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Shorter communication

Components of attentional biases in contamination fear: Evidence for difficulty in disengagement

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ABSTRACT

Attentional bias for threat has been implicated in the contamination fear (CF) subtype of obsessive-compulsive disorder, but the components of the bias (facilitated attention versus difficulty in disengagement) and the stage of processing during which the bias occurs (early versus late stage of processing) remains unclear. Further, it is unclear whether attentional biases in CF are towards fear or disgust-related stimuli. The present study examined attentional biases in a group of individuals selected to have elevated CF ($n = 23$) and a control group ($n = 28$) using the spatial cueing task. Stimuli were neutral, disgusting, or frightening pictures presented for either 100 or 500 ms. Results revealed evidence for delayed disengagement from both fear and disgust stimuli in the CF group, but not in the control group. The effect appeared to be greater at 500 ms stimulus presentation, but did not appear to differ between fear and disgust stimuli. The CF group was associated with delayed disengagement from threat even when controlling for generic response slowing. Theoretical and clinical implications are discussed.

A wealth of research demonstrates that attention is biased towards threat among individuals with anxiety disorders (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). Although attentional biases towards threat are central to cognitive theories of anxiety disorders in general, there has been inconsistent evidence of attentional biases in obsessive-compulsive disorder (OCD). Moritz and colleagues have found that individuals with OCD exhibit neither a modified Stroop effect towards disorder-relevant words (Moritz et al., 2008) nor biased spatial attentional allocation in the spatial cueing task (Mortiz & von Muhlenen, 2008). OCD is theorized to be dimensional (Mataix-Cols, do Rosario-Campos, & Leckman, 2005) and it is important to consider the presentation of OCD (e.g., contamination versus checking) as a moderator of attentional biases. Among the subtypes of OCD, there is stronger evidence for attentional biases towards threat in contamination fear (CF). Individuals with CF-related OCD demonstrate longer response latencies towards contamination words compared to neutral words in the emotional Stroop task (Foa, Ilai, McCarthy, & Shoyer, 1993) and demonstrate greater attentional bias towards contamination words relative to high trait-anxious individuals in the dot probe task (Tata, Leibowitz, Prunty, Cameron, & Pickering, 1996). Accordingly, there is initial evidence for attentional biases in CF.

Although an attentional bias for threat has been observed in CF, the specific components of the bias remain unclear. Research has revealed that attentional biases are comprised of facilitated attention towards threat, difficulty in disengaging attention from threat, and attentional avoidance away from threat (Cisler, Bacon, & Williams, 2009; Cisler, Olatunji, Lohr, & Williams, 2009; Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002). Facilitated attention refers to the relative ease with which threat stimuli draw attention. Difficulty in disengagement refers to difficulty removing attention from a threat stimulus once attention is allocated onto it. Attentional avoidance refers to strategic efforts to avoid allocating attention to a threat stimulus. Further, research has begun to elucidate the temporal characteristics of attentional bias, with the component of attentional bias observed possibly differing as a function of early (e.g., 100 ms) versus late (e.g., 500 ms and longer) stages of processing (Koster, Crombez, Vershuere, Van Damme, & Wiersema, 2006; Koster, Verschuere, Crombez, & Van Damme, 2005).

Delineating the specific components that underlie attentional biases in CF has important theoretical implications. For example, evidence for attentional biases only in early stages of processing might suggest that CF is characterized by a relatively automatic threat detection mechanism, whereas evidence for biases only in late stages of processing might implicate more strategic goal-engagement mechanisms (Bar-Haim et al., 2007). Evidence for only difficulty in disengagement might implicate deficiencies in inhibition (cf. Chamberlain, Blackwell, Fineberg, Robbins, & Sahakian, 2005), such

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that CF individuals have impaired ability to inhibit emotional reactions and, consequently, attention lingers on threat stimuli and disrupts on-going goal-directed behavior. These theoretical distinctions have treatment implications. For example, attentional retraining procedures, in which individuals are trained to disengage attention from threat stimuli, have been found to be efficacious treatments for a variety of emotional disorders (Koster, Fox, & MacLeod, 2009). If difficulty in disengagement underlies CF, then these attention training procedures may augment the efficacy of existing treatments.

