PTSD symptoms and overt attention to contextualized emotional faces: Evidence from eye tracking

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A B S T R A C T

Abnormal patterns of attention to emotional faces and images are proposed by theories of posttraumatic stress disorder (PTSD), and this has been demonstrated empirically. However, few studies have examined how PTSD symptoms are associated with attention to emotional faces in the context of emotional background images. Eye tracking data were collected from seventy-eight undergraduates with a history of experiencing at least one traumatic event as they completed the Contextual Recognition of Affective Faces Task (CRAFT; Milanak and Berenbaum, 2014), which requires subjects to identify the emotion depicted by faces superimposed on an emotional background image. Greater PTSD symptom severity was associated with more time spent looking at background contexts and less time looking at target faces. This is consistent with greater susceptibility to distraction by task-irrelevant emotional stimuli. The duration of each gaze fixation upon fear faces was shorter for those with greater PTSD symptoms, and this pattern was marginally significant for disgust faces. These findings suggest that PTSD symptoms may relate to greater attention toward non-facial background scenes and less attention toward facial stimuli, especially when conveying a fear or disgust expression.

1. Introduction

About three quarters of the general population will experience at least one traumatic event during their lifetimes (Breslau, 2009; Kessler et al., 1995; Resnick et al, 1993). Such events involve direct, witnessed or learned about experiences with potential or realized death, or serious injury (DSM-5; American Psychiatric Association, 2013) and previously also included violation of one's physical integrity (DSM-IV; American Psychiatric Association, 1994). Following such an event, about 10% develop post-traumatic stress disorder (PTSD; Breslau, 2009). Theoretical and clinical perspectives propose that two core features of PTSD, namely hypervigilance and avoidance, can involve altered patterns of attention to threat. Accordingly, researchers have identified attentional risk factors that may contribute to the development of PTSD symptoms, including biased attention toward (Fani et al., 2012) or away from threat (Wald et al., 2011), as well as the possibility of dynamic variability (Iacoviello et al., 2014). Thus, research is needed to examine how PTSD symptoms in those who have

experienced a traumatic event are related to abnormal patterns of attention for emotional stimuli.

To address this need, researchers have examined the relationship between PTSD and attention for emotional words (Bryant et al., 1995; Felmingham et al., 2011; Karl et al., 2006; Khoury-Malhame et al., 2011; Pineles et al., 2009), faces (Armstrong et al. 2013; Fani et al., 2012; Lee and Lee, 2014), and images (Kimble et al., 2010; Lee and Lee, 2012; Mueller-Pfeiffer et al., 2010). For example, Bryant et al. (1995) compared motor vehicle accident survivors who developed PTSD to those who did not as they viewed groups of neutral and threat-related words. They found that those with PTSD made more initial eye movements toward threat-related words. Similarly, another study found that, compared to matched healthy controls, individuals with PTSD showed biased attention for threatening words in both the Stroop and dot-probe paradigms (Khoury-Malhame et al., 2011). Stroop studies using negative IAPS images have supported a bias toward threat as well that is specific to PTSD (Mueller-Pfeiffer et al., 2010). Such evidence of intrusion leading to heightened attention to potential physical threat has

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been found across anxiety disorders including GAD, OCD, and specific phobia (e.g., Payne et al., 2005; Foa et al., 1993; Lipp and Derakshan, 2005). Pineles et al. (2009) conducted an experiment using a combined visual search and lexical decision task to determine whether such effects are due to facilitated orientation to threat stimuli or cognitive interference due to the enhanced salience of threat. Their results suggested that PTSD symptoms are associated with increased interference from trauma-related stimuli rather than facilitated attention toward such stimuli.

The predominance of research on attention bias linked to PTSD has focused on participant response tasks. The most commonly used of these, the dot probe task, assesses bias by comparing reaction time to probes which replace one stimulus in a pair (MacLeod et al., 1986). However, such response tasks capture only a snapshot of attention. And participant responses are downstream from multiple stages of information processing, which makes it challenging to disentangle these processes.

To address the limitations of response tasks, researchers have used eye tracking to obtain an overt measure of attention biases as they unfold over time. For example, Kimble et al. (2010) examined eye movements during viewing of pairs of negatively valenced and neutral images. PTSD symptoms were associated with more time spent looking at negatively valenced images. Eye tracking studies have shown that victims of dating violence spend more time looking at negative images and less time looking at positive images (Lee and Lee, 2012), as well as more time looking at angry faces (Lee and Lee, 2014) compared to subjects without a history of dating violence. Similarly, veterans with PTSD have been found to spend more time looking at fear and disgust facial expressions than happy facial expressions (Armstrong et al., 2013). Also, as Fani et al. (2012) found, individuals with PTSD have a heightened awareness, hyperarousal reaction to threatening stimuli, specifically threatening faces.

