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Content specificity of attentional bias to threat in Post-Traumatic Stress Disorder

Highlights

We studied the content-specificity of attentional bias to threat in PTSD patients.

PTSD participants showed a stimulus specific dissociation in processing emotional stimuli.

PTSD patients show an involuntary *content-sensitive* attentional bias to emotional information.

Content specificity of attentional bias to threat in Post-Traumatic Stress Disorder

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Abstract

Background: Attentional bias to affective information and reduced cognitive control may maintain the symptoms of post-traumatic stress disorder (PTSD) and impair cognitive functioning. However, the role of content specificity of affective stimuli (e.g., trauma-related, emotional trauma-unrelated) in the observed attentional bias and cognitive control is less clear, as this has not been tested simultaneously before. Therefore, we examined the content-specificity of attentional bias to threat in PTSD.

Methods: PTSD participants (survivors of a multistory factory collapse, n = 30) and matched controls (n = 30) performed an Eriksen Flanker task. They identified the direction of a centrally presented target arrow, which was flanked by several task-irrelevant distractor arrows pointed to the same (congruent) or opposite direction (incongruent). Additionally, participants were presented with a picture of a face (neutral, emotional) or building (neutral = normal, emotional = collapsed multistory factory) as a task-irrelevant background image.

Results: We found that PTSD participants produced overall larger conflict effects and longer reaction times (RT) to emotional than to neutral stimuli relative to their healthy counterparts. Moreover, PTSD, but not healthy participants showed a stimulus specific dissociation in processing emotional stimuli: Emotional faces elicited longer RTs compared to neutral faces, while *emotional buildings* elicited faster responses, compared to *neutral buildings*.

Conclusions: PTSD patients show a *content-sensitive* attentional bias to emotional information and impaired cognitive control.

Keywords: Attentional bias; emotion; reaction time; trauma.

1. Introduction

Traumatic life-threatening events, such as warfare, car accidents, or a building collapse often leave emotional scars and might lead to post-traumatic stress disorder (PTSD). PTSD is an anxiety disorder characterized by flashbacks and memories of a traumatic event that can significantly disrupt patients' executive and attentional processes. For instance, PTSD relative to healthy controls showed worse performance on the color–word Stroop task, which is thought to be a measure of inhibitory function and executive control (Lagarde et al., 2010). With regard to attentional processes, accumulating evidence suggest that people with PTSD experience an attentional bias to emotional information. They seem to orient their attention toward emotional stimuli (Morey, et al 2008; Morey, et al 2009; Pannu Hayes, et al 2009; Bremner, 2001; Shin, et al 2001) and have difficulties disengaging their attention away from emotional stimuli (Pineles, et al 2007; Pineles, et al 2009, see Clarke et al., 2013 for a critique of an unwarranted dissociation between allocation and disengagement of attention in anxious individuals). As a result, PTSD may result in an interplay between enhanced "emotional" processing networks that serve to enhance attention towards specific stimuli, and decreased "inhibitory" networks meant to disengage attention and redirect it to the task at hand (Aupperle et al., 2016). Moreover, evidence showed that attentional biases may maintain PTSD symptoms, impede information processing, and disrupt cognitive abilities (Weber, 2008).

However, it is not completely clear whether attentional bias in PTSD varies as a function of emotional content (i.e., *trauma-related* or *trauma-unrelated* stimuli). Some studies suggested that attentional bias in PTSD might be specific to the trauma-related information (Fleurkens et al., 2011, Ashley et al., 2013). For instance, specific interference effects were observed for trauma-related words in rape victims (Foa et al., 1991, Cassiday et al., 1992). These findings are in line with several cognitive models that emphasize the role of previous experience and memory during threat processing (Bar-Haim et al., 2007).

Conversely, other studies reported equal attentional interference by emotional *trauma-unrelated* stimuli (Litz et al., 1996, Vythilingam et al., 2007, Kimble et al., 2010). For example, Litz et al. (1996) found that Vietnam veterans who suffered from PTSD showed an emotional Stroop interference effect for both high-threat military words and high-threat education words in comparison with low-threat military words and low-threat education words. This finding suggests a generalized interference by salient affective stimuli, irrespective of content. Furthermore, recent reviews (Shin and Liberzon 2010; Liberzon and Sripada 2008; Francati, et al 2007) and meta-analyses (Etkin and Wager 2007) demonstrated a hyperactivation within the limbic regions of in PTSD patients (particularly in amygdala and insula). This implies that PTSD individuals may show an automatic and content-unspecific attentional bias to any threatening stimuli (Litz et al., 1996; Vythilingam et al., 2007; Kimble et al., 2010).

