

Purpose

Context: Simultaneous acquisition of EEG and functional MRI.

Problem: EEG, good temporal resolution (~ ms), poor spatial resolution
fMRI, good spatial resolution (~ mm), bad temporal resolution (~ s)

Goal: Coupling both modalities to achieve a high spatio-temporal resolution

Our approach: Joint reconstruction imposing sparsity constraints



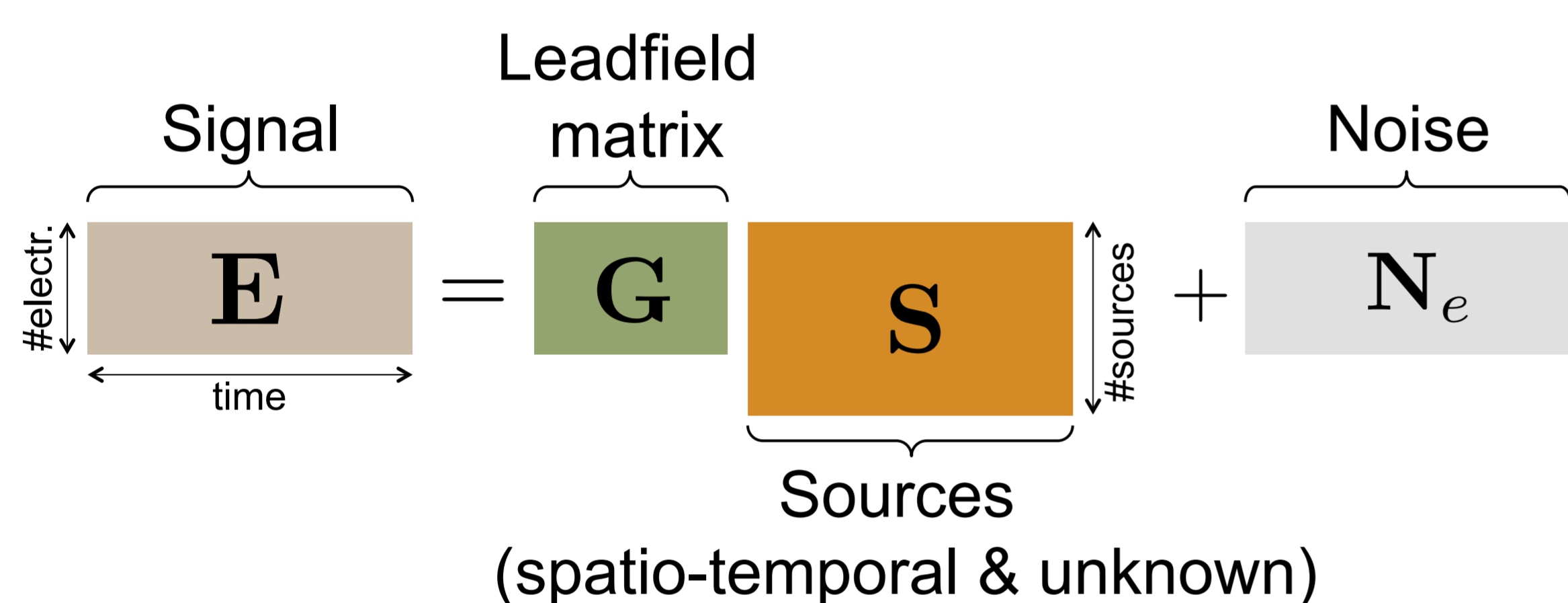
Data

- Simultaneous EEG (64 electrodes, BrainProducts cap) and fMRI (3T, Siemens) recording from 8 healthy right-handed subjects while doing motor task of clenching the right hand repeatedly.

