Estimating the Number of Active Sources in MEG Based on an F-ratio Method

Amita Giri [1,*], John C. Mosher [2], Amir Adler [3,1] and Dimitrios Pantazis [1]

[1]McGovern Institute for Brain Research, Massachusetts Institute of Technology, Cambridge, MA, USA

[2]Department of Neurology, Texas Institute for Restorative Neurotechnologies, UTHealth, Houston, TX, USA

[3]Electrical Engineering Department, Braude College of Engineering, Karmiel, Israel

Abstract

Magnetoencephalography (MEG) is a valuable method for investigating human brain function. Nevertheless, accurately determining the number of sources contributing to MEG recordings remains a difficult task due to factors like low signal-to-noise ratio (SNR), the existence of correlated sources, inaccuracies in modeling the head, and differences in individual anatomy. In response to these challenges, our research introduces a robust approach to precisely estimate the number of active sources within the brain. Our approach leverages the F-ratio statistical technique, enabling a direct comparison between a full model with $K+1$ number of sources and a reduced model with K number of sources, where $K \in \mathbb{Z}$. We have developed a formal statistical procedure that incrementally increases the number of sources in the context of the multiple dipole localization problem until all relevant sources are identified. The flowchart of the F-ratio method is shown in Figure 1. Our findings reveal the importance of selecting appropriate thresholds, which must be adjusted in accordance with the number of sources and SNR levels. Interestingly, these thresholds remain relatively stable for factors such as inter-source correlations, inaccuracies in translational modeling, and diverse cortical anatomies. By identifying the optimal thresholds and confirming the effectiveness of our F-ratio-based approach using simulated, actual phantom, and real human MEG data, we illustrated the superiority of our method over established statistical techniques like the Akaike Information Criterion (AIC) and Minimum Description Length (MDL). In summary, when fine-tuned for threshold selection, our method provides researchers with a reliable tool for estimating the genuine count of active brain sources and faithfully representing brain function.

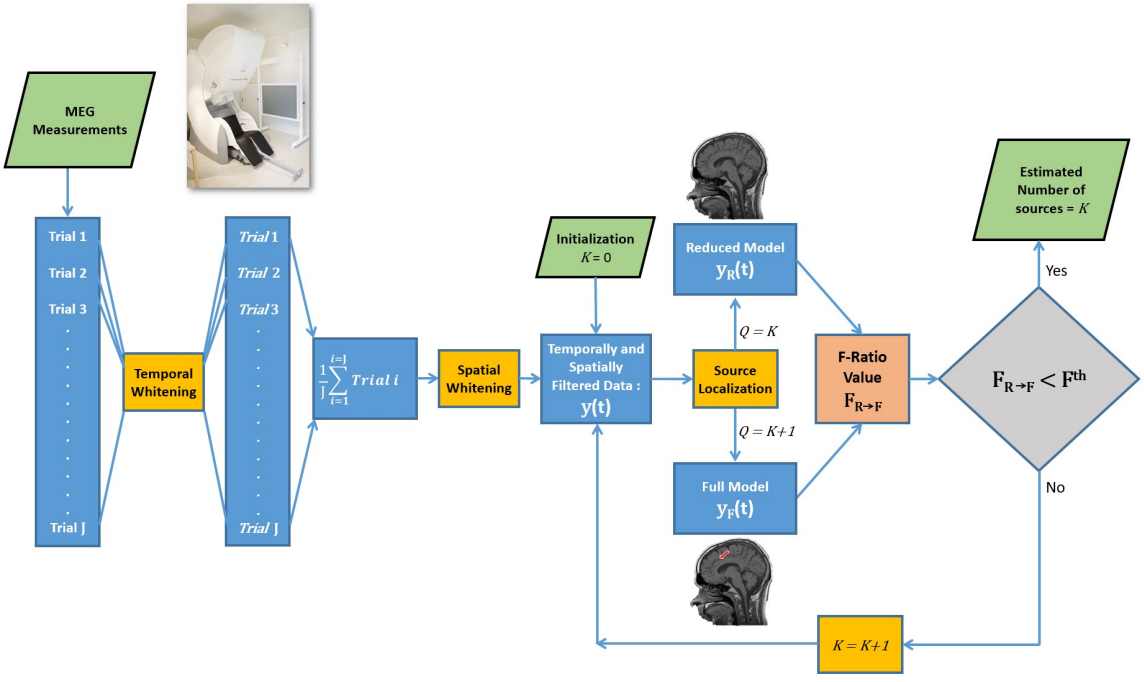

Figure 1: Flowchart of the F-ratio method for estimating the number of sources.