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Presentation Abstract

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Abstract:	In both humans and non-human primates, corrective motor responses following mechanical limb perturbations are modulated by contextual factors, such as higher-order task goals and environmental constraints (Scott et al., 2015). Following mechanical perturbations, motor cortical neurons exhibit rapid, context-modulated changes in firing rate, suggesting motor cortex operates as a feedback controller whose control policy is modulated by task context. Here, we tested the hypothesis that primate primary motor (M1) cortical activity might reflect not only the details of the movement presently being produced, but also the particular feedback control policy being engaged, which could then shape the context-dependent response to errors and perturbations. We trained a rhesus macaque to move a haptic feedback device (delta.3, Force Dimension) in the vertical plane, which controlled the position of a visual cursor on a screen, in order to produce brisk, accurate reaches towards visual targets while avoiding virtual obstacles. On 40-75% of trials, we delivered an unpredictably directed, step-force perturbation (3 N) early in the movement. We designed a set of target and obstacle arrangements to vary the control policy employed by the monkey during movement. In the "high-gain" arrangement, the monkey was required to resist lateral perturbations to avoid

flanking obstacles, whereas in the "low-gain" arrangement, the monkey needed to respond with less corrective force and re-aim for a more-laterally positioned target. As the initial target was identical in both arrangements, hand kinematics on high- and low-gain non-perturbed trials were nearly identical. However, on perturbed trials, high-gain reaches diverged from low-gain reaches back towards the central target with a latencies of 106-185 ms (Hedges' $g > 0.25$, $p < 0.05$), consistent with goal-dependent modulation of a transcortical feedback loop. We found that most M1 units responded rapidly after perturbation onset (364/405, Kruskal-Wallis test, $p < 0.05$ over 25 ms). However, we also found that in some units, firing rates for high-gain vs. low-gain trials were significantly different before a perturbation was delivered (202/405) and during non-perturbed trials (314/405). These results suggest that motor cortex (along with other motor feedback regions) might engage different dynamics when different feedback control policies are engaged, enabling the context-specific dynamics to shape neural responses to perturbation and the resulting corrective movements. This suggests that motor cortical dynamics support adaptive feedback control in addition to motor command generation for voluntary movement.

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MOTOR CONTROL

MACAQUE

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