Finally, several studies have failed to replicate the finding of greater interference for trauma-related words in PTSD (Freeman and Beck, 2000, Devineni et al., 2004, Wittekind et al., 2010). Overall, due to inconsistencies in previous findings, the role of attentional bias specificity in PTSD is poorly understood. In this context, the goal of the present study was twofold: (i) we intended to identify the presence of a deficit in cognitive control among individuals with PTSD, and if so, (ii) further examine whether any such deficit may vary as a function of stimulus type (trauma-related and emotional trauma-unrelated).

The PTSD group consisted of the survivors from the Rana Plaza building collapse [1](Fitch et al., 2015) as well as age- and education-matched healthy controls. Importantly, a unique factor of the current sample is the homogeneity of PTSD group. Previous studies on content-specificity of attentional bias tested PTSD participants who have been exposed to a variety of traumatic events, and it was also difficult to control for the onset of trauma between participants. Alternatively, trauma experience in the current PTSD group relates to a single event and, thus, current sample overcomes this problem.

Participants were presented with an arrow Flanker task (Ridderinkhof et al., 1999) and were asked to identify whether the centrally presented arrow was pointing to the left or to the right while ignoring two adjacent arrows on either side, pointing in the same (congruent trial) or in the opposite direction (incongruent trials). Participants were asked to make a decision by pressing either the right or left button. Most importantly for the purpose of the study, in each trial either a picture of a face (neutral, emotional) or a building (control = intact buildings, collapsed Rana Plaza) was presented as a background image and was task-irrelevant.

Based on the existing evidences, we hypothesized that PTSD patients would show larger conflict effect, compared to the healthy controls (Lagarde et al., 2010). We expect a number of possible outcomes with regard to the influence of trauma-specific and non-specific threatening information on cognitive conflict processing. For example, emotional stimuli might not influence conflict processing at all, considering that these stimuli are entirely task-irrelevant (Freeman and Beck, 2000, Devineni et al., 2004). It is more likely, however, that both trauma-related and threat-general stimuli would interfere with cognitive control (Litz et al., 1996, Vythilingam et al., 2007,

[1]Multistory factory collapse (called Rana Plaza, in 2013) resulted in over 1,120 deaths and 2,000 causalities. Many victims remain missing.

Kimble et al., 2010). More specifically, we expect trauma-specific stimuli to elicit greater interference effect compared to non-specific threatening stimuli in PTSD patients (Foa, Feske, Murdock, Kozak, & Mccarthy, 1991; Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007).

2. Methods

2.1. Participants

Thirty healthy participants (male = 15, mean age = 22.5 years, SD = 3) and thirty PTSD patients who were matched for age and level of education (see Table1; male = 18, mean age = 23 years, SD = 4) and with normal or corrected-to normal vision participated in this study. All participants were right handed, had normal or corrected-to-normal vision and were naïve with respect to the purpose of the study. Participants were recruited at the Gonoshasthaya Kendra (Peoples Health Center), Dhaka, Bangladesh. PTSD was diagnosed by registered clinical psychologists with the Structured Clinical Interview for DSM-IV (American Psychiatric Association, 2000) and met DSM-IV diagnostic criteria for post-traumatic stress disorder. In addition to the clinical interview, we have also asked participants to fill out a Bangladesh version of the 22-item Impact of Events Scale-Revised (IES-R; Weiss and Marmar, 1997). Furthermore, the exclusion criteria included any neurological or additional psychiatric disorders (i.e., schizophrenia, epilepsy). Additionally, we excluded patients who suffered from alcohol dependence (1 patient) and who were not able to remember the traumatic event, as the nature of this memory loss was not clear (2 patients). The patients were non-medicated. All participants signed a consent form prior to participation. The experiment was conducted in accordance with guidelines of the Declaration of Helsinki and approved by the Ethics Committee of the North South University, Dhaka, Bangladesh (NSU/Pharmacy/2015/001).

Table 1: Demographic information of the participants.

