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Presentation Abstract

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Abstract: Reaction times (RTs) are faster when subjects have time to prepare their movements before they are executed. This preparatory process is reflected in several cortical areas including primary motor (M1) and dorsal premotor cortex (PMd). The structure of this neural activity has led to the idea that planning seeds motor cortical activity with an initial state beneficial for executing the instructed movement. In a perturbative test of this hypothesis, electrical microstimulation (e-stim) delivered to PMd just before the time of movement initiation largely erases the RT reduction achieved by preparation (Churchland and Shenoy, 2007). However, electrical recording artifacts and the inability to target precise circuit elements has precluded more informative experiments using e-stim. Optogenetics allows temporally precise control of genetically-defined neural populations and simultaneous electrical recording of spiking activity. We asked whether optical stimulation (o-stim) delivered to PMd just before movement initiation would similarly erase the RT benefit of motor preparation. Two rhesus macaque monkeys (Q,O) were injected with AAV5-CaMKIIα-C1V1(T/T)-ts-eYFP in multiple locations in the upper arm region of PMd. We verified functionality of the optogenetic tool in this setting by recording neural responses to periodic pulse trains or continuous pulses of 561 nm (green) light. We then trained these monkeys on a reaching task in which target presentation was followed by a

variable length instructed-delay before movement initiation was permitted. As expected, RTs were faster (~30 ms on average) for trials with longer delays. On a fraction of trials (~10%), o-stim was delivered to PMd before movement initiation. In both monkeys, we found that RTs were slower (~12 ms on average in O, $p < 10^{-14}$) in long-delay trials where o-stim was delivered near the time of go cue, indicating that the optogenetic perturbation partially erased the RT benefit of motor preparation. On long-delay trials where o-stim was delivered more than 150 ms in advance of the go cue, RTs were not different from non-stimulated trials (-3.5 ms on average in O, $p = 0.99$), suggesting that this motor preparatory process can recover from the effects of optogenetic perturbation on a rapid timescale. These findings demonstrate the potential for targeted optogenetic perturbation to elucidate causal links between neural dynamics and behavior in primate models.

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PREMOTOR

MOTOR CORTEX

Support: HHMI (KD)

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