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Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 44(44)

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Publication Date
2022

Peer reviewed

Posttraumatic stress disorder and differences in eye gaze during a visual search task with cognitive load

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Abstract

Military deployments often expose personnel to highly threatening and stressful circumstances that put them at greater risk for developing Posttraumatic Stress Disorder (PTSD). PTSD may alter internal processes that affect one's ability to maintain situational awareness (SA). Military personnel conducting patrols must maintain SA to search for threats, with potentially life-threatening consequences if SA drops. Here an exploratory analyses was conducted to determine whether there were differences in performance and eye gaze behavior between those with and without PTSD during a free-viewing visual search task conducted in a virtual desktop environment. Cognitive workload was increased through an additional auditory Math Task. While performance did not differ significantly between the two Groups, key differences in gaze behavior were found. Results showed that those with PTSD viewed significantly more trail markers, had increased duration of individual fixations overall, and decreased fixation and saccade rates during the Math Task. These results appear consistent with previous findings suggesting those with PTSD may have difficulty disengaging from stimuli.

Keywords: Posttraumatic Stress Disorder; Visual Search; Cognitive Workload; Eye Tracking

Introduction

While deployed, military personnel must maintain situational awareness (SA) of the area and dynamic context of the environment unfolding around them. This is especially important when patrolling dangerous areas where there may be improvised explosive devices or other threats for which personnel must maintain vigilance in visual search. Deployments can expose individuals to greater risk of experiencing trauma and developing Posttraumatic Stress Disorder (PTSD). Unfortunately, PTSD does not just present itself when the personnel is safely home and under care, but it is also possible for those serving on active duty to be suffering from PTSD and not realize it (Wadsworth, 2022). Given the inherently stressful environment of serving in a deployment and the risk for developing stress disorders such as PTSD, it is important to understand how behavior and task performance may be affected by PTSD symptoms. This could be especially informative towards understanding individual differences to build models of cognitive state and inform adaptive autonomous agents that could act as team members or provide support to help an individual or team compensate for cognitive or performance detriments.

Symptoms associated with PTSD have been found to alter internal processes that affect SA. These include hypervigilance, an increased arousal, a pattern of behavior involving constantly scanning the environment, and a high responsiveness to stimuli, all of which are often studied with modified dot probe (Fani at al., 2012; Armstrong et al., 2013) or Stroop tasks (Constans et al., 2004). PTSD symptomology is associated with significant memory deficits (DeLaRosa et al., 2020; Nejati et al., 2018) and attentional biases towards negative or threatening cues across a variety of cognitive tasks (Fani et al., 2012; Armstrong et al., 2013; Constans et al., 2004). When presented with ambiguous stimuli, those with PTSD are more likely to interpret it as threatening (Bomyea et al., 2017). In the context of visual search, such negativity bias is characterized by an interference or difficulty disengaging from a threat rather than facilitating or enhancing threat detection (Pineles et al., 2007).

Free-viewing paradigms are increasingly being used to explore how viewing patterns inform one's perception of the environment (Helbing et al., 2020). Eye tracking provides a powerful and opportunistic way to unobtrusively measure eye activity and explore the perceptual, attentional, and cognitive processes involved in scene processing and thus SA (Williams & Castelhano, 2019). In accordance with studies that utilize more traditional research paradigms related to PTSD (e.g., Stroop tasks), a majority of PTSD studies that integrate eye tracking have found increased attention towards negative stimuli (Armstrong et al., 2013; Kimble et al., 2010) for those with PTSD. Specifically, those with PTSD have been found to have increased pupil size (Kimble et al., 2010) and fixations (Felmingham et al., 2011) when viewing negative or threatening stimuli. Stewart et al. (2013) found even with non-threatening stimuli, those with PTSD rated scenes as more threatening and those with increased hypervigilance engaged in more saccades and shorter fixations. Hypervigilance search conditions of neutral images have been associated with significantly more fixations, spread out over a greater percentage of the scene, and larger pupil size, suggesting that there is increased visual scanning and arousal even to neutral stimuli (Kimble et al., 2014). These findings highlight how we may leverage eye tracking to capture physiological responses and differences between those with and without PTSD to gain insight into how these Groups build SA and may process information and visual scenes differently.