		Control (n=30)		PTSD (n=30)	
		(number)	(%)	(number)	(%)
Education (year)	1-5	4	13.33	8	26.67
	6-10	16	53.33	18	60.00
	>10	10	33.33	4	13.33
BMI status	Underweight	-		5	16.67
	Normal	29	96.67	19	63.33
	Overweight	1	3.33	5	16.67
	Obese			1	3.33
Rescue time	0-5 hr			15	50.00
	5-10 hr	-	-	10	33.33
	10 hr>			5	16.67
	Average hr			12.19	
Blood Pressure*	Systolic (mmHg)	118 ± 2.05		112.33 ± 2.07	
	Diastolic (mmHg)	79 ± 1.87		72.67 ± 1.59	
	Mean Arterial Pressure (mmHg)	91 ± 1.93		85.89 ± 1.67	
Pulse		72		71.43 ± 0.61	
Smoking condition	Yes	5	16.67	6	20.00
	No	25	83.33	24	80.00

*Indicates value in mean±SD

2.2. *Stimulus material*

Stimuli consisted of pictures of human faces (male, female) and buildings. The faces could either be neutral (neutral condition) or emotionally negative (negative condition). The buildings could also be neutral (*normal buildings*) or emotional (pictures of the collapsed Rana Plaza). The pictures of faces and neutral buildings were taken from the Lifespan Database of Adult Facial Stimuli and House stimuli of the University of Dallas (Lang, 2008).

2.3 *Design and Tasks*

Experiment was split into four blocks with 52 pictures/trials each (26 emotional and 26 neutral, half were congruent and the other half incongruent) presented in a pseudo-randomized order. Overall, there were 208 trials and testing took approximately 45 minutes per participant.

Each trial contained a target arrow that was presented in the centre either pointing to the right or to the left. Additionally, two task-irrelevant flanker arrows were presented to the right and to the left side of the central target arrow. These flanker arrows either pointed in the same direction as the central target arrow (congruent trials) or in the opposite direction (incongruent trials). The Flanker stimulus subtended visual angles 6.29° x 2.29° (11 cm x 4 cm). In each trial, there was also a task-irrelevant picture presented in the background of the centrally presented Flanker task. The picture stimulus subtended visual angles 10.85° x 8.01° (19 cm x 14 cm) and remained on the screen as long as the flanker stimuli. Participants were instructed to report whether the central target arrow was pointing to the left (left-hand button) or to the right (right-hand button) and to ignore task-irrelevant flankers and background pictures.

2.3. Procedure

Participants were seated in a dimly lit room about one metre from a computer screen. Each trial started with a fixation cross on a blank computer screen for 200 ms (see Figure 1). Subsequently, experimental trials were presented for 1500 ms and participants had to respond as soon as possible. An inter-stimulus interval (ITI) of 1000, 1250, 1500, 1750, and 2000 ms was used randomly before the onset of the next trial. The pictures and flankers were delivered to the computer screen using the PsychoPy stimulus presentation software (Peirce, 2007).

