

# The impact of hypervigilance: Evidence for a forward feedback loop<sup>☆</sup>



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## ABSTRACT

A number of prominent theories suggest that hypervigilance and attentional bias play a central role in anxiety disorders and PTSD. It is argued that hypervigilance may focus attention on potential threats and precipitate or maintain a forward feedback loop in which anxiety is increased. While there is considerable data to suggest that attentional bias exists, there is little evidence to suggest that it plays this proposed but critical role. This study investigated how manipulating hypervigilance would impact the forward feedback loop via self-reported anxiety, visual scanning, and pupil size. Seventy-one participants were assigned to either a hypervigilant, pleasant, or control condition while looking at a series of neutral pictures. Those in the hypervigilant condition had significantly more fixations than those in the other two groups. These fixations were more spread out and covered a greater percentage of the ambiguous scene. Pupil size was also significantly larger in the hypervigilant condition relative to the control condition. Thus the study provided support for the role of hypervigilance in increasing visual scanning and arousal even to neutral stimuli and even when there is no change in self-reported anxiety. Implications for the role this may play in perpetuating a forward feedback loop are discussed.

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## 1. Introduction

Past and present theories have suggested that attentional bias toward threat plays a central role in anxiety disorders, including posttraumatic stress disorder (Brewin, Dalgleish, & Joseph 1996; Chemtob, Roitblat, Hamada, Carlson, & Twentyman, 1988; Cisler & Koster, 2010; Dalgleish, Moradi, Taghavi, Neshat-Doost, & Yule, 2001; Ehlers & Clark, 2000; Foa & Kozak, 1986; Foa, Steketee, & Rothbaum, 1989; Litz & Keane, 1989). In many of these models, attentional bias and hypervigilance are thought to play a critical role in the maintenance, and perhaps etiology, of the disorder. Dalgleish et al. (2001) for example, argued that “anxiety leads to increased hypervigilance for threat, a greater level of threat detection leads to increased anxiety which, in turn, leads to increased hypervigilance, and so on in a vicious circle” (p. 541). Beck, Emery, and Greenberg (2005) later argued that anxiety disorders were associated with a hypervigilance that led them to misinterpret ambiguous situations and exaggerate minor threats,

all of which would further increase anxiety. Empirical evidence for attentional bias across a range of anxiety disorders is quite prevalent (Bögels & Mansell, 2004; Horley, Williams, Gonsalves, & Gordon, 2004; Schofield, Johnson, Inhoff, & Coles, 2012; Weeks, Howell, & Golden, 2013). Referring specifically to PTSD, Chemtob et al. (1988) argued for a threat detection network that was easily potentiated and could initiate a positive feedback loop. The error in interpretation then provides subjective evidence for threat, thereby increasing threat-related arousal. It is argued that this increased arousal facilitates greater attention toward threat and decreases cognitions or behaviors that may inhibit anxiety. Recognizing the critical role of hypervigilance, Conoscenti, Vine, Papa, and Litz (2009) updated the body of work regarding hypervigilance in PTSD and considered the symptom a gateway to posttraumatic disturbance.

Supporting this theory are both long standing clinical evidence for hypervigilance (Kardiner & Spiegel, 1947) as well as ample empirical support for the existence of attentional biases in PTSD. In visual search tasks (Pineles, Shipherd, Welsh, & Yovel, 2007), dot probe tasks (Bryant & Harvey, 1997; Dalgleish et al., 2001), and modified Stroop tasks (Beck, Freeman, Shipherd, Hamblen, & Lacker, 2001; McNally, Kaspi, Riemann, & Zeitlen, 1990), there has been evidence for both facilitation (i.e., increased detection of) as well as an interference (i.e., poor disengagement from) threat-related stimuli (for mixed evidence or exceptions see Kimble, Frueh, & Marks, 2009; Pineles et al., 2007; Pollak & Tolley-Schell, 2003).

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Evidence for facilitation and poor disengagement in PTSD has been bolstered by recent work using eye tracking technology (Beevers et al., 2011; Bryant, Harvey, Gordon, & Berry, 1995; Felmingham, Rennie, Manor, & Bryant, 2011; Kimble, Fleming, Brandy, Kim, & Zambetti, 2010). Eye tracking techniques can assess patterns in eye fixations, fixation durations, and eye movement. In addition, the technology provides continuous, non-invasive indices of attention to visual stimuli. It has a distinct advantage over dot probe, Stroop, visual search, and spatial cueing tasks in that it can directly assess visual attention without the difficulties of interpretation associated with reaction time. This early work in PTSD has shown evidence for increased detection for threat with little avoidance of threatening stimuli after detection (Bryant et al., 1995; Felmingham et al., 2011; Kimble et al., 2010). In a recent study, however, Beevers et al. (2011) found that predeployment avoidance of angry faces predicted the development of PTSD when exposed to war zone stressors. The authors argued that avoidance of fear-related information prior to deployment may indicate a tendency to avoid thinking about trauma and may later interfere with the extinction and reappraisal processes necessary for recovery (Beevers et al., 2011). Eye gaze was not assessed post-deployment however, and thus it is unclear whether the subsequent PTSD was associated with the facilitation and poor disengagement found in the previous studies.

