Biologists show that what a neuron can do is a function of mechanical context

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The brain as command center for bodily movement was too simple an idea, thought the Russian physiologist Nicolas Bernstein some 60 years ago. After studying human movements for years, Bernstein pointed out in 1940 that the great flexibility of the body, coupled with unexpected events in the world, meant that the nervous system had to prepare the body in advance for what might happen next.

If Bernstein were right, it would affect the design of prosthetic devices and biologically inspired robots.

Using computer technologies unavailable to their predecessor, researchers at Case Western Reserve University have provided direct evidence for Bernstein's hypothesis. Reporting on their findings in the *Journal of Neuroscience* are Hillel Chiel, professor of biology, neurosciences and biomedical engineering; Hui Ye, Chiel's former graduate student who is currently a postdoctoral fellow at the Toronto Western Research Institute; and Dr. Douglas Morton, another former graduate student who is currently a radiologist at Premier Medical Imaging in Michigan.

To test Bernstein's hypothesis in animals, Ye, Morton and Chiel studied the neural control of swallowing in the sea slug Aplysia californica. In stronger swallows, part of the neural output sets up feeding muscles so that they act in new ways. Specifically, a "grasper" muscle, controlled by motor neuron B8, acquires a new function: it not only grasps the food, but also pulls it in.

Another muscle, called the "hinge," that exerts no force in weak swallows can pull the grasper back during strong swallows. This means that the motor neuron for the hinge, B7, affects behavior in one context, but not in another.

These studies provide the first demonstration of Bernstein's hypothesis in a behaving animal, and indicate that the behavioral roles of motor neurons can change depending on how parts of the body are positioned.

The Case scientists have previously applied their research findings to the creation of mechanical devices that mimic the interactions of an animal's neurons and muscles to produce movement.

"This study demonstrates the interconnectedness of the neurons and the muscles and how it is just as relevant in humans as it is in the less complicated system of the slug," said Chiel, who has patented robotic graspers based on the sea slug's behavior.

Understanding how neurons trigger and interact with the muscles will help Chiel and his research group develop new generations of robots that can move through water or tube-like structures such as pipes, blood vessels and the colon.

Source: Case Western Reserve University