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BCI Training-Induced Neuroplasticity: Evidence from Long-Term Neural Activity Analysis

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Introduction: Brain-Computer Interfaces (BCIs) offer innovative potential for motor substitution and rehabilitation by facilitating direct communication between the brain and external devices. Beyond their practical applications, BCI protocols can also induce neural plasticity, driven by prolonged training. Despite its importance, the dynamics of BCI-induced plasticity remain poorly explored. Yet, it could highlight that BCI is supported by a mutual learning process between brain and the algorithmic decoder, often referred as co-adaptation [1].

Material, Methods and Results: This study investigates the potential of BCI-induced neural plasticity in a patient implanted with WIMAGINE® electrocorticographic (ECoG) recording device [2]. We analyzed brain activity of a patient engaged in an extended BCI training over several months with a fixed decoder (without any recalibration) [3]. Using the ECoG recordings of BCI sessions, we evaluated both sensorimotor activity patterns and functional connectivity at regular intervals. Connectivity is a key marker of neuroplasticity, reflecting changes in the interaction between neural networks. Results revealed progressive changes in brain activation patterns overs sessions. Connectivity analysis demonstrated increased interregional cortical synchronization, suggesting an adaptive remodeling of functional networks. These findings provide compelling evidence of sustained changes in motor brain function induced by BCI training, even in the absence of decoder updates.

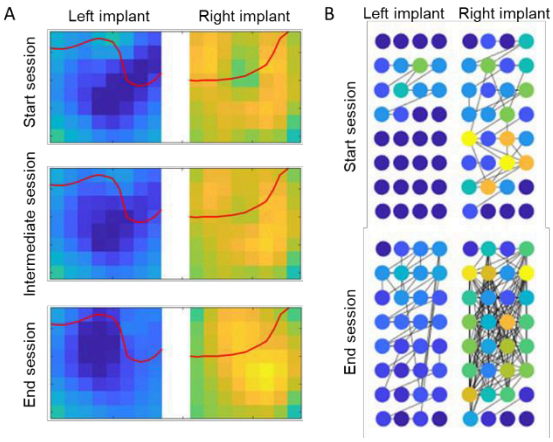

Figure 1: Evolution of brain patterns over sessions. (A) Regression of activation over the sessions in gamma band (100Hz – left minus right motor imagery). (B) Degree of activation between electrodes in the first and last session of training.

Conclusion: Our findings demonstrates that the user's brain undergoes significant changes in intensive BCI training, highlighting patient's learning and adaptation, even under fixed decoder. This potential of BCIs to drive neuroplasticity underlines the dual role of BCIs as tools for both motor compensation and rehabilitation, offering new avenues for neurorehabilitation and optimized therapeutic protocols.

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