DIFFERENT EEG ALPHA POWER PROFILES DURING SPACEFLIGHTS MISSIONS – PRELIMINARY RESULTS

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INTRODUCTION

Space exploration has long been a frontier that pushes the boundaries of human endurance and adaptability [1]. In this context, spaceflight presents unique challenges to the human neurophysiology, including exposure to microgravity, radiation, isolation, and confinement, which can impact health, performance and mission success [2]. While brief episodes of microgravity have been shown to induce neurophysiological changes, the implications for **short-duration and long-duration spaceflights** remain uncertain.

This study seeks to explore the extent of **neurophysiological alterations** during space missions, shedding light on potential functional problems and contributing valuable insights to the evolving field of spaceflight neurophysiology. Finally, the study emphasizes the importance of **electroencephalography** (EEG) as a biomarker for predicting changes due to the space environment and objectively assessing the effects of countermeasures, thus enhancing our ability to ensure the well-being and performance of astronauts during space exploration missions.

MATERIALS & METHODS

AXIOM-2
- 32 channels EEG
- 1 male (31 years old)
- 10 day mission on ISS

NEUROSPAT
- 59 channels EEG $\xrightarrow{\text{reduced to}}$ 32 channels EEG
- 5 males (54.2 ± 2.6 years old)
- 6 months in low earth orbit (174.6 ± 19.9 days)

Pre-flight (ground level) → In-flight (extraterrestrial) → Post-flight (ground level)

α power (eLORETA source reconstruction) + Functional Connectivity (iPLV) → Default Mode Network (DMN)

Power ratio → Relative power of each condition / pre-flight (baseline)

STATISTICAL ANALYSIS

ANOVA with Tukey's multiple comparisons post-hoc
- Pre-flight *vs.* In-flight
- In-flight *vs.* Post-flight

RESULTS

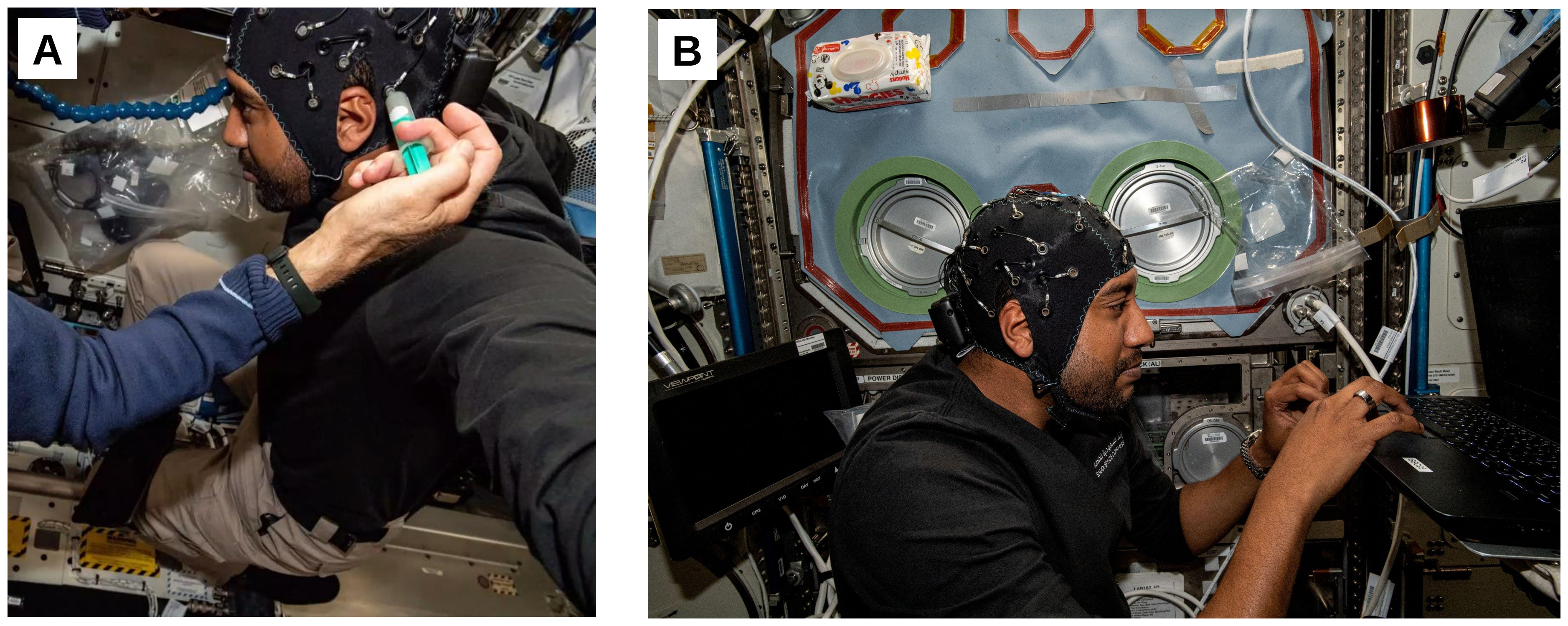

Figure 1. **AXIOM-2 EEG recording.** (A) Saudis astronaut (S1) during EEG recording, eyes open. (B) EEG setup with conventional wet electrodes.

