Abstract of “Volitional Strategies Engaged During Neural Interface Control: The Impact of Watching, Imagining, and Attempting Movement on Neural Activity” by Brandon F. King, Ph.D., Brown University, May 2017

Implantable brain-computer interface (BCI) systems may one day offer persons with locked-in syndrome a means of interacting and communicating with the outside world. These systems elevate a small group of neurons to the position of sole output for the entirety of a user's internal neural processes. However, current systems do not differentiate neural activity representing volitional movement from activity encoding nonvolitional, movement-related processes. The ability to accurately and safely interact with the world outside a controlled lab environment requires strict adherence to user intention.

We recorded high resolution neural activity from two participants in the BrainGate2 neural interface clinical trial during an open-loop task in which they were instructed to either watch, imagine, or attempt depicted movements. Individual candidate neurons for BCI control exhibited selectivity for isolated cognitive movement strategies in addition to activity across combinations of strategies. Perhaps most importantly, we found neurons in both participants that were selectively active when the participant watched or imagined movement, but were not significantly modulated while attempting to execute the same movements. Furthermore, tuning depth often varied between conditions for neurons responding to more than one cognitive strategy. While we observed no statistically significant changes to tuning direction or Kalman decoding performance between cognitive strategies, we strongly urge future studies to explore these questions in greater detail.

Our results indicate that the better characterization of the non-movement related properties of motor cortical neurons may lead to better BCI control. These non-volitional properties may not present immediate concerns for current BCIs operating in controlled environments and under strict supervision. However, it is vital that future BCIs properly delineate neural activity representing intended output from other, non-volitional processes if these systems are to operate safely in an unpredictable world.