University of Tsukuba & University of California, Irvine: Exploring the neural substrates of mild exercise-enhanced human cognition: a functional neuroimaging study

Kyeongho Byun\textsuperscript{1,2}, Kazuya Suwabe\textsuperscript{1}, Michael Yassa\textsuperscript{2}, and Hideaki Soya\textsuperscript{1}

\textsuperscript{1} Faculty of Health and Sport Sciences, University of Tsukuba
\textsuperscript{2} Department of Neurobiology and Behavior, University of California, Irvine

From a practical perspective, mild intensity exercise such as walking or Tai Chi might be more attractive to and applicable for both young and older adults with a sedentary lifestyle. Recently, animal studies in our laboratory discovered that even mild intensity exercise that does not induce the stress response could improve memory function by enhancing adult hippocampal neurogenesis in the dentate gyrus. When translated to humans, our work revealed that a long-term mild exercise training program in older adults has been shown to improve the age-related decline of human cognition by preventing brain atrophy. However, it is still unknown whether acute mild exercise has beneficial effects on human brain function and its underlying neural substrates in prefrontal cortex and hippocampus. To address this question, we combined an executive-function task that has been confirmed in many neuroimaging studies to target underlying neural substrates with a functional near-infrared spectroscopy neuroimaging technique that allow monitoring of task-related cortical activation shortly after exercising. Our results demonstrated that acute mild exercise improves executive task performance, which was positively correlated with increased arousal level and also evoked task-related cortical activations in the left dorsolateral prefrontal cortex and left frontopolar area in both young and older adults. Although the neural substrate underlying our findings are unclear, recent animal microdialysis studies found that mild exercise induced an increase in several neuromodulators such as acetylcholine and dopamine, which play an important role in human cognition in prefrontal cortex as well as hippocampus. Based on these findings, we aim to expand our research to examine the effect of acute mild exercise on human hippocampal function by using high-resolution task-activated fMRI and a battery of pattern separation memory tasks that have been found to specifically tax the hippocampus. Initial behavioral work between the University of Tsukuba and UCI has found that mild exercise indeed improves memory function on these pattern separation tasks in young adults. We will next expand this investigation to include task-activated fMRI in healthy older adults as well as those with amnestic mild cognitive impairment.