Short-term Synaptic Depression Enriches Responses to Stationary Stimuli in Continuous Attractor Neural Networks

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Continuous attractor neural networks (CANNs) are able to hold bump states, the ensemble activity supposed to be the neural correlate of spatial representation. These ensemble activities show various spatial-temporal patterns under short-term synaptic depression (STD) and external stimuli. Weak STD modulates bump states spatially, resulting in "moving bump", while strong STD modulates bump states temporally, which means the moving bump will drop after its height reaches a maximum, wait for the recovery of resources and rise up again from the position of the stimulus. We call that "emitter". A stationary external stimulus attracts the bump towards its location, thus playing against the mobility enhanced by STD. Under a strong stimulus, "moving bump" is changed to "slosher", in which case the bump moves around the stimulus, while "emitter" is changed to "population spikes". In the intermediate parameter region, mixtures of these basic patterns are observed. Our results show the relation among these response patterns and suggest that different STD level and stimulus gain control may be employed by the brain to perform different tasks.