

ORIENTING AND MAINTENANCE OF GAZE IN CONTAMINATION-BASED
OCD: BIASES FOR DISGUST AND FEAR CUES

By

Thomas Armstrong

Thesis

Submitted to the Faculty of the
Graduate School of Vanderbilt University
in partial fulfillment of the requirements

for the degree of

MASTER OF ARTS

in

Psychology

August, 2009

Nashville, Tennessee

Approved:

Professor Bunmi O. Olatunji

Professor Dr. Stephen D. Benning

Professor Dr. David H. Zald

TABLE OF CONTENTS

	Page
LIST OF TABLES	iii
LIST OF FIGURES.....	iv
Chapter	
I. INTRODUCTION.....	1
Attentional biases in obsessive-compulsive disorder	1
Reaction time measures of attention and their limitations.....	3
Eye tracking technology.....	4
Disgust specificity of attentional biases in contamination-based OCD.....	6
The present study.....	7
II. METHODS.....	8
Participants	8
Measures	9
Public restroom behavioral avoidance task (BAT).....	10
Materials and apparatus.....	10
Procedure.....	11
Eye movement data reduction	12
III. RESULTS.....	14
Validation of group membership.....	14
Vigilance bias: direction and speed of orienting to threat.....	16
Maintenance bias: dwell time on threat	17
Attentional biases and symptom measures.....	20
IV. DISCUSSION	23
REFERENCES.....	28

LIST OF TABLES

Table	Page
1. Measures of self-reported symptoms, valence of facial stimuli, and behavioral avoidance by participant group	15
2. Measures of vigilance bias and maintenance bias	18
3. Dwell time during 6 intervals of 3000 ms trial	20
4. Correlations between attentional biases and symptom measures.....	22

LIST OF FIGURES

Figure	Page
1. Eye movement data for a high contamination fear participant, selected randomly from a trial with the disgusted expression.....	4
2. Group differences in orienting bias for disgusted, fearful, and happy facial expressions	16
3. Group differences in time course of maintenance bias for disgusted, fearful, and happy facial expressions	19

ABSTRACT

The present study examines the extent to which attentional biases in contamination-based obsessive-compulsive disorder (OCD) are specific to disgust or fear cues, as well as the components of attention involved. Eye tracking was used to provide greater sensitivity and specificity than afforded by traditional reaction time measures of attention.

Participants high (HCF; $n = 23$) and low (LCF; $n = 25$) in symptoms of contamination-based OCD were presented with disgusted, fearful, or happy faces paired with neutral faces for 3 s trials. Evidence of both vigilance and maintenance-based biases for threat was found. The high group oriented attention to fearful faces but not disgusted faces compared to the low group. However, the high group maintained attention on both disgusted and fearful expressions compared to the low group, a pattern consistent across the 3 s trials. The implications of these findings for conceptualizing emotional factors that moderate attentional biases in contamination-based OCD are discussed

CHAPTER I

INTRODUCTION

Attentional biases in obsessive-compulsive disorder

Over two decades worth of research suggests that anxiety disorders are characterized by attentional biases to threat (for review, see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). The modal finding in such research is increased allocation of attention to threatening stimuli, through biases in the orienting of attention (vigilance; Mogg & Bradley, 1998), or in the continued engagement of attention (maintenance; Weierich, Treat, & Hollingworth, 2008). Biases are typically found for disorder-specific threats, for example, social stimuli in social anxiety (faces; Garner, Mogg, & Bradley, 2006), or spider stimuli in spider phobia (Rinck & Becker, 2006). Recent research suggests that attentional biases to threat may play a causal role in the maintenance or etiology of anxiety (Koster, Fox, & MacLeod, 2009). Accordingly, experimental treatments that target attentional biases have been found to reduce symptom severity, as reflected in self-report measures and clinician ratings (Schmidt, Richey, Buckner, & Timpano 2009), as well as behavioral outcomes (Amir, Weber, Beard, Bomyea, & Taylor, 2008).

While attentional biases appear to be a cardinal feature of anxiety disorders, demonstrating such biases in obsessive-compulsive disorder (OCD) has been difficult (Summerfeldt & Endler, 1998). OCD is an anxiety disorder defined by persistent, unwanted thoughts or impulses (obsessions) that motivate rigid, excessive behaviors

(compulsions) aimed at undoing obsession-related harm (Abramowitz, Khandker, Nelson, Deacon, & Rygwall, 2006). Many have noted that OCD is an anomalous anxiety disorder, and some have even suggested that the diagnoses be reclassified (Enright & Beech, 1990). The failure to demonstrate attentional biases to threat in OCD, across multiple studies (e.g. McNally, Riemann, Louro, Lukach, & Kim, 1992; Moritz et al., 2004; Moritz et al., 2008) may provide evidence for these positions. However, another possibility is that the heterogeneity of OCD concerns, as well as their idiosyncratic nature, has made the demonstration of attentional biases in OCD particularly difficult. Many null findings may be attributed to the use of the same or largely overlapping threat stimuli for patients with different OCD subtypes (Kampman, Keijsers, Verbraak, Naring, & Hoogduin, 2002; Kyrios & Iob, 1998; Moritz et al., 2004). In contrast, most of the studies that have demonstrated attentional biases in OCD (Amir, Najmi, & Morrison, 2009; Foa, Ilai, McCarthy, Shoyer, & Murdock, 1993; Tata, Liebowitz, Prunty, Cameron, & Pickering; 1996) have matched threat stimuli with specific OCD concerns.

Reaction time measures of attention and their limitations

In addition to problematic selection of stimuli, research on attentional biases in OCD is limited by a reliance on reaction time measures, which may fail to register, or conflate components of attention involved in biases. Many of these studies have used the Emotion Stroop task (MacLeod, 1991), in which quick and accurate responding to a word's color requires ignoring the word's meaning. Individuals with anxiety disorders show delayed color responses when words are threatening (more so than healthy controls), suggesting that anxiety disorders are characterized by increased attentional

engagement by threat, as well as difficulty disengaging attention from threat (Williams, Mathews, & MacLeod, 1996). However, the Emotional Stroop does not allow the demonstration of an orienting bias, as there are not multiple stimuli in different locations competing for attention. In addition, the response interference caused by emotional word content may not hinge on attentional capture, *per se*; instead, affect elicited by the word's meaning could delay response selection or execution by other means (MacLeod, Mathews, & Tata, 1986).

