EEG-based Neurofeedback Modulation of Visual Attention: Implication for Hemi-spatial Neglect Syndrome Rehabilitation

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Covert visuospatial attention (CVSA) emerges through top-down modulation of sensory visual responses, driven by the action of bilateral frontoparietal networks on early occipital areas which both amplify neural activity and entrain specific neural rhythms to propagate visual information to higher associative cortical areas (Horschig, 2015; Ptak, 2012; Schneider, 2019). These top-down influences may be severely disrupted by brain damage, leading to left unilateral spatial neglect (USN) after right hemisphere stroke.

One EEG correlate of CVSA is alpha asymmetrical distribution in occipital /parietal sites, i.e. an alpha power increase ipsilateral to the attended hemifield along with a relative decrease in contralateral hemisphere (Schneider, 2019; Lasaponara, 2019). Patients suffering from spatial neglect exhibit a pathological enhancement of alpha oscillations over occipital and parietal sites, resulting in weaker alpha symmetry (Lasaponara, 2019). Neurofeedback training is a process in which individuals learn to self-regulate their brain activity in real-time based on the online analysis of neural data, raising the possibility to either improve specific behavioral performances or deploy potential therapeutic application.

The current project aims at exploiting the emerging knowledge on brain oscillations and their role in visual attention processing, to design, optimize, and validate novel neurofeedback procedures to train visual attention and, in doing so, further unravel the neural underpinnings of attention in humans. Our study is using EEG Neurofeedback based on alpha asymmetry as a potential neurorehabilitation tool, to improve spatial attention in one hemifield, and thus ultimately reduce spatial neglect in stroke patients.

In a first ongoing study, healthy subjects undergo EEG-NFB training, while the same protocol will then be applied to patients with USN. Preliminary data suggest that EEG-NFB can help modulate alpha lateralization. We also perform an EEG-NFB training session inside the MRI scanner, which allows for analysis with both high temporal resolution (EEG) and spatial precision (fMRI).

A research project using real-time fMRI-based NFB is also being conducted with similar objectives (R Galli, from LabNIC lab as well).