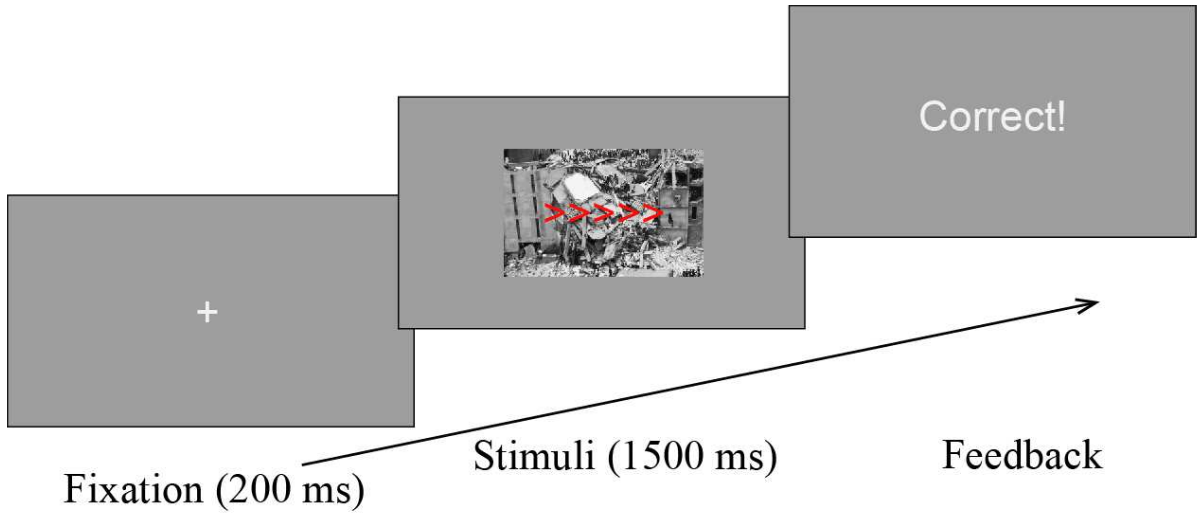

Figure 1. Example of a Trial Sequence. First, participants fixated on the fixation point for 200 ms, then a stimuli was presented for 1500 ms. Feedback was immediately displayed on the basis of response as “correct,” “incorrect, ” or, if participants took longer than 1500 ms to respond, “too slow.”

2.4. Data analysis

RTs exceeding 2.5 standard deviations from the mean were excluded from analysis as well as error trials. This outlier procedure resulted in exclusion of < 4 % of all trials. Subsequently, the values were submitted to a repeated-measures ANOVA as independent variables with the factors: Valence (2 levels: emotional, neutral), Stimulus type (2 levels: faces, houses), and Congruence (2 levels: congruent, incongruent). The group (PTSD, control) was a between-subjects factor. The results are expressed as a mean ± standard error of the mean (SEM). If the *p-value* was less than 0.05, we rejected the null hypothesis.

3. Results

3.1. Reaction time (RT)

We observed a three-way interaction of Group x Valence x Stimulus type (F(1, 58) = 12.64, $p < 0.01$, $\eta_p^2 = 0.179$) and resolved this interaction by group. The interaction of Valence x Stimulus type was not significant in healthy controls (p > 0.1; Figure 2, right). In contrast, PTSD group showed a significant two-way interaction of Valence x Stimulus type (Figure 2, left; F(1, 29) = 12.53, $p < 0.01$, $\eta_p^2 = 0.302$). We further resolved this interaction by Valence. Pictures of buildings produced overall longer reaction times compared to pictures of faces, and this effect was larger for the neutral stimuli (F(1, 29) = 19.09, $p < 0.01$, $\eta_p^2 = 0.397$) than the emotional stimuli (F(1, 29) = 10.78, $p < 0.01$, $\eta_p^2 = 0.271$).

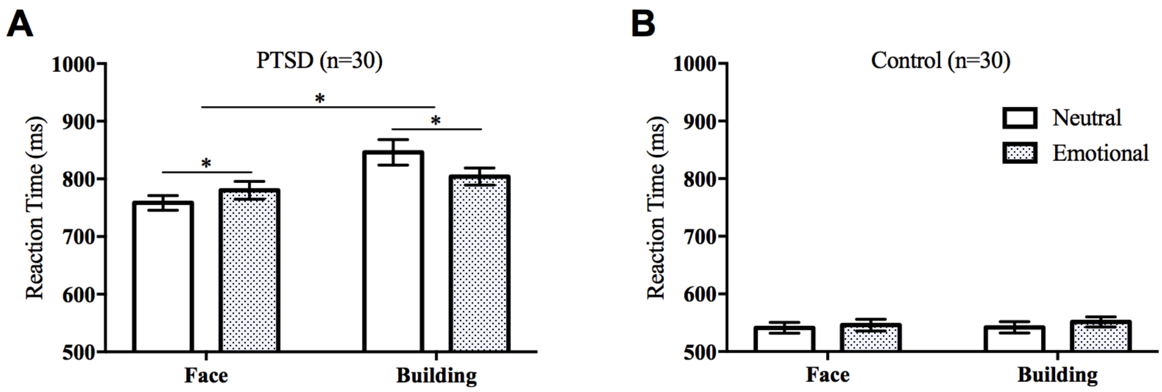

Figure 2. Reaction Time (milliseconds) data for face and building/emotional and neutral conditions in PTSD and healthy controls. Data presented as mean ± SEM. In PTSD group, emotional *faces* produced longer RTs compared to neutral faces ($p < 0.01$), while emotional *buildings* resulted in shorter RTs compared to normal buildings ($p < 0.01$). This interaction was not significant in the control group ($p > 0.5$).

We further resolved the Valence x Stimulus type interaction by stimulus type and found a stimulus-specific dissociation in PTSD patients: Emotional *faces* produced longer RTs compared to neutral faces F(1, 29) = 7.12, $p < 0.02$, $\eta_p^2 = 0.197$), while emotional *buildings* resulted in shorter RTs compared to normal buildings F(1, 29) = 11.99, $p < 0.01$, $\eta_p^2 = 0.293$). Importantly, the Valence x Stimulus type interaction was not significant (F(1, 29) = 0.36, $p > 0.5$, $\eta_p^2 = 0.012$) for the control group.

