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► To cite this version:

Giulia Lioi, Mathis Fleury, Simon Butet, Anatole Lécuyer, Christian Barillot, et al.. Bimodal EEG-fMRI Neurofeedback for stroke rehabilitation. ISPRM 2018 -International Society of Physical and Rehabilitation Medicine, Jul 2018, Paris, France. inserm-01932954

HAL Id: inserm-01932954

<https://inserm.hal.science/inserm-01932954>

Submitted on 23 Nov 2018

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Bimodal EEG-fMRI Neurofeedback for Stroke Rehabilitation

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BACKGROUND

Neurofeedback (NF) has potential to be applied for stroke rehabilitation [1],[2] however the effectiveness of NF for stroke has not been thoroughly assessed yet.

Bimodal EEG-fMRI NF [3],[4] is a promising technique to achieve a more efficient and specific self-regulation, which may be crucial for clinical application.

AIMS

Within the project **HEMISFER** (Hybrid Eeg-Mri and Simultaneous neuro-FEedback for brain Rehabilitation), the aims of this preliminary study are to:

- Test the feasibility of applying bimodal EEG-MRI NF for stroke rehabilitation in two chronic patients affected by left hemiplegia (subcortical lesion).
- Identify problematics and guidelines in view of a clinical study on stroke patients.

