Accepted for publication in 'Journal of Obsessive-Compulsive and Related Disorders'

Note: This is an uncorrected version of an author's manuscript accepted for publication. Copyediting, typesetting, and review of the resulting proofs will be undertaken on this manuscript before final publication. During production and pre-press, errors may be discovered that could affect the content. The final publication is available at Elsevier via https://doi.org/10.1016/j.jocrd.2017.09.001

The effects of obsessive-compulsive symptoms and disorder-relevant stimuli on the dynamics of selective attention

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Abstract

Two studies were conducted in order to examine the link between selective attention and trait and state OCD symptoms. Selective attention was both considered as a dynamic process in time by investigating attentional bias scores at trial level and as a stable concept by investigating traditional attentional bias scores. In the first study we investigated the difference in selective attention between a group scoring high (*n* = 32) and low (*n* = 32) on contamination fear at a cross-sectional level. In the second study we administered a dot probe task before and after an experimental manipulation of OCD symptoms (*n* = 35) or a neutral induction (*n* = 33) in a convenience sample in order to determine the effects of state OCD symptoms on selective attention. In the current studies we found no evidence for either a trait-related presence of attention bias nor for influences of experimentally induced contamination fear. Furthermore, baseline selective attention did not predict symptoms after an OCD symptom induction. These results point to either a more complex relationship between OCD and selective attention than an unidirectional relationship or suggest that selective attention may not be as important for obsessive-compulsive disorders as it is for anxiety disorders.

Key words: obsessive-compulsive disorder, OCD, selective attention, contamination fear, dot probe, attentional bias

1. General Introduction

Obsessive-Compulsive Disorder (OCD) is a persisting and severe disorder which consists of recurrent intrusive thoughts and/or compulsions (American Psychiatric Association, 2013). It's lifetime prevalence is 2-3.5 %, making it the fourth most common mental disorder (Angst et al., 2004; Ruscio, Stein, Chiu, & Kessler, 2010). Some cognitive models have proposed that attentional bias to threat is one of the mechanisms contributing to the development and maintenance of OCD (e.g., Bar-Haim et al., 2007; Muller & Roberts, 2005). Attentional bias refers to the tendency to selectively attend to threatening stimuli over nonthreatening stimuli. For instance, the integrative model of Bar-Haim et al. (2007) is a model of threat processing comprising four stages: preattentively evaluating stimuli in the environment; allocating cognitive resources to threat stimuli; comparing threat with memory, assessing context of threat and available coping resources; and interrupting current goals and orienting attention toward threat. This model was based on a meta-analysis in which the results for OCD were not significantly different from anxiety disorders, which suggests that the integrative models applies to OCD. This phenomenon can be observed in patients whose attention is consistently drawn by potential sources of contamination (e.g., door handles, stair handrails), after which they allocate their cognitive resources (e.g., wondering if anyone touched the door handle while being ill), assess context and coping resources (e.g., did they bring hand sanitizer), subsequently further elaborating this contamination source interrupts with ongoing activities.

Other models have suggested a mutually reinforcing relation between attentional bias toward threat and anxiety. For instance, Eysenck, Derakshan, Santos, and Calvo (2007) proposed the attentional control theory (ACT). This model poses that attentional control is governed by bottom-up capture and top-down control (Corbetta & Shulman, 2002). Bottom-up capture is activated by threat stimuli that can be internal (such as intrusive thoughts) and external stimuli (such as pictures of threatening stimuli) whereas top-down control is goal-oriented and enables to focus on the task at hand. Applied to OCD, ACT implies increased bottom-up capture in the context of obsessive thoughts and threatening external stimuli. Since resources in working memory are limited, increased bottom-up capture would result in decreased top-down control, causing decreased efficiency (e.g., slower reaction times) in the performance on cognitive tasks. Therefore, ACT predicts that an induction of OCD symptoms would enhance bottom-up capture and thus attentional bias toward threat. Indeed, Cohen, Lachenmeyer, and Springer (2003) found a significant deterioration on performance on a non-emotional Stroop Task after an OCD symptom induction. The view of a mutual reinforcing relation between attentional bias toward threat and anxiety was further corroborated by Van Bockstaele et al. (2014), where their review demonstrated that a unidirectional cause-effect model between attentional bias to threat and anxiety is unlikely.

Some research has indeed shown an attentional bias for OCD-related stimuli in subclinical or clinical OCD (e.g., Amir, Najmi, & Morrison, 2009; Lavy, Van Oppen, & Van Den Hout, 1994; Moritz, Von Muehlenen, Randjbar, Fricke, & Jelinek, 2009; Tata, Leibowitz, Prunty, Cameron, & Pickering, 1996). However, other studies failed to find an attentional bias for OCD (e.g., Harkness, Harris, Jones, & Vaccaro, 2009; Morein-Zamir et al., 2013; Moritz et al., 2008; Moritz & von Mühlenen, 2008). Moreover, Summerfeldt and Endler (1998) argued in their review that, in contrast to anxiety disorders, attentional bias in OCD has only been demonstrated in OCD with contamination concerns. In contrast, Bar-Haim et al. (2007) found no significant difference between OCD and anxiety disorders in attentional bias in their meta-analysis.