We also observed an interaction of Congruence x Group (F(1, 58) = 5.18, $p < 0.05$, $\eta_p^2 = 0.082$). The conflict effect was larger for PTSD patients (87 ms, SD = 10.3 ms; F(1, 29) = 106.21, $p < 0.0001$, $\eta_p^2 = 0.786$) compared to the healthy control (62 ms, SD = 0.17 ms; F(1, 29) = 152.74, $p < 0.001$, $\eta_p^2 = 0.840$). We also found an interaction of Stimulus type x Group (Figure 2; F(1, 58) = 17.77, $p < 0.001$, $\eta_p^2 = 0.235$), and resolved this interaction by group. The main effect of Stimulus type was significant for the PTSD patients: Pictures of buildings elicited longer RTs compared to pictures of faces (F(1, 29) = 21.25, $p < 0.001$, $\eta_p^2 = 0.423$). This effect was not significant for healthy controls (F(1, 29) = 0.457, $p > 0.5$, $\eta_p^2 = 0.016$). Additionally, the Valence x Group interaction was significant (F(1, 58) = 6.94, $p < 0.02$, $\eta_p^2 = 0.107$). The main effect of Valence was significant in PTSD patients: Emotional compared to neutral stimuli produced overall longer RTs (F(1, 29) = 3.98, $p < 0.05$, $\eta_p^2 = 0.121$). This effect was not significant for healthy controls (F(1, 29) = 2.99, $p > 0.9$, $\eta_p^2 = 0.094$).

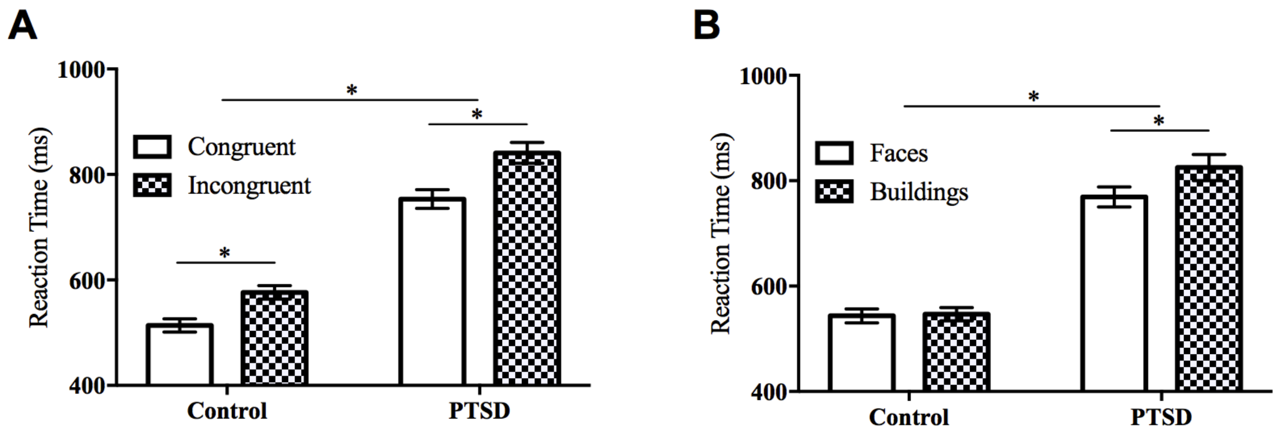

Figure 3. A. Reaction time for congruent and incongruent trials in PTSD and healthy controls. **B.** Reaction time for face and building stimuli in PTSD and healthy controls. Data presented as mean ± SEM. Pictures of buildings resulted in longer RTs compared to pictures of faces in PTSD patients ($p < 0.01$), but not in healthy controls ($p > 0.2$). * indicates p value is less than 0.05

3.2. Error rate

We observed a significant main effect of Congruence: Incongruent trials produced more errors compared to congruent trials ($F(1, 58) = 55.39$, $p < 0.001$, $\eta_p^2 = 0.488$). No other significant main effects or interactions were observed, with the largest F and smallest p values reported (all p's > 0.1).