Although eye tracking research has advanced our understanding of attention biases in PTSD, research has yet to address how attention is deployed toward contextualized emotional stimuli. Such research is needed as multiple emotional stimuli are often encountered simultaneously rather than in isolation. Thus, research is needed to examine how PTSD symptoms are related to attention biases for emotional faces in the context of emotional background images. The Contextual Recognition of Affective Faces Task (CRAFT; Milanak and Berenbaum, 2014) is one tool for assessing attention and discrimination of emotional facial expressions in the context of task-irrelevant emotional background images. The goal of this study was to track eye movements in trauma-exposed individuals as they completed the CRAFT in order to advance our understanding of how PTSD symptoms are associated with goal-directed attention to emotional faces in the context of emotional background images.

Based on prior research such as Mueller-Pfeiffer et al. (2010) showing attentional biases to threat-related stimuli as well as theoretical and clinical perspectives of PTSD (e.g., Davidson and Foa,1991) detailing hypervigilance in individuals with PTSD, we hypothesized that PTSD symptoms would be related to more time spent looking at task-irrelevant background emotional images. We also hypothesized that PTSD would be associated with shorter fixations on fear faces (see Beevers et al., 2011).

2. Methods

2.1. Participants

Participants were 98 university students. Because we were interested in individuals with trauma histories, we limited our analyses to 72 individuals who had direct trauma exposure and who met PTSD criterion A, the assessment of which is described below. While the DSM-5 includes not only direct experience of a traumatic event but also witnessing or learning about an event, we decided to choose a more conservative estimate of trauma experience including only individuals who reported directly experiencing a potentially traumatic event. This decision was based upon previous research showing high rates of false positives based upon LEC self-report alone (Schoenleber et al., 2018). Participants included in the analyses (52.8% female) ranged in age from 18 to 30 ($M = 19.3$, SD = 1.7). The ethnic composition of the sample was as follows: 58.3% European American/White, 31.9% Asian American, 5.6% Latino/a, 2.8% African American/Black, and 1.4% Bi-racial. Participants received course credit in return for participating.

2.2. Procedure

In a single session, participants completed the Contextual Recognition of Affective Faces Task (CRAFT), a UFOV (useful field of view) task, and self-report measures. Both the CFAFT and UFOV were administered using a full color 21-inch CRT monitor with a resolution of 800 × 600 pixels.

2.2.1. The Contextual Recognition of Affective Faces Task

CRAFT (Milanak and Berenbaum, 2014) was used to measure attention to emotional faces in the context of emotionally matching, mismatching, and neutral backgrounds. During the CRAFT, participants identified the emotional valence of faces (male and female faces of Sub-Saharan African, East Asian, and European decent) displaying different facial expressions (i.e., neutral, happy, fear, sadness, and disgust) superimposed upon emotionally valenced (i.e., happy, fear, sadness, and disgust) and neutral images. The context images upon which the facial expressions were superimposed were selected following pilot testing in which participants ($n = 73$) made two types of ratings of images ($n = 104$) selected from IAPS (Lang et al., 1999) and selected from publicly available online images. Each image was rated on a 1–5 Likert Scale for each of the 6 emotions, as well as neutral. Examples of context images included in the CRAFT are: a hand holding a gun, a shark, a tornado scene (fear); a beach, cute puppies, fireworks (happy); bugs on food, a dismantled arm, a bloody scene (disgust); a casket, a cemetery, a funeral procession (sadness); a coat rack, a filing cabinet, a desk lamp (neutral). For additional details, please see Milanak and Berenbaum (2014).

The CRAFT is composed of 168 trials (each of the 54 face images was presented three times – once paired with a neutral background image, once paired with the matching emotion context image, and once paired with a mismatching emotion context image). The order in which the 168 trials were administered was randomized separately for each participant. On each trial, the participant is presented with a single face image superimposed upon a single emotionally valenced or neutral image. All context images covered the entire computer monitor; the size of the face superimposed upon the context image was identical in all trials. Participants responded using a keyboard that had five keys labeled with the following emotions: "happy," "sad," "fear," "disgust," and "neutral." Participants had to select, by pressing one of the five labeled keyboard keys (using the index finger of their dominant hand), which of the aforementioned labels most accurately described the emotional expression on the face. They read the following instructions on the screen: "You will be seeing 168 sets of images. Each image is made up of a background picture and a picture of a face. The faces will appear in different locations on the screen. Your task is to decide which of the five emotional expressions is being shown by the face."

