Neuroengineering 2021-2022

Jan 11th 2023 – Part II

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

A **novel approach** for the **cognitive rehabilitation** of **working memory functions** is tested in a group of elderly patients.

The patients are subjected to two sessions of **neurophysiological assessment**: one immediately before (**PRE**) and one immediately after (**POST**) the rehabilitative intervention (Fig. 1). During the measurements, the patients perform a working memory task consisting of memorizing and retrieving a string of digits. To avoid **learning** and **habituation** effects, the duration of the recordings is kept **short**.

Six cortical regions (3 for each hemisphere) are selected for a connectivity study of **causality in the statistical sense**. The goal is to understand if the **integration** between the **two hemispheres** (a measure known to be related to cognitive functions) has increased after the rehabilitation.

Fig. 1 – Temporal organization of the study

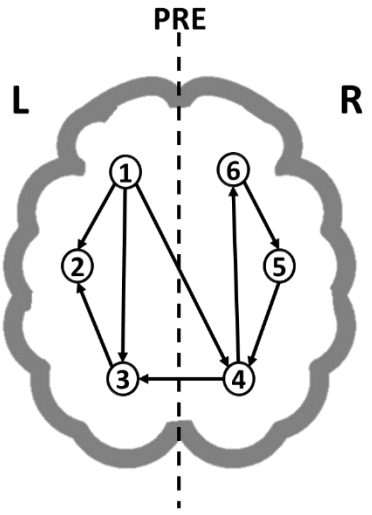

Fig. 2-A

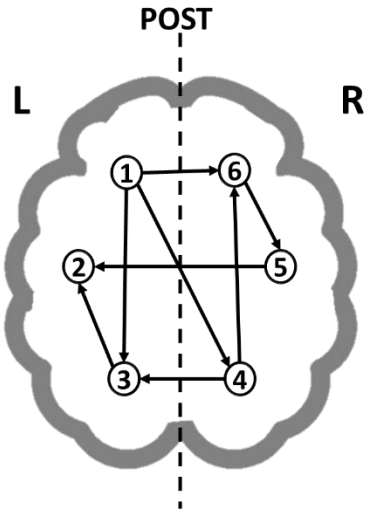

Fig. 2-B

Questions

(unless otherwise specified, write the answer in the exam.net editor)

A1. Indicate **which technique** for the **acquisition** of **neuroelectrical signals** you would use, and **why**. **List the pro and cons of your choice**. *(2 points)*

A2. Indicate **which connectivity estimator** you would use to perform the **network analysis**. **Justify your choice**. *(3 points)*

A3. The functional connectivity networks obtained for the PRE and POST sessions are reported in **Figg. 2-A** and **2-B**. *(write the answer on paper and scan the solution)*

A3.1. Extract the corresponding **adjacency matrices** *(0.5 points)*

A3.2. Compute the **Density** for each graph *(0.5 points)*

A3.3. Compute the **Divisibility D** and the **Modularity Q** of the network for the **PRE** session, considering the two hemispheres as classes: C=[1,1,1,2,2,2] *(2 points)*

A3.4. Compute the **Divisibility D** and the **Modularity Q** of the network for the **POST** session, considering the two hemispheres as classes: C=[1,1,1,2,2,2] *(2 points)*

A4. Comment on the **changes** (POST vs PRE) in D and Q after the intervention. According to those two indices, has the integration between the two hemispheres increased after the rehabilitation, as hypothesized? *(1 point)*