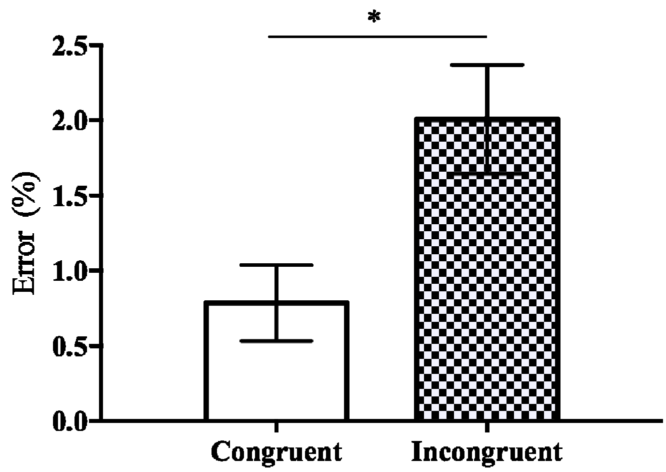

Figure 4. Error rate for congruent and incongruent conditions. Data presented as mean ± SEM. Incongruent trials resulted in more errors compared to congruent trials ($p < 0.01$). * indicates p value of less than 0.05

4. Discussion

The present study tested the role of trauma-related and emotional trauma-unrelated stimuli in the cognitive conflict processing in patient with the post-traumatic stress disorder (PTSD). We used an arrow Flanker task and presented emotional and neutral stimuli as background images. In line with previous findings, PTSD patients produced an overall larger conflict effect in comparison to the control group (Lagarde et al., 2010). In addition, emotional, compared to neutral stimuli expectedly elicited overall longer RTs in PTSD patients (Morey, et al 2009; Pannu Hayes, et al 2009), but not in healthy controls. Furthermore, pictures of buildings produced overall longer reaction times, compared to pictures of faces, but only for PTSD patients. Interestingly, in the PTSD patients, we found a stimulus-specific dissociation: Emotional *faces* produced longer RTs compared to neutral faces, while emotional (i.e., collapsed) *buildings* resulted in shorter RTs compared to neutral (i.e., intact) buildings.

PTSD patients experience extreme trauma related distress and often physical injury. Acute stress seems to disrupt functioning in the conflict-sensitive brain area, the anterior cingulate cortex (ACC). For instance, PTSD patients were shown to have a reduced ACC volume in comparison to the healthy controls (Abe et al., 2006, Karl et al., 2006). Furthermore, studies showed greater ventral ACC activation (Morey et al., 2009, Werner et al., 2009) and dorsal ACC activation in PTSD (Felmingham et al., 2009, Shin et al., 2011). It is possible that trauma-related alterations in the ACC functioning may lead to the reduced cognitive control in PTSD patients observed in the current study, which is consistent with previous studies (Johnsen et al., 2011). However, whether impeded executive functions in PTSD represent a pre-existing vulnerability to PTSD or develop as a consequence of the disorder (Gilbertson et al., 2002), remains unknown. In this context, further studies are necessary to measure executive control in PTSD (e.g., soldiers prior to and after deployment to combat zones).

We observed that PTSD patients respond slower when the background stimuli are emotional images (i.e., negative facial expressions, collapsed buildings) compared to neutral images. This also accords with previous findings that showed both emotional trauma-unrelated stimuli (Ashley et al., 2013) and trauma-related stimuli (Ashley et al., 2013; Kimble et al., 2010) prolong RTs in PTSD. Traumatic experience enhances brain regions that are responsible for regulating emotional responses, for example, the ventromedial prefrontal cortex (Koenigs and Grafman, 2009), and also leads to amygdala hypersensitivity (van den Heuvel et al., 2005). A possible explanation is that PTSD patients have a general and content-unspecific attentional bias to threatening information. Similarly, Eysenck and colleagues (2007) developed a theory of attentional control, which posits that anxiety disrupts two central executive functions: inhibition and shifting. In other words, highly anxious individuals experience difficulties to inhibit or regulate dominant or automatic responses (Cisler et al., 2010). On the other hand, anxiety is also able to potentiate shifting of attention, that is, anxiety expedites the degree to which attention is shifted from one task to another (Cisler et al., 2010).

