November 9, 2009
RIKEN

Shaping the way we move

A new experimental technique for measuring neural activation patterns in moving rats has clarified the function of excitatory and inhibitory neurons in the brain's motor cortex. In a paper to appear in *Nature Neuroscience*, researchers at the RIKEN Brain Science Institute challenge conventional thinking on neuron function and shed light on the mechanisms governing self-initiated voluntary movement.

When carrying out bodily movements, motor cortex neurons fire before and during motion in a sequence corresponding to the phases of motor preparation, initiation and execution. The dynamics of the complex neural microcircuitry underlying these phases, however, is poorly understood, due to the technical difficulty involved in directly measuring neuron activity in a moving animal.

To overcome this difficulty, the researchers applied new techniques enabling them to record the firing activity and accurately determine the location and identity of individual neurons in the motor cortex of moving rats. Analyzing location and timing data, they were able to identify a key difference between neuron types: whereas excitatory pyramidal cells in all cortical layers fired during every phase of movement, fast-spiking (FS) interneurons, the most prevalent type of inhibitory neurons, fired only during motor execution.

These results suggest that FS interneurons, rather than functioning as a "gate" as typically conceived, act instead to shape and temporally sharpen motor commands via inhibition. While challenging conventional ideas on how cortical motor information is processed, this discovery also promises advancements in the treatment of brain damage and in the development of cutting-edge Brain Machine Interface (BMI) technology.

For more information, please contact:

Dr. Tomoki Fukai
Dr. Yoshikazu Isomura
Laboratory for Neural Circuit Theory, RIKEN Brain Science Institute
Tel: +81-(0)48-462-1111 (ext. 7463) / Fax: +81-(0)48-467-6899

Ms. Saeko Okada (PI officer)
Global Relations Office
RIKEN
Tel: +81-(0)48-462-1225 / Fax: +81-(0)48-462-4715
Email: koho@riken.jp

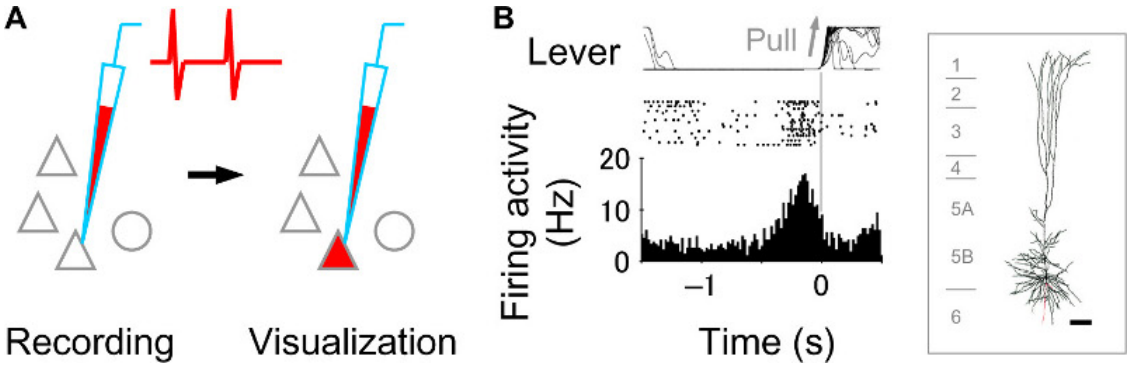

Figure 1. Juxtacellular recording from a single neuron of behaving rats
A) Left, recording of firing activity in a single motor cortex neuron with a glass electrode. Right, loading of dye to the recorded neuron through the electrode for visualization.
B) A visualized layer 5 pyramidal cell (right) showing firing activity prior to pull movement, which may be involved in motor initiation (left).

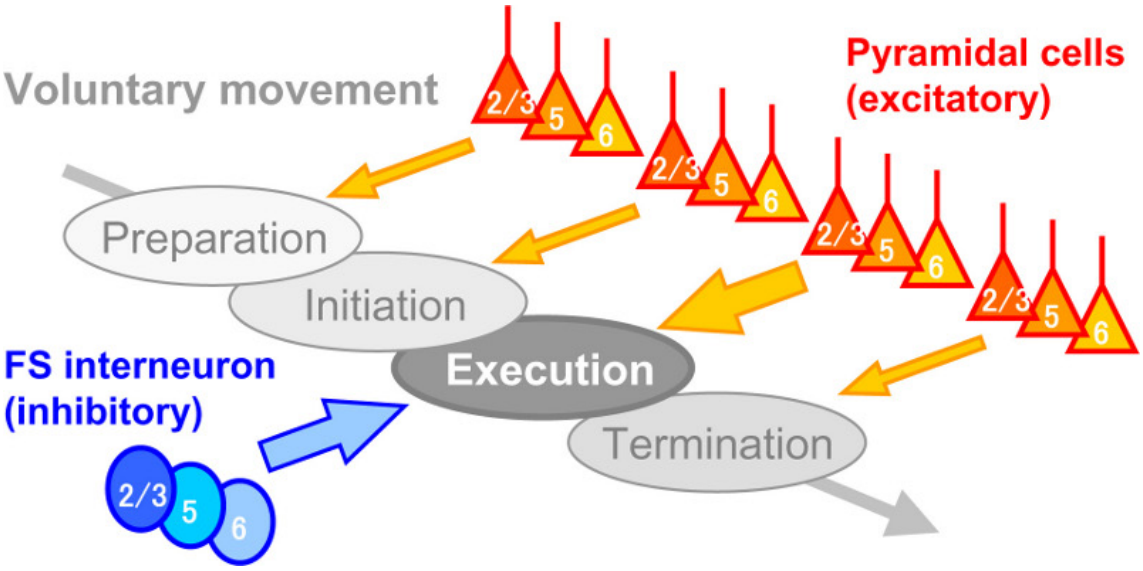

Figure 2. Different functions of pyramidal cells and fast-spiking (FS) interneurons in self-initiated voluntary movement
Pyramidal cells participate in motor phases such as motor preparation, initiation, and execution across all layers of motor cortex. FS interneurons mostly contribute to the motor execution, suggesting that they may not gate but shape a motor command.