Project 1.10. Neuronal mechanisms of working memory: a combined single-neuron and network-level approach in humans.

Supervisor: dr hab. Aneta Brzezicka/dr Jan Kamiński

Laboratory: BrainCity

Background:

Every time when we think, make a decision, add digits in the mind or even when we put new phone number to our smartphones, we used cognitive capacity called Working Memory. Working Memory is a capacity to hold and manipulate a small chunk of information in our minds. Our intellect is based on this "thinking stage ground". Surprisingly we know very little how our neuronal networks inside our, human, brains make it happened. This is because direct recordings of neurons in human brain is very difficult. It is possible only during treatment of different disseises when we need to put in to human brain because of clinical reasons. This project will take advantage of unique opportunity to directly record activity of human neurons during procedure of implantation Deep Brain Stimulation electrode to help people with a variety of conditions. We will record neuronal activity directly from Frontal Cortex, in area called Dorsolateral Prefrontal Cortex and from the nucleus located deep inside the brain called Substantia Nigra. Both areas play key function in Working Memory. This project for the first time will characterize activity of neurons in these areas when subjects perform tasks using Working Memory.

Aim:

In the project, we plan to test a hypothesis that information currently held in our minds – thoughts - is represented by activity of specific cells which are also responding when we see given concept. It was showed that this mechanism is observed in animals, but we do not know if similar phenomena is also observed in human brain? Moreover, we will also probe function of neuromodulator called dopamine in Working Memory. It is thought that dopamine can act as a gating mechanism protecting content of Working Memory from distraction. Substantia Nigra is a key nucleus producing dopamine in the brain. During the research, we will record from this nucleus and ask subjects to memorize images for few seconds during which they face distractors. Additionally, we use weak electrical stimulation to test if disturbing local activity of dopaminergic cell will impact our ability to face distractors. Finally, we will also test what is the relation between activity of neurons and brain oscillation during Working Memory. Brain oscillation are one of the most prominent feature of brain electrical activity but relationship between activity of neurons and ongoing oscillation is not well understood. The result of this project will give us much better understanding of neuronal mechanism supporting Working Memory. This will inspire new ideas for treatments of many neurological and

psychiatric diseases like ADHD, Schizophrenia or Depression as they are characterized by WM disturbance and abnormalities in the DLPFC and the dopaminergic system.

Requirements:

- Master thesis

- exceptional motivation for the scientific research

- proficiency in English and Polish (research with Polish speaking subjects)

- motivation to work in a neurosurgical environment

- ability to travel to Bydgoszcz where research is performed

- knowledge of neuronal basis of working memory

Additional

- experience in working in a neurosurgical environment

- knowledge of statistics and data analysis

- experience in human research