Attentional bias has been previously observed in a number of tasks, suggesting that this phenomenon is not simply an artifact of a particular experimental procedure. Previous studies employed a modified Stroop task (see Bar-Haim et al., 2007), dot probe task (Bar-Haim et al., 2007; MacLeod et al., 1986), visual search (Rinck et al., 2003) and spatial cueing tasks (Cisler et al., 2009). However, to our knowledge, this is the first study to examine cognitive control and content-specificity of attentional bias using identical experimental procedure. In short, we have tested the impact of attentional bias, when it has to compete with a different demanding cognitive task (i.e., Flanker).

It is unclear to what degree the threat detection and attentional control mechanisms are related? It has long been debated whether availability of cognitive attentional resources is necessary to observe an attentional bias to threat. In this regard, the automatic processing account postulated that processing is capacity free and occurs without intent, control, or awareness (Cisler et al., 2010). For instance, attentional bias was shown for masked stimuli that were presented below the conscious level of participants (Bar-Haim et al., 2007; Mogg et al., 1993). Whalen and colleagues (1998) found greater activation of the amygdala to masked images of fearful relative to neutral eyes, suggesting that amygdala may respond automatically to threat-relevant features. Alternatively, strategic processing account argues that processing is intentional, controllable, capacity limited and dependent on awareness. For instance, attentional bias occurs specifically in participants who show lower levels of cognitive control (Lonigan & Vasey, 2009). Furthermore, automatic activation of amygdala towards threat is still dependent on availability of attentional resources (Pessoa et al., 2005), which implies that threat detection mechanism does not operate completely automatically. Our current findings seem to favor more the first automatic model. We show content-specific attentional bias that is unrelated to cognitive capacities. More specifically, participants showed a similar bias effect both in congruent Flanker trials (where capacities of cognitive control are high and the task is easy) and in the incongruent trials (capacity is low, task is difficult). Importantly, both groups of participants showed overall inhibited performance on incongruent than congruent trials, suggesting that incongruent trials were more demanding and occupied some portion of cognitive resources. It is also possible, however, that the cognitive task was not demanding enough to influence attentional bias. Therefore, future studies may use a staircase procedure and manipulate cognitive load to test the role of cognitive resources in attentional bias to threat (Van Dillen & Koole, 2009).

Unlike PTSD, healthy volunteers did not show any influence of emotion on conflict processing. These results are inconsistent with previous reports that task-irrelevant emotions slow RTs in younger adults (Zinchenko et al., 2015) and inhibit conflict processing (Blair et al., 2007). Possibly, as the Flanker task was not demanding (error rate ~ 2%), performance was already at ceiling, and emotional stimuli were unable to influence conflict processing in the control group. In line with this hypothesis, task difficulty has been shown to modulate the impact of emotional distracters on neural responses in the brain regions responsible for cognitive and executive control, as well as in the Amygdala (Jasinska et al., 2012).

We also observed a stimulus-specific dissociation in the processing of emotional stimuli which was limited to PTSD group. Emotional faces elicited prolonged RTs compared to neutral faces, while trauma-related threatening (i.e., collapsed) buildings elicited faster responses compared to control stimuli (i.e., intact buildings). Both trauma-related and emotional (e.g., threatening) trauma-unrelated stimuli draw attention away from the task and prolong reaction times (Ohman et al., 2001, Pine et al., 2005; Sveen et al., 2009; Vuilleumier, 2005). However, it seems that some compensation mechanism is activated that allows *emotional* trauma-related information to be disengaged faster, relative to *neutral* trauma-related information. Importantly, the observed attentional bias toward and away from the two-types of threat stimuli is congruent with some of the most common PTSD symptoms: hypervigilance and avoidance/dissociation (Naim et al., 2015). In a similar vein, previous studies reported rather mixed results on attentional bias in PTSD. Several studies observed an attentional bias toward threat (Jenkins et al., 2000), while others showed attentional bias away from threat (Wald et al., 2011; but see Clarke et al., 2013 for a critical evaluation of these findings). Furthermore, studies reported an increased bias variability in PTSD, i.e., greater attentional fluctuations alternating towards and away from threat within a single experiment (Naim et al., 2015). Possibly, the observed variability in PTSD may at least partially come from the content-specificity of stimuli used to test the effect. Based on the current findings, trauma-related stimuli would result in faster suppression of threat stimuli and shorter RTs, while trauma-unrelated context would result in an inhibited suppression and, thus, longer RTs.

