Facing Fears when Fearing Faces: Binocular Rivalry Perceptual Alternation and Approach-Avoidance in College-Aged Women with Autistic Traits and a History of Adverse Experiences

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FACING FEARS WHEN FEARING FACES: BINOCULAR RIVALRY PERCEPTUAL ALTERNATION AND APPROACH-AVOIDANCE IN COLLEGE-AGED WOMEN WITH AUTISTIC TRAITS AND A HISTORY OF ADVERSE EXPERIENCES

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Submitted to Brigham Young University in partial fulfillment of graduation requirements for University Honors

Neuroscience Center
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ABSTRACT

FACING FEARS WHEN FEARING FACES: BINOCULAR RIVALRY PERCEPTUAL ALTERNATION AND APPROACH-AVOIDANCE IN COLLEGE-AGED WOMEN WITH AUTISTIC TRAITS AND A HISTORY OF ADVERSE EXPERIENCES

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Women with Autism Spectrum Conditions (ASCs) may be more likely to experience symptoms of trauma exposure due to greater likelihood of facing adverse childhood experiences (ACEs). In order to gain a better understanding of the neural mechanisms involved with ASC and PTSD in women who experience difficulty with social interactions, I examined the ability of two vision tasks-- Binocular Rivalry Perceptual Alternation (BR) and Visual Approach/Avoidance by the Self Task (VAAST)-- to predict symptoms of both conditions as well as differentiate between them. I also examined differences in response to neutral or emotional (angry or fearful) faces under both paradigms. I found that the neutral BR condition as well as VAAST error count were predictive of ASC and PTSD symptomology as measured by the Ritvo Autism Asperger Diagnostic Scale Revised (RAADS-R) and the PTSD Checklist for DSM 5 (PCL-5). Neutral BR switch rates were also significantly predictive of Autism Quotient (AQ) and Social Anxiety Questionnaire (SAQ) scores, but not of general anxiety as measured by
the Harm Avoidance segment of the Temperament and Character Inventory (TCI).
Emotional BR switch rates were only predictive of RAADS-R scores. In addition to
highlighting a biological difference that may be measurable in early- and late-stage visual
processes, these results may suggest a common, underlying mechanism behind social
difficulties in both ASCs and PTSD.
ACKNOWLEDGEMENTS

This project is dedicated to S., S., D., and R., the elementary school students that inspired me to ask this question in the first place.

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You have all empowered me to “face my fears” and

I’m forever thankful that my reality has your faces in it.
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Facing Fears when Fearing Faces: Binocular Rivalry Perceptual Alternation and Approach-Avoidance in College-Aged Women with Autistic Traits and a History of Adverse Experiences

Given that twice as many females meet diagnostic criteria for Post-Traumatic Stress Disorder (PTSD) as compared to males (Yehuda et al., 2015; McLean & Anderson, 2009), many studies have explored PTSD in women specifically. On the other hand, with four times as many males meeting diagnostic criteria for Autism Spectrum Condition (ASC) as compared to females (Halladay et al., 2015; Kreiser & White, 2014), women are only recently being equally represented in ASC research. Additionally, few projects have examined the overlap between the two conditions, even though, in the words of a viral Twitter post by advocate NeuroDivergent Rebel, “...trauma and [A]utism are so hard to distinguish [from one another] because society doesn’t make untraumatized autistics.”

More specific estimates suggest that the annual prevalence of ASC in women in the United States is 0.86% (Dietz et al., 2020). PTSD, on the other hand, is more prevalent with 10-12% of women qualifying for diagnosis during at least one period of their life (Olf, 2017). Although there has not yet been an epidemiological study on autistic1 women with PTSD, it has been suggested that adverse childhood experiences (ACEs) may increase one’s likelihood of developing PTSD, either during childhood or later on in life, regardless of whether additional trauma exposure occurs later on in

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1 I use this term interchangeably with the American Psychological Association’s (APA) preferred person-first language in respect of self-advocates who have visited our lab who prefer the label “autistic” over “individual with autism spectrum disorder (or condition)”, though individual preferences vary.
development (Ogle et al., 2013). Unfortunately, since adults may not have appropriate skills for working with children with autism and/or autistic children might be easily taken advantage of in social situations they do not understand, children with autism are also more likely to endure ACEs than neurotypical controls (Hoover & Kaufman, 2018; Rigles, 2017).

Due to differences in language processing, sensory sensitivity, and emotional regulation, as well as increased social isolation, women with autistic traits and high ACE scores may not only be more likely to experience PTSD symptoms than individuals with low ACE scores or low autistic traits, but they may also experience PTSD symptoms in ways which are unique or amplified (Brenner et al., 2018). This would be in line with Haruvi-Lamdan et al.’s (2020) observation that women with ACEs are more likely to suffer from re-experiencing and hyperarousal symptoms of PTSD than autistic males or neurotypical controls and are also three times as likely to identify a social-related event as their most distressing trauma.

While one may assume that these heightened and/or unique symptom presentations might make it easier to recognize women who could benefit from trauma-informed treatment, it is possible that ASC-specific variances in PTSD presentation may also make it more difficult for clinicians to recognize autistic women who are also struggling with PTSD symptoms. This may be especially true if these symptoms manifest in ways which are different from current DSM criteria, for instance via increased repetitive behaviors already characteristic of ASC (Allely & Faccini, 2019). This diagnostic overshadowing may also work the other direction, in which individuals with trauma histories are not recognized as also being autistic because clinicians attribute
symptoms to PTSD alone (Becker-Haimes et al., 2021), with the effect being potentially even more relevant to autistic women than men since they are already an underrecognized ASC group (Halladay et al., 2015; Whitlock et al., 2020).

Research on PTSD and ASC comorbidity is difficult given that individuals with ASC may be less likely to report abuse or symptoms of trauma than neurotypical individuals (Brenner et al., 2018; Mazefsky et al., 2011). This is further complicated by significant symptom overlap between the two conditions. In particular, difficulties with social-emotional reciprocity (a symptom of ASC) and avoidance of social interactions (a symptom of PTSD) may both manifest as lack of interest in peers (Stravopoulos et al., 2018). Similarly, differences in social communication seen in ASC and the reduced positive emotional affect seen in PTSD might both be recognized as clinical failure to mirror emotions (Stravopoulos et al., 2018) while the sensory sensitivities seen in ASC may also be confused for PTSD’s hypervigilance (Acevedo et al., 2018).

Despite their potentially far-ranging effects, studies on these commonalities are limited, in part because some researchers also theorize that individuals with ASC may be less likely to experience the negative effects of adverse experiences due to ASC-related differences in social awareness and internal processing which may prevent autistics from recognizing traumatic events as traumatic (Brenner et al., 2018; King, 2010). This, unfortunately, may be leaving many autistics (and autistic women in particular who statistically may be at higher risk for PTSD) without access to much needed interventions, especially when considering that the experience of having autism in a neurotypical world can be traumatic in and of itself due to increased rates of bullying.
(Maiano et al., 2016) and lack of accommodation for or even recognition of painful sensory sensitivities (Fulton et al., 2020).

