FUNCTIONAL CONNECTIVITY COMPARISON BETWEEN HEAD-DOWN TILT BED REST AND MICROGRAVITY DURING SPACEFLIGHTS

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INTRODUCTION

In the course of space travel, the central nervous system (CNS) encounters a variety of environmental stress factors [1, 2]. Microgravity is considered the primary factor influencing the brain, acting through various mechanisms such as weightlessness, vestibular deprivation or cephalic fluid shift [1]. On Earth, **head-down tilt bed rest** (HDBR) is a commonly used technique, as it is considered a spaceflight analogue that mimics the effect of microgravity in the cardiovascular system.

We have studied how the **brain functional connectivity** (FC), calculated from **electroencephalography** (EEG) recordings, is affected during spaceflights and HDBR experiments. FC quantifies the synchronization between two or more brain areas, and is generally studied in different neural networks such as the default mode network (DMN), or all cortical and subcortical regions mapped by the AAL atlas (here named as whole brain network - WBN), among others [3]. To study these changes, we have compared EEG data recorded before, during and after spaceflight/bed rest (see timeline in *poster ID: 1648549*).

The main objective of this study was to compare the **NEUROSPAT** experiments [4] with **HDBR** findings [5], to elude possible neurophysiological differences between those two experimental conditions.

MATERIALS & METHODS

NEUROSPAT data 55 channels | NEUROSPAT data 32 channels | HDBR data 32 channels

Source reconstruction using eLORETA method

Calculate the PLV (phase locking value) matrix for each subject and condition

Calculate the Strength matrix for each PLV matrix

Mean strength for each band (θ,α,β and γ) in each network (DMN and WBN)

Statistical analysis: One-way ANOVA, Tukey's multiple comparisons test

Results A | Results B | Results C

5 male ISS astronauts

21 male participants

RESULTS

A

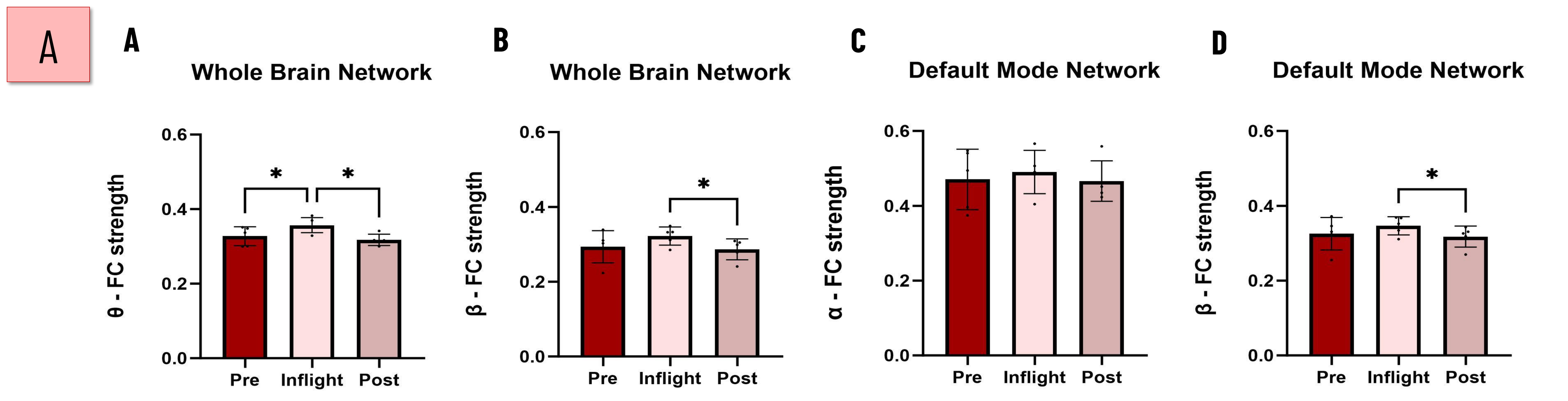

Figure 1. Changes in strength (FC—eyes closed) between conditions in the NEUROSPAT experiment (55 electrodes). The bar graph depicts the mean±SEM of the (A) WBN theta band, (B) WBN beta band, (C) DMN alpha band, (D) DMN beta band, FC strength for each condition (*p<0.05).