METHODS

Experimental Platform

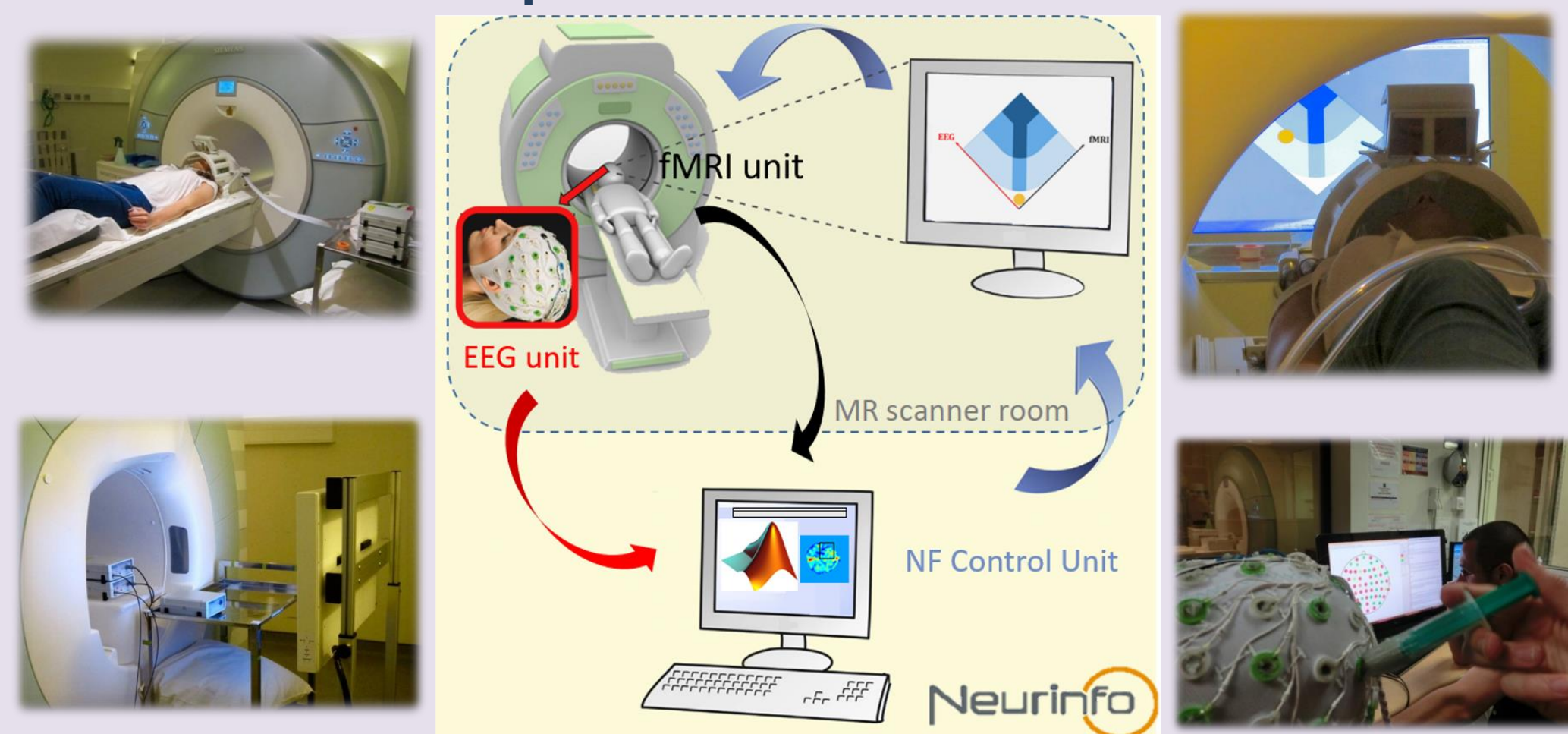


Figure 1. Bimodal EEG-fMRI NF platform [5] (Neurinfo, CHU Pontchaillou, Rennes). The platform integrates and synchronizes EEG and fMRI subsystems and signal flow for the computation and visualization of the bimodal NF.

Neurofeedback Protocol

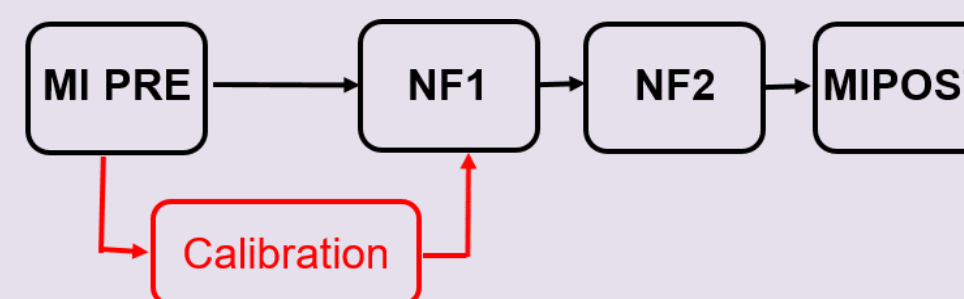


Figure 2. Schematic of the experimental protocol. Each session consisted of 8 blocks of 40 s (20 s rest, 20s task). MI=Motor Imagery (without NF display). MI_PRE=preliminary session used for calibration (ROI, EEG filter). MI_POST=transfer session.

