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Re-Configuration of Resting State Brain Networks after BCI training in subacute stroke patients

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Introduction: Motor imagery (MI) practice within a BCI-assisted rehabilitative intervention proved to influence brain plasticity phenomena underlying post-stroke motor recovery as outlined by resting state (RS) brain networks analysis based on graph theory (GT) approach [1]. We investigated RS networks in a subgroup of stroke patients recruited within a longitudinal randomized controlled trial evaluating the efficacy of a MI-based BCI on upper limb (UL) motor rehabilitation [2] describing brain re-organization at the single subject level.

Material, Methods and Results: High resolution EEG data (61 channels, sampling frequency of 200Hz) were acquired during 2 minutes of open-eyes rest in 16 post-stroke patients (8 BCI, 8 CTRL) before (T0) and after (T1) the intervention. Patients in the BCI group underwent 1 month of BCI-supported UL MI training, while CTRL group received equally intense MI training without BCI. The UL function, as assessed via the Fugl-Meyer Assessment (FMA), improved in both groups from T0-T1 (BCI 15±16.60 - 25±21.13; CTRL 15±15.27 - 19±19.12). RS brain networks have been estimated in 5 frequency bands by means of Partial Directed Coherence (PDC) for each patient in the two groups and each timepoint. Graph theory indices characterizing RS networks were computed and subjected to a two-way mixed ANOVA considering TIME (T0, T1) and GROUP (BCI, CTRL) as within and between factors, respectively. Results in Figure 1 showed a significant increase in the connections density as for alpha frequency oscillations between the two hemispheres (F= 8.3378, p= 0.02) and the anterior and posterior areas (F=6.8306, p=0.020431) in BCI group after the intervention. No changes were found for the CTRL group.

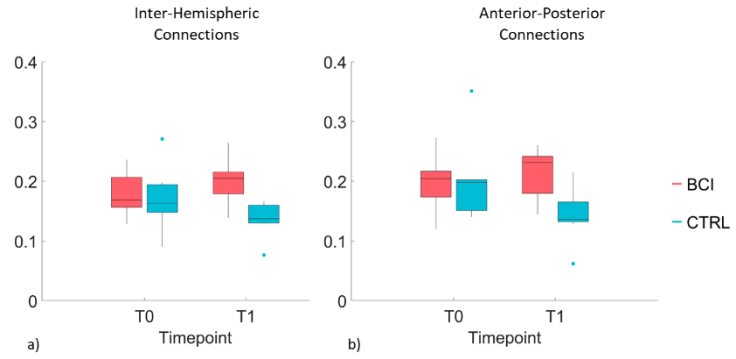

Figure 1. *Boxplot reporting graph theory indices distribution obtained for RS networks estimated in alpha band at T0 and T1 in the two groups: a) inter-hemispheric connections and b) antero-posterior connections.*

Discussion: Despite the preliminary nature of our findings (ie. small sample size) we were able to highlight significant changes in GT indices estimated at single subject level, which are in line with previous literature findings [1,3]., likely induced by the training yet unrelated to the task which potentially extends to other functions and contexts (eg. other than UL recovery).

Significance: The observed changes in RS brain networks depict a modified neural configuration, whose correlation with functional outcome will be investigated further as the clinical trial progresses. Stratification allowed by the increased sample size (eg. moderate vs severe patients) will eventually allow to identify brain network properties which best correlate with a favorable motor outcome.

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