High ruminators use different neural processes during a recognition memory task

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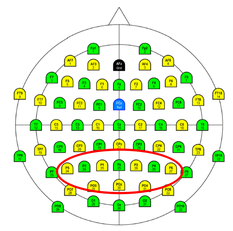
Background

- Rumination is when a person gets “stuck” on a thought or memory and the individual cannot redirect their attention away from the thought (Nolen-Hoeksema et al. 2008).
- The inflexibility hypothesis states that rumination occurs due to an impairment in cognitive flexibility (Davis et al. 2000).
- Cognitive flexibility is the ability to flexibly shift attention between different tasks or modes of thinking (Dajani et al. 2015).
- Brain oscillations in the alpha (8-12 Hz) and beta (13-30 Hz) frequency bands are important for cognitive flexibility (Minarik et al., 2018) and also for successful memory encoding and retrieval (Hanslmayr et al., 2016).
- Alpha and beta power dynamics are altered in individuals with a high tendency to ruminate (Ferdek et al. 2016).
- The current study investigated differences in alpha and beta power dynamics during a source memory task related to an individual’s tendency to ruminate.

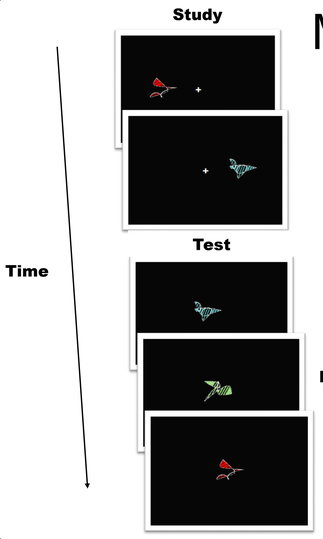
Figure Information

- Each EEG graph displays a significant (p<.006) relationship revealed by the regression analysis.
- The average percent change in power from baseline for either alpha or beta in the preselected parietal area are displayed on the vertical axis for EEG graphs.
- Old/hit/hit refers to successful memory, while old/hit/miss or miss refers to unsuccessful memory.
- The scatterplots show individual trial data for each participant (represented by dots) and the line of best fit for the data. The corresponding BDI-II, RRS-R, or BAI score are displayed on the horizontal axis.
- The line graphs display interactions between predictor variables that are significant. Preselected values for the predictor variables were entered in to the regressions equation to generate the graphs shown. For RRS-R score, the highest (28) and lowest (13) scores from our sample were used. For BDI-II or BAI score, the mean (5) score and one standard deviation from the mean score on either side (1 and 10) were used.

Electrodes Used in Analysis



Methods



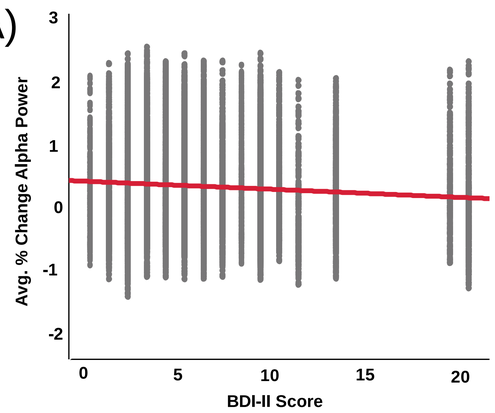
- Subjects (n=43) completed a source memory task. The task consists of a study phase followed by a test phase. During study, non-nameable objects (Slotnick et al. 2004) were presented on the left or right side of the computer screen. During test, the studied objects were mixed in with unstudied objects. Each object was presented in the center of the computer screen. Participants were to decide if each object was studied (old) or unstudied (new), and if they believed the object was old, they also responded with which side of the screen the object was originally presented on. A correct judgement of item and side of screen is termed an old/hit/hit (OHH). A correct judgement of item, but incorrect side of screen is termed an old/hit/miss (OHM). An incorrect judgment of an old item as new is termed a miss (M).

EEG Analysis

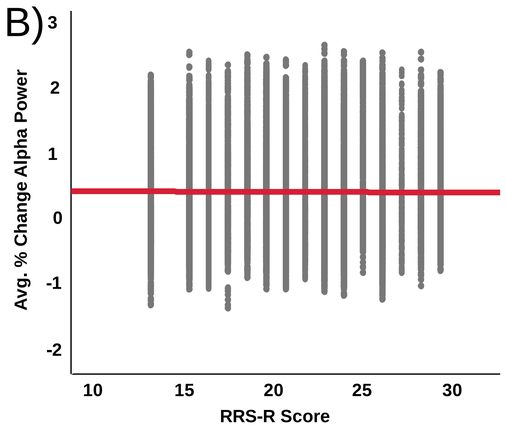
- EEGLAB (Delorme et al. 2004) was used to preprocess and analyze the data.
- EEG data was filtered from 1-100 Hz.
- The data was re-referenced to the average EEG signal.
- Data was epoched in segments from -1000 ms to 2000 ms after presentation of the stimulus. Epochs with changes in voltage greater than 75mv were removed.
- Independent Component Analysis was used to separate the data into independent components for analysis.
- ADJUST 1.1 (Mognon et al., 2010) was used to mark artifact components, which were then removed.
- Data was converted back in to sensor space and data from electrodes P5, P3, P1, Pz, P2, P4, P6, PO3, POz, and PO4 were used for final analyses.
- Trial by trial power values were extracted from Matlab and converted in to average percent change in signal from baseline post cue. The resulting numbers were entered in to separate regressions with rumination, anxiety, depression, and their interaction terms as predictors.

