Memory impairment is a hallmark of cognitive deficits experienced at some point in life in one-third of our aging population. Memory impairments can be a comorbidity of neurodegenerative, neuropsychiatric or neurodevelopmental diseases, brain injury, systemic illness, and medication to any of those. They are observed even in the healthy aging population. Hence, there is an urgent need to develop new, reliable strategies and approaches for the treatment of memory deficits. Among all the available approaches, new neurotechnologies based on direct interfacing with the brain using implantable electronic devices for electrical stimulation emerge as promising tools. The communication between brain cells (neurons) is primarily based on the transmission of electrical pulses between them. Therefore, direct electrical stimulation in specific brain regions implanted with intracranial electrodes has been successfully used to improve memory functions. The reproducibility of such positive effects, however, is compromised by limited insight into the underlying physiological mechanisms. Along with new technologies, new target brain sites with a greater potential for modulation of declarative memory functions are being proposed. One of them is the part of the thalamus called anterior thalamus, a central component of the neural circuit responsible for certain aspects of learning and memory. Damage to either of two brain regions, the medial temporal lobe or the medial and anterior thalamus, is most consistently associated with anterograde amnesia. Within these respective circuits, the hippocampal formation and the anterior thalamus, but also prefrontal cortex, are the particular structures of interest. In this project, we propose to study the basic electrophysiological mechanisms of electrical stimulation of anterior thalamus on the physiology of hippocampal and prefrontal circuitry and behavior in freely moving rats. First, we propose to test how different stimulating currents and stimulation frequencies applied in anterior thalamus affect firing of hippocampal and prefrontal neurons and their communication at single-cell and network levels when rat is resting. In parallel, we will check how continuous stimulation of anterior thalamus affects the activity of hippocampal and thalamic place cells (neurons that fire whenever animal is in a particular location in the environment), and prefrontal neurons during a foraging task and rest, when place cells spontaneously ‘replay’ past trajectories. In addition, we will evaluate the network activity and hippocampal-prefrontal neuronal communication. To our knowledge, the effects of electrical stimulation of anterior thalamus on the physiology of place cells remain unexplored. Finally, we propose a behavioral task designed to verify if electrical stimulation of anterior thalamus at selected current frequencies can improve spatial memory performance. The task is based in an open field arena equipped with a reward dispensing area and nine equally-spaced buttons, which a rat can easily press with a fraction of its body weight. Rats will need to learn and memorize the location and sequence of switches to get reward. We will keep rats at a stable success rate by individually adjusting task difficulty. This will allow us to track both positive and negative changes in spatial memory performance in response to stimulation (the effects can be bidirectional and depend on stimulation current parameters). We expect the results of this project to advance our understanding of the mechanisms underlying the effects of anterior thalamus electrical stimulation and provide stimulation parameters with the highest potential to improve memory performance. The proposed project can directly benefit and be translated into the clinical studies with human patients led by Dr. Michal Kucewicz at the Gdansk University of Technology.