Another reaction time measure utilized in research on attentional biases in OCD is the modified Dot Probe (MacLeod et al., 1986). In this task, participants respond to a neutral “probe” placed behind one of two simultaneously presented pictures. The Dot Probe improves on the Emotional Stroop by allowing multiple stimuli to compete for the engagement, as well as the orienting of attention. Despite this improvement, reaction times in the Dot Probe task may fail to discriminate components of attention, as faster responses to probes at the location of a threatening stimulus could be the result of orienting to that location first, or of maintaining attention to that location, once fixated (Koster, Crombez, Verschuere, & De Houwer, 2004). As Weierich et al. (2008) note, the 500 ms asynchrony between stimulus onset and probe presentation used in most Dot Probe studies allows for multiple fixations during the stimulus presentation, making it unclear which component(s) of attention are responsible for decreased response latencies. In addition, the modified Dot Probe has limited ability to register biases in later stages of processing. The inhibition of detailed, elaborative processing of threat described in multiple theories of anxiety (Foa & Kozak, 1986; Mogg & Bradley, 1998) can, in theory, be measured by longer probe onset asynchronies; however, a continuous measure of

attention, as opposed to the snapshot provided by reaction times, would address the question with more efficiency.

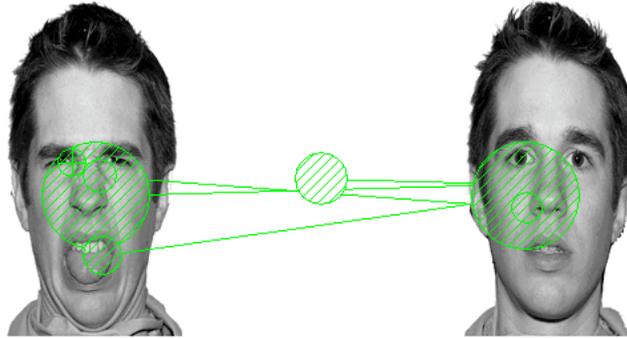


Figure 1. Eye movement data for a high contamination fear participant, selected randomly from a trial with the disgusted expression. Circles indicate fixations; diameter represents fixation duration; lines illustrate saccade sequence.

Eye tracking technology

Increased allocation of attention to threat in OCD could derive from facilitated detection, reflected in biased orienting towards threat (Mogg & Bradley, 1998); alternatively, increased attention could begin *after* detection with difficulty disengaging attention (Fox, Russo, Bowles, & Dutton, 2002), reflected in increased dwell time on threat. Weierich and colleagues (2008) note that the former “vigilance” hypothesis and the latter “maintenance” hypothesis need not be mutually exclusive, and could both account for increased allocation of attention to threat. Unfortunately, reaction time measures of attentional biases do not allow for the direct examination of vigilance and maintenance processes. However, eye tracking technology may provide the sensitivity and specificity needed to parse components of attention, and thus adequately test both vigilance and maintenance hypotheses. The eye movements registered by eye tracking are

more closely linked to attention than key press behavior, which occurs downstream of intervening response selection and skeletal muscle movement (Weierich et al., 2008). Indeed, eye movements are a direct indicator of overt attention, that is, the selection of stimuli for fine-grained, foveal perception. In addition to providing a highly direct measure of visual attention, eye tracking also allow continuous measurement of eye movements, with gaze location typically sampled at rates of once per 16.7 ms (60 Hz) or faster. By directly and continuously measuring eye movements (see Figure 1 for a sample scan path), eye tracking enables researchers to parse the orienting and engagement of attention, as the locations of initial fixations indicate orienting (i.e. where one looks first), while the durations of these fixations indicate the engagement of attention (i.e. how long one looks).

Eye tracking also provides richer data for the analysis of later attentional processes. Whereas extended Dot Probes trials can reveal the probability of attending to one location at a single point in time, eye tracking allows the comparison of fixation durations at multiple locations across the time course of the trial. In other words, eye tracking devices liberate the measurement of attention from the parameters of the task. The Dot Probe requires varying the presentation time of the stimulus in order to register either early or late attentional processes. Whereas additional conditions, or even studies are required to assess different components of attention or stages of processing in the Dot Probe paradigm, eye tracking can assess a multitude of attentional processes within the same trial.

Disgust specificity of attentional biases in contamination-based OCD

Although methodological limitations involving stimulus selection and reaction time measurement likely explain many failures to demonstrate attentional biases in OCD, another possibility is that attentional biases are not present in certain OCD subtypes. Some have suggested that attentional biases in OCD occur only in the contamination-based subtype (Summerfield & Endler, 1998). Indeed, biases have been found most often in patient groups in which all (Foa et al., 1993; Tata et al., 1996) or a majority of individuals (Foa & McNally, 1986) have contamination concerns. Of the many symptom dimensions in OCD, contamination concerns are the most common (Rasmussen & Tsuang, 1986), reported by roughly 50% of patients (Rachman & Hodgson, 1980; Rasmussen & Eisen, 1992). Recent investigations of this symptom dimension have focused on the role of disgust, which is thought to serve a disease-avoidance function by motivating withdrawal from contamination threats (Matchett & Davey, 1991; Oaten, Stevenson, & Case, 2009). Some have suggested that contamination-based OCD can be understood as a fundamental dysregulation of disgust (Olatunji, Lohr, Sawchuk, & Tolin, 2007). Indeed, increased disgust sensitivity (Haidt, McCauley, & Rozin, 1994)—a construct encompassing how frequently one experiences disgust, and how distressing one finds the experience—is predictive of OCD symptom severity (e.g. Muris et al., 2000) and behavioral avoidance (e.g. Tsao & McKay, 2004), a finding replicated in many studies, including those that controlled for trait anxiety and depression (Deacon & Olatunji, 2007; Olatunji et al., 2007). These findings suggest that in contamination-based OCD, threat may be more strongly associated with disgust than fear. As a consequence, disgust cues may modulate attention more effectively than fear cues. However, no studies

have examined the differential effects of disgust and fear cues on attention in contamination-based OCD.

The present study

The present study investigated the possibility of a disgust-specific attentional bias in OCD with contamination concerns. Given that threat should be more associated with disgust than fear in the context of this disorder, we hypothesized that increased allocation of attention would occur more for disgusted faces, compared to fearful or happy faces. Facial stimuli have been used in many studies on attentional biases in anxiety disorder (e.g. Mogg, Millar, & Bradley, 2000; Garner et al., 2006) because they allow experimenters to vary emotional content while holding other stimulus attributes constant. Further, lexical stimuli used in prior research on attentional biases in OCD may have been too specific, given the idiosyncratic nature of OCD concerns. For example, Foa et al.'s (1994) finding of an attentional bias in OCD was driven by just one of the study's contamination words (*unclean*). Amir et al. (2009) addressed this difficulty by selecting stimuli idiographically, through a prior ratings procedure. However, the present study adopts a nomothetic approach, using disgust expressions because they capture the abstract property hypothesized to unite idiosyncratic contamination concerns. Eye tracking was used to determine whether the hypothesized increase in attention to disgust cues in contamination-based OCD derived from vigilance or maintenance based biases (Weierich et al., 2008).

