OBJECT-PLACE MEMORY AS FORMATION OF A COGNITIVE MAP BASED ON A THEORY OF THETA PHASE CODING IN THE HIPPOCAMPUS.

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In the study of primate memory, object-place associative memory is known to necessitate the hippocampus. The ability to store the compound of visual scene in one-time experience has not been clarified as neural mechanisms. The authors theoretically proposed a theory of hippocampal memory for one-time experience based on "theta phase precession"(Yamaguchi, 2003; Sato & Yamaguchi, 2003). Theta phase precession has advantages for the on-line memory encoding of temporal sequence in several seconds by compressing into every theta cycle. Although it is not clear whether the primate and rodents share common neural dynamics, theta phase coding provides a necessary function for the one-time experience. In this paper, we elucidate the object-place associative memory based on the neural network model with theta phase coding. The network consists of visual system and hippocampus. The former includes peripheral and central vision, which are respectively transmitted to parahippocampal and perirhinal cortices. By assuming saccadic eye movement, a temporal sequence of visual information is obtained and applied as input to the hippocampus. Our computer experiments on a series of eye movement, demonstrate that each object and concurrent scene are instantaneously stored in symmetric and asymmetric connections of the CA3 region as a cognitive map representing the visual environment. In the retrieval stage, associated sets of scenes and objects are recalled sequentially one by one. These results provide a novel on-line memory processing available for compound information such as object-place memory, by using transformation between spatial and temporal information via the cognitive map.
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