

Peer Review

Review of: "Is There a Direct Relation Between EEG Band Spectrum and DMN Activity in fMRI? A Multivariate Exploratory Study"

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Abstract

1. Change “This will help us better understanding” (future tense) to “This helps us better understand” (present tense) for improved readability.
2. The phrase “the DMN may be acting similarly in rest and light sleep stages but start to slightly deviate in N2 and largely deviate in N3 stage” is wordy. Consider splitting into two sentences:
3. The abstract mentions “multiple frequency bands” without specifying how many or which ones. While it’s acceptable in an abstract to be somewhat general, providing a concise detail—e.g., “across seven canonical bands (delta through gamma2)” —could be more informative.
4. The authors use “rest” in the first sentence but later label the stage as “wake.” It would be clearer to specify “wake-eyes closed rest” or “wake resting state” to indicate the conditions under which EEG-fMRI were acquired.
5. An abstract should normally state how many subjects were included. There is no mention of the number of participants (or at least the number of EEG-fMRI sessions) here. Readers will want to know the sample size to gauge generalizability.
6. The abstract says “DMN activity corresponds to the EEG band powers...,” but the actual analysis is predictive modeling (using Random Forest regression). I would explicitly state “Using Random Forest regression, we demonstrate that DMN BOLD magnitude can be predicted by the combination of EEG band powers, particularly from midline electrodes.”

1. Background

1. The sentence “EEG and fMRI are extensively employed in neuroscience research, each with their own advantages and limitations” is acceptable, but consider using a semicolon or splitting into two sentences to avoid a slight run-on impression: “EEG and fMRI are extensively employed in neuroscience research. Each modality comes with its own advantages and limitations.”
2. The phrase “offers high spatial resolution but low temporal resolution” is standard, but you can simplify: “fMRI provides high spatial but low temporal resolution, whereas EEG provides high temporal but low spatial resolution.”
3. Change “we hoped to clarify” to “we hope to clarify” to maintain present-tense consistency throughout the Background.
4. The paragraph states “DMN regions, a resting state network,” but does not define which regions will be studied (MPFC, PCC, bilateral IPL). A brief parenthetical listing here would orient the reader: “Specifically, we focus on MPFC, PCC, and bilateral parietal lobules.”

2. Methods

1. The authors do not specify how many subjects (or sessions) were included, nor age/gender or basic demographics. This is critical. At minimum, state: “Data from N = X healthy adults (age range: ..., sex: ...) were obtained from the OpenNeuro/NEMAR repository (Dataset ID: ...).”
2. Saying “automated fMRI artifact removal” is too vague. In EEGLAB, typical artifact removal for simultaneous EEG-fMRI involves “FASTR,” or the FMRIB plugin, or specific gradient artifact correction and ballistocardiogram (BCG) removal steps (e.g., AAS, OBS, or optimal basis set). The authors must state which method was used (e.g., “Gradient artifact removal was performed using the ‘fmrib_fastr’ algorithm; ballistocardiogram artifacts were removed using the Optimal Basis Set approach”).
3. They also do not mention line noise removal (e.g., 50 Hz notch filtering), bad channel detection, or re-referencing. Without these details, it is not reproducible.
4. Similarly, for CONN preprocessing, one expects: slice timing correction, realignment, co-registration with structural, normalization to MNI space, smoothing kernel size, and denoising steps (e.g., CompCor, motion regressors, band-pass filters). None of this is given.
5. They mention “assigned the sleep stage corresponding to the scoring file” but do not describe who scored sleep (e.g., a trained technician? Based on what criteria—AASM?). The source dataset likely includes scored epochs, but mention the reference standard (AASM 2017 rules, etc.). This is important for reproducibility.

6. For the Welch method, specify whether there is overlap between windows (e.g., “1s Hamming window with 50% overlap”).
 7. Insert a comma between “alpha” and “beta1” to read “... alpha, beta1, beta2, gamma1, and gamma2).”
 8. The authors define seven bands (delta, theta, alpha, beta1, beta2, gamma1, gamma2), but do not specify their frequency boundaries (e.g., delta = 0.5–4 Hz, theta = 4–8 Hz, etc.). That is essential for reproducibility.
 9. Taking the arithmetic mean of four ROIs’ BOLD signals is a simplistic way to define “DMN activity.” Common alternatives include:
 10. How many time points fall into each stage? If some stages (e.g., N3) are under-represented, that can bias the Random Forest. A descriptive table (N per stage per subject) would be helpful.
 11. They mention outliers were removed using Isolation Forest, but they do not specify:
 12. They say “regression model based on Random Forest algorithm (196 EEG feature trained to predict average DMN value).” Key details missing:
 13. Feature importance maps are descriptive, but the manuscript does not test whether certain bands/electrodes are statistically more important than chance. Bootstrapping or permutation tests on importance could strengthen the claims.
 14. When plotting seven frequency bands × 28 electrodes (=196 features), there is a high chance of false positives if one attempts to interpret individual electrode-band “peaks.” The authors should discuss how they control for multiple comparisons (e.g., by setting a threshold on importance or applying FDR correction).
- Using principal component analysis (PCA) across these voxels/ROIs to derive a representative time course;
 - Computing the network eigenvariate (e.g., Bartlett’s method) or extracting the first eigenvariate from a subject-specific ROI.
 - Which features were used for outlier detection (EEG only, DMN only, or combined)?
 - The contamination parameter (e.g., 5% of time points marked as outliers) or criteria for removal.
 - Whether outlier removal was done separately per subject or on the pooled data.
 - The hyperparameters (number of trees, max depth, etc.).
 - Whether they used default scikit-learn settings or tuned hyperparameters (e.g., with grid search).
 - The train/test split strategy: they say “leave-one-out cross validation,” but is that LOOCV across subjects (i.e., train on all subjects except one) or LOOCV across time points within each subject?

Normally, for time-series regression, LOOCV across time points can artificially inflate performance.

- If they did LOOCV across subjects, that means they need many subjects; if they did LOOCV across time within each subject, features from adjacent time points may be highly autocorrelated, leading to information leakage. Clarity is needed.

3. Results

1. The MSE is reported as 0.04–0.06, but units are missing. Since DMN values come from BOLD percent change or z-scores, what is the scale? For instance, if DMN values are z-scored, an MSE of 0.05 might be quite high; if DMN values are small (e.g., 0–1), then 0.05 is different. Provide context: “Since the BOLD time series were z-scored per ROI, an MSE of 0.05 corresponds to an average absolute error of ~0.22 z-score units.”
2. The heading “N3” should match “N3 Stage” for parallelism.
3. Likely fewer N3 epochs exist. If so, training on fewer points could artificially lower MSE (overfitting). It is important to report the number of training/test points and whether any balancing procedures (e.g., oversampling) were used.

4. Discussion

The sentence “The results also indicate that... N3 stage” is long. Break into two: “Furthermore, DMN activity patterns appear similar during wakefulness and light sleep (N1), but begin to diverge in N2 and deviate substantially in N3.”

Change “could have contributed” to “may have contributed,” and “but the models were still well trained will low MSE values” to “yet models still achieved low MSE values.” And “will” in “will low MSE values” should be “with.”

With the above revisions—particularly in clarifying preprocessing steps, specifying modelling details, and introducing statistical rigour—the manuscript will be methodologically stronger and more transparent. Stylistically, breaking up long sentences, correcting typographical errors, and adopting consistent formatting will substantially improve readability. Once these changes are made, the study’s contribution—illuminating how multiband EEG relates to DMN BOLD across sleep—will be both credible and impactful for the field.

Declarations

Potential competing interests: No potential competing interests to declare.