CHAPTER II

METHODS

Participants

Three large undergraduate classes at a Southern University (n = 368) were screened using the contamination and washing subscale of the Padua Inventory (PI; Burns, Keortge, Formea, & Sternberger, 1996), in order to identify students high and low in OCD with contamination concerns¹. Individuals one standard deviation or more above the sample mean were recruited for the high contamination fear (HCF) group (n = 23; mean age = 18.95, SD = .90; % female = 78.3), while individuals one standard deviation or more below the sample mean were recruited for the low contamination fear (LCF) group (n = 25; mean age = 19.17, SD = 1.27; % female = 60). Mean age and percent female did not significantly differ between groups.

¹ An important issue concerns whether the study of analogue OCD samples is relevant to understanding OCD in clinical populations. A growing literature supports the notion that OCD symptoms occur on a continuum of severity and have their origin in largely normal human processes, such as biased thinking and negative reinforcement. Thus, the model predicts that these OCD-related phenomena also occur in the general population (see Gibbs, 1996 for a review). A series of studies investigating the use of non-patient samples in the study of OCD supports this assumption. For example, Burns, Formea, Keortge, and Sternberger (1995) found that non treatment-seeking individuals who scored highly on self-report measures of OC symptoms often met diagnostic criteria for OCD, evidenced stability of symptoms over time, and exhibited similar associated symptoms features as patients diagnosed with OCD. Thus, the results of studies using analogue OC samples as in the present study are relevant to understanding symptoms of OCD patients.

Measures

The *Padua Inventory* (PI; Burns et al., 1996) contamination fear subscale is a 10-item measure of contamination obsessions and washing compulsions. The PI contamination fear subscale had an alpha coefficient of .96 in the present study.

The *Obsessive-Compulsive Inventory—Revised* (OCI-R; Foa et al., 2002) is an 18-item questionnaire assessing six types of OCD symptoms: Washing Concerns, Checking/Doubting, Obsessing, Mental Neutralizing, Ordering, and Hoarding. The OCI-R Washing concerns scale was used in the present study and had an alpha coefficient of .78.

The *State Trait Anxiety Inventory—Trait Version, Form Y* (STAI-T; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) is a 20-item scale that measures the enduring or chronic experience of anxiety. The alpha coefficient for the STAI-T was .91 in the present study.

The *Disgust Scale—Revised* (DS-R; Olatunji et al., 2007) is a 25-item questionnaire assessing sensitivity to a range of disgust elicitors, including core, animal-reminder, and contamination disgust. The DS-R had an alpha coefficient of .89 in the present study.

Public restroom behavioral avoidance task (BAT)

Participants were led into a nearby public restroom, and were asked to touch surfaces that sampled a spectrum of perceived contamination risk. Participants were asked to touch inside of the sink, inside of the trashcan, on the seat of the toilet, and inside of the toilet (in that order). After each step, experienced distress was rated verbally on a 0 (no distress) to 10 (extreme distress) scale. If participants declined to complete a step, they were asked to imagine completing the step with their eye closed, and then provide a rating.

Materials and Apparatus

Stimuli were selected from the NimStim set of facial expressions of emotion (Tottenham et al., in press). Disgusted, fearful, happy, and neutral expressions for 8 individuals were chosen. All expressions were the open-mouth version. Images were converted to greyscale, and resized to subtend a visual angle of 5.4° x 3.6°. Each emotional expression (disgusted, fearful, happy) was paired twice with a neutral expression from the same individual, appearing once on each side in a 1 x 2 horizontal array. The paired images were presented against a white background, and separated by 10.1° of visual angle, from center to center (see Figure 1). Stimuli were presented using E-Prime version 1.0 software on a 17-in. widescreen monitor, with a resolution of 1280 x 1024, and a refresh rate of 60 Hz. Eye movements were recorded with the iView X RED-III system from SensoMotoric Instruments (SMI), a video-based eye tracker with a dark pupil tracking method. This system has a sampling rate of 60 Hz, and a spatial resolution

of .5°-1°. Participants' heads were stabilized with a chinrest at a viewing distance of 60.5 cm.

Procedure

Following completion of measures, participants read instructions explaining the eye tracking task. The eye tracking cameras were said to measure pupil dilation during the task, to conceal the recording of gaze in order to reduce demand effects (Kellough, Beevers, Ellis, & Wells, 2008). Participants were asked to respond to the fixation target (“x” or “o”) by pressing the corresponding labeled key—a task included to further obscure the purpose of the study (Caseras, Garner, Bradley, & Mogg, 2007). The fixation image offset after participants responded, or after 700 ms, depending on which occurred first. A pair of faces was then presented for 3 s, followed by an inter-trial interval of 1500, 2000, or 2500 ms, varied randomly to mitigate the monotony of the task (Garner et al., 2006). Participants were instructed to fixate on the central target prior to stimulus onset. During stimulus presentation, participants were asked to view the faces as they please, not to look away from the monitor, and not to continue looking at the fixation cross location. To minimize signal loss, participants were asked to blink only during the ITI. There were 16 practice trials, in which participants viewed pairs of neutral faces not used in the actual trials. After the practice trials, a 12-point calibration procedure was completed, followed by validation. There were 64 experimental trials, divided into 4 blocks of 16. Each block was balanced in terms of the Nimstim individual, the emotions expressed, and the sides each emotion was presented on. Stimuli were presented in a pseudo random order, in 4 distinct orders between subjects that balanced

the presentation order of stimuli. After each block prior to the last, participants were given a brief resting period, and then the calibration procedure was repeated. After the procedure, participants were presented with each of the 32 pictures used in the experiment, and provided ratings on how pleasant the pictures made them feel, using a bipolar scale ranging from 0 (extremely unpleasant) to 6 (extremely pleasant). Participants then completed the BAT.

Eye movement data reduction

Eye movement events (saccades, fixations, blinks) were defined using BeGaze 1.0 software from SensoMotoric Industries (SMI). Gaze direction was sampled every 16.7 ms, with a fixation classified as 80 ms or more in which gaze was stable within a 1.4° radius of visual angle. Areas of interest were defined as the area of each image, as well as a circle with 1.5° radius at the location of the fixation target (central region). In line with previous eye tracking studies (e.g. Garner et al., 2006), trials were excluded if gaze was not directed at the region of the fixation target during picture onset, if eye movements away from the central region occurred within 80 ms of picture onset, or if no eye movements were made during the trial. After removing blocks of trials with unacceptable calibration (2.83% of trials), invalid first fixations occurred on 5.82% of trials, and no eye movements were made in 0.49% of trials. Independent samples *t*-tests revealed that the amount of missing trials overall and for each emotional expression did not significantly differ between groups, $t_s(46) < .74, p_s > .46$. Kolmogorov–Smirnov tests revealed that for the eye tracking data used in analyses distributions did not significantly differ from normality.

