Influence of anxiety and depression on error-related brain activity

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Introduction

- Error-related negativity (ERN) is a reliable component of the event-related brain potential (ERP) and serves as a neurobiological indicator of error monitoring and recognition processes (Olvet & Hajcak, 2008).
- Numerous studies have examined the relationship between anxiety and the ERN, with consistent findings demonstrating increased ERN amplitudes in patients with Generalized Anxiety Disorder (GAD) and in individuals with higher symptoms of anxiety (e.g., Weinberg et al., 2013).
- While numerous studies have examined the relationship between anxiety and ERN, there has yet to be a study comparing this relationship to depression and anxiety.
- The primary aim of this study is to examine the ERN among individuals reporting higher symptoms of anxiety (with low depression), those reporting depressive symptoms (with low anxiety).
- It is expected that the anxiety group will exhibit increased ERN amplitudes, while the depression group will exhibit less exaggerated ERN amplitudes.

Materials and Methods

Clinical Symptom Measures

Beck's Depression Inventory
Beck's Anxiety Inventory

ERP Components
ERN/CRN grand-averaged and subtraction-based and residualized ΔERN difference waveforms.
Time Window: 0-100 ms
Electrode Site: FCz

Modified Flanker Task

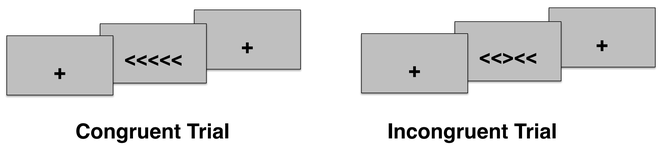
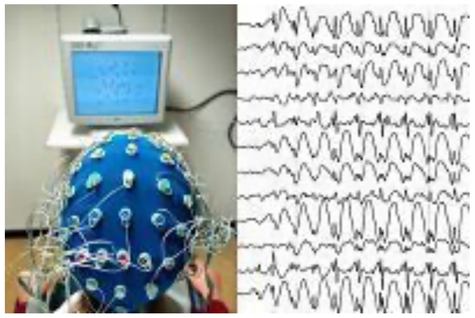


Figure 1. Modified Flanker Task with example congruent (left) and incongruent (right) trial stimuli. On each trial, there was a fixation cross followed by the flanking arrows for 100 ms and a 1,000 ms response window. There was a random, jittered intertrial interval that ranged between 900-1,300 ms.



Results

Characteristics	Controls (n = 59)	MDD (n = 53)	GAD (n = 39)
Age (years)	20.3 (1.3)	20.6 (1.8)	20.4 (2.0)
Sex (% Female)	53.4	79.5	75.5
Body Mass Index (kg/m^2)	23.7 (5.1)	23.8 (3.5)	22.9 (2.8)
Depressive Symptoms	7.3 (5.1)	23.4 (8.2)	19.0 (10.9)
Anxiety Symptoms	6.4 (4.7)	8.5 (6.0)	19.6 (10.2)

Table 1. Demographics and Clinical Characteristics. Relatively young college-students exhibiting differences in symptoms of depression and anxiety.

