Monitoring Error-related potentials

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Dataset Description

The existence of neural correlates of subject's error processing, and the feasibility of decoding them in single trial, has triggered the interest for its application in Brain-Computer Interfacing [Chavarriaga et al., 2014]. This dataset corresponds to an experiment on EEG error-related potentials (ErrPs) elicited when the user monitors the behavior of an external device upon which he/she has no control whatsoever. This experiments was one of the first that showed that these correlates could be observed and decoded during monitoring of external agents. Works that make use of this dataset should cite [Chavarriaga and Millán, 2010]

Experimental protocol [Chavarriaga and Millán, 2010]

We have adapted an experimental protocol used previously to study error potentials during brain–computer interaction. In this study, humans do not send commands to the autonomous agent and are asked to only assess whether it performs properly.

Subjects seat in front of a computer screen where a moving cursor (i.e., a green square) and a target location are displayed. The working area consists of 20 locations along the middle horizontal plane of the computer monitor, and subjects are asked to fixate the center of the screen. A colored square at either the left or right of the cursor indicates the target location (targets in the left appear as a blue square, while targets on the right of the cursor are red). Therefore, the relative position of the target with respect to the cursor is not necessarily in the same visual hemifield. At each time step (i.e., thereafter termed a trial) the cursor moves horizontally depending on the location of the target. Trials have an approximate duration of 2000 ms. Once the target is reached, the cursor remains in place and a new target location is drawn at no more than three positions away from the current cursor position. If the new location falls outside of the working area, it is relocated at the center of the screen.

During the experiment, the user has no control over the cursor's movement and is asked only to monitor the performance of the agent, knowing that the goal is to reach the target. In order to study signals generated by erroneous actions, at each time step there is a probability of about 0.20 for the cursor to move in the wrong direction (i.e., opposite to the target location).

Six subjects (mean age 27.83 +- 2.23) performed two recording sessions separated by several weeks. Table I shows the number of days between the two recordings for all subjects and conditions. Each experimental session consists of 10 blocks of 3 min each (approximately 50 trials per block).

TABLE I. Time difference (in days) between recording sessions for each subject

Subject	**1**	**2**	**3**	**4**	**5**	**6**
Days	51	50	54	211	628	643

EEG potentials were recorded at full DC at a sampling rate of 512 Hz for all subjects using a Biosemi ActiveTwo system. We used 64 electrodes placed according to the extended 10/20 international system. Protocol events (cursor direction of movement and target location) where stored in the EEG recording using a hardware trigger. Triggers were coded bitwise as follows (0: Least significant bit):

Bit	Description
0	Target located in the left
1	Target located in the right
2	Cursor movement to the left
3	Cursor movement to the right

In consequence events' 5' and '10' mark correct movements, while erroneous movements are marked with events '6' and '9'.

Data description

The data is provided in matlab format. Data from each subject is provided in a separate file: `Subject_XX_sY.mat` (>250MB/file)

Where, `XX` corresponds to the subject number (from 1 to 6), and `Y` denotes the session number. Each file contains a variable `run` containing the data for the session (i.e., 10 runs), as follows,

`run{idx}.eeg`	raw EEG data. (n_samples x n_channels)
`run{idx }.header`	Recording metadata, as follows:

Where `idx` is the run number (from 1 to 10). The `header` contains the following fields:

`header.Subject`	Subject number
`header.Session`	Session number
`header.SampleRate`	Recording sampling rate
`header.Label`	Electrode labels
`header.EVENT`	Recording events

Event information is stored in the structure `EVENT`. It contains two fields `EVENT.POS` and `EVENT.TYP` containing the type and position (in samples) of all events, respectively.

References

- Chavarriaga, R. & Millán, José del R. Learning from EEG Error-related Potentials in Noninvasive Brain-Computer Interfaces. IEEE Trans Neural Syst Rehabil Eng, 2010, 18, 381-388. DOI: 10.1109/TNSRE.2010.2053387
- Chavarriaga, R.; Sobolewski, A. & Millán, J. d. R. Errare machinale est: the use of error-related potentials in brain-machine interfaces. Front Neurosci, 2014, 8, 208. DOI: 10.3389/fnins.2014.00208