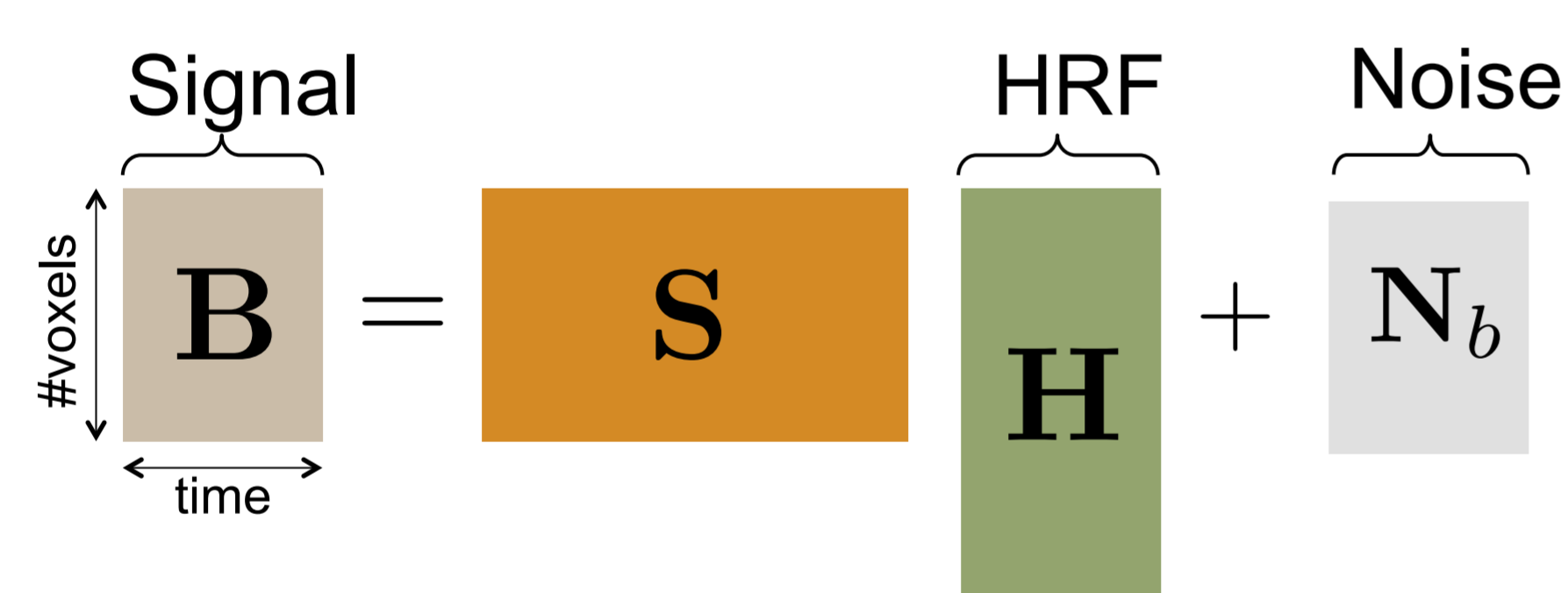
- One session: 10 blocks of 20s each, alternating Task/Rest/Task/...
- A head model of 3 spheres (brain/skull/scalp) is used for modeling the position of the electrodes.

Method

• EEG signal modeling



• BOLD fMRI signal modeling



• Our joint reconstruction

$$\hat{\mathbf{S}} = \underset{\mathbf{S}}{\operatorname{argmin}} \left\{ \alpha \|\mathbf{GS} - \mathbf{E}\|_2^2 + (1 - \alpha) \|\mathbf{SH} - \mathbf{B}\|_2^2 + \lambda \|\mathbf{S}\|_1 \right\}$$

