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Presentation Abstract

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Presentation Title: Towards robust performance and streamlined training of cortically-controlled brain-machine interfaces.

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Abstract: Brain-machine interfaces aim to restore function in disabled patients. Despite several compelling proof-of-concept demonstrations, barriers to translation still remain. Among these are robust, sustainable performance and a rapid training protocol. Here, we describe the impact on the performance and robustness of a BMI system when using two 96-electrode arrays in different areas of movement-related cortex. We then present a method of streamlined training based on an understanding of neural signal invariance between hand control and brain control. First, BMI performance improved when using arrays in two sites (M1 and PMd) in Monkey J. We used threshold crossings set at -4.5 RMS (Chestek et al. 2011), as these signals can be robust for years. On an 8 cm center-out-and-back 2D cursor task, using both arrays reduced average target acquisition time by 14% versus just the M1 array and by 13% versus just the PMd array. This suggests that increasing the electrode count lowers the impact of spiking noise and provides better controllability. This was manifest primarily as a reduction in dial-in-time (time spent near the target before finally settling for the 500ms hold time). Using both arrays decreased average dial-in-time by 27% vs M1 alone and by 34% vs PMd alone. We found little difference in BMI control between using only the M1 or the PMd array.

Second, we describe a method of streamlined training for BMI systems. Training

set modifications previously applied to brain control training data (Gilja et al, SFN 2010) can be directly applied to hand control training data. This was informed by our finding that there is little difference in the preferred directions of threshold crossings under both hand and brain control. This led us to hypothesize that the subject may be acting in a similar manner regardless of the control modality, and thus the resulting neural activity should be similar. Comparable performance with both training paradigms was verified in Monkeys L & J on a center-out-and-back 2D cursor task. Training set modifications were also guided by mutual information analyses between kinematics and neural activity. The new approach leads to a high-performance decoder that can be derived from a single session of hand control trials, bypassing the first step in the previously reported two-stage training protocol (Gilja et al, SFN 2010).
Together, these two findings enable more robust performance and a streamlined training process for brain-machine interfaces.

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