The human brain is the most complex and remarkable organ of the body that builds itself by adapting to the surrounding world. It contains over ca. 86 billion nerve cells that have the unique capacity to communicate with each other through highly specialized contacts, called synapses. These synapses connect brain areas responsible for different functions – those basic like sight, hearing, touch, speech and those more complex like understanding of speech, feelings, future planning or memories – both positive and negative. This enormous degree of connectivity is what makes the brain so exceptional. The brain responds to the surrounding world by integrating information from those different structures. This way it defines our behavior and personality. Such integration is based on two key processes – forming new connections and strengthening or weakening of existing ones.

Those connections – synapses – will be subjects of our study. In particular, we would like to understand where in the brain and how memories are formed. Those positive ones, associated with pleasant emotions. Which synapses of which neurons are crucial in memory formation? Nowadays neurobiologists made huge progress investigating memory formation processes. We can now point, which brain structures play key roles in learning. Nonetheless, the exact way of interactions between them still remains elusive.

In our project we plan to use a clever tool, which labels memory-activated neurons in order to be seen under the microscope. This tool will be a transgenic rat, created in The Nencki Institute. This rat possess an additional gene coding a green fluorescent protein. This gene gets expressed specifically in cells which were activated by increased synaptic signaling – learning. We will focus on a brain structure responsible for receiving information about positive memories – the amygdala. The positive memory we will elicit in our rats is a memory of receiving a food reward.

Additionally, using viruses (inactive, specifically created) we will deliver this green fluorescent protein gene into brain structures that send out connections towards the amygdala. This way we will be able to observe brain pathways that create memory traces.

Lastly, all mentioned elements – cells of the amygdala and projections that activate them will be tested using electrodes. This way we will have a direct access to measure how did the synapse change after formation of a memory.

This research will help to narrow down the cellular localization of positive memories. Moreover, careful characterization of brain connections involved in positive memory formation will provide potential therapeutic targets for neuropsychiatric disorders, such as addiction.