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Attenuation of Attention Bias in Obsessive-Compulsive Disorder

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Abstract

Cognitive theories of obsessive-compulsive disorder (OCD) suggest that the disorder is characterized by an attention bias towards personally relevant threatening material. However, existing research on attention bias in OCD has yielded conflicting findings. One possibility that might account for the null findings is that attention bias may diminish over the course of the experiment. The present study tested this hypothesis using a visual dot-probe task with idiographic word selection. Results from our study confirmed that individuals with OC symptoms show an attention bias towards idiographically-selected, threatening information in the first block of trials, and that the degree of this bias is correlated with the severity of OC symptoms. The temporal pattern of attention bias over the course of the experiment was consistent with our hypothesis: A comparison of early and late blocks of trials revealed an attenuation of attention bias in individuals with OC symptoms, potentially reflecting habituation to threatening information over the course of the experiment.

Keywords

Obsessive-Compulsive Disorder; Attention; Probe Detection; Idiographic

Obsessive-compulsive disorder (OCD) is characterized by unwanted, intrusive thoughts that cause anxiety (obsessions), and repetitive, ritualistic behaviors or thoughts intended to reduce the anxiety (compulsions). Cognitive models of OCD have emphasized a role of dysfunctional beliefs (Rachman, 1997; Salkovskis, 1985, 1989) in the etiology and maintenance of the disorder. Other investigators have proposed that the characteristic repetitive obsessions and compulsions in OCD may be the result of deficient and/or biased processing of threat-relevant information (e.g., Tallis, 1997). To test this hypothesis researchers have examined attention bias for OCD-relevant, threatening material in individuals with OCD (for reviews see Muller & Roberts, 2005; Summerfeldt & Endler, 1998). However, this research has not always yielded consistent findings.

One of the first studies to address attention bias in OCD used a dichotic listening task before and after exposure and response prevention treatment (Foa & McNally, 1986). In a dichotic listening task, participants are presented simultaneously with distinct passages of prose to each ear and asked to shadow the passage presented to the dominant ear while also detecting target words included in each passage. Foa and McNally (1986) found that patients with OCD were better at detecting fear-relevant words in the unattended passage compared to detecting neutral

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words in the unattended passage. After treatment by exposure and response prevention, participants with OCD did not detect fear-relevant and neutral words differentially. Therefore, successful treatment may have ameliorated this information processing bias.

Several researchers have used a modified (i.e., emotional) Stroop task (Stroop, 1935) to investigate biased attention in OCD, but results from these studies are mixed. In one study, individuals with OCD exhibited longer response latencies to color-name negatively-valenced OCD-related words compared to neutral words (Lavy, van Oppen, & van den Hout, 1994). However, they did not display interference for positively-valenced OCD-related words or general threat words (Lavy et al., 1994). Likewise, in another study, OCD washers showed greater interference for contamination words (i.e., their specific fear) compared to non-anxious controls (Foa, Ilai, McCarthy, Shoyer, & Murdock, 1993). In the same study, OCD non-washers showed greater interference for general threat words compared to the OCD washers and non-anxious controls. A few other studies using the emotional Stroop have failed to find significant interference for OCD-related threat material in individuals with OCD (Kyrios & Iob, 1998; van den Heuvel et al., 2005). Taken together, results from the emotional Stroop task suggest that individuals with OCD may exhibit an attention bias towards OCD-relevant threat information, but this finding is not replicated easily.

Some researchers have questioned whether the emotional Stroop task is a valid measure of selective attention. Fox (1993) noted that in order to test for selective attention, the attended stimulus and unattended stimulus must be spatially separate and outside the immediate visual field. Other studies suggest that Stroop interference confounds attention bias and cognitive avoidance, with avoidance likely contributing more to the observed interference effects (e.g., Williams, Mathews, & MacLeod, 1996). In response to these critics, researchers have used the probe detection task (MacLeod, Mathews, & Tata, 1986). In a typical probe detection task, participants are presented with pairs of words, one above the other, on a computer screen. On some trials a probe (e.g., a dot or letter) replaces the location of one of the words. Participants are instructed to respond to the probe by pressing a key as soon as it is detected. Biased attention is defined as smaller response latencies to probes located in the vicinity of threat words compared to probes located in the vicinity of neutral words.

