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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 a costly and exhausting for patients modality.

**EXTRODUCTION**

**METHOD**

**- Design and strategy:** Machine learning mechanism based on bimodal NF scores and EEG signals.

**- Model:** Non linear structured design matrix $X$

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

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

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

Conds. 1. and 2. Cond. 3.

**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**

**- Method tested on 17 subjects with 3 bimodal neuro-feedback sessions of motor imagery tasks.**

**- We tested 5 NF-predictors:**
  1. $\hat{y}_{NF}(t) = (X, \alpha)$, learned from $X$ and NFZ = NF-EEG + NF-fMRI
  2. $\hat{y}_{NF}(t) = (X, \alpha)$, learned from $X_3$ and NF-EEG
  3. $\hat{y}_{NF}(t) = (X, \alpha)$, learned from $X_4$ and NF-fMRI
  4. $\hat{y}_{NF}(t) + \hat{y}_{NF}(t)$
  5. $y(t) + \hat{y}_{NF}(t)$, with $y(t) = NF$-EEG(t)

**References:**