Alpha Power Encoding Results

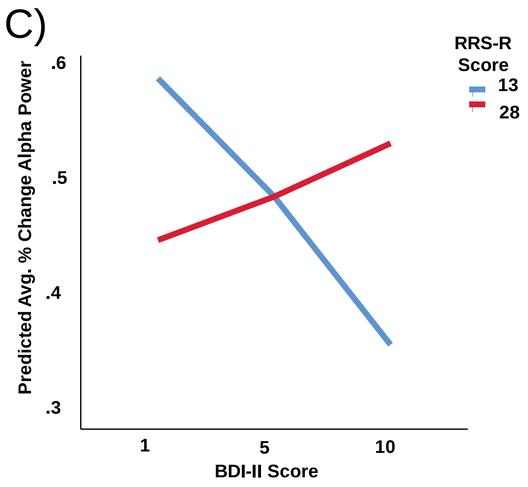
A)



B)



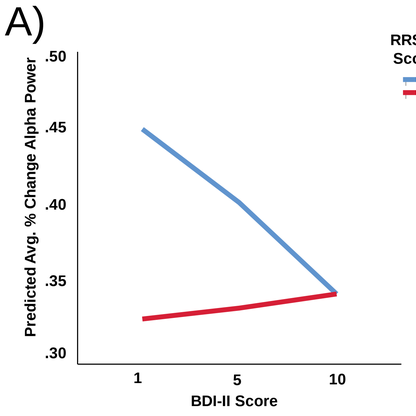
C)



- During encoding for items that were later old/hit/hits, as BDI-II score increases, average percent change in alpha power from baseline decreases post cue (A). As RRS-R score increases, alpha power increases from baseline (B).
- During encoding for items that were later old/hit/miss or miss, as BDI-II score increases, the relationship between RRS-R score and alpha power becomes more positive (C).

Alpha Power Retrieval Results

A)



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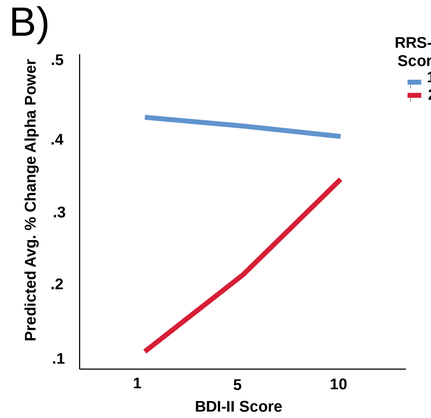

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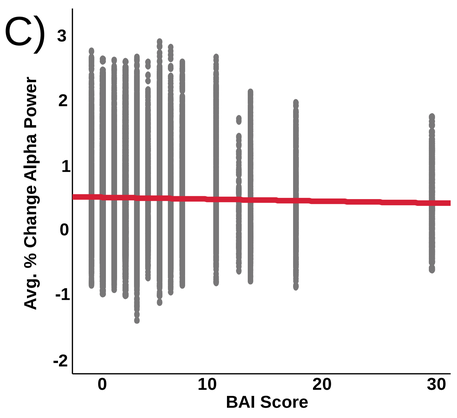
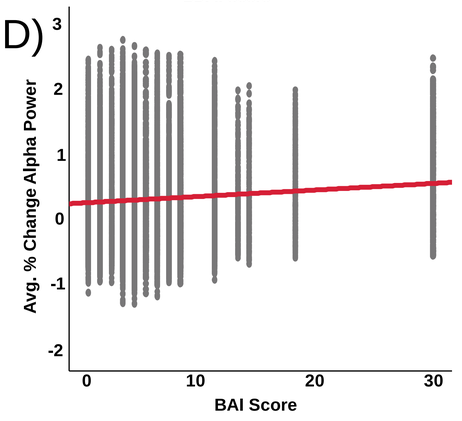


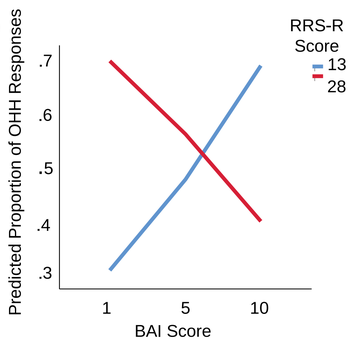
D)



- During retrieval of an old/hit/hit, as BDI-II score increases, the relationship between RRS-R score and alpha power becomes more positive (A). The same trend is observed for retrieval of an old/hit/miss or miss trial (B).
- During retrieval of an old/hit/hit, as BAI score increases alpha power decreases (C). As BAI score increases during an old/hit/miss or miss trial, alpha power increases (D).

