FEATURE:
Neuroplasticity in Stroke/Aphasia Recovery, September 2014

Editor's Note:
Neuroplasticity is the brain's amazing capacity to change and adapt. In this feature article, we review research evidence showing how neuroplasticity helps stroke and aphasia recovery.

Stroke is the leading cause of long-term disability. In the United States more than 700,000 people suffer a stroke each year, and approximately two-thirds of these individuals survive and require rehabilitation. [1]. Aphasia is a common result of stroke, affecting over one million Americans; it is a condition that may be defined as "the partial or complete loss of language function after brain damage".[2]

In their 2011 article in The American Journal of Therapeutics, Young and Tolentino [3] comment that a clinical interest and research concerning neuroplasticity have reached a new level. They state:

"In just the last two decades, science has begun to appreciate the central nervous system's attempts to repair itself through a process termed neuroplasticity . . . This review describes the various studies on neuroplasticity and the variety of interventions now available. "

The use of functional neuroimaging has been helpful to identify brain areas involved in language and motor recovery. Because of the availability of advanced imaging techniques such as functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI), we have seen the emergence of non-invasive brain stimulation, specifically Transcranial Magnetic Stimulation (TMS), Transcranial Direct Current Stimulation (tDCS) and repetitive Transcranial Magnetic Stimulation (rTMS), as potential treatments for post-stroke motor recovery and aphasia.[4, 5]

In this next section, we discuss a neuroplastic tool used for stroke and aphasia - **Constraint-Induced Movement Therapy**, also known CI or CIMT. CI is a form of rehabilitation treatment that improves upper extremity function in stroke victims by increasing the use of their affected upper limb. It was developed by **Edward Taub of the University of Alabama at Birmingham.** (See Taub Therapy- Clinic Overview- http://www.uabmedicine.org/Locations/taub-therapy).

Taub argues that, after a stroke, the patient stops using the affected limb because they are discouraged by the difficulty. As a result, a process that Taub calls "learned non-use" sets in, furthering deterioration. In limb or motor treatment and recovery, human and animal studies provide evidence that "CI therapy produces marked neuroplastic changes in the structure and function of the Central Nervous System.".[6, 7 , 8]

As with any rehabilitation research, there can be controversy, and CI as a tool and Taub as a researcher are no different.[9]

CI or CIMT has also been used a tool in aphasia treatment and recovery, where it is known as **Constraint – Induced Language Therapy (CILT**). CILT creates an environment that "constrains patients to systematically complete intensive practice of speech acts with which they have difficulty"; It limits the use of writing, gesturing, drawing or giving up on a message all together in order to promote oral expression. As with any aphasia/apraxia treatment program, individual clinicians have evolved to using modified versions of CILT. [10]

Some current evidence shows some positive effects combining CILT and intensive aphasia treatment for individuals with nonfluent chronic aphasia, but additional research is needed with the use of CILT, in individuals with acute aphasia and those with fluent types of aphasia [11,12, 13] Additional research, however, disputes this position. In a paper in the journal *Aphasiology*, Rose proposed that multi-modal (client responses are open to speech, gesture, pointing, facial expression, etc.) aphasia therapy is as beneficial as CI indicating that, "..there is limited support for constraining client responses to the spoken modality".[14]

Treatment using the BCAT program at aphasiatoolbox.com utilizes constraint as one technique among many in the skilled aphasia clinician's toolbox. The patient may temporarily be limited to one way of responding but in order to best facilitate neural interaction among speech, language and motor systems, open responses are nearly always encouraged. According to Aphasia Clinician Bill Connors, "To maximize aphasia recovery, clients need to have a rich, robust program that is challenging but not frustrating. This allows for better interaction between areas of the brain and enhances the exploitation of neuroplasticity."

Neuroplasticity - New Research/New Technology
A number of interesting current and upcoming clinical trials have combined technology and neuroscience for stroke and aphasia rehabilitation to specifically show/prove *how* neuroplasticity helps the brain.

One current trial is "Examining How Motor Rehabilitation Promotes Brain Reorganization Following Stroke, an MRI Study".

Clinical Trial Background:
Constraint-induced movement therapy (CI therapy) is a highly efficacious treatment for residual motor disability in chronic stroke. Its effectiveness is believed to be due, at least in part, to the therapy's ability to aid the brain in "rewiring itself." For example, CI therapy produces increases in the amount of grey matter (the parts of the brain where neuron cell bodies are most closely clustered) in certain areas of the human brain (Gauthier et al., 2008). The cellular and molecular mechanisms that are responsible for this increase in grey matter volume are not known, however. Thus, it is unclear how the therapy helps brains "rewire" themselves. This study aims to better understand the timecourse and cellular/molecular nature of brain changes during CI therapy. Because there is currently no way to directly measure cellular/molecular changes in the brain noninvasively, this study will infer what is happening on a microstructural level using new MRI techniques (three dimensional pictures of the brain). For example, by charting the timecourse of grey matter changes during CI therapy, and cross-comparing this to what is known about the timecourses of different cellular/molecular processes, the investigators can gain a greater understanding of what cellular processes may be responsible for increases in grey matter. The investigators will gain additional information about which cellular processes are important for rehabilitation-induced

improvement by measuring larger-scale changes (e.g.,amount of blood flow through different brain areas) that accompany cellular changes. The investigators are hopeful that by better understanding how CI therapy can change the brain, the effectiveness of rehabilitation can be improved upon. For example, insight into the mechanisms of rehabilitation-induced brain change may suggest particular drug targets to increase brain plasticity. This study will help us better understand how the brain repairs itself after injury.

The study began in July 2012 and will conclude by June 2016.

Reference: http://clinicaltrials.gov/show/NCT01725919

Another clinical trial is "Neuroplastic Change in Myelin of the Brain: Structural and Functional Correlates of Neuroplastic Change Associated With Stroke".

Clinical Trial Background:
The main goal of this research is to advance understanding of how stroke changes both the structure and function of the brain. The investigators will determine which is the key driver of recovery of arm function after stroke: changes in the structure of the brain or changes in how brain regions interact with one another.

The study began in June 2014 and will conclude by September 2018.

Reference: http://clinicaltrials.gov/show/NCT01937910

Other clinical trials related to aphasia include:

Neurobiology of Language Recovery in Aphasia: Natural History and Treatment-Induced Recovery

Clinical Trial Background:
The purpose of this study is to investigate the effects of treatment for specific language deficits in people with aphasia. In addition to language and cognitive measures, changes in brain function will also be gathered before and after the treatment is administered in order to track any changes resulting from receiving treatment.

The study began in April 2013 and will conclude by March 2019.

Reference: http://clinicaltrials.gov/show/NCT01927302

Enhancing Written Communication in Persons With Aphasia

Clinical Trial Background:
The purpose of this study is to evaluate whether a computerized speech-language treatment delivered by a virtual therapist (Oral Reading for Language in Aphasia (ORLA) + Writing) results in improved written communication skills of study participants with aphasia (i.e., difficulty with the comprehension and expression of spoken and written language).

The study began in Feb 2013 and will conclude by - Sept 2015..

Reference: http://clinicaltrials.gov/show/NCT01790880

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