In J. Culbertson, A. Perfors, H. Rabagliati & V. Ramenzoni (Eds.), *Proceedings of the 44th Annual Conference of the Cognitive Science Society*.

The overall goals of this study were to isolate and quantify neuro-physiological markers of SA in a complex visual search task and to understand how these markers are modulated by cognitive state. This paper presents analyses conducted to examine differences in eye tracking behavior during the visual search task, with and without additional cognitive load, between those with and without PTSD. Although this is exploratory, we expect differences in how each Group visually explored and navigated their environment. Specifically, we will examine differences in gaze patterns for targets and distractors to provide information on SA, and for trail markers to examine reliance on navigational cues.

Methods

Participants

Data from 76 participants was collected in two phases for this study. During phase one, 48 participants, consisting of 18 females, with mean (M) and ± standard deviation (SD) of ages in years (*M* = 37.44, *SD* = 12.29) and 30 males (*M* = 40.73, *SD* = 14.60), were recruited from the general population from the Los Angeles (LA) area. In phase two, 28 participants, consisting of 5 females (*M* = 39.80, *SD* = 8.64) and 23 males (*M* = 34.30, *SD* = 8.20), with military experience were recruited from Joint Base San Antonio (JBSA). All participants were 18 years of age or older, fluent in English, without colorblindness, and with normal hearing and vision or corrected-to-normal with contacts. Eligible participants received a $50.00 Amazon gift card for their participation. This study was conducted in accordance with the accredited Institutional Review Board at the U.S. Army Research Laboratory (ARL) and conducted in compliance with the U.S. ARL Human Research Protection Program (ARL 19-122). All participants reviewed and signed an IRB approved consent form prior to participation.

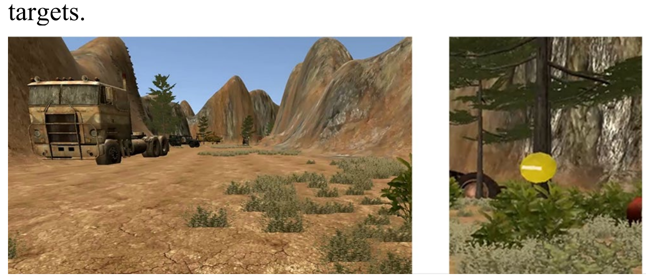
A subset of the data was extracted to conduct the exploratory analyses which are the focus of this paper. To create this subset, 13 individuals categorized with PTSD (*M* = 35.5, *SD* =13.2) were age and gender matched to 13 Non-PTSD individuals (*M* = 35.5, *SD* =11.5). Of those 26 individuals, 18 were recruited from LA and 8 from JBSA. Groups did not significantly differ in mean age (Independent t-test, $p = 0.89$). Non-PTSD individuals were matched based on reported gender and were ± 10 years compared to their PTSD counterparts. If more than one participant match was available for a PTSD participant, then the Non-PTSD match whose assigned target allowed for balanced number of target types across the Groups was chosen (see below). There were seven females and six males included in both Groups.

Note, while this paper focuses on a subset of the data, it also focuses on the primary visual and auditory tasks (described below). A more comprehensive description of the full study and primary results may be reviewed here: Enders et al., 2021.

