

Corticostriatal processing resolves the conflict between context and dominance apparent in the prefrontal cortex

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Abstract

A previous experimental study [Buschman et al., 2012] showed that neurons in the prefrontal cortex (PFC) resolve context-based competition between two sensory modalities through enhanced oscillatory activity at beta frequencies when the context and the sensory dominance were aligned. In contrast, no apparent difference at beta frequencies was found when context pointed to the non-dominant sensory modality, even though the subjects performed the task similarly well. In addition, pre-stimulus alpha-band activity emerged in non-dominant trials on the prefrontal neurons encoding the dominant dimension. Two critical yet unresolved questions arise from this study: first, if not within the PFC, what other region of the brain resolves non-dominant trials? and second, what is the role of alpha oscillations in the PFC, specifically present in dominant-selective neurons when these neurons do not carry the relevant information?

Here, we build upon a previous computational model of corticostriatal processing [Ardid et al., 2019] to test the hypothesis that the conflict between context and dominance may be resolved downstream in the striatum. Results from our computational model show that pre-stimulus alpha inputs from cortex trigger a temporal asymmetry in the striatal microcircuit through short-term synaptic depression: on stimulus presentation, despite that equally strong beta inputs target the dominant and the non-dominant striatal populations, their responses become transiently different since the two populations depart from different states. Dominant-selective striatal neurons depart from a highly active alpha-triggered regime and therefore are in a depressed state, whereas non-dominant selective neurons depart from silence, hence they are not depressed. This creates a window of opportunity to propagate the activation of the non-dominant response, which is capable of resolving the conflict between dominance and context present in the PFC.

Keywords— context-dependent decision-making, inhibitory control, short-term depression, oscillations

References

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