The capacity to remember the distinctive features of the surrounding environment and the ability to effectively utilize this knowledge is one of the natural life functions in most animals. In mammals, this ability depends on the proper functioning of a number of brain structures, among which the hippocampus plays a central role. Until recently, the hippocampus was considered the central unit for processing information and creating a mental map of the surrounding space. Recent studies in animal models suggest that it may not be the only structure storing information crucial for spatial orientation. Other brain areas may also contain specific maps of spatial relationships and utilize them during navigation, effectively replacing the 'main' one. We have managed to preliminarily identify a fragment of the cerebral cortex (retrosplenial cortex) showing properties similar to the hippocampus. The occurrence of such a phenomenon raises a number of interesting scientific questions. The answers to these questions could change the way we perceive the world.

First and foremost, we are interested in the issue of the mutual independence of these two structures. Is the spatial map created in the retrosplenial cortex dependent on the hippocampus? Does the hippocampus 'authorize' and control its creation, or is it an independent 'project' of our brain? So far, experiments and observations have allowed us to conclude that it is possible to create an independent representation in the retrosplenial cortex because there are neural connections leading directly to it from sensory areas. Interestingly, the hippocampus has the ability to block it directly when it detects 'insubordination,' i.e., inconsistency with its own map, but there is no such possibility in the reverse case.

The experiments we propose will aim to investigate whether the same type of spatial information is collected in both 'competitive' centers responsible for the spatial map. For this purpose, we will use the mouse model in which most of the previous observations have been made. The mice will be trained in a special maze to learn to respond to various spatial cues and find a sweet reward based on them. These cues can be complex (such as an arrangement of glowing LED tiles) or very simple (a fluorescent bulb or strip). Before starting the experiment, we will introduce small 'windows' into their brains, and during its course, we will be able to look inside and see what the molecular pattern of memory traces looks like. This is a painless process and is not harmful or even noticeable to the mice. Thanks to this, we will see which cues have the greatest impact on memory traces in both the hippocampus and the retrosplenial cortex. In the next stage, we will introduce a very thin electrode into the window, allowing the recording of the activity of individual nerve cells. We will try to determine whether the molecular memory trace is encoded by specialized neurons that respond to the animal's head direction or its position in the maze.

The results of our research will expand the knowledge of how we perceive the external world. They may have applications in professional training in occupations where efficient segregation of spatial cues and quick response to them is essential (pilots, operators of unmanned aircraft). They will facilitate the ergonomic design of cities, buildings, and transportation networks. Importantly, they may be relevant to the prevention and therapy of neurodegenerative diseases such as Alzheimer's disease. The existence of two independent memory traces gives hope that certain deficits can be reversed by transferring information between brain centers or by strengthening one of them unaffected by the disease. However, to effectively plan such therapies, we need to better understand the basics of spatial memory function. This is the exact focus of our project.