MO39. Cochlear Implant Sound Coding Using a Model of the Auditory Nerve

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Category: Auditory Prostheses

Background: Cochlear implants can restore speech understanding in quiet, but the average performance is still below that of normal hearing subjects and decreases rapidly with background noise. Most commercial and research speech coding strategies focus on encoding and potentially enhancing features from frequency bands, primarily the temporal envelope. The improvements in speech understanding that can be achieved with various modifications of such strategies have been found to be small and inconsistent. Seeber and Li (2022, proceedings of the ISH) proposed a new way of speech coding: a neural-model based sound coding approach which starts with a desired neural response and tries to approximate this response by altering the stimulation. The connection between stimulation pulses and neural response is made with a model of the electrically stimulated auditory nerve. The difficulty is the reversed operation: the output is known but the input is unknown. Seeber and Li demonstrated a proof of concept with a single neuron and one possible stimulation electrode. We present an extension of this approach that is able to derive a multi-electrode stimulation sequence that approximates the desired target neurogram.

Methods: Like Seeber and Li, we used the model by Takanen and Seeber (2022, Trends in Hearing) of a single electrically stimulated auditory neuron which is able to accurately model adaptation, facilitation, and refractoriness. In a first step, we extended the model to simulate multiple neurons stimulated by multiple electrodes using exponentially decaying current spread. The proposed algorithm then optimizes the electric pulse positions and amplitudes such that the neurogram is met as closely as possible. The amplitudes of all possible pulse positions over time are regarded separately in sequential order, while the pulses at different electrodes are optimized simultaneously. The algorithm was constrained such that the pulses at different electrodes do not overlap. Before the final placement of an electric pulse, it was tested if placing it in a later position would not be more beneficial. To develop, study, improve, and validate the algorithm, target neurograms were created by various means, for example, using continuous interleaved sampling together with the multi-neuron model.

Results: The algorithm was able to create an electrodogram resulting in a neurogram which closely approximates the target neurogram. Due to the many degrees of freedom and the non-linearity in the neural model, the electrodogram can differ from the original one.

Conclusions: We propose an algorithm creating an electrodogram such that a target neurogram is approximated by a model. If future studies show an improvement in speech understanding with these electrodograms, it can form the basis for the development of future cochlear implant coding strategies.

Support: ERC Starting Grant No. 716800 to M.D.