A more precise understanding of the components underlying attentional biases in CF may also be informed by a more precise understanding of the source of threat relevant to CF. Indeed, recent research has begun to implicate the role of disgust in CF (Olatunji, Lohr, Sawchuk, & Tolin, 2007). This research suggests that CF is characterized by elevated disgust propensity (Olatunji et al., 2007) and that self-reported disgust during exposure to contamination-relevant stimuli predicts avoidance among individuals with elevated CF (Deacon & Olatunji, 2007). Prior research demonstrates attentional biases towards disgust cues and that this effect may be enhanced among high disgust prone individuals (Charash & McKay, 2002; Cisler, Bacon, et al., 2009; Cisler, Olatunji, et al., 2009), but the extent to which a disgust bias is more characteristic of CF relative to a fear bias is unclear. Research along these lines would foster a better understanding of emotional and cognitive processes underlying CF.

The present study addressed these gaps in the literature by examining the specific component of attentional biases for threat in CF, and the specific affective component of threat in CF. The spatial cueing task (cf. Posner, 1980) was used to measure attentional biases because this task can differentiate facilitated attention, difficulty in disengagement, and attentional avoidance (Fox et al., 2001, 2002; Koster et al., 2006). The central cueing task (cf. Mogg, Holmes, Garner, & Bradley, 2008) was also used in order to control for generic response slowing. That is, research suggests that the mere presentation of threat stimuli causes a general slowing of reaction times (RTs) independent of attentional processes (Algom, Chajut, & Lev, 2004; Mogg et al., 2008). The central cueing task allows for the assessment of generic response slowing and the ability to test whether CF is characterized by attentional biases when statistically controlling for generic response slowing. This analysis allows for a stronger conclusion that CF is characterized by biases in components of attention specifically, and not merely generic response slowing. Stimuli used in the present study were either neutral, disgusting, or frightening pictures. These stimuli allow for a test of whether CF is characterized by biased attention towards fear or disgust stimuli. Finally, stimuli were presented for either 100 or 500 ms, which allows for a test of whether CF is characterized by biases in early or late stages of processing.

Method

Participants

Participants were recruited from introductory psychology courses at a public university based on scores on the contamination subscale of the Padua Inventory (PI, range 0–40; Burns, Keortge, Formea, & Sternberger, 1996). The clinical mean of the contamination subscale is 14, with an *SD* of 6 (Burns et al., 1996). To ensure that participants in the CF group had sufficiently elevated CF, participants ($n = 23$; PI $M = 25$, $SD = 4$) were recruited for the study if their PI score was 20 or higher (i.e., at or above 1 *SD* above the clinical mean). Participants scoring below the PI mean (i.e., below a score of 6) were recruited for the control group ($n = 28$; PI $M = 3$, $SD = 2$). Although the CF group cannot be considered a clinical sample, a recent meta-analysis found that there were no differences in the magnitude of attentional biases between diagnosed clinical samples and analogue clinical samples (Bar-Haim et al., 2007). Furthermore, research has shown that non treatment-seeking individuals who scored highly on self-report measures of OCD symptoms often met diagnostic criteria for OCD (Burns, Formea, Keortge, & Sternberger, 1995).

Measures

The PI (Burns et al., 1996) contamination subscale is a 10-item verbal-report instrument that measures contamination obsessions and washing compulsions. Individuals respond to each item on a 5-point Likert scale indicating the degree to which they would be disturbed by the situations described in the items (0 = "not at all," 4 = "very much"). The PI contamination scale correlates highly with other measures of OCD (Burns et al., 1996). Internal consistency in the present study was .91.

Tasks

Central cueing task

The central cueing task (adapted from Mogg et al., 2008) was used to control for generic response slowing. This task begins with an empty box displayed in the center of a computer screen with a fixation cross displayed in the middle. A stimulus picture is then displayed for 200 ms. The picture then disappears and either a '/' or 'X' probe is displayed in the box. The participant's task is to press the key (i.e., '/' or 'X') corresponding to the correct stimulus as quickly as possible without making errors. This task does not manipulate the components of attention needed to complete the task. Thus, any differences in RTs between the stimulus types cannot be attributed to any particular component of attention. Mogg et al. (2008) argued that this task measured generic response slowing in response to the presentation of threat.

There were 18 trials in the central cueing task, 6 trials in which the picture was disgusting, 6 frightening, and 6 neutral. The probe type was fully counterbalanced. Only 18 trials were used to prevent priming effects, such that the central cueing task always occurred before the spatial cueing task. The order of the tasks was not counterbalanced because Mogg et al. (2008) found no difference between results from the central cueing task occurring before and after the spatial cueing task, suggesting that another manipulation (i.e., task order) may have introduced an unnecessary source of variance and decreased power.

