SCAN FOR POSTER AND GITHUB REPOSITORY !

EXPLORING DYNAMIC BRAIN STATES SUPPORTING WORKING MEMORY IN RELATION TO ALCOHOL

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Introduction

Alcohol consumption has shown to exert dose-dependent effects on working memory (WM), with moderate intake enhancing performance and higher levels impairing it [1,2]. At the neural level, alcohol is known to alter resting-state networks, affecting dynamic functional connectivity (dFC) in acute and habitual drinkers [3]. In parallel, EEG markers such as increased theta activity have been associated with poorer WM performance [4]. Yet the relation between alcohol-related changes in functional networks and WM performance remains less understood. Insight into how resting-state dynamics relate to cognitive performance under varying levels of alcohol consumption is lacking.

Aim of the study

We conducted a data-driven study investigating the joint relationship between resting-state dFC and WM performance. We hypothesized that alcohol consumption alters network activity and WM performance, and that dFC patterns predict WM outcomes. We also investigated whether any overlap between scalp topography based microstates and source-based dFC exists.

Methodology

Resting-state EEG data (6 mins) from 32 subjects (age: 20-30) were obtained from the Max-Planck LEMON open dataset.

Connectivity

Source-level time series were extracted from the Schaefer atlas using Brainstorm, focusing on **Fronto-Parietal (FPN), Default Mode (DMN), and Dorsal Attention (DAN)** networks. Connectivity was computed in the **theta** band (5–7 Hz) using **coherence**, with a sliding-window approach (5-s windows, 50% overlap). Time-coherence matrices were clustered using k-means **(k = 3)** to identify recurring dynamic functional connectivity (dFC) states in each of the 3 networks.

Microstates (MS)

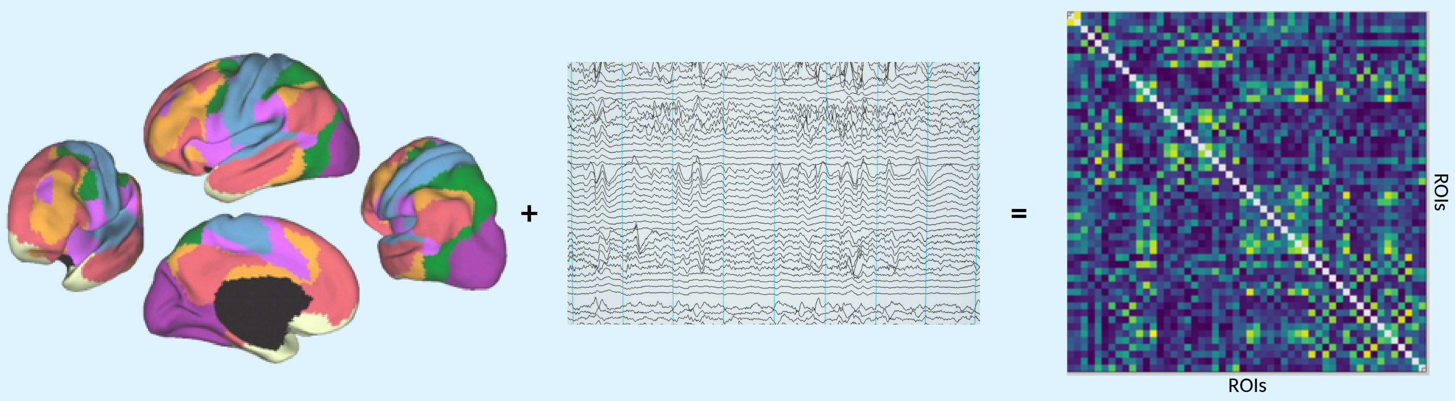
EEG data were average-referenced, normalized, and global field power (GFP) was computed. Topographies at local **GFP peaks** were extracted. MS segmentation was performed using modified k-means clustering, and solutions were evaluated based on fit measures, where a **5 MS** solution was selected. The MS prototypes were backfitted to the individual EEGs by assigning the MS with the highest spatial correlation at each time point.

Behavior and Alcohol

Working memory (WM) was assessed using the Test of Attentional Performance (TAP).

The sample was divided into two groups: **Heavy drinkers (HD)** vs. **Low/Moderate drinkers (LD)** based on drinks per week.

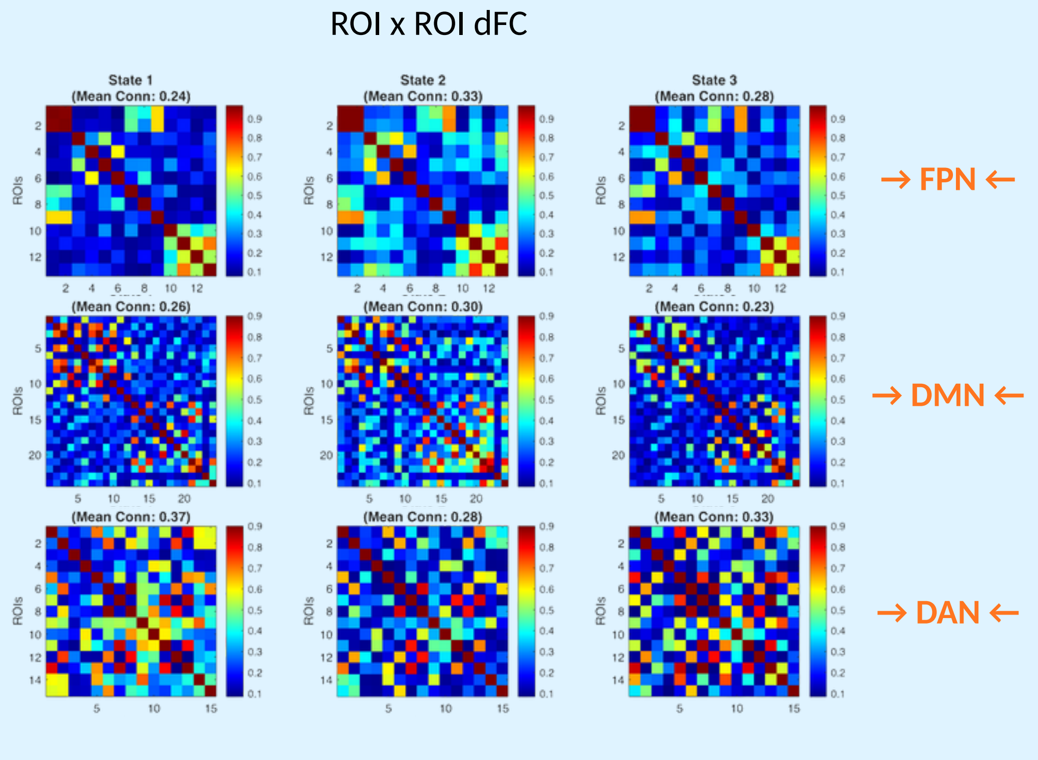
Linear regression and interaction analyses examined associations between dFC and MS measures, WM performance, and alcohol consumption.



