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Timing is crucial from the brain to the spinal cord

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Just a slight movement of the hand is an intricate concert of interactions between nerve cells. For a signal from the brain to reach the spinal cord and then the muscle, different neuronal networks must find a common rhythm. Neurosurgeon Professor Alireza Gharabaghi and his team have broken down this complex process in a study at the University of Tübingen. A better understanding of such processes can help to develop new therapies for patients with hand paralysis. The findings were published in the journal *Cerebral Cortex*.

Brushing our teeth, drinking coffee or using a smartphone: We use our hands naturally and without thinking while going about our lives. It is different for people who are paralyzed after a stroke or accident, causing signals transmitted from the brain along the spinal cord to the muscles to become out of sync. This is why we need to understand the exact rhythm in which the nerve cells in the motor system normally communicate with each other in order to be able to restore this rhythm even after damage to the nervous system.

Transcranial magnetic stimulation (TMS), a non-invasive and painless method of diagnosis and treatment, is particularly suitable for this purpose. TMS allows the activity of nerve cells in the brain and spinal cord to be investigated without contact. A magnetic field generates a pulse above the head; neuronal signals are transmitted from nerve cells to nerve cells until, for example, they reach the hand and trigger movement. Simultaneous electrical recordings with electroencephalography (EEG) and electromyography (EMG) can be used to determine the state of activity of the nerve cells when they communicate particularly well with each other.

Alireza Gharabaghi's team has now been able to show that two different neuronal networks, which oscillate in different rhythms, are particularly important for interaction between the brain and spinal cord: The first network occurs in the motor areas of the left and right hemispheres of the brain and oscillates at a frequency of 14-17 Hz and the second oscillates mainly between the brain and the spinal cord at a frequency of 20-24 Hz. Timing is crucial in both networks: Impulses must arrive exactly to the millisecond so that they are passed on optimally to the hand. "These findings can help us to develop more targeted therapies for people with paralysis of the hand," says Gharabaghi. Further studies are planned to investigate a clinical application for stroke patients.

More information: Fatemeh Khademi et al. Distinct Beta-band Oscillatory Circuits Underlie Corticospinal Gain Modulation, *Cerebral Cortex* (2018). DOI: 10.1093/cercor/bhy016

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