Brain plasticity – the ability to constantly adapt to the surrounding world, memorize, forget, and fine-tune skills – is one of the most fascinating and still not fully explored phenomena of nature. All our memories, abilities, and even feelings are stored in form of synaptic contacts between brain cells. The human brain creates 10^{15} synapses that are constantly re-shaped, strengthened, weakened, or pruned altogether. Among these highly active connections, there is a group of synapses that do not participate in basal synaptic transmission. They are called “silent” because at resting state they do not generate any signal.

Their exceptional nature, however, lies in the ability to be “awakened” when needed and become fully functional. During periods of increased activity, such as learning new skills, memorizing events, and exploring new places, they begin to participate in the strengthening of the synaptic connection. Therefore, the presence of silent synapses in the brain represents its capacity to learn new things.

Silent synapses are very common in juvenile brains, but their number declines to very little in adulthood. Their function during development is to ensure the brain’s learning capacity, by providing sites to establish new functional synapses in rapidly rewiring circuits. Nonetheless, silent synapses function does not end in early life. The research on drug addiction – which is conceptualized as a particularly strong form of memory – shows that silent synapses transiently reappear during addiction-related learning. These silent synapses, once matured into fully functional contacts contribute to the development of addiction. Yet the full understanding of silent synapse function in the adult brain is still missing.

This project aims to explain the role of silent synapses in learning. We hypothesize that their induction is universal to the majority of learning paradigms in general, not restricted only to early development and drug addiction. We will therefore focus on appetitive learning (creating positive memories), by giving various rewards to adult laboratory mice. We will study the formation of silent synapses in the amygdala – a brain structure pivotal for making positive and negative associations. We will decipher the cellular mechanism of silent synapse induction. Moreover, we will test the hypothesis, of whether the enrichment in silent synapses will enhance learning.

This project aims on expanding our understanding of the fundamentals of brain plasticity. It seeks to bridge the knowledge gap between the phenomenon of silent synapse existence in adult brains and their actual function in learning.