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Is hippocampal phase precession a useful temporal code?

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Hippocampal CA1 pyramidal cells in both rodents and humans fire in a spatially selective manner, and are called place cells. Sitting atop this rate coded output of a CA1 cell is the hippocampal temporal code. When a rat runs, local field potential recordings from the CA1 region reveal an 8 Hz oscillation: the theta oscillation. As a rat enters the place field of a CA1 place cell, the first spikes fired by the cell occur late in the first theta cycle. In subsequent cycles, the spikes occur earlier and earlier in each cycle, precessing to the beginning of the last theta cycle in the place field. This advancement of spike times with respect to theta is called phase precession. CA3, the dentate gyrus and layer II of the medial entorhinal cortex also show phase precession. We have previously used computational models to predict the limited set of conditions that allow phase precession to be "inherited" from phase precessing inputs. Here we take a data-driven approach to the same problem by recording from hippocampal place cells and analyzing the statistics of *in vivo* phase precession data. We combine the properties of *in vivo* place fields with new computational models to delineate the precise conditions under which phase precession in the entorhinal cortex or in CA3 can be seamlessly transferred to CA1 cells.