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Presentation Abstract

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Presentation Title: Selection and integration of relevant sensory evidence without gating of sensory inputs

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Abstract: Computations in neural circuits are inherently flexible, allowing humans and animals to respond to sensory stimuli with actions that are appropriate in a given context. Fundamental to this flexibility is the ability to integrate only context-relevant sensory information while ignoring irrelevant, distracting information. We studied the neural mechanisms underlying such context-dependent integration in monkeys performing two different sensory discriminations on the same set of visual stimuli. A contextual cue instructed the monkeys to report either the direction of motion or the color of a noisy visual stimulus with a saccade to one of two targets. During this task, we recorded neural responses from the frontal eye fields (FEF), which are thought to contribute to the integration of sensory evidence in favor of saccades to contralateral targets.

The recorded responses suggest that FEF plays a crucial role not only in the integration, but also in the selection of the contextually relevant evidence. Using linear regression, we identified a multitude of task-related signals represented simultaneously in the responses of FEF neurons, including the sensory evidence provided by the momentary motion and color of the stimulus, the context, as well as the integrated, relevant evidence towards the target in the response field. While these different signals are mixed at the level of single neurons, they can be separated at the level of the population by projecting the neuronal activity onto the corresponding regression vectors. Surprisingly, the representations of momentary

motion and color evidence are virtually unchanged by context, suggesting that the corresponding inputs into FEF are not gated differently in the two contexts.
To understand how sensory inputs can be selected without gating, we trained a randomly initialized recurrent network model to contextually integrate only one of two noisy input streams. We found that the network created two context-dependent, approximate line attractors to integrate the relevant sensory inputs. As in FEF, both the relevant and irrelevant inputs strongly drive the network activity along directions in state space that are almost orthogonal to the direction of integration. The selection and integration of the relevant input is completely explained by the local, linear dynamics around the line attractors, and is achieved by aligning the dynamics to the relevant input rather than by suppressing the irrelevant one.
We conclude that selection can occur without gating of sensory inputs, and can be understood as one aspect of a dynamical process occurring in the same areas responsible for integrating the inputs towards a choice.

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Keyword(s): DECISION MAKING

ATTENTION

CONTEXT

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