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Presentation Abstract

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Title:	Evidence of trial-by-trial relationships between EMG and neural population activity in PMd
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Abstract:	Understanding the relationship between neural activity in motor cortex and muscle activity during movements is important both for basic science and for the design of neuroprostheses. One common approach is to use linear decoders to predict EMG activity from neural data (e.g., Pohlmeyer, *et al.*, 2007). Most of this work assumes different time relationships between neural activity and recorded behavior (i.e., lag times) for each neuron, which can make the analysis susceptible to overfitting by requiring many parameters. Another approach is to look for features in neural activity that can be linked to features in recorded EMG. Previous work related peaks in the activity of corticomotoneurons in M1 with peaks in EMG activity, but the neural data used in that study was limited to single-neuron recordings, which individually, were not found to correlate strongly with muscle EMG (Griffin, *et al.*, 2007). We asked if we could find features in the activity of a population of simultaneously-recorded (and unidentified) neurons in PMd that could be linked to EMG activity on a trial-by-trial basis. To address these points, we trained one macaque monkey to perform a center-out reach task to 28 targets on a circle (max 120 mm) and recorded simultaneous behavioral, neural (from PMd with microelectrode array), and EMG data from multiple muscles. To denoise the neural data and obtain a more compact trial-by-trial representation of the neural population activity, we used dimensionality reduction.

Using factor analysis, we reduced our neural data to 5 dimensions for each target separately, thereby creating neural trajectories for each trial in a low-D space that varied by target. We were able to correlate, per target, the timing of points of high curvature (POHC), a very salient feature of these low-D trajectories, with the timing of POHC in the EMG data from each muscle recorded with r^2 of 0.60-0.74. We also found that the neural POHC preceded the EMG POHC with mean lag times of 46-59ms, and SDs of 9.3-14.7ms. We regressed the EMG data for each muscle against the neural recordings (without dimensionality reduction) for all reaches assuming a single lag time for the entire neural population. We then systematically swept this assumed population lag and found a peak in generalization performance around the lag time found in the POHC analysis. These results suggest that: features in the low-D PMd neural population trajectories relate to EMG features on a trial-by-trial basis; and, a single lag time for the entire neural population in PMd can be used to relate trial-by-trial neural recordings with EMG data. Together, these support a strong relationship between the neural activity in PMd and muscle activity.

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