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An Attentional Bias to Threat: Event-Related Potentials in EEG Studies of Children with Anxiety

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ABSTRACT

Background. Anxiety is a common concern among children. The present study looked at the latency to several different event related potential (ERPs) during an attentional bias to threat task in children with and without anxiety concerns. **Methods.** Children were shown angry and neutral adult facial images while wearing and electroencephalography (EEG) cap. Each image was presented for 1,000 ms, after which children were asked to indicate whether the image was "scary" or "not scary." **Results.** Children with anxiety had longer latency to N2 ERPs when viewing scary images as opposed to not scary images. This was qualified by Anxious x Scary and Gender x Scary interactions. Latency to N2 ERP did not vary between Scary and non-Scary images for anxious children, but did for non-anxious children. For the Gender x Scary interaction, latency to the ERP signal was longer for boys when they were shown Scary vs. Not Scary images. There was no effect of image type for girls. **Conclusions.** Going forward more research needs to be done to investigate responses to emotional stimuli of all kinds to tease apart potential gender differences and to understand how anxiety status may mediate these interactions.

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Chapter 1

Introduction

Anxiety is a basic fear response to stressful situations that is evolutionarily beneficial in situations that present threats (Teubert & Pinquart, 2011). Because of this, anxiety in children is common and often normal. There are common anxieties associated with different age groups. For instance, infants often experience separation anxiety from caretakers, and school-aged children often grapple with anxiety surrounding death as they become mature enough to conceptually grasp the idea of death. Anxiety becomes a disorder when the feeling of anxiousness interferes with daily functioning. However, anxiety disorders can be hard to diagnose in children because children are developmentally less capable of verbally communicating their fears (Weems, Taylor, Marks & Varela, 2010). Instead, report of behaviors from parent, teachers, and others close to the child are used (Teubert & Pinquart, 2011) so that diagnoses in children are often reliant on the presence of observable symptoms as opposed to symptoms reported by the patient. As children age and reach adolescence it becomes easier to make a diagnosis based on their self-report and less on the reports of individuals close to the patient (Teubert & Pinquart, 2011).

Anxiety disorders affect anywhere from 4%-25% of children, with 10%-15% of children affected being the most frequently reported numbers in studies (Teubert & Pinquart, 2011). Most anxiety disorders in children (about 75%) begin between the ages of 11 and 21 years old (Beesdo, Knappe & Pine, 2009). For this reason, late childhood and adolescence appear to be a sensitive time for the development many different types of anxiety disorders. Anxiety disorders

are likely to persist throughout the life course of the individual (Teubert & Pinquart, 2011). Multiple studies have suggested that intervention and treatment of anxiety disorders that present in children is important to the child reaching remission (Beesdo et al, 2009). In other words, treating anxiety disorders of all types in children, whether it be with talk therapy or pharmaceutical intervention, is often essential. Without proper treatment, most anxiety disorders will not go away on their own.

A diagnosis of an anxiety disorder in childhood or adolescence leads to an increased risk of the development of anxiety disorders in adulthood of the individual. Different anxiety disorders have been found to manifest at different ages in children. Younger children are most frequently diagnosed with Separation Anxiety and Specific Phobias. Roughly 2%-8% of children are diagnosed with a Separation Anxiety disorder before the age of 12 (Teubert & Pinquart, 2011). Although Separation Anxiety is the most common anxiety disorder diagnosed in children, rates of up to and between 7% and 10% of children being diagnosed with a Specific or Social Phobias have been reported (Teubert & Pinquart, 2011). The prevalence of Social Phobias increases as children age. Agoraphobia and Panic Disorder are among the least prevalent anxiety disorders in children with rates of 1% or less of children being diagnosed. These rates do however generally increase in adolescence (Teubert & Pinquart, 2011).

