A novel benchmark for Electrophysiological Source Imaging validation

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INTRODUCTION:

The estimation of imaging brain activation and connectivity from noninvasive electrophysiological recordings (MEG/EEG) is known as Electrophysiological Source Imaging (ESI). ESI methods have a long history in brain basic and clinical research, due to the fine-grained temporal resolution of the EEG/MEG data. However, current simulation benchmarks for ESI validation are too naïve and straightforward.

OBJECTIVE:

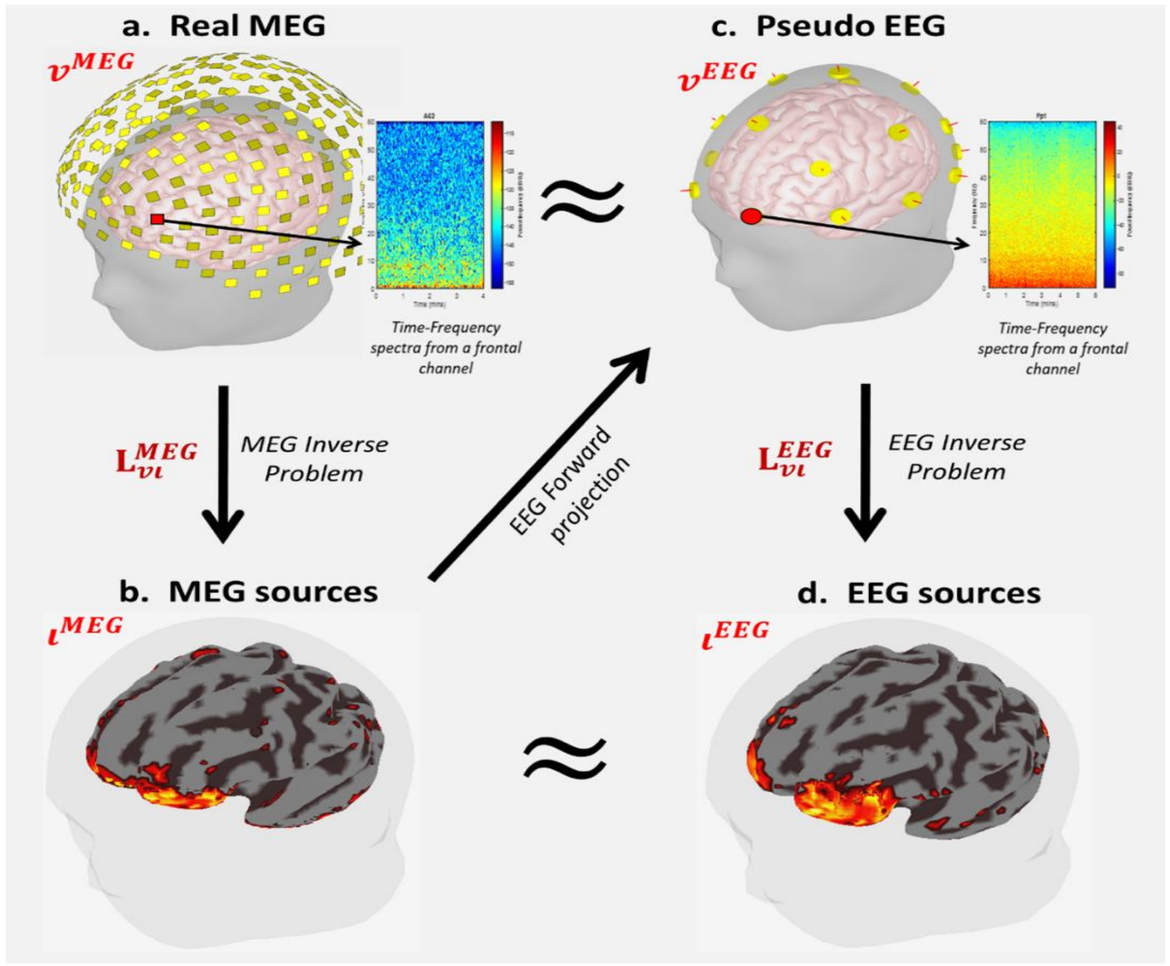
To develop an entirely new benchmark for the confirmation of ESI methods based on concurrency of the spectral source responses from high-density MEG recordings with the sources of its pseudo-EEG of much lower density

METHODOLOGY:

Our benchmark for ESI validation follows the next steps (the code and data are available in GitHub, https://github.com/egmoreira80/Concurrency_sSSBL-):

1. Estimation of the frequency domain MEG data sources in the cortex, using the Lead Field (LF) of the MEG head model, via ESI with a Minimum Norm method.
2. Generation of frequency domain pseudo-EEG data, using the Lead Field of the EEG head model from the MEG source activity determined in the first step.
3. Estimation of the spectral pseudo-EEG sources over the cortex, using the Lead Field of the EEG head model, via ESI with the different methods selected for validation purpose.
4. Determination of Variability ESI solutions for the pseudo-EEG, by comparing their distortion with respect to the MEG based Minimum Norm ground truth.
5. Estimation of the spectral real-MEG sources over the cortex, using the Lead Field of the MEG head model, via vESI with the different methods selected for validation purpose.
6. Evaluation of the concurrency for the vESI estimation in the pseudo-EEG with their estimation in the real-MEG.

RESULTS:



Methodology for ESI validation. a) shows the actual distribution of MEG sensors in the subject's native space and the time-frequency composition of a signal from a frontal sensor. b) the ground truth for spectral source activity simulations construed by means of an ESI Minimum Norm method for the MEG signals. c) 10-20 EEG system adjusted to the native subject's space, which produces pseudo-EEG from the projected MEG alpha source landmark, with a BS Boundary Element Method LF. d) This produces concurrent "pseudo-EEG signals whose time-frequency spectrogram for the frontal sensor is quite analogous to that of the MEG.

CONCLUSIONS:

We proposed a new benchmark to confirm any ESI method carrying out realism and increasing the dimensionality to theoretical limits for MEG/EEG.

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