Task Description for Written Examination

Module PSY4320

Your task is to analyze EEG and behavioral data of a stop signal task, and to write your own MATLAB code to do so. Parameterized event-related potential and behavioral data will then be assessed statistically using SPSS. All necessary files can be downloaded from Canvas.

File description:

The files (specific info on the files in Canvas) contain EEG data of 15 participants from a study using a stop signal task. The data are stored in EEGLAB's EEG data format.

- As online reference served an electrode place at the nose, and AFz as gound; these channels thus are not included as physical channels in the data. There is no need to recompute the online-reference channel, but the data should be re-referenced to the average of all EEG channels.
- There are 64 EEG channels in total. You can use frontal (e.g., FP1/FP2) and temporal channels (e.g., T7/T8) for artifact rejection.

The data stem from a stop signal task with two possible go-responses (left or right button press, depending of the presented go-stimulus). Subjects were asked to respond with the correct button press to the frequently occurring go-stimuli, but to withhold the response when the go-stimulus is followed by a second one (the stop signal). The stop-stimulus is presented with a variable delay (the stop signal delay, SSD) relative to the go signal. The SSD is adapted in accordance with the participant's behavior (prolonged after successful stops, shortened after unsuccessful stops). These are the corresponding trigger/marker codes:

- 200/224 - go left/go right stimuli in go-trials
- 144/208 - go left/go right stimuli in stop-trials
- 176/240 - stop left/stop right stimuli
- 160/132 – left/right responses
- 148 - pause

The following trial categories can be differentiated:

- Correct go trials (go signal followed by correct response, e.g., go-left and response left)
- Incorrect go trials (go signal followed by wrong response, e.g., go-left and response right)
- Omissions (go signal followed by no response)
- Successful stop trials (a stop signal was presented and no response was given)
- Unsuccessful stop trials (also called false alarms; a stop signal was presented, but a response was given after its presentation)
- Invalid stop trials (a stop signal was presented, but the subject had already responded)

Task specifications:

1) Write functions implementing the basic processing steps to extract event-related potentials (ERPs). Those processing steps include the recoding of triggers, data filtering, re-referencing, epoching, artifact rejection, baseline correction, and averaging.

The functions should be flexible to use. Hence, settings should be able to vary and differ from those needed for the datasets at hand; i.e., the functions will have to accept parameters to change their functionality (see below). Please also provide a short documentation for these functions (a document that shortly describes the functions and their input/output parameters).

Please follow these instructions for the analysis of the EEG data:

- No high-pass filtering is needed, but you should program a function for low-pass filtering based on a moving average procedure (see Luck, chapter 7, here called running average). You are free to choose a window width for the analysis of the given data, but one should be able to change the window width as input parameter of the function.
- Re-reference the data to the average reference (see Luck, chapter 5 for details).
- Extract epochs from -200 to 800 ms with respect to the trigger/marker of interest (successful stop trials: stop signal; unsuccessful stop trials: stop signal; correct go trials: go signal).
- Trials with artifacts should be rejected. Relevant artifacts in this context include eye blinks and muscle activity. More than one criterion for rejection should be implemented and used (see Luck, chapter 6).
- The function for the baseline correction should accept the start/end times in ms, and implement a procedure to extract the corresponding indices from EEG.times.

You should implement the processing of the subjects' data as loop; please submit the corresponding .m file and comment the different processing steps in the script.

Visualize the ERPs of electrodes Fz, Cz, and Pz, i.e. plot the ERPs of successful stop trials, unsuccessful stop trials, and the go trials. Also plot the topographies of the N2/P3 peaks across the scalp using EEGLAB's topoplot() function.

2) In order to be able to analyze the data statistically, you will first have to write functions to extract relevant parameters from the EEG and the behavioral data. These functions should then be used in a script to fill a matrix or table with the subjects' data.

- Write a function to extract the peak amplitudes and peak latencies for ERPs, i.e. the amplitude and latency of the most positive or negative value in a predefined time-window. Use this function to extract peak amplitudes and latencies of the N200 and P300 for the correct go and the successful and unsuccessful stop conditions. To compute the peak amplitude, the function should locate each individual's peak amplitude for a given ERP at a specified electrode (or set of electrodes), and then compute the mean of the peak and its surrounding 4 data points (peak +/- 2; however, the number of data points across which to average is defined as input parameter to the function).
- Another function is needed to extract the following behavioral parameters: mean response time in correct go trials (go-RT), mean response time in unsuccessful stop trials, the percentage of successful stop trials, and the stop signal reaction time (SSRT). The SSRT is calculated as the difference of the mean go-RT and the mean of the SSDs (i.e., mean(goRT) – mean(SSD)).

Again, implement the processing across subjects as a loop, write the subjects' data into a table/matrix and save the data as excel sheet.

3) Having computed the ERPs and extracted their amplitudes (N200, P300) from all subjects and conditions, compute the following statistics using SPSS:

- Compare peak amplitudes of the N200 and P300 of go and successful stop trials. Specifically, set up a three-factorial ANOVA with one factor for the experimental conditions, one for electrodes along the front-to-back axis and one for the left-to-right axis (a simple example for such analyses can be found in Luck, chapter 10). The latter two factors should have three levels each. Use the same setup to compare N200 and P300 amplitudes and latencies of successful and unsuccessful stop trials.

- Compare the mean response times of correct go trials and unsuccessful stop trials. Also, correlate the behavioral and EEG parameters (using the three midline electrodes Fz, Cz, Pz; this is an exploratory analysis).

Provide a description of your procedure as word or pdf document, and also submit the SPSS-syntax. Shortly describe the results and provide a concise interpretation.

General comments:

- Stick to the code conventions accompanying the datasets (in Canvas).

- Should you have problems with task 1 (I the implementation of the EEG processing pipeline), you can use the condition-specific EEG files to keep working on task 2 (the extraction of EEG and behavioral parameters). Similarly, should you run into problems with task 2, you may use the parameter files to continue with task 3 (statistical analyses).

Files to hand in:

1) A pdf-document containing a short documentation of the functionality of the MATLAB-functions, a description of the actual EEG processing, statistical analysis, results and interpretation. Append the SPSS output.

2) The m-files for all functions programmed for task 1 (including a short documentation), scripts for the automated processing of the EEG and the parameter extraction (three files in total).