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Distinct patterns of whole-body representation in human motor cortex and posterior parietal cortex

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Introduction: Understanding how different parts of the brain contribute to motor control is fundamental to both neuroscience and building effective brain-machine interfaces (BMIs). Traditionally, specific cortical locations within the motor cortex (MC) and posterior parietal cortex (PPC) have been linked to specific effectors [1,2]. However, recent work has found multiple effectors represented in small patches of MC and PPC [3,4]. How do we reconcile these conflicting results?

Materials, Methods, and Results: To address this question we recorded from single neurons in human PPC and MC (hand knob) as a subject attempted movements distributed from head to foot (left and right side of the body). Our results show that both MC and PPC code for effectors across the body, but with clearly distinct coding schemes. In MC, population-level tuning strength for the wrist and thumb was significantly stronger than other effectors. At the single neuron level, nearly all neurons were best activated by either the contralateral wrist or thumb and more weakly engaged by other effectors, most often the ipsilateral wrist and thumb. During simultaneous movements, neurons tracked the contralateral wrist and thumb, with little to no representation of the other effector. PPC represents the whole body as well, however, unlike in MC, there is similar tuning strength across effectors. At the single neuron level, roughly equal numbers of neurons were best activated by each tested effector, with a more random distribution of which other effectors were also encoded. Finally, in PPC simultaneous movements preserve the representation of both effectors.

Discussion and Significance: Choosing neural populations with appropriate functional properties is fundamental to both building an effective BMI and understanding its limitations. Our results provide information about the differences in functional properties of common target brain regions for motor BMIs. In MC, a strong representation of the contralateral hand supports choosing the implantation location based on the desired effector of control. While in PPC, equal representation across effectors supports a BMI that can be flexibly controlled by multiple effectors across the body.

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