Variables were formed to measure biases in vigilance and maintenance of attention for each emotional face (disgusted, fearful, happy). Vigilance was measured by examining the direction and speed of initial fixation. Directional bias was computed by counting the number of trials in which the emotion of interest captured the initial fixation, and dividing this sum by the total number of valid trials containing the emotion of interest (Garner et al., 2000). The resulting scores ranged from 0-1, with .5 (i.e. 50%) representing no bias, and scores higher than .5 reflecting a tendency to orient attention towards the emotion of interest. For trials in which the emotion of interest captured the initial fixation, the average latency to initial fixation was also computed, to assess how quickly the face was detected (Mogg et al., 2000). Biases in the maintenance of attention were measured by assessing relative gaze duration at multiple intervals across the trial. Time spent fixating the emotion of interest, minus time spent fixating the accompanying neutral face, was computed for 6 time intervals: 0-500, 500-1000, 1000-1500, 1500-2000, 2000-2500, 2500-3000 ms (Hermans, Vansteenwegen, & Eelen, 1999; Rinck & Becker, 2006).

CHAPTER III

RESULTS

Validation of group membership

Self-report measures. Independent samples *t*-tests revealed that in addition to their higher scores on the PI [$t(46) = 20.42, p < .001$] the HCF group was significantly higher in OCD washing symptoms [$t(46) = 7.49, p < .001$]. In addition, the HCF group was higher in trait anxiety [$t(46) = 3.72, p < .001$], and in disgust sensitivity [$t(46) = 5.74, p < .001$]. This would suggest that our clinical analogue HCF participants are distinct from the LCF individuals (see Table 1).²

Valence ratings of faces. A 2 (group: HCF, LCF) x 4 (emotional expression: disgusted, fearful, happy, neutral) mixed-factor Analysis of Variance (ANOVA) revealed a significant main effect of emotion [$F(3, 126) = 188.01, p < .001, \eta^2 = .82$], qualified by a group by emotion interaction [$F(2, 92) = 5.00, p < .01, \eta^2 = .11$]. As shown in Table 1, independent-samples *t*-tests revealed that HCF individuals rated the disgusted face as marginally more unpleasant, compared to LCF individuals [$t(42) = 1.93, p = .06$]; HCF individuals also rated the happy face as significantly more pleasant [$t(42) = 2.08, p < .05$]. There were no group differences for ratings of fearful [$t(42) = 1.35, p > .05$] or neutral [$t(42) = .721, p > .05$] faces

² Due to delays setting up the eye tracker, 4 participants were not able to complete the ratings, and 5 participants were not able to complete the behavioral avoidance task.

Table 1. Means (SDs) of measures of self-reported symptoms, valence of facial stimuli, and behavioral avoidance by participant group.

<i>Self-Report Measures</i>			
	HCF	LCF	
Measure	<i>M (SD)</i>	<i>M (SD)</i>	<i>t</i>
OCI-R Washing	4.43 (2.23)	0.48 (1.36)	7.49***
DS-R	64.65 (12.62)	42.64 (13.87)	5.74***
STAI-T	45.37 (6.67)	37.91 (7.19)	3.72**
<i>Valence Ratings of Expressions</i>			
Emotion	<i>M (SD)</i>	<i>M (SD)</i>	<i>t</i>
Disgusted	1.00 (.89)	1.56 (1.09)	1.93‡
Fearful	1.67 (1.15)	2.07 (.81)	1.35
Happy	4.85 (.72)	4.34 (.88)	2.08*
Neutral	2.63 (.60)	2.76 (.64)	0.72
<i>Behavioral Avoidance in a Public Restroom</i>			
Outcome	<i>M (SD)</i>	<i>M (SD)</i>	<i>t</i>
% Completion	43% (23)	85% (20)	6.55***
Reported distress	24.68 (7.19)	8.92 (7.43)	7.17***

Note. HCF = High Contamination Fear, LCF = Low Contamination Fear, OCI-R = Obsessive-Compulsive Inventory—Revised, DS-R = Disgust Scale—Revised, STAI-T = State Trait Anxiety Inventory—Trait Version, Form Y, ‡ $p < .07$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Behavioral avoidance of contamination. As predicted, independent-samples t -tests revealed that HCF individuals completed significantly fewer steps overall [$t(43) =$

6.55, $p < .001$], and experienced significantly more distress overall [$t(43) = 8.92$, $p < .001$] in the public restroom (see Table 1).

Vigilance bias: direction and speed of orienting to threat

To assess vigilance for threat, orienting biases were first analyzed by entering the directional bias scores for disgusted-neutral, fearful-neutral, and happy-neutral face pairs into a 2 (group: HCF, LCF) x 3 (emotional expression: disgusted, fearful, happy) mixed-factor ANOVA. As predicted, there was a significant interaction of group and face [$F(2, 92) = 3.82$, $p < .03$, $p\eta^2 = .08$]. However, a between-groups difference occurred only in the fearful face condition. As shown in Figure 2, HCF individuals oriented to the fearful face on 61% of fear trials, while LCF individuals oriented to the fearful face on 51% of trials [$t(46) = 2.88$, $p < .01$]. A 2 (group: HCF, LCF) x 3 (emotional expression: disgusted, fearful, happy) mixed-factor ANOVA on latency to first fixation did not reveal the predicted interaction of group and face [$F(2, 92) = 1.64$, $p > .05$, $p\eta^2 = .02$]. Group means for directional bias and latency to initial fixation are shown in Table 2.

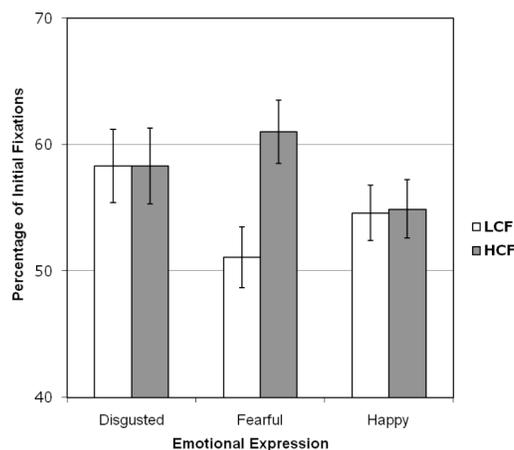


Figure 2. Group differences in orienting bias for disgusted, fearful, and happy facial expressions. Error bars represent standard error.

Maintenance bias: dwell time on threat

A 2 (group: HCF, LCF) x 3 (emotional expression: disgust, fear, happy) x 6 (time interval: 0-500, 500-1000, 1000-1500, 1500-2000, 2000-2500, 2500-3000 ms) mixed-factor ANOVA on relative fixation duration for emotional faces at 6 time intervals was conducted to examine the maintenance of attention across the time course of the trial. There was a significant main effect of time interval [$F(5, 230) = 8.83, p < .001, \eta^2 = .16$] such that participants showed greater dwell time on emotional faces at earlier compared to later time intervals. The main effects of group [$F(1, 46) = 2.23, p > .05, \eta^2 = .05$] and emotional expression [$F(1, 46) = 2.85, p > .05, \eta^2 = .06$] were not significant. However, there was a significant interaction of group and emotional expression [$F(2, 92) = 9.18, p < .001, \eta^2 = .17$], which was further qualified by a significant three-way interaction of group, emotional expression, and time [$F(10, 460) = 3.05, p < .001, \eta^2 = .06$].