The inconsistencies in the current literature could be due to two major limitations. First, the current research on attentional bias to threat in the context of OCD has often viewed attentional bias as a stable bias. However, Rodebaugh et al. (2016) argued that one of the reasons for the unreliability of most of the measures capturing attentional bias could be that attentional bias is not a stable trait, but rather a dynamic process. Moreover, recently a novel way to express attentional variability has been developed in order to capture attentional bias as a dynamic process in time (Zvielli, Bernstein, & Koster, 2015). These scores are calculated by repeatedly estimating trial-level attentional bias by subtracting temporally contiguous incongruent-congruent trial pairs at the level of trials instead of at the level of the entire task. In line with the view of attentional bias as a dynamic process, Bradley et al. (2016) found no evidence of OCD symptoms predicting vigilance or delayed disengagement, but OCD symptoms did predict the tendency to repeatedly re-orient and fixate upon OCD stimuli over time as measured with eyetracking. As there is very little research on the variability of attentional bias in the context of OCD, the current studies considered attentional bias not only with the traditional bias scores as a stable concept, but also with the new trial-level bias scores (TL-BS) approach considering attentional bias as a dynamic process.

Secondly, from the current research it is still unclear whether attentional bias has an influence on OCD symptoms or whether state OCD symptoms can also influence attentional bias. For instance, a study that more explicitly examined the nature of the relationship between attentional bias and OCD showed that an experimental reduction of attentional bias resulted in increased behavioral approach toward contamination stimuli in subclinical contamination fear participants, suggesting a link between attentional bias and behavioral avoidance in contamination fear (Najmi & Amir, 2010). However, it is noteworthy that there is limited research using prospective designs to examine whether attentional bias influences the presence and expression of OCD symptoms. Furthermore, in a meta-analysis Pergamin-Hight, Naim, Bakermans-Kranenburg, van Ijzendoorn, and Bar-Haim (2015) showed that attentional bias was specific for disorder-congruent stimuli in anxiety disorders. However, only four studies on OCD were included. Therefore, further research on the specificity of attentional bias in OCD is warranted.

In order to further elucidate the link between attentional bias to OCD-related stimuli and OCD symptoms, two studies were conducted. In the first study we investigated the relationship between trait OCD and attentional bias for OCD-related stimuli using a cross-sectional design, whereas in the second study we tested whether attentional bias for OCD-related stimuli is influenced by state OCD-related concerns. We hypothesized that high trait OCD symptoms would be associated with attentional bias (variability) to OCD-related stimuli compared to low trait OCD symptoms. Furthermore, we hypothesized that the experience of state OCD-related concerns would increase attentional bias (variability) to OCD-related stimuli. Moreover, in the second study we checked whether attentional bias for OCD-related stimuli at baseline can predict an increase in symptoms after an OCD symptom induction, which we would expect if attentional bias contributes to OCD symptoms.

2.1. Study 1

The first study set out to examine the relationship between attentional bias toward contamination stimuli on the one hand and on the other hand subclinical OCD participants scoring high (HCF) on the cleaning subscale of the Maudsley Obsessional-Compulsive Inventory (Hodgson & Rachman, 1977) versus participants scoring low on contamination fear (LCF). Contamination fear consists of the fear of being contaminated or contaminating someone else and is one of the most common symptom dimensions of OCD (Ball, Baer, & Otto, 1996; Markarian et al., 2010). As attentional bias to threat has been put forward a mechanism to develop OCD symptoms, we expected to observe an attentional bias toward contamination-related stimuli in HCF. This study used a subclinical sample as the meta-analysis of Bar-Haim et al. (2007) did not show a difference between clinical patients and participants with high self-reported anxiety in attentional bias. Furthermore, the utility of analogue samples in research on the mechanisms of OCD has been demonstrated previously by Gibbs (1996) and Abramowitz et al. (2014).

In this study selective attention was measured using a dot probe task including, contamination-related, neutral and positive (i.e., representing cleanliness) pictures. Previous research on selective attention to OCD-related and positive words in OCD found no effect of positive words (Lavy et al., 1994). However, Moritz et al. (2008) argued that words may not be strong enough to elicit an attentional bias.

