Project title: Localizing sounds with one ear

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

Donders Institute Theme: Perception, Action and Control

Project description

We can localize sounds near-perfectly. In fact, the acuity of human spatial hearing is excellent and belongs to the best in the animal kingdom. This feat is achieved by the non-trivial and nonlinear neural processing of implicit spatial cues hidden in the spectrotemporal information that is picked up by both our ears. When listening with two normal-hearing ears (binaural), the perceived location of a sound is derived from the interaural level and intensity differences and from the spectral pinna (ear shape) cues. Crucially, based on first principles, we know that we can only accurately and unambiguously localize sounds when we can listen with two ears. Therefore surprisingly, some individuals are seemingly able to localize sounds with only one ear! In this internship, we will study how we localize sounds with only one ear (monaural hearing).

In one subproject of this research line, we will have normal-hearing listeners wear a plug in one ear and test their sound localization behaviour acutely. By plugging one ear we will perturb and distort the binaural cues in a level-dependent and location-dependent manner. We hypothesize that the auditory system combines all sound localization cues in an optimal fashion and that weighting of the cues can be immediate. If this hypothesis is true, we predict that localization with one ear will be better for low-level sounds on the side of the unplugged ear than for high-level sounds on the plugged ear side.

Figure 1. The Sphere. One of the sound-localization labs.

Project Alternatives

- Adaptation to a plugged ear
- Audiovisual integration in monaural listening
- *Clinically oriented (Medical Biology, Biomedical Sciences)*: Sound localization by single-sided deaf, listeners with asymmetric hearing impairment, and bimodal cochlear implant users (in collaboration with the Otorhinolaryngology department of the Radboudumc)
- *Modelling oriented (Physics or AI)*: Modelling binaural and monaural sound localization (e.g., Bayesian Inference)

Key words
Humans | Head Movements | Monaural | Binaural | Sound Localization | Spatial Hearing | Auditory System | Interaural Time and Level Differences | Spectral Pinna Cues | Psychophysics | Psychoacoustics | Perception

Relevant literature

- Van Wanrooij, M. M., & Van Opstal, A. J. (2007). Sound localization under perturbed binaural hearing. *Journal of Neurophysiology*, *97*(1), 715–726. https://doi.org/10.1152/jn.00260.2006
- Van Wanrooij, M. M. & Van Opstal, A. J. (2004). Contribution of Head Shadow and Pinna Cues to Chronic Monaural Sound Localization. *Journal of Neuroscience*, *24*(17), 4163–4171. https://doi.org/10.1523/JNEUROSCI.0048-04.2004

Tasks & skills

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

- Design and develop sound-localization tasks in state-of-the art sensorimotor labs (Fig. 1).
- Measure (eye and) head movements (with the search coil technique or with eye trackers and inertial measuring units)
- Analyze data in Matlab and quantify sound localization 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

Supervisor: dr. Marc M. van Wanrooij

Principal investigator: dr. Marc M. van Wanrooij

Collaborating Researchers: dr. Nathan van der Stoep (Helmholz Institute, Utrecht University), Nina Haukes, Msc.

More information: marc.vanwanrooij@donders.ru.nl

Internship Site: Radboud University, Donders Center for Neuroscience, Huygens building (HG00.1xx, ground floor, wing 1)