Behavioral Results

A)



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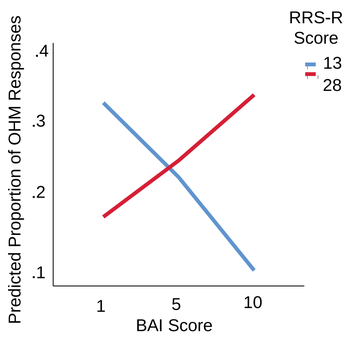
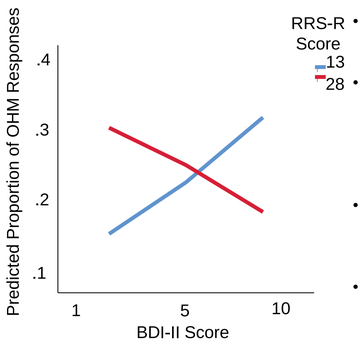


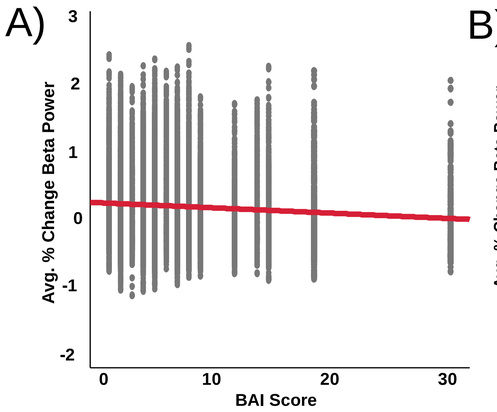
C)



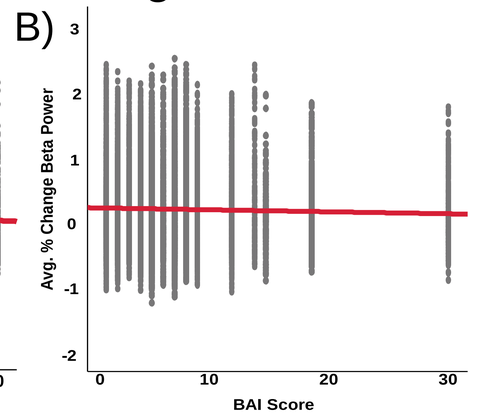
- A moderation analysis including rumination, depression, anxiety and their interaction terms revealed:
- The interaction of rumination and anxiety predicts accuracy for OHH and OHM. The relationship between rumination and OHH accuracy becomes more negative with increasing anxiety (A) The opposite relationship is observed for OHM accuracy(B).
- The interaction of rumination and depression can predict accuracy for OHM. The relationship between rumination and OHM becomes more negative with increasing depression (C).
- An alpha level of .05 was used for behavioral results.

Beta Power Encoding Results

A)



B)



- During encoding for items that were later old/hit/hits, as BAI score increased, the average percent change in beta power from baseline decreased (A). For items that were later an old/hit/miss or miss, the same trend is observed (B).

References

- Dajani, D.R, et al. (2015). *Trends in Neurosciences.*
- Davis, R.N., et al. (2000) *Cognitive Therapy and Research.*
- Delorme, A., et al. (2004). *Journal of Neuroscience Methods.*
- Ferdek, M.A., et al. (2016). *Cognitive, Affective, and Behavioral Neuroscience.*
- Hanslmayr, S., et al. (2016). *Trends in Neurosciences.*
- Minarik, T., et al. (2018). *Neuroimage.*
- Mognon, A., et al. (2011). *Psychophysiology.*
- Nolen-Hoeksema, S., et al. (2008) *Perspectives on Psychological Science.*
- Slotnick, S.D., et al. (2004). *Nature Neuroscience.*

Conclusions

- Participants who have a higher tendency to ruminate combined with higher anxiety show decreased memory for contextual details.
- In parietal brain regions, high ruminators exhibit alpha power dynamics suggestive of diminished recruitment of attentional resources for both trial types during encoding and retrieval when paired with higher levels of depression (Minarik et al., 2018).
- More anxious individuals exhibit greater beta power decreases in parietal areas during encoding which could reflect a more detail rich memory being formed (Hanslmayr et al., 2016).
- Rumination and anxiety together decrease memory for contextual details possibly due to engaging in rumination during encoding and retrieval leading to attentional resources being divided. Also, a more detail rich memory representation may be formed due to difficulty with attentional focus during encoding.

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