To investigate the significant group X emotional expression X time interval interaction, separate 2 (group: HCF, LCF) X 6 (time interval: 0-500, 500-1000, 1000-1500, 1500-2000, 2000-2500, 2500-3000 ms) mixed-factor repeated-measures ANOVAs were conducted for each emotional expression. These analyses revealed a significant main effect of group in the disgusted expression condition [$F(1, 46) = 7.63, p < .01, \eta^2 = .14$], and in the fearful expression condition [$F(1, 46) = 5.29, p < .03, \eta^2 = .10$], such that HCF individuals showed increased maintenance of attention on disgusted and fearful expressions, compared to LCF individuals, as reflected in longer fixation durations across the course of the trial, compared to accompanying neutral expressions. There was no

main effect of group in the happy expression condition [$F(1, 46) = 1.55, p > .05, \eta^2 = .03$]. Group means for total dwell time are shown in Table 2.

Table 2
Means (SDs) for measures of vigilance bias and maintenance bias

Measure	Bias		Expression	
	Vigilance	Disgusted	Fearful	Happy
Percentage of initial fixations				
HCF		58.3 (14.2)	61 (10.0)	55.9 (11.0)
LCF		58.3 (14.5)	51 (13.0)	55.6 (11.0)
Latency to initial fixation (ms)	Vigilance			
HCF		306 (59)	366 (224)	323 (96)
LCF		327 (138)	327 (107)	314 (97)
Dwell time (ms)	Maintenance			
HCF		535 (419)	450 (345)	264 (364)
LCF		152 (528)	135 (568)	418 (477)

Note. HCF = High Contamination Fear, LCF = Low Contamination Fear; dwell times for emotional expressions are relative to accompanying neutral expression.

Main effects of time interval for each emotional expression were also observed [disgusted: $F(5, 230) = 8.47, p < .001, \eta^2 = .16$; fearful: $F(5, 230) = 2.97, p < .03, \eta^2 = .06$; happy: $F(5, 230) = 2.43, p < .04, \eta^2 = .05$]. This main effect was qualified by a group by time interval interaction only in the happy expression condition, [$F(5, 230) = 4.07, p < .001, \eta^2 = .08$]. In the HCF group, there was a significant linear trend [$F(1, 24) = 5.36, p < .03, \eta^2 = .18$] indicating that dwell time on the happy face decreased from

earlier to later time intervals. In the LCF group, there was also a significant linear trend [$F(1, 24) = 5.74, p < .03, \eta^2 = .21$], however, in the opposite direction, indicating that dwell time on the happy face increased from earlier to later time intervals (see Figure 3). Group comparisons at each time interval revealed that significant differences emerged in the last second of the trial, with no significant differences during the first 2000 ms, but significant difference from 2000-2500 ms [$t(46) = 2.88, p < .01$] and from 2500-3000 ms [$t(46) = 2.88, p < .04$], such that the LCF group dwelled more on the happy face compared to the HCF group. Group means for dwell time during each interval are shown in Table 3.³

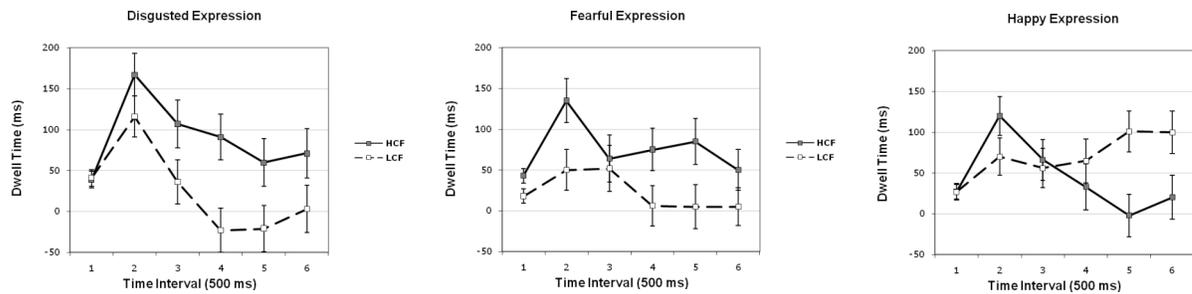


Figure 3. Group differences in time course of maintenance bias for disgusted, fearful, and happy facial expressions. Error bars represent standard error.

³ Including the STAI-T as a covariate did not significantly attenuate any of the present findings, suggesting that negative affect alone does not account for group differences in the attentional biases observed.

Table 3
Means (SDs) for dwell time during 6 intervals of 3000 ms trial

Expression	Group	Time Interval					
		0-500 ms	500- 1000 ms	1000- 1500 ms	1500- 2000 ms	2000- 2500 ms	2500- 3000 ms
Disgusted	HCF	39 (47)	167 (105)	107 (124)	91 (150)	60 (108)	71 (123)
	LCF	41 (52)	116 (142)	36 (148)	-23 (110)	-21 (161)	3 (159)
Fearful	HCF	43 (38)	135 (110)	64 (125)	75 (106)	85 (106)	49 (98)
	LCF	18 (48)	49 (141)	52 (152)	6 (137)	5 (153)	5 (125)
Happy	HCF	27 (44)	120 (120)	66 (120)	33 (132)	-2 (114)	20 (124)
	LCF	27 (48)	69 (106)	56 (121)	65 (134)	100 (132)	100 (137)

Note. HCF = High Contamination Fear, LCF = Low Contamination Fear; dwell times for emotional expressions are relative to accompanying neutral expression.

Attentional biases and symptom measures

Correlations between indices of attentional biases and symptom measures are given in Table 4. In the HCF group, there was a marginal relationship between orienting toward disgusted expressions and symptoms of contamination-based OCD, as revealed by the OCI-R Washing subscale ($r = .36, p < .10$), such that increased orienting toward disgusted expressions was associated with increased washing symptoms. In the LCF

group, this relationship was not present, however, there was a marginal relationship between dwell time on disgusted expressions and the OCI-R Washing subscale ($r = .39, p < .06$), such that increased dwell time on disgusted expressions was associated with increased washing symptoms. In the LCF group, there was also a significant relationship between orienting toward happy expressions and the OCI-R Washing subscale ($r = -.48, p < .02$), such that increased orienting toward happy expressions was associated with fewer washing symptoms. Similarly, in the LCF group there was a marginal relationship between orienting toward happy expressions and distress ratings on the BAT ($r = -.39, p < .06$), such that increased orienting toward happy expressions was associated with lower distress ratings during the BAT. Lastly, in the LCF group there was a significant relationship between dwell time on happy expressions and trait anxiety, as measured by the STAI-T ($r = -.53, p < .01$) such that increased dwell time on happy expressions was associated with lower trait anxiety.

