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Behavioral Hypervigilance in a Normative Population

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Abstract

Hypervigilance is a physiological and behavioral state characterized by being constantly on guard or alert for potential danger. Although hypervigilance is conceptualized as a symptom of trauma-related disorders, it also can occur in a normative population. To distinguish between normative hypervigilance and trauma-related hypervigilance, it is necessary to investigate the frequency and contexts in which hypervigilance occurs in trauma-exposed and non-trauma-exposed people. 372 participants (123 trauma-exposed and 249 non-trauma-exposed) completed an online questionnaire assessing the frequency of behavioral hypervigilance in everyday life contexts. Trauma-exposed participants reported greater levels of hypervigilance in 3 contexts, including when in a new or unfamiliar place, scanning the crowd when in public or new places, and having trouble falling or staying asleep. However, trauma-exposed and non-trauma-exposed participants reported experiences of hypervigilance at a similar frequency across most contexts.

Behavioral Hypervigilance in a Normative Population

Hypervigilance is a behavioral state characterized by being constantly on guard or alert for potential danger. Hypervigilant behaviors, or indices of hypervigilance, include constant visual scanning for threat in public places, an alertness for unusual sounds, noting of entrances and exits in enclosed places, constant checking of locks inside the home, or investigation of circumstances that seem out of the ordinary (Kimble et. al, 2010). This is normative hypervigilance, and it can occur in appropriate settings. For example, if it becomes obvious that there is a rodent inside of a home, visual scanning can help in finding the rodent, and alertness for unusual sounds will help detect where the rodent is. This type of hypervigilance is not pathological and it is a common experience. However, non-normative hypervigilance refers to this occurring too often, or more than is normal, especially in the absence of a threat.

Although hypervigilance to threat is adaptive in potentially dangerous situations, it can be maladaptive when activated in non-threatening environments, where it can be disruptive to daily life. Vigilance, or the ability to sustain attention and respond appropriately to demands and changes in the environment (Shaw, et al., 2010), requires mental load and can drain information processing resources (Warm, Parasuraman & Matthews, 2008).This has clinical implications, because this would suggest that people suffering from trauma-related symptoms or any condition with increased vigilance, or hypervigilance, have fewer resources to use for other important things, which can prevent them from fully participating in their lives. For example, if a soldier is hypervigilant while deployed, he/she can aid in threat detection and save lives, but if the soldier is hypervigilant while at home with his/her family and focused on detecting threat in a non-threatening environment, it can lead to feeling distant in family settings and missing out on what

is going on in the environment. It can also lead to the soldier never being able to feel calm and relaxed, even in environments that should be relaxing.

1.2 Hypervigilance and Attention

Selective attention refers to the tendency for organisms to selectively process a subset of sensory input (Moore & Zirnsak, 2017). This can occur in the presence of a threat, but in relation to hypervigilance, selective attention refers to the narrowing of attention onto a specific threatening stimulus in order to react appropriately. However, hypervigilance by nature is a state of overt awareness of any potential of a threat, so it can occur in an environment where there is no threat (Moore & Zirnsak, 2017). Selective attention is a key factor in anxiety-related psychopathologies, including trauma-related disorders, because the brain is preparing the body to selectively attend to the anxiety-producing stimuli. In contrast, a person with hypervigilance is engaging in behaviors that will help them pay special attention to potential threats whether they are present or not. For example, eye scanning behaviors help visually perceive threats, and a person with hypervigilance might engage in eye scanning behaviors whether they are in an environment where a threat might occur or in an environment deemed safe.

There are two prominent theories to explain the engagement of threatening stimuli in relation to anxiety- the vigilance avoidance hypothesis and the attention maintenance hypothesis. Both of them explain how anxiety and arousal can arise from threat detection. Some researchers believe that these two hypotheses are mutually exclusive, while others believe that they can exist at the same time (Weierich, Treat & Hollingworth, 2008). The vigilance avoidance hypothesis proposes that when someone first perceives threatening stimuli they engage with it instantly, then subsequently avoid engaging with it in order to mitigate the anxiety of engaging with the specific stimuli. However, avoiding the specific stimuli prevents the person from habituating to the

stimuli or object reappraisal, which are both processes that could ease the anxiety, thus ensuring that the threat retains its ability to provoke negative reactions.

The other prominent theory, the attention maintenance hypothesis, suggest that when someone perceives threatening stimuli, an anxious person will fixate and maintain attention toward the stimuli and disengage from it more slowly than non-threatening stimuli. This suggests that the anxiety is maintained because of the prolonged engagement with the stimuli. Whether one or both of these theories are correct, both can speak to the early building blocks of hypervigilance by way of a learned threat.

1.3 The Stress Response and Hypervigilance

The body's stress response can point to the development of trauma-related symptoms, including hypervigilance. When humans are faced with a stressor, the body enacts a 'fight, flight or freeze' response. The hypothalamic- pituitary-adrenal axis is activated, and the hypothalamus signals the release of corticotropin-releasing hormone (CRH), which stimulates the release of adrenocorticotropic hormone (ACTH), which stimulates the release of glucocorticoids, which help prepare the body to fight, run away, or freeze. The sympathetic nervous system is also activated, which causes the release of epinephrine and norepinephrine (Sapolsky, Romero & Munck, 2000). When these hormones travel throughout the body, their main focus is on inhibiting bodily responses that could hinder the fight flight or freeze response, and encouraging body responses that could help in survival. For example, they help inhibit digestion, which is unnecessary while facing a severe threat, but cause vasoconstriction and increased heart rate, helping blood plump faster and stronger to muscles that can help with escaping or combatting threat (Sapolsky, 2004). Epinephrine causes a surge of arousal in a stressful situation. This leads

to an increase in perception and processing of the environment and threating stimuli (Henckens, Hermans, Pu, Joëls & Fernández, 2009), the basis of hypervigilance.

The stress response is adaptive when it occurs in an appropriate time and place because can aid in survival. Hypervigilance that occurs during a threat or when it's possible that a threat can occur is adaptive hypervigilance. However, if the stress response occurs too often in non-threatening environments, such as in people with trauma-related disorders, it is maladaptive because necessary bodily processes are inhibited and unnecessary bodily responses, such as hypervigilance, are encouraged. This activation of the stress response too often can also encourage an increase in hypervigilance in non-threatening situations, which points to a cycle of an overactive stress response leading to more maladaptive hypervigilance (Silove, 1998).

1.4 Behavioral Theories of Trauma-Related Hypervigilance

Hypervigilance can occur in people who are trauma-exposed and is conceptualized as a symptom of trauma-related disorders. Trauma-related disorders can occur in people who have been exposed to a traumatic event, such as a physical assault, a shooting, natural disaster, war, etc. Trauma-related disorders are characterized by intrusion symptoms, persistent avoidance of stimuli associated with the traumatic event, negative alterations in cognition or mood and hyperarousal (American Psychiatric Association, 2013). Hypervigilance is a key factor of diagnosis of trauma-related disorders, and is categorized as an alteration in arousal or reactivity.

Behavioral theory can also explain the development of chronic hypervigilance. Behavioral researchers believe that when the stress response is activated too often, it can leave lasting impressions on the brain, which causes some of the processes driving trauma symptoms to be triggered more often and in non-threatening situations (Lissek & van Meurs, 2015). Behavioral theory, and more specifically classical conditioning, can account for development of

trauma-related symptoms as well, including hypervigilance. In regards to trauma, the theory is that a traumatic event (the unconditioned stimulus) occurs, thus teaching the trauma-exposed person that factors related to event (conditioned stimuli) are something to fear. This leads someone to constantly be on guard for these conditioned stimuli. For example, if a hurricane hits (the unconditioned stimulus), the victims may consider high winds and hot weather stimuli to fear (Taylor, 2017).