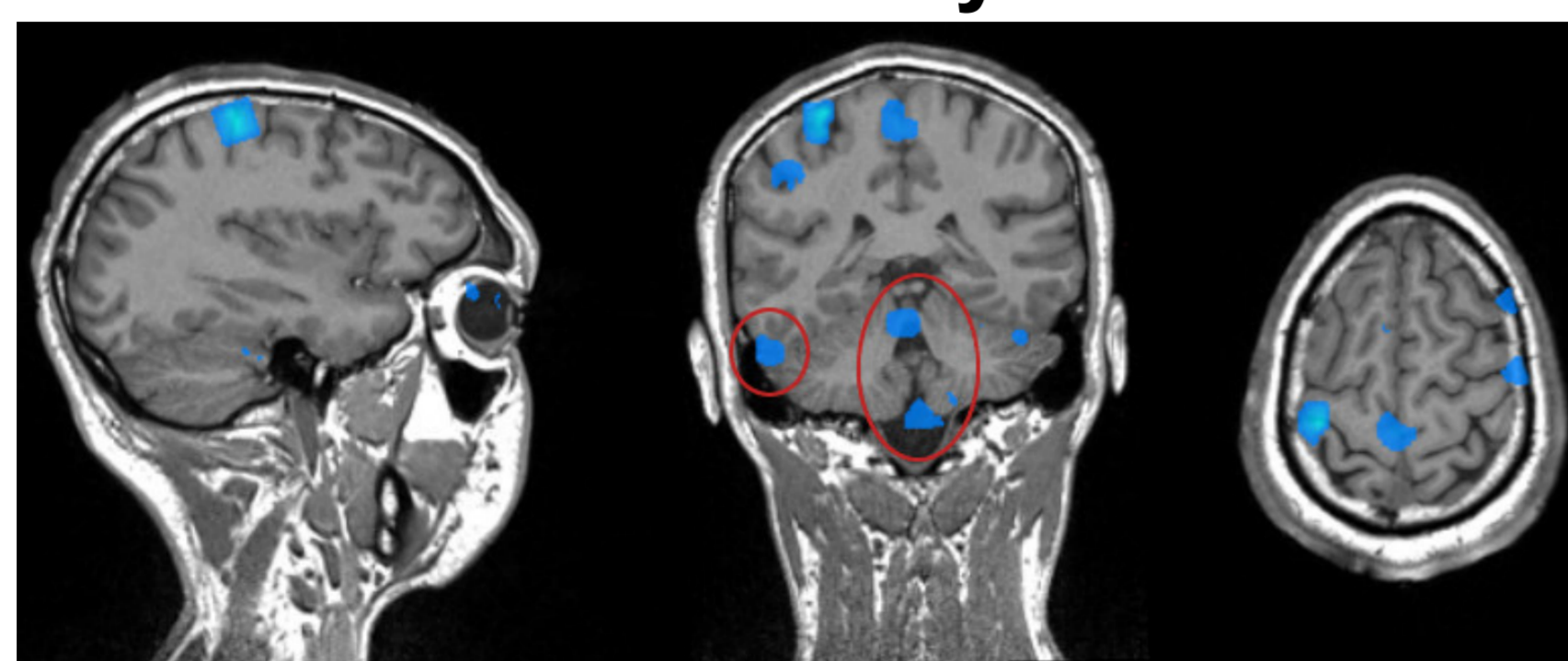
- The L_1 penalty term is enforcing sparsity of sources.
- In [1], other penalty terms are investigated on simulated data.
- Minimization : proximal algorithm & Iterative Soft Thresholding,

• Parameter calibration

- The two fidelity terms have different orders of magnitude.
- α is then difficult to adjust.
- Each term is therefore first calibrated/normalized based on unimodal data.

