Timescales of neural activity and their determinants in spatially connected model

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Abstract

Neural activity exhibits dynamics across multiple timescales, reflecting the specialization of circuits for task-relevant computations. We studied how these timescales can be flexibly modulated on a trial-by-trial basis depending on cognitive states such as attention and why their modulation is relevant for computations. We analyzed the autocorrelation structure of population spiking activity recorded from individual cortical columns in primate area V4 during a spatial attention task and a fixation task. Our results reveal at least two distinct timescales in both spontaneous and stimulus-driven activity. Notably, the slower timescale was significantly prolonged in trials where monkeys attended to the receptive field location of the recorded neurons, compared to control trials when attention was directed elsewhere. To investigate the mechanisms underlying this modulation, we used computational models and demonstrated that the observed timescales naturally emerge from recurrent network dynamics shaped by spatial connectivity structure.