A link between dynamics and function in the brain's navigation system

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Abstract

The thalamus plays a central role in cognition by relaying sensory signals and supporting cortico-cortical communication. Thalamic function is generally understood through the structural organization of its nuclei, each showing different patterns of connectivity with cortical and subcortical structures. However, how the activity of individual neurons relates to their role in the circuit remain largely unclear.
Among the large family of thalamic nuclei, those of the anterior thalamic nuclei (AT) are located at the central stage of the Papez circuit. They are reciprocally connected with all limbic structures and play a key role in memory, spatial navigation and arousal states. While it is challenging to determine in vivo the exact coupling of thalamic neurons with all their input and output structures, the functional integration of neurons into the limbic system is indicated by the modulation of neurons by hippocampal oscillations.
By simultaneously monitoring ensembles of neurons in the AT and local field potentials in the hippocampus, we found that neurons show a large spectrum of firing dynamics and modulation by hippocampal activity. While neurons from a given nucleus share, on average, common firing characteristics, AT neurons are characterized by an invariant relationship between spike train dynamics and hippocampal modulation, irrespective of their nucleus of origin. Our findings indicate that AT neurons are independent channels orchestrating information flow in the limbic network with cell-specific spiking dynamics.

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