Whole Brain Network – β band (q values)

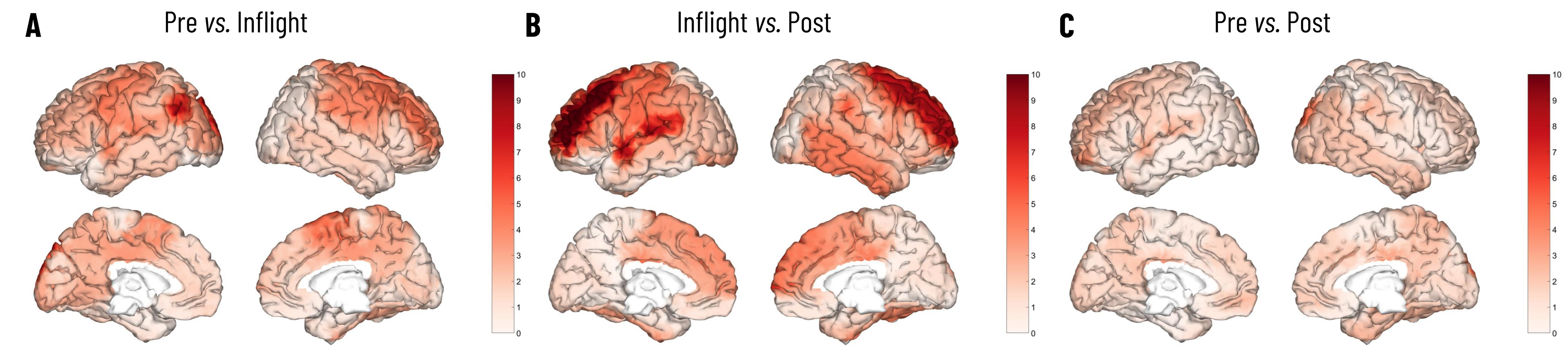

Figure 2. Brain figures represent the areas with higher statistical differences in the beta band when comparing ROIs. (A) pre-fight vs. in-fight conditions, (B) in-fight vs. post-fight conditions, (C) pre-fight vs. post-fight conditions. The colorbar is displayed as a family-wise corrected significance level of q value > 4, corresponding with a minimum p value of 0.05.

