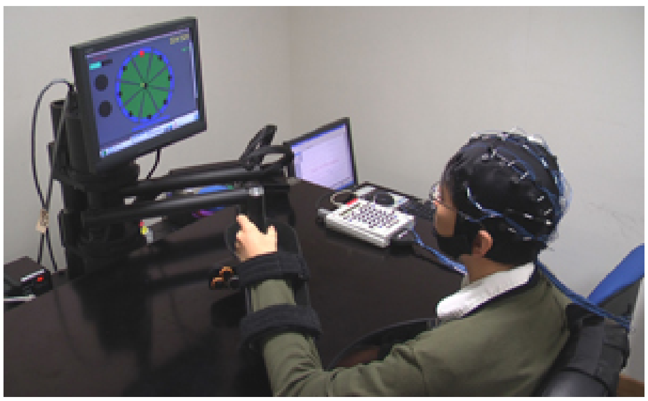
Rehabilitation based on brain-computer interfaces could be superior to robot-assisted programs, research finds

June 5 2013



A user operating the brain–computer interface stroke rehabilitation system. Credit: 2013 A*STAR Institute for Infocomm Research

Changes in the pattern of connections in the resting brain predict the extent to which stroke patients will recover following rehabilitation, according to new research led by Cuntai Guan of the A*STAR Institute for Infocomm Research, Singapore and Karen Chua of the Tan Tock Sen Hospital, Singapore, in collaboration with Bálint Várkuti of the University of Tübingen, Germany.

Strokes are caused by blockage of, or damage to, blood vessels in the brain. They are a leading cause of death, often result in speech deficits and paralysis on one side of the body, and frequently cause brain damage and disability. Rehabilitation, however, can help to partially restore the motor deficits.

Guan and his co-workers studied nine individuals who had recently suffered their first stroke. The team trained the participants for one month using either a robot-assisted rehabilitation program or a brain–machine interface (BCI). Via scalp electrodes, the BCI reads brain waves associated with movement planning, and then translates them into commands that move a robotic arm (see image).

The researchers used functional magnetic resonance imaging to examine connections in the participants' brains. They also used a standardized clinical scale to assess their upper-limb movements, both before and after rehabilitation. Specifically, they examined long-range connections within the so-called default mode network, a set of brain regions that become active when external stimuli are ignored and the mind is allowed to wander instead.

Guan and co-workers found that patients rehabilitated with the BCI recovered better than those who received robot-assisted rehabilitation. This was associated with increased connectivity between certain components of the default mode network—especially the anterior cingulate cortex, the inferior parietal lobule, and the supplementary motor cortex. Furthermore, these connectivity changes accurately predicted the extent to which the stroke patients would recover.

A stroke often disrupts long-range connections within the brain, but neuroscientists now widely believe that the brain can build or strengthen alternative pathways to compensate for the damage, leading to some functional recovery. The enhanced connectivity in the brain's resting state observed by the team could therefore be an after-effect of these processes, and may reflect increased cooperation between the regions involved, which compensates for the damage caused by the stroke.

"Stroke rehab is a complex and effortful process," says Guan, "and in terms of saving therapists' time, there is currently a lack of efficient and productive approaches." The team's BCI stroke rehabilitation system can supplement other approaches. "We are now working with industry to further develop [the system] and make it accessible to patients in hospitals, rehab centers, and eventually the home."

More information: Varkuti, B. et al. Resting state changes in functional connectivity correlate with movement recovery for BCI and robot-assisted upper-extremity training after stroke. *Neurorehabilitation and Neural Repair* 27, 53–62 (2013). nnr.sagepub.com/content/27/1/53

Provided by Agency for Science, Technology and Research (A*STAR), Singapore