Research suggests that anxious individuals show an attention bias for threat in the probe detection task (for reviews see Mogg & Bradley, 2005; Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & IJzendoorn, 2007). However, to our knowledge, only one study has examined attention bias in individuals with OCD using a probe detection task. In this study, Tata, Liebowitz, Prunty, Cameron, and Pickering (1996) presented a modified probe detection task with social threat and contamination-related words to a subset of OCD patients with contamination concerns. They found that OCD patients, but not low and high trait anxious controls, displayed an attention bias for contamination threat words, but not social threat words, indicating specificity of attention bias to personally relevant material. However, a more recent study using a spacial cueing paradigm (based on the Posner paradigm; Posner, 1980) failed to find evidence for an attention bias in OCD checkers (Moritz & von Muhlenen, 2008).

Taken together, some research suggests that individuals with OCD show an attention bias towards OCD-related threatening material (Foa & McNally, 1986; Foa et al., 1993; Lavy et al., 1994; Tata et al., 1996). In contrast, some researchers have failed to find any attention bias within individuals with OCD (Kyrios & Iob, 1998; Mortiz & von Muhlenen, 2008; van den Heuvel et al., 2005). One explanation that may account for the null findings is that attention bias attenuates over the course of the experiment. Consistent with this hypothesis, McNally, Riemann, and Kim (1990) found that participants with panic disorder and non-anxious controls displayed a significantly larger attention bias to threat during the first block of trials compared to the last block of trials in a modified Stroop task. These authors suggested that this attenuation

of interference may be due to the effect of habituation to the semantic content of the threatening words over the course of the experiment. More recent studies on attention processing have replicated this finding. For example, in a series of experiments, McKenna and Sharma (1995) systematically examined the effects of stimulus valence and repetition on habituation over the course of the emotional Stroop task. These authors found that participants showed an interference effect for emotional words in the first block of trials but not in any of the remaining four blocks. Similar findings were reported in a study of attention to anger-related stimuli using a visual search task (Cohen, Eckhardt, & Schagat, 1998) and in a study of attention to threatening pictures using a modified probe detection task (Liu, Qian, Zhou, & Wang, 2006). Here, too, the authors attributed their findings to the effects of habituation to the stimuli over the course of the experiment.

The goal of the current study was to investigate the temporal pattern of attention bias in individuals with OC symptoms, using a modified probe detection task and idiographic stimuli. We hypothesized that individuals who endorse obsessive-compulsive symptoms will reveal an attention bias towards personally-relevant, threatening stimuli during the early trials of the experiment, but that this bias will diminish significantly over the course of the experiment.

Method

Participants

Participants were undergraduate students who received partial course credit for their participation. To select these individuals, we first screened 400 individuals from a large pool of undergraduate psychology students using the Maudsley Obsessive-Compulsive Inventory (MOCI; Hodgson & Rachman, 1977). We used this measure to identify individuals in the high-OC group ($n = 23$) if their total score on the MOCI was above 12 or the low-OC group ($n = 24$) if their total score on the MOCI was below 8 (see Emmelkamp, Kraaijkamp, & van den Hout, 1999, for MOCI cutoff value). Participants identified as low or high-OC were then invited to participate in the study.

