NEUROPHYSIOLOGICAL CORRELATES OF SPATIAL MEMORY — 2014 NOBEL PRIZE IN PHYSIOLOGY OR MEDICINE

Summary

The ability to recognize and remember the features of external environment and to utilize this knowledge is one of the most fascinating adaptive features in the animal kingdom. This phenomenon is commonly referred to as spatial memory. The development of such capability is fueled by evolutionary progress in the complexity of brain structure and function. This includes the emergence of specialized brain structures responsible for all aspects of spatial memory. In mammals the central structure involved in spatial memory is the hippocampus. This structure is believed to be responsible for indexing and retrieval of memory traces that form a coherent three dimensional spatial representation (cognitive map). It also orchestrates processes such as differentiating or finding common features between similar yet distinct contexts. Hippocampus harbors the place cells: neurons that respond to a particular location in the environment by firing action potentials. The entorhinal cortex is anatomically positioned as a gateway to the hippocampal formation. It gathers information from other brain areas and feeds it to hippocampus. In the medial part of entorhinal cortex several types of spatially modulated neurons can be found. The grid cells fire at the nodes of a hexagonal pattern as the animal traverses the environment, creating a lattice that can serve as metric for the generation of place fields. Border cells react to the physical boundaries of the environment, firing at the edge of impassable walls. The head direction cells react to the changes in the head position, firing preferentially at a specific horizontal angle. Together, the interactions within elements of this system form the neurophysiological foundation for spatial memory in all mammals. They are also responsible for complex episodic memory in humans