Spatial cueing task

The spatial cueing task begins with two empty boxes displayed on the left and right of a central fixation cross. A cue (i.e., stimulus picture) is then displayed in one of the boxes for either 100 or 500 ms. The picture then disappears and either a '/' or 'X' probe is displayed in one of the boxes. The participant's task is to press the key (i.e., '/' or 'X') corresponding to the correct stimulus as quickly as possible without making errors. Two-thirds of trials were valid: the probe appeared in the location of the cue. One-third of trials were invalid: the probe appeared in the location opposite of the cue. More valid compared to invalid trials results in the participant using the cue as a useful marker of the likely position of the probe (Fox et al., 2002). The specific two-thirds valid, one-third invalid ratio has been used in prior research (Amir, Elias, Klumpp, & Przeworski, 2003). The cue was disgusting, frightening, or neutral on an equal number of trials, randomly determined by the computer for each participant. The cue was displayed for either 100 or 500 ms on an equal number of trials, randomly determined by the computer for each participant. There were a total of 216 trials in this task.

Faster RTs on disgust or fear valid trials relative to neutral valid trials indicates facilitated attention towards disgust or fear, respectively. Slower RTs on disgust or fear invalid trials relative to neutral valid trials indicates difficulty disengaging attention from disgust or fear, respectively. Attentional avoidance from disgust or fear stimuli is indicated by slower RTs on disgust or fear valid trials relative to neutral valid trials, or by faster RTs on disgust or fear invalid trials relative to neutral invalid trials.

Stimuli

Stimuli used in the present study were pictures selected from the International Affective Pictures System (IAPS; Lang, Bradley, & Cuthbert, 1999). Pictures were neutral, disgusting, or frightening.[1] At the end of the experiment, participants were asked to rate how disgusting and frightening they found each picture on a scale from 0 to 10, with 10 being the highest. The disgust pictures were rated as more disgusting than the neutral ($t = 40.59$, $p < .001$) and frightening ($t = 18.51$, $p < .001$) pictures. The frightening pictures were rated as more frightening than the neutral ($t = 23.52$, $p < .001$) and disgusting ($t = 5.48$, $p < .001$) pictures. The CF group rated the disgusting pictures as more disgusting than the control group, $F(1, 49) = 22.33$, $p < .001$, and rated the frightening pictures as more frightening than the control group, $F(1, 49) = 33.12$, $p < .001$.

Results

Preliminary analyses

Sample characteristics

Participants in the control group ($n = 28$; 57% female) had a mean age of 19.56 ($SD = 1.25$), 89% were Caucasian. Participants in the CF group ($n = 23$; 91% female) had a mean age of 19.13 ($SD = .87$), 70% were Caucasian. There were more females in the CF group relative to the control group ($\chi^2 = 7.4$, $p = .007$). There were no other differences between groups (Fs < 1.9, $p > .18$).

Data preparation

RT data were cleaned by first removing errors, then removing RTs that were 2.5 standard deviations or more above the individual's mean or less than 200 ms. This procedure is consistent with prior research (e.g., Fox et al., 2001, 2002; Koster et al., 2006). Mean number of removed RT data per participant was 14.16 ($SD = 8.18$) trials; i.e., on average, analyses were run on 94% of participant's RT data. There were no differences between control and CF groups in number of data removed, $F(1, 50) = .35$, $p = .56$.

Components of attentional bias in CF

The omnibus 3 (disgust, fear, versus neutral trials) $\times$ 2 (valid versus invalid trials) $\times$ 2 (100 ms versus 500 ms stimulus duration) $\times$ 2 (CF versus control group) ANOVA was first tested. CF group only marginally interacted with the effect of cue emotion type, ($F(2, 98) = 2.61$, $p = .079$, $\eta_p^2 = .052$). Though this omnibus analysis only revealed modest evidence for attentional biases, when the analysis was repeated collapsing across fear and disgust trials (i.e., comparing neutral stimuli to threat stimuli) and across stimulus durations, there was a significant group $\times$ emotion $\times$ validity interaction, $F(1, 49) = 4.73$, $p = .034$, $\eta_p^2 = .09$, further providing evidence for group differences in attention. Demonstrating difficulty in disengagement for disgust cues, a 2 (CF versus control group) $\times$ 2 (disgust versus neutral trials) ANOVA on invalid trials collapsed across stimulus duration revealed that CF group significantly interacted with cue emotion type, $F(1, 49) = 5.30$, $p = .026$, $\eta_p^2 = .10$. Demonstrating difficulty in disengagement for fear cues, a 2 (CF versus control group) $\times$ 2 (fear versus neutral trials) ANOVA on invalid trials collapsed across stimulus duration similarly revealed that CF group significantly interacted with cue emotion type $F(1, 49) = 4.57$, $p = .038$, $\eta_p^2 = .07$. Given this evidence for difficulty in disengagement from both disgust and fear cues when collapsed across stimulus duration, follow-up t-tests were conducted separately in each group. In the control group, neither disgust nor fear invalid trials differed from neutral invalid trials (ts $< .28$, ps $> .78$). In the CF group, RTs were significantly longer on disgust relative to neutral invalid trials ($t = 2.57$, $p = .018$), and marginally longer on fear relative to neutral invalid trials ($t = 1.90$, $p = .071$). There were no differences in either group between fear and disgust invalid trials (all ps $> .05$). Table 1 displays the mean RTs for the spatial cueing task.

