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Characterization of single unit activity in the hippocampal-entorhinal network during memory formation

Summary

The hippocampal-entorhinal network is thought to play a crucial role in memory formation and memory consolidation. Since the discovery of spatially selective cells, the hippocampal-entorhinal network is also considered as a main part of the spatial self-representation system. The key components of this network are the hippocampal place cells and the entorhinal grid cells, which are localized in two very strongly connected brain regions. Both cell types are supposed to interact, but the underlying mechanisms remain to be elucidated. Moreover, it is highly debated how the spatial selective patterns in the hippocampal-entorhinal network are generated. In the last decade, various hypotheses, models and observations describing spatial coding have been discussed.

This study addresses the possible interactions of grid and place cells by concurrent in vivo recording. The data presented in this study are in line with some of the most recent publications, and also provide new ideas for further experiments. In particular, new information about the firing associations of grid cells was obtained. Furthermore, new data about theta phase precession were generated, which may help to understand the mechanism underlying the formation of episodic memories. The main focus of this study, however, was to establish the relationship between grid and place cells during exploration and sleep by comparing their spatial and temporal firing pattern. This approach revealed that different environments are encoded by differential firing of grid and place cells within the hippocampal-entorhinal network. However, comparison of joint firing activity under exploratory and sleeping conditions provided no evidence for reactivation. Thus, this analysis should be extended to the deep layers of the entorhinal cortex or different cell types in the future. Altogether these data challenge some of the traditional models of spatial coding in the hippocampal-entorhinal network, and thus provide the basis for further studies on this subject.