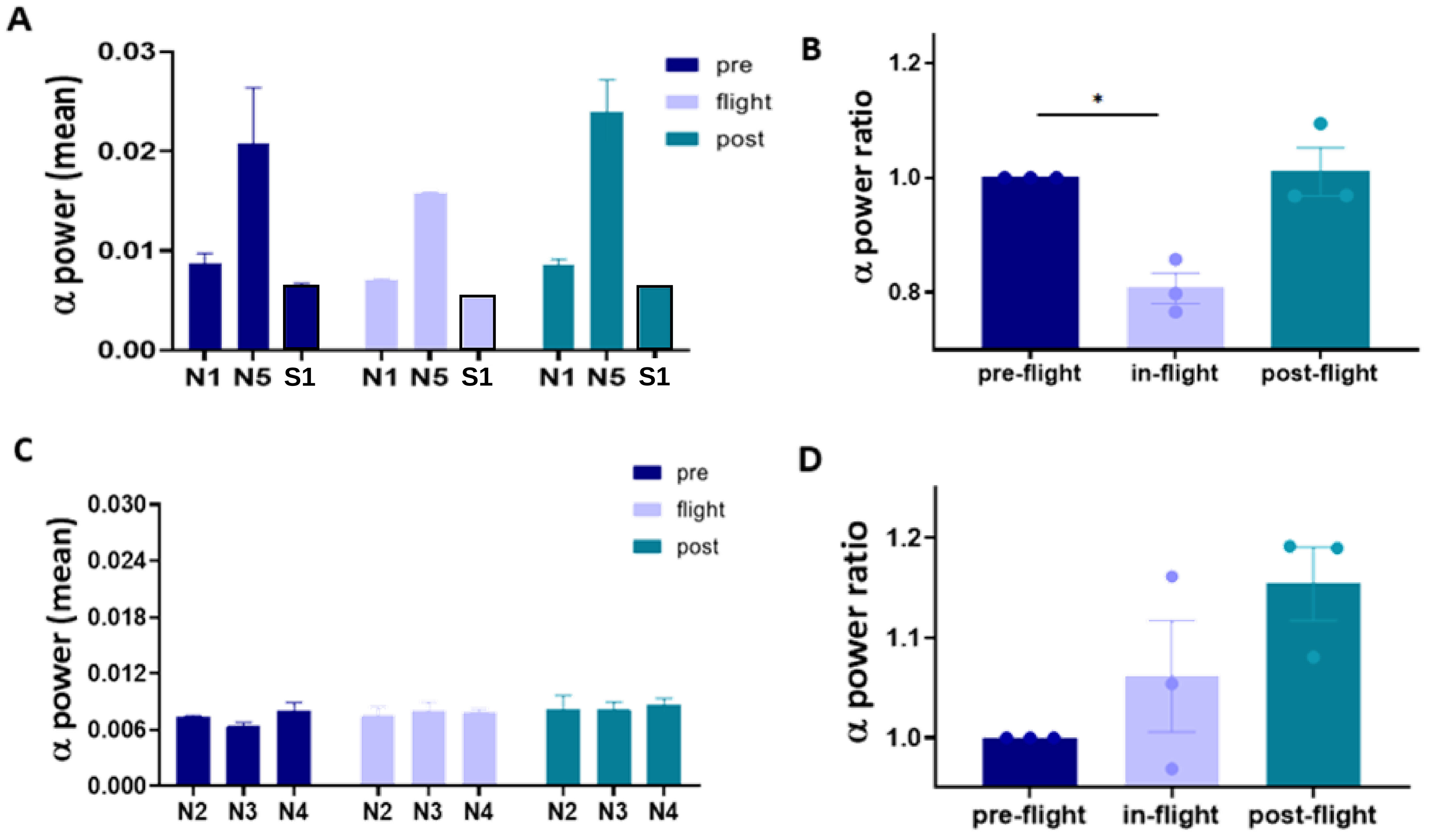

Figure 2. **Comparisons of the DMN alpha power between AXIOM-2 astronaut and the NEUROSPAT experiment** (ISS mission for 6 months reported by Cebolla et al., 2016). (A) DMN alpha power decrease trend found for two subjects of the NEUROSPAT (N1 and N5) and in the dataset from the AXIOM-2 (S1). (B) DMN alpha power ratio between flight conditions and the subjects where an alpha power reduction was found in the in-flight condition compared to the pre-flight condition ($P < 0.05$). (C) No trend found in the DMN alpha power between subjects (N2, N3 and N4) and flight conditions. (D) DMN alpha power between flight conditions and the subjects where no trend was found.

CONCLUSIONS

DIFFERENT NEUROPHYSIOLOGICAL PROFILES

N1, N5 and S1 ⇒ Significative **decrease in α power ratio** during spaceflights

N2, N3 and N4 ⇒ No significative results were found during spaceflights

NEUROSPAT — **AXIOM-2**

59 channels ⇒ 32 channels = 32 channels

No **functional connectivity** significative results

⇓

A low number of electrodes is not enough for reliable results (See in *poster IDs: 1648424 and 1649526*)

More data and experiments are needed

Identifying **electrophysiological changes** and individual response profiles may serve as **crucial markers**, guiding the development of mitigation strategies to ensure astronaut's **long-term neuronal integrity** and enhance the safety of future space exploration.

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[2] Afshinnekoo, E. et al. (2020) Cell 183, 1162–1184.

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