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PMd delay activity during rapid sequential - movement plans

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Neural prosthetic systems, capable of translating cortical activity into control signals for guiding prostheses, must operate quickly and accurately in order to be clinically viable. In communication prostheses, it is important to be able to directly estimate desired cursor positions from the delay (plan) activity present before, or even without, arm movements. We report in this volume (Santhanam et al.) that such systems can achieve high performance. Here we asked how premotor cortex (PMd) neurons respond during planning to a rapid succession of targets. Targets could appear at one of 4 (or 8) locations and the next target location was drawn pseudo-randomly. Three or more targets were presented in a row (chain). For each neuron, data were grouped by target location and position in the chain. Few changes in tuning direction were observed for sequential chain positions, though tuning curve peaks were often modulated up or down. This change in gain is consistent with our observation that decode performance in prosthetic cursor experiments tended to worsen with increasing chain position. Interestingly, monkey G tended to have positive gains (pop. median: 0.67 spikes/schange per chain position, 25th pctl: -0.19, 75th pctl: 1.72, $p < 0.05$) whereas monkey H tended to have more negative gain cells (pop. median: -0.11, 25th pctl: -0.67, 75th pctl: 0.30, $p < 0.05$). This gain effect seen during rapid movement preparation could be due to a variety of influences, including attention, reward expectation or intrinsic cortical dynamics. Differences in gain effects across monkeys could be due to anatomical differences in array placement, slight behavioral training differences, or chain lengths (monkey G continued until a decode error, ~5-10 trials; monkey H had fixed chain lengths of 3). Further experiments and characterization are required to elucidate the neural mechanisms underlying the observed gain modulation effects.

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