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Can we learn from coupling EEG-fMRI to enhance neuro-feedback in EEG only?

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**INTRODUCTION**

- Neuro-feedback (NF) : Learn to control your brain with your brain.
- EEG and fMRI, grounds solutions in the context of brain rehabilitation protocols.
- EEG and fMRI provide complementary information.
- EEG is easy to use, fMRI is costly and exhausting for patients modality

**METHOD**

- **Design and strategy**: Machine learning mechanism based on bimodal NF scores and EEG signals.
- **Model**: Non linear structured design matrix $X$

$$X = \{X_0; X_3; X_4; X_5\} \in \mathbb{R}^{T\times 4\times 8\times B}, \text{ with } X_i \in \mathbb{R}^{T\times 4\times B}$$

$$X_0(t, e, b) = \text{Freq}(\text{EEG}(e, t), F_b), \forall t \in \{1, ..., T\} \text{ and } \forall b \in \{1, ..., B\}$$

$$X_3(t, e, b) = X_0(t, e, b) \ast \text{HRF}(3) \quad \forall e \in \{1, ..., E\} \text{ and } \forall b \in \{1, ..., B\}$$

$$X_5(t, e, b) = X_0(t, e, b) \ast \text{HRF}(5)$$

- **Optimisation**: structured sparse regularisation following 3 conditions:
  1. Spatial sparsity
  2. Smooth across frequency bands

$$\alpha = \arg\min_{\alpha} \sum_{t=1}^{T} \frac{1}{2} \left( NF(t) - \langle X(t), \alpha \rangle \right)^2 + \lambda \| \alpha \|_2 + \rho \| \alpha \|_1$$

**RESULTS**

- **Significant information from NF-fMRI can be captured by the model, and enhance EEG only neurofeedback.**
  - **Prediction with NF-predictor 5 with a median correlation of 0.74**

$$y(t) = y_{EEG}(t) + y_{NF}(t)$$

**References**


