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Poster presentation

Can a temporal code be transferred from one brain region to another? Lessons from phase precession

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Hippocampal CA1 pyramidal cells in both rodents and humans fire in a spatially selective manner, and are called place cells. These place cells also display a prominent temporal code known as phase precession. As a rat enters the place field of a cell, the cell fires its first spike very late in the first theta cycle, but the phase of the spikes with respect to theta steadily precesses to lower values, all the way to 0 degrees as the rat reaches the end of the place field. CA1 is not alone in showing such phase precession: cells in CA3 and the dentate gyrus have long been known to show phase precession. CA3 cells are the main source of input to CA1. More recently, cells in layer II of the entorhinal cortex (grid cells) have also been shown to phase precess as a rat runs across a single grid field. These cells provide input to both the CA3 and dentate gyrus. However, cells in layer III of the entorhinal cortex do not show phase precession. These layer III cells provide direct input to CA1. Here, we use integrate and fire as well as Hodgkin-Huxley style conductance models to explore the conditions necessary for a CA1 place cell to 'inherit' phase precession from its inputs. We show how CA1 phase precession depends on the standard deviation of the phase of its excitatory inputs, as well as on the precise timing and strength of theta-modulated inhibitory inputs.