There were 3 context conditions: matching (both face and image are the same emotion), mismatching (face and image are different emotions), and neutral (emotional face on a neutral image; see Fig. 1). Each type of emotional facial expression (happy, sad, fear and disgust) was presented 36 times (12 times in the matching condition, 12 mismatching, and 12 neutral), and neutral facial expressions were presented 24 times (12 matching and 12 mismatching). For example, for fear facial expressions: (a) 12 fear faces on fear images were presented; (b) 12 fear faces on mismatching contexts (4 on happy contexts, 4 on

Fear Face
Matching Context

Happy Face
Mismatching (Fear) Context

Sad Face
Neutral Context

Fig. 1. CRAFT stimuli.

sad contexts, and 4 on disgust contexts) were presented; and (c) 12 fear faces on neutral contexts were presented. Images were displayed on the screen until the participant made a response. As soon as the participant made a response, the next face superimposed on an image would appear. There were multiple positions where the face could be located (top or bottom left, top or bottom right, or center). Multiple positions were used so that the participant would have to scan each image. Had the face always been placed in the same position, participants might have learned over trials to focus exclusively on the face and to ignore the background context information).

2.2.2. Psychological trauma

We operationalized the experience of psychological trauma as the individual having indicated that they personally experienced a stressful/traumatic event. The Life Events Checklist (Gray et al., 2004), a self-report checklist that measures exposure to potentially traumatic life events, lists the 17 most common stressful/traumatic experiences that individuals could encounter (e.g., transportation accidents, sudden, unexpected death of someone close to them, natural disaster, sexual or physical abuse). Participants rate each of the potentially stressful/traumatic events as to whether: (1) it happened to them (direct trauma exposure), (2) they witnessed it; (3) they learned about it; (4) they do not remember; or (5) it does not apply. The most common trauma types reported by participants in this study were natural disasters, transportation accidents, unwanted sexual experiences, and sudden, unexpected death of someone close to them. The mean number of traumatic life events experienced by participants was 2.8 (ranging from 1 to 10 traumatic life experiences).

2.2.3. Posttraumatic stress disorder symptoms

PTSD symptoms were measured using the PTSD checklist – Civilian version (PCL; Blanchard et al., 1996; Weathers et al., 1994), a self-report questionnaire measuring frequency and severity of PTSD symptoms. These symptoms include re-experiencing (nightmares, flashbacks), avoiding people and places that remind them of the event, emotional disturbance, and being easily startled. Participants rate each symptom on a scale from 1 (not at all) to 5 (extremely). The PCL has been found to have excellent reliability ($\alpha = 0.94$) and other psychometric properties (Blanchard et al., 1996; Conybeare et al., 2012; Ruggiero et al., 2003).

2.2.4. Eye tracking

An EyeLink II eye tracker was used to assess number of fixations during the CRAFT. Eye position was sampled at 500 Hz. Default algorithms were used to define eye movements. To assess overt attention to faces, the study examined the number of fixations upon faces, the total time fixated on a face during each trial, and the average duration of each face fixation. Proportions were calculated for each face type (i.e., happy, sad, disgust, fear) and context condition (match, mismatch, and neutral). Only trials with a correct response were used.

2.2.5. Useful field of view task

A UFOV task (Ball et al., 1988, 1990; Pringle et al., 2001; Williams, 1985) was used to examine individual differences in subject's ability to detect targets appearing at different visual angles, that is, the breadth with which they could attend in a briefly presented display. During each trial, participants were presented a brief (44 ms) display containing a white triangle within a circle among square distracters. Items were arranged in eight radial spokes around a square in the center of the display. Targets occurred with equal probability on each arm at eccentricities of 10°, 20°, and $30°$ from the center of fixation. The search display was followed by a mask display consisting of random black and white lines and shapes presented for 5 ms. After the mask display, a response screen containing lines representing the eight radial arms appeared. Subjects clicked with the mouse the radial arm on which the target had appeared. Accuracy of responses was recorded. Participants completed 24 practice trials (with a presentation duration of 170 ms) followed by 120 experimental trials.

2.3. Analytic strategy

The hypotheses were tested using three mixed ANOVAs. These were used to measure effects on the number of fixations upon faces, the total time fixated on a face during each trial, and the average duration of each face fixation. Each of these three outcome measures was examined as a proportion of the total number of fixations or the total time of the trial. Each ANOVA examined two within-subjects factors: face type (disgust, fear, happy, sad, and neutral) and context (disgust, fear, happy, sad, and neutral), as well as PCL total score, which was entered as a continuous predictor. A median-split of PCL total score (median = 30.5, range: 17–60) was used in follow-up analyses. Greenhouse–Geiser correction was employed in cases of a significant Mauchly's test of sphericity. Pairwise comparisons were used to follow-up on significant main effects and interactions. Repeated measures ANOVA using the same factors was conducted on accuracy of identifying emotional faces in the CRAFT.

3. Results

Prior to the main analyses, the relationship of PTSD symptoms to UFOV was evaluated to determine whether symptom-related differences in UFOV might offer an alternative explanation for later findings. There were no significant correlations between PTSD total symptom severity or any of the PTSD symptom factors and UFOV (all $ps > 0.05$). Thus, any relationship between PTSD symptoms and UFOV in general was ruled out as a potential explanation for effects seen in subsequent analyses.