Measures

As mentioned above, the MOCI was used to classify participants into the high-OC group and the low-OC control group. The MOCI is a 30-item true/false measure of general obsessive-compulsive symptoms. The scale has acceptable psychometric properties (Taylor, 1998). In student samples, the MOCI has been shown to have internal consistency, with Chronbach's alpha coefficients ranging from 0.40 to 0.77 (Sternberger & Burns, 1990; Taylor, 1998). In the present study, internal consistency for the sample was Cronbach's $\alpha = .45$ for the total scale. Participants also completed the Spielberger State-Trait Anxiety Inventory (STAI-S/T; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), a self-report measure of anxiety symptoms with adequate psychometric characteristics. The STAI is a 20-item measure where subjects rate statements about their anxiety on a four-point Likert scale ranging from 'almost never' to 'almost always' with higher scores indicating higher trait anxiety. Both state and trait versions were administered. Participants also completed the Beck Depression Inventory II (BDI-II; Beck, Steer, & Brown, 1996), a reliable and well-validated, 21-item self-report measure of symptoms of depression.

Procedure Overview

Participants first completed the self-report measures. Next, they rated a list of words and the experimenter compiled an idiographic word set as will be outlined in detail in the next section. After the experimenter explained the instructions for the task, participants completed 20 practice trials using only neutral stimuli. Finally, participants completed the main experimental probe detection task using the idiographically-selected word pairs.

Procedure Detail

We asked all participants to rate 163 OCD-related words that were pre-selected from a study of attention bias in OCD (Foa et al., 1993) and the Obsessive-Compulsive Inventory (OCI: Foa, Kozak, Salkovskis, Coles, & Amir, 1998). The scale of emotional valence ratings ranged from -3 (negative) to +3 (positive). A score of 0 indicated the word was neutral in valence. Each participant's word ratings were then used to compile an idiographic set of 50 words, 25 threat-related and 25 neutral, to be used in the probe detection task. Words rated as -3 were categorized as threat (e.g., feces) and words rated as 0 were categorized as neutral (e.g., table). If more than 25 words received a rating of -3 or 0 for the threat and neutral categories, respectively, then 25 words receiving each rating were chosen at random. If fewer than 25 words received these ratings for each of the valences, then the cutoffs were extended to -2 for threat words and 1 for neutral words. Finally, each threat word was paired with a neutral word to form 25 critical threat-neutral word pairs. This process resulted in a set of word pairs for each participant that was relevant to his/her specific concerns.

The probe detection task used in the present study was similar to the original task used by MacLeod et al. (1986). Each trial began with a fixation cross presented in the center of the computer screen for 500ms. Then the cross was replaced by a word pair presented in the center of the screen, one word 3cm above the other, for 500ms. Participants were instructed to look at the top word (MacLeod et al., 1986). The words then disappeared and a probe (i.e., the letter "E" or "F") immediately appeared in the location of one of the two words. Participants were instructed to decide whether the letter was an E or an F and press the corresponding mouse button. The letter probe remained on the screen until the participants responded. Response latencies to identify the probe were recorded from the onset of the presentation of the letter probe to the button press. After the response, there was a 500ms interval of a blank screen before the next trial began with a fixation cross. Stimuli were presented in 12-point Arial font in black on a grey background.

During the probe detection task, participants were presented up to 300 trials comprising all combinations of Probe Type (E or F), Probe Location (Top or Bottom), and Threat Location (Top or Bottom). Trials were presented in a new random order to each participant. Two hundred of the trials were critical trials (i.e., comprised of Threat-Neutral word pairs): $2 \text{ (Probe Type)} \times 2 \text{ (Probe Location)} \times 2 \text{ (Threat Location)} \times 25 \text{ Threat-Neutral Word Pairs}$. The remaining 100 trials were control trials (i.e., comprised of Neutral-Neutral word pairs; Tata et al., 1996): $2 \text{ (Probe Type)} \times 2 \text{ (Probe Location)} \times 25 \text{ Neutral-Neutral Word Pairs}$. However, due to the fact that we used an idiographic word selection procedure, participant completed as many as 300 trials if they selected 25 OCD related threat words and as few as 204 trials if they only selected 17 OCD related threat words.

Results

Participant characteristics

As expected, the high-OC and low-OC groups differed on our measure of obsessive-compulsive symptoms (i.e., MOCI) but not on demographic variables, state or trait anxiety (Table 1). The high-OC group had significantly higher BDI scores than did the low-OC group.

