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Cognitive Tasks that Require Reliable Spatiotemporal Neural Dynamics

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Working memory, visual perception, and place navigation are all cognitive tasks that exploit spatially organized neural activity. For example, the encoding of the location of an object during a visuospatial working memory tasks relies upon persistent prefrontal cortical activity organized into a "bump." These bumps of activity also appear in hippocampus, during navigation experiments, as part of the brain's self-location system. Visual processing exploits a spatially organized network of cells tuned to the various geometrical properties of stimuli. Since the number of neurons in these networks tends to be quite large, we study them with models that simulate an average level of neural activity, rather than dynamics of individual spiking neurons. Using these mean field models, we can explore how the spatial structure of synaptic connections affects the resulting spatiotemporal dynamics. One important question is how the brain overcomes noise to produce responses that are reliable enough for the task at hand.

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