Girls are more likely than boys to experience symptoms of anxiety beginning at school age (roughly 6 years old) and are more likely to be diagnosed with an anxiety disorder. This gender difference increases through adolescence into adulthood (Teubert & Pinquart, 2011). Girls tend to experience puberty on average two years earlier than boys, and timing of pubertal development and gender orientation are more important predictors in determining anxiety symptoms than biological sex (Carter, Silverman, & Jaccard, 2012). Anxiety diagnoses are more

prevalent among some races. A recent study found that White Americans tend to be diagnosed with anxiety disorders at a higher rate than African Americans, Asian Americans, and Hispanic Americans. However, African American participants more frequently meet the criteria for PTSD diagnoses than Asian Americans, Hispanic Americans, and white Americans (Muris, Meesters & Knoops, 2005).

There are many risk factors for the development of anxiety. For instance, children with avoidant parental attachment styles are more likely to be at risk for the development of anxiety (Newman, Shin & Zuellig, 2016). Avoidant attachment style is a type of insecure attachment style that is hallmarked by deactivating emotions when a child's needs are not being met by the caregiver (Mikulincer, Shaver & Pereg, 2003). Attentional bias to threat is also considered a risk factor for the development of GAD (Puliafico & Kendall, 2006). An attentional bias to threat is a bias to processing the threatening information present above other stimuli present in the environment (Cisler, Bacon & Williams, 2009). Such biases are hypothesized to be a contributing cause to a variety of emotional disorders, in particular, many different types of anxiety disorder. This makes sense considering a function of anxiety is to process and react to potentially threatening situations (Mathews & Macleod, 2005). One recent study utilized an Emotional Stroop Task to study attentional biases in patients with preexisting anxiety and depression diagnoses. The task required patients to name the colors in which words were printed. It was found that patients with anxiety and depression took longer to answer when they were viewing words that were relevant to their clinical condition (Williams, Mathews & MacLeod, 1996).

Electroencephalography (EEG) has become instrumental in understanding neural mechanisms that might contribute to the development of anxiety. EEG is a recording of the

electrical activity at the scalp that is a result of neural processes in the brain. EEGs have more accurate temporal resolution as compared to other tools that measure the brain such as functional magnetic resonance imaging. For this reason, they have become commonplace in studies that are interested in the time course of stimulus onset (Gupta, Kujawa & Vago, 2019). Event-related potentials (ERPs) are large voltage potentials that occur as a result of an event during an electroencephalographic (EEG) recording.

There are common ERP components that have been showed to be associated with the processing of specific stimuli in the brain. For instance, a response to a change in a person's visual field would likely elicit a large positive voltage spike roughly 100ms after the onset of the change. This positive spike is known as the P1 ERP, which has been shown to be associated early visual attention (Sunohara, et al., 1999). The P1 ERP is followed by the N1 ERP which is affected by discrimination of visual stimuli and arises from the parietal and lateral occipital cortex (Gupta, et al., 2019). The P2 ERP follows the N2 and has been connected to the processing of emotional facial expressions (Torrence & Troup, 2018) and the processing of emotional images (Carretié, Hinojosa, Martín-Loeches, Mercado, Tapia, 2004) in recent studies. Finally, the N2 ERP has been demonstrated in recent studies as playing a role in processing emotion in general (Sass, et al, 2010). For this reason, the P1, N1, P2, and N2 ERP components make viable options for studying an attentional bias to threat while participants are processing emotional images (either scary or not scary).

Two of the most common ways to assess ERPs are to measure the height of the peak of the spike and the area under the curve. For instance, a recent study looked how attention training would moderate specific ERPs in anxious adults. The study trained a randomized group of anxious participants to divert their attention from threatening visual stimuli. It was found that

anxious individuals who were trained to divert their attention from or ignore threatening stimuli showed decreased P2 and P3 amplitudes as compared to other anxious participants who did not undergo training and non-anxious controls. Additionally, these participants also showed a comparatively increased amplitude in the N2 ERP component (Eldar & Bar-Haim, 2010).