Increasing understanding of neural and behavioral differences between ASC, PTSD, and instances of comorbidity may assist in clarifying whether women with ASC do experience PTSD at higher rates than or at levels which are more severe than those experienced by women without ASC. If so, this may also inform development of more sensitive and specific diagnostic criteria for PTSD in autistic cohorts, which could improve identification of individuals who may benefit from trauma-focused interventions in addition to traditional ASC treatment protocols. This is important as treatment for PTSD has been shown to reduce the severity of autistic traits in individuals who have experienced adverse events, sometimes even more so than traditional ASC treatment protocols (Carrigan & Allez, 2016; Kliman, 2016; Lobregt-van Buuren et al., 2019).

Early identification of PTSD in individuals with ASC is also vital as comorbid cases are associated with higher rates of suicidal thoughts and behaviors (Storch et al., 2013).

**Binocular Rivalry**

In this study, I investigated whether two short visual processing tasks might illuminate differences in cognition associated with ASC, PTSD, and cases of comorbidity. The most widely studied of the two tasks utilizes binocular rivalry perceptual alternation. This visual phenomenon occurs when a different image is presented to each eye. As the brain works to resolve the incongruent stimuli, an individual will typically perceive rhythmic switching between the left eye’s image, the right eye’s image, and a combination of both. Researchers theorize that these oscillations result from variance in inhibition and excitation throughout the attention and visual
systems (Robertson et al., 2013) and are modulated by GABA levels in the visual cortex (Robertson et al., 2016). As many studies indicate that modulation of inhibitory and excitatory processes may be a key component of neural differences observed in ASC (Robertson et al., 2013; Rubenstein & Merzenich, 2003) as well as stress responses associated with PTSD (Clausen et al., 2017; Jovanovic & Ressler, 2010), it is possible that binocular rivalry may reflect these distinctions in an easily measurable way.

A growing body of research demonstrates that adults with ASC experience rivalry oscillations in a way that is unique from controls. Specifically, a 2013 study found that when presented with rivalrous images of objects, individuals with ASC demonstrated longer periods of time between switches as well as increased longevity of mixed percepts, both of which correlated with symptom severity assessed via the second Autism Diagnostic Observation Schedule (ADOS; Robertson et al. 2013). These findings were later replicated using EEG, with performance on a rivalry task predicting ASC-diagnostic status with 87% sensitivity (Spiegel et al., 2019).

This project attempted to replicate these findings in order to assess whether the same correlation is present in women diagnosed with ASC and in women who are experiencing similar difficulties with social interaction. Additionally, since to date no studies have explored BR dynamics in relation to PTSD specifically (though a wide body of research has demonstrated BR differences in similar conditions such as anxiety and depression see Ting et al., 2020), this project also served as a preliminary investigation of potential trauma-related differences in women’s BR performance.

Given that trauma exposure and potentially subsequent PTSD symptoms can influence social behavior in ways similar to the difficulties frequently observed in ASC
(Stavropoulos et al., 2018), differences in processing emotionally salient information may be especially important subsets of both conditions’ symptomologies to explore. Thus, in addition to replicating a previous rivalry study’s paradigm with images of colored gratings (Freyberg et al., 2015), this project will also incorporate two additional stimulus conditions: one in which an image of a house will alternate with a neutral face, and one in which an image of a house will alternate with an emotional (angry) face.

Interestingly, decreased responses to facial expressions are associated with lower GABA levels, mediation of which has been shown to improve social and emotional behaviors in some individuals with ASC (Hadjikhani, 2015). Since BR is hypothesized to be a potential biomarker for GABA (Mentch et al., 2019; Robertson et al., 2016), it is possible that performance on the BR task might not only predict ASC- or PTSD-associated traits, but might also inform individuals’ responses to emotionally salient images in non-rivalrous settings and vice versa. BR is also of particular interest since the task does not require verbal reporting, which can be difficult for individuals with language-processing difficulties observed in severe ASC (Robertson et al., 2021). BR may also represent subconscious reactions to stimuli (Lin & He, 2008) which could be less affected by the ASC symptom-masking that is common in autistic women and may impede accurate and/or timely diagnosis (Beck et al., 2020).

Since previous studies suggest that individuals with ASC experience slower BR switching than controls (Freyberg et al., 2015; Robertson et al., 2013; Spiegel et al., 2019) as well as indicate that individuals with ASC may spend less time observing faces, and in particular eye regions, than neurotypical controls (Klin et al., 2002; Tang et al., 2017; Yi et al., 2013), I predicted that participants with more autistic traits would
experience slower perceptual alternations, with the effect being especially pronounced for conditions where faces, rather than shapes only, were presented. I also predicted that the effect would be especially pronounced for the emotional face condition since previous studies have shown that individuals with ASC spend even less time fixating on emotionally salient features as opposed to the already reduced time (as compared to TD controls) spent observing neutral ones (Bochet et al., 2020). Conversely, since individuals with higher levels of anxiety have been shown to have faster BR switch rates (Nagamine et al., 2007) as well as enhanced threat preference (Singer et al., 2012), I expected that the high states of arousal that are characteristic of PTSD would yield similarly higher switch rates in those with higher ACE scores but without ASC.

**VAAST**

In order to further investigate participant response to facial expressions, I also administered the Visual Approach/Avoidance by the Self Task (VAAST). As opposed to BR’s focus on more implicit responses, the VAAST has been shown to reliably represent approach-avoidance behaviors as measured by a conscious indicator (key press; Rougier et al., 2018). In this paradigm, participants were presented with an image of a face depicting an angry or fearful expression. Images were selected from the Karolinska Directed emotional Faces set (KDEF), which is a prevalent archive of standardized expression images (Goeleven et al., 2008). Using a computer keyboard, participants then indicated whether they would classify each face as a safe one to approach, or an unsafe one to avoid. Following their key press, the image would come closer (approach) or move further back (avoid), before the background reset to the baseline depth in preparation for the next stimulus.
Previous studies have suggested that individuals with ASC and PTSD respond to images depicting emotion in ways which are unique from each other as well as are unique from neurotypical controls. Specifically, an EEG study found that younger boys with ASC exhibited reduced responses to images depicting fear or anger when compared to controls or to within-group presentation of images associated with happiness or sadness (Van der Donck et al., 2020). A similar study in which participants identified whether facial expressions were congruent or incongruent with an image’s body language found that while participants with ASC viewed images for less time than controls overall, as suggested by even shorter viewing times, those with ASC were especially avoidant of images depicting fear (Malaia et al., 2019). Interestingly, they were also less accurate than controls at differentiating them from those associated with anger (Malaia et al., 2019). This is similar to Prehn-Kristensen et al.’s observation that individuals with ASC are more likely than controls to rate fear primes as being happy than to correctly identify them as being fearful (2018).

