Cellular substrates for network information processing in hippocampal CA1

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Hippocampal representation has both dynamic and stable facets. CA1 neurons can exhibit stable place fields over long time and repeated explorations can stabilize the spatial coding properties of active neurons, yet recent work has shown day-to-day turnover in the set of CA1 neurons that represent a familiar environment.

To understand how turnover and stability coexist in the hippocampus we employ time-lapse deep-brain *in vivo* two-photon microscopy to study the long-term dynamics of plasticity of CA1 pyramidal neurons.

We have previously reported that dendritic spines of CA1 pyramidal neurons completely turn over in 3 to 6 weeks; consistently with the approximate time memories are hippocampal dependent. Here we monitored activity-evoked plasticity by using a fluorescent indicator based on the enhanced synaptic activity–responsive element (E-SARE), that recapitulates the expression of the immediate-early gene *Arc*. We tracked the activity-evoked plasticity patterns of CA1 pyramidal neurons over several weeks and found that plasticity patterns provided specific representations of spatial environments. The plasticity patterns evoked by multiple visits to an individual environment on different days involved distinct but highly overlapping subsets of neurons. Interestingly, these evoked representations grew increasingly similar as the animals visited the environment more times. Aging impaired both the specificity of the representations for a defined environment and their stabilization over time.

Our data suggest that, despite the conspicuous synaptic turnover, hippocampal CA1 activity-evoked plasticity patterns can stabilize over time. This may support the formation of reliable memories, whereas weaker specificity and stabilization in aged subjects may contribute to memory decline.