Procedure

Visual Search and Navigation Task This study followed a between-subjects design, where subjects were randomly assigned one of four target types (motorcycle, Humvee, aircraft, and furniture) to search for in a free-viewing virtual environment resembling an outdoor canyon scene (Figure 1a) designed in a Unity 3D environment (Unity Technologies). Targets were pseudo-randomly distributed throughout the virtual environment amongst distractor items. The inclusion of distractor items is important for better mimicking of a real-world environment where targets are not present in isolation. Any object besides those assigned as targets to the participant or trail markers (e.g., truck, barrel, etc.) were labeled as distractor items. Regarding targets, the same model was used for all motorcycle targets and Humvee targets, whereas different models that varied in size were used for the aircraft and furniture targets (the original intent of the larger study was to look at how target variation impacted eye tracking metrics). For more information on the design of the virtual environment, please see Enders et al. (2021). The two Groups (PTSD and Non-PTSD) were the same in distribution of target assignment. Each Group contained three participants searching for motorcycles, seven searching for Humvees, two searching for aircrafts, and one searching for furniture targets. Participants were tasked with searching for, identifying, and mentally counting the total number of their assigned target type while navigating the virtual environment presented on a desktop computer (Figure 1a).

Each participant, regardless of target assignment, navigated the same virtual environment. Throughout the task, participants were able to freely move at their own pace and explore the virtual environment using the keyboard and mouse to move and adjust camera angle. Participants were instructed that they would be guided by the trail markers (Figure 1b) placed along the virtual environment to help orient them towards the end of the path. At the end of the task, participants verbally reported the total number of observed targets.



(a) (b)

Figure 1: Examples of the virtual environment (a) and trail marker (b).

Auditory Math Task To increase cognitive workload while counting targets during the visual search task, an additional numeric based task (the auditory Math Task) was simultaneously presented at approximately the eight-minute mark. Participants were presented over headphones with an auditory recording of a set of three to four whole numbers with values ranging from 0 to 9. Participants were required to mentally sum the numbers and verbally report the answer to the researchers. During the Math Task, participants were instructed to continue with their primary task, navigating and identifying targets within the virtual environment. All participants included in this paper's analyses completed three sets of the auditory Math Task, with an 8-30 second break between each set presentation.

PTSD Assessment The presence of PTSD symptoms was assessed using Weathers et al.'s (1994) civilian version of the PTSD Checklist (PCL-C). While the gold standard for PTSD diagnoses is a structured clinical interview, the PCL can be scored to provide a provisional PTSD diagnoses (U.S. Department of Veteran Affairs, 2021) and has been used in previous research to assess PTSD (Pineles et al., 2007; Pineles et al., 2009). The PCL-C is a standardized self-report measure comprised of 17 items corresponding to key symptoms of PTSD aligned with the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV). Responses are provided along a five-point Likert scale ranging from "not at all" (1) to "extremely" (5). In this study, participants with PTSD were defined as those who scored greater than 29 on the PCL-C (PCL-C score, M = 40.23 SD = 12.49). Those who score at least 30 have moderate to moderately high severity of PTSD symptoms of PTSD. Of those with PTSD included in this sample, eight were recruited from LA (M = 45, SD = 14.02) and five from JBSA (M = 32.6, SD = 2.41).

Physiological Assessment: Eye Tracking The Tobii Pro Spectrum monitor (EIZO FlexScan EV2451) and eye tracking system (300 Hz) was utilized in this study to capture eye movement behavior. This is a commercially available and screen-based eye tracker comprised of infrared emitters and high-frame-rate image sensors that allow the measurement of three degrees-of-freedom eye positions and two degrees-of-freedom gaze tracking, as well as eye blink detection and pupil diameter monitoring. Blinks were defined as gaps ranging from 50-500ms in the fixation data (Holmquivist et al., 2011) and saccades were detected utilizing standard velocity-based algorithms (Engbert and Kliegl 2003). Fixations of less than 100ms were discarded post saccade detection and not utilized in the analysis (Andersen et al., 2012). Eye Tracking Dropouts were defined as those gaps in fixation data greater than 500ms. These dropouts indicate fixations offscreen or the participant moving outside the bounds of the eye tracker, and thus may indicate task disengagement.

