tacts across whiskers during shape discrimination, whereas during detection they summed them across whiskers. We also recorded populations of neurons in the barrel cortex, which processes whisker input, to identify how it encoded the sensorimotor variables that mice use to recognize shape. We observed whisker-specific coding for motion (especially in deep inhibitory neurons) and touch (especially in superficial neurons). This whisker-specific pattern in the neural responses was similar to the weights that the behavioral classifier used to decode shape identity. We suggest a predictive coding model in which inhibitory whisker motion signals reformat contact responses so that shape identity may be more easily read out by downstream areas. More generally, a similar computation of comparing across multiple sensors may underlie object recognition in other brain areas and species.

III-1. Motor cortical representation and decoding of attempted handwriting in a person with tetraplegia

Frank Willett[1] WILLETT2@GMAIL.COM
Donald Avansino[1] DAVANSIN@STANFORD.EDU
Leigh Hochberg[2] LEIGH_HOCHBERG@BROWN.EDU
Jaimie Henderson[1] HENDERJ@STANFORD.EDU
Krishna Shenoy[1] SHENOY@STANFORD.EDU

[1]Stanford University
[2]Brown University

Handwriting is a fine motor skill in which straight and curved pen strokes are strung together in rapid succession. Because handwriting demands fast, richly varying trajectories, it could be a useful tool for studying how motor cortex generates complex movements. Additionally, attempted handwriting movements could be decoded by a brain-computer interface (BCI) and translated to text in real time, restoring the ability to communicate to people with severe paralysis. Here, we investigated the neural representation and decodability of attempted handwriting movements in a person (“T5”) paralyzed from the neck down (C4, ASIA-A spinal cord injury). We recorded from two microelectrode arrays in hand knob of precentral gyrus (a premotor area analogous to macaque PMd).

first, we tested whether we could neurally decode handwritten sentences. We recorded a dataset where T5 imagined writing 102 sentences in a self-paced manner. We then trained a recurrent neural network (RNN) to transform the neural data into character probabilities at each timestep. The RNN correctly labeled 95.6% of all characters on held-out data with no language model, generating understandable text at speeds exceeding prior records for intracortical BCIs (66 characters per minute vs. 39 correct characters per minute).

Next, to understand how motor cortex generates handwriting movements, we recorded neural activity while T5 imagined writing individual letters in an instructed delay paradigm. We analyzed the preparatory activity observed before each letter was written and found that it represented upcoming letter features only within a short time-horizon. That is, letters that differed only near the end (e.g. m and n) had seemingly identical preparatory representations. We also found that preparatory activity continuously re-engaged throughout the movement period. These results suggest that brain areas other than motor cortex orchestrate the generation of curved trajectories, and may feed input into motor cortex via preparatory dimensions throughout the movement.