In contrast, a 2 (CF versus control group) $\times$ 2 (disgust versus neutral trials) ANOVA on valid trials did not reveal a significant interaction with CF group and failed to provide evidence for facilitated attention for disgust cues. Similarly, a 2 (CF versus control group) $\times$ 2 (fear versus neutral trials) ANOVA on valid trials did not reveal a significant interaction with CF group and failed to provide evidence for facilitated attention for fear cues.

In order to further investigate the components of attention in CF, another ANOVA was conducted with bias scores. For these analyses, threat valid trials were subtracted from neutral valid trials (i.e., a facilitated attention bias score) for fear and disgust cue types and at each stimulus duration. Positive values reflect greater facilitated attention; negative values reflect attentional avoidance. Neutral invalid cues were subtracted from threat invalid cues (i.e., a difficulty in disengagement bias score) for fear and disgust cue types and at each stimulus duration. Positive values reflect greater difficulty in disengagement; negative values reflect attentional avoidance. Analyses on these bias scores will provide direct tests of the components of attentional biases, and analyses on bias scores are common in attentional bias research (e.g., Koster et al., 2006, 2005; Mogg et al., 2008).

A 2 (fear versus disgust) $\times$ 2 (facilitated attention versus difficulty in disengagement) $\times$ 2 (stimulus duration) $\times$ 2 (CF group)

Table 1
Mean (SD) RTs in the spatial and central cueing tasks as a function of stimulus duration, cue emotion type, cue validity, and CF group.

	Control group		CF group	
	M	SD	M	SD
Spatial Cueing Task				
Valid trial 100 ms				
Disgust cue	551	72	600	109
Fear cue	548	75	601	108
Neutral cue	542	70	595	106
Invalid trial 100 ms				
Disgust cue	532	83	599	121
Fear cue	537	83	615	160
Neutral cue	542	79	595	103
Valid trial 500 ms				
Disgust cue	525	74	596	117
Fear cue	515	75	583	137
Neutral cue	502	62	558	87
Invalid trial 500 ms				
Disgust cue	517	85	591	113
Fear cue	514	85	592	133
Neutral cue	510	74	556	85
Central Cueing Task				
Disgust cue	571	124	593	126
Fear cue	564	134	572	113
Neutral cue	535	117	576	138

[1] The IAPS pictures were: disgusting – 1270-s, 3060-s, 3120-s, 9300-s, 9320-s, 9570-s; frightening – 1120-s, 1200-s, 1300-s, 6250-s, 6510-s, 1050-s; neutral – 7000-s, 7030-s, 7035-s, 7050-s, 7190-s, 7224-s.

mixed ANOVA was conducted on the bias scores. This analysis demonstrated a significant interaction between attention component and CF group, $F(1, 48) = 5.11$, $p = .028$, $\eta^2_p = .10$. CF group did not interact with any other factors (all Fs < 2.26, all $\eta^2_p < .045$). Bias scores were then collapsed across stimulus duration and threat type (i.e., fear versus disgust), as CF group did not interact with these effects. Follow-up ANOVAs with these component bias scores demonstrated that the CF group had significantly greater delayed disengagement scores compared to the control group, $F(1, 49) = 6.7$, $p = .013$, $\eta^2_p = .12$. In contrast, there were no differences between groups in facilitated attention $F(1, 49) = .68$, $p = .41$, $\eta^2_p = .01$. Further, only the CF group's delayed disengagement bias score was significantly greater than zero ($t = 2.55$, $p = .018$), whereas the control group's delayed disengagement score did not differ from zero ($t = -.22$, $p = .83$). Both groups' facilitated attention scores were significantly lower than zero ($t = -3.67$, $p = .001$ and $t = -3.21$, $p = .004$ for the control and CF groups, respectively).

