NNJTBIS
Northern New Jersey
Traumatic Brain Injury System
at Kessler Foundation

Real-Life Science

Augmenting Cognitive Rehabilitation using functional Magnetic Resonance Imaging

By Tien Tong, research data coordinator
Center for Traumatic Brain Injury Research, Kessler Foundation

Functional Magnetic Resonance Imaging (fMRI) is a radiation-free tool allowing scientists to noninvasively assess how your brain functions when thinking, remembering events, and performing other cognitive tasks.

The mission of the Centers for Neuropsychology and Neuroscience Research and Traumatic Brain Injury Research at Kessler Foundation is to help people with neurological conditions, including multiple sclerosis, traumatic brain injury, and spinal cord injury, regain their ability to think, learn, and remember. Scientists at the Foundation use fMRI extensively in their research to study brain mechanisms' underlying cognitive deficits (e.g., difficulty in learning and remembering information) and improvements after cognitive rehabilitation.

When you engage in cognitive activities like processing or remembering information, certain regions of your brain become more active than others, requiring more energy. To meet this heightened demand, oxygen-carrying blood is transported to these active brain regions to replenish energy. By using fMRI to examine these changes in the level of oxygen-carrying blood, researchers can infer which brain regions are active when you perform cognitive tasks.

Researchers use fMRI in many of the Foundation's ongoing investigations to compare brain activation between people with and without neurological conditions when performing the same task. These studies are crucial for developing cognitive rehabilitation programs and other treatments.

Nancy Chiaravalloti, PhD, director of the Centers for Neuropsychology and Neuroscience Research and Traumatic Brain Injury Research leads a broad range of studies. One such study focuses on whether individuals with conditions such as traumatic brain injury experience more severe cognitive consequences post-COVID 19, using fMRI to identify changes in the brain resulting from COVID-19.

Another study examines brain regions involved in deficits in implicit procedural learning or learning motor skills like riding a bike, playing the piano, or learning to swim. The ability to learn motor skills during physical therapy and beyond is essential for motor rehabilitation in spinal cord injury.

Using fMRI to gauge neural mechanisms of memory deficit is a topic of great interest for Joshua Sandry, PhD, who collaborates with researchers at the Foundation on two fMRI studies. These studies examine brain regions involved in working memory (e.g., trying to keep a new phone number in your mind) and long-term memory (e.g., remembering your mom's phone number from five years ago).

Other studies that focus on cognitive rehabilitation use fMRI as well. In particular, Foundation researchers examine brain changes after cognitive rehabilitation by comparing fMRI data from the same group of people before and after cognitive treatments to study regions associated with improved performance.

Several of Dr. Chiaravalloti's investigations examine techniques to improve learning and retain new information in people with multiple sclerosis, traumatic brain injury, spinal cord injury, and aging. The Kessler Foundation modified Story Memory Technique (KF-mSMT®) incorporates the use of imagery and contextual cues to help people remember new information. An fMRI is used to identify changes in brain functioning after learning these techniques.

Scientists in the Centers for Neuropsychology and Neuroscience Research and Traumatic Brain Injury Research are also involved in investigating alternative methods to improve memory and other cognitive abilities such as exercising (Brian Sandroff, PhD), mindfulness training (Jean Lengenfelder, PhD), strategic timing of sleep (Anthony Lequerica, PhD), and feedback to boost learning (Ekaterina Dobryakova, PhD). The researchers use fMRI to identify changes in the brain that correspond to each of these methods.

Our researchers continue their tireless efforts to fulfill the Centers' mission of improving the lives of people with neurological conditions through cognitive rehabilitation and fMRI remains one of our important and innovative research tools.