Another behavioral theory behind the development of trauma- related symptoms such as hypervigilance is non-associative learning. Associative learning such as fear conditioning hinges on the basics of learning theory. Non-associative fear learning refers to the changes in reactivity that can occur after something potentially traumatic. For example, failure to habituate refers to the impaired ability for somebody to adapt or habituate to novel stimuli. For someone with combat-related trauma exposure, this could mean a failure to learn that stimuli that are potentially threatening in a warzone are not threatening when back at home. This could lead to hypervigilance because the person is constantly on a lookout for potentially threatening stimuli for fear that the stimuli will always lead to a traumatic experience (Lissek & van Meurs, 2015). Another theory of non-associative fear learning is stress sensitization. The theory is that trauma induces an autonomic hyper-excitability to both trauma related stimuli and neutral stimuli, such as lights and sounds (Lissek & van Meurs, 2015). These theories of non-associative fear learning are building blocks of both hypervigilance and alterations in arousal and reactivity, the symptom cluster in which hypervigilance lies in the diagnosis of trauma-related disorders.

The development of hypervigilance fits with proposed etiological and evolutionary models of trauma-related disorders. Jones and Barlowe (1990) describe development of hypervigilance as a learned alarm followed by anxious apprehension. A learned alarm is a

conditioned response to either interoceptive or external cues. This could be an alarm towards actual threat or something non-threatening- it just matters that it was a conditioned response. After a learned alarm is developed, anxious apprehension keeps the person nervous about encountering these learned alarm triggers. They will then think that these learned alarms can happen at any time, thus leading to a need to be constantly watching out for them, resulting in hypervigilance. Jones and Barlowe argue that hypervigilance cannot develop without these learned alarms accompanied by anxious apprehension (Jones & Barlowe, 1990).

Studying hypervigilance among veterans with trauma-related disorders can be helpful in understanding hypervigilance in trauma-exposed people. Hypervigilance is common among veterans potentially because of the way that they are trained (Kimble, Fleming & Bennion, 2013), or because of the emphasis on constant vigilance while deployed. The military requires intense vigilance at all times, because anything potentially out of the ordinary could mean imminent threat. However, studies did not find that military training was a predictor of hypervigilance. Formerly deployed veterans had greater hypervigilance levels than non-veterans with other types of trauma exposure, suggesting that deployment itself, rather than trauma exposure, is a predictor of hypervigilance (Kimble, Fleming & Bennion, 2013). This suggests that hypervigilance is a factor of retaining constant vigilance while deployed.

Trauma-related hypervigilance happens when someone is so on guard and on alert for danger that they cannot avoid focusing on their surroundings, which includes visually scanning their environment. Eye tracking studies show that people with trauma-related disorders fixate more on threatening information than controls when shown threatening and neutral words. On trials in which a threat word was present, subjects with trauma-related disorders showed more eye fixations on the threat word than the controls did (Bryant, Harvey, Gordon & Barry, 1995).

This supports the link between trauma, selective attention, and hypervigilance, in suggesting that those with trauma-exposure are more apt to focus on potentially threatening information when present than those without trauma-exposure.

Increased pupil dilation is an index of hyperarousal (Cascaridi et. al, 2015), which is the symptom cluster that hypervigilance lies in. Veterans that report higher levels of trauma symptoms had more pupil dilation when looking at negatively valenced pictures of either war scenes or motor vehicle accidents and spent more time looking at them than at neutral images. They also fixated on the war scenes or motor vehicle accident pictures first over the neutral images (Kimble et al, 2010). Pupil dilation is found in a state of hyperarousal, supporting the link between hypervigilant behaviors and hyperarousal. These results also support the idea that veterans are on the lookout for dangerous situations.

Furthermore, those with trauma-related disorders have quicker and more precise processing of threat related stimuli compared to a normative population. People with trauma-related disorders identify trauma-related stimuli better than they do neutral stimuli on blurred picture identification tasks. Trauma-exposed participants who do not have a trauma-related disorder perform similarly to non-trauma-exposed participants on blurred picture identification tasks (Kleim, Ehring & Ehlers, 2012). Further research needs to be done to address the reasons behind these findings, but it could be because the participants give these types of stimuli preferential attention.

1.5 Current Study

Hypervigilance as a symptom has been studied in people with trauma-related disorders, however it also can occur among a normative population in certain contexts. For example, when somebody is walking home late at night, they may engage in eye scanning behaviors in order to

be alert for a potential mugging. Furthermore, while a clinical level of hypervigilance isn't necessarily found in a normative population, the building blocks of hypervigilance are, such as selective attention and vigilance. This suggests that a normative population can be susceptible to hypervigilance as well, though there are still gaps in the literature related to the differences between normative and non-normative hypervigilance, especially in a trauma-exposed population. People without trauma-related disorders have been found to show symptoms of hypervigilance on a brief measure of hypervigilance (Bernstein et al., 2015).

Previous research has suggested that there are racial differences in development of trauma related symptoms. Trauma-exposed Black people have a higher risk of symptom development, while trauma-exposed Asian people have a lower risk (Roberts et. al, 2011). Though the reasons for these findings are unclear, it could relate to socioeconomic status and accessibility to mental health tools pre-traumatic event. This would suggest that perhaps there are racial differences in development of hypervigilance.

Previous literature has also discussed the gender differences in developing and expressing trauma-related symptoms. For example, among 9/11 first responders, there are different risk factors for the development of trauma-related disorders, such as Hispanic ethnicity for men, and witnessing horror and having education less than a college degree for women (Bowler et al., 2010). This suggests that men and women experience trauma differently and therefore experience symptoms differently, which would point to potential gender differences in hypervigilance.

The purpose of this study is to understand hypervigilance among both trauma-exposed and non-trauma-exposed populations. To distinguish between normative hypervigilance and trauma-related hypervigilance, it is necessary to investigate the frequency and contexts in which

hypervigilance occurs in trauma-exposed and non-trauma-exposed people, so that there can be a baseline for what is considered normative hypervigilance. We hypothesized that non-trauma-exposed (NTE) participants would report hypervigilance at similar frequencies in some circumstances compared to trauma-exposed (TE) participants. We also hypothesized that there would be both racial and gender differences in hypervigilance.

2. Method

2.1 Participants

We recruited 372 diverse participants (trauma-exposed, *n*=123; non-trauma-exposed, *n*= 249) who were fulfilling credit requirements for psychology class at an urban university.

2.2 Procedure

Participants completed the questionnaire online through the survey software Qualtrics. After consent, participants completed the general Behavioral Hypervigilance Questionnaire (BHQ), which was modeled after the Hypervigilance Questionnaire (HQ) and the Brief Hypervigilance Scale (BHS), an abridged version of the HVQ (Bernstein et al., 2015). The BHQ consisted of 30 questions assessing behavioral hypervigilance. The first 12 questions measured frequency of indices of hypervigilance with items such as "when I am in public or in new places, I need to scan the crowd or the environment," and "I feel constantly on guard, watchful and/or super-alert." Respondents checked either "Not at all true", "Sometimes true", "Often true", "Very often true", or "Always true" for each experience. The next section assessed how frequently the participant felt on guard, watchful, or alert during 13 contexts, such as "when it's dark outside," "at work," and "when encountering police or an area with high police presence." Respondents checked either "Not at all," "Infrequently," "Occasionally," "Often," "Very often," or "Extremely often" for each context. Questionnaire items are reported in Table 2.