PRELIMINARY RESULTS

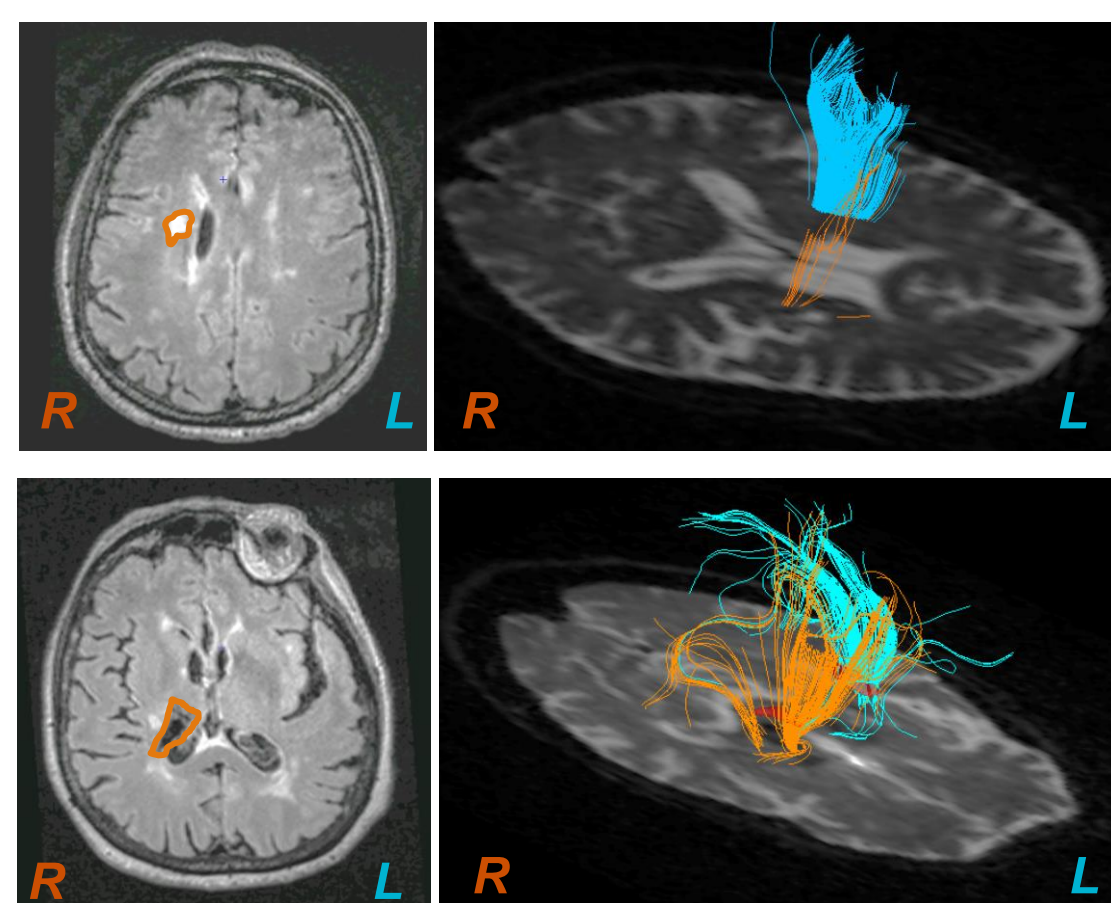


Figure 3a. Lesion and cortico-spinal tract (CST) of patient 1 (Right ischemic stroke). The CST was estimated from tractography of diffusion weighted images [6].

Figure 3b. Lesion and CST of patient 2 (Right hemorrhagic stroke)