3.1. CRAFT accuracy

There were significant main effects of face type, $F = 15.75$ (3.69,

258.01), $p < 0.001$, $\eta_p^2 = 0.18$, and context, $F = 8.63$ (3.64, 254.44), $p < 0.001$, $\eta_p^2 = 0.11$. These main effects were qualified by a significant interaction of face and context, $F = 10.56$ (10.07, 704.85), $p < 0.001$, $\eta_p^2 = 0.13$. Pairwise comparisons between faces within each context are displayed in Supplementary Fig. 1. Within disgust contexts, accuracy was for sad faces was significantly worse than for all other faces and better for happy faces than for fear faces. In the fear context, accuracy for fear faces was significantly better than for all other faces, better for disgust than happy and sad faces, and better for neutral faces than for happy or sad faces. In happy contexts, accuracy for neutral faces was better for neutral faces than for disgust, happy, or sad faces, and better for fear faces than disgust, happy, or sad faces. In sad contexts, accuracy for fear faces was better than for disgust, happy, or neutral faces, and worse for disgust faces compared to sad or neutral faces. In the neutral context, accuracy was better for neutral faces than disgust, happy, or sad faces, and better for fear than disgust, happy, or sad faces. There were no other significant main effects or interactions, $Fs < 1.66$, $ps > 0.16$.

3.2. Number of fixations on faces

The ANOVA examining the proportion of fixations on faces revealed a significant main effect of face type, $F = 78.49$ (4, 280), $p < 0.001$, $\eta_p^2 = 0.53$. There was also a significant main effect of context, $F = 135.87$ (3.32, 232.03), $p < 0.001$, $\eta_p^2 = 0.66$. The main effects of face type and context were qualified by a significant interaction between these factors, $F = 103.26$ (9.20, 644.19), $p < 0.001$, $\eta_p^2 = 0.60$. Within the disgust context, the proportion of fixations on faces was higher for neutral faces than for all other faces and higher for disgust faces than all other faces except for neutral. The proportion of fixations for sad faces was lower than for fear and happy faces. In the fear context, the proportion of fixations on disgust faces was higher than for all other faces and lower for neutral faces than all other faces. The proportion of fixations on happy faces was higher than for fear or sad faces, and it was higher for fear than for sad faces. In the happy context, the proportion of fixations was higher for fear faces than for all other faces. It was also higher for disgust compared to happy, sad, or neutral faces, and higher for sad than happy or neutral faces. In the sad context, the proportion of fixations was lower for happy faces than for all other faces. It also was higher for disgust faces than for fear faces. In the neutral condition, the proportion of fixations on happy faces was higher than all other faces, and it was lower for disgust faces than all other faces. The proportion of fixations on neutral faces was higher than on fear or sad faces. These pairwise comparisons are displayed in Supplementary Fig. 2. There was no significant main effect of PCL score, $F = 2.20$ (1, 70), $p = 0.14$, $\eta_p^2 = 0.03$, nor were there any other significant main effects or interactions, $Fs < 0.76$, $ps > 0.55$.

3.3. Total time of fixations on faces

The ANOVA examining the proportion of total duration of gaze on faces revealed a significant main effect of PCL score, $F = 4.24$ (1, 70), $p = 0.04$, $\eta_p^2 = 0.06$, such that subjects with PCL scores below the median spent a greater proportion of time gazing at faces ($M = 0.24$, $SD = 0.05$) than those with scores at or above the median ($M = 0.22$, $SD = 0.05$; see Fig. 2). There was a significant main effect of face type, $F = 101.96$ (4, 280), $p < 0.001$, $\eta_p^2 = 0.59$. There was a significant main effect of context also, $F = 141.71$ (3.14, 219.94), $p < 0.001$, $\eta_p^2 = 0.67$. These main effects of face type and context were qualified by an interaction between these factors, $F = 118.45$ (10.10, 707.28), $p < 0.001$, $\eta_p^2 = 0.63$. Within the disgust context, total time was shorter for sad faces than for all other faces and longer for neutral than for all other faces. Total time was also longer for disgust faces than for fear and happy faces. Within the fear context, total time was shorter for neutral faces than for all other faces, longer for disgust faces than for all
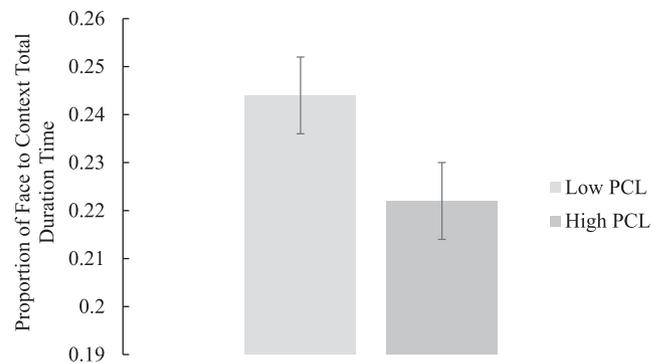

