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Relations between sensory and behavioral context and EEG spectra in a working memory task

AUTHOR BLOCK: *S. MAKEIG[1], J. ONTON[2];
[1]UCSD/Inc/SCCN, La Jolla, CA; [2]Inst. for Neural Computation, UCSD, La Jolla, CA

Abstract: The dominant approach to modeling relationships between experience, behavior, and brain dynamics is to acquire brain imaging data during presentation of a sequence of stereotyped classes of stimuli that elicit a small repertoire of participant behavioral responses, usually small finger movements. Researchers then average brain dynamics time locked to these stimulus or response classes and compare them by computing differences -- the method of planned comparisons. However, there is no guarantee that the dynamics produced by the brain during the experiment are solely or chiefly evoked by these event classes, or that each event class elicits only one type of brain response. The size, latency, and type of brain activity time locked to sensory and behavioral events may be linked to the detailed nature of the event, its relevance to the participant task, and/or to the exact context in which the event occurs. The brain may be said to continually 'respond to the challenge of the moment' so as to maximize participant rewards and minimize penalties. But what is the nature of the brain's 'challenge of the moment? What aspects of the event and its context determine the nature and size of the observed brain dynamics? Here we decomposed high-density scalp EEG data recorded during performance of a difficult continuous performance working memory task with auditory feedback ('two-back with feedback') using independent component analysis (ICA), then converted the separated signals around feedback events of components associated with probable brain sources into normalized log spectrograms. To each spectrogram we appended a vector of context indicator variables, each the (yes/no) answer to a question about the trial itself or about preceding or succeeding trials. Decomposing this fused data by ICA produced a number of 'independent context factors' combining a time/frequency log power template, plus a vector of context factor loadings, with a vector of multiplicative weights giving the relative polarity and strength of the factor on component spectral changes during the trial. The method revealed overlapping EEG spectral changes in many cortical source components that were associated with current or past reward, penalty, and neutral feedback, or with future performance.
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