Neuroengineering 2019-2020

Exam 18 January 2021 – Part II

How to submit your answers.

Most answers can be typed in the Exam.net editor.
Write the answers in the same sequence as the questions (A1, A2, … B1, B2, …) and write the same headers as the test on a separate line just above your answer, e.g.:

> Problem A
> A1
> *<your answer to question A1 goes here>*
> A2
> *<your answer to question A2 goes here>*
> …

Textual answers must be typed in the editor. When graphical elements are required in the answer, the latter can be written on paper and scanned using your mobile phone at the end of the exam.
It should always be possible to use a single sheet of paper for all answers to a specific problem. Anyway, always use separate sheets of paper for problems A and B.

Keep your answers tidy. Messy, hard-to-read answers may penalize your mark.

Your answers should not exceed the length recommended in each question.
Answers significantly longer than requested may reflect poor understanding of the problem, and thus will likely receive a lower mark.

The maximum total score for part II is 11.

Problem A

Carefully read the following scenario and answer the questions listed below:

A study has the aim to investigate a short-term memory function. It is already known that:

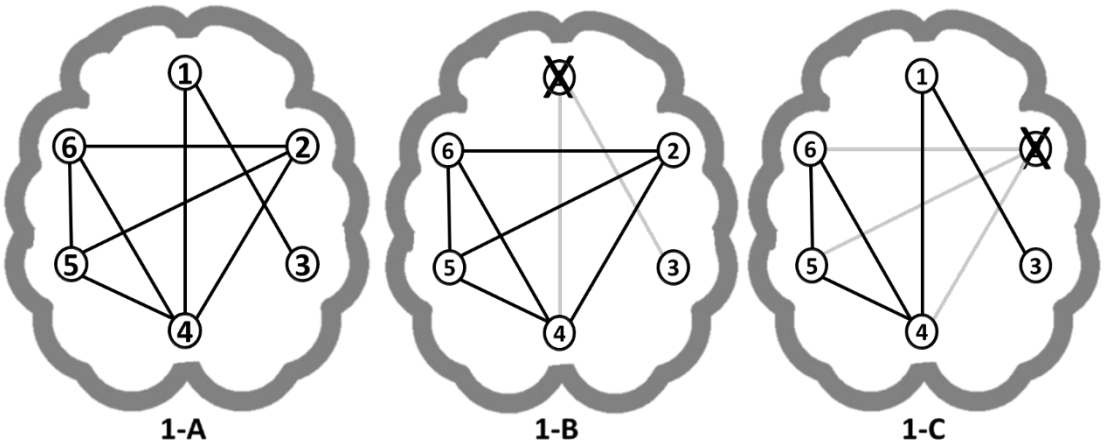
1. the function involves 6 brain regions;
2. it is based on a specific activity in alpha and theta bands;
3. learning and habituation effects prevent from performing long recording sessions.

Question A1 *(2 points)*

Indicate which method you would use to perform the functional connectivity analysis. Motivate your choice, based on the above-mentioned conditions. *(type the answer in the exam.net editor)*

Question A2 *(3.5 points)*

As a result of the study, we obtain the functional brain network reported in Fig. 1-A. Then, to investigate the role of specific regions in the network, we examine the same network after the removal of node 1 (Fig. 1-B) and node 2 (Fig. 1-C).



A2.1: Compute the Global Efficiency for each of the three graphs *(2 points)* *(write the answer on paper)*

A2.2: Indicate which, among the two removed nodes, has a more important role in the efficiency of communications in the network. Motivate your choice. *(1.5 points)* *(type the answer in the exam.net editor)*

Problem B

A somatosensory evoked potential (SEP) is recorded by delivering electrical stimulations to the peripheral nerve to the most distant segment of the subject's limb. The procedure is repeated twice, once per experimental condition (conditions "red" and "black"), in each of which 100 single trials are collected. Following synchronized averaging of the raw EEG trials, the waveforms of the averaged potentials are plotted in *Figure B1*.