Probe Detection Data

In order to ensure that a comparable number of trials was considered across subjects, we based our analyses on the first 200 trials for all subjects. The first 20 trials for each participant were considered practice trials and hence excluded from analysis. The remaining 180 trials were divided into three consecutive blocks of 60 trials each. For each block, outliers were removed in keeping with recommendations from Ratcliff (1993): Response latencies less than 300ms

or greater than 1600ms were eliminated from analysis of the first block, and response latencies less than 200ms or greater than 1200ms were eliminated from analysis of the second and third blocks. Additionally, response latencies ± 2 SD from each participant's mean response latency were also eliminated from analysis, resulting in an average of 50 trials (median = 53; mode = 56) in the first block, 51 trials (median = 53; mode = 55) in the second block, and 51 trials (median = 54; mode = 54) in the third block. Furthermore, a comparison of the ratio of critical trials (i.e., threat-neutral trials) to filler trials (i.e., neutral-neutral trials) confirmed that this ratio was similar across blocks for the low and high OC groups: For the first block, the ratio of critical to filler trials was 2:1 for the high-OC and the low-OC groups; for the second block, the ratio was 2:1 for the high-OC group and 1.9:1 for the low-OC group; for the third block, the ratio was 1.9:1 for the high-OC and the low-OC groups. Finally, there was no significant difference between accuracy rates in the high-OC and low-OC groups, $t(45) = .11, p > .91$ [mean accuracy for high-OC group = .92, mean accuracy for low-OC group = .92].

Attention Bias

We examined bias either towards or away from threatening stimuli in the probe detection task by comparing response latencies for trials where the probe was in the vicinity of a Threat-related word (i.e., Threat Location-Top/Probe Location-Top and Threat Location-Bottom/Probe Location-Bottom) to response latencies for trials where the probe was in the vicinity of a Neutral word (i.e., Threat Location-Top/Probe Location-Bottom and Threat Location-Bottom/Probe Location-Top). Mean response latencies for the different trial types are presented in Table 2. Attention bias for threat is indicated if response latencies for probes in the vicinity of threat words are smaller than response latencies for probes in the vicinity of neutral words.

To test if attention bias diminished over the course of the experiment, we subjected response latencies to a repeated-measures ANOVA with Group (high-OC, low-OC) as the between-subjects factor and Block (First, Second, Third), Probe Location (Top, Bottom), and Threat Location (Top, Bottom) as within-subjects factors. The Group $\times$ Block $\times$ Probe Location $\times$ Threat Location interaction was significant, $F(2, 41) = 3.19, p = .05, \eta^2 = .14$. We did not find a significant main effect of Threat Location [$F(1, 44) = .35, p = .56$] or Probe Location [$F(1, 44) = .51, p = .48$], and hence we proceeded with calculating attention bias scores to simplify reporting of the four-way interaction. We calculated attention bias scores for the three blocks of trials using response latencies for critical trials as follows: $0.5 * (\text{Threat Location-Bottom/Probe Location-Top} + \text{Threat Location-Top/Probe Location-Bottom} - \text{Threat Location-Bottom/Probe Location-Bottom} - \text{Threat Location-Top/Probe Location-Top})$ (Mathews & MacLeod, 1988). Bias scores were then subjected to a 2 (Group) $\times$ 3 (Block) repeated-measures ANOVA which, as expected, revealed a significant Group $\times$ Block interaction, $F(2, 41) = 3.19, p = .05, \eta^2 = .14$ (Figure 1). Attention bias was significantly different across blocks for the high-OC group, $F(2, 20) = 3.72, p = .04, \eta^2 = .27$, such that the bias decreased significantly from the first to the second block, $t(22) = 2.85, p < .01$, but not from the second to the third block, $t(21) = -.28, p > .78$. Bias in the third block was significantly lower than in the first, $t(21) = 2.18, p = .04$. For the low-OC group, attention bias was not significantly different across blocks, $F(2, 20) = 1.50, p > .24$.

