Functional connectivity of the corticostriatal network in female musicians

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Background: The dorsal striatum (caudate/putamen) is a node of the cortico-striato-pallido-thalamo-cortical (CSPTC) motor circuit, which plays a central role in skilled motor learning, a critical feature of musical performance. The dorsal striatum receives input from a large part of the cerebral cortex, forming a hub in the cortical-subcortical network. Because musical performance requires highly skilled motor control, long-term musical training may alter the organization of the network. This study sought to examine how the functional network of the dorsal striatum differs between musicians and nonmusicians.

Methods: Neuroimaging was performed using the Philips Achieva 3.0 Tesla MRI scanner at the Juntendo University Hospital. Resting state functional magnetic resonance imaging (fMRI) data were acquired from female university students majoring in music and nonmusic disciplines. The voxel size was 3.75 × 3.75 × 4.00 mm. The resting state session consisted of 200 scans (6 min 40 s). The data were subjected to functional connectivity analysis and graph theoretical analysis using the CONN toolbox (Whitfield-Gabrieli and Nieto-Castanon, 2012) running on MATLAB (Version 8.3.0, The MathWorks Inc., 2014).

Results: The functional connectivity analysis indicated that compared with nonmusicians, musicians had significantly decreased connectivity between the left putamen and bilateral frontal operculum and between the left caudate nucleus and cerebellum. The graph theoretical analysis of the entire brain revealed that the degrees, which represent the numbers of connections, of the bilateral putamen were significantly lower in musicians than in nonmusicians. The degrees did not differ between the left and right putamen in musicians (p = 0.791) and nonmusicians (p = 0.672). Nonmusicians had a higher degree in the left caudate nucleus than in the right caudate nucleus (p = 0.047), whereas this tendency was weaker at an insignificant level in musicians (p = 0.190).

Conclusions: Compared with nonmusicians, musicians have a smaller functional network of the dorsal striatum with decreased connectivity. These data are consistent with previous anatomical studies reporting a reduced volume of the dorsal striatum in musicians and ballet dancers. This finding suggests that long-term musical training reorganize the functional network of the dorsal striatum to be less extensive or selective. The altered corticostriatal network in musicians would be more appropriately designed for musical performance.