However, another useful way to assess ERPs is a metric known as latency, which measures the delay between stimulus onset to ERP onset (Sunohara, et al,1999). A multitude of factors can lead to differences in ERP latency. In one study, college-aged participants were grouped by low-trait and high-trait anxiety. Participants carried out an object identification task with threatening and non-threatening distractors. It was found that the N1 and P2 latencies were faster in participants in the high-trait anxiety group (Bar-Haim, Lamy & Glickman, 2005). Another study that utilized the emotional Stroop task mentioned earlier found similar results in adults. The study utilized adults with Panic Disorder, adults with Obsessive Compulsive Disorder, and healthy controls. Participants with PD had shorter P1 latencies when viewing threatening words as opposed to neutral words. Participants with OCD had longer N1 latencies when viewing threatening words as opposed to neutral words. These findings held true across trials where participants were asked to either attend to or ignore threatening stimuli (Thomas, Gonsalvez & Johnstone, 2013). A final study showed similar results in adults. The study looked at adults with symptoms of social anxiety and exposed them to threatening vs. non-threatening facial stimuli using a Dot Probe Task. The study found a shorter N2pc latency in groups with social anxiety symptoms when viewing threatening faces as opposed to non-anxious controls (Reutter, Hewig, Wieser & Osinsky, 2017). Therefore, there is evidence that latency to ERP onset may be a strong biomarker in the identification of anxiety disorders.

Hypotheses

Previous studies in attentional bias to threat have found faster latencies in anxious individuals when viewing threatening stimuli. However, these studies were limited by the way in which threatening stimuli were presented in the study (e.g. within emotional Stroop tasks, as distractors within the study, etc.) and the age of participants. If it is true that threatening stimuli of various types lead to faster ERPs in participants with anxiety, then we expect children with anxiety will have shorter latency to ERPs than control children within my study. Additionally, we also expect that if scary images do indeed elicit faster ERPs for anxious children, then we will see an interaction such that anxious children have faster ERPs to scary images than to neutral images.

Chapter 2

Methods

Participants

There were 77 children used in the study who were between the ages of 8 and 12 years old (M=9.40, SD=1.17). Table 1 provides details on demographics. The children were recruited for the study from a database for families interested in participating in Penn State Research known as the FIRSt Families database. Other participants were recruited via community outreach in the State College and Bellefonte areas. Additional participants were recruited via word of mouth as part of a larger study on cognitive correlates of psychopathology in children with ADHD and anxiety. These children were screened for participation following a first visit within the larger study. Children were deemed ineligible if they had an FSIQ score below 80; previous head injuries (as reported by parents or within a medical history screen); psychosis; or disabilities related to neurology, development, intellect, or sensorimotor skills.

Procedure

Prior to participation in the study, written informed consent was obtained from parents. Children additionally gave their verbal assent. Participant's parents were paid $100 for participation in the study and were provided with clinical feedback about their child. Children were given a small prize at the end of the study.

There were two sessions of the larger study that was taking place. During the first visit, questionnaires were given to the parents about the children and a structured diagnostic interview was administered. Children completed a comprehensive assessment battery.

Measures

The study involved an emotion identification tasks that was completed while the child's brain activity was recorded via EEG. The task contained 200 trials with a combination of threatening and neutral faces collected from the NimStim (Tottenham et al., 2009) and KDEF (Lundqvist, Flykt & Öhman, 1998) databases. The faces were presented for 1,000 ms followed by a prompt (also 1,000 ms) to press a button determining whether the face was "scary" or "not scary."

Each face was presented twice. Half of the faces presented were blurred whereas the other half was not blurred. The images were blurred using the speckle function in the Opencv2 package of Python. Half of the faces presented were scary and half were not scary.

Chapter 3

Results

Tables 2 and 3 provides main effects and interactions. The initial 4-way GLM indicated there were no main effects of Blur or Scary, or a Blur x Scary interaction at any location (all $p > .069$, all $n^2 < .042$). However, there was a main effect of gender on two of ERPs of interest, the N1 and N2 ERPs at the Fz and Cz electrodes (all $p < .018$, all $n^2 > .01$). There was also a main effect of Anxiety on the N2 ERP component at the Fz and Cz locations (all $p < .07$, all $n^2 > .042$).