Yeo et al. (2011)

Brainstorm (Tadel et al., 2011)

Results



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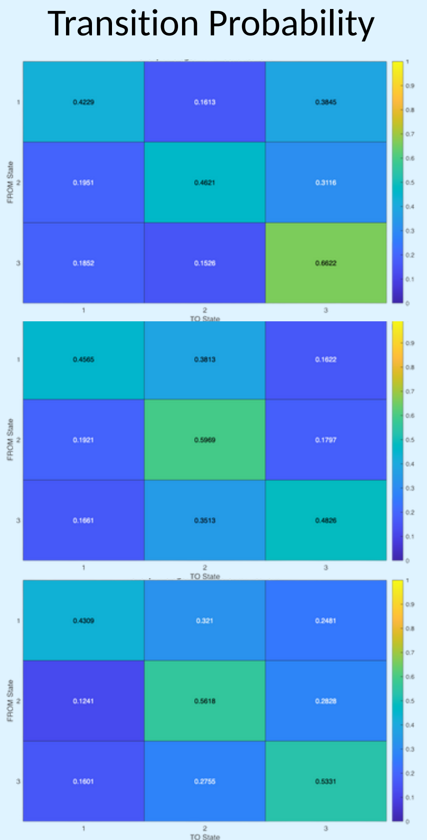

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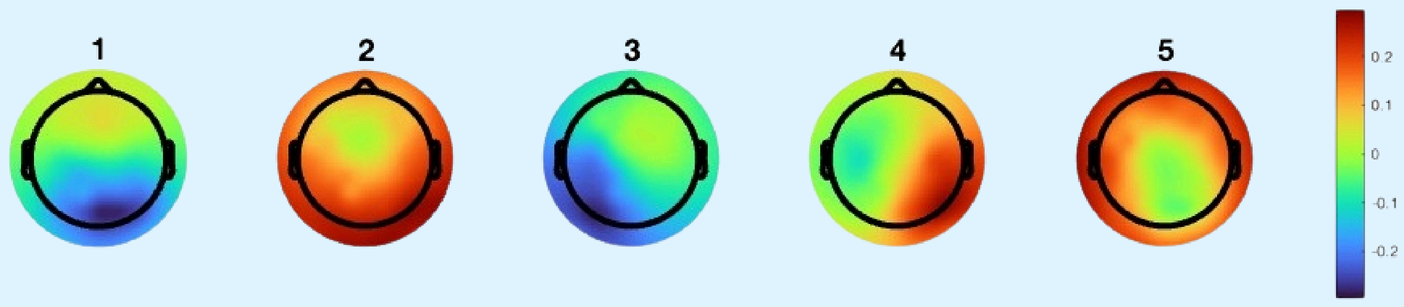
- LD showed **better** cognitive performance than heavy drinkers
- In FPN, spending more time in State 3 is associated with better WM, and State 2 with poorer WM, for HD
- In DAN State 1, predicted poorer WM for HD.
- Inspection of state transitions revealed that they exhibit high **self-transition probabilities**



EEGLAB (Delorme & Makeig, 2004)

- **Coverage** of each MS (percentage of time spent in a specific MS) and its interaction with alcohol consumption did **not** significantly predict WM.
- Correlations between time spent in 5 MS and 5 state clusters (computed amongst all FPN, DMN, and DAN ROIs) showed that **only MS #2** was associated with some of the dFC clusters.

Discussion

- Heavy drinking may alter how brain states support working memory: some states that seem beneficial to WM of LD may not be for HD.
- Negative links of states with WM may imply a compensatory shift, where the brain relies on a more effortful state to maintain connectivity.
- WM associations with FPN and DAN states, but not DMN is in line with: the networks' role in control and attention, and the role of theta in cognitive control.
- The high self-transition probability outcomes are consistent with their role as functional networks, maintaining stable states for sustained cognitive processes.
- The 5 MS solution suggested by fit measures, instead of the canonical four MS typically reported in literature, may reveal the existence of a central-to-peripheral state (like MS #2). Future studies should clarify whether the association of only MS #2, and no other MS, with dFC clusters, is simply due to volume conduction affecting both analyses.
- These conclusions do not extend to task-active neural processes, where more research is needed. The interpretation of theta connectivity differs depending on the current mental state.

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Take-Home Message

Theta-band connectivity during resting-states may predict working memory performance depending on alcohol consumption; underscoring the importance of extending this work to task-based paradigms to understand how these baseline networks are recruited or shift during cognitive demands.

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