

DRY EEG FOR FUNCTIONAL CONNECTIVITY ASSESSMENT IN SENSOR SPACE



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INTRODUCTION

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

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

Traditional EEG during spaceflight is challenging.

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

Research question:

- Can a dry EEG cap provide FC data comparable to conventional EEG?

MATERIALS & METHODS

We acquired task-free eyes closed EEG data from 12 participants using two different EEG caps:

- A 64-channel conventional (gel) EEG cap using the extended 10-20 layout.
- A 64-channel dry EEG cap using an equidistant layout.

Data preprocessing included:

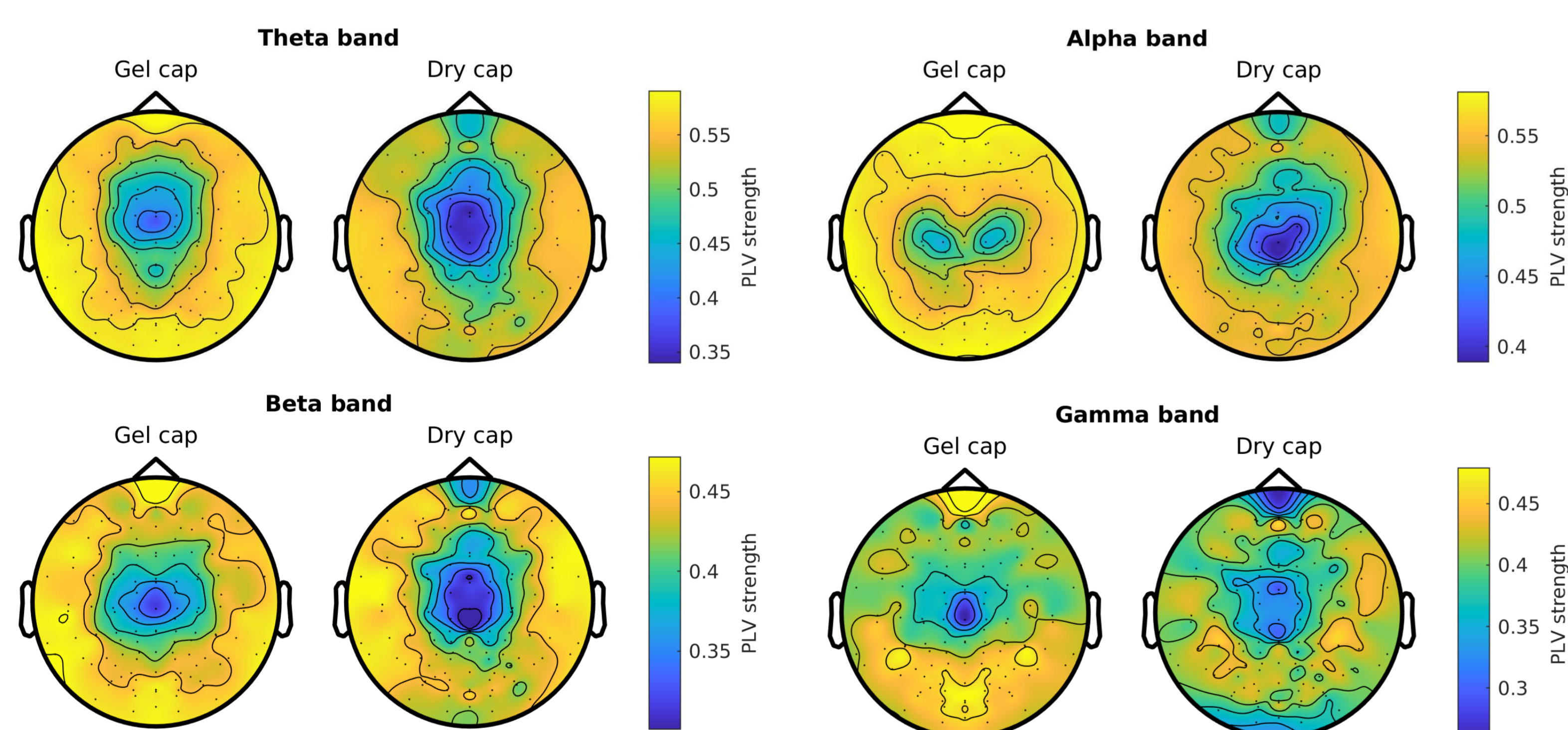
- Identification of bad channels and segments.
- Segmentation into 4-second artifact-free epochs.
- Interpolation to a common 128-channel space to allow the comparison of both caps.