These main effects were qualified by significant 2-way interactions with Scary at the Cz electrode for the N2 ERP component: Anxiety x Scary ($F(3, 77) = 5.169$, $p = .026$) and Gender x Scary ($F(3, 77) = 5.179$, $p = .026$). Figures 1 and 2 illustrate these interactions. There were no other significant main effects or interactions. For the Anxiety x Scary interaction, latency to N2 ERP did not vary between Scary and non-Scary images for anxious children, but did for non-anxious children ($F(3, 77) = 4.272$, $p = .045$). Non-anxious children had a shorter latency to scary images. For the Gender x Scary interaction, latency to the ERP signal was shorter for boys when they were shown Scary vs. Not Scary images, $F(3, 77) = 5.836$, $p = .021$. There was no effect of image type for girls.

Chapter 4

Discussion

Diagnosing anxiety in children can be a complex process given communication barriers (Weems, Taylor, Marks & Varela, 2010). This is a relevant issue given children are at risk for developing a variety of anxiety disorders (Beesdo, Knappe & Pine, 2009). Anxiety is especially common amongst school-aged girls, even more so than school-aged boys (Teubert & Pinquart, 2011). Having an anxiety disorder as a child increases the risk of other psychopathological issues in adolescence and adulthood (Teubert & Pinquart, 2011). Early intervention is key to future success of management of anxiety disorders (Beesdo et al, 2009). EEGs are a commonly utilized to understand the neural mechanisms that cause or maintain anxiety disorders. ERPs are a commonly used technique to study EEGs. Among the most common are the N1, N2, and P2 ERPs (Gupta, et al., 2019; Sass, et al, 2010; Torrence & Troup, 2018). Studies have shown that generally anxiety status affects the latency and amplitude of ERPs, especially those involved in attention and processing of visual stimuli (Sunohara, et al,1999).

Although there are many risk factors to the development of anxiety, attentional bias to threat is a key risk factor in the development of anxiety disorders (Puliafico & Kendall, 2006). While there are studies that have looked at how various types of threatening stimuli are processed by adult-aged participants, at the present there is a lack of literature in determining how children with anxiety respond to threatening stimuli and how gender might influence processing of threatening stimuli. Overall, even though women show increased prevalence of

anxiety disorder there is a lack of research that studies the differential processing between men and women of all ages of threatening stimuli (Cahill, 2006). Our study aims to fill this void.

Our study found that children with anxiety (boys and girls together) had a longer N2 ERP latency when responding to scary images as compared to not scary images. However, boys had a shorter N2 ERP latency when viewing scary images. The results partially supported my hypotheses that children with anxiety disorders would have a faster ERP latency to scary images. I found that while children with high trait anxiety responded slower to scary images than threatening images, only boys had a shorter latency. While this generally contradicts current literature, it does provide evidence that children with anxiety are processing threatening vs. non-threatening stimuli differently. Furthermore, most previous studies outlined in my literature review focused on N1 and P2 latencies. The present study found significant results only on the N2 ERP component at the Fz location.

The current study's finding that children with anxiety have longer N2 latencies when viewing scary images as opposed to viewing not scary images contradicts the previous finding that the N2pc latency is faster in adults with social anxiety when viewing threatening facial stimuli (Reutter, Hewig, Wieser & Osinsky, 2017). However, this study focused on a different age group. Our study focused on children with high trait anxiety while that study focused on social anxiety in adults. As argued by Thomas et al. (2013) differences in ERP latency are disorder-specific; hence, the difference in results could also be accounted for by the use of participants with different psychological disorders.

Furthermore, while a 2005 study showed faster N1 ERPs in anxious individuals as opposed to non-anxious controls in response to fearful faces, the study utilized electrode groups as opposed to single electrode locations. The study found no significant results at the Fz, Cz, or

Pz electrode sites individually (Bar-Haim, Lamy & Glickman). The present study utilized singular electrode locations for analysis. Results may have differed if electrode groups were used considering the characteristically poor spatial resolution EEGs in comparison to other neurological measures like fMRI (Gupta, Kujawa & Vago, 2019). Furthermore, this study utilized fearful facial expression in contrast to their neutral facial expression while our study utilized angry facial expressions (Bar-Haim, Lamy, Glickman, 2005). It is possible that different facial expressions result in differential processing that could account for the differences in ERP latencies between the studies.

