Organizing hippocampal coactivity from robust to flexible memory

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The hippocampus network uses the collective activity of the population of its neurons to support everyday memories, integrating new ones into prior knowledge of the world. In principle, the level and structure of the activity coupling between individual neurons forming sets of coactive cells could reflect a critical tradeoff between the robustness versus the flexibility of the whole population in processing information. What are the consequences of placing the hippocampal population into a robust coactivity mode for subsequent memories that instead require sparser firing patterns? In this presentation, I will discuss ongoing work reporting that acquiring a robust (food-context) memory constrains the hippocampus within a population activity space of highly correlated spike trains that prevents subsequent computation of a flexible (object-location) memory. This densely correlated firing structure develops over repeated mnemonic experience, gradually coupling neurons of the superficial CA1 pyramidale sublayer to whole population activity. Applying hippocampal theta-driven closed-loop optogenetic suppression to mitigate this neuronal recruitment during (food-context) memory formation relaxes the topological constraint on hippocampal coactivity and restores subsequent flexible (object-location) memory. These findings highlight that the density of peer-to-peer neuronal coactivity determines robust versus flexible memory expression in the hippocampus.