Ventral cortical sources of EEG alpha power predict mood variability

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Independent Researchers Investigating Emotion

Summary

In healthy, never-depressed individuals, EEG alpha power localized to multiple ventral and prefrontal cortical areas correlated with fluctuations across multiple days in reported depression symptom severity. No such relationships were found for individuals with current or prior MDD.

Background

- Mood dysregulation and variability are likely important factors underlying mood-disorder etiology.

- However, the neural circuitry that contributes to mood variability remains unclear.

- Alpha oscillations are important in functional inhibition of neural activity and play a role in synchronizing large-scale networks, and EEG localization techniques (i.e., sLORETA) can estimate intracortical sources of alpha power.

- The aim of the present study was to determine which intracortical sources of alpha power predict mood variability over a several-week period.

Methods

Participants (N = 306)
- MDD+ participants (N=143) met criteria for a lifetime history of major depressive disorder but no other Axis I disorder besides dysthymia.
- MDD- participants (N=163) never met criteria for major depression or any other Axis-I disorder.

EEG data & source estimates (standardized Low-Resolution Electromagnetic Tomography, sLORETA)
- 64-channel EEG was recorded 8 times within 2 weeks – four days, two sessions each day. Results here include all 8 sessions of eyes-closed resting data (4 minutes per recording session).
- Artifacts were identified visually and with custom MATLAB-based scripts.
- sLORETA estimated the three-dimensional power (6239 voxels) for the alpha band (8-12Hz) for each session.
- sLORETA estimates were normalized by dividing power at a voxel by the power across all voxels (sum of all voxels = 1).
- Finally, sLORETA values were averaged across all 8 recordings.
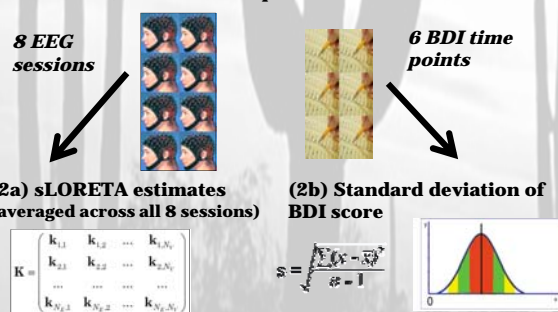
Mood variability
- The standard deviation of overall score in the Beck Depression Inventory (BDI) across six time points (screening, intake, 4 experimental session days) was calculated for each subject. These sixe time points spanned a minimum of 4 and maximum of 15 weeks.

Correlational Analyses
- Spearman rank-order correlations were used to determine associations between cortical sources of EEG alpha power and mood variability (uncorrected $p<.005$).

(1) Collect and process data

8 EEG sessions

6 BDI time points

(2a) sLORETA estimates (averaged across all 8 sessions)

$$K = \begin{bmatrix} k_{1,1} & k_{1,2} & \cdots & k_{1,N_y} \\ k_{2,1} & k_{2,2} & \cdots & k_{2,N_y} \\ \vdots & \vdots & \cdots & \vdots \\ k_{N_g,1} & k_{N_g,2} & \cdots & k_{N_g,N_y} \end{bmatrix}$$

(2b) Standard deviation of BDI score

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

(4) Spearman correlation of average sLORETA alpha and SD of BDI

Acknowledgments

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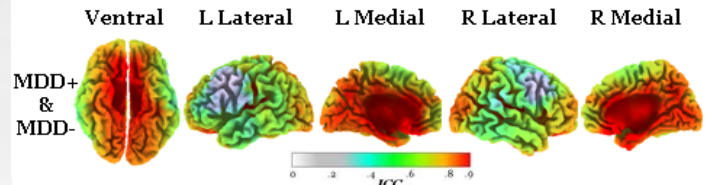
Results

Figure 1. Intraclass Correlation Coefficient (ICC) values for all subjects across the 8 EEG recordings. sLORETA estimates for ventral medial areas demonstrate the greatest stability across sessions (ICC's > .8).
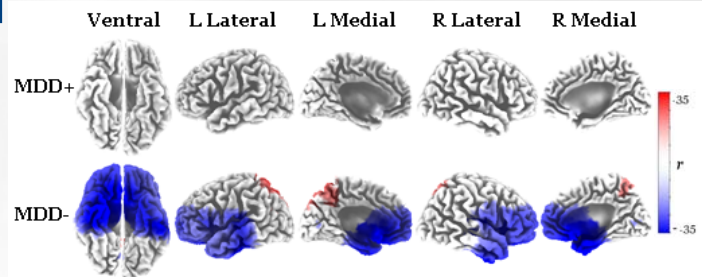

Figure 2. Correlation of source localized alpha (8-12Hz) power with the standard deviation of BDI score. In individuals without a lifetime history of depression, less alpha power (presumably greater cortical activity) in multiple ventral cortical areas predicted greater fluctuation in BDI score. No such relationship was found for the group with a history of MDD.
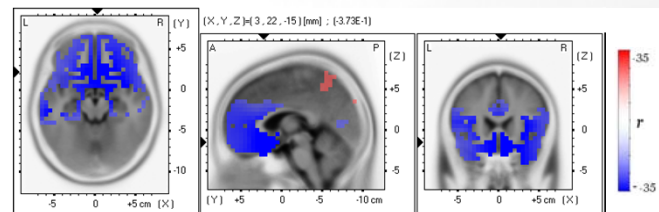

Figure 3. Axial, sagittal, and coronal slices of the correlations between EEG alpha source estimates and mood variability for the MDD- group. Associations were found most prominently in the ventro-medial prefrontal cortex (including subgenual cingulate), paralimbic cortices, ventro-temporal lobe, and parietal lobe.

Discussion

- sLORETA estimates of lower alpha power in ventral prefrontal regions predicts variability in depressive symptoms in healthy, never-depressed individuals.

- These findings build on prior literature related to pathophysiological mechanisms and potential treatment of the disorder.
  - Deficits in functional connectivity in depressed individuals, specifically in regions overlapping the present findings.
  - Subgenual cingulate (BA 25) is implicated in emotional processing and autonomic control, and is a target for deep-brain stimulation therapy.

- Findings support the promise of future prospective research to elucidate the diagnostic and prognostic significance of these EEG alpha cortical sources.

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