In contrast, individuals who experienced childhood trauma have been shown to exhibit heightened attention to threat-related stimuli (Lakshman, 2020). This may correspond to easier recognition of fearful or angry faces, which is in line with Ashley and Swick’s (2019) observation that individuals with PTSD were faster than controls at identifying angry expressions in congruent arrays. However, an eye tracking study on women with PTSD specifically found that greater delays in initiating fixation on angry faces corresponded to greater avoidance symptoms, as did longer overall dwell times (Powers et al., 2019).
Based on these findings, I predicted that individuals with ASC would be slower and less accurate at classifying faces as safe ones to approach and unsafe ones to avoid, particularly when the images presented denote fear or anger. This would be in contrast with neurotypical participants in a previous experiment, who reliably indicated that they would avoid angry stimuli and approach fearful ones (Marsh et al., 2005). I also predicted that the college-aged women with trauma exposure but without ASC would perform similarly to the women in Powers et al.’s (2019) paradigm. Namely, like those with more autistic traits, they may have longer reaction times towards angry faces than controls, but unlike the ASC group, I predicted they would be more accurate than controls at distinguishing between fearful and angry expressions.

Methods

Participants

Thirty-seven women who were at least 18 years old and who had finished at least 10th grade were recruited from the Utah County area via flyers on Brigham Young University (BYU) and Utah Valley University (UVU) campuses as well as digital versions distributed via department email newsletters. Flyers were also placed with services relevant to ASC, including local treatment clinics, BYU’s Counseling and Psychological Services center, and LGBTQ+ (De Vries et al., 2010) and PTSD support groups. Nine women with high levels of autistic traits and one neurotypical woman were also recruited from contact lists generated from previous BYU projects if they had agreed to further contact.

While all participants self-identified as having difficulty with social interactions, participants were divided into two groups based on Autism Spectrum Quotient (AQ)
scores collected during screening and/or self-report of ASC diagnosis. Rather than the highest clinical threshold of 34, Woodbury-Smith et al’s (2005) suggested cut-off score of 26 was chosen for this project since women with ASC typically show lower AQ scores than men (Baron-Cohen et al., 2001). Five participants self-reported a clinician verified diagnosis of autism. In total, 20 participants had an autism diagnosis and/or AQ score over 26, and 17 participants had an AQ score of less than 26. One participant also had a sub-threshold AQ score of 20 but reported an autism diagnosis and so was included in the high-AQ group. Six participants (4 with high-AQ score/autism diagnosis and 2 with low-AQ score/no autism diagnosis) also self-reported a diagnosis of PTSD.

After each participant in the high-AQ group was identified, they were matched with a low-AQ participant who had a similar (±1) ACE score. One participant was excluded from the final analysis due to disclosure of current gabapentin usage which may impact BR switch rates (Mentch et al., 2019). An additional six participants completed all psychometrics and either the VAAST or BR task, but not both tasks, with one also completing only AQ, ACE, and PCL-5 as psychometrics. Among all participants included in analysis, one subject was currently taking a prescription stimulant medication and 8 participants (5 high-AQ and 3 low-AQ) consumed between four and 20 oz of caffeine within 24 hours of one or both BR sessions.

In sum, 37 participants ($M = 22.3$ years, $SD = 5.4$, Range = 18-44) were included in the final analysis, with 31 completing all tasks, 33 having completed the BR task, and 33 having completed the VAAST. Although this sample size is small, it is representative of that used in prior BR projects in autistic cohorts (see Karaminis et al., 2019; Robertson et al., 2013; Spiegel et al., 2019).
Participants were compensated with a $35 in Amazon gift card or 15 SONA credits (used by some instructors for assignment credit) for completing all three phases or a $15 gift card or 10 SONA credits for completing the online portions only. Those who did not continue beyond the initial screening received $5 or 2 SONA credits.

Measures

Six measures were surveys administered online via Qualtrics (Qualtrics.com):

1. Adverse Childhood Experiences (ACEs) were quantified via the California Surgeon General’s Clinical Advisory Committee’s version of the Center for Disease Control and Prevention’s 10-question self-report form (California, 2020).

2. Autism Spectrum Quotient (AQ). This 50-question survey is frequently used to broadly assess ASC-associated traits in clinical as well as neurotypical cohorts and served as our marker for likelihood of ASC (Simon Baron-Cohen et al., 2001).

3. Ritvo Autism Asperger Diagnostic Scale-Revised (RAADS-R). This survey provided additional insight into how traits identified in the AQ might influence social interaction and facial expression identification. It also measured lifetime traits as opposed to the AQ’s focus on present experience. It has high sensitivity (97%) when using a cut-off score of 65 (Ritvo et al., 2010).

4. PTSD Checklist for DSM-5 (PCL-5). This 20-question scale (Weathers et al., 2013) is used as part of the formal PTSD diagnostic processes and quantifies the severity of symptoms that an individual currently experiences. When considered together, the ACE and PCL-5 can help differentiate those who experienced
trauma but no PTSD symptoms (or who have since recovered) from those who were exhibiting clinical signs of traumatic stress at the time of testing.

5. Harm Avoidance segment of the Temperament and Character Inventory (TCI). These fifty items assessed comorbidity of anxious traits such as pessimistic worry, passive avoidance, and shyness, which may confound ASC and PTSD diagnosis and/or affect BR switch rates (Cloninger et al., 1993).

6. Social Anxiety Questionnaire (SAQ). This 10-question survey (Laukta, 2018) has been shown to reliably identify those at risk for Social Anxiety disorder, which may affect recognition of facial expressions even more than more general anxiety as measured by the TCI. Along with the TCI, this helped ensure any differences in performance which were observed between the ASC and trauma-exposed participants were specific to those conditions rather than representative of symptom overlap between ASC and trauma-independent anxiety.

Equipment

**VAAST**

Version 1.01 of the VAAST was administered remotely through PsyToolkit software (Stoet, 2010, 2017). Images of angry and fearful faces were selected from KDEF’s respective groupings of Caucasian male and female faces. Furthermore, since the VAAST only uses 25 images in each category and the KDEF supplies 35, in addition to KDEF’s own emotion classifications, I conducted a pilot study of nine women who indicated whether they felt each face best represented fear, happiness, anger, or some

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2 This database was selected due to its open access and wide usage. While our participants presented as white and therefore using images of white individuals seemed appropriate to reduce potential race effects, it is worth noting that this is a limitation of the project and the database at large.
other emotion. The top 25 images with the greatest levels of agreement were selected for each emotion category.

Three sizes of the same image were used: 350x263ppi served as the baseline for initial presentation, and then the image expanded to 420x315ppi if a participant decided to “approach” the face as indicated by pressing the letter “y” on their keyboard or decreased to 280x210ppi if a participant decided to “avoid” the face as indicated by pressing the letter “n” (Figure 1).