2.2. Methods

2.2.1. Participants

According to a power analysis based on $d = 0.38$ (the effect size found for between-group comparisons of threat-related bias in the dot probe task; Bar-Haim et al., 2007), with $\alpha = 0.05$ and a power of 0.8 for 2 groups and 2 measurements, we needed a minimum of 58 participants in total in order to be able to find a within-between interaction. The total sample included 64 participants with ages ranging from 17 to 51 years ($M = 19.42$, $SD = 5.16$; 50 females). Thus, we would have sufficient power to find an interaction between Valence (contamination versus negative) and Group (HCF or LCF). Undergraduate students of Ghent University interested in participating could subscribe to the website http://www.screeningpsychologie.be/, where they filled out the cleaning subscale of the Maudsley Obsessive-Compulsive Inventory online (MOCI; Hodgson & Rachman, 1977). For the HCF group participants were invited to the laboratory when they scored 5 or higher on the cleaning subscale, which is the mean of OCD patients on the cleaning subscale (Hodgson & Rachman, 1977) . This cut-off was applied in order to ensure a HCF group that scored similar to clinical OCD patients to enhance the generalizability of the results to clinical practice. For the LCF group participants were invited when they scored 0 on the cleaning subscale. This resulted in 32 participants in the LCF group and 32 participants in the HCF fear group. The study was approved by the ethical committee at Ghent University. Informed consent was obtained from all individual participants included in the study. Participants received course credit for their contribution.

2.2.2. Measures and Materials

2.2.2.1. Structured Clinical Interview for DSM-IV Axis I Disorders (SCID). In order to check diagnostic status the OCD-section of the Dutch version of the SCID was used (First, Spitzer, Gibbon, & Williams, 1998). The SCID is a widely used semi-structured clinical interview developed to asses psychopathology according to the DSM-IV.

2.2.2.2. Maudsley Obsessive-Compulsive Inventory (MOCI). The cleaning subscale of the MOCI (Hodgson & Rachman, 1977) was used in order to preselect participants on contamination fear. This subscale consists of several statements regarding cleanliness (e.g., “My hands do not feel dirty after touching money”). Participants responded by selecting “true” or “false”. The MOCI has good psychometric properties (Hodgson & Rachman, 1977).

2.2.2.3. Padua Inventory-revised (PI-R). In order to assess OCD symptoms the PI-R (Van Oppen, Hoekstra, & Emmelkamp, 1995) was used. The subscales of the PI-R assess impulses, washing, checking, rumination, and precision. Participants rated the 41 items on a Likert scale form 0 (never/not at all) to 4 (very often). The PI-R has good psychometric properties (Van Oppen et al., 1995).

2.2.2.4. Obsessive Compulsive Inventory-revised (OCI-R). In addition to the PI-R, the OCI-R (Foa et al., 2002; Foa, Kozak, Salkovskis, Coles, & Amir, 1998) was used to assess OCD symptoms. The OCI-R consists of six subscales: washing, checking, ordering, obsessing, hoarding, and neutralizing. The 18 items were rated on a Likert scale from 0 (not at all) to 4 (extremely). The OCI-R has good psychometric properties (Hajcak, Huppert, Simons, & Foa, 2004).

2.2.2.5. Dimensional Obsessive-Compulsive Scale (DOCS). An adaptation of the contamination subscale of the DOCS (Abramowitz et al., 2010) was used in order to compare momentary OCD symptoms during the experiment between the LCF and the HCF group. Participants rated the items on a Likert scale from 0 (none at all/not at all difficult) to 4 (most of the time/extremely difficult). The three adapted questions were: “How much time have you spent during the experiment on washing or cleaning behaviors because of feelings of contamination?”, “How difficult was it for you during the experiment to disregard thoughts about contamination and refrain from behaviors such as washing, showering, cleaning and other decontamination routines when you try to do so?”, and “How much time have you spent during the experiment on thinking about contamination?”.

2.2.2.6. Disgust Scale-Revised (DS-R). As disgust sensitivity is elevated in the contamination fear symptom dimension of OCD (Broderick, Grisham, & Weidemann, 2013), the DS-R (Haidt, McCauley, & Rozin, 1994; Olatunji et al., 2009; Olatunji et al., 2007) was used to assess disgust sensitivity. The DS-R consists of three subscales: core disgust, animal reminder disgust, and contamination disgust. The 25 items were rated on a Likert scale from 0 (completely disagree/not disgusting at all) to 4 (completely agree/very disgusting). The DS-R has good psychometric properties (Olatunji et al., 2009; Olatunji et al., 2007).

2.2.2.7. Mood scales For ethical reasons, Visual Analogue Scales (VAS) assessing mood were administered before and after the dot probe task in order to ensure that participants were not negatively impacted by the experiment. This was done by three VAS scales assessing happiness, sadness, and anxiety on a scale from “neutral” to “as happy/sad/anxious as I can imagine”. At the end of the experiment momentary experience of disgust was assessed by asking how much disgust they experienced on a Likert scale from 1 (not at all) to

9 (very much). In order to cancel out any negative impact from the experiment a short movie was shown as a means of a positive mood induction when these mood scales showed a large decrease in positive mood or increase in negative mood and anxiety. As these scales were only used for ethical reasons we did not include these data in the analyses.

