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Presentation Abstract

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Title:	Impact of spike waveform instability on BMI performance measured across seven weeks using a wireless system
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Authors:	*C. A. CHESTEK[1], V. GILJA[2], P. NUYUJUKIAN[3,4], J. D. FOSTER[1], M. T. KAUFMAN[5], S. I. RYU[7], K. V. SHENOY[1,6]; [1]Electrical Eng, [2]Computer Sci., [3]Bioengineering, Stanford Univ., STANFORD, CA; [4]Med. Sch., Stanford Univ., Stanford, CA; [5]Neurosciences Program, Stanford Univ., STANFORD, CA; [6]Neurosciences Program, Stanford Univ., Stanford, CA; [7]Neurosurg., Palo Alto Med. Fndn., Palo Alto, CA
Abstract:	Recent work in brain machine interfaces has demonstrated substantial improvements in performance (Gilja, Nuyujukian et al., SFN). Experiments usually involve collecting training data each day, and using that data to sort spikes from individual units and generate a new neural decoder using those units. This assumes that there are changes in neural waveforms and possibly neural tuning across days, which have not yet been fully quantified. Also spike sorting substantially increases the size, cost, and complexity of any miniature or implantable clinical system compared to simple threshold crossings and its importance to decoder performance has also not been fully quantified. To explore these issues, we examine waveform stability, and compare decoders over weeks using both sorting single units and simple threshold crossings. One monkey performed a center-out reaching task while neural data was recorded from a 96-channel “Utah” array for 39 out of 45 days. Between task sessions, wireless data was obtained from a subset of channels using HermesC, a wireless recording

system for freely moving primates that uses the Integrated Neural Interface microchip (Chestek*, Gilja* et al, Harrison et al, IEEE TNSRE, 2009). Offline neural decodes were performed using a discrete classifier to determine which of 7 targets the animal was reaching for. Average performance was 87% correct with spike sorting. We observed substantial changes in waveforms across days. Although 86% of the electrodes had a single unit on at least one day, only 1 out of 96 electrodes had a stable single unit on all days. For the small subset of single units that could be tracked for many days, tuning curves were highly correlated, averaging R = 0.99. However, due to waveform changes, we found a dramatic decline in performance when the neural decoder was not retrained daily, reaching 50% of the initial performance value within 7 days. With threshold crossings, the performance drop across 7 weeks could be reduced to 26% (rather than 56%) by setting the threshold to match the average firing rate on day one. With daily retraining, we found a relatively small decrease in performance from using an spike-sorting model from a different day (-5.4%), or from using threshold crossings (-5.3%) rather than fully spike-sorted data. Moving from fully spike-sorted data to threshold crossings, it may be possible to demonstrate high performance from cortical arrays for longer periods of time. In fact, prosthetics experiments demonstrating high speed and accuracy have now been performed using only threshold crossings on this same array 2.25 years after implantation (Gilja, et al, Nuyujukian et al, SFN).

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