



THE NEUROCOGNITIVE INSTITUTE

Integrating Science with Practice

Neuroimaging, Functional Brain Mapping and Neuromodulation

Neuroimaging and Brain Mapping

At NCI, we use a variety of neuroimaging techniques to assess the structure and physiology of the brain. For many patients a structural MRI of the brain is necessary as part of the neurodiagnostic process. Unlike most centers that rely only on the radiologist's interpretation of the scan, at NCI our neuroradiologists' use quantitative MRI software. NeuroQuant™ is FDA approved image software that compares a patient's regional brain volume in areas such as the hippocampus and white matter with those of a normative database that corrects for age, gender and head size. This quantitative structural neuroimaging technique is proving to be a useful tool in helping to discriminate among the various neurodegenerative dementia causing diseases.

Complementing these structural based approaches are a number of neurophysiological techniques used at NCI to help diagnosis the underlying cause or causes of a patient's cognitive impairment. Perfusion MRI of the brain is a quick scan that takes less than a minute and can help identify neurovascular causes of cognitive impairment. We can also measure the brain response to intervention we use to treating cognitive impairment from ischemic neurovascular disease. Additional procedures such as FDG-PET can help distinguish among dementia from Alzheimer's disease (AD) from a variety of Frontotemporal dementia producing diseases by analyzing patterns of hypometabolism. The recently FDA approved amyloid PET brain imaging has increased specificity over FDG-PET by identifying amyloid plaques in the brain. This diagnostic procedure allows our doctors to definitively rule-out AD as an underlying cause of a patient's cognitive impairment. Additional nuclear medicine based neurodiagnostic procedures used in the differential dementia evaluation at NCI include DATscans. This scan uses SPECT imaging to help our doctors identify synucleinopathy related dementias such as Lewy-body disease.

Functional Cortical Assessment

Neuropsychological testing tells the doctors at NCI how the patient's cortex is functioning. A neuropsychological test battery assesses various cognitive domains such as information processing speed, attention, learning, memory and executive systems. Emotional and behavioral assessments are

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also included. These tests are combined with a comprehensive medical history, neurological and psychiatric examination.

Overview of Functional Brain Mapping

Functional brain mapping allows for the correlation of abnormalities in various cortical networks with a patient's symptoms or deficits. For instance – brain mapping combines neuropsychological testing of cognition with the results from sLORETA or fMRI brain mapping. At NCI we predominantly use sLORETA analysis which is an electrical neuroimaging technique. This advanced neurodiagnostic procedure allows us to more accurately diagnosis and treat a wide variety of cognitive, neurobehavioral and neuropsychiatric disorders. For example, we can map various cortical networks in the brain, such as the attention, executive, language, depression or the pain network. If abnormalities are detected, we can identify the precise location within the network and determine if these deviations are due to cortical tone, connectivity and/or timing abnormalities. We are able to determine if the finding is abnormal by comparing the brain mapping results to a large age and gender matched normative database. In addition, we use various clinical databases to generate a Probability Index score to assess the probability that the abnormalities are due to central nervous system disorders such as ADHD, Alzheimer's disease, Seizures, Traumatic Brain Injury or a Learning Disability.

Currently, the largest normative and clinical databases of brain imaging data have been developed from electrical neuroimaging techniques. These databases continue to be cross validated with multiple other functional brain mapping techniques such as functional MRI. Using source analysis software, brain topography and tomography imaging not only has excellent temporal (time) resolution, but structural location can be computed throughout the cortex including the limbic system. Spatial resolution as precise as a 3 mm area of localization using standardized MRI imaging templates can be visualized. Another advantage, and perhaps this is the most important advantage, electrical neuroimaging can also be used as an intervention.

Interventional Brain Mapping

Neuromodulation treatment applications such as transcranial direct current stimulation (tDCS), rapid transcranial magnetic stimulation (rTMS) and EEG Neurofeedback can be used to treat clinically significant brain abnormalities detected on brain mapping. Among these various neuromodulation applications, Neurofeedback currently has the widest range of clinical applications. Although Neurofeedback has been used as a clinical tool since the 1960s, brain mapping neurofeedback using

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LORETA software is a relatively recent development dating back to approximately 2008. This technology uses advancements made over the past 15 years mapping multiple brain circuits responsible for a plethora of human experiences; from basic functions such as sustaining wakefulness to complex functions such as decision making.

Clinically, sLORETA Neurofeedback is rapidly growing around the globe as a treatment application to alter brain networks that are not functioning at their optimal levels. In non-clinical populations, brain mapping Neurofeedback is also being used to enhance performance and cognitive functions such as reaction time and decision speed in individuals who are functioning in highly competitive environments.

For additional information on these and other recently developed diagnostic tests, treatment interventions such as cognitive rehabilitation, behavioral management, psychotherapy, psychopharmacological and nutraceutical treatments, clinical research trials, as well as, peak performance training – please call the NeuroCognitive Institute and schedule a consultation. Neuroimaging, FBMAP and neuromodulation interventions such as neurofeedback are clinical procedures and reimbursed by most 3rd party healthcare insurance carriers. NCI participates in most healthcare plans including Medicare and Medicaid.

One of Many Scientific References on Functional Brain Mapping and Neuromodulation

Functional Brain Mapping and the Endeavor to Understand the Working Brain: Signorelli and Chirchiglia (2013).

Mind Over Chatter: Plastic up-regulation of the fMRI salience network directly after EEG Neurofeedback. Neuroimage, 65, 324-335.

Quantitative Structural MRI for early detection of Alzheimer's disease: McEvoy and Brewer (2010). Expert Reviews in Neurotherapy. November: 10 (11): 1675-1688.

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