Musical Cues During Motor Dexterity Training Influence Structural Brain Plasticity in Healthy Subjects

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Introduction. In healthy controls (HC), brain gray matter (GM) and white matter (WM) structural changes may occur following motor learning (1-3).

Objective. To assess, in HC, the structural changes of GM and WM associated with a manual dexterity training, with and without musical cue and their association with improvement of motor function.

Methods. Forty-five right-handed HC, without any musical experience, performed a 2-week motor training, consisting of 10 daily sessions of 30 minutes each, where they executed with their right hand a pre-defined sequence on a computer modified keyboard, following a rhythmical metronome cue having 60 beats-per-minute. Subjects were randomized into three groups: "Metronome" group (MG) heard no additional musical cue, "Rhythm group" (RG) heard a musical cue at the same rhythm of the metronome, and "Over-rhythm group" (OG) heard a musical cue at a higher rhythm. The manual dexterity was evaluated with the 9 Hole Peg Test (9HPT). All subjects underwent structural magnetic resonance imaging (MRI) at baseline (T0 - before the training) and after 2 weeks (W2 - at the end of the training). Longitudinal morphologic changes of GM volumes were evaluated using "Tensor-based morphometry" (TBM) analysis. Longitudinal modification of WM architecture were evaluated on diffusion tensor MRI scans using "Tract-based spatial statistics" (TBSS) analysis.

Results. An improvement of the performance at the 9HPT, significant in the OG only (p=0.04), was detected in the three study groups. Diffusivity parameters in the WM skeleton did not change after training. All groups showed a positive correlation between the improvement of 9HPT, performed with both right and left hand, and the changes of GM volume in the right precentral gyrus, in the left cerebellum, as well as in the left supramarginal gyrus (p<0.001; R ranging from -0.55 and 0.50). Additionally, when considering each group separately, the OG also showed a significant correlation between improvement of 9HPT, performed with the right hand, and GM changes in the left precentral gyrus and in the right middle frontal gyrus (p<0.001; r ranging from -0.66 and 0.75).
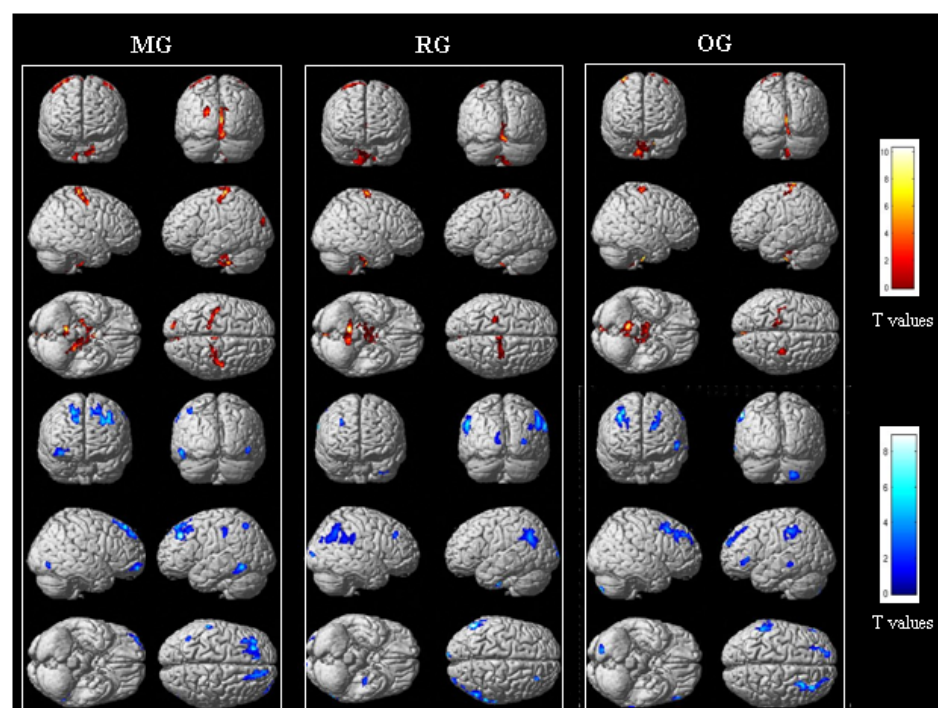

Figure 1. Clusters of significant gray matter (GM) increase (in red) and GM decrease (in blue) in each group of study, after two weeks of motor training.

Conclusions. In HC, a musical stimulation during motor training improves motor performance and influences structural plasticity of the GM. The complexity of the task is associated with more pronounced changes of GM structure.

References. 1. Doyon J. et al. Curr Opin Neurol 2008;21:478–483. 2. Doyon J. et al. Curr Opin Neurobiol 2005;15:161–167. 3. Draganski B et al. Behav Brain Res 2008;192:137–142.