2.2.2.8. Dot probe task. In order to assess selective attention the dot probe task (MacLeod, Mathews, & Tata, 1986) was used. The dot probe was programmed using Inquisit Millisecond 3 software (2011). The dot probe task consisted of three trial types: contamination-related vs. neutral, safety vs. neutral and neutral vs. neutral. There were 64 trials per trial type resulting in a total of experimental 192 trials. These trials were preceded by 12 practice trials in which participants received feedback on their performance. Half of the contamination-related vs. neutral and safety vs. neutral trials were congruent, in which the dot appeared at the location previously occupied by the contamination-related or safety picture. The other half of the trials were incongruent, in which the target appeared at the location previously occupied by the neutral picture. The task was programmed so that each picture category was presented equally often in each location and that each picture within the picture category was presented equally often. The order of the trial types was randomized for each participant.

All stimuli were presented against a white background. A trial started with a black fixation cross presented in the middle of the screen. After 500ms two pictures (384 x 288 pixels) appeared above and below the fixation cross for 500ms. Subsequently the pictures were erased and a black dot appeared at the same location as one of the previous pictures. The dot remained on the screen until the participant responded with a press on the “Q” key when the dot was above the fixation cross and a press on the “M” key when the dot was below the fixation cross on an AZERTY keyboard.

A total of 64 neutral (e.g., a bus), 16 contamination-relevant (e.g., a dirty toilet) and 16 pictures representing safety (e.g., a bottle of soap) were selected for this task. The neutral pictures were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1997). The contamination-related pictures were selected from the IAPS, the Maudsley Obsessive-Compulsive Stimuli Set (Mataix-Cols, Lawrence, Wooderson, Speckens, & Phillips, 2009), the picture set of Vogt, Lozo, Koster, and De Houwer (2011), and publically available online sources. The safety pictures were selected from the cleanliness picture set of Vogt et al. (2011) and publically available online sources.

2.2.3. Procedure

At the start of the experiment participants read and signed the informed consent form. Afterwards participants were interviewed with the OCD-section of the SCID. Subsequently, participants filled out the PI-R, DS-R, OCI-R, and the VAS scales. After the questionnaires the dot probe task was administered. Finally, participants filled out the mood scales, adapted DOCS and, if necessary, they received a positive mood induction with a short movie. At the end of the study participants received a full debriefing about the experiment. An overview of the procedure is depicted in Fig. 1.

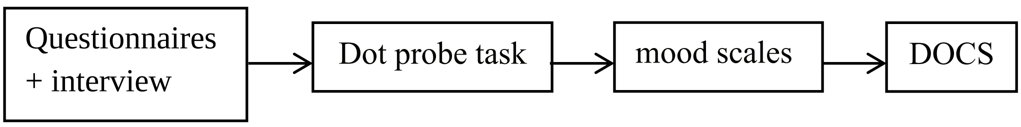

Figure 1. Overview of the procedure of study 1.

2.2.4. Statistical Analysis

SPSS (version 20; IBM Corp, 2011) was used in order to perform statistics with the significance level set at $p < .05$. Partial eta-squared (η_p^2) was used for effect sizes. Continuous sample characteristics such as age, state OCD symptoms experienced during the experiment, DS-R, washing subscales, and total scores of the PI-R and OCI-R were analyzed with separate *t*-tests. Subsequently, the difference between groups in gender was analyzed using Fisher's exact test.

As a first step in the dot probe data preparation, in line with previous research (e.g., Zvielli, Bernstein, & Koster, 2014), all trials with errors and reaction times (RT) faster than 200 and slower than 1500ms were removed (2.16%). Generally accuracy was high (M = 97.98%, SD = 1.70%, range = 92% - 100%). Subsequently, all RTs deviating more than three standard deviations from the participant's individual mean per trialtype (i.e., safety congruent, safety incongruent, threat incongruent, threat congruent, and neutral) and from the sample mean RT per trialtype were removed (3.50%). Finally, attentional bias for threat was calculated by subtracting mean threat-congruent trials from mean threat-incongruent trials and attentional bias for safety by likewise subtracting mean safety-congruent trials from mean safety-incongruent trials. Positive attentional bias scores refer to attentional bias toward threat/safety and negative attentional bias scores refer to attentional avoidance away from threat/safety. Attentional interference for threat was calculated by subtracting mean neutral trials from mean threat-incongruent trials and attentional interference for safety by likewise subtracting mean neutral trials from mean safety-incongruent trials. Attentional interference scores above zero refer to interference by threat/safety pictures. Attentional bias variability is one of the TL-BS measures[1]. Attentional bias variability for threat and safety was calculated using the computation code as used in Zvielli et al. (2014). This code subtracts RTs between temporally contiguous matched trials (incongruent vs. congruent) so that attentional bias can be estimated at trial-level.

[1] As other TL-BS measures (i.e., mean attentional bias toward or away) correlated highly with attentional bias variability (all r's > .81, all p's < .001), we did not repeat analyses with these other TL-BS measures in order to avoid an inflation of type I error.

