Doctoral School of Information and Biomedical Technologies Polish Academy of Sciences

Subject

Neurovascular coupling: new understanding based on deep brain recordings in freely moving animals and modeling.

Supervisors, contact, place of research

dr hab. Tiaza Bem (tiaza.bem@ibib.waw.pl)_ tel. 226599143 w. 413, IBIB PAN, Trojdena 4
dr hab. Jan Karbowski (jkarbowski@mimuw.edu.pl) , tel. 226599143 w. 408, IBIB PAN, Trojdena 4

Project Description

The two main neuroimaging methods of investigation of human brain functions such as functional magnetic resonance imaging (fMRI) and functional near-infrared spectroscopy (fNIRS) are based on hemodynamic response to the neuronal activity of the brain, so called blood-oxygen-leveldependent (BOLD) signal. The BOLD signal reflects the changes in concentration of deoxygenated hemoglobin in the brain and is related to changes of blood flow and blood vessels volume due to ongoing neuronal activity. Whereas a large body of evidence at cellular and molecular levels indicate that neuronal activity and hemodynamic signals are closely related, the spatial and temporal relationship between hemodynamic response and the underlying activity of the working brain remain still elusive since the signal is only indirectly related to the neural activity [1].

The purpose of this project is to develop a new understanding of relationships between the neuronal activity (spiking (multi-units activity, MUA), as well as excitation and inhibition of populations of neurons (local field potential, LFP) with changes of the hemodynamics within a very small volume of the brain where this activity is generated. For this aim simultaneous recordings of NIRS and electrophysiological signals will be performed using implanted system of tetrodes and optodes placed in a small volume of the brain (< 1 mm^3).. We demonstrated in the pilot study that NIRS system operating on implanted optodes in hippocampus is useful in imaging hemodynamic response to acoustic stimulation. Interesingly moreover, during generation of so called “sharp wave ripples” – hippocampal oscillations crucially involved in memory processing - a striking stabilization of NIRS signal occurs – a phenomenon not predicted by existing models of neurovascular coupling. This effect may be explained by an effect of neuromodulation, a non-linear interaction of slow- and high-freguency oscillations in the neural network or changes of optical properties of the brain tissue. This will be further studied and extended in a modeling approach within the framework of this proposal. Collaboration with Bordeaux University.

Bibliography

1. Logothetis N. What we can do and what we cannot do with fMRI. Nature 453, 869-878 (2008) Review.

updated: June 7, 2019