Next, participants completed the Life Events Checklist and a demographics questionnaire. The Life Events Checklist (LEC) assesses exposure to a number of potentially stressful/traumatic events (Weathers et. al., 2013). It lists 17 potentially stressful/traumatic events, and asks the participant to indicate whether they have been exposed to that event. The participant indicates whether it "happened to them," they "witnessed it," "learned about it," "not sure," or "doesn't apply." We included participants in the trauma-exposed group if they indicated that a physical assault, sexual assault, serious accident or injury, assault with a weapon, or exposure to combat happened to them. Finally, participants completed a demographics questionnaire to collect information on the participant's age, gender, and ethnicity.

2.3 Data Analyses

We conducted a Principal Components Analysis to assess whether there were any correlations between any of the items on the questionnaire and to see if there were any primary components driving the results of the questionnaire. This was necessary as there were 25 items on the questionnaire that were not entirely independent. This explains why we could not use a composite variable for the questionnaire, along with having a large enough sample size to control for a Type 1 error. We conducted a one way ANOVA to compare means of trauma-exposed and non-trauma-exposed controls, both independent groups, and post-hoc non parametric *t*-tests because our data was not distributed normally. We used Cohen's d as a measure of effect size for all comparisons except for when comparing trauma-exposed Black participants, due to a small sample size. For the first 12 items, we used the average for each item as a summary variable to conduct non parametric *t*-tests.

3. Results

3.1 Demographic information.

We recruited 372 diverse participants (*M* age=20.6, *SD*=4.6). Participant characteristics are reported in Table 1.

3.2 Principal Components Analysis

We conducted a principal components analysis to identify the primary components underlying the questionnaire items. The analysis captured two distinct components, which we categorized as "contexts" and 'indices of hypervigilance." Within the first component, contexts, the PCA captured distinct contextual categories and together accounted for 86% of total variance. Within the second component, the PCA captured twelve categories addressing frequency of indices of hypervigilance. The second component, indices of hypervigilance, accounted for 13% of total variance. Loadings and components variance can be seen in Table 3 and Figure 7.

3.3 One Way ANOVA

We then conducted a one way ANOVA with BHQ items as the within subjects factor and trauma exposure as the between subjects factor to compare the frequency of behavioral hypervigilance in trauma-exposed participants compared with non-trauma-exposed controls. The results indicated no group differences ($F(24)=1.48$, $p=0.122$).

3.3.1 Contexts

To test group differences in hypervigilance levels in specific contexts, we conducted post-hoc non-parametric *t*-tests (Bonferroni-corrected alpha = 0.0039). In 12 of 13 contexts, both trauma-exposed and non-trauma-exposed participants reported a similar frequency of hypervigilance. The only context in which trauma-exposed participants reported more hypervigilance than non-trauma-exposed participants was in a new or unfamiliar place ($z = -3.047$, $p < 0.001$, $d = 0.97$).

3.3.2 Gender and Contexts

This effect remained when we tested frequency of behavioral hypervigilance in a new or unfamiliar place within gender (trauma-exposed men compared with non-trauma-exposed men: $z = -2.15$, $p < 0.05$, $d = 0.24$; trauma-exposed women compared with non-trauma-exposed women: $z = -2.58$, $p < 0.05$, $d = 0.11$). However trauma-exposed men also reported more hypervigilance at school ($z = -2.126$, $p < .05$, $d = 0.21$) compared to non-trauma-exposed men, which is an effect that we did not see in women.

We conducted post-hoc non-parametric *t*-tests to test gender differences without division into trauma groups. There were no contexts in which men reported more hypervigilance than women. Women reported more hypervigilance than men when it's dark outside ($z = -5.16$, $p < 0.001$, $d = 0.54$), late at night ($z = -4.94$, $p < 0.001$,' $d = 0.55$), in an area that does not have a lot of people in it ($z = -5.56$ $p < 0.001$, $d = 0.58$), in contained spaces ($z = -2.41$, $p < 0.05$, $d = 0.34$), in an environment where you expect some type of harassment ($z = -3.24$, $p < 0.05$, $d = 0.3$), when taking public transportation ($z = -4.25$, $p < 0.001$, $d = 0.57$), and in a new or unfamiliar place ($z = -2.71$, $p < 0.05$, $d = 0.45$).

Trauma-exposed women reported more hypervigilance than trauma-exposed men when it's dark outside ($z = -3.75$, $p < 0.001$, $d = 0.61$), late at night ($z = -3.73$, $p < 0.001$, $d = 0.61$), in an area that doesn't have a lot of people in it ($z = -3.99$, $p < 0.001$, $d = 0.73$), in an environment where you expect some type of harassment ($z = -2.65$, $p < 0.05$, $d = 0.39$), and when taking public transportation ($z = -2.14$, $p < 0.05$, $d = 0.27$). This suggests that while trauma-exposed men reported more hypervigilance at school than non-trauma-exposed men, this effect is not seen when compared to trauma-exposed women. The similar findings between these groups in the

context of in a new or unfamiliar place supports our aforementioned findings that show non-trauma-exposed and trauma-exposed groups differed in a new or unfamiliar place.

Non-trauma-exposed women reported more hypervigilance than non-trauma-exposed men when it's dark outside (z = -3.62, $p < 0.001$, d =0.53), late at night (z = -3.48, $p < 0.001$, d =0.52), in an area that does not have a lot people in it (z = -3.9 $p < 0.001$, d =0.62), in contained spaces (z = -2.15, $p < 0.05$, d =0.23), in an environment where you expect harassment (z = -2.07, $p < 0.05$, d =0.31), at work (z = -1.97, $p < 0.05$, d = 0.14), at school (z = -2.06, $p < 0.05$, d =0.02), when taking public transportation (z = -3.99, $p < 0.001$, d =0.42), and in a new or unfamiliar place (z = -2.49, $p < 0.05$, d =0.22).

3.3.3 Race and Contexts

We also conducted an independent samples *t*-test to test for racial differences in contexts. We first compared trauma-exposed US ethnic/racial minorities to trauma-exposed White participants. There were no differences in any contexts between Asian/Pacific Islander participants and White participants. There were also no differences in frequency of hypervigilance in any context between trauma-exposed Asian/Pacific Islander participants and non-trauma-exposed Asian/Pacific Islander participants.

Compared to trauma-exposed White participants, trauma-exposed Black participants reported more hypervigilance when it's dark outside (z = -2.08, $p < 0.05$, Hedges' g =0.89) in contained spaces (z = -2.29, $p < 0.05$, Hedges' g =0.73) and when encountering police or an area with high police presence (z = 2.83, $p < 0.05$, Hedges' g =1.64). There were no contexts in which there was a difference in reported frequency of hypervigilance between trauma-exposed Black participants and non-trauma-exposed Black participants.

Compared to White participants, Hispanic/Latino participants reported more hypervigilance when it's dark outside (z = -2.61, $p < 0.05$, d = 0.58), late at night (z = -2.13, $p < 0.05$, d = 0.56), in contained spaces (z = -2.44, $p < 0.05$, d =0.44), and when encountering police or in an area with high police presence (z = -2.17, $p < 0.05$, d = 0.63). There were also no differences in frequency of hypervigilance in any context between trauma-exposed Hispanic/Latino participants and non-trauma-exposed Hispanic/Latino participants.