Table 4
Correlations between attentional biases and symptom measures

<i>Group</i>	<i>Measure</i>	<i>Orientation Bias (% of Initial Fixations)</i>			<i>Maintenance Bias (Dwell Time)</i>		
		<i>Disgusted</i>	<i>Fearful</i>	<i>Happy</i>	<i>Disgusted</i>	<i>Fearful</i>	<i>Happy</i>
HCF	OCI-R Washing	.36‡	.13	.10	-.35	-.18	-.04
	STAI-T	.02	-.05	.32	-.25	-.26	-.17
	DS-R	.01	-.22	-.19	-.06	.02	.23
	BAT Distress	-.10	.01	-.19	-.29	.04	.27
	BAT Completion	-.15	-.18	.11	.33	.13	.11
LCF	OCI-R Washing	.19	-.12	-.48*	.39‡	.29	-.11
	STAI-T	.09	.24	-.31	-.09	-.22	-.53**
	DS-R	.03	-.29	-.22	-.31	-.32	-.25
	BAT Distress	.02	-.22	-.39‡	-.27	-.32	-.30
	BAT Completion	.12	.06	.04	.27	.34	.31

Note: HCF = High Contamination Fear, LCF = Low Contamination Fear; OCI-R = Obsessive-Compulsive Inventory—Revised; DS-R = Disgust Scale—Revised; STAI-T = State Trait Anxiety Inventory—Trait Version, Form Y; ‡ $p < .10$, * $p < .05$, ** $p < .01$.

CHAPTER IV

DISCUSSION

To our knowledge, this is the first study to employ eye tracking methods to investigate attentional biases relevant to OCD. Both vigilance for threat and maintenance of attention on threat were observed in HCF individuals, compared to LCF individuals. Specifically, the HCF group oriented attention to the fearful expression more often than the LCF group. Subsequent to this orienting bias, the HCF group showed increased maintenance of attention on both disgusted and fearful expressions, compared to the LCF group.

The finding of an orienting bias for fearful but not disgusted expressions in the HCF group was not predicted, but is consistent with research suggesting that fearful faces more efficiently convey threat under suboptimal viewing conditions (Jiang & He, 2006; Yang, Zald, & Blake, 2007). In the present study, facial stimuli were presented at 5.05° of retinal eccentricity, well outside the 2° limit of foveal processing, and at the farthest limit of parafoveal processing (Rayner, 1998). It is possible that only fearful expressions can elicit orienting at this eccentricity, as fearful expressions can be registered through a few basic physical features (i.e. the enlarged sclera or whites of the eyes; Whalen et al., 2004) while disgusted expressions require the integrations of more complex features (e.g. wrinkling of the nose combined with gaping or raising of the lip; Rozin & Fallon, 1987). Although the HCF group's "attentional control settings" (Öhman, Flykt, & Esteves, 2001; Folk, Remington, & Johnston, 1992) may facilitate orienting to both disgusted and fearful

cues, at the limits of parafoveal vision, perhaps only fearful faces can trigger these settings.

Subsequent to the initial orienting of attention, a bias in the maintenance of attention emerged for both disgusted and fearful expressions in the HCF compared to LCF group. HCF individuals dwelled on the disgusted and fearful expressions longer, across the course of the trial, seen in increased fixation durations on disgusted and fearful expressions. Time course analysis revealed that increased dwell time to disgusted and fearful expressions in the HCF group was relatively consistent across the course of the trial, with no group by time interval interaction for either emotion. However, a group by time interval interaction occurred for the happy expression. As the trial progressed, HCF individuals showed decreased dwell time on the happy expressions, while LCF individuals showed the opposite pattern, with increased dwell time on the happy expression in later intervals. This finding raises the possibility that vigilance for threat interferes with elaborative processing of ‘safety’ signals. Research on visual search in anxiety disorders suggests that speeded detection of threat depends on faster disengagement from non-threatening stimuli (Rinck, Reinecke, Ellwart, Heuer, & Becker, 2005). In anxious individuals, a tendency to quickly disengage from safety signals may work in tandem with facilitated detection of threat to increase perceptions of vulnerability. Indeed, in the LCF group increased dwell time on happy expressions was significantly correlated with lower trait anxiety, suggesting that a tendency to maintain attention on safety signals could provide stable reductions in anxiety.

Although the predicted maintenance bias for disgusted expressions was confirmed, the bias did not show the hypothesized specificity, as fearful expressions also

held attention longer in the HCF compared to LCF group. These findings do appear to be consistent with covariation bias research into contamination-based OCD (Connolly, Lohr, Olatunji, Hahn, & Williams, 2007), which found that HCF individuals overestimate the co-occurrence of both disgusted and fearful expressions with images of contamination. This finding suggests that individuals with contamination-based OCD strongly associate both disgust and fear with contamination threat. These associations could derive from affective experience, as the response to contamination threat may consist of both disgust (at the stimulus) and fear (at the potential consequences of exposure to the stimulus). The maintenance bias for disgusted and fearful expressions among HCF individuals may also suggest that both expressions embody threat that is relevant for contamination-based OCD.

The sustained nature of the maintenance bias observed in this study may distinguish contamination-based OCD from other anxiety disorders. In eye tracking research on trait anxiety (Rohner, 2002), spider phobia (Hermans, Vansteenwegen, & Eelen, 1997; Rink & Becker, 2006), and social anxiety (Garner et al., 2006), increased allocation of attention to threat, though present initially, was found to give way to avoidance. For example, Rohner (2002) found that while anxious individuals initially showed increased dwell time on angry faces, the pattern reversed 1800 ms into the trial; for the last 1000 ms of the 3 s trial, high trait anxiety individuals looked at angry faces *less* compared to low trait anxiety individuals. One possible reason that attentional avoidance was not found in the present study may be due to the observation that individuals with OCD show increased difficulty suppressing unwanted thoughts (Tolin, Abramowitz, Przeworski, & Foa, 2002). Difficulty suppressing unwanted attention

allocation may be due to a common deficit in cognitive control. Alternatively, the absence of avoidance of threat in the HCF group may be attributable to the use of *cues* of threat, as opposed to objects of threat. Disgusted and fearful expressions may convey a probable risk of contamination, whereas images of contaminated objects convey an unequivocal, immediate risk. The ambiguity of threat cues may prompt increased maintenance of attention on the cue, in order to glean information regarding their referent. Further, disgust and fearful expressions, being possible contamination cues as opposed to actual contaminants, are less potent, and may lack the aversiveness required to motivate attentional avoidance.

