Non-Invasive Brain Stimulation Shown to Impact Walking Patterns

In a step towards improving rehabilitation for patients with walking impairments, researchers from the Kennedy Krieger Institute [1] found that non-invasive stimulation of the cerebellum, an area of the brain known to be essential in adaptive learning, helped healthy individuals learn a new walking pattern more rapidly. The findings suggest that cerebellar transcranial direct current stimulation (tDCS) may be a valuable therapy tool to aid people relearning how to walk following a stroke or other brain injury.
Previous studies in the lab of Amy Bastian, PhD, PT [2], director of the Motion Analysis Laboratory [3] at Kennedy Krieger Institute, have shown that the cerebellum, a part of the brain involved in movement coordination, is essential for walking adaptation. In this new study, Dr. Bastian and her colleagues explored the impact of stimulation over the cerebellum on adaptive learning of a new walking pattern. Specifically, her team tested how anode (positive), cathode (negative) or sham (none) stimulation affected this learning process.

"We've known that the cerebellum is essential to adaptive learning mechanisms like reaching, walking, balance and eye movements,"says Dr. Bastian. "In this study, we wanted to examine the effects of direct stimulation of the cerebellum on locomotor learning utilizing a split-belt treadmill that separately controls the legs."

The study, published today in the Journal of Neurophysiology [4], found that by placing electrodes on the scalp over the cerebellum and applying very low levels of current, the rate of walking adaptation could be increased or decreased. Dr. Bastian's team studied 53 healthy adults in a series of split-belt treadmill walking tests. Rather than a single belt, a split-belt treadmill consists of two belts that can move at different speeds. During split-belt walking, one leg is set to move faster than the other. This initially disrupts coordination between the legs so the user is not walking symmetrically, however over time the user learns to adapt to the disturbance.

The main experiment consisted of a two-minute baseline period of walking with both belts at the same slow speed, followed by a 15-minute period with the belts at two separate speeds. While people were on the treadmill, researchers stimulated one side of the cerebellum to assess the impact on the rate of re-adjustment to a symmetric walking pattern.

Dr. Bastian's team found not only that cerebellar tDCS can change the rate of cerebellum-dependent locomotor learning, but specifically that the anode speeds up learning and the cathode slows it down. It was also surprising that the side of the cerebellum that was stimulated mattered; only stimulation of the side that controls the leg walking on the faster treadmill belt changed adaptation rate.

"It is important to demonstrate that we can make learning faster or slower, as it suggests that we are not merely interfering with brain function," says Dr. Bastian. "Our findings also suggest that tDCS can be selectively used to assess and understand motor learning."

The results from this study present an exciting opportunity to test cerebellar tDCS as a rehabilitation tool. Dr. Bastian says, "If anodal tDCS prompts faster learning, this may help reduce the amount of time needed for stroke patients to relearn to walk evenly. It may also be possible to use tDCS to help sustain gains made in therapy, so patients can retain and practice improved walking patterns for a longer period of time. We are currently testing these ideas in individuals who have had a stroke."

Other co-authors on this study were Pablo Celnik and Gowri Jayaram, Johns Hopkins University School of Medicine; and Byron Tang, Rani Pallegadda, and Erin V.L. Vasudevan, Kennedy Krieger Institute.

The study was funded by the National Institutes of Health [5] and the Johns Hopkins Brain Sciences Institute.

About the Kennedy Krieger Institute:
Internationally recognized for improving the lives of children and adolescents with disorders and injuries of the brain and spinal cord, the Kennedy Krieger Institute in Baltimore, MD serves more than 16,000 individuals each year through inpatient and outpatient clinics, home and community services and school-based programs. Kennedy Krieger provides a wide range of services for children with developmental concerns mild to severe, and is home to a team of investigators who are contributing to the understanding of how disorders develop while pioneering new interventions and earlier diagnosis. For more information on Kennedy Krieger Institute, visit www.kennedykrieger.org [1].

About the Motion Analysis Laboratory:
The Motion Analysis Laboratory [3] at Kennedy Krieger Institute studies performance and learning of reaching and walking movements in healthy adults and children, and in different patient populations including: adults and children with cerebellar damage, adults with hemiparesis from stroke, adults with multiple sclerosis or adrenomyeloneuropathy, children with hemispherectomy, children with cerebral palsy and children with autism. All studies are designed to test specific hypotheses about the function of different brain areas, the cause of specific impairments and/or the effects of different interventions.

Links:
[1] http://www.kennedykrieger.org/node/3723

[2] http://www.kennedykrieger.org/node/1200
[3] http://www.kennedykrieger.org/node/2196
[4] http://jn.physiology.org/
[5] http://www.nih.gov/