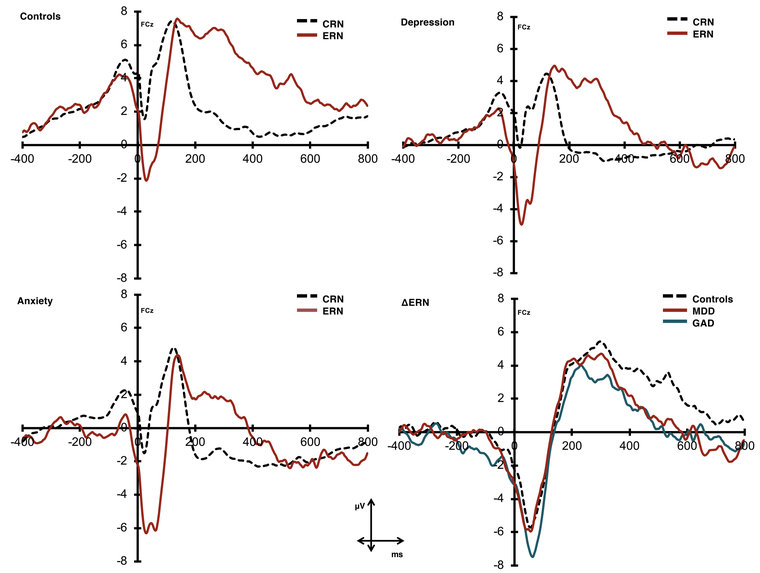


Figure 2. Response-locked grand-averaged parent and difference waveforms for healthy controls, individuals with a MDD diagnosis, and those with an Anxiety diagnosis. The difference waveform depicted in the lower right panel displays the subtraction-based ΔERN (error-correct trials) for each group.

Measure	Controls	MDD	Anxiety
Accuracy (%)	87.5 (1.7)	89.7 (1.3)	88.9 (1.9)
RT (ms)	590.5 (24.7)	592.0 (23.8)	618.9 (31.3)
CRN *	4.2 (0.8)	1.9 (0.5)	0.9 (0.7)
ERN *	0.2 (1.0)	-2.8 (0.9)	-4.8 (0.8)
Subtraction-based ΔERN *	-4.0 (0.7)	-4.7 (0.8)	-5.7 (0.9)
Residualized ΔERN	0.6 (1.1)	0.1 (1.4)	-1.3 (1.4)

Table 2. Means (and Standard Errors) for the Controls, MDD, and Anxiety groups. *$p < .05$.

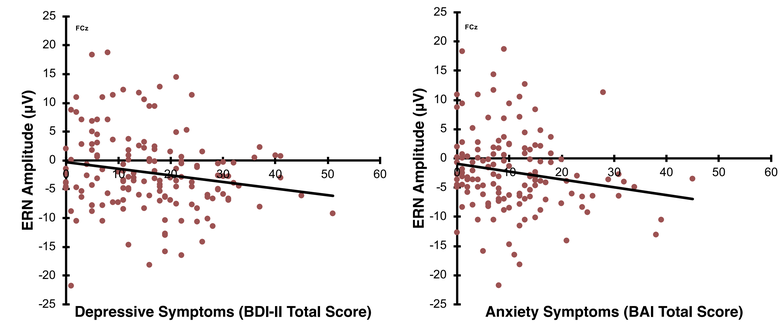


Figure 3. Bivariate Pearson Correlation plots displaying the relationship between clinical symptom measures of depression (left) and anxiety (right) and ERP measures.

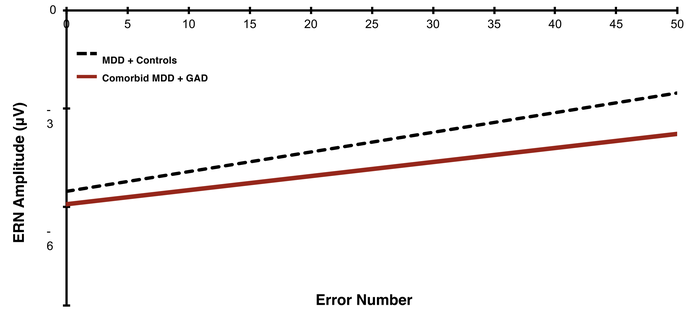


Figure 4. Trajectory of the ERN across the course of the flanker task. Since there are three groups, MDD and controls served as the referent group and were compared to individuals with Anxiety. The CRN was included as a covariate to test group differences in ERN while controlling for differences in neural responses to correct trials.

Conclusions

- The findings are consistent with the notion that an anxiety diagnosis is characterized by a larger ERN.
- Interestingly, these between-group findings emerged along with the presence of relationships between ERP measures and behavioral performance, suggesting that the findings fit within the framework of the compensatory error monitoring hypothesis.
- Further investigation will add clarity to the complex relationship between depression and anxiety, by demonstrating that they are distinct disorders
- Promotes the possibility of ERN serving as a transdiagnostic variable, thereby potentially aiding in treatment interventions
- Highlights the potential for ERN to be used as a future diagnostic tool

Acknowledgments

I would like to extend my gratitude toward Dr. Alderman for his guidance and mentoring, the Aresty Undergraduate Research Department for funding, and the Rutgers Department of Kinesiology and Health.