing Chair investigating multipulse train integration in Cochlear Implant (CI) users. CIs allow people with severe hearing loss to perceive sound again or for the first time and are the most successful neuroprostheses restoring a human sense so far.

How are multiple pulses integrated in the auditory system?

Cochlear Implants (CIs) restore auditory perception through direct electrial stimulation of auditory nerve fibres in the cochlear.

Hearing with state of the art CIs is still far from optimal and different stimulation strategies need to be tested to improve speech perception. Temporal integration of stimulus pulses poses a natural limit to high stimulation rates. How multiple pulses are integrated in the auditory system and hence how high the stimulation rates could be is yet unknown.

To address this question Auguste together with a PhD student in the lab combined psychophysics with instrumental measurements using electrically evoked auditory brain stem responses (eABR) in postlingually deafened CI users to investigate the effect of multipulse train integration.

One stimulation epoch consisted of varying numbers of pulses that were closely following one another so that they were perceived as a single sound. This stimulation approach is different from standard eABR measurements as mostly single pulse trains are used. It hence bridges the gap between standard eABR measurements to the more natural situation where the implanted electrodes receive amplitude modulated high frequency signals.

Can we infer the ideal stimulation range using eABR?

How strong the stimulation should be to percieve sound differs a lot from subject to subject. The adequate strength needs to be adjusted in a CI fitting process to avoid painful loudness or no perception at all when using the CI.

The threshold level and the maximum comfortable level are commonly determined through psychophysics experiments that require feedback of the subjects.

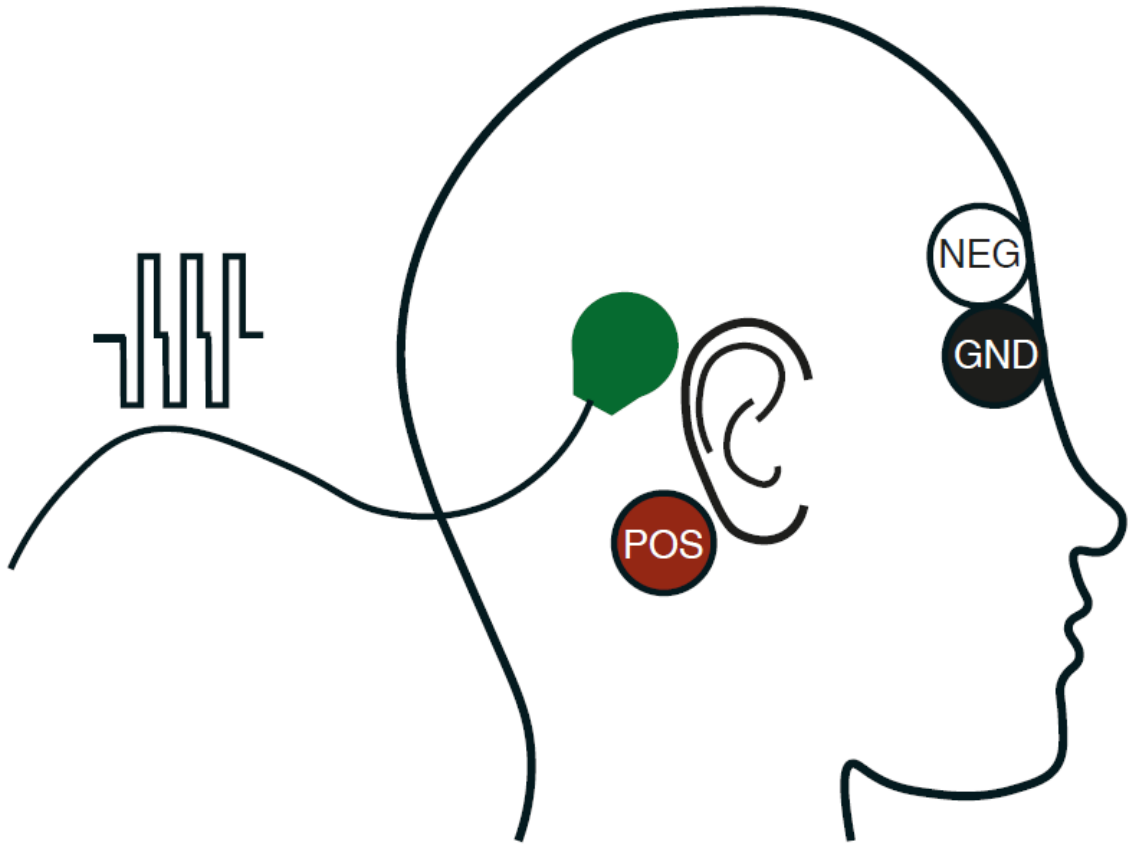
Feedback is not required in eABR measurements that can be used for diagnostic measures as one can infer the auditory nerve fiber activity in response to electrical stimulation. This is done via ectrocencephalography (EEG) recordings with three electrodes as depicted in the figure. These measurement can be done even with small infants unable to respond which is in fact the largest group of new implant receivers.

Another aspect that was adressed in this study was therefore if eABR data can be used to infer the threshold to identify the ideal stimulation range even for subjects that cannot participate in psychophysics experiments.

How do neurotechnologies affect our society?

Working with CI users inspired Auguste to pick up on this topic in her final essay of the MSNE course “Societal Impacts and Ethics” which addresses the relation between neuroengineering and society.

In the case of CIs the societal aspect is particularily important as a ‘Deaf culture’ exists with own languages, traditions and values. The development of the CI is often regarded as a threat to said culture and has led to a heated controversy, often referred to as the Cochlear Implant Debate which is useful to be aware of as a researcher in this field.



The figure depicts the eABR measurement set-up with the placement of the three recording electrodes and the Cochlear-Implant stimulation coil (green).

Elite Graduate Program „Neuroengineering“:

https:// www.msne.ei.tum.de/en/home/

More information:

https:// www.researchgate.net/publication/328477455_Electrically--Evoked_Auditory_Brainstem_Responses_to_Multi--Pulse_Train_Stimulations