Event-related power changes associated with complicated situational context

Julie Onton[1] and Scott Makeig[2]

[1]Naval Health Research Center, San Diego
[2]Swartz Center for Computational Neuroscience, UCSD

Event-related brain dynamics are usually revealed through averaging of presumably comparable trials which averages out non-event related activity that occurs inconsistently across trials. However, this approach ignores the rich complexity of the trial-to-trial variability that may be the result of behavioral context, and not simply spurious thoughts that are unrelated to task demands. It is likely that many aspects of even a simple task may influence brain activity in a particular trial. For example, the nature of the previous trial (target? nontarget? same? different?) and the recent subject performance will affect how the current trial is experienced and processed. These and many more aspects of the current trial context are very difficult to disentangle by *a priori* comparisons because of myriad possible combinations. Moreover, at that level of specificity and reduced number of trials, the confounds of unknown subjective states may distort a standard statistical analysis of event-related brain dynamics. In order to associate the brain activity that is truly associated with a complicated behavioral context, it is necessary to use a computational approach that can extract brain activity that is consistently associated with a very specific behavioral context even with overlapping contexts and spurious activity occurring in each trial.

Here we present a method for joint decomposition of behavior context indicators and event-related spectral perturbations (ERSP) using independent component analysis (ICA). The behavioral task was a two-back continuous performance task that delivered feedback for each trial about whether the subject was correct or incorrect. In addition, some trials gave feedback that the current trial was not only correct or incorrect, but that it was either a 'bonus' or 'penalty' trial wherein the subject earned or lost 4 extra points compared to a normal trial. To control for the rare occurrence of these events, some trials delivered a feedback that was uninformative as to trial performance, though subjects knew that points were still tallied correctly. In such a task, prior performance and feedback signals, among many other factors are very important and skew brain dynamics in subtle ways during each trial. *A priori* comparisons are certainly possible in such a task (e.g., correct vs incorrect, match vs nonmatch, etc), but we show here that much more detail can be extracted using ICA to find brain processes responding specifically to particular behavioral challenges.

We will demonstrate the advantages of joint ERSP and context decomposition and compare this method with decomposition of context or ERSP alone. Furthermore we will describe how the results from this method can be interpreted and conceptualized for researchers to easily apply as a way to discover truly event-related activity in a complex behavioral context.

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