Neurons in human muscles emphasize the impact of the outside world

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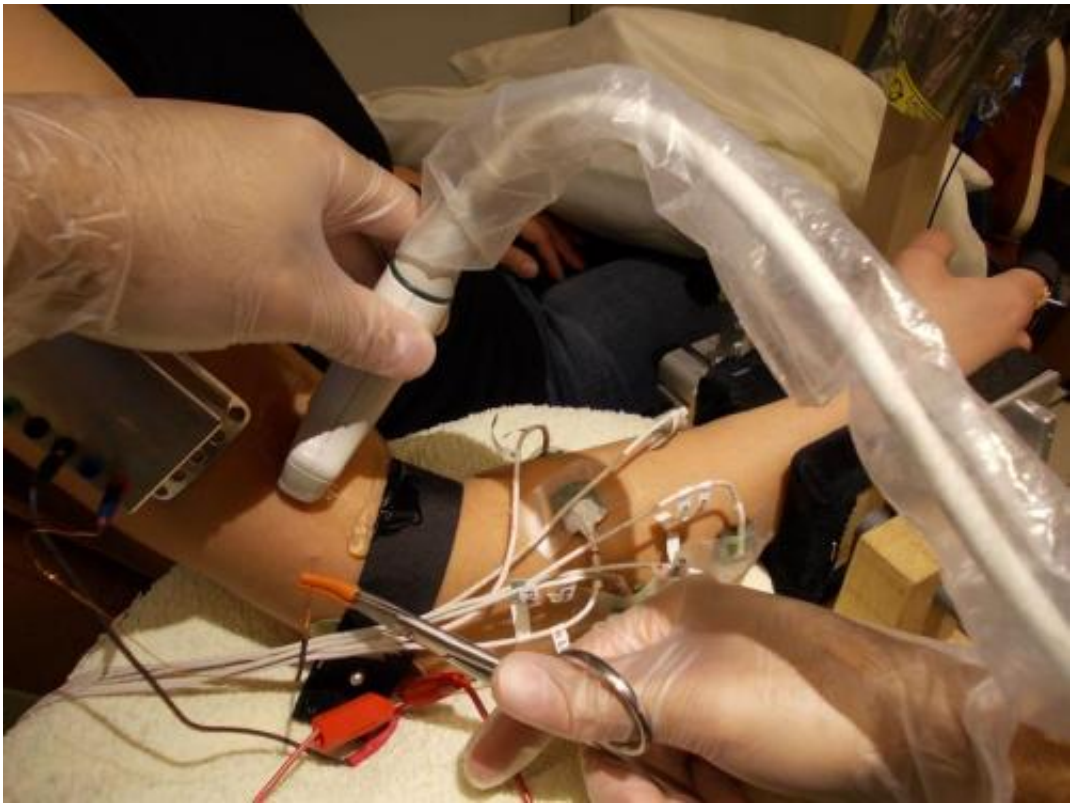

The results of the study show that stretch receptors in our muscles indicate more than which limb is moving or how fast; these sensors also adjust their signals according to who caused the movement. Credit: Michael Dimitriou

Stretch sensors in our muscles participate in reflexes that serve the subconscious control of posture and movement. According to a new study published in the *Journal of Neuroscience*, these sensors respond

weakly to muscle stretch caused by one's voluntary action, and most strongly to stretch that is imposed by external forces. The ability to reflect causality in this manner can facilitate appropriate reflex control and accurate self-perception.

"The results of the study show that stretch receptors in our muscles indicate more than which limb is moving or how fast; these sensors also adjust their signals according to who caused the movement," says Michael Dimitriou, who conducted this study and is currently a post doc at the Department of Integrative Medical Biology, Umeå University, Sweden.

Normally, we can easily distinguish between movements we make ourselves and movements that are imposed on our body by external forces. The ability to discriminate between self-generated and externally generated sensory events is crucial for accurate perception and the control of posture and movement. This ability is also believed to form the foundation on which conscious self-awareness is built.

Such discrimination between self and other has previously been thought to arise as a result of complex computations performed in the brain, that use prior knowledge or memories of the consequences of own actions. But the study by Michael Dimitriou shows that information on the cause of a sensory effect can be provided in real-time by so-called 'muscle spindles', a class of stretch receptors found in most of our skeletal muscles.

Muscle spindles differ from other sensory receptors, such as stretch receptors in the skin, because their sensitivity can be controlled by the nervous system via specialized motor neurons. The purpose of this control has been unclear. The neural data presented by Michael Dimitriou indicates that these specialized motor neurons increase the sensitivity of stretch receptors when the body is exposed to an externally

imposed stretch stimulus, such as when a falling ball is caught in the hand. Because amplified spindle responses mean stronger stretch reflexes, the resulting muscle activity instantly counteracts movement of the hand. When making a voluntary movement, however, the nervous system 'automatically' reduces the sensitivity of spindles in the stretching muscles, thereby making it possible for us to move without setting off strong stretch reflexes that would otherwise counteract movement. Uncontrollably strong stretch reflexes are commonly referred to as 'spasticity'.

"These results provide an explanation of how reflexes can be functionally adjusted to help us achieve our everyday tasks, without requiring conscious control of reflex sensitivity or complex computations in the brain for predicting the sensory consequences of our actions," says Michael Dimitriou.

He believes that these new findings are important both for understanding the neural mechanisms that underlie movement control and self-perception, but also for understanding pathological states where these mechanisms are disturbed.

"With these findings, we also get new insights into mechanisms whose malfunction may contribute to neuromuscular problems such as spasticity or alien hand syndrome (also known as 'Dr. Strangelove syndrome'), and help identify potential treatment targets for these conditions," says Michael Dimitriou.

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