

Abstract

Neuronal ensembles—coactive groups of neurons—are proposed to serve as fundamental building blocks of cortical circuits, potentially emerging through activity-dependent Hebbian plasticity. For technical reasons related to microscope field of view size, neuronal ensembles have previously been studied primarily within brain regions. The extent to which ensembles can span brain regions is therefore poorly understood. Here we propose to test first whether the synthetic formation of ensembles across connected brain regions is possible using approaches developed in within brain region studies. Second, we test whether the formation and recall of these ensembles differ across brain states, specifically comparing wakefulness, sleep, and REM sleep. To address these questions, we will describe the use of a custom mesoscopic two-photon optogenetic system, which allows stimulation with single-cell resolution across spatially distributed networks. We use this system to show how to selectively coactivate small groups of neurons to test whether this manipulation is sufficient to imprint persistent ensemble activity across distal cortical networks. We further hypothesize that these artificially induced ensembles will exhibit pattern completion, such that stimulation of a single neuron can trigger reactivation of the entire group in distal areas.