Abstract

In real world environments, animals need to organize their behavior relative to other moving animals or objects; when hunting a predator, when migrating in groups or during various social interactions. In all of these situations, the animal needs to orient relative to another moving animal/object. To understand the role of the hippocampus in this ability we adopted a two-step approach. We developed a task that would mimic important elements of this behavior in the laboratory. The task required the rats to assess not only their distance from the moving object but also their position relative to the object. We further studied how neurons in the hippocampal CA1 subfield encode the subject, the moving object and the environment in the behavioral paradigm and how do these representations interact among themselves.

In rats, we aimed to characterize spatial behaviors relative to moving objects and to explore the cognitive mechanisms controlling these behaviors. Three groups of animals were trained to avoid a mild foot-shock delivered in one of three positions: either in front, on the left side, or the right side of a moving robot. Using different variations of the task, we also probed whether avoidance was simply due to increased noise level or size of the retinal image or appearance of the robot.

As the hippocampus is believed to be the anatomical site combining what and where information about an experience. It has been hypothesized that what and where information reaches the hippocampus primarily via lateral entorhinal cortex (LEC) and medial entorhinal cortex (MEC), respectively (Hargreaves et al., 2005). It is also known that the distal region of the hippocampal CA1 subfield primarily receives direct inputs from LEC and the proximal region receives input from MEC (Witter et al., 2000). We thus hypothesized that input about what part of our behavioral paradigm, in this case, the moving robot, should be represented in the distal CA1. We, therefore, targeted our electrodes to this area in the hippocampus.

The main conclusions from these experiments are as follows:

1) Rats recognize geometrical spatial relationships relative to a moving object. We found that rats can learn to avoid the front or either side of a moving object.

2) This ability is not solely dependent upon retinal size, noise levels, or prominent visual marks on the object. By using an all-white version of the moving robot we observed that rats can perform similarly as with the black and white moving object.

3) Electrophysiology recording from trained and untrained rats indicated that the animal represented both the position of the rat in the room as well as a spatial relationship between the rat and robot, we observed different responses in the recorded cells. However, they did not cluster into different classes of cells.

4) Analysis of spatial parameters, like coherence and spatial information suggested subtle differences between spatial activity in trained and untrained rats.