*Figure 1.* Sample image sets in VAAST task during congruent block. (A: fixation, B: baseline, C: approach, D: baseline, E: avoid)
**Binocular Rivalry**

Each participant viewed three sets of images designed to induce binocular rivalry effects. The first image included a red, striped circle which was presented to the left eye, and a blue, striped circle which was presented to the right eye. In an effort to encourage fixation, the stripes in the center of the circles were programmed to spin synchronously (Parker & Alais, 2007).

In order to observe the effects of emotional salience on rivalry dynamics, I also presented to participants faces with emotional expressions sampled from Paul Ekman’s Photos of Facial Affect (Ekman, 1975). Participants viewed an image of a blue face with an angry facial expression with their left eye, paired with an image of a red house presented to their right eye. This was compared with another image set that combined a blue image of the same face but with a neutral facial expression, which was presented to the left eye, and an image of the same red house, which was presented to the right eye. Each of the images included a fixation point and a textured background or nonius lines in order to maintain stable vergence (Carmel et al., 2010). The images of the faces were also positioned so that the central fixation point was below the image’s eyes, so as to reduce the potentially confounding effects of eye-avoidance that is sometimes seen in ASCs (Tanaka & Sung, 2016; see Figure 2).
Participants used a BR LabView program on a desktop computer along with the arrow keys on a keyboard (pressed with their dominant hand) to record when their perception changed from seeing one image as dominant to the other. A 7140-79 LEEDS Luxury Virtual Reality Headset holding a smartphone was used to present the aforementioned image sets.

**Design**

**VAAST**

PsyToolkit’s algorithm randomly assigned each participant to experience a fearful or an angry image first. I selected these emotions based on prior studies which showed they can be especially confusing for individuals experiencing distress during social interactions (Ashley & Swick, 2019; Mogg & Bradley, 2002) The order of each face’s presentation was also randomized between each of the 40 trials in each instruction condition (congruent: fearful = approach, anger = avoid; incongruent: fearful = avoid,
anger = approach). The VAAST incorporates both congruence conditions in order to verify that any differences are not merely a reversed preference for angry over fearful faces. Since to date no VAAST results have been published for facial expression images, congruency was assigned based on Marsh et al.’s (2005) similar joystick task. Every participant began with 40 trials of the congruent instruction block and ended with 40 trials of the incongruent block.

**Binocular Rivalry**

All participants completed six, 30-second trials for each image set during two different sessions, for a total of 18-trials per session, or 36 trials in all. All participants had at least 35 successful trials (one trial each from two participants (two trials total) were eliminated from analysis due to data loss).

All subjects viewed the baseline spinning circle image-set first, and the order of presentation of neutral or emotional image sets was evenly split according to participant number. Half of the participants saw the neutral set first (odd participant number), and half saw the emotional block first (even participant number). Order for each participant was maintained across both 18-trail sessions.

**Procedure**

**Phase I**

Participants began the study by reviewing the consent form for all three phases, providing their birthdate, diagnostic information, and consent for further contact, and then completing the ACE survey and AQ remotely via Qualtrics.

**Phase II**
Based on the ACE and AQ scores collected in phase I, individuals in the elevated-likelihood for ASC group and their matching controls were invited to participate in the second online phase. Therein, after reiterating consent, participants completed the RAADS-R, PCL-5, TCI, and SAQ remotely on Qualtrics. Following completion of the online surveys, participants were instructed to take at least a 10-minute break, but were also reminded they could take longer, even returning to the online vision task a different day. After they finished the break, which was intended to mitigate eye strain and cognitive fatigue, subjects accessed the VAAST task on their own computers (with the exception of one participant who did not have access to a PC and used one in our lab room).

During the VAAST task, instructions and a demonstration were presented through a series of brief training slides. Participants were told that, similar to a video game, they would experience an environment in which they could move forward or backwards. Then, they viewed a preview of the image background and read a chart denoting which keys would trigger which responses, with the “h” key being assigned the role of “start,” “y” (short for yes) being used to signal approach, and “n” (short for no) being used to avoid, or move backwards.

At the start of each trial, participants saw a circle, which indicated the need to press the “h” key to start the trial. Once the trial began, a fixation cross appeared in the center of the screen, which participants focused on until the image of the face appeared. Participants were told that their job was to move forward or backward as fast as possible by pressing the applicable keyboard key with their dominant index finger. During the first block (congruent), they were instructed to approach fearful faces and avoid angry ones,
and during the second block (incongruent) the reverse criteria were given in like form. Participants were allowed 5 practice trials for each congruency block before the 20 test trials for each segment began.

**Phase III**

After completing all of the online measures, participants scheduled two appointments to participate in the BR task on BYU campus. Appointments took place between 10 minutes and 6 weeks apart, depending on subject preference.

Following a review of goggle risks and reiteration of consent, participants were informed that fitting the goggles properly would improve their comfort as well as the quality of the data. Once subjects confirmed understanding that a proper fit would yield a clear, singular center point, participants held the goggles to their face and described the central fixation point (small white circle or black square) to the researcher. If the shape was blurry or double, the image width was adjusted manually. If it was clear but slightly overlapping, participants fine-tuned the adjustment by using the sliders on the top of the goggles.

Once correct goggle settings were established, participants fastened the goggles to their foreheads using three elastic straps and the researcher reviewed the procedure for keyboard reporting. Participants were shown one of the three image sets for six thirty-second intervals. During each interval, participants were instructed to self-report perceptual switches between the image presented to the left eye, the image presented to the right eye, or a mixed percept using arrow keys on a keyboard. More specifically, they would tap the left arrow key each time they saw 80% or more red, the right arrow key each time they saw 80% or more blue, and the up-arrow key each time they saw both
colors but could not discern which was more dominant, or in other words, perceived a 50/50 split. After the thirty seconds were finished, subjects were told to close their eyes and rest for fifteen seconds, after which the researcher would prompt them to open their eyes again and continue the next 30-second reporting period.

In order to ensure accuracy of keyboard reporting as well as to account for changes in focus upon ocular relaxation, participants were given two practice rounds before the first image set (spin) and one practice round before each subsequent set (emotional or neutral). Between each of these practice runs, the researcher vocally confirmed that the image remained clear and comfortable to look at.

After the six trials for the first set were complete, participants were instructed to remove the goggles and the fitting procedure was repeated for the next image set. If participants completed both the first and second BR appointments in one day, they were required to rest for at least ten minutes between segments one and two, during which time they were encouraged to relax their eyes by looking at distant scenes.