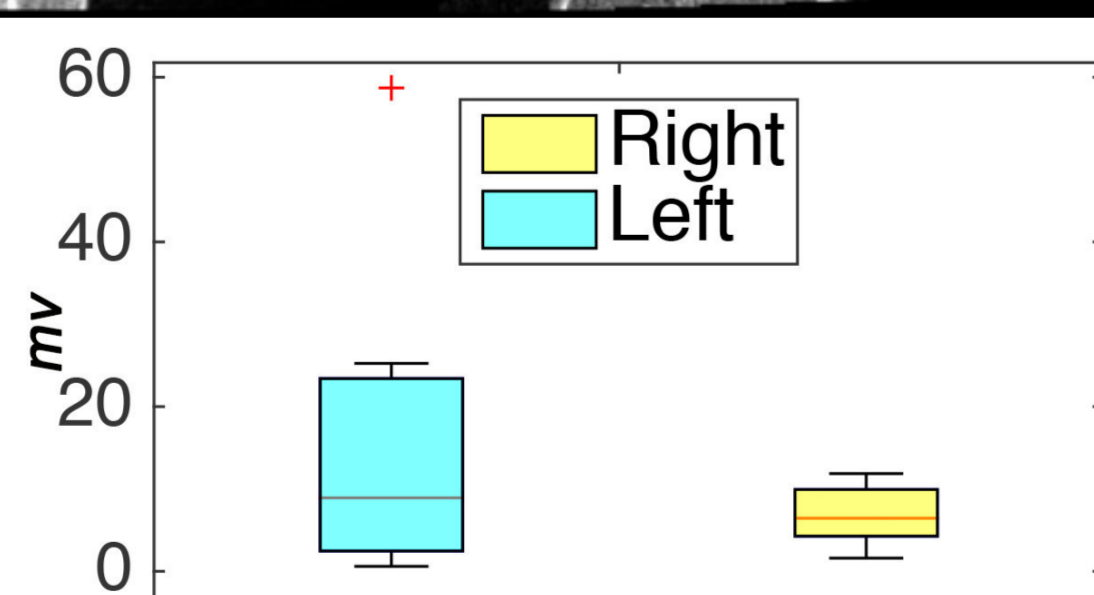
Results

fMRI only

