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Presentation Abstract

Program#/Poster#: 80.03/WW9

Presentation Title: Overlapping neural representations of upper extremity movements in human primary motor cortex during volitional, imagined, observed, and passive movements

Location: Halls B-H

Presentation time: Saturday, Nov 09, 2013, 3:00 PM - 4:00 PM

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Abstract: Previous work with rhesus macaques has demonstrated that neurons in M1 modulate their firing during volitional, observed, and passive movements. In addition, studies with persons with tetraplegia have demonstrated modulation in M1 during attempted and imagined movements, as well as observed and passive movements. However, activity in human M1 during volitional movement, and its relationship to these other movement paradigms, remains uncharacterized. Here we report data from a participant at Stanford (T6) with amyotrophic lateral sclerosis (ALS), enrolled in the multi-site BrainGate2 IDE pilot clinical trial. An array of 100 electrodes was implanted in the “hand knob” area of M1. The presence of partially retained motor function in this participant provided a unique opportunity to record neural activity in human motor cortex during volitional movement, and to compare it to activity during imagined, observed, and passive

movements.
We summarize results from 7 sessions in which the participant performed 4 movements: index finger, thumb, wrist, and elbow flexion. The task also compared 4 paradigms: volitional, imagined, observed, and passive movements. In the volitional phase, the participant moved as instructed by a visual cueing system. In the imagination phase, the participant watched the same cueing system, but was instructed to imagine making movements while remaining still. In the observation phase, the participant watched a clinical technician perform the movements. In the passive phase, the participant eyes were closed while the technician moved the participant's limbs.
We first examined representations of the four different movements under the volitional paradigm. Neural modulation was assessed using multiunit activity (threshold crossings, 4.5 x RMS), and compared during movement and rest periods. Consistent with previous studies (macaques), we found that neural representations of different movements were largely overlapping: of the electrodes that exhibited statistically significant modulation to any movement, 78% showed significant modulation to multiple movements. Similar results were found in a small sample of well-isolated single units: 6 out of 11 single units displayed modulation to multiple movement types. Next we examined modulation across the four paradigms. Of the channels that showed modulation during movement, 86% were also modulated during at least one other paradigm (imagine: 49%, observe: 18%, passive: 78%). These results represent the first intracortical array recordings from human M1 during movement, and confirm that neural representations of movements in human motor cortex are largely overlapping.

Disclosures: **C. Pandarinath:** None. **V. Gilja:** None. **C.H. Blabe:** None. **L.R. Hochberg:** None. **K.V. Shenoy:** None. **J.M. Henderson:** None.

Keyword(s): AMYOTROPHIC LATERAL SCLEROSIS

NEURAL CODING

MOTOR CORTEX

Support: NIH-NINDS, Stanford Institute for Neuro-Innovation and Translational Neuroscience, Stanford BioX-NeuroVentures, Garlick Foundation, Stanford Office of Postdoctoral Affairs

Office of Research and Development, Rehabilitation R&D Service, Department of Veterans Affairs (B6453R), NIDCD (R01DC009899), Doris Duke Charitable Foundation, MGH-Deane Institute

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