Given evidence for group differences in difficulty in disengagement, for completeness this effect was tested separately for fear and disgust trials and at 100 ms and 500 ms stimulus durations. The CF group demonstrated greater difficulty in disengagement from disgust ($F(1, 50) = 7.17$, $p = .01$, $\eta^2_p = .13$) and fear ($F(1, 50) = 4.31$, $p = .043$, $\eta^2_p = .08$) stimuli at 500 ms compared to the control group, but the groups did not differ for either threat type at 100 ms (all Fs < 2.14, all ps $> .15$). In the control group, all of the difficulty in disengagement bias scores did not differ from zero (see Fig. 1). In the CF group, the disgust and fear disengagement scores both differed from zero at 500 ms ($t = 3.93$, $p = .001$; $t = 2.43$, $p = .024$, respectively, see Fig. 1), but neither of the bias scores differed from zero at 100 ms (ts < 1.2, ps $> .25$). Fear disengagement did not differ from disgust disengagement (all ts $< .91$, ps $> .37$).

Given that biological sex was not evenly distributed across the CF and control groups, it was next tested whether sex differences across the groups could account for the above significant attention effects. When analyses were restricted to females, the CF group continued to display greater difficulty in disengagement bias scores compared to the control group, $F(1, 35) = 4.02$, $p = .05$, $\eta^2_p = .10$. The groups did not differ in facilitated attention bias scores, $F(1, 35) = .01$, $p = .97$, $\eta^2_p = .00$. Uneven sex distribution does not appear to account for the above attention effects.

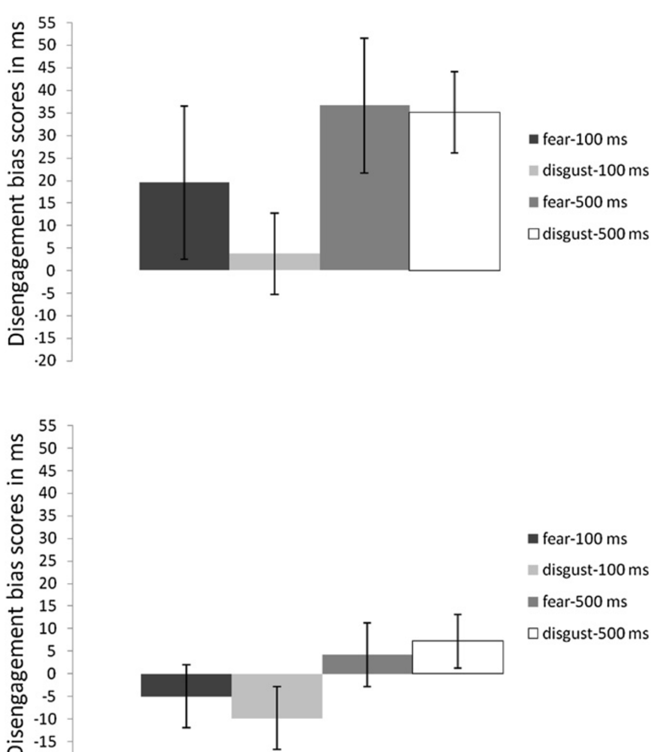

Fig. 1. Disengagement bias scores (and error bars) for fear and disgust cues at 100 and 500 ms among CF (top) and control (bottom) groups.

Response slowing as a potential confound

A 3 (fear versus disgust versus neutral cue) $\times$ 2 (CF versus control group) mixed ANOVA on RTs in the central cueing task revealed no main or interaction effects (see Table 1, all Fs < 2, all $\eta^2_p < .04$). Bias scores were created by subtracting RTs on neutral trials from RTs on both fear and disgust trials (i.e., positive values reflect greater response slowing in the presence of threat). There was no difference between groups on disgust or fear response slowing (all Fs < 2.26, all $\eta^2_p < .04$).