Fig. 2. Main effect of PCL group on total duration of fixation on faces. *Note*: Error bars denote standard error.

other faces, longer for happy than for fear or sad faces, and longer for fear faces than for sad faces. Within the happy context, total time was longer for fear faces and shorter for happy faces compared to all other faces. Total time was longer for disgust than for sad or neutral faces, and longer for sad than neutral faces. Within the sad context, total time was shorter for happy faces than for all other faces and longer for disgust than for all other faces. Total time was also longer for sad than fear faces. Within the neutral context, total time was longer for happy faces than for all other faces, shorter for disgust faces than for all other faces, and longer for neutral than for fear or sad faces. These pairwise comparisons are displayed in Supplementary Fig. 3. There were no other significant main effects or interactions, $Fs < 1.0$, $ps > 0.40$.

3.4. Average duration of each fixation on faces

The ANOVA used to examine the average duration of fixations on faces revealed a significant interaction between face type and PCL score, $F = 2.96$ (3.39, 237.39), $p = 0.027$, $\eta_p^2 = 0.04$ (see Fig. 3). Those with high PCL scores showed significantly shorter fixations on fear faces ($M = 1.14$, $SD = 0.13$) compared to those with low PCL scores ($M = 1.22$, $SD = 0.13$, $p = 0.02$). High PCL scorers also showed marginally significant shorter fixations on disgust faces ($M = 1.19$, $SD = 0.27$) compared to low PCL scorers ($M = 1.31$, $SD = 0.27$, $p = 0.06$). There were not significant between groups differences for other face types, all $ps > 0.44$. In addition to the interaction, there was a main effect of face type, $F = 28.40$ (3.39, 237.39), $p < 0.001$, $\eta_p^2 = 0.29$. There also was a significant main effect of context, $F = 30.71$ (3.22, 225.24), $p < 0.001$, $\eta_p^2 = 0.31$. The main effects of face and context were qualified by a significant interaction, $F = 32.15$ (6.79, 475.59), $p < 0.001$, $\eta_p^2 = 0.32$. Within the disgust context, the average duration was longer for disgust faces than for all other faces except for neutral, which was not significant. Average duration was also shorter for sad faces than for all other faces. Within the fear context, average duration was shorter for neutral than for all other faces. Within the happy context, average duration was longer for fear than for happy, sad, or neutral faces. Within the sad context, average duration was longer for disgust than for fear, happy, or sad faces and longer for sad than fear or happy faces. Average duration was also longer for neutral than for happy faces. Within the neutral context, average duration was longer for happy compared to all other faces. These follow-up pairwise comparisons of faces within each context are displayed in Supplementary Figure 4.[1] There were no other significant main effects or interactions, $Fs < 0.82$, $ps > 0.36$.

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[1] Due to the exploratory nature of this study, follow-up analyses were conducted using each PCL subscale (i.e., re-experiencing, avoidance, hyperarousal, emotional numbing) in place of the PCL total score. However, there were no significant effects involving any of the PCL subscales.
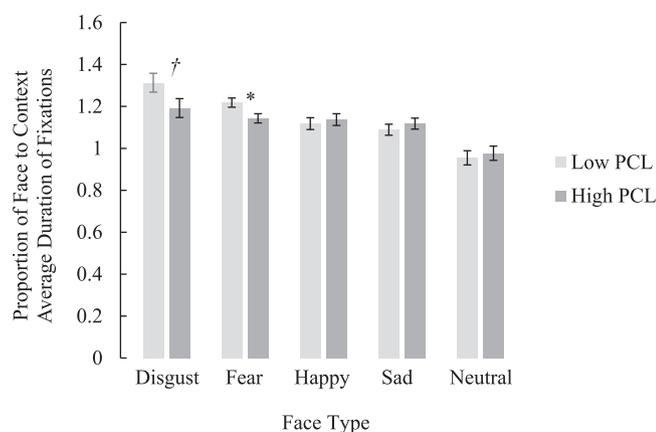
Fig. 3. Interaction of PCL and face type on duration of fixations on faces.
Note: †*p* = 0.06, **p* < 0.05. Error bars denote standard error.