3.3.4 Indices of Hypervigilance

After conducting analyses on the component containing the contexts, we conducted analyses on the component that addresses indices of hypervigilance, which were items 1-12 on the questionnaire. We conducted non parametric *t*-tests (Bonferroni-corrected alpha= .0042) to test group differences between trauma-exposed and non-trauma-exposed participants within any of the 12 items. Trauma-exposed participants reported a greater frequency of feeling the need to scan the crowd or the environment when in public or in a new environment (z = -3.05, $p < 0.05$, d = 0.36), and having trouble falling or staying asleep (z = -2.17, $p < 0.05$, d = 0.29). We also conducted a non-parametric t-test using the average as a summary variable to compare indices of hypervigilance. Trauma-exposed participants reported a greater frequency of feeling the need to scan the crowd when in public or in a new environment (z= 3.47, $p < 0.001$, d = 0.36), having trouble falling or staying asleep (z= 2.89, $p < 0.001$, d = 0.29), and feeling jumpy or easily startled (z= 3.04, $p < 0.05$, d = 0.27).

3.3.5 Gender and Indices of Hypervigilance

We conducted non parametric *t*-tests to see whether there were differences in frequency of indices of hypervigilance between men and women. Women reported a greater frequency of feeling physically unsafe when there is no obvious reason to feel that way (z = -2.42, $p < 0.05$, d

= 0.58), feeling jumpy or easily startled (z = -3.84, $p < 0.05$, d = 0.46), and feeling nervous, anxious, or on edge (z = -2.84, $p < 0.05$, d = 0.37).When comparing items by gender using the summary variable, women reported a greater frequency of feeling the need to scan the crowd when in public or in a new environment (z = -3.32, $p < 0.05$, d =0.36), feeling overwhelmed in public (z = -3.32, $p < 0.001$, d =0.39), feeling physically unsafe without reason (z = -2.03, $p <$ 0.05, d =0.46), feeling that something bad is going to happen (z = -4.4, $p < 0.001$, d =0.42), having trouble falling or staying asleep (z =- 4.16, $p < 0.001$, d =0.44), feeling jumpy or easily startled (z = -5.97, $p < 0.001$, d =0.62), and feeling nervous, anxious or on edge (z = -3.87, $p <$ 0.001, d =0.4).

Compared to trauma-exposed men, trauma-exposed women reported a greater frequency of feeling physically unsafe when there is no obvious reason to feel that way (z = -3.0, $p < 0.05$, d =0.28), feeling that something bad is going to happen (z = -2.18, $p < 0.05$, d =0.16), feeling jumpy or easily startled (z = -4.32, $p < 0.001$, d =0.47), and feeling nervous, anxious or on edge (z = -2.71, $p < 0.05$, d=0.39). There were no differences in frequency of indices of hypervigilance among non-trauma-exposed women and non-trauma-exposed men. When comparing items by gender and trauma exposure using the summary variable, trauma-exposed women reported a greater frequency of feeling the need to scan the crowd when in public or in a new environment (z = -2.96, $p < 0.05$, d =0.55), feeling constantly on guard watchful and/or super-alert (z = -3.03, $p < 0.05$, d =0.53), and feeling nervous, anxious or on edge (z = -2.97, $p <$ 0.05, d =0.52) compared to trauma-exposed men.

3.3.6 Race and Indices of Hypervigilance

We conducted non parametric *t*-tests to look at potential racial group differences. There were no differences in frequency of indices of hypervigilance between trauma-exposed

Asian/Pacific Islander participants and trauma-exposed White participants. Compared to non-trauma-exposed Asian/Pacific Islander participants, trauma-exposed Asian/Pacific Islander participants endorsed greater levels of feeling like they need to scan the crowd or environment when in public or in new places (z = -2.17, $p < 0.05$, d=0.4). There were no differences when comparing either trauma-exposed White participants to trauma-exposed Asian/Pacific Islander participants, nor when comparing non-trauma-exposed Asian/Pacific Islander participants to trauma-exposed Asian/Pacific Islander participants using the summary variable.

When compared to trauma-exposed White participants, trauma-exposed Black participants reported a greater frequency of watching for signs of trouble as soon as they wake up and for the rest of the day (z = -2.23, $p < 0.05$, Hedges' g =1.1), thinking about what they would do or where they would go if someone tried to surprise or harm them while outside (z = -2.26, $p < 0.05$, Hedges' g=1.03) feeling the need to scan the crowd or the environment when in public or in a new environment (z = -2.17, $p < 0.05$, Hedges' g =1.11), and feeling constantly on guard, watchful and/or super-alert (z = -2.72, $p < 0.05$, Hedges' g =1.45). When comparing trauma-exposed White participants to trauma-exposed Black participants using the summary variable, trauma-exposed Black participants reported a greater frequency of thinking ahead about what they would do or where they would go if someone tried to surprise or harm them while outside (z = 2.69, $p < 0.05$, Hedges' g =1.58), feeling the need to scan the crowd or the environment when in public or in a new environment (z = 3.3, $p < 0.05$, Hedges' g =0.54), and feeling constantly on guard, watchful and/or super-alert (z = 3.25, $p < 0.05$, Hedges' g =1.41).

When compared to non-trauma-exposed Black participants, trauma-exposed Black participants reported a greater frequency of watching for signs of trouble as soon as they wake up and for the rest of the day (z = -2.1, $p < 0.05$, Hedges' g =1.09), thinking ahead about what they

would do or where they would go if someone tried to surprise or harm them while outside (z = -2.39, $p < 0.05$, Hedges' g =1.27), and feeling constantly on guard, watchful and/or super-alert (z = -2.94, $p < 0.05$, Hedges' g =1.73). When comparing non-trauma-exposed Black participants to trauma-exposed Black participants using the summary variable, trauma-exposed Black participants reported a greater frequency of of thinking ahead about what they would do or where they would go if someone tried to surprise or harm them while outside (z = 68.74, $p < 0.001$, Hedges' g =1.26), feeling the need to scan the crowd or the environment when in public or in a new environment (z = 2.45, $p < 0.05$, Hedges' g =0.86), and feeling constantly on guard, watchful and/or super-alert (z = 3.64, $p < 0.05$, Hedges' g =1.74).

Compared to trauma-exposed White participants, trauma-exposed Hispanic/Latino participants reported a greater frequency of feeling the need to scan the crowd or the environment when in public or in a new environment (z = -2.01, $p < 0.05$, d =0.58), and feeling that if they don't stay alert and watchful, something bad will happen (z = -2.37, $p < 0.05$, d =0.47). When comparing trauma-exposed White participants to trauma-exposed Hispanic/Latino participants using the summary variable, trauma-exposed Hispanic/Latino participants reported a greater frequency of feeling the need to scan the crowd or environment when in public or new places (z = 2.1, $p < 0.05$, d =0.58).

When compared to non-trauma-exposed Hispanic/Latino participants, trauma-exposed Hispanic/Latino participants endorsed a greater frequency of feeling the need to scan the crowd or environment when in public or new places (z = -2.019, $p < 0.05$, d =0.52). There were no differences when comparing non-trauma-exposed Hispanic/Latino participants and trauma-exposed Hispanic/Latino participants using the summary variable.

3.5 Bernstein Paper Comparison

In order to evaluate the similarities and differences between the Bernstein and colleagues results and ours, we compared the results of the 5 BHS questions that we used in the BHQ in both samples. In the Bernstein et al., sample, the average for the No PTSD group of the 5 BHS questions combined was 3.72, and the average of the PTSD group was 10.07. In our sample, the average of the non-trauma-exposed group was 2.13, and the average of the trauma-exposed group was 2.35.