B

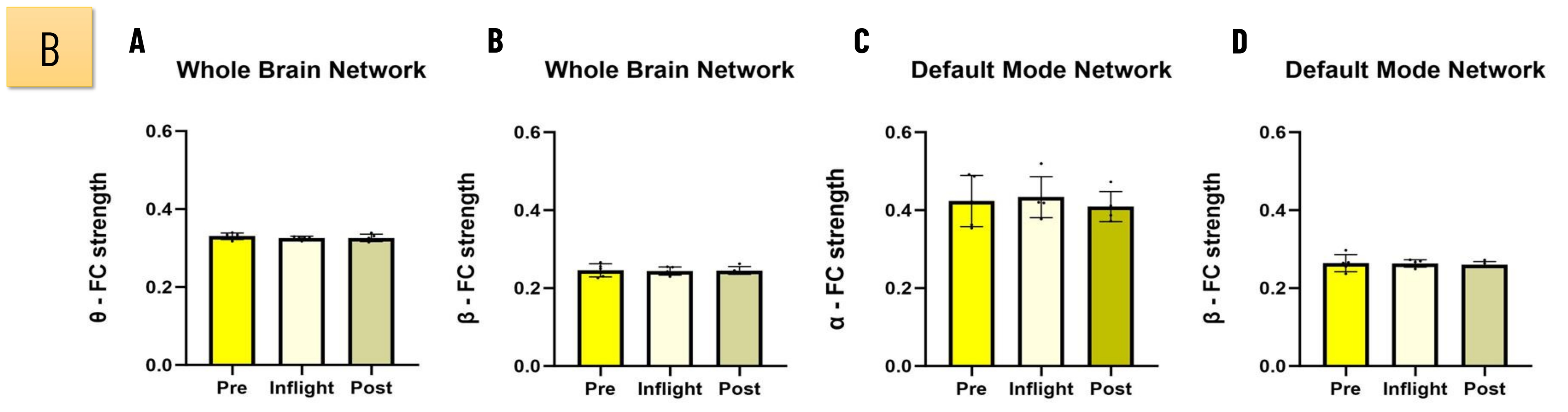

Figure 3. Changes in strength (FC—eyes closed) between conditions in the NEUROSPAT experiment (32 electrodes). The bar graph depicts the mean±SEM of the (A) WBN theta band, (B) WBN beta band, (C) DMN alpha band, (D) DMN beta band, FC strength for each condition (*p<0.05).

C

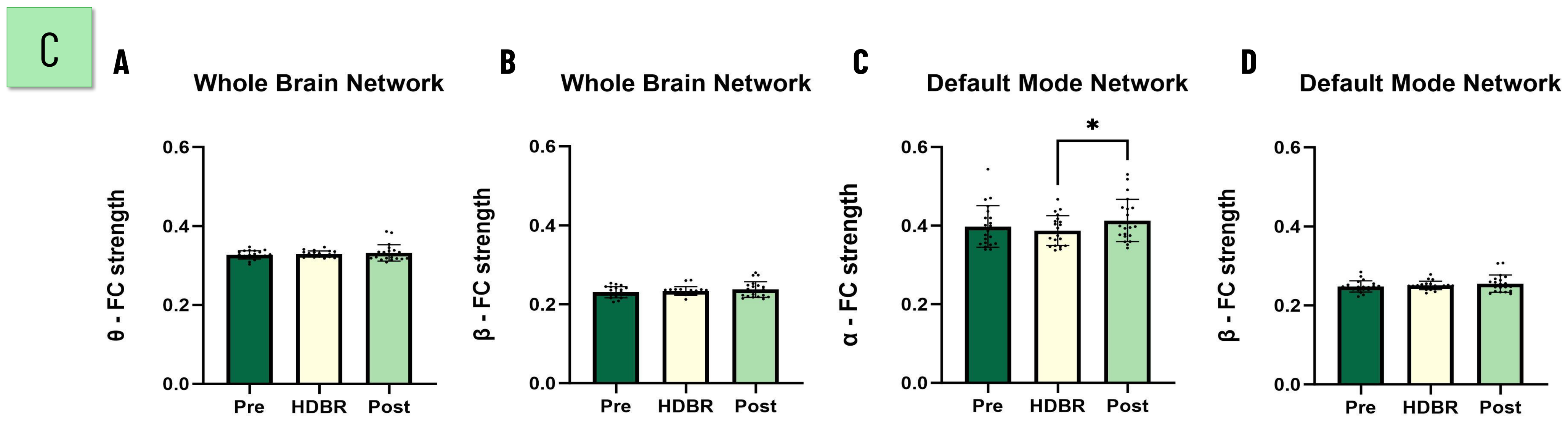

Figure 4. Changes in strength (FC—eyes closed) between conditions in the HDBR experiment (32 electrodes). The bar graph depicts the mean±SEM of the (A) WBN theta band, (B) WBN beta band, (C) DMN alpha band, (D) DMN beta band, FC strength for each condition (*p<0.05).

CONCLUSIONS

Inflight: ↑ **β** FC in the **left angular gyrus**
Involved in spatial processing (i.e. verticality assessment) [6]

Inflight: ↑**β** FC in the **superior frontal gyrus**
Involved in spatial working memory [7]

Adaptative response to the microgravity environment

NEUROSPAT data: **increase of θ** and **β** FC ≠ **HDBR data: reduction of α** FC

The HDBR analogue capture **dissimilar** EEG dynamics compared to microgravity ⟹ **more data needed**

HDBR data **θ** and **β FC: almost no differences** between conditions

When **reducing** the NEUROSPAT data **to 32 channels: no significant results**

A low number of electrodes is not enough to correctly calculate the FC. As described in *poster ID: 1648424* at least more than 64 electrodes EEG systems are needed to obtained reliable results

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