Group differences were investigated using *t*-tests and Fisher's exact test when applicable. In order to test the main hypothesis of this study that there is a difference between HCF and LCF in selective attention toward threat and safety, separate mixed ANOVA's were performed on the different indices of selective attention for threat and safety (i.e., attentional bias, attentional interference, and attentional bias variability) with Valence (threat or safety) as a within-subject factor and Group as a between-subject factor.

2.3. Results

2.3.1. Sample Characteristics

Age did not differ between groups ($t(62) = 0.07$, $p = .943$). There were significantly more women in the HCF group ($n = 29$), than in the LCF group ($n = 21$; $\chi^2(1) = 5.85$, $p = .032$). Moreover, there was no difference between experienced state OCD symptoms during the experiment ($t(62) = 1.63$, $p = .109$). Importantly, in line with the pre-selection, there were significant differences between groups in the DS-R, washing subscales, and total scores of the OCI-R and PI-R (all t's > 3.86, all p's < .001), in which the HCF group scored higher than the LCF group (for means see Table 1). Of the HCF group the SCID identified six participants with clinical levels of OCD, while no participants were identified with OCD in the LCF group.

Table 1.

Means and standard deviations on demographic for HCF and LCF from study 1

	HCF (n = 32)		LCF (n = 32)	
	M	*SD*	*M*	*SD*
Age	19.38[a]	4.43	19.47[a]	5.87
DS-R	62.69[a]	14.32	45.44[b]	14.21
OCI-R washing subscale	4.56[a]	3.04	0.75[b]	1.57
OCI-R total	24.88[a]	11.84	14.75[b]	8.97
PI-R washing subscale	15.09[a]	8.51	4.00[b]	5.24
PI-R total	58.03[a]	22.18	33.63[b]	13.19
DOCS	2.63[a]	2.25	1.72[a]	2.20

Note. HCF = high contamination fear group, LCF = low contamination fear group, DS-R = Disgust Scale-Revised, OCI-R = Obsessive Compulsive Inventory-revised, PI-R = Padua Inventory-revised, DOCS = Dimensional Obsessive Compulsive Scale. For each row, variables that share the same subscript are not significantly different from each other ($p < .05$).

Table 2.

HCF versus LCF in selective attention to threat and safety

	Main effect of Valence				Main effect of Group				Valence x Group interaction			
Variables	*F*	*df*	*P*	η_p^2	*F*	*df*	*p*	η_p^2	*F*	*df*	*p*	η_p^2
Attentional Bias	18.33	1, 62	< **.001**	.23	0.92	1, 62	.340	.01	0.87	1, 62	.354	.01
Attentional Interference	50.61	1, 62	< **.001**	.45	0.02	1, 62	.878	< .01	0.07	1, 62	.786	< .01
Attentional Bias Variability	5.64	1, 62	**.021**	.08	3.66	1, 62	.060	.06	0.18	1, 62	.676	< .01

Note. Mixed ANOVA with Valence (threat or safety) as a within-subject factor and Group as a between-subject factor.

2.3.2. HCF versus LCF in Selective Attention to Threat and Safety

The results of the mixed ANOVA's are represented in Table 2. Contrary to predictions, for all measures of selective attention (i.e., attentional bias, attentional interference, and attentional bias variability) analyses revealed no significant interaction effect between Valence x Group or a main effect of Group. However, there was a significant main effect of Valence for every measure, in which participants generally showed more attentional bias and attentional interference for threat than for safety and higher attentional bias variability in the presence of threat-related pictures.

In order to test whether attentional bias or interference differed from zero (i.e., no attentional preference, interference or variability), one sample *t*-tests were performed. One sample *t*-tests showed that for safety attentional avoidance and variability were significantly different from zero (zero represents no bias). For threat all measures of selective attention differed significantly from zero (see Table 3). Participants generally showed attentional bias toward threat, attentional interference after threat, and attentional bias variability, whereas they showed a slight attentional avoidance from safety pictures.

Table 3.

One-samples t-tests from zero

	M	*SD*	*t*(63)	*p*
Attentional Bias Safety ms	-3.54 ms	13.57 ms	-2.09	**.041**
Attentional Bias Threat ms	7.20 ms	16.68 ms	3.45	**.001**
Attentional Interference Safety ms	-1.62 ms	12.70 ms	-1.02	.313
Attentional Interference Threat ms	15.25 ms	18.40 ms	6.63	< **.001**
Attentional Bias Variability Safety ms	78.66 ms	20.67 ms	30.45	< **.001**
Attentional Bias Variability Threat ms	85.29 ms	25.15 ms	27.13	< **.001**

2.4. Discussion

The first study set out to investigate selective attention toward contamination-related stimuli in a HCF and LCF group. Results indicated a general effect of attentional bias and interference toward threat, attentional avoidance from safety and attentional bias variability. However, contrary to predictions, this was not specific for HCF.

