MOTOR CONTROL

# A sense of movement

Neuroscience textbooks tell us that the motor cortex controls movement. But now, Carl Petersen and colleagues show that sensory cortex may have an equally important role in motor control.

The authors showed that a single, brief deflection of the C2 whisker induced activity in the corresponding barrel column of the primary somatosensory cortex (S1), followed by a response in a small area in the primary motor cortex (M1). Direct microstimulation or optogenetic stimulation of either area induced a brief retraction of the C2 whisker, with a shorter latency after S1 stimulation than after M1 stimulation. Thus, S1 and M1 are both involved in whisker motor and sensory processing. The M1 area that induced C2 retraction was termed $M1_{retract}$; a more medial M1 region that induced C2 protraction under microstimulation was termed $M1_{protract}$.

The authors next investigated the functional relevance of this finding. By attaching metal particles to the C2 whisker and applying a pulsed magnetic field, the authors could evoke C2 whisker deflections. The whisker retracted in response to this stimulus, and this response was abolished when S1 was inactivated — but not when M1 was inactivated — with tetrodoxin (TTX). This suggested that S1 drives the retraction response.

These data raised the question of whether M1 requires S1 activation to induce whisker retraction. In fact, microstimulation or optogenetic stimulation of $M1_{retract}$ combined with S1 inactivation using TTX resulted in whisker protraction, and stimulation of $M1_{protract}$ while S1 was inactivated enhanced whisker protraction. This indicates that M1 primarily drives whisker protraction, and that $M1_{retract}$ only induces whisker retraction indirectly, through S1 activation.

By mapping the neural pathways involved in C2 whisker retraction and protraction, the authors found that $M1_{C2}$ and $S1_{C2}$ have reciprocal connections and project to adjacent regions in subcortical areas. In the brain stem, this includes the reticular formation as a projection area of M1, and the spinal trigeminal nuclei as a projection area of S1. Both areas project to the facial nucleus, which contains whisker motor neurons. Indeed, direct electrical stimulation of the reticular formation and spinal trigeminal nuclei induced whisker protraction and retraction, respectively.

Together, these findings point to the existence of two parallel pathways for opposing whisker movement. Whether sensory cortex drives motor responses in other species, including humans, remains to be investigated.

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