MLSP 2005 Competition:
Artifact Removal from Event-related Potential Data

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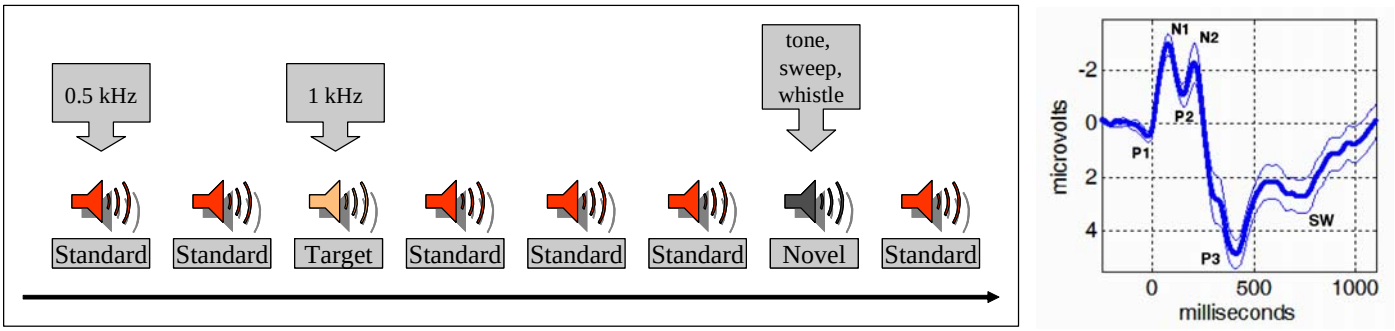
1. Introduction

Electroencephalography (EEG) is a technique for measuring the electric current produced by neuronal transmission. Event-related potentials (ERPs) are time-locked averages of EEG data during the presentation of the same stimuli, repeated multiple times. Electrodes are placed at various positions around the scalp in order to record the signals. The auditory oddball task is a paradigm in which infrequent, task-relevant target 'oddball' stimuli are interspersed with infrequent task-irrelevant novel stimuli and frequent standard stimuli. A picture of the auditory oddball task and a target time-locked average is presented below. One of the most prominent features of the oddball response is a large positive complex peaking at approximately 300 ms post stimulus (marked P3, for third positive going peak, on the figure below right). The P3 response is typically maximal at electrode #48 (left/right centrally located over the parietal lobe).



Auditory Oddball Paradigm (left) and time-locked average for onset of target stimuli (right)

Note the plot uses the convention of having positive values at the bottom. Typical approaches to processing these data include band-pass filtering to remove 60Hz noise or independent component analysis for removal of eye movement artifacts (Jung *et al.*, 2000).

2. Data

The data is contained at http://www.nrc-iol.org/mialab/results.htm is a matlab file compressed into a *.zip file (contact Vince if you do not have access to Matlab). In this file are several variables:

1) *data*, a 373568-by-64 matrix containing 48 target trials sampled at 500 Hz. This matrix contains the samples of the EEG signal for each of the 64 sensors placed on the scalp
2) *stim_onset*, a 48-by-1 vector containing indices for the onset of the target stimuli
3) *response*, a 48-by-1 vector containing indices for the response to the target stimuli (a button press)

3. Submissions

Submissions should be in the form of a Matlab *.mat file that contains a single 64-by-550 variable, *y*, which contains the averaged ERP response from 100ms prior to the stimulus until 1second post-stimulus. The submission should be sent by the deadline to the MLSP Committee by email.

The e-mail should contain either the *.mat (zipped) as an attachment or a URL from which the data can be obtained (the latter is preferred). In addition, the email should include a one paragraph description of the approach used.

4. Performance Metric

The contrast to noise (CNR) performance metric to be used is the following:

$$CNR \triangleq \frac{\left(\arg\max y(200:500,48) - \frac{1}{50}\sum_{j=1}^{50} y(j,48) \right)}{\frac{1}{48}\left(\sum_{j=1}^{48} \left(data\left(a(j):\left(a(j)+500\right),48\right) - y(50:550) \right)^2 \right)}$$

Where $a(\cdot)$ is the vector of stimulus onset indices, $data(\cdot)$ is the original data matrix and $y(\cdot)$ is the submitted data. There are two goals: 1) to maximize CNR, and 2) to completely automate the process (*i.e.* manual selection of eye movement artifacts using ICA is not permitted unless it can be automated).

1. Jung TP, Makeig S, Humphries C, Lee TW, McKeown MJ, Iragui V, Sejnowski TJ. 2000. Removing Electroencephalographic Artifacts by Blind Source Separation. Psychophysiology 37(2):163-78.