RELIABILITY OF A HIGH-DENSITY DRY-EEG CAP TO ESTIMATE FUNCTIONAL CONNECTIVITY IN SOURCES SPACE

Bruña R.[1,2], A Quivira-Lopesino A.[1,3], Sevilla-García M.[1,3], Cuesta P.[1,2], Maestú F.[1,4], ME. Funke[3], Haueisen J.[5], Fiedler P.[5]

[1] Center for Cognitive and Computational Neuroscience, Universidad Complutense de Madrid, Madrid, Spain; [2] Department of Radiology, Universidad Complutense de Madrid, Madrid, Spain; [3] McGovern Medical School, University of Texas Health Science Center at Houston, Houston, TX, USA; [4] Department of Experimental Psychology, Universidad Complutense de Madrid, Madrid, Spain; [5] Ilmenau University of Technology, Ilmenau, Germany;

INTRODUCTION

It is paramount to monitor brain health during long-term spaceflight missions.

- EEG is the most direct and spaceflight-ready way to study brain function.
- Research has shown strong correlation between EEG and brain functional integrity.
- EEG-derived functional connectivity (FC) is a promising surrogate of functional brain integrity.

Traditional EEG during spaceflight is challenging.

- Requires a second person to attach and prepare the cap.
- Requires supplies with limited self lifetime and has profound implications in hair hygiene.
- Dry-electrode EEG system could overcome these challenges.

Research question:

- Can high-density dry EEG provide reliable activity estimates in source-space?
- Are source-space FC estimates from dry EEG similar to estimates from conventional EEG?

MATERIALS & METHODS

EEG data: 3 minutes eyes open, 3 minutes eyes closed task-free EEG data from 30 participants.

- Recording session 1 using a conventional (gel) EEG cap, recording session 2 using a dry EEG cap.
- 256 channels each, identical equidistant electrode layout.

Minimal preprocessing pipeline.

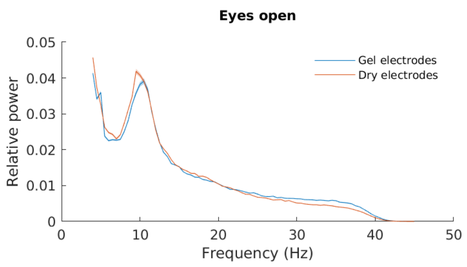
- Identification of bad channels and segments.
- Selection of 30 seconds of artifact-free data for analysis.
- Clean data segmented into 2-second epochs with 1-second overlap.

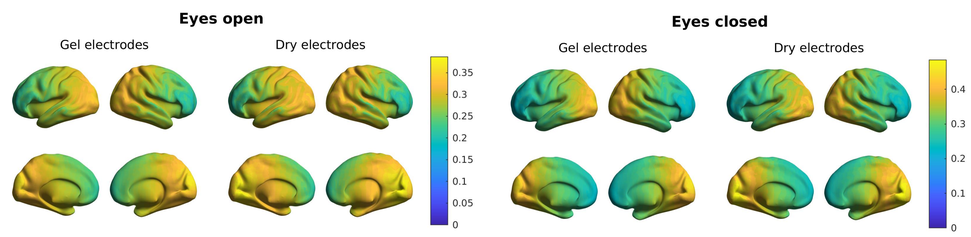
Processing:

- Source reconstruction using LCMV beamformer and a standard head model.
- FC in source estimation under the phase synchronization paradigm.
- Application of phase locking value (PLV) and its corrected-imaginary counterpart (ciPLV).

RESULTS

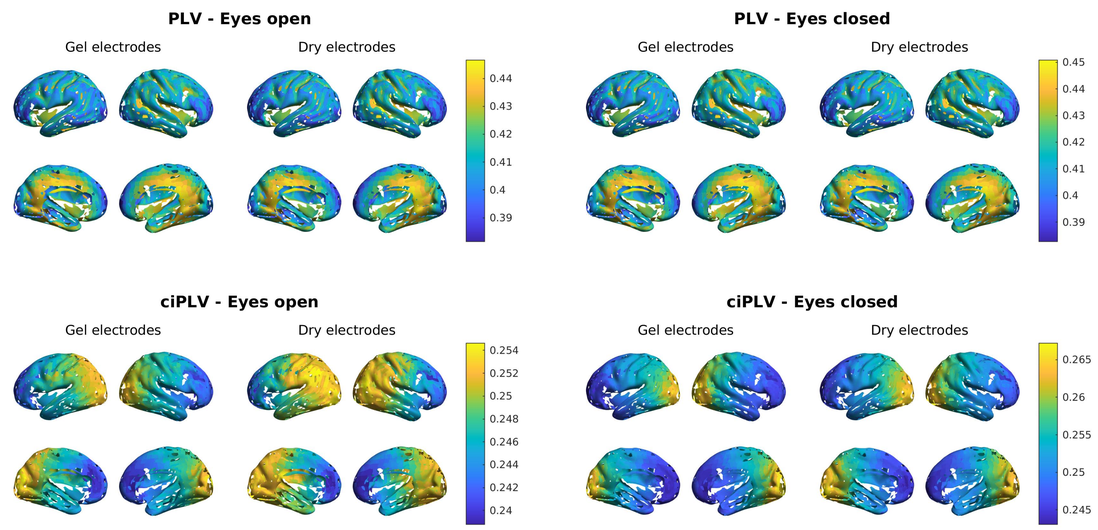
1. Power spectrum.





- Low frequency delta band (1-4 Hz) removed due to noise with dry caps.
- Occipital power spectrum is similar when using conventional and dry electrodes.
- Alpha power distribution is more spread when using dry electrodes.
- Differences are larger in the eyes open condition.

2. Funcitonal connectivity.



- Functional connectivity estimates and maps from convenitonal and dry electrodes are surprisingly similar.
- Dry electrodes might present slighlty larger spread than conventional electrodes.

CONCLUSIONS

- Study of **spaceflight EEG would benefit from the use of dry-electrode** EEG systems.
- Spatial resolution for power seems lower when using dry electrodes.
- Occipital power spectra are similar in both techniques.
- **256-channel dry caps** provide reasonable source reconstructions.
- It is important to guarantee an adequate **electrode density and coverage**.
- Source spread in eyes open might be related to a **lower SNR** when using the dry cap.

Corresponding author: Ricardo Bruña (ricardo.bruna@ucm.es).

Related work: Pusil et al. (2023) Sci Rep 13:9489; Fiedler et al. (2015) Brain Topogr, 28:647; Huang et al. (2016) NeuroImage 140:152; van Veen et al. (1997) IEEE Trans Biomed Eng 44:867; Bruña et al. (2018) J Neural Eng 15:056011.

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