The use of eye tracking methodology in the present study extends the available literature on attentional processes in OCD. However, these findings should be interpreted with multiple limitations in mind. The absence of significant correlations between attentional biases and symptom measures in the HCF group may reflect a limitation of the analogue sample. It is possible that attentional biases and symptoms of contamination-based OCD would be more coherent in treatment-seeking individuals with a more complete presentation of the disorder. Although mean scores for the HCF group on the PI contamination fear subscale were well-above the clinical cutoff, these findings require replication with a community sample of patients meeting diagnostic criteria for OCD. Such a research agenda would address the generalizability of the present findings. As previously discussed, the present study is also limited by the use of threat cues (images of faces), in place of actual threat (images of scenes or objects). While prior research has shown that HCF individuals associate both disgusted and fearful expressions with contamination, it is possible that the observed biases were not driven by a facial

expression's relation to contamination, but instead by a more general property, such as its negative valence. Future research utilizing patient samples, and employing images of contamination itself (and other threat-relevant stimuli), as opposed to contamination cues, would further clarify the nature of attentional biases in contamination-based OCD.

To address the limitations of the present study, a second study using images of objects and scenes from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005) is currently underway. Whereas stimuli were displayed for 3 s in the present study, the second study utilizes extended exposure, displaying stimuli for 30 s in order to further investigate the time course of attentional biases in OCD. The longer stimulus exposure and more potent stimuli used in the second study will provide a more thorough investigation of attentional avoidance in contamination-based OCD. Lastly, an additional study will use affective conditioning to follow up on the present study's finding that both fear and disgust may be associated with disorder-relevant threat in contamination-based OCD. Research using the Emotional Stroop (Lee, Lim, Lee, Kim & Choi, 2009) and Dot Probe (Pischeck-Simpson, Boschen, Neumann, & Waters, 2009) has demonstrated attentional biases to fear conditioned stimuli in healthy controls, with a greater bias in individuals with heightened anxiety (Lee et al, 2009). We will investigate attentional biases to both fear and disgust conditioned stimuli in contamination-based OCD. Besides providing further insight into the nature of attentional biases in contamination-based OCD, this additional study will provide a constructive replication of the present study by using alternative disgust and fear cues (conditioned stimuli as opposed to facial expressions).

REFERENCES

- Abramowitz, J. S., Khandker, M., Nelson, C. A., Deacon, B. J., & Rygwall, R. (2006). The role of cognitive factors in the pathogenesis of obsessions and compulsions: A prospective study. *Behaviour Research and Therapy, 44*, 1361-1374.
- Amir, N., Najmi, S., & Morrison, A. S. (2009). Attenuation of attention bias in obsessive-compulsive disorder. *Behaviour Research and Therapy, 43*, 153-157.
- Amir, N., Weber, G., Beard, C., Bomyea, J., & Taylor, C. T. (2008). The effect of a single session attention modification program on response to a public speaking challenge in socially anxious individuals. *Journal of Abnormal Psychology, 117*, 860-868.
- Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and non-anxious individuals: A meta-analytic study. *Psychological Bulletin, 133*, 1-24.
- Burns, G. L., Formea, G. M., Keortge, S., & Sternberger, L. G. (1995). The utilization of nonpatient samples in the study of obsessive compulsive disorder. *Behaviour Research and Therapy, 33*, 133-144.
- Burns, G. L., Keortge, S. G., Formea, G. M., & Sternberger, L. G. (1996). Revision of the Padua Inventory of obsessive-compulsive disorder symptoms: Distinctiveness between worry, obsessions, and compulsions. *Behaviour Research and Therapy, 34*, 163-173.
- Caseras, X., Garner, M., Bradley, B. P., & Mogg, K. (2007). Biases in visual orienting to negative and positive scenes in dysphoria: An eye movement study. *Journal of Abnormal Psychology, 116*, 491-497.
- Connolly K. M. Lohr, J. M. Olatunji, B. O., Hahn, K. S., & Williams, N. L. (2009). Information processing in contamination fear: A covariation bias examination of fear and disgust. *Journal of Anxiety Disorders, 23*, 60-68.
- Deacon, B. J., & Olatunji, B. O. (2007). Specificity of disgust sensitivity in the prediction of behavioral avoidance in contamination fear. *Behaviour Research and Therapy, 45*, 2110-2120.
- Enright, S. J., & Beech, A. R. (1990). Obsessional states: Anxiety disorders or schizotypes? An information processing and personality assessment. *Psychological Medicine, 20*, 621-627.

- Foa, E. B., Huppert, J. D., Leiberg, S., Langner, R., Kichic, R., Hajcak, G., et al. (2002). The Obsessive–Compulsive Inventory: Development and validation of a short version. *Psychological Assessment, 14*, 485–496.
- Foa, E. B., Ilai, D., McCarthy, P. R., Shoyer, B., & Murdock, T. (1993). Information processing in obsessive-compulsive disorder. *Cognitive Therapy and Research, 17*, 173-189.
- Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin, 99*, 20–35.
- Foa, E. B., & McNally, R. J. (1986). Sensitivity to feared stimuli in obsessive-compulsives: A dichotic listening analysis. *Cognitive Therapy and Research, 10*, 477–485.
- Folk, C. L., Remington, R. W., & Johnston, J. C. (1992). Involuntary covert orienting is contingent on attentional control setting. *Journal of Experimental Psychology: Human Perception and Performance, 18*, 1030-1044.
- Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General, 130*, 681-700.
- Garner, M., Mogg, K. & Bradley, B. P. (2006). Orienting and maintenance of gaze to facial expressions in social anxiety. *Journal of Abnormal Psychology, 115*, 760-770.
- Gibbs, N. A. (1996). Nonclinical populations in research on obsessive-compulsive disorder: A critical review. *Clinical Psychology Review, 16*, 729-773.
- Haidt, J., McCauley, C., & Rozin, P. (1994). Individual differences in sensitivity to disgust: A scale sampling seven domains of disgust elicitors. *Personality and Individual Differences, 16*, 701–713.
- Hermans, D., Vansteenwegen, D., & Eelen, P. (1999). Eye movement registration as a continuous index of attention deployment: Data from a group of spider anxious students. *Cognition and Emotion, 13*, 419-434.
- Jiang, Y., & He, S. (2006). Cortical responses to invisible faces: Dissociating subsystems for facial-information processing. *Current Biology, 16*, 2023–2029.
- Kampman, M., Keijsers, G. P., Verbraak, M. J., Näring, G., & Hoogduin, C. A. (2002). The emotional Stroop: a comparison of panic disorder patients, obsessive–compulsive patients, and normal controls, in two experiments. *Journal of Anxiety Disorders, 16*, 425–441.

