Corresponding relationships between Resting State EEG power and connectivity

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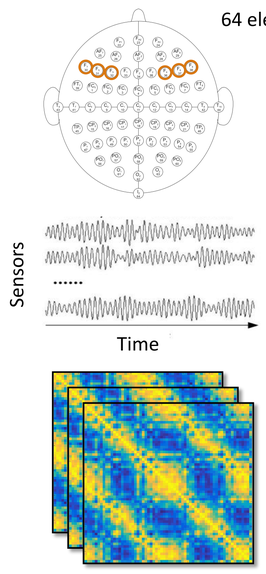
Introduction

EEG alpha oscillations (8-13 Hz) are important in functional inhibition of neural activity and play an important role in synchronizing large-scale networks.

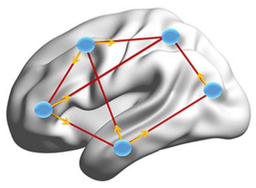
- **Distribution of alpha** rhythms observed in frontal brain regions **infer distinct traits of psychopathology** including internalization disorders such as depression[1].
- Prefrontal alpha at rest displays hemispheric asymmetry known as **frontal alpha asymmetry** (FAA);
  - *greater right than left alpha power* is linked to psychological well-being
  - *greater left than right alpha power* has been examined as **a stable trait and risk factor for depression[2]**.
- Less is known regarding how alpha connectivity reflects interactions both within and between brain networks.

Methods



1. Eyes Open (**EO**) and Eyes Closed (**EC**) resting state EEG was collected and preprocessed using BrainVision. Data were band pass filtered to include the alpha band (8-13 Hz) and epoched into non-overlapping segments of 2000ms. EO and EC time-series were truncated to 180 epochs each, corresponding to the participant with the fewest clean epochs.

2. Synchronization Likelihood[3] connectivity estimates of alpha were extracted using the HERMES toolbox[4] yielding 64x64 channel connectivity matrices of EO and EC rest for each participant.



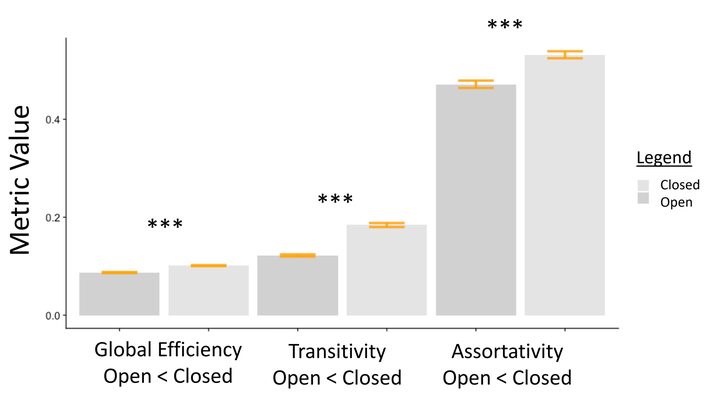
3. Network Analysis[5,6] was used to identify global differences in alpha connectivity and topology as well as local changes in prefrontal alpha (channels F3-F8) between EO and EC rest.
   - **Global Efficiency**- a measure of integration
   - **Transitivity**- reflective of segregation
   - **Assortativity** – network resilience
   - **Node Strength** – sum of edges belonging to a node

Study Sample

Healthy Controls	n= 75
Remitted MDD	n = 79
Current MDD	n = 59

Figures and Results

Global Network Topology Changes between Eyes Closed and Eyes Open Rest



Paired t-test

(n = 213; df = 212; FC 10% thresholded)

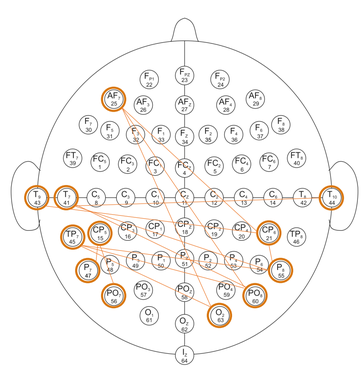
Global Efficiency: Closed > Open (t **=** 18.405) **p<0.001**