— Ipsilesional
— Contralesional

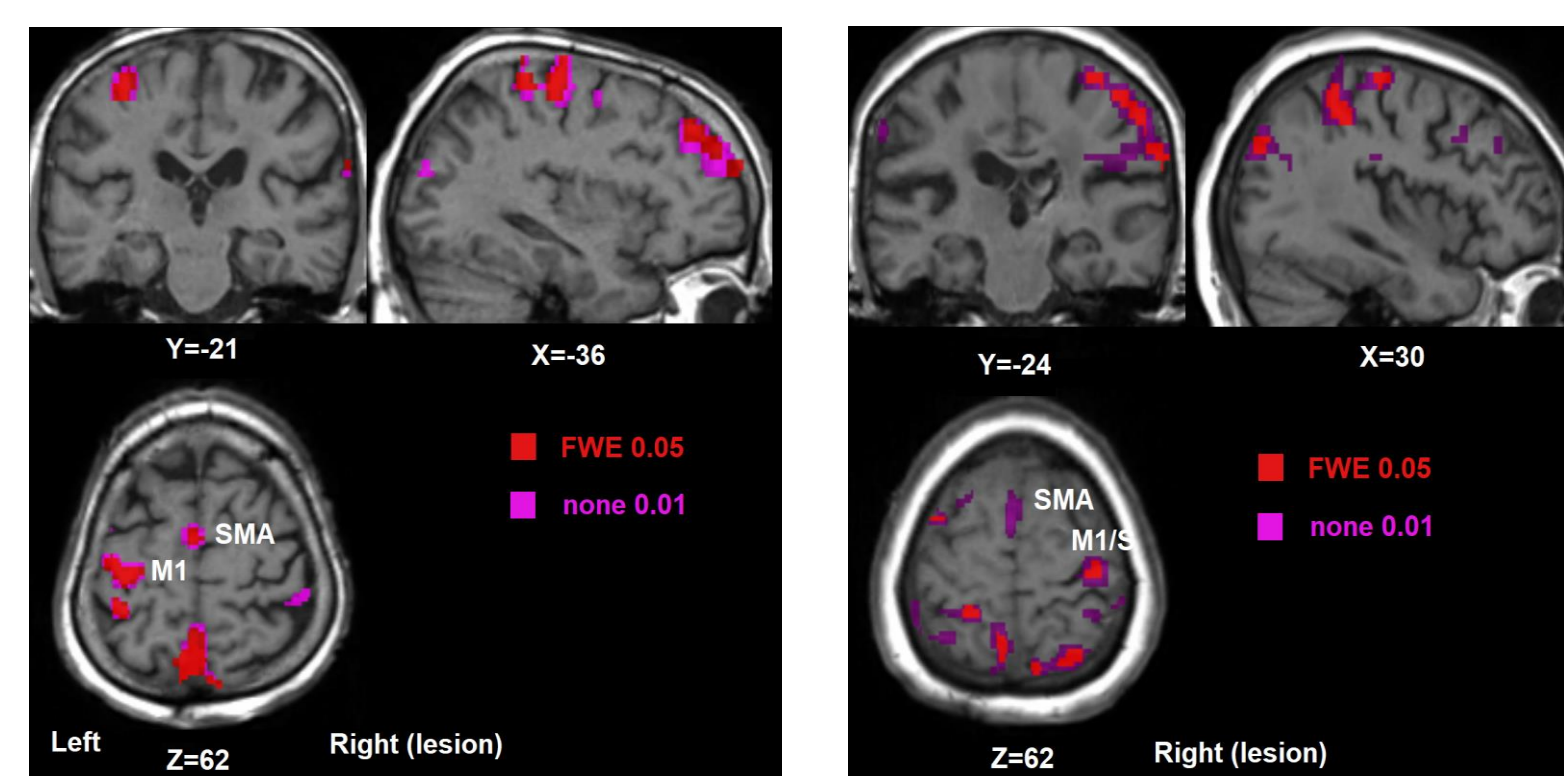


Figure 5. Average BOLD activations maps over the two NF sessions for patient 1 (left) and 2 (right) (TASK>REST; $k > 10$ voxels).