4. Discussion

This study built on previous studies by examining attention to emotional faces in the context of emotional background images. We found that high PCL scores were associated with more time looking at background contexts and less time looking at target faces. This is consistent with theoretical (Ehlers and Clark, 2000) and clinical proposals (American Psychiatric Association, 2013) that attention in PTSD is influenced by hypervigilance. It is also consistent with past research suggesting that PTSD is associated with the involuntary capture of attention by emotional images (Mueller-Pfeiffer et al., 2010). In other words, previous research showed that individuals with PTSD have difficulty disengaging attention and focus on threatening stimuli, even if it is irrelevant to the task at hand. Our findings support this theory as individuals with higher severity/frequency of PTSD symptoms spent more time focusing on the background image vs. the face. Notably, the lack of significance in the UFOV task does not suggest that our results can be explained by differences in the useful field of view. PCL scores were not a factor in accurately identifying emotional faces, suggesting that the increased visual attention for emotional background images did not produce a clear cost to task performance.

We also found that the duration of each fixation upon fear faces was shorter for those with high PCL scores. We also found marginally significant evidence of shorter fixations on disgust faces in those with high PCL scores. These findings are consistent with a previous study which found that shorter eye fixations on fear faces prior to deployment was associated with a stronger relationship between stress exposure and PTSD symptoms in soldiers (Beevers et al., 2011). However, our findings are somewhat at odds with results obtained by Armstrong et al. (2013) who found that veterans with PTSD spend more time looking at fear and disgust faces when they are paired with a neutral face. This difference in results may be due to differences in the tasks used by each study. For example, our study required subjects to identify the emotion depicted by each face whereas Armstrong and colleagues assessed passive viewing. Our findings highlight a need for more systematic research examining attention biases for emotional facial expressions using a variety of paradigms, including those which include task-irrelevant emotional images.

Shorter duration of fixations on target fear and possibly disgust faces is consistent with data suggesting disengagement when fear-salient stimuli are detected. However, the presence of emotionally salient background images allows for an alternative interpretation that fear and possibly disgust faces resulted in greater attention toward the background context. This interpretation is consistent with our findings that subjects with high PCL scores spent more time in total looking at background images. Therefore, this may be providing evidence of a general mechanism of interference at play. However, it is also

important to note an alternative interpretation that these findings could also be providing evidence of a core component of PTSD, hypervigilance. In other words, finding that individuals with high PCL scores spend more time examining background images when threat-related faces are present (i.e., fear and disgust faces) compared to when happy and sad (non-threat related faces) are present could be an indication that they recognize that there is something bad going on causing the fear/disgust face which in turn activates more hypervigilance to see what is happening in the background "causing" that face. Conversely, as a happy face does not typically suggest any threat and while sad is not a positive emotion, it again is not typically indicative of a present threat, there would not be as much of a need to look at the background to promote safety. This could also explain why fear faces had a stronger effect than disgust faces as fear is the clearest indication of potential threat.

As has been the case with many studies, it is unclear whether our results are driven by involuntary capture of attention by emotional distractors, avoidance of emotional targets, or some complex combination of both. For this specific research, the group by face interaction on mean duration could be interpreted as evidence of disengagement from fear and possibly disgust (due to marginal significance), or could even suggest that fear, and perhaps disgust, faces cue a widening of attention to the context. In support of the disengagement interpretation, we found group differences in how long each fixation lasted for fear faces, but we did not find group differences in the number of fixations. Consistent with the second interpretation, we found an overall lower rate of total time spent looking at faces compared to backgrounds, which is consistent with more attention to context across the board. Consequently, further research is needed to further unpack the underlying mechanisms accounting for the attentional differences. Past research has attempted to address this question by modifying existing paradigms (e.g., Pineles et al., 2009). Our goal was broader, to explore patterns of overt attention for faces in the context of emotional images. Future research may probe the mechanisms of our results by modifying the CRAFT or using other methodology.

Our findings bear implications for interventions for PTSD. Studies have suggested that attentional biases in PTSD, which has been linked to impairments in fear extinction (Fani et al., 2012), may be reduced with successful treatment (Khoury-Malhame et al., 2011). Additionally, the effectiveness of exposure therapy may be dependent on overt engagement of attention toward distressing aspects of the situation (Foa et al., 2006). Subtle patterns of avoidance in the overt deployment of attention may impact exposures. Our findings suggest that post-traumatic stress symptoms may be associated with a greater tendency for distraction by emotional images.

Although our study partially addresses limitations of past research, it is not without its own limitations. Future studies are needed using clinical populations to determine whether the exploratory effects noted in this study generalize to individuals with a diagnosis of PTSD. Furthermore, given that this research was conducted on a non-clinical university sample, it is important to note that we were not able to examine existing physical and psychological co-morbidities that may have a significant effect on the results. Additionally, research is needed comparing performance on the CRAFT among different diagnoses to assess the specificity of our results to PTSD versus other affective psychopathology.

In summary, our findings suggest that symptoms of posttraumatic stress are linked to more time spent looking at task-irrelevant emotional images than task-relevant emotional facial expressions. Furthermore, symptoms are associated with shorter fixations on fear and possibly also disgust facial expressions. These findings advance the literature of attention biases linked to traumatic exposure. Future studies are needed to continue clarifying abnormal patterns of attention to emotional stimuli which are associated with posttraumatic stress symptoms and PTSD diagnosis.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2018.08.102.