- Kellough, J., Beevers, C. G., Ellis, A., & Wells, T. T. (2008). Time course of selective attention in depressed young adults: An eye tracking study. *Behavior Research and Therapy*, *46*, 1238-1243.
- Koster, E. H. W., Crombez, G., Verschuere, B., & De Houwer, J. (2004). Selective attention to threat in the dot probe paradigm: Differentiating vigilance and difficulty to disengage. *Behaviour Research and Therapy*, *42*, 1183–1192.
- Koster, E. H. W., Fox, E., & MacLeod, C. (2009). Introduction to the special section on cognitive bias modification. *Journal of Abnormal Psychology*, *118*, 1-4.
- Kyrios, M., & Iob, M. A. (1998). Automatic and strategic processing in obsessive–compulsive disorder: attentional bias, cognitive avoidance or more complex phenomena? *Journal of Anxiety Disorders*, *12*, 271–292.
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2005). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual*. Technical Report A-6. University of Florida, Gainesville, FL.
- Lee, T. H., Lim, S. L., Lee, K., Kim, H. T., & Choi, J. S. (2009). Conditioning-induced attentional bias for face stimuli measured with the emotional Stroop task. *Emotion*, *9*, 134-139.
- MacLeod, C. M. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin*, *109*, 163–203.
- MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology*, *95*, 15-20.
- Matchett, G. & Davey G. C. L. (1991). A test of a disease-avoidance model of animal phobias. *Behaviour Research and Therapy*, *29*, 91-94.
- McNally, R. J., Riemann, B. C., Louro, C. E., Lukach, B. M., & Kim, E. (1992). Cognitive processing of emotional information in panic disorder. *Behaviour Research and Therapy*, *30*, 143–149.
- Mogg, K., & Bradley, B. P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy*, *36*, 809-848.
- Mogg, K., Millar, N., & Bradley, B. P. (2000). Biases in eye movements to threatening facial expressions in generalized anxiety disorder and depressive disorder. *Journal of Abnormal Psychology*, *109*, 695–704.

- Moritz, S., & Fischer, B., Hottenrott, B., Kellner, M., Fricke, S., Randjbar, S., & Jelinek, L. (2008). Words may not be enough! No increased emotional Stroop effect in obsessive-compulsive disorder. *Behaviour Research and Therapy*, *46*, 1101-1104.
- Moritz, S., Jacobsen, D., Kloss, M., Fricke, S., Rufer, M., & Hand, I. (2004). Examination of emotional Stroop interference in obsessive-compulsive disorder. *Behaviour Research and Therapy*, *42*, 671-682.
- Muris, P., Merckelbach, H., Nederkoorn, S., Rassin, E., Candel, I., & Horselenberg, R. (2000). Disgust and psychopathological symptoms in a nonclinical sample. *Personality and Individual Differences*, *29*, 1163-1167.
- Oaten, M., Stevenson, R. J., & Case, T. I. (2009). Disgust as a disease avoidance mechanism. *Psychological Bulletin*, *135*, 303-321.
- Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General*, *130*, 466-478.
- Olatunji, B. O., Lohr, J. M., Sawchuk, C. N., & Tolin, D. F. (2007). Multimodal assessment of disgust in contamination-related obsessive-compulsive disorder. *Behaviour Research and Therapy*, *45*, 263-276.
- Olatunji, B. O., Williams, N. L., Tolin, D. F., Sawchuk, C. N., Abramowitz, J. S., Lohr, J. M., et al. (2007). The Disgust Scale: Item analysis, factor structure, and suggestions for refinement. *Psychological Assessment*, *19*, 281-297.
- Pischeck-Simpson, L. K., Boschen, M. J., Neumann, D. L., & Waters, A. M. (2009). The development of an attentional bias for angry faces following Pavlovian fear conditioning. *Behaviour Research and Therapy*, *47*, 322-330.
- Rachman, S. J., & Hodgson, R. J. (1980). *Obsessions and compulsions*. Englewood Cliffs, NJ: Prentice Hall.
- Rasmussen, S. A. & Eisen, J. L. (1992). The epidemiology and clinical features of obsessive-compulsive disorder. *Psychiatric Clinics of North America*, *15*, 743-758.
- Rasmussen, S. A. & Tsuang, M. T. (1986). Clinical characteristics and family history in DSM-III obsessive-compulsive disorder. *American Journal of Psychiatry*, *143*, 317-322.
- Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, *124*, 372-422.

- Rinck, M., & Becker, E. S. (2006). Spider fearful individuals attend to threat, then quickly avoid it: Evidence from eye movements. *Journal of Abnormal Psychology, 115*, 231-238.
- Rinck, M., Reinecke, A., Ellwart, T., Heuer, K., & Becker, E. S. (2005). Speeded detection and increased distraction in fear of spiders: Evidence from eye movements. *Journal of Abnormal Psychology, 114*, 235-248.
- Rohner, J. C. (2002). The time-course of visual threat processing: High trait anxious individuals eventually avert their gaze from angry faces. *Cognition and Emotion, 16*, 837-844.
- Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Review, 94*, 23-41.
- Schmidt, N. B., Richey, J. A., Buckner, J. D., & Timpano, K. R. (2009). Attention training for generalized social anxiety disorder. *Journal of Abnormal Psychology, 118*, 5-14.
- Spielberger C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press, Inc.
- Summerfeldt, L. J., & Endler, N. S. (1998). Examining the evidence for anxiety related cognitive biases in obsessive-compulsive disorder. *Journal of Anxiety Disorders, 12*, 579-598.
- Tata, P. R., Leibowitz, J. A., Prunty, M. J., Cameron, M., & Pickering, A. D. (1996). Attentional bias in obsessional compulsive disorder. *Behaviour Research and Therapy, 34*, 53-60.
- Tolin, D. F., Abramowitz, J. S., Przeworski, A., & Foa, E. B. (2002). Thought suppression in obsessive-compulsive disorder. *Behaviour Research and Therapy, 40*, 1255-1274.
- Tottenham, N., Tanaka, J. W., Leon, A. C., McCarry, T., Nurse, M., Hare, T. A. et al. (in press). NimStim set of facial expressions: judgments from untrained research participants. *Psychiatry Research*.
- Tsao, S. D, & McKay, D. (2004). Behavioral avoidance tests and disgust in contamination fears: distinctions from trait anxiety. *Behaviour Research and Therapy, 42*, 207-216.
- Weierich, M. R., Treat, T. A., & Hollingworth, A. (2008). Theories and measurement of visual attentional processing in anxiety. *Cognition and Emotion, 22*, 985-1018.

- Whalen, P. J., Kagan, J., Cook, R. G., Davis, F. C., Kim, H., Polis, S., et al. (2004). Human amygdala responsivity to masked fearful eye whites. *Science*, *306*, 2061.
- Williams, J. M., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin*, *120*, 3–24.
- Yang, E., Zald, D. H., & Blake, R. (2007). Fearful expressions gain preferential access to awareness during continuous flash suppression. *Emotion*, *7*, 882-8