Training the brain to improve on new tasks

April 15 2013

A brain-training task that increases the number of items an individual can remember over a short period of time may boost performance in other problem-solving tasks by enhancing communication between different brain areas. The new study being presented this week in San Francisco is one of a growing number of experiments on how working-memory training can measurably improve a range of skills – from multiplying in your head to reading a complex paragraph.

"Working memory is believed to be a core cognitive function on which many types of high-level cognition rely, including language comprehension and production, problem solving, and decision making," says Brad Postle of the University of Wisconsin-Madison, who is co-chairing a session on working-memory training at the Cognitive Neuroscience Society (CNS) annual meeting today in San Francisco. Work by various neuroscientists to document the brain's "plasticity" – changes brought about by experience – along with technical advances in using electromagnetic techniques to stimulate the brain and measure changes, have enabled researchers to explore the potential for working-memory training like never before, he says.

The cornerstone brain-training exercise in this field has been the "n-back" task, a challenging working memory task that requires an individual to mentally juggle several items simultaneously. Participants must remember both the recent stimuli and an increasing number of stimuli before it (e.g., the stimulus "1-back," "2-back," etc). These tasks can be adapted to also include an audio component or to remember more than one trait about the stimuli over time – for example, both the color and location of a shape.

Through a number of experiments over the past decade, Susanne Jaeggi of the University of Maryland, College Park, and others have found that participants who train with n-back tasks over the course of approximately a month for about 20 minutes per day not only get better at the n-back task itself, but also experience "transfer" to other cognitive tasks on which they did not train. "The effects generalize to important domains such as attentional control, reasoning, reading, or mathematical skills," Jaeggi says. "Many of these improvements remain over the course of several months, suggesting that the benefits of the training are long lasting."

As yet unresolved and controversial, however, has been understanding which factors determine whether working-memory training will generalize to other domains, as well as how the brain changes in response to the training. Work by Postle's group using a new technique of applying electromagnetic stimulation on the brains of people undergoing working-memory training addresses some of these questions.

Training increases connectivity

Bornali Kundu of the University of Wisconsin-Madison, who works in Postle's laboratory, used transcranial magnetic stimulation (TMS) with electroencephalography (EEG) to measure activity in specific brain circuits before and after training with an n-back task. "Our main finding was that training on the n-back task increased the number of items an individual could remember over a short period of time," explains Kundu, who is presenting these new results today. "This increase in short-term memory performance was associated with enhanced communication between distant brain areas, in particular between the parietal and frontal brain areas."

In the n-back task, Kundu's team presented stimuli one-at-a-time on a computer screen and asked participants to decide if the current stimulus matched both the color and location of the stimulus presented a certain number of presentations previously. The color varied among seven primary colors, and the location varied among eight possible positions arranged in a square formation. The control task was playing the video game Tetris, which involves moving colored shapes to different locations, but does not require participants to remember anything. Before and after the training, researchers administered a range of cognitive tasks on which subjects did not receive training, and simultaneously delivered TMS while recording EEG, to measure communication between brain areas during task performance.

After practicing the n-back task for 5 hours a day and 5 days per week over 5 weeks, subjects were able to remember more items over short periods of time. Importantly, for those whose working memory improved, communication between the dorsolateral prefrontal cortex (DLPFC) and parietal cortex also improved. "This is in comparison to the control group, who showed no such differences in neural communication after practicing Tetris for 5 weeks," Kundu says.

Working-memory training also produced improvement on cognitive tasks for which participants were not trained that are also believed to rely on communication between the parietal cortex and DLPFC. For two of these tasks – the ability to detect a change in a briefly presented array of squares, and the ability to detect a red letter "C" embedded in a field of distracting stimuli of rotated red "C"s and blue "C"s – those who had trained in the n-back test also showed a decrease in task-related EEG. The training exercise had registered a similar decrease. "The overall picture seems to be that the extent of transfer of training to untrained tasks depends on the overlap of neural circuits recruited by the two," Kundu says.

Developing future therapies

Moving forward, many cognitive neuroscientists are working to see how working-memory training may specifically help clinical populations, such as patients with ADHD. "If we can learn the 'rules' that govern how, why, and when cognitive training can produce improvements that generalize to untrained tasks, it may be that therapies can be developed for patients suffering from neurological or psychiatric disease," Postle says.

Both Jaeggi's team, as well as Torkel Klingberg of the Karolinska Institute in Sweden, who is also presenting at the symposium today in San Francisco, have had success with such training for children with ADHD, decreasing the symptoms of inattention. "Here, the reason working-memory training may transfer to tests of fluid intelligence, as well as to a reduction in ADHD-associated hyperactivity symptoms, may be because both of those complex behaviors use some of the same brain circuits also used in performing the working-memory training tasks," Kundu says.

"Individual differences in working memory performance have been related to individual differences in numerous real world skills such as reading comprehension, performance on standardized tests, and much more," she adds. "I would not expect the same sorts of transfer effects that have been seen with working-memory training to happen if an individual practiced a task that used a minimally overlapping network, such as, for example, shooting three-pointers – which presumably uses different brain areas like primary and secondary motor cortex and the cerebellum."

Jaeggi says that it is important to understand that cognitive abilities are not as unchangeable as some might think. "Even though there is certainly a hereditary component to mental abilities, that does not mean that there are not also components that are malleable and respond to experience and practice," she says. "Whereas we try to strengthen participants' working memory skills in our research, there are other routes that are possible as well, such as for example physical or musical training, meditation, nutrition, or even sleep."

Despite all the promising research, Jaeggi says, researchers still need to understand many aspects of this work, such as "individual differences that influence training and transfer effects, the question of how long the effects last, and whether and how the effects translate into more real-world settings and ultimately, academic achievement."

The symposium "The effects of working memory training on brain and behavior" takes place on April 15, 2013, at the 20th CNS annual meeting. More than 1,500 scientists are attending the meeting in San Francisco, CA, from April 13 to April 16, 2013.

Provided by Cognitive Neuroscience Society

Citation: Training the brain to improve on new tasks (2013, April 15) retrieved 3 May 2024 from https://medicalxpress.com/news/2013-04-brain-tasks.html