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Exercise-induced Changes of White Matter Integrity in Healthy Young Subjects

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Introduction: A growing body of evidence suggests positive influences of fitness training on human brain structure and cognitive function. Although, it has been shown that when a new skill is learned, such as juggling, white matter (WM) volume increases in healthy subjects (Scholz et al., 2009), there are only limited studies published how exercise influence on WM microstructure and cognitive ability. In this study, we aimed to explore exercise related changes of WM using DTI in young healthy subjects.
Methods: A total of 45 healthy subjects (age: 19 ~ 27, exercise group (EG) (n=25) vs. non-exercise group (NEG) (n=20)) were included. All EG subjects underwent a 6-month physical exercise (1h daily, 40 min aerobic, 20 min muscle strengthening). NEG group was defined as undertaking less than 1h of physical activity weekly. The cognitive ability was assessed using Stop Signal Task (SST) and Attention-switching Task (AST) scores. DTI (30 directions) were acquired on a 3 Tesla Siemens. We performed 2 different analyses, the first one was tract-based spatial statistics (TBSS) analysis, which is a voxel-wise analysis for group comparison. Secondly, each diffusion metrics including fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (AD), and radial diffusivity (RD) were obtained from 14 ROIs. Independent t-test was used for group difference between ROIs and cognitive assessment items. Pearson correlation analysis was done to verify the relationship between ROIs and cognitive assessment scores.
Results: No significant differences were found between exercise and controls group in mean age, handedness, body mass index, level of education, cognitive ability. TBSS analysis showed significantly increased FA in the left anterior WM (corrected $p<0.05$), while wide spread decrease of AD in frontotemporal area and decrease of RD in only in frontal WM. The FA value of anterior WM was well correlated with SST and AST. Group difference of ROI analysis showed that significant changes in all diffusion metrics of left anterior limb of internal capsule, FA of bilateral dorsolateral prefrontal cortex (DLPFC), FA of right nucleus accumbens, MD and AD of bilateral anterior corona radiate ($p<0.05$). Among the significant ROIs, FA of left DLPFC was negatively correlated with AST correct latency, MD of bilateral anterior corona radiata was positively correlated with SST response time and with AST correct latency, and AD of right anterior corona radiata was positively correlated with SST response time ($p<0.05$).
Conclusion: In this study, regular exercise group showed increased WM

integrity in the executive and reward related network, which was well correlated with cognitive ability.