Jeffrey C. MAGEE
Howard Hughes Medical Institute
Baylor College of Medicine - USA

Microcircuit mechanisms of CA1 place fields

We have examined the microcircuit mechanisms of place field generation using whole-cell voltage recordings from hippocampal CA1 neurons in mice running on a linear track. We found that CA1 cells receive a constant barrage of excitatory input from thousands of presynaptic cells that are tuned to all features of the environment and that a novel form of synaptic plasticity (BTSP), induced in as few as a single trial by dendritic Ca2+ spikes and operating over a many seconds long asymmetric time course, selects a particular subset of excitatory inputs by strengthening their synaptic weights. In addition, a constant level of un-tuned inhibition counter acts the barrage of un-potentiated input thus suppressing a potential source of “noise”. The time course of the plasticity produces predictive place fields whose center of mass and peak firing is actually tens of centimeters before the location where they were induced and the induction mechanism (dendritic plateau potential) appears to make this a non-autonomous form of one-shot learning. In the end this scheme allows the behavioral aspects of the environment to rapidly shape the CA1 representation such that it reports something about the world approximately one second (or 30 cm) ahead of the animal.