4. Discussion

These results suggest that, in most contexts, trauma-exposed people experience hypervigilance at similar frequencies as non-trauma-exposed people. This supports the idea that while hypervigilance needs to be studied as a trauma-related symptom, it also needs to be understood in a normative population. This could be due to the fact that, even though someone non-trauma-exposed did not experience a traumatic even in these certain contexts, they still could have learned to stay alert for potential threatening stimuli. For example, a trauma-exposed person could have been mugged while walking late at night, hence causing their stress response to prepare the body for a mugging while walking in the dark. A non-trauma-exposed person can know logically that muggings can take place at night, therefore purposefully engaging in hypervigilant behaviors. The main difference is the addition of the overactive stress response in trauma-exposed people.

Trauma-exposed people in general report more hypervigilance in new or unfamiliar places, consistent with the existing literature on physiological hyper-reactivity to novelty and impaired habituation to familiar information in trauma-exposed people. For example, trauma-

exposed participants showed less novelty discrimination in the amygdala when showed both novel and familiar negative scenes compared to no-trauma controls (Yoon & Weierich, 2017).

These results also suggest that trauma-exposed men experience a greater frequency of hypervigilance while at school, which was an effect not found in women. This fits with previous literature that suggests that there are gender differences in development of trauma symptoms. Also, the most common types of traumatic events that occur to men and women do differ. According to the National Sexual Violence Resource Center, 91% of victims of rape and sexual assault are female, while 9% are male. This could suggest why our data suggested that women felt less on guard in places like their school, where they feel comfortable and are surrounded by people. This leaves the question of why trauma-exposed men feel greater hypervigilance at school open to be addressed in future research. This effect is not found when comparing trauma-exposed men to trauma-exposed women, which suggests that trauma-exposed women do feel hypervigilant at school at a similar frequency to trauma-exposed men. The difference is between trauma-exposed and non-trauma-exposed men.

There was significant overlap in the contexts in which there was a difference relating to gender. For example, non-trauma-exposed women compared to non-trauma-exposed men, women in general compared to men, and trauma-exposed women compared to trauma-exposed men, all reported more hypervigilance when it's dark outside, late at night, in an area that doesn't have a lot of people in it, in an environment where you expect some type of harassment, and when taking public transportation. This points to a potential relationship between gender and these specific contexts. It is also important to note that in almost all comparisons, one group reported a greater frequency of feeling the need to scan the crowd or environment when in public

or new places. This could suggest that this index of hypervigilance is more salient or more widely experienced than the others.

The data also suggests that there are racial differences in hypervigilance. We found that trauma-exposed Hispanic/Latino and Black participants reported more hypervigilance in more contexts than trauma-exposed White participants. Also, both trauma-exposed Hispanic/Latino participants as well as Black participants reported more hypervigilance when encountering police or an area with a higher police presence, which was an effect we did not see in any of the other analyses.

These results have various clinical implications. First, clinicians having a deeper understanding of hypervigilance both as a symptom of trauma-related disorders and as a phenomenon that happens in non-trauma exposed people, can only aid in treatment. Also, because our results depicted that trauma-exposed people experience greater hypervigilance in a new or unfamiliar place, clinicians can provide targeted treatment towards coping with new or unfamiliar places.

Furthermore, these results provide a more complete picture of racial differences in regard to hypervigilance, which can help clinicians attain greater cultural competency. For example, due to heightened racial tension in the United States, including discrimination by police towards US minorities, it is necessary for clinicians to understand the differing experiences of minority groups in order to provide effective treatment.

While our study was addressing the same gap in the literature as Bernstein and colleagues, there are some key differences in the two studies. Bernstein and colleagues measured PTSD symptoms and used them to operationalize trauma exposure in the sample, while we used the Life Events Checklist which does not provide information about trauma symptoms. This

means that participants who they did not consider trauma-exposed due to lack of symptoms could have been trauma-exposed in our sample, leading to differing results.

Another key difference is sample diversity. The subject pool from their study was predominately Caucasian, while ours was predominately Asian-American. Their sample was 2.2% African American, while Black participants made up 8% of our sample. We also captured more potential gradations in race by including categories such as 'Middle Eastern,' Hispanic/Latino,' and 'multiple,' though they separated Asian and Pacific Islander into two distinct groups while we did not (Bernstein et al., 2015). While these labels are reflective of the geographical differences in which our studies take place, a more diverse sample leads to results that are able to be generalized to a population more effectively. We were able to perform a more varying array of comparisons in hypervigilance between different races because we provided a more diverse set of racial categories for participants to identify with.

There are a few potential confounds to our study. While the Life Events Checklist measures different stressful life events, it does not leave room for gradations of the severity of these traumatic events. Prolonged victimization can be associated with an increase in symptoms (Yehuda, McFarlane & Shalev, 1998). The LEC does not address this- someone who saw combat for a month and someone who engaged in combat for multiple years can endorse the same score on the LEC.

While we attempted to create a measure that depicted hypervigilance as effectively as possible, there were limitations to the scope of the measure. The measure did not assess lifestyle factors that could contribute to a difference in hypervigilance. For example, the measure did not

ask about whether or not they lived in an unsafe neighborhood. If a participant lives in a perceived unsafe neighborhood, even if they are not trauma-exposed, it might contribute to reporting hypervigilance at a greater frequency than those who live in a safe neighborhood, especially with regards to the questions that address indices of hypervigilance.

Furthermore, as previously discussed in relation to the study by Bernstein and colleagues, we did not measure if trauma-exposed participants met criteria for trauma-related disorders. Hypervigilance is a symptom of trauma-related disorders, so the results might be different if our trauma-exposed group was either composed of those with trauma-related disorders or there was a third group of participants with trauma-related disorders. Without a group of participants with trauma-related disorders, it is unclear how well the hypervigilance of our trauma-exposed sample would generalize to the greater population. The trauma-exposed sample consisted of participants functional enough to attend a rigorous college program, despite any trauma-related symptoms that they may have had.

We also did not assess whether participants met criteria for other psychological diagnoses. Hypervigilant behaviors can be found in other psychological disorders, such as phobia and various anxiety disorders. In particular, people with social anxiety have been shown to engage in hypervigilant behaviors, such as prolonged eye scanning (McTeague et al., 2018). This could have affected our results, as we could have controlled for participants who met criterion for other disorders that involve hypervigilant behaviors.

While we identified contexts in which hypervigilance occurs differently in trauma-exposed and non-trauma-exposed populations, this research does not address the reasons behind these discrepancies. Further research should explore why trauma-exposed people experience greater hypervigilance only the context of being in a new or unfamiliar place, while they

experience hypervigilance similarly to non-trauma-exposed people in the other context. Future research should also explore the gender differences in hypervigilance between the two populations.

