Functional Organization of Information Flow in the Corticospinal Pathway

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Abstract:

Transmission of information in the corticospinal (CS) route constitutes the fundamental infrastructure for voluntary actions. The anatomy of this pathway has been studied extensively, but there is little direct evidence regarding its functional organization. Here we explored the areal specificity of CS connections by studying two related questions: the functional significance of the parallel, motor, and premotor CS pathways; and the way in which finger-related motor commands are handled by this pathway. We addressed these questions by recording from primary motor (M1) and premotor cortical sites in primates (Macaca fascicularis) performing a motor task, while measuring the evoked intraspinal unit response to single pulse cortical stimulation. Stimulation in M1 evoked spinal neuronal responses more frequently than stimulation in premotor cortex. The number of muscles excited by M1 stimulation was higher than the number excited by premotor stimulation. Within subregions of M1 finger-related sites were sparsely connected with intermediate zone interneurons and tended to affect the ventrally located motoneurons directly. These results suggest that, despite the parallel anatomical organization, the flow of motor commands is predominantly relayed via M1 to downstream elements. The functional impact of premotor cortex is weak, possibly due to inhibitory systems that can shape the flow of information in the CS pathway. Finally, the difference in spinal processing of finger versus wrist-related motor commands points to a different motor control strategy of finger versus wrist movements.

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