Medical Xpress

Stimulating the brain to improve speech, memory, numerical abilities

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One of the most frustrating challenges for some stroke patients can be the inability to find and speak words even if they know what they want to say. Speech therapy is laborious and can take months. New research is seeking to cut that time significantly, with the help of non-invasive brain stimulation.

"Non-invasive brain stimulation can allow painless, inexpensive, and apparently safe method for cognitive improvement with with potential long term efficacy," says Roi Cohen Kadosh of the University of Oxford. Recent results, presented this week at a meeting of cognitive neuroscientists in Chicago, offer exciting possibilities for improving variety of abilities – from speech to memory to numerical proficiency.

A focus of many of these studies is tDCS – transcranial direct current stimulation. In tDCS, researchers apply weak electrical currents to the head via electrodes for a short period of time, for example 20 minutes. The currents pass through the skull and alter spontaneous neural activity. Some types of stimulation excite the neurons, while others suppress them. Subjects usually feel only a slight tingling for less than 30 seconds. The effects of tDCS can last for up to 12 months, Cohen Kadosh says, "most likely due to molecular and cellular changes that are important mechanisms implementing learning and memory."

Stimulating speech recovery

For Jenny Crinion of University College London, who is both a neuroscientist and clinical speech and language therapist, the interest in tDCS sprang from a desire to help stroke patients through their long recovery. While speech therapy works well at improving speech following aphasic stroke, it can be frustratingly slow. She hopes to pair brain-stimulation interventions with proven language-rehabilitation methods, Crinion says, "such that the same maximum recovery is ultimately achieved as with therapy alone but with fewer hours of rehab."

Crinion's current work focuses on understanding how tDCS affects the areas of the brain involved in speech production. She paired an fMRI picture-naming study with a 6-week-long tDCS and word-finding treatment study to see if brain stimulation could improve stroke patients' speech both immediately after treatment and three months later. In the picture-naming task, people were presented with pictures of simple, everyday words such as car and asked to name them as quickly and accurately as possible.

The results support other studies that tDCS can speed up word finding in both healthy older people and stroke patients, and are helping to identify which parts of the brain should be stimulated. "My work supports the idea that excitatory tDCS could be applied to the stroke hemisphere to optimize recovery," Crinion says. At the same time, she cautions, one type of treatment may not fit all patients, and further work will clarify whether some patients may also benefit from treatments targeted at the brain hemisphere not affected by stroke.

"What I've been most impressed by is how learning and, in the case of stroke patients, re-learning of language continues and the brain remains plastic, adapting and changing throughout our lifespan," Crinion says. "It is never too late to recover more and continue to improve with the right training."

Stimulating better memory

In a different set of experiments that look at the effects of brain stimulation on memory, Paulo Sérgio Boggio of Mackenzie Presbyterian University in São Paulo, Brazil, used tDCS to try to enhance the memory of Parkinson's and Alzheimer's disease patients. His work builds on research that showed that tDCS can enhance working memory in healthy subjects.

In his study of Alzheimer's patients, Boggio tested how many sessions of tDCS would lead to sustained improvements in memory and visual recognition. His team used five consecutive sessions of tDCS to excite two different areas of the brain involved in motor planning, organization, and regulation. Visual recognition increased by as much as 18% in the Alzheimer's patients, and the effects lasted a month. In a similar study with Parkinson's disease patients, tDCS improved memory by 20%.

"These studies demonstrate the potential of tDCS for memory improvement in elderly with Parkinson's or Alzheimer's disease and open a venue for future studies to examine the potential long-term effects," Boggio says. "It is important to understand that these tools are still on research level but at the same time are showing promising results with some advantages – low cost, simple to use, and reduced side-effects."

Stimulating numerical skills

Cohen Kadosh of the University of Oxford studied a very different application of tDCS – how to improve how people learn about numbers. Citing a recent study that found that approximately 20% of British adults have numeracy skills below the minimum requirement for being fully functional in the modern economy, Cohen Kadosh explains that there is

currently no solution for low numerical abilities, aside from behavioral training. "I believe that this is an important problem with many implications for society," he says.

His studies have found that it is possible to enhance numerical abilities using tDCS applied to the part of the brain called the posterior parietal cortex. The observed improvements lasted up to 6 months after tDCS and were specific to the trained material.

Cohen Kadosh has also tested the effects of tDCS on people with low numerical abilities due to congenital factors – dyscalculia, the equivalent to dyslexia with numbers that affects about 5% of the population. For those individuals, tDCS was only effective if it targeted different regions of the brain than those in people without dyscalculia. "This suggests that people with dyscalculia recruit different brain areas for numerical processing, probably due to brain reorganization," he says.

Future studies are investigating the use of tDCS to improve mathematical learning in children with low numerical abilities. "Cumulatively, these experiments advance our understanding of how numerical abilities are sub-served in the typical and atypical brain, and provide a possible means to improve numerical cognition, thus having important implications for education, intervention, and rehabilitation."

The symposium "Using Non-Invasive Brain Stimulation to Enhance Cognitive and Motor Abilities in the Typical, Atypical, and Aging Brain" takes place on April 2, 2012, at the 19th annual meeting of the Cognitive Neuroscience Society (CNS). More than 1400 scientists are attending the meeting in Chicago, IL, from March 31 to April 3, 2012.

Provided by Cognitive Neuroscience Society