New research discovers independent brain networks control human walking

August 7 2007

In a study published in the August issue of *Nature Neuroscience*, researchers at the Kennedy Krieger Institute in Baltimore, Maryland found that there are separate adaptable networks controlling each leg and there are also separate networks controlling leg movements, e.g., forward or backward walking.

These findings are contrary to the currently accepted theory that leg movements and adaptations are directed by a single control circuit in the brain. The ability to train the right and left legs independently opens the door to new therapeutic approaches for correcting walking abilities in patients with brain injury (e.g., stroke) and neurological disorders (e.g., cerebral palsy and multiple sclerosis).

Using a split-belt treadmill to separately control the legs, Kennedy Krieger researchers Dr. Amy Bastian and Julia Choi studied forty healthy adults and tracked each person's ability to learn various walking exercises. Utilizing specialized computer software and infrared tracking devices placed on key joints, researchers found subjects could store different walking patterns for forward versus backward walking simultaneously, with no interference between the two, revealing that separate brain systems control the two directions of walking. Surprisingly, people could also walk easily with one leg moving forward and the other backward, a pattern referred to as "hybrid walking." Adaptation of hybrid walking, in which varying speeds were applied to legs walking in opposite directions, was found to interfere with subsequent "normal" forward and backward walking. The combined results demonstrate there are distinct brain modules responsible for right/forward, right/backward, left/forward and left/backward walking. Most significantly, these modules can be individually trained, which would be critical for rehabilitation focused on correcting walking asymmetries produced by brain damage.

“The notion that we can leverage the brain’s adaptive capacity and effectively ‘dial in’ the patterns of movement that we want patients to learn is incredibly exciting,” said Dr. Amy Bastian, senior study author and Director of the Motion Analysis Laboratory at the Kennedy Krieger Institute. “These findings significantly enhance our understanding of motor skills, effective therapeutic approaches and the true adaptive nature of the brain.”

The walking adaptations studied here represent a form of short term learning from practicing on this unusual treadmill. Investigators set different speeds for each belt of the treadmill causing subjects to walk in an abnormal limping pattern. However, within 15 minutes subjects adapted and learned to walk smoothly with a normal pattern and rhythm, as verified by computer models. This indicates that the phenomenon of brain plasticity can occur in short intervals. When subjects returned to normal conditions (same speed for the two legs), this adaptation caused an after-effect that resulted in a limp that lasted for five-to-ten minutes as they “unlearned” the correction. Regardless of how hard subjects tried, they were unable to stop this after-effect, because walking patterns are controlled by automatic brain systems that recalibrate themselves according to current conditions.

“As we understand more about the way the brain learns, relearns and adapts in relation to motor skills, physical therapy professionals have a vastly expanding toolbox from which to tailor therapeutic interventions,” explains Gary Goldstein, MD, President and CEO of the Kennedy Krieger Institute. “This study and other research from Kennedy Krieger’s

Motion Analysis Laboratory provide a glimpse into the rehabilitative potential made possible through the pairing of our talented researchers and cutting-edge technologies."

Past studies by Bastian and her colleagues have found that certain types of brain damage interfere with walking ability, while others do not. For example, individuals with damage to the cerebral hemispheres can adapt while those with damage to the cerebellum are rarely able to.

This body of work sheds light on the specificity of walking adaptations and demonstrates that patients with certain types of brain damage can store a new walking pattern in the short term. Based on these findings, Bastian's goal is to learn how to make that pattern last for an extended period. Currently, Bastian is planning a study of stroke victims in order to test the long-term benefits of split-belt treadmill therapy. She is also studying children with more extreme forms of brain damage, including those that undergo a hemispherectomy, a neurosurgical procedure to treat seizures in which an entire half of the brain is removed. The initial findings are quite promising, showing that these children can adapt in the short term and improve their walking patterns. These and other similar studies are leading researchers down the path to more targeted, rational therapies for patients with brain injuries.

Source: Kennedy Krieger Institute

Citation: New research discovers independent brain networks control human walking (2007, August 7) retrieved 25 April 2024 from https://medicalxpress.com/news/2007-08-independent-brain-networks-human.html