Following administration of the BR task, risk of suicidality was assessed using the Columbia-Suicide Severity Rating Scale-Revised (C-SSRS) interview questions. This screening is designed to identify individuals who are at high risk for acting on suicidal thoughts or feelings. I did not analyze these scores, but instead included this measure out of an abundance of caution in order to ensure participants were not sent home in distress (due to preexisting stressors outside of the study) given the higher suicide rates previously observed in our target population (Hirvikoski, 2020) as well as the extra stress of isolation due to COVID-19. If participants indicated immediate risk for suicidality, I ensured their safety by having them speak with a therapist.
Analysis

In order to calculate BR switch rates, I counted the number of times participants indicated a shift between left-dominant or right-dominant perceptions and divided this count by the 30 seconds in which keypresses were collected during each trial in order to find the number of switches per second. After verifying test-retest reliability with Pearson correlation coefficients (see Appendix A), switch rates for each condition (spin, neutral, and emotional) from each of the two repeated sessions were averaged before analysis. Similarly, due to our small sample size, VAAST reaction times and error rates were averaged between all trials for each participant before analysis, rather than separated by congruency or valence. The rest of the tasks were scored according to the keys included with the measure.

While I had originally hoped to recruit 30 women from each high- and low-AQ/ASC diagnosis category, the sample size was smaller than anticipated and there was not sufficient power for our planned between-group analyses with four divisions. With this in mind, prior to analyzing the data I reworded our hypotheses to be conducive to between two-group or within-group designs. It is also of note that while three participants in the high-AQ group had ACE scores over 7, I was unable to recruit any low-AQ subjects with ACE scores over 4, so comparisons between high-trauma high-AQ and high-trauma low-AQ groups were also not possible with this dataset.

Instead, to measure whether the difference between neutral stimuli and emotional stimuli during the BR face/house conditions was larger for the high-AQ group than for the low-AQ group, or in other words, whether there was an ASC-related difference in BR switch rates across face conditions, I subtracted the average neutral switch rate from the
average emotional switch rate the create a difference score and then conducted an independent samples t-test with that difference score as the outcome and AQ/ASC-group as the grouping variable.

Then, in order to evaluate whether the vision tasks corresponded to AQ scores in both groups combined, I conducted a regression with AQ as the outcome and BR switch rates for the spin, neutral, and emotional conditions as well as VAAST error and reaction time as predictors. Next, in order to determine if ASC group membership predicted TCI along with BR and VAAST scores, I looked at whether those same factors would predict TCI score. Finally, in order to evaluate whether ACEs were related to any group differences in performance, I also repeated the same regression but with ACE as the outcome. The p-values were corrected for multiple comparisons using the Holm-Bonferroni method. See Appendix B for SPSS script.

**Results**

**Descriptives**

ACE was the only variable with significant skew, and its residuals were normally distributed so I took no further action. Among all participants, the average ACE score was 1.9 with responses ranging from 0-9. The AQ also indicated a wide spread of autistic trait levels, with scores averaging at 25.9 but ranging from 7-46. This was similarly reflected by RAADS-R (Table 1). Between groups, there was a 17-point mean difference ($SD = \pm 10.3$) in average AQ score as well as an 80-point difference ($SD = \pm 52.9$) in average RAADS-R scores, suggesting appropriate likelihood-group assignments.
As a whole, participants experienced greater anxiety and PTSD symptoms than would be expected from the general population, which is in line with the social difficulties they reported during recruitment and screening (Table 1).

Table 1

**Psychometric Scores**

<table>
<thead>
<tr>
<th></th>
<th>ACE</th>
<th>AQ</th>
<th>RAADS-R</th>
<th>PCL-S</th>
<th>SAQ</th>
<th>TCI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-Likelihood</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>2.5</td>
<td>33.8</td>
<td>124.8</td>
<td>35.21</td>
<td>34.05</td>
<td>81</td>
</tr>
<tr>
<td>SD</td>
<td>2.8</td>
<td>5.85</td>
<td>36.08</td>
<td>26.6</td>
<td>6.88</td>
<td>10.59</td>
</tr>
<tr>
<td><strong>Low-Likelihood</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>1.24</td>
<td>16.53</td>
<td>44.47</td>
<td>20.82</td>
<td>24.82</td>
<td>57.82</td>
</tr>
<tr>
<td>SD</td>
<td>1.09</td>
<td>4.94</td>
<td>32.47</td>
<td>19.44</td>
<td>8.03</td>
<td>13.66</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>1.92</td>
<td>25.86</td>
<td>87.89</td>
<td>28.42</td>
<td>29.69</td>
<td>70.06</td>
</tr>
<tr>
<td>SD</td>
<td>2.25</td>
<td>10.25</td>
<td>52.94</td>
<td>24.28</td>
<td>8.69</td>
<td>16.75</td>
</tr>
<tr>
<td>R</td>
<td>0.9</td>
<td>7.46</td>
<td>7.178</td>
<td>0.87</td>
<td>13.44</td>
<td>44.90</td>
</tr>
</tbody>
</table>

*Note.* High-likelihood *N* = 19-20, low-likelihood *N* = 17

Among the entire sample, the average VAAST error was 6.5. Average reaction time was also just over 1.1 seconds per trial, which may suggest that participants paid consistent attention to the task even though it was administered remotely. (Table 2)

Table 2

**VAAST Performance and BR Switch Rates**

<table>
<thead>
<tr>
<th></th>
<th>VAAST Error</th>
<th>VAAST RT</th>
<th>Spin</th>
<th>Neutral</th>
<th>Emotional</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-Likelihood</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>7.88</td>
<td>1183.93</td>
<td>0.33</td>
<td>0.23</td>
<td>0.21</td>
</tr>
<tr>
<td>SD</td>
<td>6.42</td>
<td>349.19</td>
<td>0.13</td>
<td>0.13</td>
<td>0.14</td>
</tr>
<tr>
<td><strong>Low-Likelihood</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>5.06</td>
<td>1094.92</td>
<td>0.27</td>
<td>0.16</td>
<td>0.14</td>
</tr>
<tr>
<td>SD</td>
<td>3.4</td>
<td>339.83</td>
<td>0.1</td>
<td>0.11</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>6.47</td>
<td>1139.42</td>
<td>0.31</td>
<td>0.20</td>
<td>0.18</td>
</tr>
<tr>
<td>SD</td>
<td>5.26</td>
<td>342.27</td>
<td>0.12</td>
<td>0.13</td>
<td>0.13</td>
</tr>
</tbody>
</table>

*Note.* High-likelihood *N* = 17-20, low-likelihood *N* = 14-17
Main Analysis

First, I completed a t-test to determine if our groups showed difference patterns of responses to neutral and emotional stimuli in the BR task. Although the high-AQ group (neutral $M = 0.23$ switches/second, $SD = 0.13$; emotional $M = 0.21$, $SD = 0.14$) exhibited slightly more frequent perceptual switching during the facial BR tasks than the low-AQ group (neutral $M = 0.16$, $SD = 0.11$; emotional $M = 0.14$, $SD = 0.09$; Figure 3), there was no significant effect for group in neutral/emotional difference scores $t(34) = 0.072$, $p = 0.445$, suggesting that both groups responded proportionally to one another when emotional valence changed during BR.

