Training shapes Cerebellum and parieto-frontal network in professional badminton players

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Introduction Recent brain imaging studies have demonstrated that elite athletes have distinct brain structures (1-3), and neural response patterns (4-5). But the resting-state studies about motor training are quite limited. Specially, the characteristics of professional badminton players' brain have not yet been explored. In the present study we investigated the resting brain difference between professional badminton players and control college students with both structural and resting functional MRI.

Methods 20 badminton players (10 males, mean age 22.5) and 18 controls (9 males, mean age 20.7) were scanned in a Siemens 3 T Trio scanner. Resting BOLD data was acquired using a standard EPI sequence with the following parameters: TR=2s, TE=30ms, flip angle=90°, 32 interleaved axial slices with 4 mm thickness, no gap, in-plane resolution=3.13 x 3.13 mm. A high spatial resolution T1 weighted structural image was also acquired with a volume resolution of 1 x 1 x 1 mm. Both of the structure and functional Imaging data were analyzed by SPM8. Voxel based morphometry (VBM), amplitude of low frequency fluctuation (ALFF), and resting seeded functional connectivity analysis were conducted to examine structural and functional brain differences between two groups.

Results Voxel-wised comparison revealed two clusters in the right cerebellum (Lobule 6 & 8) where gray matter concentration (GMC) was larger in athlete group than in control group (Fig 1). No region showed larger GMC in control group than in athlete group. Athlete group also showed larger ALFF in two clusters in the cerebellum (vermis lobule 6) than control group (Fig 2). In contrast, control group showed larger ALFF in the left superior parietal lube (BA 7/19) than athlete group. Using this parietal region as the seed for functional connectivity analysis, it showed increased functional connectivity to anterior cingulate, orbitofrontal, and anterior middle frontal gyrus (BA6), and decreased functional connectivity to posterior middle frontal gyrus (BA9) in athlete group than in control group, respectively (Fig 3).

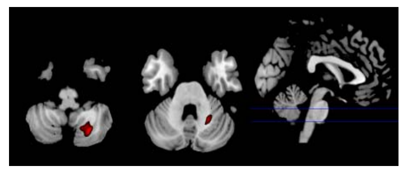


Fig. 1 Larger GMC in athlete group ($p<0.001$, uncorrected)

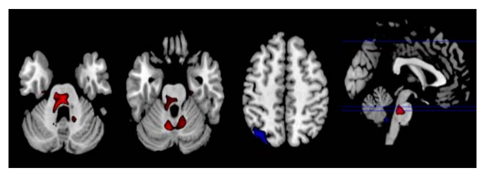
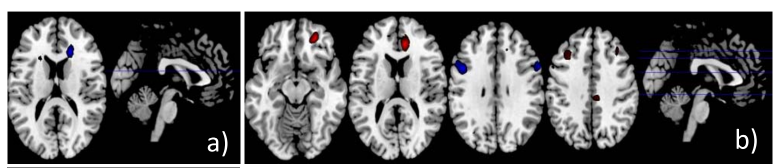


Fig. 2 Different ALFF between athlete and control group (Red, athlete > control; Blue, control > athlete. $p<0.001$, uncorrected)



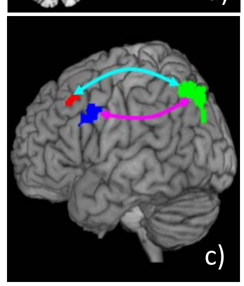


Fig. 3 a) Cluster showed reduced connectivity to medial cerebellum seed region in athlete group; b) Cluster showed different connectivity to left parietal seed region between groups (Red, athlete > control; Blue, control > athlete. $p<0.001$, uncorr); c) Cyan arrow represents enhanced connectivity between left superior parietal lobule (green) and anterior frontal gyrus (red) in athlete group, while purple arrow represents decreased connectivity between left superior parietal lobule (green) and posterior middle frontal gyrus (blue) in athlete group.

Discussions and Conclusions Consistent with previous studies (1-2, 6-8), our data demonstrated strong links between specialized motor skills and particular brain structures in cerebellum. However, Badminton players revealed unique functional changes in the parietal-frontal network than other athletes such as golfers, and diving players. This may reflect enhanced visuomotor coordination skills in professional players after long-term everyday badminton training.

References

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