# Cancellation of MEG and EEG Signals with Distributed Source Activation on Realistic Cortical Surface

**Fa-Hsuan Lin[*,†], Seppo P. Ahlfors[*,‡], Thomas Witzel[*], Anders M. Dale[*], Bruce R. Fischl[*], Arthur K. Liu[*], John W. Belliveau[*], Eric Halgren[*]**

[*]*Massachusetts General Hospital NMR Center, Department of Radiology*

[†]*Harvard-MIT Division of Health Sciences and Technology*

[‡]*Albert Einstein College of Medicine, Department of Neurology*

**Abstract**

INTRODUCTION

The spatial patterns of magnetoencephalographic (MEG) and electroencephalographic (EEG) signals generated by source currents in different parts of the brain typically overlap extensively. For simultaneous sources, overlapping patterns result in reduced resolution in inverse estimates of the underlying source distributions. In particular, cancellation due to superposition of fields with opposite signs reduces the measurable signal magnitude, thus reducing the effective signal-to-noise ratio per source. To quantify this cancellation, we computed a cancellation index as a function of the number of simultaneous, randomly selected sources on a realistic reconstruction of the human cortical surface.

METHODS

The cortical surface was represented by a mesh of ~330000 vertices, constructed from the white-matter segmentation of anatomical MRI [1]. A subset (~7000) of these vertices were chosen for the allowed locations of MEG/EEG sources [2], with approximately even 10-mm distance between neighboring points. The source orientations were assumed normal to the surface. The elements $a_{ij}$ of a forward matrix describe the signal strength in sensor $i$ generated by unit activity in source dipole $j$. The forward matrix was constructed using a boundary element model of the head [3]. A configuration of 306 MEG sensors was assumed (VectorView, Neuromag Ltd.: 102 magnetometers and 204 1st-order planar gradiometers). For EEG, a montage of 64 electrodes was used. The magnitude of signal cancellation due to overlapping field patterns generated by simultaneously active sources was described with the cancellation index $C = \Sigma_i \mid \Sigma_j a_{ij} \mid / \Sigma_j \Sigma_i \mid a_{ij} \mid$, where $j$ runs over a subset of $n$ source locations. For independent signals, C=1; for complete cancellation C=0. We calculated C for subsets of $n$ sources, selected randomly from the 7000. This random selection was repeated 1000 times for each $n$, and the values for C were averaged.

RESULTS

Fig. 1 shows the cancellation index as a function of the number of randomly selected point sources on the cortical surface. The index decreased monotonically for both MEG and EEG. Cancellation effects were prominent even for a small number of sources: with 5 sources the index was ~50%. When all sources were active simultaneously, the cancellation index was 1% for MEG and 4% for EEG. The index was smaller (i.e., cancellation was larger) for EEG than for MEG when the number of sources was less than 200. For 1000 dipoles (corresponding to 14% of the total cortical surface) or more, the index saturated to 4-5% for EEG, but for MEG it decreased until the total number of

dipoles was reached.

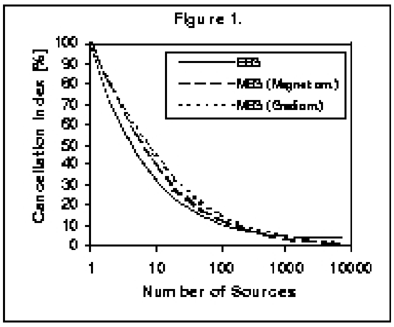

Figure 1.

DISCUSSION

The results suggested that cancellation of MEG and EEG signals can be substantial for even a small number of simultaneously activated sources. This implies that the effective signal-to-noise ratio per source is likely to be reduced for simultaneously active sources; this has to be taken into account when evaluating the resolving capabilities of MEG/EEG source analysis techniques.

REFERENCES

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