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Decoding gestures from intracortical neural activity in ventral precentral gyrus

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Introduction: Intracortical brain-computer interfaces (iBCIs) can restore communication for individuals with paralysis by decoding their motor intent from neural signals and performing computer actions. Recently, we showed that precentral gyrus encodes a broad range of body movements/gestures and speech in a widely distributed manner [1,2]. Following this observation, in this study we integrated gesture decoding with computer cursor control driven by electrodes in ventral (speech) motor cortex with the goal of introducing discrete assistive computer actions, such as mouse right-click, scroll, copy/paste, etc. into an existing multimodal cursor and speech neuroprosthesis framework.

Material, Methods and Results: One participant with ALS was implanted with 4 Utah arrays in precentral gyrus (areas 4, 6v and 55b) [3,4]. We first collected a dataset examining the neural representation of 60 broadly sampled body movements, with a specific focus on hand and face (**Figure 1a**). Neural responses exhibited distinguishable signatures for most attempted body movements (**Figure 1b**), and these movements could be reliably decoded from the neural data (**Figure 1c**). Next, we selected a set of 2, 3, or 4 movements and asked the participant to perform a multi-gesture cursor and click task, in which the participant moved a cursor towards a target and then attempted a cued gesture to select it (**Figure 1d**). We observed significant neural modulation to both cursor direction and attempted gesture. Signals from all arrays contributed significantly to gesture decoding (**Figure 1e**). Cursor movement and gestures were decoded in real time as described in [3], and the participant achieved closed-loop decoding accuracy of **91**%, **89**% and **80**% for 2, 3 and 4 gestures, respectively.

Conclusion and future work: We showed that gestures can be decoded from neural activity in cortical areas 6v, 4 and 55b in a closed-loop task. Next, we will integrate gesture decoding into personal computer use to allow flexible and intuitive mapping between attempted gesture and computer actions.

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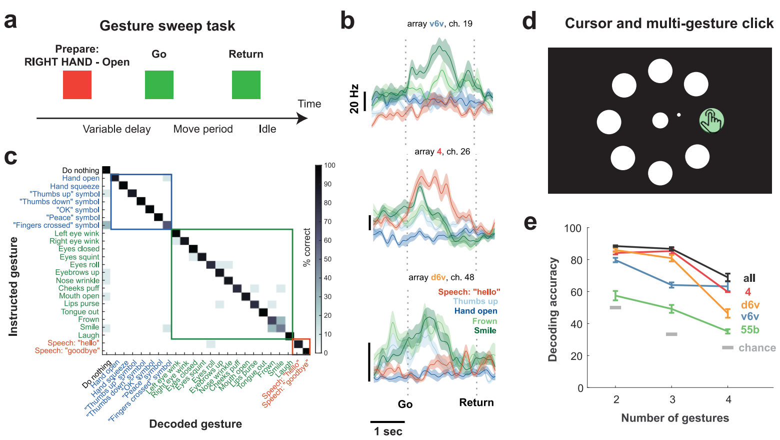

Figure 1. a) Instructed delay task to evaluate neural tuning to 60 attempted movements. A cued movement was displayed on the screen above a red rectangle in the center of the screen. After a variable delay, the rectangle turned green (go cue), prompting the participant to execute the movement until a return cue was displayed. b) Trial-averaged firing rates (mean±s.e.) for five example conditions recorded from three example electrodes from different arrays, aligned to the go cue and color-coded by condition. c) Confusion matrix for gesture classification of a subset of gestures from the hand (blue), face (green), and speech (orange) was performed using Linear Discriminant Analysis (LDA). Colored squares group gestures by their corresponding modality. d) Example cursor and gesture task. The participant was instructed to move the cursor to the green target and, once the target was reached, execute the prompted action. e) Offline decoding accuracy (LDA) of 2, 3 and 4 gestures with signals split by array. Grey bars indicate chance classification accuracy.

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