Results

Statistical Analyses

Distribution of the data was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests for normality. Parametric tests were conducted for interval data that were normally distributed and non-parametric tests were conducted for basic analysis using non-normally distributed data or non-interval data. Non-parametric tests were utilized to compare the PTSD and Non-PTSD Groups for the following variables: Math Score, Self-Reported Assigned Target Count (total number of observed targets verbally reported), Gaze-Validated Target Counts (validated meaning having at least one qualifying fixation) and the Total Distance Traveled (total path distance of the avatar in meters). The Gaze-Validated Target Count confirmed that an object was seen by the participants and could be used as a validation check for the self-reported target count. For more information on how eye tracking data was used to identify fixations and on the calculation of variables and their definitions, please see Enders et al. (2021).

For variables that were non-normally distributed and were utilized in the more complex analyses (PTSD vs Non-PTSD Groups, during and outside the Math Task), data was transformed prior to analysis. Non-transformed data is provided in the Figure 6 for visualization of the raw data. A log transformation was applied to the Eye Tracking Dropout Rate and a reciprocal transformation was applied to the Eye Tracking Dropout Mean Duration data. Outliers (± 3 SDs) were removed prior to statistical analysis. For this reason, one PTSD individual was removed from analysis of Mean Dwell Time on Objects (Math Task) and the Eye Tracking Dropout Duration variables, and one Non-PTSD individual was removed from the analysis of Mean Dwell Time on Objects, Duration of Individual Fixations, Blink Rate, and the Position Velocity (avatar speed through the virtual environment) variables. In addition, two Non-PTSD individuals did not have Eye Tracking Dropout Rate or Eye Tracking Mean Duration data. IBM SPSS Statistics for Windows (Version 22, Armonk, NY: IBM Corp, Released 2013) software was utilized to carry out all statistical analysis and the significance threshold was set to 0.05.

Results

Three separate Independent-Samples Mann-Whitney U Tests determined the effect of Group (PTSD, Non-PTSD) on Self-Reported Assigned Target Counts, Gaze-Validated Target Counts, and Gaze-Validated Distractor Counts. There was no significant effect of Group on either Self-Reported Assigned Target Counts (Z = -0.30, p = 0.799), Gaze-Validated Target Counts (Z = -0.730, p = 0.511), or Gaze-Validated Distractor Counts (Z = -0.693, p = 0.511). Two separate Related-Samples Wilcoxon Signed Rank test determined that there was no difference between the Self-Reported Assigned Target Count and the Gaze-Validated Target Count for either the PTSD Group (Z = -0.40, p = 0.688) or the Non-PTSD Group (Z = -1.83, p = 0.068). The median ± interquartile range (IQT) for Self-Reported Assigned Target Counts was 15.0 ± 1.25 for the PTSD Group and 15.5 ± 2.75 for the Non-PTSD Group. The median ± interquartile range (IQT) for Gaze-Validated Target Counts was 14 ± 1 for the PTSD Group and 15 ± 1 for the Non-PTSD Group. The median ± interquartile range (IQT) for Gaze-Validated Distractor Counts was 135 ± 27 for the PTSD Group and 147 ± 29 for the Non-PTSD Group.

An Independent Samples T-test determined the effect of Group on the Number of Trail Markers viewed (gaze-validated) during navigation (Figure 2a). The PTSD Group (14 ± 3.3) viewed a significantly greater Number of Trail Markers compared to the Non-PTSD Group (11 ± 4.3) ($t(22) = -2.25$, $p = 0.035$). An Independent Samples Mann-Whitney U Test determined that there was no significant difference on Total Distance Traveled (Figure 2b) in the virtual environment between the PTSD (2,693 ± 145.1 m) and Non-PTSD Group (2,685 ± 285.4 m) ($Z = -0.897$, $p = 0.390$).

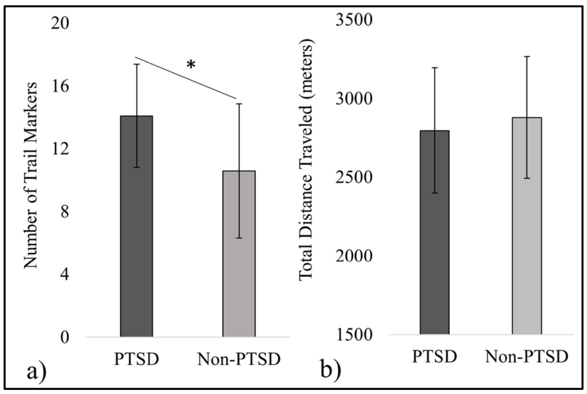


Figure 2. Number of Trail Markers viewed by Group (a) and the Total Distance Traveled by Group (b).