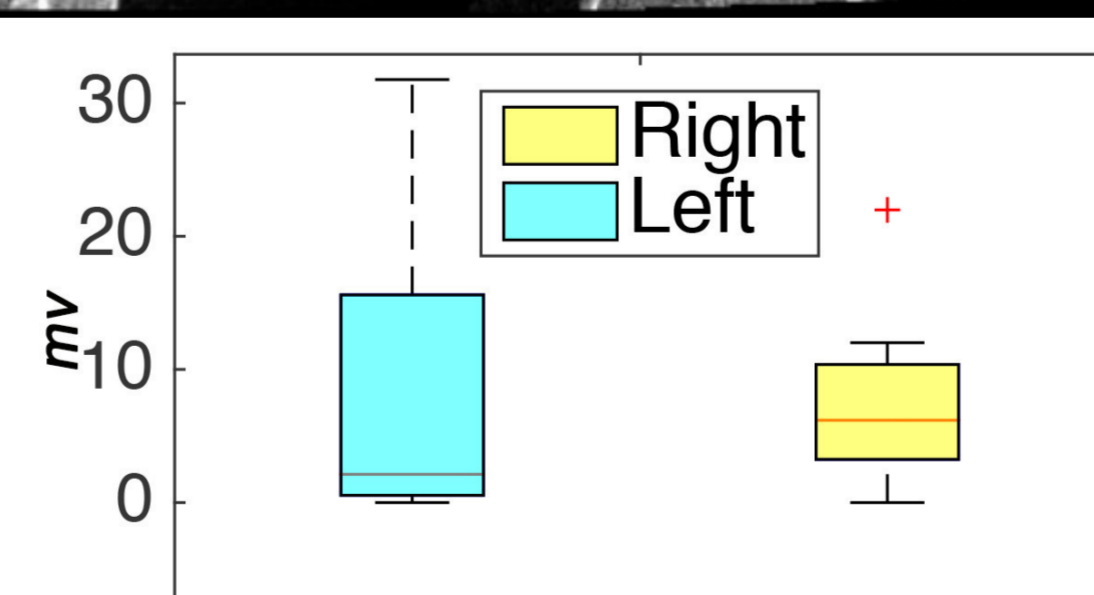
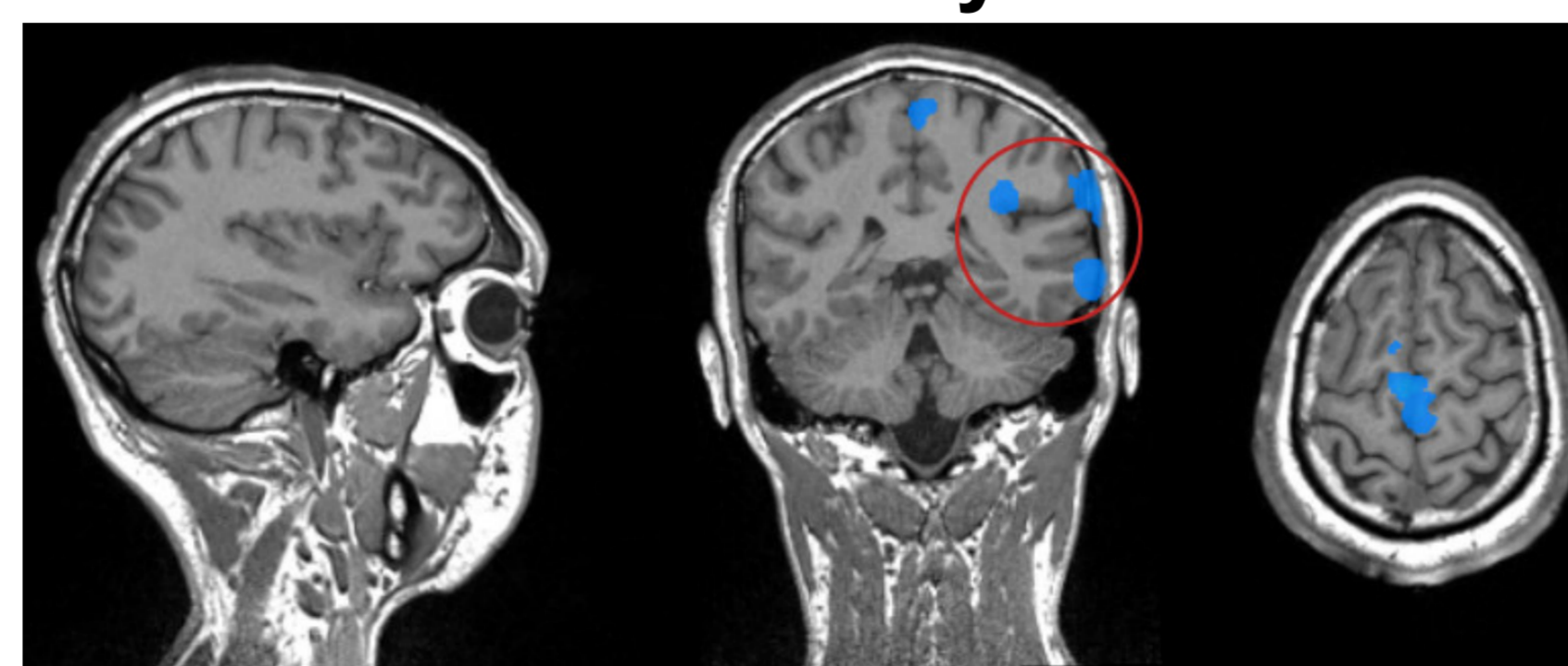


