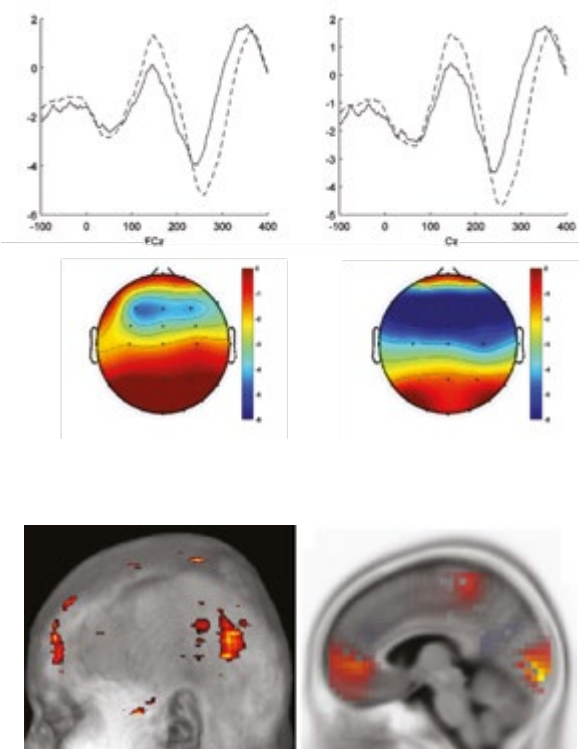


Extraction of Relevant Components of Electroencephalogram Signals During Cognitive Tasks

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The electroencephalogram (EEG) and functional magnetic resonance (fMRI) are widely used tools in cognitive brain studies. A combination of both profits from high a temporal resolution of the EEG and a high spatial resolution of fMRI. However due to interferences of other biomedical signals or due to the low amplitude of the interesting events the signals need to be processed. The most widely used methodologies involve the signal decomposition into components whose goal might be to extract interferences or the significant components. Event-related potential (ERP) studies associated with the Halstead Category Test (HCT) are only possible if the high amplitude ocular and movement artifacts during performance of the test are removed. The decomposition of the EEG signal inspired on Singular Spectrum Analysis (SSA) allows the enhancement of the feedback-related negativity (FRN) wave, which is related to error-processing (fig. 1). This preliminary study show the importance of the pre-processing step in a scenario where the interferences are very difficult to avoid.

Lately, Ensemble Empirical Mode Decomposition (EEMD) techniques receive growing interest in biomedical data analysis. Event-Related Modes (ERMs) represent the relevant features extracted by an EEMD from electroencephalographic (EEG) recordings. Then, based upon the problem at hand, the most closely related ERM, in terms of frequency and amplitude, is combined with inverse modeling techniques for source localization. Bidimensional Empirical Mode Decomposition(BEMD) interprets an image as a superposition of Intrinsic Modes. This study introduces a new technique to extract the latter based on Green's function with tension(fig.2).



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FIGURE 1
HCT test data analysis: Top: Grand-average waveforms of individual ERPs for two channels considering two subsets of trials: Wrong responses (dash line) and Right responses (solid line). Bottom: Head topography of the grand-average waveforms considering a visualization window centered at 250 ms: left: Wrong response and right: Correct responses.

FIGURE 2
EMD decompositions of fMRI and EEG. Left: The intrinsic mode as extracted with Bi-dimensional EEMD from fMRI data, and right: data reconstructed from ERM5 of the EMD decomposition of EEG data. The comparison concentrates on the late ERP N200.