We conducted additional analyses specifically for the first block to test our hypothesis that, in early trials, the high-OC group will show a significantly larger bias toward threat than will the low-OC group. A repeated-measures ANOVA on response latencies yielded a significant Group $\times$ Probe Location $\times$ Threat Location interaction, $F(1, 44) = 5.16, p < .03, \eta^2 = .11$. A comparison of bias scores revealed that attention bias towards threat was significantly larger in the high-OC group than in the low-OC group, $t(44) = 2.27, p < .03$. Consistent with our hypothesis, the attention bias score for the first block, and not for the second and third blocks,

was positively correlated with MOCI scores ($r = .39, p < .01$), but not with BDI ($r = .13, p = .40$), state STAI-state scores ($r = .07, p = .63$) or STAI-trait scores ($r = .12, p = .44$).

Finally, it is important to note that an analysis of response latencies collapsed across all three blocks yielded a non-significant Group $\times$ Probe Location $\times$ Threat Location interaction, $F(1, 45) = .54, p > .46$.

Discussion

To our knowledge, this is the first study to examine the temporal pattern of attention bias in individuals with OC symptoms. Results from our study suggest that attention bias towards threatening information diminished significantly after the first block of trials in individuals with OC symptoms, potentially reflecting habituation to threatening information over the course of the experiment. The control group of individuals low in OC symptoms showed neither an initial attention bias, nor a significant change in bias over the course of the experiment. Given that different studies of attention bias in OCD have used different numbers of trials, it may well be the case that the attenuation of bias over time results in null findings in many of these experiments.

Using the emotional Stroop task, McNally et al. (1990) found that the attenuation of attention bias occurred in participants with panic disorder whereas McKenna and Sharma (1995) found the same effect for attention bias towards threat-related words in non-clinical college students. These authors suggested that this attenuation of attention bias may be due to the habituation to the semantic content of the threatening words over the course of the experiment. Cohen et al. (1998) reported similar findings for attention bias towards anger-related threat using a visual search task. Finally, Liu et al. (2006) reported similar findings in high-anxious college students using a pictorial dot-probe task. Thus, it appears that the phenomenon of attenuation of attention bias towards threat is not specific to experimental task or clinical group. Monk et al. (2004) examined the neural correlates of change in attention bias over time using an fMRI paradigm. They found that attention bias away from threat increased over time in non-clinical participants, and that this change in attention bias over time was associated with increased activation in the occipitotemporal cortex. The authors interpreted their findings as indicating that top-down cortical processes that are associated with categorization of threat become increasingly engaged over time. However, Monk et al. did not find evidence for a change in amygdala activation over time, which raises questions regarding their suggestion that a change in attention bias is the result of cortical modulation of amygdala activation.

Cognitive models of anxiety (e.g., Eysenck, 1997) state that vulnerability to anxiety is associated with an initial attention bias towards personally relevant threat, and that this effect is evident in anxiety disorder patients and in high-anxious, non-clinical individuals (Mogg, Mathews, & Eysenck, 1992; Tata et al., 1996; Williams et al, 1996). Results of the present study are consistent with the concept of an *initial* attention bias towards personally relevant threat in individuals with OC symptoms. Results are partially consistent with the notion of a vigilance-avoidance pattern—an initial orienting of attention towards threat followed by attention bias away from threat—proposed by other researchers (e.g., Mogg, Bradley, de Bono, & Painter, 1997; Mogg, Bradley, Miles, & Dixon, 2004; Mogg & Bradley, 2006). However, our experimental design (based on the number of presentations of threat-related stimuli) is different from the paradigm that has been used to study the vigilance-avoidance pattern (based on the duration of presentation of the threat-related stimuli). An equally likely explanation for our findings is that threatening stimuli lose their threat value with repeated presentation over time.