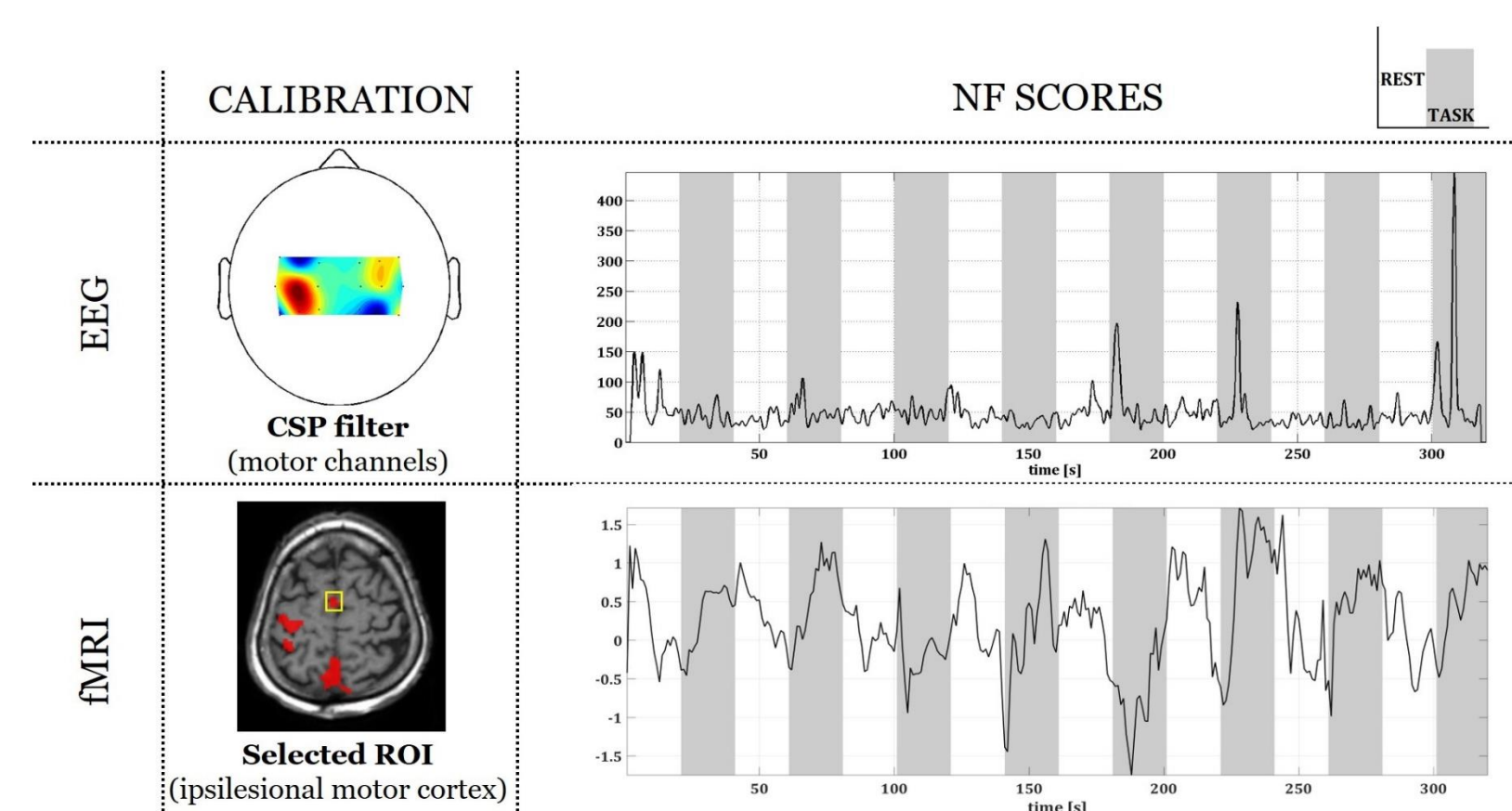
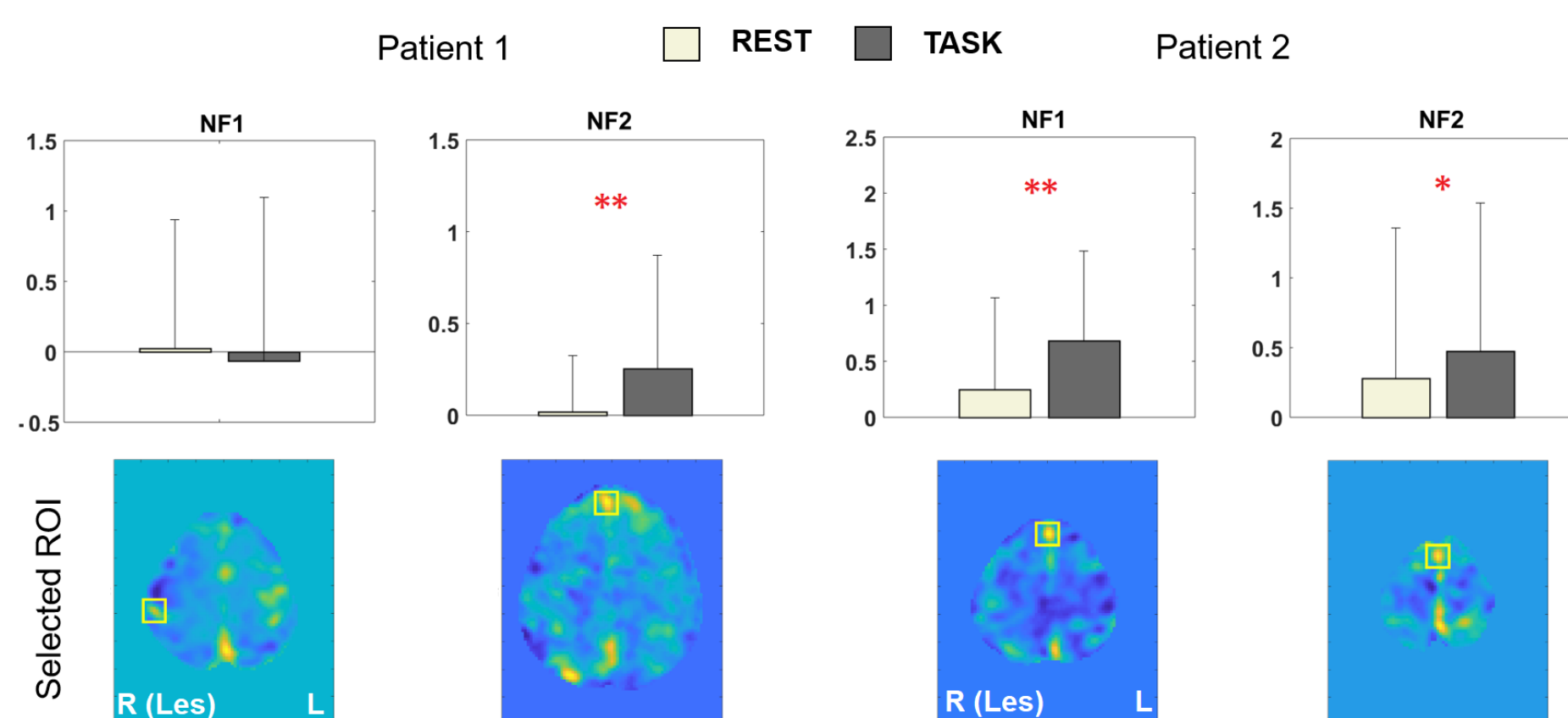


Figure 4. EEG and fMRI NF scores during a NF session. Example from one patient (1). The left column shows the filter and the ROI selected for NF computation during calibration.

Figure 6. fMRI signal regulation as a function of the selected ROI. The bar plots represent BOLD activity in the selected ROI with respect to background (mean+std across blocks) during rest and NF. Relative statistics are shown (Wilcoxon tests, * $p < 0.05$, ** $p < 0.01$)

CURRENT AND FUTURE WORKS

- Improve performances and simplify the workflow of the bimodal NF platform.
- Clinical study on Stroke patients to test the efficacy of multisession bimodal NF for rehabilitation.

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