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Multi-gesture BCI control of a communication board

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Introduction: Amyotrophic lateral sclerosis (ALS) can lead to severe paralysis with impaired communication. Eye-trackers are commonly used for controlling assistive devices but can become unreliable due to eye-movement deterioration [1]. Alternatively, brain computer interfaces (BCIs) can be used to control assistive devices by translating neural signals during attempted movements into device-specific outputs. Despite previous studies demonstrating the potential for online decoding of upper-limb and facial gestures [2-5], multi-gesture decoding has not been applied for controlling assistive devices. Here we show that a clinical trial participant with ALS can control an assistive device by attempting six upper-limb and facial gestures. The BCI operated by translating electrocorticographic (ECoG) signals from a high-density 128-electrode grid over sensorimotor cortex (Figure 1) into directional control of a communication board (Figure 2).

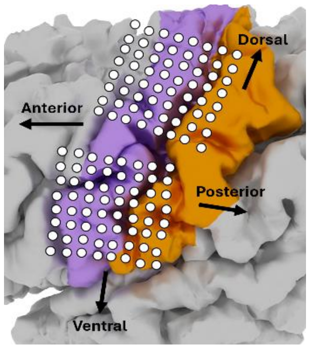

Figure 1: ECoG grid over right sensory (orange) and motor cortex (purple) of speech and upper-limb representations.

Materials, Methods, and Results: We selected a set of six gestures for communication board control by first sampling multi-band frequency features from repeated trials of 16 gestures (200 trials/gesture). We then down-selected a set of six gestures that showed the highest performance in simulations. Specifically, we calculated a performance score for each gesture, which accounted for the sensitivity, accuracy, precision, and false positive frequency, and used the six gestures with the highest performance scores (control gestures). The control gestures were each mapped to one of six communication board commands (up, down, left, right, enter, back). A gesture classification occurred when the probability of the rest class fell beneath a specified threshold. The control gesture class with the highest probability was classified. We determined our six control gestures and tested our model in real-time with the communication board (Figure 2) by verbally instructing the participant to attempt one of the six gestures.

Figure 2. Communication board where it is possible to navigate to, select, and de-select an n icon using BCI control.

Conclusion: Multi-gesture classification is a feasible BCI control strategy for a participant with ALS implanted with high-density ECoG electrodes.

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