And the analysis:

- We estimated FC under the phase synchronization paradigm.
- We used phase locking value (PLV) and its corrected-imaginary counterpart (ciPLV).

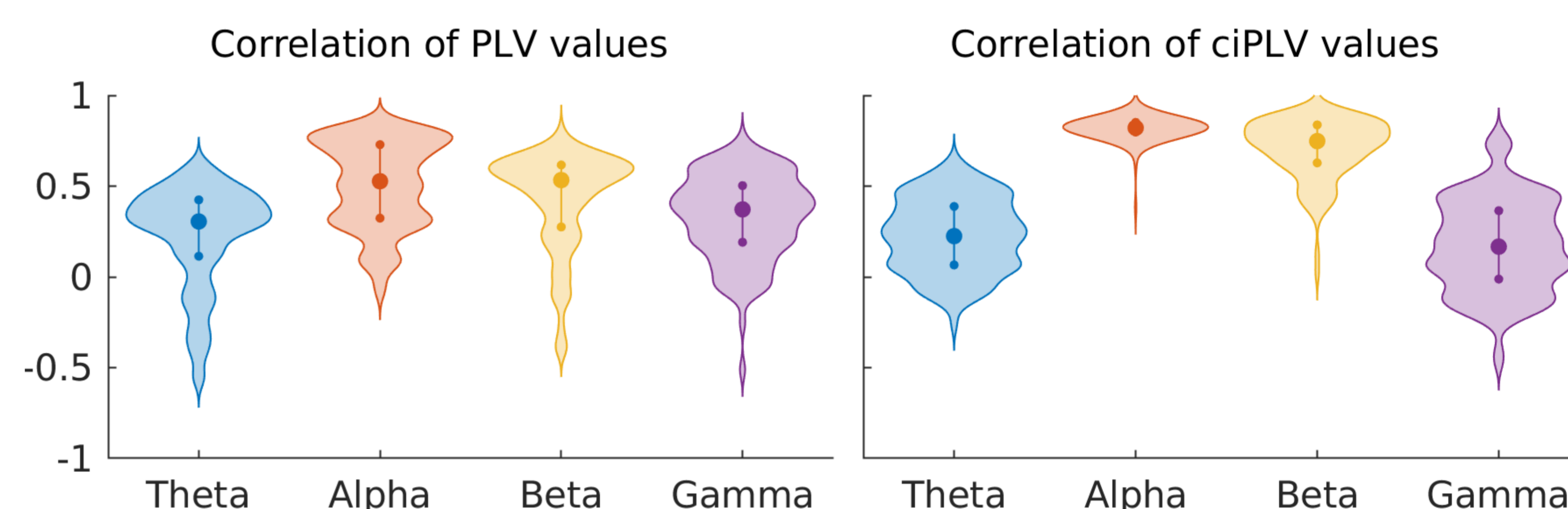
RESULTS

1. Comparison of average FC estimated from traditional (gel) and dry EEG caps.



- FC estimation is systematically lower when using the dry EEG caps.
- Dry EEG cap shows smoother topographies (lower spatial resolution).
- Spatial distribution is similar in both caps for intermediate (i.e., alpha and beta) frequencies.
- Dry EEG seem less reliable in very low (i.e., delta) and very high (i.e., gamma) frequencies.

2. Correlation of the FC estimated from traditional (gel) and dry EEG caps.



- Almost all correlations are positive, showing consistency between caps.
- FC estimated using gel and dry caps show very high consistency in alpha and beta bands.
- Consistency is higher when removing the effect of volume conduction (using ciPLV).

CONCLUSIONS

- Study of spaceflight EEG would benefit from the use of dry-electrode EEG systems.
- Spatial sampling (electrode layout and density) seems to impact the results.
- 64 channels might be the **bare minimum** for a good estimation of FC.

- Dry electrodes provide **similar sensitivity to changes in FC** than traditional EEG caps.
- Results are consistent even with different electrode layouts (and different head coverage).
- FC values estimated using traditional caps are **not directly translatable** to dry EEG systems.

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Related work: Takács et al. (2021) Sci Rep 11:9590; Pusil et al. (2023) Sci Rep 13:9489; Fiedler et al. (2023) PLoS One 18(2):e0280822.

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