Neural Field Coding of Short Term Memory

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Abstract: Short term memory (STM) is the ability of the brain to maintain a perceived stimulus even after the stimulus has disappeared. STM is assumed to be implemented in the sustained activity observed in the prefrontal cortex (PFC) during diverse tasks, like visual memory, object labelling, identity or other cognitive tasks. We here suggest that this activity can be explained as the result of changes in recurrent activation in the PFC. We use a linear Neural Field model with inhomogeneous connections to explain activity during a visual perception task. In this task, the subject is asked to remember the value of a cue (angle) during a delay period. This bypasses expensive computational costs of nonlinear (e.g. conductance-based) models that have previously been used to implement synaptic modulation. We show that population's internal state encodes a parameterization of the presented stimulus and consider activity-dependent synaptic efficacy. We show that the PFC population exhibits tuning sensitivity reaching different attractors for different stimulus values that maintain persistent activity during the delay. We also study qualitative changes of PFC connections induced by input from the sensory cortex and compare connectivity strengths before, during and after visual cue.