DONDERS INSTITUTE

Project title: Characterization of auditory performance using EEG

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Donders Theme: 2 (Perception, Action and Control)

Research centre: DCN-FNWI

Project description: The goal of this project is to find optimal stimuli to characterize individual monaural and binaural auditory performance using Auditory Steady State Response (ASSR) measurements. This characterization, the auditory equivalent of a fingerprint, is important for the fitting (finding the optimal settings) of hearing aids and cochlear implants. The project includes a theoretical and an experimental part.

In the theoretical part you will work with two existing monaural models (Zilany and Verhulst) to predict the response of the auditory nerve, cochlear nuclei and inferior colliculus on different ASSR stimuli. The models allow simulation of different types of hearing impairment. The auditory system is highly nonlinear. A stimulus consisting of only two pure sines will result in an output containing a multitude of frequencies, for example the difference of the two input frequencies, the "beat". This makes it possible to characterize not only the low frequency, but also the middle and high frequency part of the auditory system, which would be impossible with EEG in case of a linear system, since EEG can't register high frequencies. In addition to modelling, you can use the results of two sets of ASSR measurements, performed recently in the Biophysics department. These experiments presented combinations of sines (so called "beat" stimuli) and amplitude modulated (AM) stimuli in the frequency range of 400-1000Hz, 25 subjects were measured. The outcome of this theoretical part is a selection of stimuli that are 1) suitable to test a large frequency range, 2) sensitive to hearing impairments and 3) expected to give a significant response within measurement times of maximal 20 minutes.

In the experimental part you will perform EEG measurements to determine the efficacy of ASSR measurements using the chosen stimuli. If time allows, you can compare the predictions of the models with the outcome. This is important for improvement of the models and for the development of models of the binaural cortical response.

We expect from you:

1) Experience with Matlab: understand the working of existing scripts and implement extensions.
2) Experience with EEG measurements and FieldTrip is a plus. After a training period you will perform the EEG measurements independently.

Relevant literature: Computational modeling of the human auditory periphery - Auditory nerve, evoked potentials - hearing loss. Sarah Verhulst, Alessandro Alto, Viacheslav Vasilkov 2018. Hearing Research 360 55-75. Model 2018 v1.1: https://www.waves.intec.ugent.be/hearing-technology

A phenomenological model of the synapse between the inner hair cell and auditory nerve: Implications of limited neurotransmitter release sites. Ian C. Bruce, Yousof Erfani., Muhammad S.A. Zilany 2018. Hearing Research 360:40–54.

Human auditory steady-state responses. Terence W. Picton, M. Sasha John, Andrew Dimitrijevic & David Purcell 2003. Int. Journal of Audiology Volume 42, 2003

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