

Context-dependent modulation of functional connectivity: S2 to PFC connections in two-stimulus-interval discrimination tasks

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In a complex world, processing of signals from the environment must be flexible: a sensory cue may prompt different actions in different contexts. A laboratory example of context-dependent sensory processing is the two-stimulus-interval discrimination task. In each trial, a first stimulus (f1) must be stored in short-term memory, and later compared to a second stimulus (f2), in order to come to a binary decision as the result of the comparison (was f1 > f2? Y or N). The two stimuli, applied to the very same sensory receptors, must be treated quite differently. This task thus provides a clear example of context-dependent processing.

Our laboratory recently proposed a network model of processing in the prefrontal cortex (PFC) that addresses both the short-term memory and decision-making component of such tasks [1]. But the model requires connections from sensory cortex to PFC to switch sign in between the first and the second stimulus. The sign inversion is part of how the two stimuli are treated differently and is crucial to the proposed model. Yet how it is achieved in biology is unclear.

Here we develop a biologically plausible model of the signal transformation from secondary somatosensory cortex (S2) to PFC. To ground our model in experimental neurophysiology, we use neurophysiological data recorded by R. Romo's laboratory from both cortical area S2 and PFC in monkeys performing the task. Our main goal is to use experimentally-observed context-dependent modulations of firing rates in cortical area S2 as the basis for a model that achieves a context-dependent inversion of the sign of S2 to PFC connections [2]. This is done without requiring any changes in connectivity [3]. We (a) characterize the experimentally-observed context-dependent firing rate modulation in area S2; (b) construct a model that results in the sign transformation; (c) characterize the robustness and consequent biological plausibility of the model.

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References

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