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Appendix A

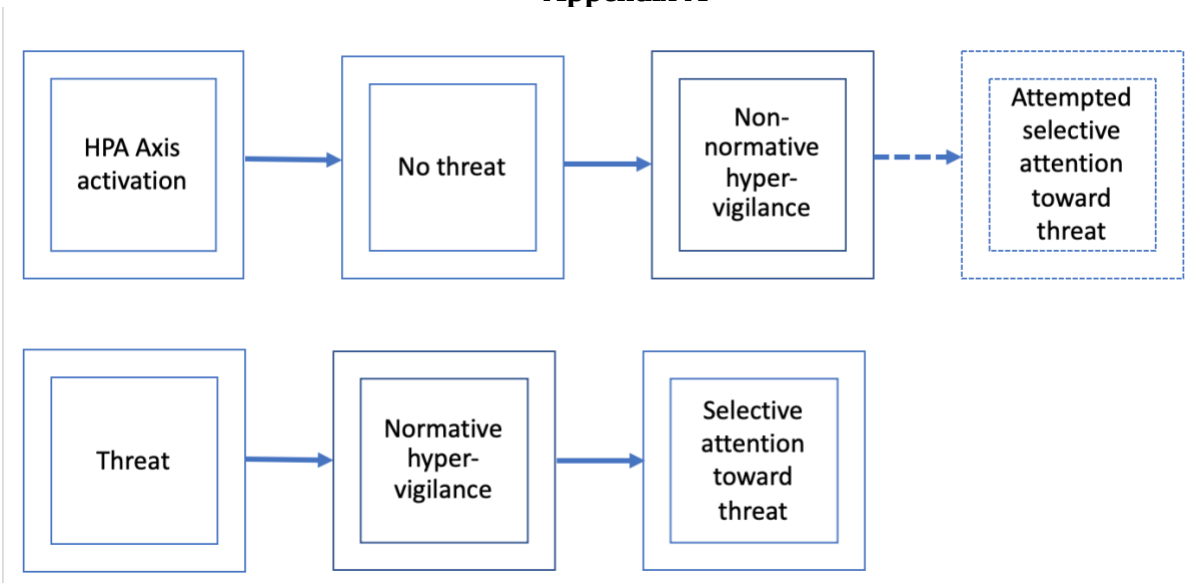

Figure 1. Conceptual model displaying the connection between selective attention, threat, and hypervigilance in both normative and non-normative hypervigilance

Table 1. Participants

Variable	Statistic
Trauma-Exposed, *n*	123
Non-trauma Exposed, *n*	249
Age in years, *M* (*SD*), range	20.6 (4.6), 17-56
Gender, *n (%)*	
Female	250 (67)
Male	122 (33)
Race/ethnicity, *n* (%)	

Asian/Pacific Islander	141	(38)
White	79	(21)
Hispanic/Latino	65	(18)
Black	31	(8)
Middle Eastern	9	(2)
Native American/First Nations	1	(0.27)
Multiple	37	(10)
Other	13	(4)

Table 2. Average responses per item

Item	TE *M*(SD)	NTE *M*(SD)
As soon as I wake up and for the rest of the day, I am watching for signs of trouble.	1.9 (1.09)	1.66 (0.82)
When I am outside, I think ahead about what I would do (or where I would go) if someone tried to surprise or harm me.	2.4 (1.17)	2.15 (0.95)
When I am in public or in new places, I need to scan the crowd or the environment.	3.3 (1.17)	2.85 (1.06)
When I am in public, I feel overwhelmed because I cannot keep track of everything going on around me.	1.95 (1.12)	1.79 (0.95)
I feel that if I don't stay alert and watchful, something bad will happen.	2.28 (1.15)	2.18 (0.97)
I feel constantly on guard, watchful and/or super-alert.	2.23 (1.1)	2 (0.98)
I avoid activities or events because I feel on guard, watchful or super-alert.	1.7 (.99)	1.6 (0.92)
I feel physically unsafe, when there is no obvious reason to feel that way.	1.67 (1)	1.44 (0.75)
I feel that something bad is going to happen.	1.93 (1.05)	1.7 (0.81)
I have trouble falling and/or staying asleep.	2.45 (1.4)	2.08 (1.14)
I feel jumpy or easily startled.	2.12 (1.29)	1.82 (0.8)
I feel nervous, anxious, or on edge.	2.32 (1.23)	2.11 (1.05)

When it is dark outside.	3.12 (1.52)	3.04 (1.35)
Late at night.	3.35 (1.46)	3.24 (1.46)
In an area that does not have a lot of people in it.	3.29 (1.46)	3.31 (1.36)
In crowds.	2.67 (1.42)	2.53 (1.23)
In contained spaces.	2.56 (1.33)	2.34 (1.2)
In a neighborhood you perceive to be unsafe.	3.46 (1.52)	3.49 (1.4)
In a neighborhood where you feel unwelcome.	3.23 (1.48)	3.05 (1.43)
When encountering police or an area with high police presence.	2.6 (1.5)	2.65 (1.32)
In an environment where you expect some type of harassment.	3.31 (1.56)	3.3 (1.52)
At work.	1.58 (0.96)	1.55 (0.93)
At school.	1.88 (1.18)	1.63 (0.93)
When taking public transportation.	3.1 (1.51)	2.8 (1.15)
In a new or unfamiliar place (e.g., first time in a building, when traveling).	3.17 (1.41)	2.73 (1.3)

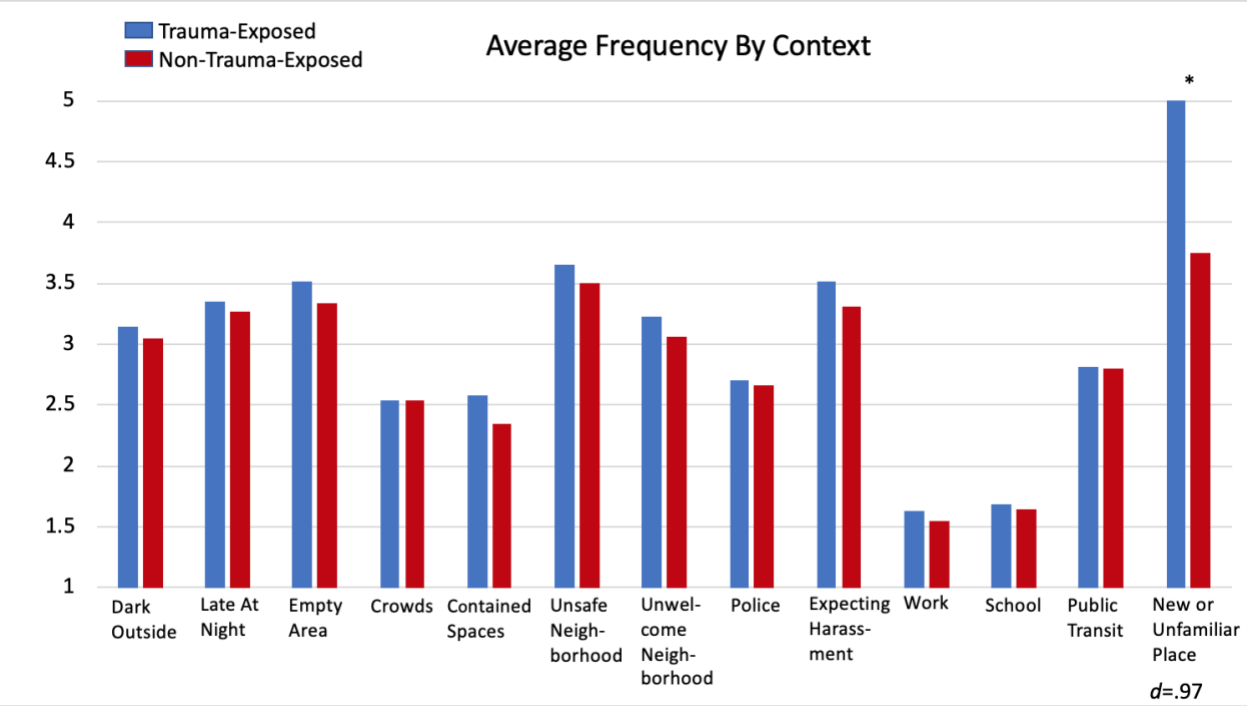

Figure 2. Average frequency by context for trauma-exposed and non-trauma exposed participants

