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Presentation Abstract

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Presentation Title: An experimental paradigm for neural prosthetics research using human electrocorticographic signals

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Abstract: Motor related electrocorticographic (ECoG) signals recorded in patients undergoing epilepsy monitoring provide the opportunity to test the potential of ECoG based prosthetic devices. Three such participants undergoing ECoG monitoring agreed to participate in experiments involving motor tasks. These participants had 64-72 grid/strip electrodes implanted in various brain areas, including somatosensory and motor regions.
Neural data were recorded using a Cerebus system (Blackrock Microsystems) at 30 kHz. The behavioral task was sequenced using Matlab xPC (Mathworks) and tasks were displayed to the instructor and the participant using a custom Java-based display.
Detailed instruction was found to be important in order for participants to perform tasks accurately and continuously. An instructor explained up to 64 wrist, arm, and hand movements including brief single movements, repeated tapping movements, and isometric movements against resistance. Tapping movements were chosen to match prior literature, while isometric movements were used to provide an intuitive control signal for operating a prosthetic hand.
Three participants wore a Cyberglove (5DT technologies) to measure finger position and one participant additionally wore ShapeTape (Measurand) to measure

arm and wrist position.
During the experiment, the instructor provided timely cueing of movements, observed the participant's actions, and provided feedback throughout the task. Each task movement was allowed 4 seconds for completion followed by 4 seconds of rest. Explanation of tasks was likely helpful toward encouraging robust repeatable behavior. Two participants were also instructed to perform imagined movement. Imagined movements were used to help segregate motor signals from sensory signals.
Participant 1 performed brief individual movements of 64 varieties while wearing a Cyberglove and ShapeTape. Participants 2 and 3 performed grasps and finger movements wearing only the Cyberglove. These consisted of individual finger flexion, pinch, splay, fist, point, and rest. Tapping or isometric movements continued for 4 seconds, which provided robust modulation of high gamma ECoG power (72-244 Hz) over sensory and motor brain areas (Gilja et al., SFN 2011). Consequently, the five isometric grasps could be decoded successfully from this activity (Chestek et al., SFN 2011).
We believe this is a reasonable experimental paradigm for exploring further motor control questions, including closed loop control. Epileptic ECoG participants performing motor tasks may provide a good research model to develop prosthetic devices for amputee and spinal cord injury patients.

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