Two separate two-way multivariate analysis of variance (MANOVAs) assessed how Group impacted non-normalized and normalized Mean Number of Fixations and Mean Dwell Time on Fixation Object (targets or distractors) during navigation (Figure 3a – b, d - e). Overall, non-normalized Mean Number of Fixations and Mean Dwell Time were significantly dependent on Fixation Object ($F(2, 23) = 13.69$, $p = 0.000$), but were not significantly impacted by Group ($F(2, 23) = 0.15$, $p = 0.859$) or the interaction of Fixation Object and Group ($F(2, 23) = 0.14$, $p = 0.867$). Follow-up with univariate ANOVAs showed that both PTSD and Non-PTSD Groups significantly increased Mean Number of Fixations ($F(1, 24) = 16.67$, $p = 0.000$) and Mean Dwell Time ($F(1, 24) = 27.72$, $p = 0.602$) on targets over distractors (Figure 3a – b). Two additional mixed-model ANOVAs determined the effect of Fixation Object, Group, and the interaction of Fixation Object and Group on normalized and non-normalized Mean Distance (Figure 3c, f). Mean Distance (the distance between the participant and the object in the virtual environment during that fixation) was significantly dependent upon Fixation Object ($F(1, 24) = 4.55$, $p = 0.043$) but not Group ($F(1, 24) = 2.19$, $p = 0.152$) or the interaction of Group and Fixation Object ($F(1, 24) = 0.39$, $p = 0.539$). Both Groups significantly decreased distance when focusing on targets compared to distractors (Figure 3c). Because the Mean Number of Fixations, Dwell Time, and Distance outcomes were significantly impacted by object size and those assigned to larger targets would naturally have an unbalanced advantage to find targets in the environment, a normalization technique (subtraction from the mean across all participants for each individual object not considered to be a target) was applied for the comparison of target versus distractor and also analyzed. The same findings were found with normalized Mean Number of Fixations, Mean Dwell Time, and Mean Distance (Figure 3d - f) as were found with the non-normalized data.

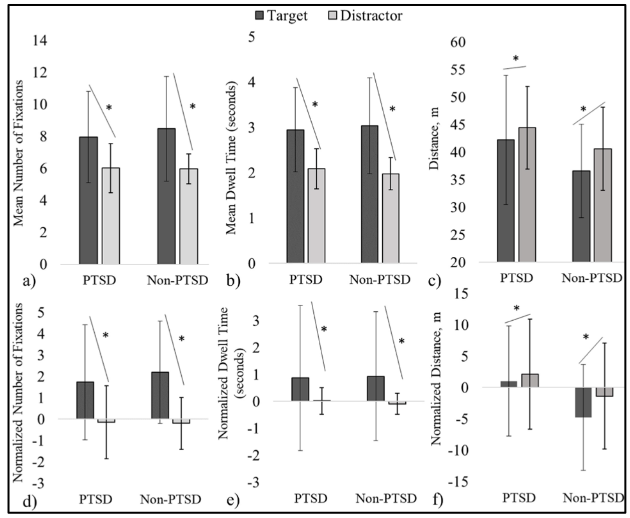


Figure 3. Number of Fixations (a, d), Dwell Time (b, e), and Distance by Group (c,f).

