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

- popular science description

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 use a cognitive ability called Working Memory (WM). Working Memory is a capacity to hold and manipulate a small chunk of information in the minds. Our intellect is based on this "thinking stage ground". Surprisingly we know very little how neuronal networks inside our, human, brains make it happened. This is because direct recording of neuronal activity in the human brain is very difficult. It is possible only during treatment of different diseases when we need to put an electrode to the human brain because of clinical reasons.

This project will take advantage of such a 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 (DLPFC)* 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 requiring Working Memory.

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 a given concept. It was showed that this mechanism is observed in animals, but we do not know if similar phenomena is also observed in the 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 will use weak electrical stimulation to test if disturbing local activity of dopaminergic cells will impact the ability to face distractors.

Finally, we will also test what is the relation between activity of neurons and brain oscillations during Working Memory. Brain oscillations 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 results 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.