References

American Psychiatric Association, 1994. Diagnostic and Statistical Manual of Mental Disorders, fourth ed. American Psychiatric Association, Washington, DC.

American Psychiatric Association, 2013. Diagnostic and Statistical Manual of Mental Disorders, fifth ed. American Psychiatric Association, Washington, DC.

Armstrong, T., Bilsky, S.A., Zhao, M., Olatunji, B.O., 2013. Dwelling on potential threat cues: an eye movement marker for combat-related PTSD. Depress. Anxiety 30, 497–502. http://dx.doi.org/10.1002/da.22115.

Ball, K.K., Beard, B.L., Roenker, D.L., Miller, R.L., Griggs, D.S., 1988. Age and visual search: expanding the useful field of view. J. Opt. Soc. Am. 5, 2210–2219.

Ball, K.K., Owsley, C., Beard, B., 1990. Clinical visual perimetry underestimates peripheral field problems in older adults. Clin. Vis. Sci. 5, 113–125.

Beevers, C.G., Lee, H.-J., Wells, T.T., Ellis, A.J., Telch, M.J., 2011. Association of pre-deployment gaze bias for emotion stimuli with later symptoms of PTSD and depression in soldiers deployed in Iraq. Am. J. Psychiatry 168, 735–741. http://dx.doi.org/10.1176/appi.ajp.2011.10091309.

Blanchard, E.B., Jones-Alexander, J., Buckley, T.C., Forneris, C.A., 1996. Psychometric properties of the PTSD Checklist (PCL). Behav. Res. Ther. 34, 669–673. http://dx.doi.org/10.1016/00057967(96)00033-2.

Breslau, N., 2009. The epidemiology of trauma, PTSD, and other posttrauma disorders. Violence Trauma Abuse 10, 198–210. http://dx.doi.org/10.1177/1524838009334448.

Bryant, R.A., Harvey, A.G., Gordon, E., Barry, R.J., 1995. Eye movement and electro-dermal responses to threat stimuli in post-traumatic stress disorder. Int. J. Psychophys. 20, 209–213. http://dx.doi.org/10.1016/0167-8760(95)00036-4.

Conybeare, D., Behar, E., Solomon, A., Newman, M.G., Borkovec, T.D., 2012. The PTSD Checklist—civilian version: reliability, validity, and factor structure in a nonclinical sample. J. Clin. Psychol. 68, 699–713. http://dx.doi.org/10.1002/jclp.21845.

Davidson, J.R., Foa, E.B., 1991. Diagnostic issues in posttraumatic stress disorder: considerations for the DSM-IV. J. Abnorm. Psychol. 100 (3), 346.

Ehlers, A., Clark, D.M., 2000. A cognitive model of posttraumatic stress disorder. Behav. Res. Ther. 38, 319–345. http://dx.doi.org/10.1016/S0005-7967(99)00123-0.

Fani, N., Tone, E.B., Phifer, J., Norrholm, S.D., Bradley, B., Ressler, K.J., et al., 2012. Attention bias toward threat is associated with exaggerated fear expression and impaired extinction in PTSD. Psychol. Med. 42, 533–543. http://dx.doi.org/10.1017/S0033291711001565.

Felmingham, K.L., Rennie, C., Manor, B., Bryant, R.A., 2011. Eye tracking and physiological reactivity to threatening stimuli in posttraumatic stress disorder. J. Anxiety Disord. 25, 668–673. http://dx.doi.org/10.1016/j.janxdis.2011.02.010.

Foa, E.B., Huppert, J.D., Cahill, S.P., 2006. Emotional processing theory: an update. In: Rothbaum, B.O. (Ed.), Pathological Anxiety: Emotional Processing In Etiology And Treatment. Guilford, New York, pp. 3–24.

Foa, E.B., Ilai, D., McCarthy, P.R., Shoyer, B., Murdock, T., 1993. Information processing in obsessive–compulsive disorder. Cogn. Ther. Res. 17 (2), 173–189.

Gray, M.J., Litz, B.T., Hsu, J.L., Lombardo, T.W., 2004. Psychometric properties of the Life Events Checklist. Assessment 11, 330–341. http://dx.doi.org/10.1177/1073191104269954.

Iacoviello, B.M., Wu, G., Abend, R., Murrough, J.W., Feder, A., Fruchter, E., et al., 2014. Attention bias variability and symptoms of posttraumatic stress disorder. J. Trauma Stress 27, 232–239. http://dx.doi.org/10.1002/jts.21899.