Workload Related Outcomes

Performance on the Math Task, Math Task Score (1 point awarded for each set of Math Task correctly summed), was compared across Groups with a Mann-Whitney U Test. The PTSD Group (2.0 ± 2) and the Non-PTSD Group (2.5 ± 1) did not significantly differ on Math Task Score ($Z = -0.683$, $p = 0.551$). Two separated MANOVAs showed that the Mean Number of Fixations and Mean Dwell Time on all objects (not separated out to targets or distractors) was significantly dependent upon the Math Task ($F(2, 21) = 13.84$, $p = 0.000$) but not Group ($F(2, 21) = 1.42$, $p = 0.264$) or the interaction of Group and Math Task ($F(2, 21) = 0.36$, $p = 0.704$). Follow-up using Univariate ANOVAs showed that both Groups significantly decreased the Number of Fixations ($F(1, 22) = 25.23$, $p = 0.000$) and the Dwell Time ($F(1, 22) = 9.43$, $p = 0.006$) on objects in the environment during the Math Task.

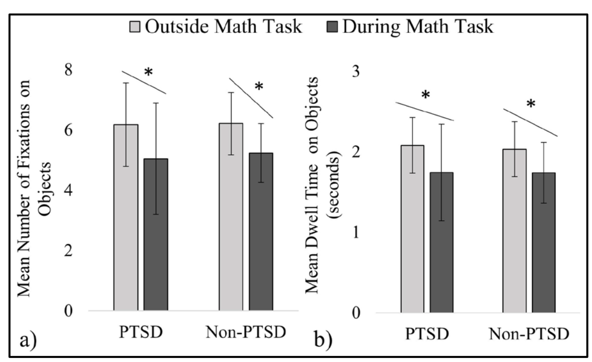


Figure 4. Number of Fixations (a) and Dwell Time (b) outside/during the Auditory Math Task by Group.

As these analyses were exploratory, we were interested in any possible effects that may warrant further investigation in a follow-up study. Therefore, 12 separate Two-Way Mixed ANOVAs examined the effect of Math Task and Group and the interaction of Math Task and Group on the Duration of Individual Fixations, Fixation Rate, Object Rate (the scanning of unique, new objects), Saccade Rate, Saccade Magnitude (the angular distance of scanning behavior), Saccade Angle (with 0° set as the horizon), Blink Rate, Eye Tracking Dropout Rate, Eye Tracking Dropout Mean Duration, the Proportion of Fixations on Objects (as opposed to on terrain or the sky) in the Environment, Pupil Diameter, and Position Velocity. The Duration of Individual Fixations was significantly dependent upon Group where the PTSD Group overall had increased Duration of Individual Fixations compared to the Non-PTSD Group ($F(1, 23) = 5.49$, $p = 0.028$, Figure 5). Math Task was a significant main effect for Fixation Rate ($F(1,24) = 16.16$, $p = 0.001$), Object Rate ($F(1,24) = 8.58$, $p = 0.007$), Saccade Rate ($F(1,24) = 18.34$, $p = 0.000$), Saccade Magnitude ($F(1,24) = 8.16$, $p = 0.009$), Blink Rate ($F(1,23) = 11.66$, $p = 0.002$), Pupil Size ($F(1,24) = 35.61$, $p = 0.000$), and Position Velocity ($F(1,23) = 37.36$, $p = 0.000$). Both Groups showed significantly increased Object Rate, increased Saccade Magnitude, increased Blink Rate, increased Pupil Size, and decreased Position Velocity during the Math Task compared to outside the Math Task (Figures 5 and 6). There was a significant Group and Math Task interaction for Fixation Rate ($F(1,24) = 29.80$, $p = 0.000$) and Saccade Rate ($F(1,24) = 12.40$, $p = 0.002$). Only the PTSD Group significantly decreased Fixation Rate and Saccade Rate during the Math Task, whereas the Non-PTSD Group maintained their Fixation Rate and Saccade Rate independent of increased cognitive load. All other comparisons were not statistically significant.