Figure 3

Average Neutral and Emotional Switch Rates Across ASC-Likelihood Groups

In addition to the above, I ran three planned regressions. I hypothesized that BR switch rates for spin, neutral, and emotional stimulus conditions, VAAST reaction time, VAAST error, and group membership would predict AQ, TCI, and ACE scores, respectively. The model predicting AQ scores was significant after using the Holm-Bonferroni Sequential Correction to correct for multiple comparisons ($R^2 = .79$, $p < .001$), with neutral BR switch rate ($B = 38.79$, $p = .037$) as a significant predictor (Figure 4) and VAAST error ($B = .402$, $p = .073$) nearing significance (Table 3). Unsurprisingly, AQ score was also predicted by ASC-likelihood group status ($B = 14.86$, $p < .001$).
Conversely, BR switch rates for spin and emotional conditions as well as VAAST response time were not significant predictors.

**Figure 4**

*Average Switch Rates vs. AQ Score*

![Graph showing average switch rates vs. AQ score](image)

**Note.** Only neutral switch rates significantly predict AQ score.

**Table 3**

*Regression Analysis Summary for BR and VAAST Predicting AQ*

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Spin</td>
<td>-1.838</td>
<td>-0.023</td>
<td>-0.161</td>
<td>0.874</td>
</tr>
<tr>
<td>Average Neutral</td>
<td>38.792</td>
<td>0.484</td>
<td>2.212</td>
<td>0.037**</td>
</tr>
<tr>
<td>Average Emotional</td>
<td>-21.46</td>
<td>-0.26</td>
<td>-1.328</td>
<td>0.197</td>
</tr>
<tr>
<td>VAAST Error</td>
<td>0.402</td>
<td>0.211</td>
<td>1.874</td>
<td>0.073*</td>
</tr>
<tr>
<td>VAAST Reaction Time</td>
<td>-0.001</td>
<td>-0.043</td>
<td>-0.379</td>
<td>0.708</td>
</tr>
<tr>
<td>ASC Likelihood Group</td>
<td>14.856</td>
<td>0.738</td>
<td>6.972</td>
<td>0.00</td>
</tr>
</tbody>
</table>

When I repeated the regression for traits of anxiety measured by the TCI, I found that once again, the model was significant after using the Holm-Bonferroni Sequential
Correction to correct for multiple comparisons \((R^2 = .482, p = .027)\), but only ASC-likelihood group was individually predictive \((B = 10.75, p = .05)\), with neutral switch rates nearing significance \((B = 76.006, p = 0.088; \text{Table 4})\).

**Table 4**

*Regression Analysis Summary for BR and VAAST Predicting TCI*

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Spin</td>
<td>8.491</td>
<td>0.069</td>
<td>0.305</td>
<td>0.763</td>
</tr>
<tr>
<td>Average Neutral</td>
<td>76.006</td>
<td>0.608</td>
<td>1.777</td>
<td>0.088*</td>
</tr>
<tr>
<td>Average Emotional</td>
<td>-21.316</td>
<td>-0.166</td>
<td>-0.541</td>
<td>0.593</td>
</tr>
<tr>
<td>VAAST Error</td>
<td>0.647</td>
<td>0.218</td>
<td>1.237</td>
<td>0.228</td>
</tr>
<tr>
<td>VAAST Reaction Time</td>
<td>-0.006</td>
<td>-0.134</td>
<td>-0.756</td>
<td>0.457</td>
</tr>
<tr>
<td>ASC Likelihood Group</td>
<td>10.745</td>
<td>0.343</td>
<td>2.068</td>
<td>0.05*</td>
</tr>
</tbody>
</table>

Finally, BR switch rates, VAAST reaction time, VAAST error, and group did not predict ACE scores \((R^2 = .324, p = .24)\).

*Post Hoc*

Because I was uncertain whether or how individuals with autism traits would experience or report adverse events, I used the PCL-5 to determine if those with high ACE scores also had PTSD symptoms. The ACE scores measure past childhood events and do not account for whether an individual is currently struggling with trauma symptoms either from those events or from adverse events they may have experienced in adulthood. Therefore, I also did an exploratory analysis with the PCL-5, which measures current symptoms of PTSD, as the dependent variable and group, and BR switch rates and VAAST response time and error as predictors. This model was significant \((R^2 = .48, p = .01)\), with neutral BR switch rate \((B = 187.691, p = .009)\) and VAAST error \((B = 2.842, p = .002)\) as significant predictors (Figure 5; Table 5).
Figure 5

Neutral Switch Rate and VAAST Error vs. PCL-5

Note. Neutral switch rate and VAAST error significantly predict PCL-5 score.

Table 5

Regression Analysis Summary for BR and VAAST Predicting PCL-5
In addition, in order to verify that AQ was a sensitive measure of autistic traits in this sample, I repeated the model that was used for AQ but used our alternative autism traits measure, the RAADS-R. While as was for the AQ, the model was significant ($R^2 = .77$, $p < .001$) and neutral BR switch rate ($B = 343.11$, $p = .001$) was a significant predictor, VAAST error moved from a “near significant” predictor of the AQ to a significant predictor of RAADS-R scores ($B = 3.82$, $p = .003$). Emotional switch rate was also a significant predictor ($B = -183.3$, $p = .043$; Figure 6). Lastly, ASC-likelihood group status was also significantly predictive of RAADS-R scores suggesting potential concurrent validity between measures ($B = 47.1$, $p < .001$; Table 6)

**Figure 6**

*Neutral and Emotional Switch Rates and VAAST Error vs. RAADS-R*
Neutral and emotional switch rates as well as VAAST error significantly predict RAADS-R score.

**Table 6**

**Regression Analysis Summary for BR and VAAST Predicting RAADS-R**

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Beta</th>
<th>t</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Spin</td>
<td>29.834</td>
<td>0.075</td>
<td>0.493</td>
<td>0.627</td>
</tr>
<tr>
<td>Average Neutral</td>
<td>341.113</td>
<td>0.847</td>
<td>3.671</td>
<td>0.001**</td>
</tr>
<tr>
<td>Average Emotional</td>
<td>-183.302</td>
<td>-0.443</td>
<td>-2.142</td>
<td>0.043**</td>
</tr>
<tr>
<td>VAAST Error</td>
<td>3.823</td>
<td>0.4</td>
<td>3.366</td>
<td>0.003**</td>
</tr>
<tr>
<td>VAAST Reaction Time</td>
<td>-0.02</td>
<td>-0.142</td>
<td>-1.185</td>
<td>0.247</td>
</tr>
<tr>
<td>ASC Likelihood Group</td>
<td>47.125</td>
<td>0.466</td>
<td>4.174</td>
<td>0.00**</td>
</tr>
</tbody>
</table>

In order to compare general anxiety (TCI) to more socially-oriented anxiety concerns, I also repeated the TCI regression with SAQ as the dependent variable and found that the model was again significant ($R^2 = .409$, $p = 0.035$). Unlike the model for TCI (Table 4), specific tasks were significantly predictive of SAQ scores. Namely, the neutral switch rate was significantly predictive of SAQ scores ($B = 57.41, p = .032$; Figure 7), with VAAST error rates also nearing significance ($B = .585, p = .07$; Table 7). This is very similar to the regression results for AQ (Table 3).
Figure 7

*Average Neutral Switch Rate vs. SAQ*

![Graph showing the relationship between Neutral switch rate and SAQ score.](Image)

*Note.* Neutral switch rates significantly predict SAQ score.