Karl, A., Malta, L.S., Maercker, A., 2006. Meta-analytic review of event-related potential studies in post-traumatic stress disorder. Biol. Psychol. 71, 123–147. http://dx.doi.org/10.1016/j.biopsycho.2005.03.004.

Kessler, R.C., Sonnega, A., Bromet, E., 1995. Posttraumatic stress disorder in the national comorbidity survey. Arch. Gen. Psychiatry 52, 1048–1060. http://dx.doi.org/10.1001/archpsyc.1995.03950240066012.

Khoury-Malhame, Lanteaume, L., Beetz, E.M., Roques, J., Reynaud, E., Samuelian, J-Cl, et al., 2011. Attentional bias in post-traumatic stress disorder diminishes after symptom amelioration. Behav. Res. Ther. 49, 796–801. http://dx.doi.org/10.1016/j.brat.2011.08.006.

Kimble, M.O., Fleming, K., Bandy, C., Kim, J., Zambetti, A., 2010. Eye tracking and visual attention to threating stimuli in veterans of the Iraq war. J. Anxiety Dis. 24, 293–299. http://dx.doi.org/10.1016/j.janxdis.2009.12.006.

Lang, P.J., Bradley, M.M., Cuthbert, B.N., 1999. International Affective Picture System (IAPS): Technical Manual and Affective Ratings. Center for Research in Psychophysiology, Gainesville.

Lee, J.-H., Lee, J.-H., 2012. Attentional bias to violent images in survivors of dating violence. Cogn. Emot. 26, 1124–1133. http://dx.doi.org/10.1080/02699931.2011.638906.

Lee, J.-H., Lee, J.-H., 2014. Attentional bias towards emotional facial expressions in survivors of dating violence. Cogn. Emot. 28, 1127–1136. http://dx.doi.org/10.1080/02699931.2013.867834.

Lipp, O.V., Derakshan, N., 2005. Attentional bias to pictures of fear-relevant animals in a dot probe task. Emotion 5 (3), 365.

MacLeod, C., Mathews, A., Tata, P., 1986. Attentional bias in emotional disorders. J. Abnorm. Psychol. 95, 15–20. http://dx.doi.org/10.1037/0021-843X.95.1.15.

Milanak, M.E., Berenbaum, H., 2014. The effects of context on facial affect recognition. Motiv. Emot. 38, 560–568. http://dx.doi.org/10.1007/s11031-014-9401-x.

Mueller-Pfeiffer, C., Martin-Soelch, C., Blair, J.R., Carnier, A., Kaiser, N., Rufer, M., et al., 2010. Impact of emotion on cognition in trauma survivors: what is the role of posttraumatic stress disorder? J. Affect. Disord. 126, 287–292. http://dx.doi.org/10.1016/j.jad.2010.03.006.

Payne, K.A., Binik, Y.M., Amsel, R., Khalifé, S., 2005. When sex hurts, anxiety and fear orient attention towards pain. Eur. J. Pain 9 (4), 427.

Pineles, S.L., Shipherd, J.C., Mostoufi, S.M., Abramovitz, S.M., Yovel, I., 2009. Attentional biases in PTSD: more evidence from interference. Behav. Res. Ther. 47, 1050–1057. http://dx.doi.org/10.1016/j.brat.2009.08.001.

Pringle, H.L., Irwin, D.E., Kramer, A.F., Atchley, P., 2001. The role of attentional breadth in perceptual change detection. Psychon. Bull. Rev. 8, 89–95.

Resnick, H.S., Kilpatrick, D.G., Dansky, B.S., Saunders, B.E., Best, C.L., 1993. Prevalence of civilian trauma and posttraumatic stress disorder in a representative national sample of women. J. Consult. Clin. Psychol. 61, 984–991. http://dx.doi.org/10.1037/0022-006X.61.6.984.

Ruggiero, K.J., Del Ben, K., Scotti, J.R., Rabalais, A.E., 2003. Psychometric properties of the PTSD Checklist-Civilian version. J. Trauma Stress 16, 495–502. http://dx.doi.org/10.1023/A:1025714729117.

Schoenleber, M., Milanak, M., Schuld, E., Berenbaum, H., 2018. Rating procedures for improving identification of exposure to potentially traumatic events when using checklist measures. J. Aggress. Maltreat. Trauma. 1–20.

Wald, I., Shechner, T., Bitton, S., Holoshitz, Y., Charney, D.S., Muller, D., et al., 2011. Attention bias away from threat during life threatening danger predicts PTSD symptoms at one-year follow-up. Depress. Anxiety 28, 406–411. http://dx.doi.org/10.1002/da.20808.

Weathers, F.W., Litz, B.T., Huska, J.A., Keane, T.M., 1994. PTSD Checklist—Civilian Version. Behavioral Sciences Division. National Center for PTSD, Boston.

Williams, L.J., 1985. Tunnel vision induced by a foveal load manipulation. Hum. Factors 27, 221–227.