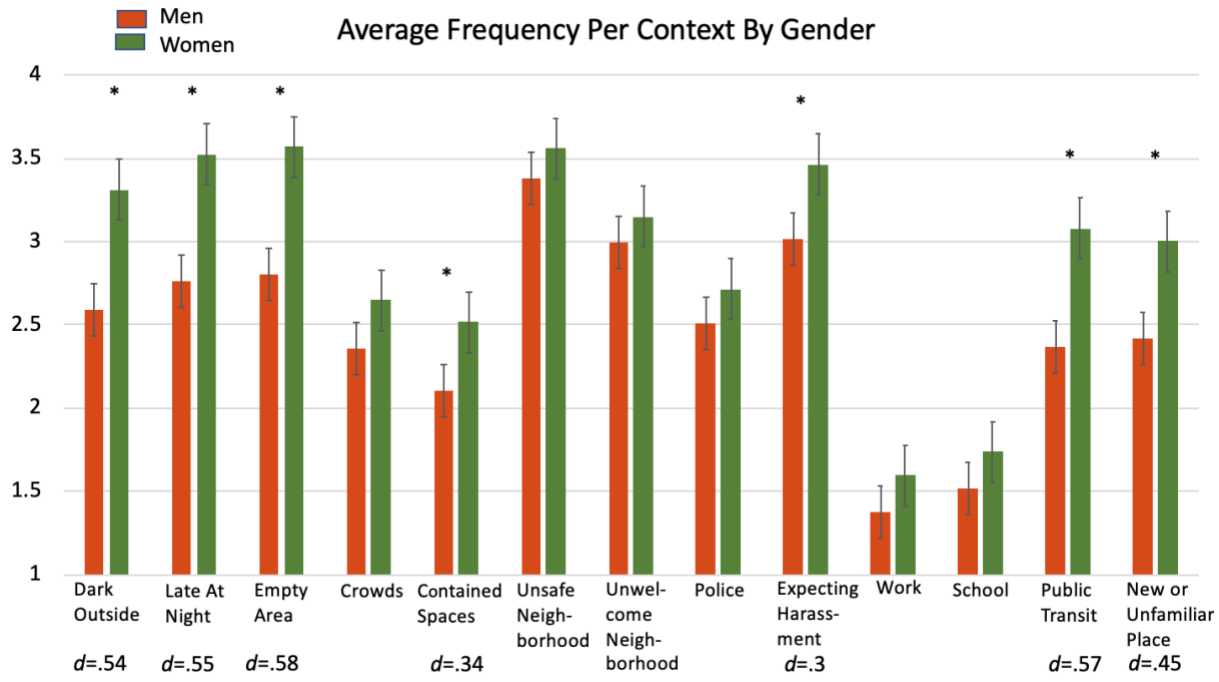

Figure 3. Average frequency per context by gender

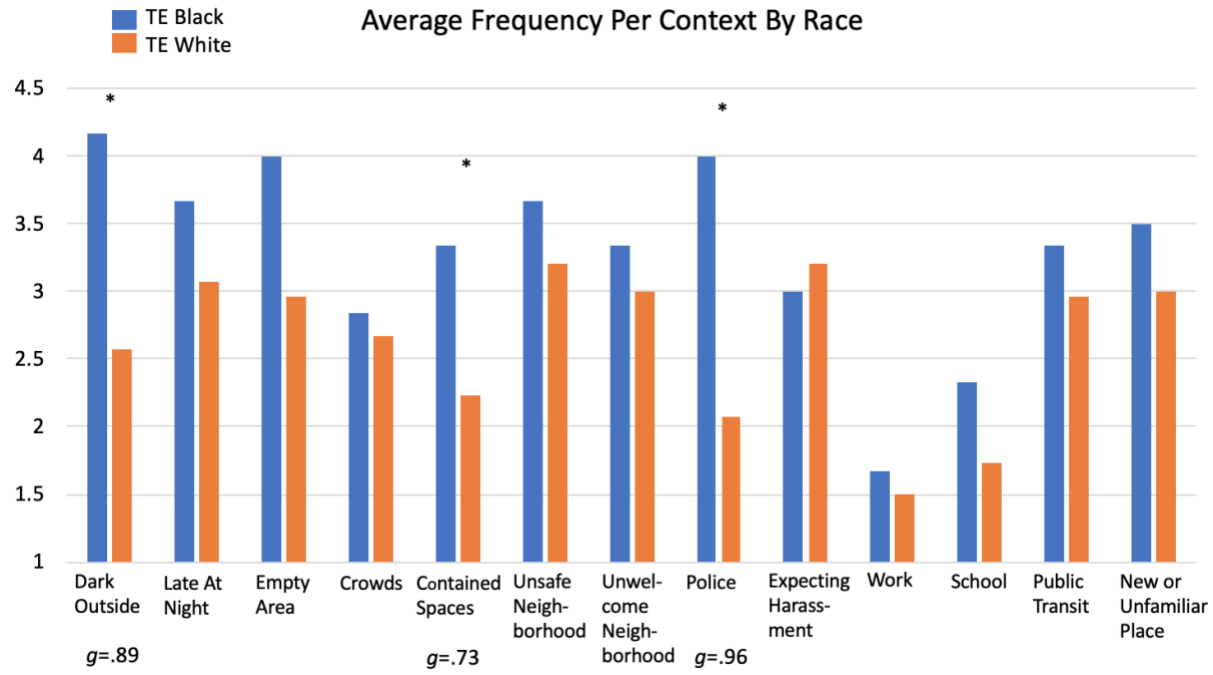

Figure 4. Average frequency per context by race among trauma-exposed Black and trauma-exposed White participants

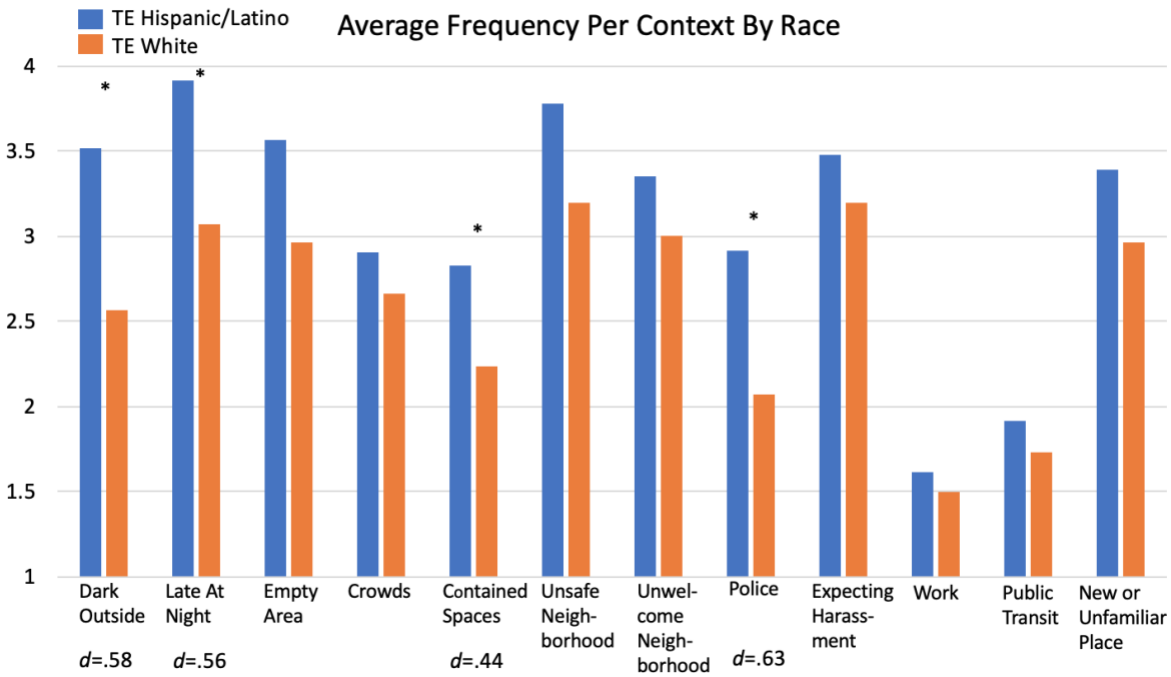

Figure 5. Average frequency per context by race among trauma-exposed Hispanic/Latino participants and trauma-exposed White participants