Table 7

*Regression Analysis Summary for BR and VAAST Predicting SAQ*

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Beta</th>
<th>t</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Spin</td>
<td>6.745</td>
<td>0.099</td>
<td>0.41</td>
<td>0.686</td>
</tr>
<tr>
<td>Average Neutral</td>
<td>57.406</td>
<td>0.831</td>
<td>2.272</td>
<td>0.032*</td>
</tr>
<tr>
<td>Average Emotional</td>
<td>-37.422</td>
<td>-0.527</td>
<td>-1.608</td>
<td>0.121</td>
</tr>
<tr>
<td>VAAST Error</td>
<td>0.585</td>
<td>0.357</td>
<td>1.895</td>
<td>0.07*</td>
</tr>
<tr>
<td>VAAST Reaction Time</td>
<td>-0.004</td>
<td>-0.178</td>
<td>-0.939</td>
<td>0.357</td>
</tr>
<tr>
<td>ASC Likelihood Group</td>
<td>3.621</td>
<td>0.209</td>
<td>1.18</td>
<td>0.257</td>
</tr>
</tbody>
</table>

**Discussion**

In this study, I sought to understand one aspect of the neural mechanisms behind ASCs and PTSD in women who self-identified as having difficulty with social intersections: early visual processing. I investigated whether BR and VAAST tasks with facial stimuli could predict scores on well-established measures of symptomatology. Our most interesting finding is that the neutral BR switch rate and VAAST error rate predicted most of our measures of symptoms (general anxiety, autism traits, PTSD symptoms, and social anxiety). While likelihood group-status did predict TCI score in our general anxiety regression model, VAAST and BR corresponded more strongly to
measures of social anxiety and post-traumatic stress such as the SAQ and PCL-5 than to general anxiety alone. More specifically, neutral switch rates were significantly predictive of SAQ scores, as they were for the AQ. Interestingly, the RAADS-R was the most sensitive to these vision measures, with emotional switch rate, neutral switch rate, and VAAST error all being significantly predictive of overall score.

While neutral switch rates were predictive of our measures of ASCs, namely the AQ and RAADS-R, the positive correlation I observed was contrary to our hypothesis and opposite of that which was identified in prior projects which found that greater levels of autistic traits corresponded with slower BR switching (Freyberg et al., 2015; Robertson et al., 2013; Spiegel et al., 2019). This difference may be due to the fact that our ASC group was highly traumatized (mean PCL-5 score = 35 which is 4 points above the threshold for PTSD evaluation, see Table 1) and our target group was those with high levels of social anxiety, which may correspond to faster switching as observed by Nagamine et al. (2007). This would also align with prior studies which show that females with ASCs are more likely to experience internalizing symptoms such as anxiety than males with ASCs (Mandy et al., 2012; Solomon et al., 2012) and are also more likely to camouflage their ASC symptoms than autistic males (Jorgenson et al., 2020), with greater levels of symptom masking corresponding with greater levels of psychological distress (Beck, et al., 2020).

The faster switch rates I observed in this all-female sample may also be representative of autistic female’s retained preference for social stimuli. This was observed in a paired preference eye tracking study comparing responses to objects and faces, wherein researchers found that object-preference was only present in males with
ASC, and females’ attention patterns closely resembled that of neurotypical women (Harrop et al., 2018). Along with this more neurotypical preference for facial stimuli, threat bias may also have played a role in increased switch rates since greater attention is associated with faster oscillations (Paffen et al., 2006).

While I expected participants with both conditions to experience greater threat-bias, and therefore the fastest switch rates, when viewing the BR image sets, the neutral face condition most frequently corresponded with measures of ASCs and PTSD, with emotional switch rates also being significantly predictive of RAADS-R, but spin switch rates were not predictive of any symptom measures. It appears that including facial stimuli in BR tasks is important for identifying those who may be struggling with social concerns related to either condition. The frequency at which neutral-face switch rates were predictive of ASC and PTSD psychometrics may also be related to an attentional bias towards ambiguous expressions. For example, in the still face paradigm, infants at high genetic likelihood for having ASCs exhibit fewer prosocial behaviors when interacting with an unresponsive, neutral-faced caregiver, and these decreases in social bids corresponded to greater difficulties with emotional regulation later on in life (Qui et al., 2020). While this decrease in outreach could reflect lack of interest, given that the high-likelihood infants still exhibited other signs of stress and frustration at similar levels to the TD group, it has been theorized that this withdrawal is actually a stress/freeze response resulting from heightened emotional and sensory sensitivity to the ambiguous response (Qui et al., 2020). This is also in line with Tottenham et al.’s (2014) findings that autistic participants’ visual avoidance of neutral faces corresponded to each image’s level of perceived threat. The same study also used fMRI to observe that while autistic
individuals experienced differential amygdala activation for all facial valances, the effect was most strong for neutral stimuli.

In a similar vein, a study on adults with PTSD found that during a dot-probe task, attentional preference was not displayed in response to angry-faced primes, but was present following neutral-faced primes, as measured by P100 and P300 event-related potential (Shah et al., 2018). The authors interpreted these findings as a tendency to avoid angry-faced stimuli, but they may also represent an increase in perceived threat to neutral faces themselves. A similar phenomena has also been observed in Social Anxiety Disorder (SAD) with greater difficulty habituating to (or in other words prolonged attention-bias towards) neutral faces being predictive of markers for SAD in the right hippocampus and amygdala (Bas-Hoogendam et al., 2019) and has also been verified behaviorally with individuals with greater levels of social anxiety (Peschard & Phillippot, 2017) or who have experienced childhood sexual abuse (Pfaltz et al., 2019) being more likely to perceive a neutral face as angry than controls.

Although I did not observe significant predictive effects outside of RAADS-R for the emotional/angry BR condition, differences in angry and fearful expression recognition were evident in VAAST task error rates and were predictive of RAADS-R, PCL-5, and the revised model for ACEs. Once again, the observed positive correlation was opposite of our hypothesis given previous research on faster and more accurate recognition of fear and anger in post-traumatic stress syndromes (Ashley & Swick, 2019; DiGangi et al., 2017; Masten et al., 2008).