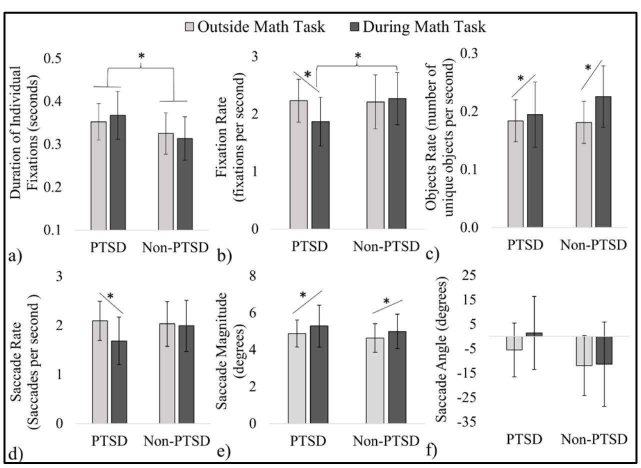


Figure 5. Eye tracking metrics 1 outside/during the Auditory Math Task by Group (a-f).

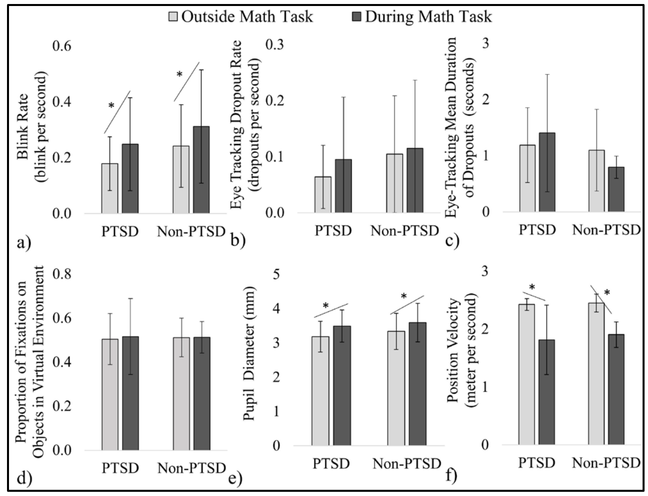


Figure 6. Eye tracking metrics 2 outside/during the Auditory Math Task by Group (a-f).

Discussion

Overall, the PTSD and Non-PTSD individuals performed the visual search task and the auditory Math Task similarly. However, the PTSD Group had an increased duration of individual fixations compared to the Non-PTSD Group. The PTSD Group also visually fixated on more trail markers as they navigated the environment compared to the Non-PTSD Group. This did not translate to a significant difference in Total Distance Traveled between the two groups.

When cognitive workload was increased with the Math Task, both Groups tended to perform the task similarly with a few notable differences. Individuals in both Groups significantly increased their scanning of unique or new objects (Object Rate) by reducing the Number of Fixations and Dwell Time on each object during the Math Task and decreasing their speed of movement through the environment (Position Velocity). However, only the PTSD Group appeared to adapt to the increased cognitive workload by decreasing Fixation Rate and Saccade Rate during the Math Task whereas there was no significant change for the Non-PTSD Group. Regardless of this decrease in Fixation Rate and Saccade Rate for the PTSD Group, both Groups showed an increase in their Blink Rate and pupil dilation. Although not significant, there was a tendency for the PTSD Group to keep saccades moving along or near the horizon (where a positive Saccade Angle is above the horizon and a negative Saccade Angle would be below the horizon) compared to the Non-PTSD Group ($p = .06$ for Group main effect).

Findings indicated that the PTSD Group had overall (not dependent on cognitive load task) longer individual fixation durations than the Non-PTSD Group. We speculate that this may indicate an increased difficulty disengaging from one stimuli before switching to the next. This appears to be consistent with Pineles et al. (2007) assertion that the attention bias associated with PTSD is characterized by difficulty disengaging from threatening stimuli. Rather than facilitating the detection of threats this leads to increased attentional interference and difficulty redirecting attention to task-related performance (Pineles et al. 2007; Pineles et al. 2009). Although our stimuli were not designed to be threatening in this study *per se*, some targets included (such as military Humvees) could be perceived as such. We see further evidence of this in the Math Task with increased cognitive load, where those with PTSD significantly decreased fixation and saccade rate. Together, the decrease in fixation and saccade rate along with the overall decrease in individual fixation duration indicates a difference in compensatory strategies between the two Groups. This also suggests this Group may have experienced increased difficulty disengaging from stimuli while meeting the two external task demands. The PTSD Group also viewed a significantly greater number of trail markers which may also indicate a difficulty disengaging from one stimulus (navigation-related) to focus on targets and objects (visual search-related).

