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Simultaneous independent control of two cursors on the first day of intracortical BCI use by a participant with microelectrode arrays in bilateral precentral gyri.

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Introduction: Although independent bimanual movements are ubiquitous in daily living, restoring this functionality for people with tetraplegia using intracortical brain-computer interface (iBCI) technology has received little attention. Electrophysiological studies in monkeys and humans have shown that neuronal ensemble activity in the unilateral motor cortex reflects both contralateral and ipsilateral movement[1,2], which can be harnessed to control two cursors simultaneously[3,4]. However, neurons can be tuned differently to uni- and bilateral arm movements[2,5], requiring non-linear decoders trained on multiple days of data order to gain bimanual cursor control[4]. Here, we demonstrate independent control of two cursors on the first session of closed-loop iBCI control by a BCI-naive participant using microelectrode arrays in bilateral motor cortices. A rapid calibration paradigm[6] enabled our participant to gain control of both cursors within minutes without the need for any prior training data.

Material, methods and results: We recorded data from a single human participant (T18) enrolled in the ongoing BrainGate pilot clinical trial (www.ClinicalTrials.gov; Identifier: NCT00912041). T18 is a 48 y/o male with tetraplegia from a cervical spinal cord injury (C4 ASIA A). T18 has six 64-channel intracortical microelectrode arrays placed in bilateral hand knob areas, of which four are in the left motor cortex and two in the right motor cortex. He was asked to perform a bimanual grid task, by moving two cursors simultaneously to their corresponding targets and holding both in place for 300ms. Once acquired, the next set of targets were immediately presented. T18 moved each cursor by attempting to control an imaginary joystick with the corresponding hand. A single Kalman filter was used to decode 2D directional vectors for both cursors simultaneously for a total of four control dimensions. A rapid calibration paradigm, where the decoder parameters were recomputed every 3 seconds, enabled T18 to gain control of the two cursors within minutes of the block on the first day of closed-loop iBCI sessions.

Conclusion: This work demonstrated that neuronal ensemble activity from bilateral precentral gyri enables a iBCI user to rapidly gain independent control of two independent effectors simultaneously operating in four dimensions, without the need for any open loop calibration block.

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