An alternative explanation for the null findings in the existing research on attention bias in OCD may be the considerable heterogeneity of subtypes in OCD. Since the content areas of threat can vary considerably between individuals with OCD symptoms, it is possible that many experimental stimuli that are pre-selected by experimenters as threat-related are not in fact threatening to individual participants. To address this issue, we used idiographic word selection to ensure that the participants were presented words that were threatening to them. Results from our study confirm that individuals with OC symptoms show an attention bias towards idiographically-selected, threat-relevant, information in the first block of trials: Response latencies for probes following threatening words were smaller than response latencies for probes following neutral words in individuals high in OC symptoms, but not in the control group. Moreover, the degree of attention bias towards personally-relevant threatening material in the first block of trials was correlated with the severity of OC symptoms. Important to note is that the degree of attention bias was not correlated with the severity of depressive symptoms, although the high-OC group had higher BDI scores than did the low-OC group. This supports the idea that although higher OC symptoms tend to be comorbid with depressive symptoms, it is only the OC symptoms that predict attention bias towards OCD-related threat.

Our study has limitations. First, to our knowledge, this is the first study to investigate the temporal pattern of attention bias in OCD, and hence the evidence presented here should be treated as preliminary until our findings are replicated. Second, our findings are in a non-clinical sample and therefore may not generalize to individuals with a clinical diagnosis of OCD. Follow-up studies conducted with samples of individuals with OCD would greatly improve the conclusions that can be drawn regarding the pattern of attention bias towards threat in OCD. Third, the procedure we used for idiographic word selection resulted in an unequal number of trials (ranging from 204 to 300) completed by each individual, and it is possible that the difference in total number of trials completed by the participants influenced their response. We addressed this issue by limiting our analyses to the first 200 trials for each subject so that a comparable number of trials was considered for all participants. Furthermore, we confirmed that using the first 200 trials for each participant yielded a comparable ratio of critical trials (threat-neutral trials) to filler trials (neutral-neutral trials) across groups (high-OC, low-OC) and blocks (first, second, third).

Despite these limitations, results from this study add to the research on information processing in OCD, providing evidence for an attention bias towards OCD-related threat, and determining the temporal course of this bias. Furthermore, these results offer a note of caution to investigators of attention bias to consider the number of trials as a critical factor in the study design and a key variable to help explain failures of replication.

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Figure 1. Attention Bias scores for individuals high in obsessive-compulsive symptoms (high-OC group) compared to individuals low in obsessive-compulsive symptoms (low-OC group).

Table 1
Demographics and Measures of Psychopathology

	High-OC n = 23	Low-OC n = 24	
Sex	4 M, 19 F	9 M, 15 F	$\chi^2(1) = 2.37, p > .12$
Age	18.83	19.13	$t(45) = -1.04, p > .30$
MOCI	16.87	4.42	$t(45) = 18.09, p < .01$
BDI	12.74	7.38	$t(45) = 2.70, p < .01$
STAI-T	42.04	36.29	$t(45) = 1.83, p > .07$
STAI-S	36.83	32.83	$t(45) = 1.49, p > .14$

High-OC = Individuals high in obsessive-compulsive symptoms; Low-OC = Individuals low in obsessive-compulsive symptoms; MOCI = Maudsley Obsessive-Compulsive Inventory; BDI = Beck Depression Inventory; STAI-T = Spielberger State-Trait Anxiety Inventory-Trait Form; STAI-S = Spielberger State-Trait Anxiety Inventory-State Form.

Table 2

Mean Response Latencies (milliseconds)

		n	Neutral-Neutral Pairs <i>M</i> (<i>SD</i>)	Probe following Threat Word <i>M</i> (<i>SD</i>)	Probe following Neutral Word <i>M</i> (<i>SD</i>)
Block I	High-OC	23	574(136)	570(124)	599(160)
	Low-OC	24	546(138)	569(209)	543(120)
Block II	High-OC	23	547(88)	573(90)	558(79)
	Low-OC	23	544(116)	537(108)	528(113)
Block III	High-OC	22	554(99)	566(100)	557(107)
	Low-OC	23	524(96)	529(100)	537(102)
All Blocks	High-OC	23	581(112)	587(102)	585(104)
	Low-OC	24	557(122)	557(123)	551(112)