It was also tested whether CF group predicted the component bias scores when controlling for both disgust and fear response slowing. If it were true that the relation between CF and attentional bias was spurious to generic response slowing, then there should be no relation between CF and attentional bias when the effect of response slowing on attentional bias is controlled. A regression analysis was conducted with the delayed disengagement bias score as the dependent measure, disgust and fear generic response slowing bias scores were entered as predictors in step 1, and PI group (dummy coded 0 = control group, 1 = CF group) was entered in step 2. In Step 1, only disgust response slowing demonstrated a marginal effect on disengagement bias scores ($B = .31$, $t = 1.82$, $p = .075$, partial $r = .26$). In step 2, CF group significantly predicted delayed disengagement ($B = .38$, $t = 2.87$, $p = .006$, partial $r = .39$, final model $F(3, 50) = 3.91$, $p = .014$) when controlling for response slowing. The analysis was repeated using facilitated attention bias score as the dependent measure. Disgust response slowing was a significant predictor ($B = -.39$, $t = -2.30$, $p = .026$, partial $r = -.32$), but CF group was not ($t = -1.4$, $p = .17$, partial $r = -.20$). Similarly, an ANCOVA with disgust and fear response slowing entered as covariates also revealed greater difficulty in disengagement in the CF compared to the control group, $F(1, 50) = 8.25$, $p = .006$, but there was no differences between groups in facilitated attention, $F(1, 50) = 1.99$, $p = .17$.

Discussion

Previous evidence of attentional biases in CF is limited to two studies (Foa et al., 1993; Tata et al., 1996). The present study not only demonstrates attentional biases, but suggests that attentional biases in CF are comprised of difficulty disengaging attention from threat. There are two explanations for why CF individuals may display difficulty disengaging attention from threat. First, it may be the case that difficulty in disengagement reflects an impaired ability to remove attention from sources of threat. This interpretation is consistent with theories positing that deficient inhibition ability is central to OCD (see Chamberlain et al., 2005). That is, deficient ability to inhibit orienting attention to threatening pictures in the present task may explain why the CF group displayed difficulty in disengagement. Second, it may be the case that CF individuals purposefully (i.e., strategically) maintain attention onto threat, possibly due to exaggerated appraisals of the stimuli as harmful or dangerous. The finding that difficulty in disengagement seems confined to late stages of processing is consistent with both of these explanations. Future research is necessary to further clarify the mechanisms underlying difficulty in disengagement.

There was little evidence that attentional biases differed as a function of fear versus disgust stimuli. These results suggest that fear and disgust stimuli may be equally relevant sources of threat for CF individuals. This finding may also suggest that CF is characterized by difficulty disengaging attention from general sources of threat, as opposed to only disorder-specific stimuli. The competing explanations for the source of threat in CF and the mechanisms underlying difficulty in disengagement can be tested by using a cognitive load manipulation as well as a threat source manipulation. If cognitive load weakens difficulty in disengagement from both disorder-relevant and general threat cues, then the disengagement is likely to due to strategic maintenance of attention onto general threat. That is, depletion of cognitive resources may inhibit the ability to purposefully maintain attention onto general threat. If cognitive load strengthens difficulty in disengagement from only disorder-relevant threat and not general threat, then the disengagement is likely due to difficulties inhibiting emotional reactions elicited from only disorder-relevant stimuli. That is, depletion of cognitive resources may potentiate difficulties controlling attention from disorder-relevant stimuli. Future research along these lines is necessary to elucidate the emotional and cognitive processes underlying CF.

There was no evidence for facilitated attention in CF. While the facilitated attention bias score was negative and indicative of attentional avoidance, only generic response slowing predicted this effect. Accordingly, the effect is likely not indicative of attentional avoidance and instead can be explained by generic response slowing. Further, it is difficult to explain how individuals could simultaneously have a difficulty disengaging attention from threat and avoid allocating attention from threat, as these are competing processes. The finding that generic response slowing could not account for the greater difficulty in disengagement among the high CF group is strong evidence that CF is characterized by difficulty removing attention from threat cues.

Finally, the present results may inform treatment procedures for CF. Recent research has begun testing attention training procedures as interventions for emotional disorders (Koster et al., 2009). The present evidence for difficulty in disengagement suggests that these attention training procedures may be useful treatment components to add to existing treatments (e.g., exposure and response prevention; ERP) for CF. Future research should test whether ERP plus attention training results in greater CF symptom reduction relative to ERP or attention training alone. Research along these lines will help elucidate the most effective treatments for CF as well as demonstrate the clinical utility of attentional bias research in OCD.

The present findings further elucidate the components of attentional biases in CF, but the study is not without limitations. First, the present findings are limited to a sample with elevated CF and generalization to clinical samples may not be appropriate. Second, general fear and disgust stimuli were used, and it is unclear whether similar results would be found if ideographic stimuli were used. Third, the CF group had a higher percentage of females. However, subsequent analyses suggested that this gender distribution difference could not account for the attentional effects. Future research addressing limitations of the present investigation could allow for stronger inferences.

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