Active sources (one subject)

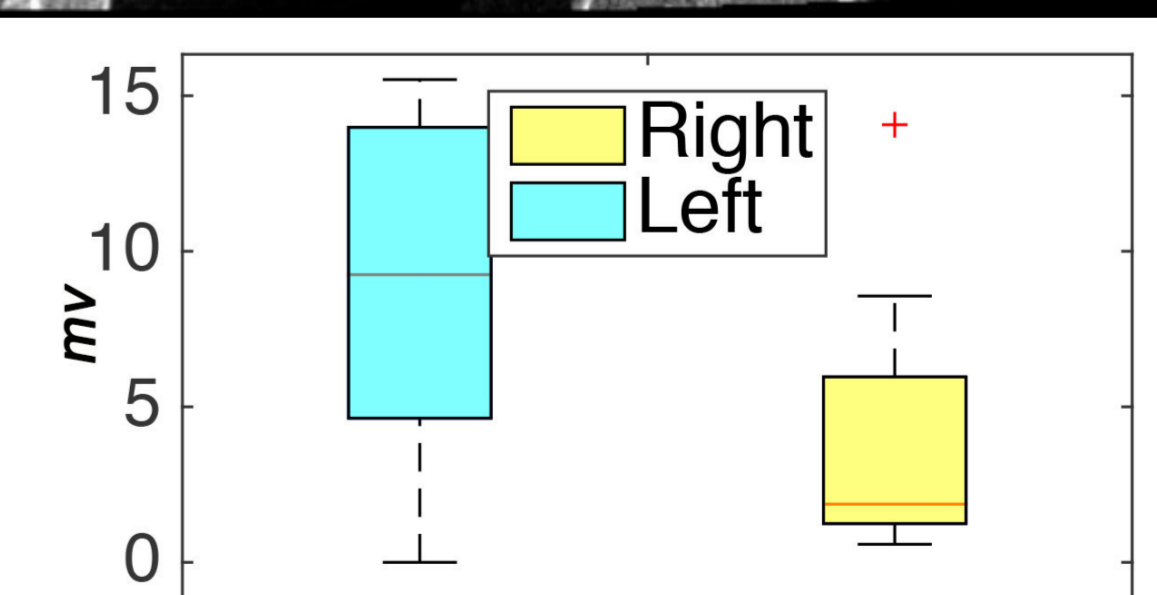
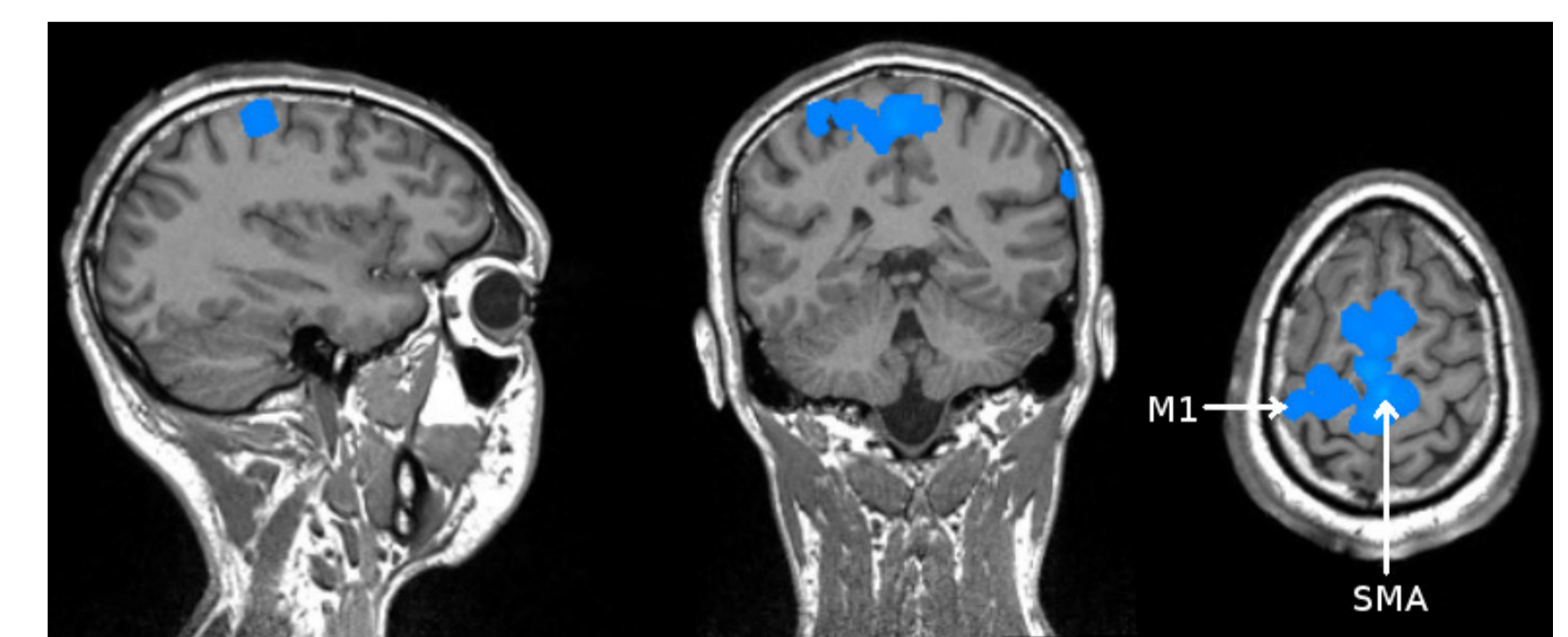
Activity in primary motor & premotor cortices (PMA/M1) (eight subjects)