3.1. Study 2

Provided that we failed to observe trait influences of HCF we examined whether a state induction of contamination fear influenced selective attention. Moreover, we examined whether attentional bias at baseline influences the response to a contamination symptoms induction. The hypothesis, main methods, and analyses of this study have been preregistered at https://aspredicted.org/88p6e.pdf.

The current study used a convenience sample, since previous research has shown that symptoms similar to OCD can effectively be induced in healthy participants (De Putter, Van Yper, & Koster, 2017). Moreover, Moritz et al. (2009) found that OCD patients did not rate OCD-related stimuli as more negative than healthy control subjects. Therefore, a convenience sample lends itself to investigate the effect of an OCD symptom induction on OCD-related stimuli. Furthermore, as contamination fear is best construed as dimensional rather than categorical (Mataix-Cols, do Rosario-Campos, & Leckman, 2005), it is likely at least some stimuli will elicit contamination fear in healthy participants. In order to make the stimuli more idiosyncratic, participants rated their anxiety following a range of contamination-related pictures. Only the pictures eliciting most anxiety were presented in the dot probe task. In the current study the dot probe task included contamination-related, neutral, and generally negative pictures. Including generally negative pictures allowed for investigating whether an effect would be specific for contamination-related stimuli or for negative stimuli in general.

For the OCD symptom induction, an induction was selected based on a meta-analysis on induction procedures of OCD symptoms (De Putter et al., 2017). Mental contamination emerged as one of the most potent induction to induce OCD symptoms in healthy participants. Mental contamination consists of a sense of internal dirtiness and often includes a moral element (Rachman, 2004). Coughtrey, Shafran, Knibbs, and Rachman (2012) showed that mental contamination is experienced by approximately half of patients with OCD and is associated with OCD severity. Feelings of internal dirtiness and urge to wash in mental contamination overlap in part with contact contamination, yet mental contamination differs in that there is no contact with a physical contaminant (Coughtrey et al., 2012).

3.2. Methods

3.2.1. Participants

According to an a priori power analysis based on the effect size *d* = 0.38 (the effect size found for between-group comparisons of threat-related bias in the dot probe; Bar-Haim et al., 2007), with α = 0.05 and a power of 0.8 for 2 groups and 2 measurements, we needed a minimum of 58 participants in total in order to be able to find a within-between interaction. In line with our preregistration, we tested 70 healthy participants to have sufficient power to find an interaction between Time (baseline and after induction) and Group (OCD induction or neutral induction). All participants were female as our OCD symptom induction was specifically designed for women. Participants age ranged from 17 to 37 years (*M* = 22.56, *SD* = 3.26). Most participants were undergraduate students from Ghent University. The study was approved by the ethical committee at Ghent University. Informed consent was obtained from all individual participants included in the study. Participants received 10 euro for their participation.

3.2.2. Measures

3.2.2.1. PI-R. The PI-R as described in study 1 was used to assess OCD symptoms.

3.2.2.2. Impulsiveness–Venturesomeness–Empathy questionnaire (I_7). As attentional bias has previously been associated with impulsivity (e.g., Coskunpinar & Cyders, 2013; Hou et al., 2011), the impulsiveness subscale of the I_7 (Eysenck, Pearson, Easting, & Allsopp, 1985; Lijffijt, Caci, & Kenemans, 2005) was used to check for any group differences in levels of impulsivity. This subscale consists 19 dichotomous (yes/no) items.

3.2.2.3. Mood and Anxiety Symptoms Questionnaire (MASQ-D30). As depression levels have also been associated with attentional bias (e.g., Koster, De Raedt, Goeleven, Franck, & Crombez, 2005), the anhedonic depression scale of the short adaptation of the

MASQ (Wardenaar et al., 2010; Watson, Clark, et al., 1995; Watson, Weber, et al., 1995) was used in order to check for group differences in levels of depression. The 10 items of the anhedonic depression scale were rated on a Likert scale from 1 (not at all) to 5 (extremely).

3.2.2.4. Yale-Brown Obsessive–Compulsive Scale (Y-BOCS). In order to measure severity of any obsessive-compulsive symptoms the Y-BOCS severity self-report as designed by Baer (1991) was used. This Y-BOCS is very similar to the interview and has good psychometric properties (Steketee, Frost, & Bogart, 1996; in the current study $\alpha = .83$). The questionnaire included an explanation of what obsessions and compulsions entail. Participants indicated the time spent, interference, distress, resistance, and control over obsessions and compulsions separately on a scale from 0 (none) to 4 (extreme).

