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Presentation Abstract

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Presentation Title: Long-term decoding stability without retraining for intracortical brain-computer interfaces.

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Abstract: Intracortical brain-computer interface (BCI) systems have traditionally relied upon daily retraining to maintain stable performance across time. While this is feasible in a lab, it is not clear that the burden of such daily recalibration will be viable in clinical practice. We therefore sought to investigate the long-term decoding stability of an intracortical BCI system without retraining. While this has been studied for continuous cursor control (Li et al., 2011), we consider here this question for discrete classification systems (Santhanam et al., 2006).
We recorded neural activity using a 96-electrode array implanted in the motor cortex of a rhesus macaque (L) performing center-out reaches in 7 directions during 41 separate recording days spanning 48 days in total. Threshold crossings were used in place of spike sorting (Chestek, 2011), and a classifier based on the first 10 days of data was constructed. This classifier was then held static and the discrete reach direction on the remaining 31 days of data was classified. We found

that when classifying reach direction based on threshold crossings collected during arm movement the overall performance of such a static decoder was lower than one that was retrained daily. However, we surprisingly found that day-to-day performance for the static decoder did not significantly decline, though day-to-day variability was large.
We then investigated how tuning parameters, when characterized using threshold crossings, changed within and between days. We developed a statistical model that assumed tuning parameters drifted according to a random walk model and fit this model to the 41 days of recorded data. We examined the most probable time courses of tuning parameters returned by this model and found that drift between days was substantially larger than drift within days. This finding motivates the application of a novel decoder, which ignores within-day drift but models the between-day drift of tuning parameters. We found that this decoder outperformed the static decoder by 12% in mean day-to-day decode accuracy. In fact, the mean day-to-day accuracy of this decoder was not significantly different than one that was retrained daily in a supervised manner. While these results must be reproduced in a closed-loop setting, we believe such insights into the role of decoder training will be important for the clinical translation of BCI systems.

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