## Neural plasticity of Brain Motor Networks in Professional Fencers Studied with Functional MRI

Laura Parisi[1], Maria A. Rocca[1], Letizia Leocani[2], Roberto Gatti[3], Carlotta Castellani[2], Monica Rossi[3], Andrea Falini[4], Giancarlo Comi[5], and Massimo Filippi[1]
*[1]Neuroimaging Research Unit, Institute of Experimental Neurology, San Raffaele Scientific Institute and Vita-Salute San Raffaele University, Milan, Italy, Italy, [2]Dept. of Clinical Neurophysiology, San Raffaele Scientific Institute and Vita-Salute San Raffaele University, Milan, Italy, Italy, [3]Rehabilitation Department, San Raffaele Scientific Institute and Vita-Salute San Raffaele University, Milan, Italy, Italy, [4]Department of Neuroradiology, San Raffaele Scientific Institute and Vita-Salute San Raffaele University, Milan, Italy, Italy, [5]Department of Neurology, San Raffaele Scientific Institute and Vita-Salute San Raffaele University, Milan, Italy, Italy*

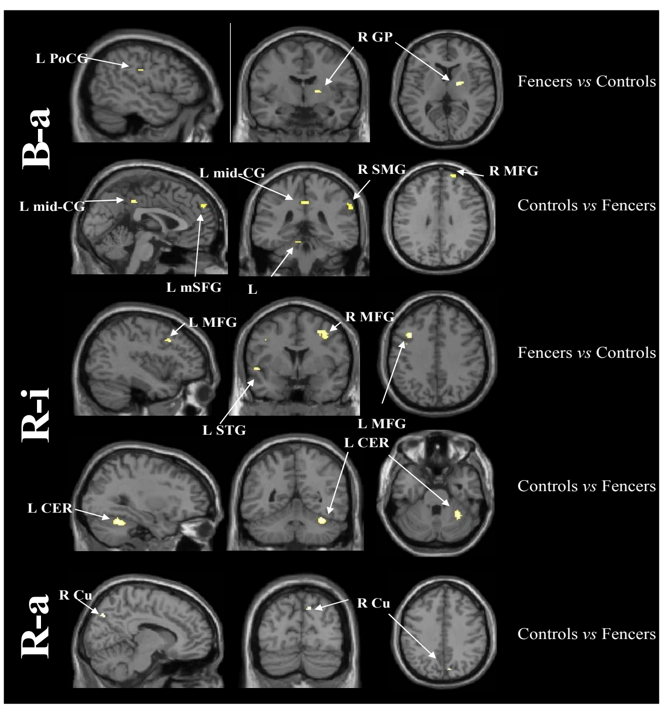
**Introduction.** Bilateral, symmetrical movements of limbs with respect to the longitudinal axis of the body are performed more accurately than asymmetrical ones. Ipsilateral coordination of wrist and foot is easier if limb segments move in the same (in-phase) than in the opposite (anti-phase) direction. Fencing requires an optimal level of interlimb coordination and asymmetrical motor skills.

**Objective.** Using functional magnetic resonance imaging (fMRI), we investigated the brain areas involved in interlimb coordination in young high-level professional fencers in comparison to matched young, untrained subjects. We hypothesized that an intensive and continuous motor training in fencers could optimize the recruitment of their neural networks.

**Methods.** fMRI during the performance of bimanual anti-phase, right hand-foot in-phase and right hand-foot anti-phase movements was acquired from 14 high-level professional fencers (mean age=21.5 years; mean age at starting professional activity=8.9 years; mean weekly training=11 hours) and 15 controls (mean age=21.7 years), who did not practice any continuous physical activity.

**Results.** During bimanual movements, controls *vs*. fencers had an increased recruitment of areas known to be involved in bimanual tasks. Fencers *vs*. controls had an increased activation of the right (R) pallidum and left (L) postcentral gyrus. During R hand-foot in-phase movements, controls *vs*. fencers had an increased activation of the R cerebellum, while fencers had higher recruitment of several frontal areas. During R hand-foot anti-phase movements, controls *vs*. fencers had an increased activation of the R cuneus. During the three motor tasks, the motor cortex (left and right hand and left foot areas) had an increased functional connectivity with bilateral fronto-temporal areas and thalami in fencers, and with bilateral cerebellum and temporo-parietal areas in controls.

**Conclusions.** Specific intensive motor training can modulate neural plasticity of cerebro-cerebellar-basal ganglia loops involved in interlimb coordination and their functional connectivities.



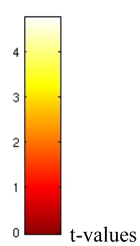




**Figure 1.** Between-group comparisons of functional magnetic resonance imaging activations during the performance of three motor tasks (two-sample t-test, p < 0.001, uncorrected) in fencers vs. controls and vice versa. Movements: B-a: bimanual anti-phase; R-i: right hand-foot in-phase; R-a: right hand-foot anti-phase.

L=Left; R=Right; PoCG= Postcentral gyrus; GP=Globus Pallidum; mid-CG=middle cingulum; mSFG= middle superior frontal gyrus; CER= cerebellum; SMG=supramarginal gyrus; MFG= middle frontal gyrus; STG=superior temporal gyrus; Cu=cuneus.