How does the brain process sound? Computational modelling as a tool for fundamental research

Nina Härtwich
Research Group Comparative Neuroscience
Leibniz Institute for Neurobiology
Magdeburg, Germany

31 January 2023

Abstract

Auditory information processing starts in the ear, where sound wave vibrations are amplified and then transduced into neuronal signals. The structure and function of this first "station" along the auditory processing pathway is well understood. So well, in fact, that the development of neural prostheses that can replace the human ear in case of malfunction was possible. These prostheses, called cochlear implants (CIs), have been commercially available for several decades already.

In contrast, the structure and function of the human auditory cortex (AC), the first higher order processing station along the auditory pathway, remains elusive. This is, in part, due to the fact that invasive approaches to study the healthy human brain are unethical and thus forbidden. Only non-invasive measurement techniques, such as magnetoencephalography (MEG) and electroencephalography (EEG), are available. The signals measured with these techniques reflect the summed activity of millions of neurons across the entire AC. This makes their interpretation, in terms of the underlying neuronal events, quite difficult. A tool that can help to access these neuronal events, and thus to explain and even predict empirically measured signals, is computational modelling.

In my talk, I will first briefly introduce the structure and function of the human ear in order to explain the functionality of the classic electrical CI as well as an exciting new type of neural prosthesis, the optical CI. Next, I will move up the auditory pathway towards the brain to describe and explain the computational model that we have created in order to gain new knowledge about the structure and function of the human AC. I will conclude the talk by showing examples of new research findings about the AC that we achieved by employing this computational model.

About the presenter

I am a PhD student at the Leibniz Institute for Neurobiology with a background in both Physics and Neuroscience. My project aims to further our understanding of auditory processing in the brain through a combination of computational modelling and the analysis of both non-invasively and invasively recorded data from the auditory cortex of humans and animals.