From spinal cord injury to recovery

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Spinal cord injury disconnects communication between the brain and the spinal cord, disrupting control over parts of the body. Studying the mechanisms of recovery, Leuven researcher Aya Takeoka (NERF) found that a specific type of neuronal feedback from sites below the injury plays a crucial role during early recovery and for maintaining regained motor functions. These new basic research findings implicate the importance of continued use of affected body parts for rehabilitative success in spinal cord injury patients.

"Following spinal cord injury, disrupted neuronal pathways can no longer provide sufficiently strong signals to the spinal networks below the injury, often leading to permanent and devastating motor impairment," explains prof. Aya Takeoka from NERF (NeuroElectronics Research Flanders), an interdisciplinary research center empowered by VIB, KU Leuven and imec. Her lab studies the mechanisms of motor learning and control, including how motor functions recover after injury.

"Incomplete injuries, where only part of the neuronal connections are damaged, frequently recover spontaneously," adds Takeoka. "We know that activating a very specific type of sensory feedback pathway plays a crucial role during rehabilitative training, promoting the formation of detour circuits. Understanding this process in more detail can help us design rehabilitation strategies with maximal benefit for spinal cord injury patients."

Early and maintained feedback for maximal success

One type of so-called somatosensory feedback is proprioception, which entails the unconscious perception of self-movement and body position through nerve cells that are located in close proximity of the spinal cord and can detect muscle stretch.

To learn more about where and when proprioceptive feedback affects locomotor recovery after injury, Takeoka devised a conditional genetic approach to eliminate this type of feedback at different locations and time points in mice. Using these models, she showed that proprioceptive feedback below but not above the site of injury is critical for naturally occurring circuit rearrangement and locomotor recovery.

"We found a central role for so-called proprioceptive afferents, nerve fibers which signal proprioceptive information back to the spinal cord," says Takeoka. "Afferents below the lesion undergo specific rearrangements soon after injury, and without them regained motor function cannot be maintained, even if detour circuits have formed."

In short, proprioceptive feedback is not only essential to initiate locomotor recovery but it is also permanently required to maintain any regained motor function. According to Takeoka, these findings can inform rehabilitation practices for patients as well: "The fact that proprioceptive feedback, specifically from below the site of injury, is so important, suggests that task-specific rehabilitative training that emphasizes such feedback is likely to maximize functional outcomes in rehabilitation clinics."

More information: Aya Takeoka et al. Functional Local Proprioceptive Feedback Circuits Initiate and Maintain Locomotor Recovery after Spinal Cord Injury, *Cell Reports* (2019). DOI: 10.1016/j.celrep.2019.03.010

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