Transitivity: Closed > Open (t = 18.310) **p<0.001**

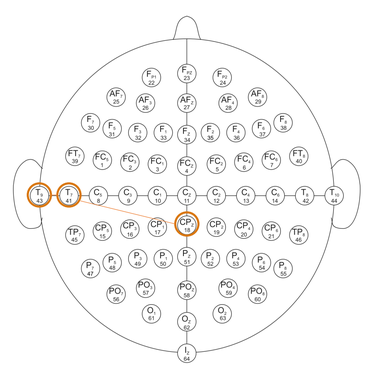
Assortativity: Closed > Open (t = 8.374) **p<0.001**

Network Based Statistic: Identifying Alpha Connectivity Changes across the scalp during *eyes closed* rest

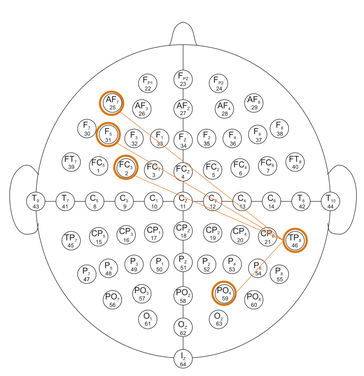
A. Alpha SL between Group Comparisons, t > 3.1, 5000 permutations



HC > Remitted MDD
p = 0.024

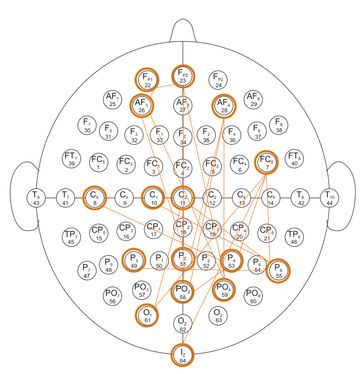


HC > Current MDD
p = 0.0198



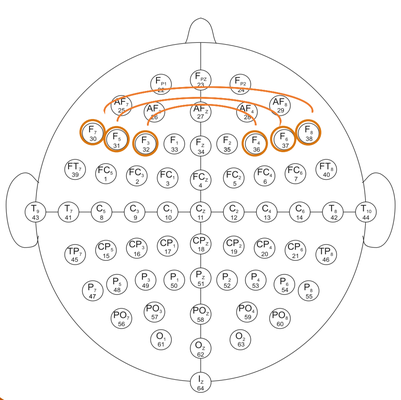
Current MDD> Remitted MDD
p = 0.0198,

B. Alpha SL inverse relationship with BDI (n = 213), f > -9.5, 5000 permutations



All participants
p = 0.046

Local Connectivity Changes between Eyes Closed and Eyes Open Rest



1. Alpha Connectivity is greater during EC than EO
   - **SL** between bilateral frontal sensors:
     - $SL_{F3,F4}$, $SL_{F5,F6}$, $SL_{F7,F8}$ all **p < 0.001**
   - **Node Strength** of channels F3-F8 all **p < 0.001**
2. Alpha Connectivity is inversely correlated with Beck Depression Inventory[7](BDI) during *eyes closed* rest:
   - **SL** between bilateral frontal sensors (n=213):
     - $SL_{F5,F6}$ (**p = 0.015**, r = -0.166), $SL_{F7,F8}$ (**p = 0.022**, r = -0.157)
   - **Node Strength** of channels F3-F8 all **p < 0.05**

Conclusion

- Connectivity characteristics in alpha band were greater during eyes closed rest, corresponding with the inhibitory role of alpha oscillations.
- The relationship between Alpha connectivity and depressive symptoms (BDI) is strongest during eyes closed rest.
- Local ($SL_{F5,F6}$, $SL_{F7,F8}$) and global (node strength) connectivity measures support prior research suggesting that individual differences in the distribution of alpha power across the scalp is linked to depression.

Future Directions

We are currently examining these findings in source space to better understand the cortical sources of these relationships.

We plan to extend the current analyses to include additional oscillation ranges (e.g. theta, beta) in addition to conducting test-retest reliability analysis of these data.

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References

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