Avoidance and Anxiety in Adolescence: An Analysis of Phase-Locked Potentiation and Theta-Band Neural Responses of Avoidance Behaviors in Anxiety

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Abstract

Social anxiety is likely highly prevalent in adolescence. A primary hallmark of social anxiety and other anxiety disorders is the tendency to avoid risky or threatening situations. To further understand the neural and behavioral differences in adolescents during a task in which threat was certain, and participants decided to what degree they wished to avoid the potential for gain. We had participants play the Balloon Risk Avoidance Task, in which a balloon is sure to pop and participants must decide how much to deflate the balloon. The amount to which they deflate the balloon correlates to the number of points which is subtracted from their possible score for that round. We used EEG to measure ERPs as well as ERSPs for theta-band frequencies in the midfrontal region. Participants that were more socially anxious showed less theta activation in the midfrontal region during successful avoidance trials than did less anxious participants. Additionally, more socially anxious participants had greater frontal P2 in successful conditions, and greater FRN and SW for unsuccessful conditions than less anxious participants. Behaviorally, females were more avoidant than males, and older participants were both more avoidant and won more points than younger participants.

Results

Low anxiety (SPAI-C):

High anxiety (SPAI-C):

Fig. 1. One trial series of the BRAT, showing both unsuccessful and successful avoidance conditions.

Participants (N = 59) completed 60 trials of the BRAT, while EEG signal was being monitored continuously. Represented EEG channels are shown at the center of Figure 3. Participants self-reported anxiety was measured using the Social Phobia and Anxiety Inventory for Children (SPAI-C).

Fig. 2. Spectral analyses for theta-band changes in the midfrontal region for unsuccessful and successful conditions, as well as the difference between conditions.

Fig. 3. ERP analyses for midfrontal (top) and midposterior (bottom) for successful and unsuccessful avoidance conditions. Leftmost plots are the low anxiety (SPAI-C) groups, rightmost are of the high anxiety (SPAI-C) group.

Conclusion

• ERP analyses showed larger midfrontal P2 after having unsuccessfully avoided risk (failure to avoid). Due to existing evidence on the significance of frontal P2 signal, this indicates that anxious persons weigh failure conditions more heavily than success conditions in terms of risk/reward, respectively.
• ERP analyses showed larger midfrontal FRN after having unsuccessfully avoided risk. This is consistent with expectations for anxious individuals to weigh failure conditions more heavily than do non-anxious persons.
• ERP analyses found in larger midfrontal SW after having unsuccessfully avoided risk, indicative of prolonged feedback processing.
• These findings suggest altered feedback processing in anxious persons, discriminatory between successful and unsuccessful avoidance conditions.
• ERSP analyses found that midfrontal theta-band power was weakened in anxious participants in conditions where risk was successfully avoided.
• This decrease in power is indicative of desynchronization of theta power between midfrontal regions – hippocampus, insula, prefrontal cortex, and amygdala.
• Having higher theta power during unsuccessful conditions was also positively correlated to scoring more points on the BRAT, indicative of a cognitive neural adjustment to the BRAT.
• Results indicate a role of midfrontal theta synchronization to be a relevant aspect of avoidance behavior.
• We suggest that the sensitivity of midfrontal theta and ERP components to unsuccessful avoidance conditions is significant and specific enough to act as a biomarker for avoidance patterns in anxious individuals.

Acknowledgements

I would like to thank Dr. Michael Crowley for his mentorship, commentary, and discussion on this project. I would also like to thank Dr. Jia Wu for her contribution with EEG signal processing.