On the other hand, our results are consistent with current research suggesting that non-anxious men tend to process threatening stimuli earlier than non-anxious women (Sass et al., 2010). The study looked at men and women prone to anxious apprehension and anxious arousal. Overall, women who were anxious showed greater processing of stimuli in the early stages of stimulus presentation. More interestingly, however, the non-anxious women in the study showed evidence of processing threatening stimuli later, around 300 ms while the non-anxious control men in the study were processing threatening stimuli around 100 ms after stimulus presentation. (Sass et al., 2010). This study which indicates that men and women process threatening stimuli, in addition to ours, could have important implications for understanding the higher prevalence of anxiety disorders among women in the future.

Consistent with our study, a 2004 study found that men and women process threatening stimuli differently. The study, however, incorporated the use of both positive and negative stimuli. The time course of the processing of oddball happy and oddball angry faces in males and females was analyzed. Both men and women took longer to respond to happy faces as opposed to angry (and potentially threatening faces). Males also had a delayed N2b ERP

component for happy faces as compared to angry faces (Campanella, et al). This study suggests that men and women may process emotional stimuli of all types differently.

This study was limited by the subjectiveness of the facial stimuli that were presented to each participant. Children of different ages that have grown up in homes with a variety of parental techniques could be more or less desensitized to angry faces than others. Furthermore, our study presented only threatening and neutral stimuli only. It is difficult to tease apart whether participants were eliciting an attentional bias to threat or a bias to emotional images in general without the inclusion of stimuli that evoke positive emotions.

While there is ample literature on the way individuals with depression respond differentially to positive stimuli, there is limited literature studying the way individuals with anxiety respond to positive stimuli and how this may be mediated by gender. Future studies should look at gender and anxiety-status differences in response to a variety of emotional stimuli in order to confirm that the attentional bias is in response to threat and not emotion in general. Studies should utilize a variety of age-groups to confirm the bias is consistent throughout the life course of patients.

Chapter 5

Conclusion

Anxiety is a common issue amongst children (Beesdo, Knappe & Pine, 2009) with girls more commonly affected than boys (Teubert & Pinquart, 2011).This study found that anxious children had slower N2 ERPs when viewing Scary images as opposed to Not Scary images. This was qualified by an Anxious x Scary and Gender x Scary interactions in which latency to N2 ERP did not vary between Scary and non-Scary images for anxious children, but did for non-anxious children. There was also a main effect of gender in which boys had significantly shorter N2 ERP latencies when viewing Scary images as opposed to Not Scary images. There was no effect of image type found for girls within the study. These findings are not entirely consistent with previous findings, which could potentially be explained by the age group of our participants, the types of anxiety disorders our participants had, or the singular electrode analysis we utilized.

Moving forward, we recommend more research be done to determine gender differences amongst various age groups and anxiety statuses in processing emotional stimuli of all types.

