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Rats' brains are more like ours than scientists previously thought

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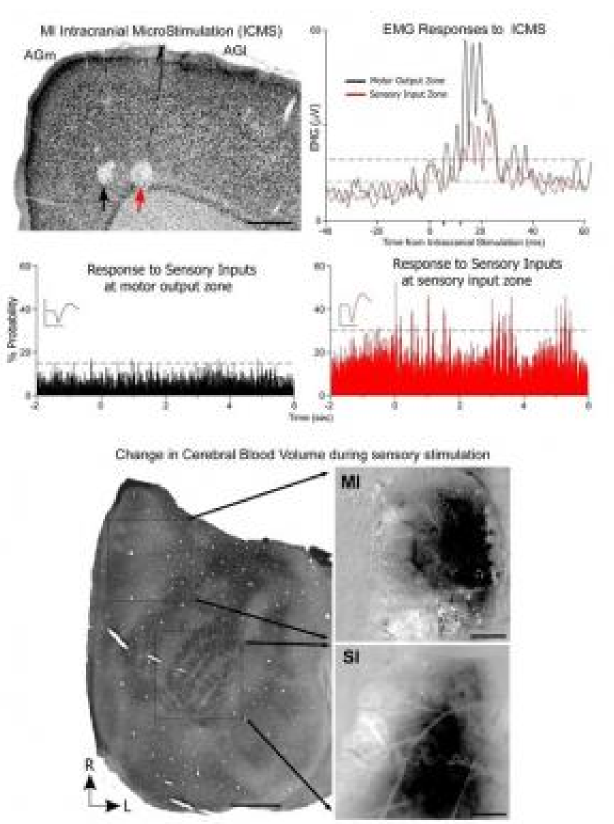

Sensory-motor transformations in rat motor cortex; from collaborative work between Jared Smith, Kevin Alloway and Patrick Drew. Credit: Alloway Lab, Penn State

(Medical Xpress)—Neuroscientists face a multitude of challenges in their efforts to better understand the human brain. If not for model organisms such as the rat, they might never know what really goes on inside our heads.

The brain is a phenomenal processor that in a year's time can generate roughly 300,000 petabytes of data—30,000 times the amount generated by the Large Hadron Collider. Trying to decipher its signals is a daunting prospect.

But particularly for individuals who have lost a limb or been partially or fully paralyzed, such research has potentially life-changing results because it can enable such biotechnological advances as the development of a brain-computer interface for controlling prosthetic limbs.

Such devices require a detailed understanding of the motor cortex, a part of the brain that is crucial in issuing the neural commands that execute behavioral movements. A recent paper published in the journal *Frontiers in Neural Circuits* by Jared Smith and Kevin Alloway, researchers at the Penn State Center for Neural Engineering and affiliates of the Huck Institutes of the Life Sciences, details their discovery of a parallel between the motor cortices of rats and humans that signifies a greater relevance of the rat model to studies of the human brain than scientists had previously known.

"The motor cortex in primates is subdivided into multiple regions, each of which receives unique inputs that allow it to perform a specific motor function," said Alloway, professor of neural and behavioral sciences. "In the rat brain, the motor cortex is small and it appeared that all of it received the same type of input. We know now that sensory inputs to the rat motor cortex terminate in a small region of the motor cortex that is distinct from the larger region that issues the motor commands. Our work demonstrates that the rat motor cortex is parcellated into distinct subregions that perform specific functions, and this result appears to be similar to what is seen in the primate brain."

"You have to take into account the animal's natural behaviors to best understand how its brain is structured for sensory and motor processing," said Jared Smith, graduate student in the Huck Institutes' neuroscience program and the first author of the paper. "For primates like us, that means a strong reliance on visual information from the eyes, but for rats it's more about the somatosensory inputs from their whiskers."

In fact, nearly a third of the rat's sensorimotor cortex is devoted to processing whisker-related information, even though the whiskers' occupy only one-third of one percent of the rat's total body surface. In humans, nearly 40 percent of the entire cortex is devoted to processing visual information even though the eyes occupy a very tiny portion of our body's surface.

To understand the structure and function of the rat motor cortex, Smith and Alloway conducted a series of experiments focused on the medial agranular region, which responds to whisker stimulation and elicits whisker movements when stimulated.

"Our research," said Smith, "was conducted in two stages to investigate the functional organization of the brain: first tracing the neuronal connectivity, and then measuring how the circuits behave in terms of their electrophysiology. Just like in any electrical circuit, the first thing you need to do is trace the wires to see how the different components are connected. Then you can use this information to make sense of the activity going on at any particular node. In the end, you can step back and see how all the circuits work together to achieve something more complex, such as motor control."

"We discovered different sensory input regions that were distinct from the region that issued the motor commands to move the whiskers," said Alloway. "In this respect, we were fortunate to have Patrick Drew [assistant professor of engineering science and mechanics and neurosurgery at Penn State] help us analyze the EMG signals produced by microstimulation because this showed that the sensory input region was significantly less effective in evoking whisker movements."

As a result of Smith and Alloway's discovery, previously published data on the rat motor cortex can be revisited with a new degree of specificity, and more similarities between the brains and neural processes of rats and humans may eventually come to light, perhaps even informing studies of other model organisms. This discovery is also likely to advance the study of the human brain.

"This study opens up avenues for studying some very complex neural processes in rodents that are more like our own than we had previously thought," said Smith. "The tools now available for studying activity in the rodent brain are improving at a remarkable pace, and the findings are even more interesting as we discover just how similar these mammalian relatives are to us. This is a very exciting time in neuroscience."

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