3.2.2.5. VAS. In line with Rossi and Pourtois (2012), seven VAS were adopted from the Profile of Mood States (McNair, Lorr, & Dropplemann, 1992) as a means of a manipulation check for neutral or OCD symptom induction. As in study 1, the scale “disgusted” was added because of its relevance to the contamination symptom dimension of OCD (Broderick et al., 2013). The mean of the scales “tense”, “angry”, “depressed”, and “disgusted” was used to estimate negative mood. The mean of the scales “happy”, “energetic”, and “satisfied” was used to estimate positive mood. Finally, one scale was used to estimate fatigue. The VAS scales were administered before and after neutral or OCD symptom induction. The VAS scales were also administered at the end of the experiment in order to check participants’ mood before leaving the experiment for ethical reasons. As preregistered, the data of the VAS scales at the end of the experiment were therefore not included in the data analyses.

3.2.2.6. Mental Contamination Report (MCR). As a means of a manipulation check, the MCR as developed by Radomsky, Elliott, Rachman, Fairbrother, and Newth (2008) was administered after neutral or OCD symptom induction. Radomsky et al. (2008) modified this version from the mental contamination report as used by previous studies (Fairbrother, Newth, & Rachman, 2005; Herba & Rachman, 2007). The 21 items were rated on a scale from 0 (not at all) to 100 (completely). The MCR assessed internal negative emotions (e.g., guilt), external negative emotions (e.g., anger), feelings of dirtiness, urge to wash (e.g., face), ease to imagine the scenario, desirability of the kiss, and the man's morality before and after the kiss.

3.2.2.7. DOCS. The same adapted version of the DOCS as used in study 1 was used in study 2 as a means of a manipulation check after neutral or OCD symptom induction. All questions of the DOCS were phrased so that they specifically referred to how participants felt during the induction. The DOCS was also administered at the end of the experiment. As preregistered, only the data of the DOCS after neutral or OCD symptom induction were included in the analysis, as the measurement at the end of the experiment was solely meant to check participants' mood before leaving the experiment for ethical reasons.

3.2.2.8. Hand washing. Washing behavior was included as a means of a manipulation check of neutral or OCD symptom induction. We asked all participants to wash their hands using a hand sanitizer pump at the end of the study in order to have a continuous measure of washing behavior. The time spent on washing hands was recorded, unbeknownst to the participants, using a stopwatch.

3.2.3. Materials

3.2.3.1. Dot probe task. The dot probe task ran using Inquisit Millisecond 4 software (2016). The dot probe task in study 2 was similar to the dot probe task in study 1 with a few adaptations. In this dot probe task the trial type safety vs. neutral was replaced with negative vs. neutral in order to assess any incremental selective attention of contamination-relevant stimuli above and beyond negative stimuli in general. Moreover, the number of experimental trials was increased to 240 trials in total, resulting in 80 trials per trial type. The dot probe task was administered before and after neutral or OCD symptom induction.

In total 60 neutral (e.g., a leaf) and 60 negative (e.g., a gun) pictures were selected from the International Affective Picture System (IAPS; Lang et al., 1997). The 60 contamination-relevant pictures (e.g., a dirty toilet) were selected from the IAPS, the Maudsley Obsessive-Compulsive Stimuli Set (Mataix-Cols et al., 2009), the picture set of Morein-Zamir et al. (2013) and publically available online sources. An independent sample (*n* = 28) rated these pictures in order to match negative and disorder-relevant pictures on arousal and how much fear and disgust the pictures elicited on a Likert scale ranging from 1 (none) to 9 (very much). Moreover, they rated the valence of the pictures on a Likert scale ranging from 1 (negative) to 9 (positive)[2]. Forty neutral pictures were selected from the IAPS to form 20 neutral-neutral pairs. In order to enhance the relevance of the contamination-related pictures to the participants, participants rated all contamination-relevant pictures on how much fear these pictures elicited before the dot probe task. Only the 16 pictures most relevant to the participant were used in the dot probe task in order to mimic the idiosyncratic nature of OCD.

3.2.3.2. Non-Consensual Kiss (NCK) induction. The NCK induction is an induction that elicits mental contamination. Participants were randomly allocated to either a NCK induction or a neutral induction. The audio script for the NCK induction was translated into Dutch from the script of the non-consensual physically dirty condition of Elliott and Radomsky (2012). The induction consists of listening to a scenario through headphones that describes a party and at the end of the party participants imagine being kissed non-consensual

[2] *M* arousal OCD pictures = 4.17, *SD* arousal OCD pictures = 0.94, *M* arousal negative pictures = 4.90, *SD* arousal negative pictures = 0.73; *M* fear OCD pictures = 2.56, *SD* fear OCD pictures = 0.91, *M* fear negative pictures = 4.29, *SD* fear negative pictures = 1.38; *M* disgust OCD pictures = 4.51, *SD* disgust OCD pictures = 1.44, *M* disgust negative pictures = 3.01, *SD* disgust negative pictures = 1.06; *M* valence OCD pictures = 3.63, *SD* valence OCD pictures = 0.60, *M* valence negative pictures = 3.01, *SD* valence negative pictures = 0.63

by a physically dirty man. For the neutral induction the audio script of the consensual physically clean condition of Elliott and Radomsky (2012) was adjusted by substituting the consensual kiss on the mouth by a kiss on the cheek as a means of saying goodbye. A kiss on the cheek is a common informal way of saying goodbye to friends in Belgium. Before listening to the scenario participants were instructed to imagine being the woman described in the scenario as vividly as possible. The experimenters conducting the experiment were blind to the condition (NCK or neutral) participants were randomized to.

