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Presentation Abstract

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Presentation Title: Frequency of multiphasic responses in dorsal premotor and primary motor cortex.

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Abstract: Functional differences between primary motor cortex (M1) and dorsal premotor cortex (PMd) have been the focus of numerous studies. A number of such studies have focused on the directional aspects of tuning, yet relatively few studies have compared the temporal properties of single-neuron activity. If one believes the goal of activity in M1 and PMd is the generation of behaviorally relevant and temporally precise control signals, then a characterization of the temporal activity patterns seems of particular importance. We therefore investigated the temporal characteristics of neural activity in PMd and M1 (six datasets; 118-213 neurons each) recorded in two monkeys performing a variant of the center-out reach task. We first computed, for each neuron and condition, the average firing rate as a function of time. Averages were made across trials and locked to movement onset. We analyzed these firing rates during a time period that started just before the movement and continued through the movement. During this time, firing rates were typically multiphasic, showing multiple peaks and valleys. Via inspection, these multiphasic firing rates tended to be higher frequency for M1 (e.g., firing rates changed more quickly from one extreme to another). To quantify this effect

we used two approaches. First, we computed the frequency spectrum for each neuron and condition. These were averaged for all recordings from a given area, and normalized by total power. At the lower frequencies (~1Hz) power was modestly greater in PMd compared to M1: a difference of 13% and 19% for the two monkeys ($p < 0.05$ for each). At higher frequencies (~3 Hz) power was greater in M1 compared to PMd: a difference of 15% and 27% for the two monkeys ($p < 0.001$ for each). In a second analysis we employed a recently developed dimensionality reduction method: jPCA. jPCA finds a state-space projection of the neural data that captures coherent dynamical structure. During reaching the neural state rotates in a fashion consistent with quasi-oscillatory dynamics at the level of firing rates (Churchland et al., 2012). For each of four datasets, we found that the highest rotational frequency was greater in M1 compared with PMd. For M1, the fastest rotations averaged 2.1 Hz (2.1, 2.0, 1.9, and 2.2 Hz for the four datasets). For PMd, the fastest rotations averaged only 1.3 Hz (1.1, 1.2, 1.2, and 1.5 Hz for the four datasets). In summary, multiphasic time-varying firing rates are a prominent characteristic of both M1 and PMd during movement execution. Despite this commonality, there exists a prominent bias towards higher frequencies within M1.

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