Appendix A

Figures

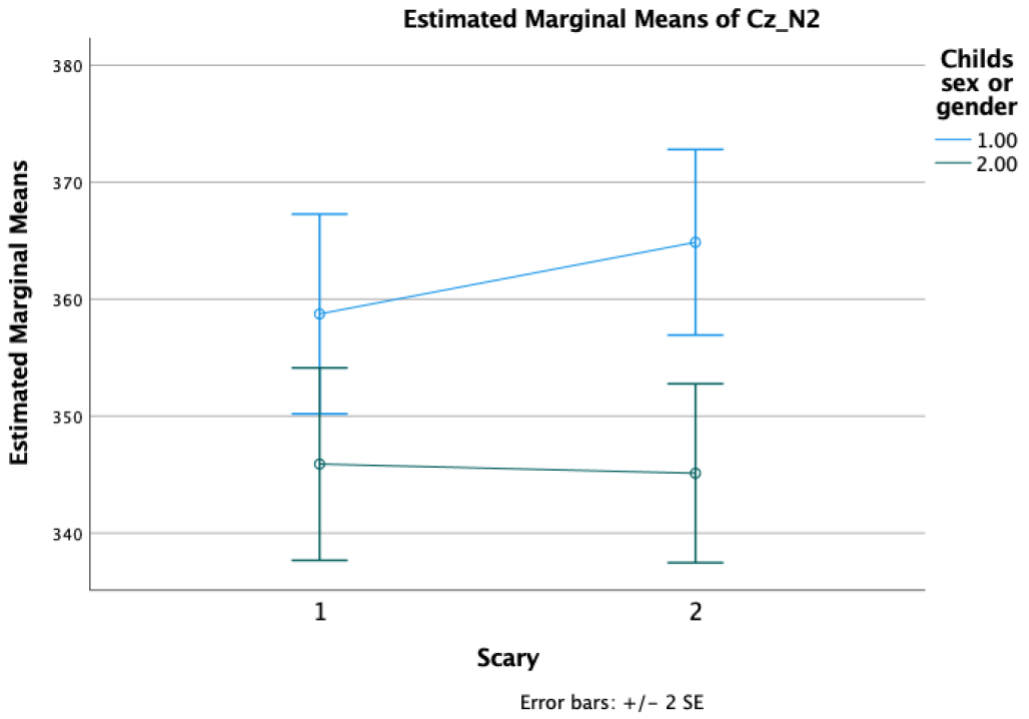

Figure 1. Latency at electrode Cz for N2 ERP component for Scary images, 1 = Male, 2 = Female

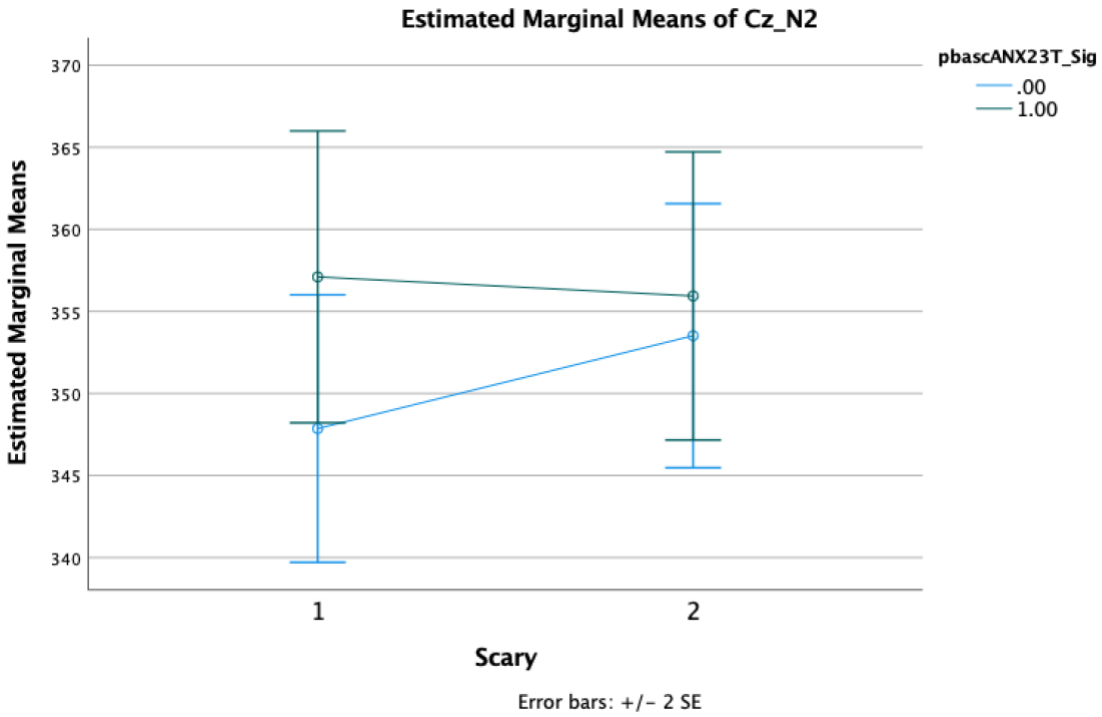

Figure 2. Latency at electrode Cz for N2 ERP component for Scary images, 0 = Not Anxious, 1 = Anxious