While there has been a preponderance of evidence for facilitation and poor disengagement in PTSD, no studies have investigated whether these attentional patterns perpetuate a forward feedback loop that results in increased anxiety, increased search for threat, and increased autonomic arousal. The lack of work in this area is partly due to the difficulty of assuring in clinical samples that any changes in anxiety or arousal are actually due to changes in hypervigilance and not some other confounding factor such as trauma type, medication status, or symptom severity. The difficulty is further complicated by ceiling effects in which increasing hypervigilance may be difficult in an already vigilant, clinical sample. However, providing such data in any sample would produce critical evidence in support of the forward feedback loop proposed in PTSD theory. For example, if hypervigilance or attentional bias for threat *does not* produce further anxiety or behavioral change then a forward feedback loop would, in theory, stop at that point.

The goal of this study was to see whether manipulating hypervigilance would affect a forward feedback loop as measured by self-reports of anxiety, impact on visual attention, and influence on autonomic arousal. In order to control for confounding variables and ceiling effects, non-clinical participants were used and were randomly assigned to hypervigilant, pleasant, and control conditions. Hypervigilance was manipulated through an instruction set in which participants were told that they needed to find the threat in a computer presented ambiguous scene in order to avoid an aversive consequence. The impact of this instruction set on anxiety, visual scanning, and pupil dilation was assessed. Consistent with theories that suggest a forward feedback loop in PTSD and anxiety disorders more generally (Beck et al., 2005; Chemtob et al., 1988; Dalgleish et al., 2001; Litz & Keane, 1989), we predicted that the hypervigilant manipulation would result in larger pupil sizes (i.e., greater autonomic arousal), a greater number of fixations (i.e., increased scanning), and higher self-reported anxiety.

In this study, we constrained the stimuli to be most relevant to those with trauma and PTSD. Most pictures were neutral scenes that those with PTSD typically describe as potentially threatening such as railway platforms, busy rooms, empty streets, parking garages, and so forth. The stimuli were purposefully neutral (without any obvious threat) and ambiguous given that those with PTSD are not necessarily seeing real threats in the environment, but rather perceiving threats that are not there. In addition, given the breadth of stimuli that those with anxiety disorders generally might

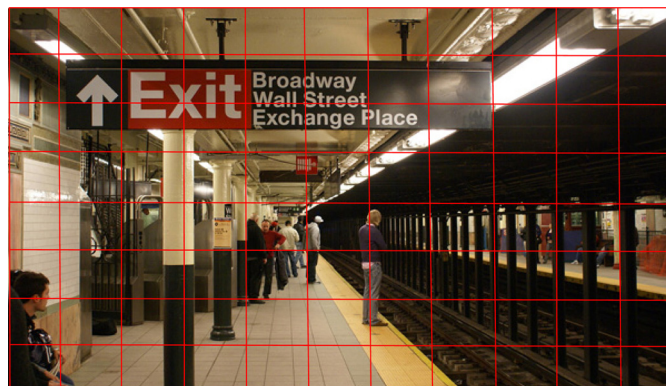


Fig. 1. Example visual stimulus with grid overlay.

respond to (i.e., animals vs. faces vs. bridges), we thought it too difficult to produce stimuli that would allow one to conclude a forward feedback loop in anxiety disorders more broadly. However, we feel this study can reasonably serve as a case in point. Specifically, a demonstration of a hypervigilant condition that produces greater visual scanning and autonomic arousal to stimuli that are most relevant to those with PTSD would certainly have implications for understanding hypervigilance in other anxiety disorders. For example, it would be reasonable to conclude that a hypervigilant mindset that produces increased anxiety and visual scanning to stimuli related to PTSD would do the same for social phobia.

## 2. Methods and materials

### 2.1. Participants

The participants were 71 students from an undergraduate liberal arts school in the northeast. One student was removed due to poor quality eye tracking data. Participants were recruited from introductory psychology courses and were given research credit for completing the experiment. The average age of participants was 18.4 years; there were 50 females and 21 males; 75% of participants were white, 6% were African American, 11% were Asian American, 1% were American Indian, and 7% reported they were biracial.

### 2.2. Procedure

Participants were asked to sign an informed consent, and subsequently administered the Spielberger State Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), the Post-traumatic Stress Scale (Foa, Riggs, Dancu, & Rothbaum, 1993), along with a brief demographic survey. Upon completion of the instruments, all participants underwent an eye tracking task in which they were asked to look at 30 pictures on a computer screen for 10 seconds each. The pictures were presented on a Dell 22" monitor and took up the entire screen. Each participant's head was stabilized with a chin rest and their eyes were 57 cm away from the monitor. The pictures were neutral in valence and included an assortment of images such as streets scenes, parking lots, ballparks, forests, stores, and classrooms (see Fig. 1 for an example stimulus). All pictures were purposefully neutral but complex in order to simulate real life situations in which those with PTSD often describe as threatening even in the absence of overt threat.

Unknown to the participants, they were randomly assigned to one of three conditions. Participants in the "hypervigilant condition" ( $N = 25$ ) were instructed to search each picture for threatening targets. They were told that if they did not find all targets, a loud white noise burst (90 dB) would be played. Participants in the

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