



BRAIN SCIENCE

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Centering in advanced countries, the importance of handling cognition-related issues and demands for well-being is expanding globally. The issues with especially high needs include: (1) maintenance and enhancement of cognitive functions against aging, (2) alleviating and reducing risks for health problems related to lifestyles, and (3) achieving subjective well-being and better stress management. Neurofeedback (NF), a technique to train people to control their own brain activity into better directions, is still on a laboratory stage but will be able to provide strong supports for managing these issues.

Various training programs, cognitive or psychological therapies, and strategies have been developed and tested aiming at enhancement of cognitive functions, improvement of mental disorders and unhealthy lifestyles, and physical rehabilitation. These cognitive methods have been expected for their utility especially in fields where medication and other invasive treatments have little effect or are difficult/costly to adopt. However, difficulty of recognizing “whether using one’s own cognition properly or not” often limits the efficacy of these cognitive methods. The NF enables directly addressing this issue, with the help of recent technological advances in functional brain measurements.

In NF, one receives real-time information on his/her neural activities measured using electroencephalography (EEG), functional magnetic resonance imaging (fMRI), near-infrared spectroscopy (NIRS), or other methods while conducting a specific task or utilizing a cognitive strategy, and trains oneself to self-regulate the activities. Acquisition of voluntary modulation of a specific brain region or a network is expected to lead to improvement of the cognitive, emotional, perceptual, and motor function associated with the region/network. NF is similar to brain-computer interface (BCI) and brain-machine interface (BMI) in regard to its use of real-time neural measurement, but is unique in aiming at the volitional self-control and its resultant beneficial effects. Our cognitive training intervention for cognitive function maintenance and enhancement has been developed based on neuroscientific knowledge, especially focusing on the activation of the prefrontal cortex (PFC), a center of higher order cognitions. We have proved the effectiveness of cognitive training intervention in elder people, as well as young population, and among different cultures. On the other hand, these studies also revealed that there are individual differences in the efficacy of intervention. In order to overcome individual differences for beneficial effects, and to enhance the efficacy of cognitive intervention, we have been developing cognitive intervention systems with the NF. Our NF-based cognitive training monitors the prefrontal brain activity reflecting the user’s cognitive involvement in the training task, and leads the user to the maintenance of high PFC activity level, by switching the task types and difficulties in real-time.