Appendix B

Tables

Table 1. Participant Demographics

	Control	Anxious	Total
N	41 (20 girls, 48.8 %)	36 (21 girls, 58.3%)	**77 (41 girls, 53.2%)**
Age (SD)	9.44 (1.21)	9.36 (1.15)	**9.40 (1.17)**
IQ (SD)	103.85 (11.91)	106.34 (14.22)	**105.16 (13.03)**
BASC Anx T-Score (SD)	47.24 (7.34)	69.72 (7.98)	**57.74 (13.61)**
Asian/Pacific Islander	0 (0.0%)	1 (2.8%)	**1 (1.3%)**
Hispanic	4 (9.8%)	1 (2.8%)	**5 (6.5%)**
White	36 (87.8%)	33 (91.7%)	**69 (89.6%)**
Mixed Race	1 (2.4%)	1 (2.8%)	**2 (2.6%)**

Table 2. Initial 4-way GLM, Between Subjects Effects, $p < .05$ indicated by *

	Within Subjects Effects			
	Parameter	F	*p*	n^2
Blur	Fz_N1	2.351	0.129	0.030
	Fz_N2	0.340	0.562	0.004
	Fz_P2	3.253	0.075	0.041
	Cz_N1	0.046	0.831	0.001
	Cz_N2	3.390	0.069	0.042
Scary	Fz_N1	3.288	0.074	0.041
	Fz_N2	1.127	0.292	0.014
	Fz_P2	0.302	0.584	0.004
	Cz_N1	0.020	0.887	0.000
	Cz_N2	2.949	0.090	0.037
Blur x Scary	Fz_N1	0.400	0.529	0.005
	Fz_N2	0.408	0.525	0.035
	Fz_P2	2.824	0.097	0.000
	Cz_N1	0.003	0.953	0.000
	Cz_N2	0.008	0.929	0.003

Table 3. Initial 4-Way GLM, Between Subjects Effects, $p < .05$ indicated by *

	Parameter	F	*p*	n^2
Gender	Fz_N1	5.806	0.018*	0.070
	Fz_N2	27.273	<.001**	0.262
	Fz_P2	0.066	0.798	0.001
	Cz_N1	6.903	0.01*	0.082
	Cz_N2	10.597	.002*	0.121
Blur x Gender	Fz_N1	0.459	0.500	0.006
	Fz_N2	1.243	0.268	0.016
	Fz_P2	1.205	0.276	0.015
	Cz_N1	0.428	0.515	0.006
	Cz_N2	0.672	0.415	0.009
Scary x Gender	Fz_N1	0.092	0.762	0.001
	Fz_N2	0.002	0.967	0
	Fz_P2	0.796	0.375	0.010
	Cz_N1	0.103	0.749	0.001
	Cz_N2	5.179	0.026*	0.063
Blur x Scary x Gender	Fz_N1	0.946	0.334	0.012
	Fz_N2	0.009	0.927	0.000
	Fz_P2	0.128	0.722	0.002
	Cz_N1	0.892	0.348	0.011
	Cz_N2	1.583	0.212	0.020
Anxiety	Fz_N1	1.691	0.197	0.021
	Fz_N2	3.377	0.07*	0.042
	Fz_P2	0.001	0.969	0.000
	Cz_N1	1.217	0.273	0.016
	Cz_N2	4.270	0.042*	0.053
Blur x Anxiety	Fz_N1	0.626	0.431	0.008
	Fz_N2	0.877	0.352	0.011
	Fz_P2	0.028	0.869	0
	Cz_N1	0.072	0.789	0.001
	Cz_N2	0.419	0.519	0.005
Scary x Anxiety	Fz_N1	0.170	0.681	0.002
	Fz_N2	0.893	0.347	0.011
	Fz_P2	0.582	0.448	0.008

