Timing is essential — Fundamentals of magnetoencephalography

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Abstract

A thrilling scene in a western often features a cowboy resting next to his fire, suddenly startling at the crack of a nearby twig. Is this plain fiction, or could it have a real background? In this lecture, we do not intend to further pursue the fate of the cowboy, but instead have a look at some imaging techniques that may bring us closer to an understanding that underlies the cowboy's reaction at the fireplace. We will present some basic principles of magnetoencephalography (MEG), an advanced neuroimaging technique that enables tracking brain activation with a superior temporal resolution of milliseconds — a quintessential condition for the monitoring of brain dynamics and the understanding of information processing in the human brain (and for shooing away an intruder). The central features of MEG will briefly be addressed in comparison to other neuroimaging techniques such as electroencephalography and functional magnetic resonance imaging. We will focus on the methodological foundations of MEG, with an emphasis on the extremely tiny magnetic fields of the brain, whose acquisition requires, for example, the application of such a sublime phenomenon as low-temperature superconductivity, and which can only be interpreted properly using certain signal-processing tricks to unveil the signal of interest (the breaking of the twig) from a noisy environment (the crackling of the fire).

About the presenters

Reinhard König received the Ph.D. degree and the habilitation degree in experimental physics from the Department of Physics, University of Bayreuth, Germany in 1993 and 2000, respectively. Since 2002, he has been working at the Leibniz Institute for Neurobiology in Magdeburg, Germany, where he is now co-head of the newly formed Research Group Comparative Neuroscience. Recently, his group has established a computational model of auditory cortex (AC) dynamics, which is allowing them to investigate, in a cross-species approach, neuronal mechanisms underlying auditory short-term memory by integrating results across spatial levels of AC activity.

Cezary Sielużycki received the Ph.D. degree in biocybernetics and biomedical engineering from the Faculty of Mechatronics, Warsaw University of Technology, Poland in 2003 and the habilitation degree in biocybernetics and biomedical engineering from the Faculty of Automatic Control, Electronics and Computer Science, Silesian University of Technology, Poland in 2019. Since 2016, he is with the Department of Biomedical Engineering at the Wrocław University of Science and Technology. His research interests include biomedical signal processing with emphasis on neuroscience studied with magnetoencephalography.