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Presentation Abstract

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Presentation Title:	Application of a high performance intracortical brain computer interface for communication in a person with amyotrophic lateral sclerosis
Location:	WCC Hall A-C
Presentation time:	Sunday, Nov 16, 2014, 1:00 PM - 5:00 PM
Presenter at Poster:	Sun, Nov. 16, 2014, 4:00 PM - 5:00 PM
Topic:	++D.18.d. Neuroprosthetics: Control of real and artificial arm, hand, other grasping devices
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Abstract:	An important potential application for Brain Computer Interfaces (BCIs) is the control of computer cursors and keyboards for the restoration of communication.

This report, combined with a paired report (Nuyujukian et al., SfN 2014), describes the development and application of one such BCI for use by a participant with amyotrophic lateral sclerosis (ALS), as part of the BrainGate2 FDA Pilot clinical trial. Our participant was achieved typing rates between 4.4-6 words per minute (22-30 net correct selections per minute), representing, to our knowledge, the highest reported communication rates of any human BCI. Participant T6 is a 51 yr old woman with declining motor function due to slowly-progressive ALS. She was implanted with a 96-channel electrode array (Blackrock Microsystems) in the hand area of dominant motor cortex. The data presented here were collected more than 13 months post-implantation. Spiking activity and high-frequency local field potential power (150-450Hz) were extracted for use as control signals. The ReFIT Kalman Filter (Nuyujukian et al., SfN 2014, Gilja*, Nuyujukian*, et al., Nat Neuro 2012) was used for continuous 2-dimensional cursor control. To achieve full "point-and-click" control of the computer interface, we added, in parallel, an algorithm for detecting transitions between movement and click-states: the Hidden Markov Model (HMM; Nuyujukian et al., SfN 2012). The participant generated a volitional click signal by attempting to squeeze her non-dominant hand (ipsilateral to the implanted array). This caused a suppression of neural firing, which could be detected as an intention to click. At each time step, the HMM estimated the state likelihoods based on a multivariate Gaussian model of the neural data, the previous likelihoods, and the prior probability of state transitions. Performance of the combined point-and-click interface was measured using two tasks - a grid task, in which the participant acquired randomly presented targets on a 6x6 square grid, and a keyboard task, in which the participant typed phrases using a QWERTY-keyboard layout without, using word completion or error correction. In the grid task, the participant was acquired targets with less than 10% false click rate and a bitrate between 2.2-3 bits per second. In the keyboard task, the participant was able select characters at speeds between 22-30 net correct selections per minute (4.4-6 wpm). These results demonstrate the successful translation of high-performance BCI methods for continuous control and discrete selection. This promising point-and-click interface could serve as a practical method to restore communication for persons with severe paralysis.

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