	Cz_N1	1.543	0.218	0.020
	Cz_N2	5.169	0.026*	0.063
Blur x Scary x Anxiety	Fz_N1	0.228	0.634	0.003
	Fz_N2	0.008	0.929	0.000
	Fz_P2	1.567	0.214	0.020
	Cz_N1	0.354	0.554	0.005
	Cz_N2	0.935	0.337	0.012
Blur x Gender x Anxiety	Fz_N1	0.719	0.399	0.009
	Fz_N2	0.005	0.945	0
	Fz_P2	0.783	0.379	0.010
	Cz_N1	0.002	0.961	0.000
	Cz_N2	0.931	0.338	0.012
Scary x Gender x Anxiety	Fz_N1	0.072	0.789	0.001
	Fz_N2	2.040	0.157	0.026
	Fz_P2	0.008	0.930	0
	Cz_N1	0.485	0.488	0.006
	Cz_N2	1.775	0.187	0.023
Blur x Scary x Gender x Anxiety	Fz_N1	1.184	0.280	0.015
	Fz_N2	0.488	0.487	0.006
	Fz_P2	0.029	0.865	0.000
	Cz_N1	0.578	0.450	0.007
	Cz_N2	0.184	0.669	0.002
Gender x Anxiety	Fz_N1	0.740	0.392	0.010
	Fz_N2	0.008	0.928	0.000
	Fz_P2	0.553	0.459	0.007
	Cz_N1	0.040	0.843	0.001
	Cz_N2	1.834	0.180	0.023

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ACADEMIC VITA

Education

The Pennsylvania State University | Schreyer Honors College — **University Park, PA**
Eberly College of Science | Bachelor of Science in Biology — *Anticipated Graduation: Dec. 2021*
Eberly College of Science | Minor in Neuroscience
College of Liberal Arts | Minor in Psychology

York College of Pennsylvania — **York, PA**
Dual enrollment program for high school students — *Sep 2016 – May 2018*

Relevant Professional Experience

Child Attention & Learning Research Lab — **University Park, PA**
Undergraduate Research Assistant — *Feb 2020 – Present*
• Administer a series of dynamic IQ tests to child participants over a 3-4 hour session
• Communicate with parents and guardians to obtain consent for child to participate in IQ and EEG testing
• Use EEG equipment to administer EEG tests to participants and export the results using BVA software
• Maintain a working knowledge of the experimental methods involved in the Event-Related Potential technique utilized in EEG research

The Selleck Laboratory — **University Park, PA**
Undergraduate Research Assistant — *Jan 2021 – May 2021*
• Maintain up to 9 cell cultures of HEK and A375 cell types for a span of 5 months
• Develop a working knowledge of confocal microscopy and use 5+ softwares to edit and evaluate results
• Develop and execute mitochondrial morphology experiments that involved staining and microscopy

York College of Pennsylvania Neuropsychology Lab — **York, PA**
Lab Assistant and Research Intern — *May 2018 – Aug 2018*
• Research, read, and report on relevant scholarly articles relating to neuroscience experimentation
• Adhere to a strict care schedule for 30 rats while maintaining controls essential to the integrity of the research

Other Professional and Leadership Experience

The Student Red Cross Club — **University Park, PA**
Biomedical Director — *Jan 2019 – Dec 2020*
• Aide in planning on-campus blood drives that occur more than twice weekly by recruiting sponsors
• Organize and fill volunteer shifts in advance and train hourly volunteers on-site
• Maintain a positive atmosphere at each drive through personable interaction with 20+ donors
On-Site Coordinator Captain — *Sep 2018 – Jan 2019*
• Maintain a dynamic list of 100+ On-Site Coordinators to staff blood drives

Fliplearning — **State College, PA**
Interpersonal Relations and Technical Support — *Apr 2019 – Dec 2019*
• Receive, investigate, and resolve technical support issues from 3,000+ student users
• Communicate with 200+ professors in order to obtain classroom preferences and feedback
• Research and maintain a dynamic list of 150+ potential authors for future textbooks

Honors and Awards

• **Honors:** Dean's List: Semesters 1, 2, 3, 4, 5, & 6; President's Freshmen Award
• **Scholarships Received:** Sprenkle Family Scholarship, Edwin P. Mangold of the Rotary Club of York Scholarship, Dallastown/Red Lion Rotary Club Scholarship, Red Lion Mason Lodge Scholarship, Red Lion Elk's Lodge Scholarship, Joseph Middleton and Eleanor Bouse Memorial Scholarship, Red Lion Area Education Foundation Scholarship