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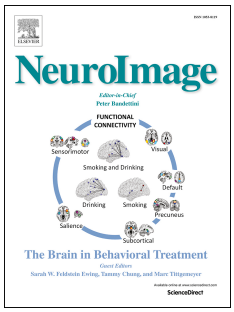

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Hierarchical multiscale Bayesian algorithm for robust MEG/EEG source reconstruction

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Abstract

In this paper, we present a novel hierarchical multiscale Bayesian algorithm for electromagnetic brain imaging using magnetoencephalography (MEG) and electroencephalography (EEG). In particular, we present a solution to the source reconstruction problem for sources that vary in spatial extent. We define sensor data measurements using a generative probabilistic graphical model that is hierarchical across spatial scales of brain regions and voxels. We then derive a novel Bayesian algorithm for probabilistic inference with this graphical model. This algorithm enables robust reconstruction of sources that have different spatial extent, from spatially contiguous clusters of dipoles to isolated dipolar sources. We test new algorithms with several representative benchmarks on both simulated and real brain activities. The source locations and the correct estimation of source time courses used for the simulated data are chosen to test the performance on challenging source configurations. In simulations, performance of the novel algorithm shows superiority to several existing benchmark algorithms. We also demonstrate that the new algorithm is more robust to correlated brain activity present in real MEG and EEG data and is able to resolve distinct and functionally relevant brain areas with real MEG and EEG datasets.

Keywords:
Brain Mapping, Magnetoencephalography, Electroencephalography, Bayesian.

1. Introduction

Mapping of the entire brain's activity in humans is an important undertaking in cognitive neuroscience research that seeks to understand neural mechanisms of complex human behaviors. It also has clinical applications in patients with brain tumors and epilepsy, where functional brain mapping is useful to guide neurosurgical planning, navigation, and resection.

Two techniques currently exist for non-invasive brain mapping of electrophysiological activity in humans: electroencephalography (EEG) and magnetoencephalography (MEG). MEG and EEG are complementary techniques that