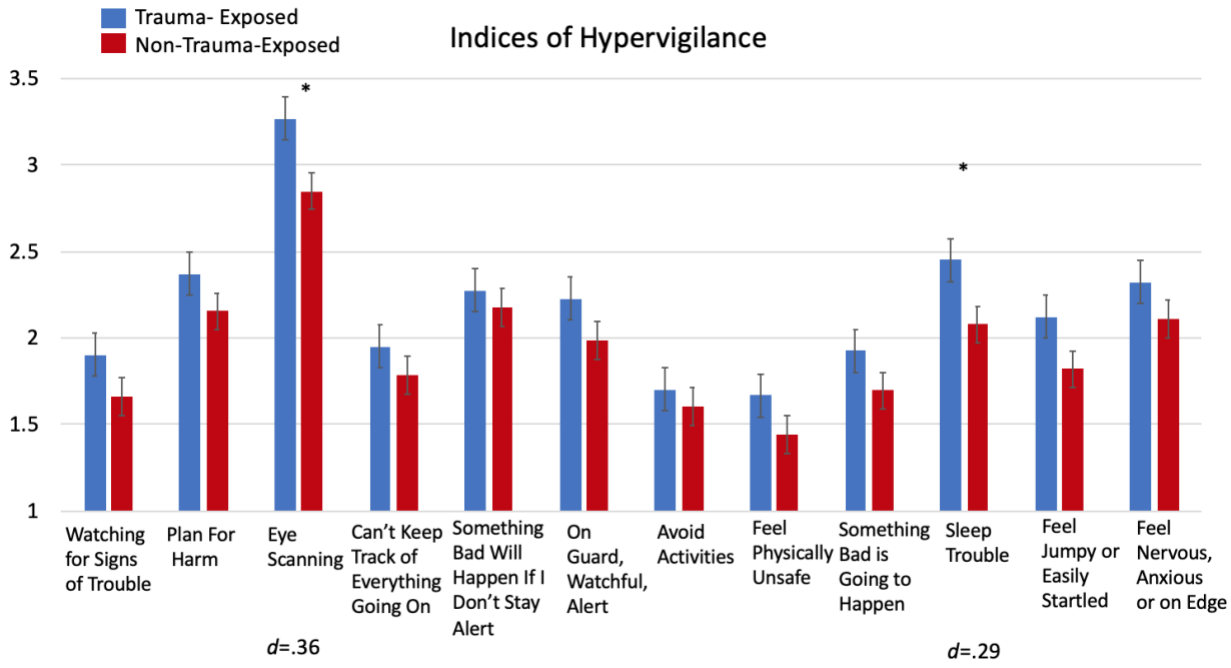

Figure 6. Frequency of indices of hypervigilance among trauma-exposed and non-trauma-exposed participants

	Component	
	1	2

In a neighborhood perceived to be unsafe	0.829	
In an area with not a lot of people	0.825	
Late at night	0.814	
Neighborhood where you feel unwelcome	0.806	
Environment where you expect harassment	0.797	
When it's dark outside	0.787	
In a new or unfamiliar place	0.687	0.389
In contained spaces	0.636	0.358
In crowds	0.541	0.476
On public transit	0.518	0.46
When encountering police	0.507	
I feel that something bad is going to happen		0.77
I feel physically unsafe without reason		0.768
I feel overwhelmed in public because I cannot keep track of everything		0.723
I avoid events because I feel on guard/watchful/super-alert.		0.695
If I don't stay alert something bad will happen		0.683
I feel nervous, anxious or on edge		0.642
I feel constantly on guard/watchful/super-alert	0.346	0.642
When outside, I think of what I would do if someone tried to harm me		0.588
I feel jumpy or easily startled		0.575
As soon as I wake up I'm watching for trouble		0.574
When I am in public/new places, I scan the crowd		0.516
At school	0.366	0.504
I have trouble falling/staying asleep		0.455
At work	0.358	0.404

Table 3. Rotated principal components matrix. Loadings for PC1 and PC2

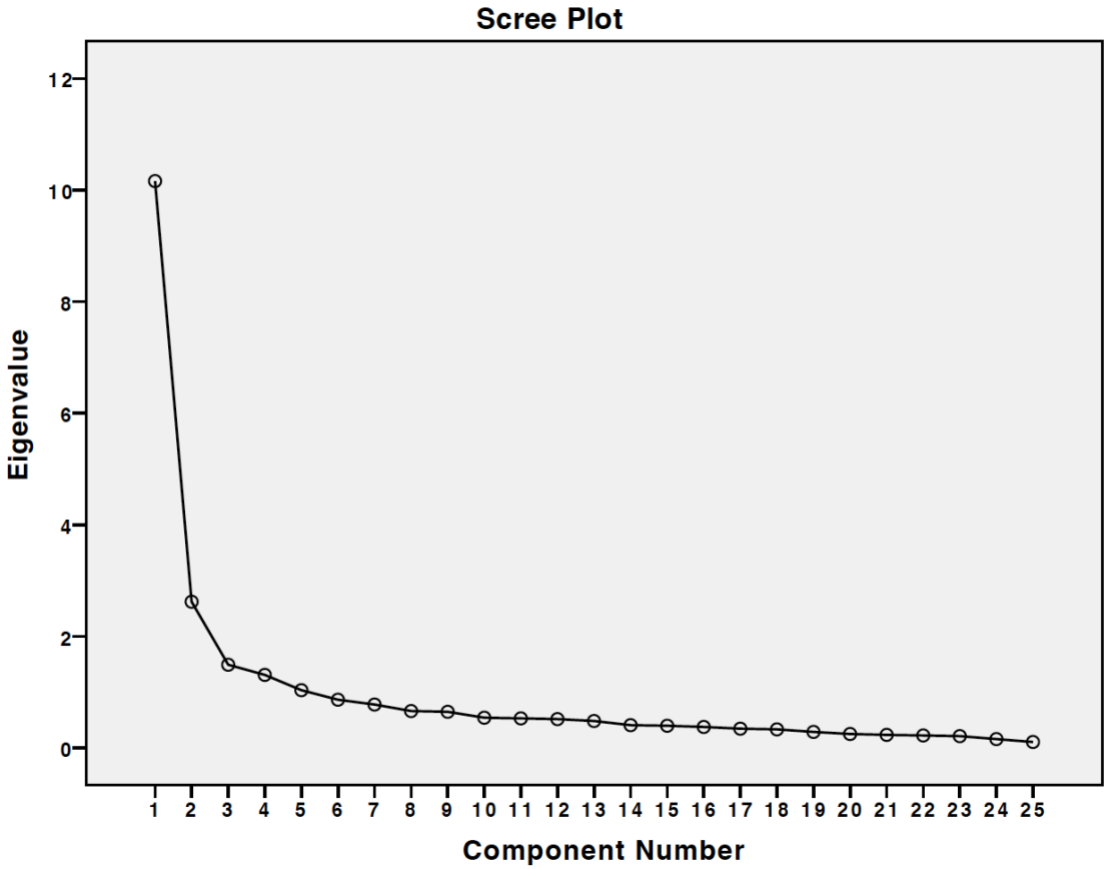

Figure 7. The principal components analysis captured two distinct components that accounted for 99% of the total variance