While surprising from a threat-bias standpoint, this increased error is in line with a meta-analysis of eye tracking studies that found no significant evidence for enhanced
threat detection in PTSD (Lazarov et al., 2018). A study using the Flanker task also found that participants with PTSD and controls both experienced slowing and increased error in emotional-stimulus conditions (Ashley & Swick, 2019). Similarly, Suzuki et al. (2015) found that individuals with greater amounts of childhood trauma exposure experienced greater error in recognizing fearful faces, but that more errors also corresponded to greater PTSD resilience due to decreased, rather than increased, fear-bias.

It is also well established that individuals with ASCs experience difficulty differentiating between facial expressions, and in line with our original hypothesis, our models of VAAST error agree with the observations of Van der Donck et al. (2020) who found that boys with autism had reduced responses to images suggesting fear and anger as compared to the same images shown to controls or to images depicting happiness or sadness. This may correspond to decreased accuracy, as does autistics’ tendency towards being especially avoidant of images depicting fear (Malaia et al., 2019), with one study finding that individuals with ASCs were significantly less accurate than controls at differentiating fearful faces from those associated with anger (Malaia et al., 2019).

It is important to recognize that our investigation is limited by our smaller sample size as well as the difficulty I experienced recruiting women with ASCs who did not have significant PTSD symptoms. This disparity may be representative of the autistic population at large, and in particular the female autistic population, which is in line with statistics that show that autistic women experience sexual assault 2-3x more often as neurotypical women (Brown-Lavoie et al., 2014), that 90% of autistic youth with other mood symptoms had experienced a significant trauma before finishing high school (Taylor & Gotham, 2016), and that ASC is significantly associated with having higher
ACE scores (Berg et al., 2016). However, our sample may also represent a trauma-bias resulting from the particular college-age group I focused on or our focus on recruiting women with significant social concerns as opposed to being representative of ASC conditions and experiences at large.

In order to reduce participation time given our population’s heightened sensitivity to visual stimuli, I also did not counterbalance image presentation across each eye during the BR task. Faces were always presented to left-eye/right cortex, which is potentially more ideal for measuring response to threat (Mogg & Bradley, 2002), but may be less conducive to local processing of facial features (de Schonen et al., 1993) which has also been shown to be altered in ASCs as compared to neurotypical controls (Happé & Frith, 2006) and women as compared to men (Kramer et al., 1996).

In addition to testing the opposite positioning during BR, given the significance of the neutral BR condition, it would be interesting to incorporate neutral faces into the VAAST paradigm to compare the observed subconscious association with more conscious processing. It would also be interesting to conduct the BR task with a neutral-emotional image pair to see whether the same pattern occurs independent of potential object preference as well as observe whether there is an implicit preference towards one expression over the other.

Overall, this project demonstrated that traits of ASC and PTSD can be predicted by BR and VAAST vision tasks, which represent neural activity in both higher and lower visual processing centers. This may suggest a biological basis for women’s symptoms of both conditions, even if they are different from what is behaviorally observed in men, and also suggests the need for continuing inclusion of autistic women in ASC studies. While
neither vision task discriminated between ASC or PTSD in our sample, they did predict symptom severity as measured by the AQ, RAADS-R, PCL-5, and SAQ. This congruence speaks to the importance of incorporating trauma screening into routine evaluations for ASCs as well as further exploration of neural systems that may underlie social difficulties observed in both conditions. Most importantly, these findings suggest that contrary to suggestions that ASC reduces risk for PTSD by preventing trauma recognition (Brenner et al., 2018; King, 2010), autistic women do experience trauma in ways which are at least neurologically similar to neurotypical women and could thus potentially benefit from PTSD treatments (Carrigan & Allez, 2016; Kliman, 2016; Lobregt-van Buuren et al., 2019).
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Appendix A

Test-Retest Reliability for BR Task

Spin

Neutral

\[ r(34) = 0.807, \ p < 0.00001 \]

\[ r(34) = 0.783, \ p < 0.00001 \]

Emotional

\[ r(34) = 0.797, \ p < 0.00001 \]
Appendix B

SPSS Script

*HYPOTHESES

COMPUTE E_ave_N_ave_difScore=E_AVG - N_AVG.
EXECUTE.

T-TEST GROUPS=ASD_grp(0 1)
/MISSING=ANALYSIS
/VARIABLES=E_ave_N_ave_difScore
/ES DISPLAY(TRUE)
/CRITERIA=CI(.95).

REGRESSION
/MISSING LISTWISE
/STATISTICS COEFF OUTS R ANOVA COLLIN TOL CHANGE
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT AQ
/METHOD=ENTER S_AVG N_AVG E_AVG VAAST_#incorrect VAAST_RT ASD_grp
/SCATTERPLOT=(*ZRESID ,*ZPRED)
/RESIDUALS DURBIN.

REGRESSION
/MISSING LISTWISE
/STATISTICS COEFF OUTS R ANOVA COLLIN TOL CHANGE
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT TCI
/METHOD=ENTER S_AVG N_AVG E_AVG VAAST_#incorrect VAAST_RT ASD_grp
/SCATTERPLOT=(*ZRESID ,*ZPRED)
/RESIDUALS DURBIN.

REGRESSION
/MISSING LISTWISE
/STATISTICS COEFF OUTS R ANOVA COLLIN TOL CHANGE
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT ACE
/METHOD=ENTER S_AVG N_AVG E_AVG VAAST_#incorrect VAAST_RT ASD_grp
/SCATTERPLOT=(*ZRESID,*ZPRED)
/RESIDUALS DURBIN.

*POST-HOC

REGRESSION
/MISSING LISTWISE
/STATISTICS COEFF OUTS R ANOVA COLLIN TOL CHANGE
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT PCL_5
/METHOD=ENTER S_AVG N_AVG E_AVG VAAST_#incorrect VAAST_RT ASD_grp
/SCATTERPLOT=(*ZRESID,*ZPRED)
/RESIDUALS DURBIN.

REGRESSION
/MISSING LISTWISE
/STATISTICS COEFF OUTS R ANOVA COLLIN TOL CHANGE
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT RAADS_R
/METHOD=ENTER S_AVG N_AVG E_AVG VAAST_#incorrect VAAST_RT ASD_grp
/SCATTERPLOT=(*ZRESID,*ZPRED)
/RESIDUALS DURBIN.

REGRESSION
/MISSING LISTWISE
/STATISTICS COEFF OUTS R ANOVA COLLIN TOL CHANGE
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT SAQ
/METHOD=ENTER S_AVG N_AVG E_AVG VAAST_#incorrect VAAST_RT ASD_grp
/SCATTERPLOT=(*ZRESID,*ZPRED)
/RESIDUALS DURBIN.