Questions:

(Type all answers in the exam.net editor. Mathematical formulas can be handwritten and a reference to the scan can be included in the text)

B1. *(2 points)* Make an informed guess on the names of the peaks (EP components) visible in the "red" condition. Briefly explain your reasoning.
Start your answer with a line including only a comma-separated list of EP components
Justify in max 5 lines.

B2. *(2 points)* Make a broad visual estimate of the amplitude of the noise affecting the waveform. (*Hint: check the baseline period*). Assuming this ERP was obtained from the average of 100 single trial, estimate the amplitude of the subject's spontaneous EEG.
Explain your reasoning.
Start your answer with two lines reporting, the amplitude of the noise and the amplitude of the EEG
Justify in max 10 lines.

B3. *(1.5 points)* Assuming the conduction velocity of the stimulus from the periphery to the brain is about 60 m/s, is it more likely that the stimulation was delivered to the upper or to the lower limb (i.e. arm or leg)? Was it delivered to the right or the left limb?. Justify.
Start your answer with a line reporting which limb, e.g. "upper, left"
max 5 lines.

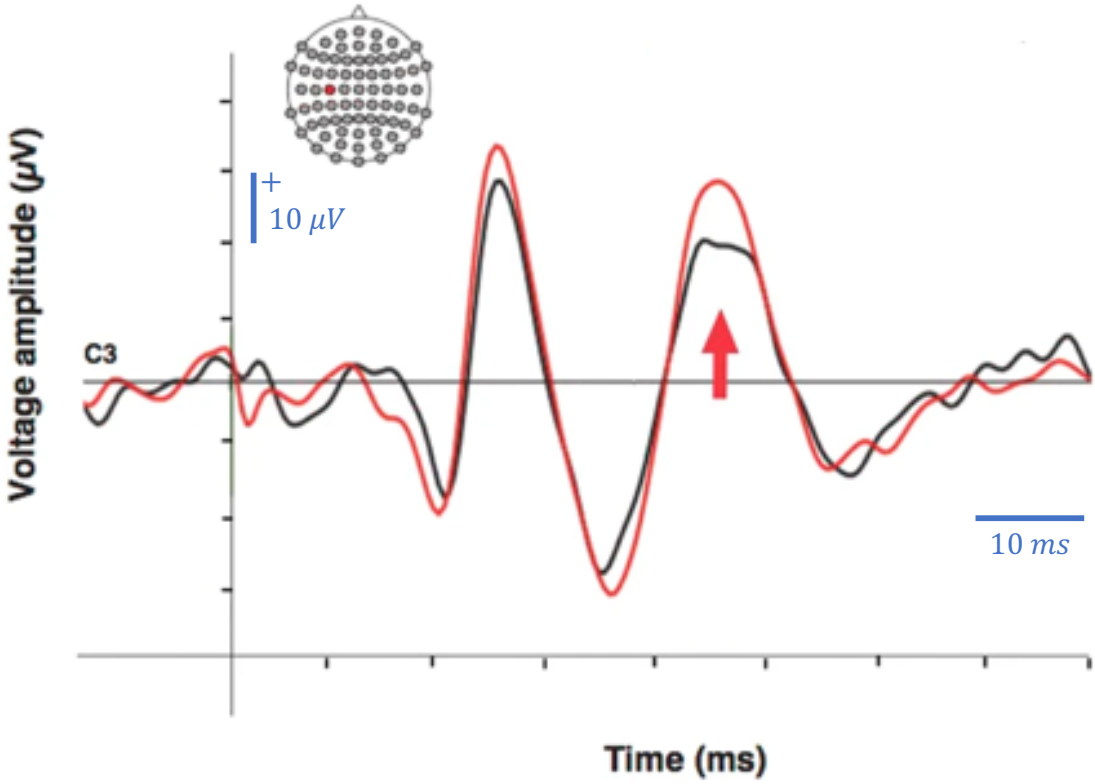


Figure B1. Example of normal Somatosensory Evoked Potential acquired in two experimental conditions (red, black). The vertical axis corresponds to the stimulation time.