

The Biological Basis of the Body Map

There are body maps in many parts of the brain, both in sensory and in motor areas. Which ones are involved in the Body Map, and do they include both sensory and motor areas? The primary motor and sensory cortices constitute final output stages for motor information to the spinal cord and brainstem, and incoming sensory information from the skin and proprioceptors, respectively. These two areas are organized as a distorted map of the body with more space accorded to the hand and face (the Penfield “Homunculus”) but also represent functional relationships between muscles and sensory inputs. For example, a given muscle may be represented in different places on the motor cortical map depending upon its functional context. Despite these functional representations, these maps probably do not reflect the complex patterns and sequences of muscular action required for different skilled movement, and so probably do not constitute the sole locus of our Body Maps but are likely to be an integral part of this representation.

The motor cortex receives input from more frontal areas concerned with these patterns and sequences, and these motor areas in turn receive information from sensory association areas in the parietal cortex. Together, these parietal and frontal areas are believed to make up a perception-action network that mediates the learning and maintenance of complex patterns and sequences of movement, and works through the primary motor cortex to deliver commands to circuits in the spinal cord and brainstem. This network fully integrates sensory information with motor planning, and is therefore a candidate set of structures, together with the primary motor and sensory cortices, that underlie our Body Maps. The learned use of inappropriate or inefficient combinations and sequences of muscular activation patterns will impact patterns of sensory input besides leading in some cases to repetitive strain injury, all of which could lead to abnormal patterns of activity in the network. These considerations lead to the hypothesis that the Body Map comprises a network in the cerebral cortex that consists of motor and sensory areas that are capable of learning and adaptation.

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