Additionally, observing threatening trauma-related relative to -unrelated information may activate valence-specific mechanisms of cognitive control and stimulus processing (Ochsner et al., 2009; Soutschek & Schubert, 2013; Zinchenko et al., 2015; Zinchenko et al., 2017). More specifically, cognitive conflict is resolved by amplified processing of the target stimulus (Egner & Hirsch, 2005), while emotional conflict processing seems to facilitate inhibition of the non-target affective distractors (Etkin et al., 2006). Possibly, trauma-related stimuli activate the emotional conflict system that results in facilitated suppression of these stimuli and thus speeded responses on such trials. Alternatively, trauma-unrelated threatening stimuli slow down the speed of processing, possibly due impaired functioning of the amygdala in PTSD (Anderson & Phelps, 2001; Öhman & Wiens, 2004). In line with this hypothesis, Cisler and colleagues (2010) suggested that attentional control and emotion regulation strategies appear to both modulate attentional biases, although the underlying mechanism of these processes may be different. Attentional control is a regulatory ability, that is, people with higher attentional control can disengage attention from threatening stimuli. In contrast, emotion regulation may reflect an individual strategy for coping with negative emotions (Cisler et al., 2010; Gross, 1998a). Therefore, PTSD patients may develop a certain strategy to avoid threatening stimuli that are strongly associated with their specific trauma.

A recent meta-analysis tested for content specificity of attentional bias to threat, controlling for the type of anxiety disorder (e.g., PTSD, SAD; Pergamin-Hight, Naim, Bakermans-Kranenburg, van Ijzendoorn, & Bar-Haim, 2015). After reviewing 37 samples from 29 articles (N = 866), the authors concluded that the corresponding trauma-relevant stimuli attract stronger attention in PTSD, social-anxiety and other anxiety disorders (Pergamin-Hight et al., 2015) when compared to trauma-unrelated threat stimuli. The authors also suggested that patients with anxiety disorders may have their attentional system biased in a content specific way. Furthermore, neuroimaging studies observed a greater activation in the conflict-specific ventral prefrontal cortex (vPFC) when performing a cognitive task with trauma-related in comparison to trauma-unrelated stimuli (Wager et al., 2008). We also tested whether trauma-relevant and –irrelevant threatening stimuli are able to bias attention and cognitive control when compared to neutral stimuli of a same category. This was achieved by presenting negative and neutral facial expressions, as well as trauma-related threatening stimuli (collapsed buildings) and control stimuli (intact buildings). Our results provide further evidence that content-specificity of the threat-related bias in PTSD is not only defined by the strength of the attentional bias, but possibly also by differences in cognitive and attentional mechanisms underlying these processes. It seems that processing of trauma-related information has a unique cognitive pattern when compared to other emotional but trauma-unrelated stimuli in PTSD.

Understanding cognitive mechanisms of attentional bias in PTSD is particularly important because it may facilitate the development of the most effective psychotherapeutic interventions (Steenkamp et al., 2015). For instance, threat-related attentional bias in anxiety has been addressed previously with the help of Attention Bias Modification Treatment (ABMT). ABMT was designed to reduce anxiety through therapeutic changes in the threat-related attention patterns. Meta-analyses of this technique show a small-to-medium effect sizes for anxiety reduction (Beard et al., 2012). One of the factors that could be causing the moderate effect sizes of ABMT could be the nature and content-specificity of the stimuli used for attention training. Therefore, further research is needed to test whether the content-specificity of stimuli may influence efficiency of the ABMT (however, see Schoorl et al., 2013; Schoorl et al., 2014 for opposite findings).

The following limitations of the current research should be noted. PTSD patients might have perceived trauma-related control stimuli (intact buildings) as emotional, as we have observed overall increased RTs for buildings in comparison to faces. In contrast to the collapsed building, an intact construction may still collapse and may therefore induce participants' idiosyncratic anxiety reaction. Therefore, further studies are necessary to control for the level of arousal produced by different stimuli, and, possibly, develop more appropriate trauma-related control stimuli for PTSD participants.

To summarize, the current study used an arrow flanker task to address the question of content-specific attentional bias and its influence on cognitive conflict processing in PTSD. We found that PTSD, compared to healthy participants, produced larger conflict effects as well as longer RTs to emotional compared to neutral stimuli. Importantly, PTSD showed a stimulus specific dissociation in processing of emotional stimuli: Emotional faces elicited longer RTs compared to neutral faces, while emotional buildings elicited faster responses compared to neutral buildings. We suggest that although PTSD patients develop an overall attentional bias to emotional information, the mechanism of this bias seems to differ in a content-specific manner.

5. Acknowledgment

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8. References

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