Alternatively, as noted in our previous report (Enders et al., 2021), it is possible that our task design (self-paced visual search) allowed participants to give precedence to the auditory stimuli of the Math Task over the visual task (Duniforn et al., 2016; Robinson & Sloutsky, 2010). Research suggests that visual dominance effects, when simultaneously presenting auditory and visual stimuli, may be restricted to visual tasks requiring an explicit response. Therefore, as our visual search task did not require an active response during the navigation (response stating count of targets was reported at the end), this may have allowed participants to preferentially attend to the auditory task (Robinson et al., 2010). In situations of auditory dominance, auditory stimuli may automatically engage attention and delay visual processing (Dunifon et al., 2016). We speculate that this effect may be more pronounced in the PTSD Group over the Non-PTSD Group, causing the PTSD Group to assign more cognitive processes to focus on the Math Task and thus have less resources to extend to simultaneously processing the visual search task. It is also possible that the Math Task itself would have been perceived as the more threatening task, thus attracting more of the cognitive resources and attention allotted by the PTSD Group.

Limitations

A significant limitation of this study was that it was not explicitly designed with studying PTSD as one of its main aims and therefore participants were not explicitly recruited for having PTSD. We were therefore limited to using a smaller subset of the data which left us with a small sample size to include in our analyses. Notably, our sample was further restricted due to the Coronavirus pandemic halting data collection entirely at our LA site. While we are primarily motivated to understand these differences in a military context, and because this was an exploratory analyses and not the primary hypotheses guiding this research, our sample contained both persons with and without military experience. It is possible that there could be differences between these two populations and effects of different origins of trauma (e.g., childhood onset, domestic violence, military, etc.). Critically, because we wanted to compare PTSD across our study participants, we used the PCL-C across all participants regardless of whether they were general population or had military experience. There is however a military specific version of the PCL, the PCL-Military (PCL-M), which may have been more appropriate to use with that population.

Future Directions

We are currently building off of this study to design a follow-on study that will explicitly investigate the behavioral and physiological markers of SA and their dependence on cognitive state (modulating stress) across visual search and related tasks, comparing those with and without PTSD. This study will also more explicitly examine the threat-bias associated with PTSD, investigating how behavioral and physiological responses differ between neutral and threatening contexts. We will specifically recruit those with military experience and assess PTSD using the PCL-M. This study will also include additional metrics closely related to PTSD (e.g., comorbid diagnoses) and military experience (e.g., combat exposure). This will allow us to get a more refined and accurate picture of the differences between these two Groups within a population with military experience. Although we do not plan to include an auditory task such as the Math Task, our virtual environment does introduce contextually relevant sounds. In order to maintain the precedence of the visual task, participants will click to provide a response when they see a target in addition to reporting the total number of targets they counted throughout each condition.

Conclusion

This was an exploratory analysis to determine whether significant differences existed in eye gaze behavior between those with and without PTSD during a visual search task within a naturalistic environment with modulated cognitive workload. Results revealed Groups did not differ significantly on their performance for target count or the Math Task. The two Groups also similarly significantly increased their mean number for fixations and mean dwell times on targets over distractors during the visual search task and significantly decreased their physical distance (were closer) when fixating on targets compared to distractors. However, key differences in gaze behavior were found between the two Groups such that those with PTSD viewed significantly more trail markers, had increased duration of individual fixations overall, and decreased fixation and saccade rates during the Math Task. Results appear consistent with previous findings suggesting those with PTSD may have difficulty disengaging from stimuli. These results may have important implications for considering how stress disorders such as PTSD may impact performance during high vigilance tasks (e.g., searching for targets) where differences in behavior may have significant consequences (e.g., military patrol) and may be compensated for in the future through the advances in supportive autonomous teammates.

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