EEG only

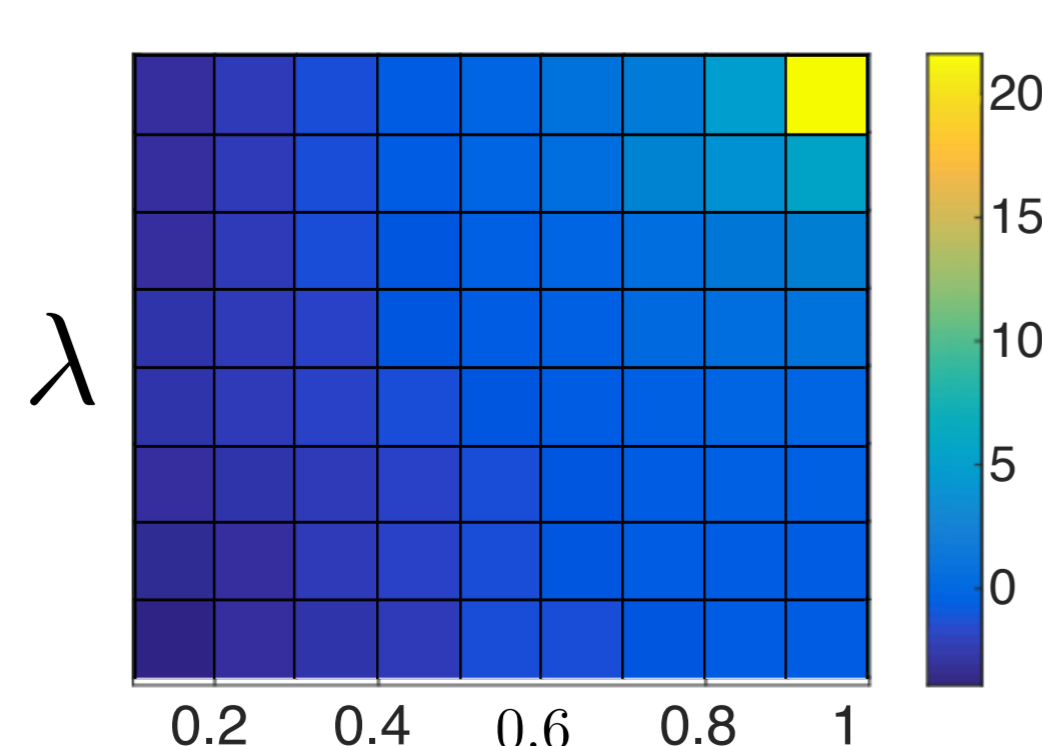


Joint EEG-fMRI

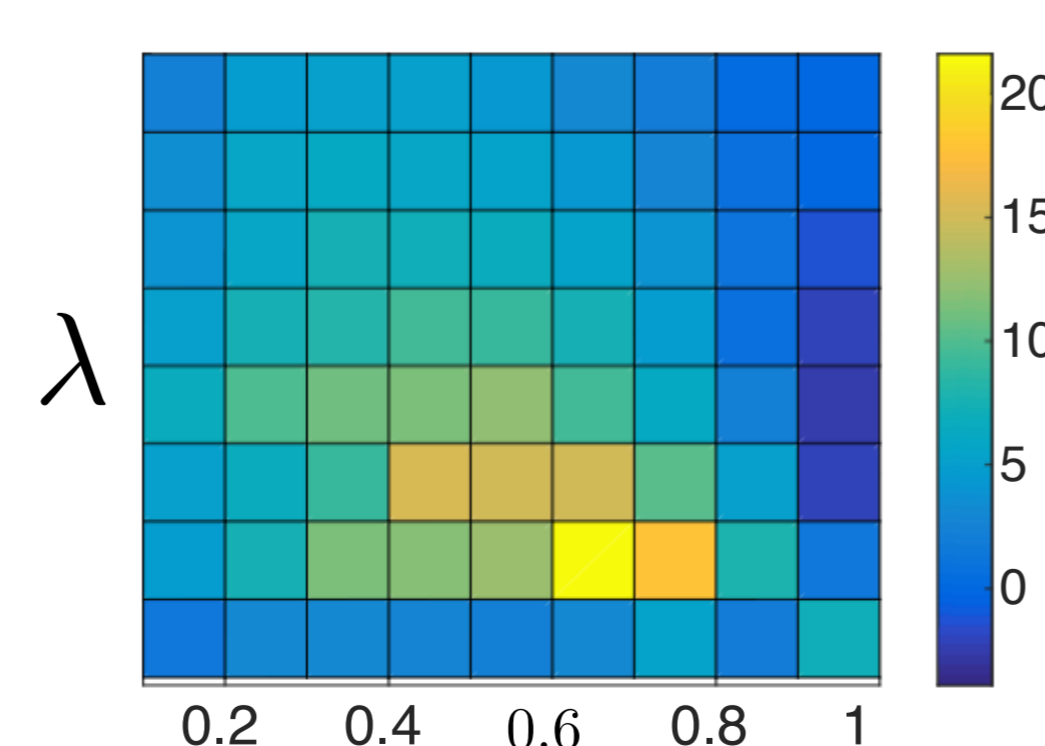


Optimal parameters

Performance score



Without calibration



With calibration

Conclusion

- A symmetric EEG-fMRI joint reconstruction can improve the spatio-temporal localization of sources, even with a simple linear model.

- What about the temporal reconstruction ?

