Project title: Listening to Complex Sounds

Project: Ongoing non-project based study in the field of psychoacoustics, Hearing Research, Audiology

Project description

Natural sounds consist of joint spectral and temporal modulations, and the human auditory system is tuned to such dynamically changing complex sounds. Conventional procedures to quantify hearing sensitivity ignore these sound modulations and instead focus on audibility of a small number of unmodulated, discrete frequencies. This focus prevents the diagnosis of speech-recognition impairment and central auditory processing disorder. These two severely disabling problems affect people such as children with attention, language and learning difficulties (3%–5% of school-aged children are affected by auditory processing disorder) and hearing-impaired individuals receiving cochlear implants (~30% are unable to understand speech). In this internship, we will study how sensitive we are to spectrotemporal modulations of sounds.

In one subproject of this research line, we aim to characterize the spectrotemporal modulation transfer function (i.e., modulation sensitivity) through reaction times. we try to identify how reaction times are affected by the parameters of a sound's modulation (modulation frequency, density and depth). We hypothesize that reaction times are generated according to the LATER model. If this hypothesis is true, we predict that the mean of reaction times will systematically shift depending on modulation frequency and density at high modulation depths, while the standard deviation will increase for near-threshold modulation depths.

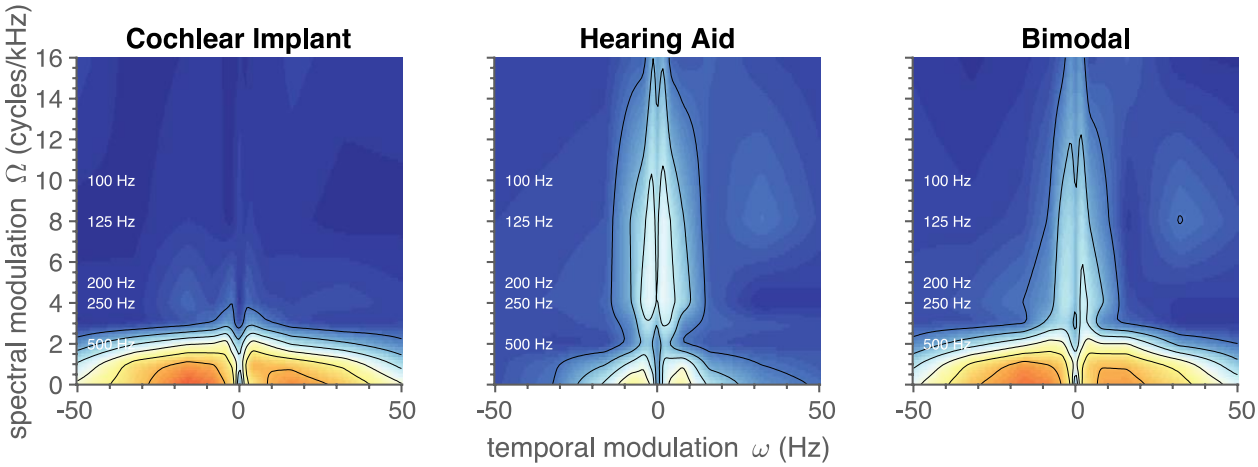

Figure 1. Spectrotemporal Modulation Sensitivity. Transfer function determined by reaction times for simulated hearing impairment.

Project Alternatives

- Monaural vs binaural race models
- Simulated hearing impairment
- *Clinically oriented (Medical Biology, Biomedical Sciences)*: listeners using hearing aids, cochlear implants and bimodal cochlear implant users (in collaboration with the Otorhinolaryngology department of the Radboudumc)

- *Modelling oriented (Physics or AI)*: Modelling reaction times to spectrotemporal modulations (e.g., LATER, race, Bayesian inference)
- *Modelling oriented (Information and Computing Sciences)*: developing a fast, continuous estimation of spectrotemporal modulation sensitivity (e.g., using Gaussian Processes)
- *Thesis/Article Review:* How is sensitivity to spectrotemporal modulations related to speech/vocalization perception?

Key words
Humans | Sound | Dynamic Ripple | Hearing | Auditory System | Reaction Time | Psychophysics | Psychoacoustics | Perception | Binaural | Monaural | Spectrotemporal Modulations

Relevant literature

- Van Wanrooij, M. M. & Van Opstal, A.J. (2022). *Reaction Time Sensitivity to Spectrotemporal Modulations of Sound*. https://doi.org/10.1177/23312165221127589
- Noorani, I., & Carpenter, R. H. S. (2016). The LATER model of reaction time and decision. *Neuroscience & Biobehavioral Reviews*, *64*, 229–251. https://doi.org/10.1016/J.NEUBIOREV.2016.02.018

Tasks & skills

You will become familiar with psychophysics and psychoacoustics. At the end of this internship, you will be able to:

- Design and develop acoustic reaction time tasks in state-of-the art sensorimotor labs
- Measure reaction times
- Analyze data in Matlab and quantify auditory behavior (through regression, generalized linear models)
- Write a report in the form of an academic paper (IMRaD)

Background

Master Cognitive Neuroscience: Perception and action track
Biology/Sciences/Physics: Psychophysics I and II, Neurobiophysics, Neural Basis of Cognition and Perception, The Auditory System

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