

June 23rd 2022 – Part II

Odd seats

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

The study is based on **neuroelectrical data synchronously and simultaneously acquired on two healthy subjects** during a task requiring their mutual collaboration (a recording technique known as *hyperscanning*).

Based on the knowledge derived from previous studies about social behavior, **4 cortical brain regions** are known to be involved in the task. Therefore, they are selected for each subject for the brain network analysis. The resulting multi-subject functional network is consequently made of **8 cortical brain regions** (Fig.1).

The **aim** of the study is to understand if the brain activities of the two subjects are **reciprocally influenced (causal effect)** as a consequence of their interaction, or if the two subjects' brains work independently.

To prevent **learning and habituation effects**, the EEG recordings must be kept **short** and only a few trials are recorded.

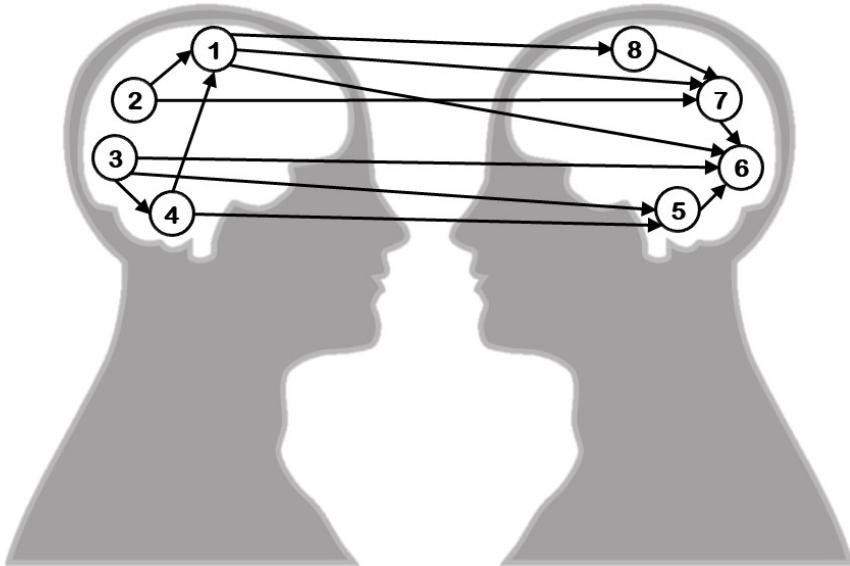


Fig. 1: Multi-subject brain functional network

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 pros and cons of your choice. *(2 points)*
- A2. Indicate **which connectivity estimator** you would use to perform the **network analysis**. Justify your choice and indicate the related pros and cons. *(3 points)*
- A3. Given the multi-subject functional connectivity network obtained, made of 8 regions, as reported in **Fig.1**:
(write the answer on paper and scan the solution)
 - A3.1. Extract the corresponding **adjacency matrix** *(0.5 points)*
 - A3.2. Compute the **in-degree** and **out-degree** of each node *(0.5 points)*
 - A3.3. Compute the **Divisibility D** and the **Modularity Q** of the network, considering the two subjects as classes: $C_a=[1,1,1,1,2,2,2,2]$ *(2 points)*
 - A3.4. Compute the **Divisibility D** and the **Modularity Q** of the network, considering two groups of homologous regions belonging to **both** subjects as classes: $C_b=[1,1,2,2,2,2,1,1]$ *(2 points)*
- A4. Comment on the **results obtained at point A3**. According to D and Q computed for the two divisions in classes C_a and C_b , are the two subjects' brains working independently, or do they influence each other during the collaboration task? *(1 point)*

Total maximum mark: 11 points