3.2.3.3. Reminder Induction. Participants were reminded of the induction in a short break after 120 trials in the second dot probe task. Participants rated their current disgust and anxiety level, right before and after being asked to focus on the scenario again on the moment they received a kiss. This was done in order to prevent that the effects of the OCD induction would subside during the duration of the second dot probe task.

3.2.4. Procedure

At the beginning of the experiment participants read and signed the informed consent form. After that, the PI-R, I_7 impulsiveness scale, MASQ, and Y-BOCS were administered. Subsequently participants performed the first dot probe task. After the first dot probe task participants filled out the VAS scales. Then participants were randomly assigned to either the OCD induction or the neutral induction. After the induction, participants filled out the manipulation check questionnaires (VAS scales, MCR, and DOCS). Subsequently participants performed the second dot probe task. During the second dot probe task there was a short break in the middle of the task in which participants rated their current disgust and anxiety level, right before and after being reminded of the induction. Afterwards, all participants were asked to wash their hands as a last manipulation check of the OCD induction. The hand washing was postponed to the end of the experiment in order to prevent it from cancelling out any effects of the OCD induction. Finally, participants filled out the last VAS scales and DOCS and if necessary received a positive mood induction by means of a short movie. All participants were fully debriefed at the end of the experiment. For an overview of the study see Fig. 2.

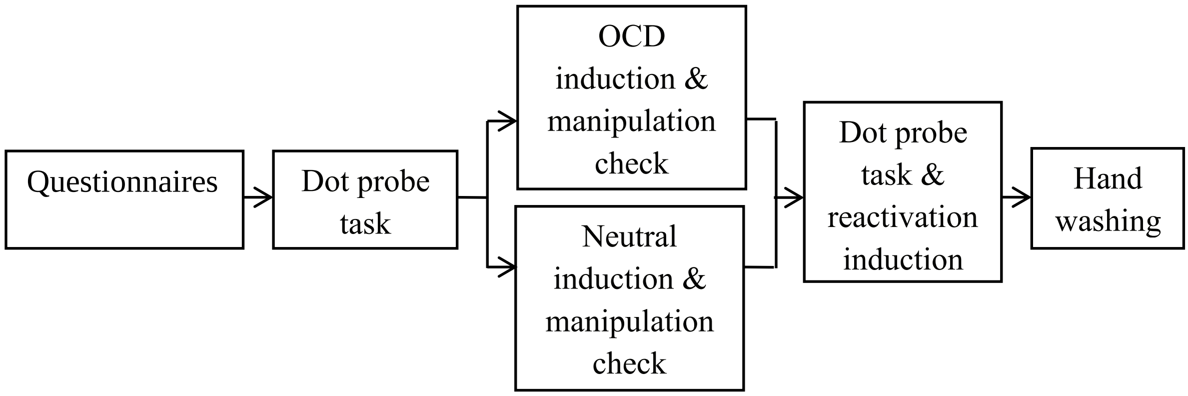

Figure 2. Overview of the procedure of study 2.

3.2.5. Statistical Analysis

All sample characteristics were analyzed using separate *t*-tests. Since a difference between induction groups in previous experienced non-consensual sexual encounter could influence the effectiveness of the induction, potential differences between induction groups in encounters were analyzed using Fisher's exact test. Dot probe analysis was done in the same manner as in study 1. Two participants had average accuracy rates of below 80% and were excluded from further analyses. After exclusion of these participants general accuracy was high (*M* = 96.28%, *SD* = 3.11%, range = 84% - 100%).

In order to check whether the manipulation was successful, we used multiple measures such as the MCR, VAS negative and positive mood, DOCS, and time spent on washing hands. In line with Elliott and Radomsky (2012), we performed separate ANOVA's on perceived kiss desirability and the difference score of pre- and post-physical dirtiness of the man as measured by the MCR as dependent variables and induction group as the independent variable. In order to test for the effects of the induction on feelings of mental contamination (i.e., feelings of dirtiness, urges to wash, internal negative emotions, and external negative emotions), a multivariate ANOVA was conducted on feelings of mental contamination as dependent variables and induction group as independent variable. Moreover, in order to test for the effect of the induction on positive and negative mood, separate mixed ANOVA's with Time (pre- and post-induction) as a within-subject factor and Induction Group as between-subject factor was performed. Furthermore, in order to test for the effect of the manipulation on the DOCS and time spent hand washing separate a ANOVA's were performed on the DOCS scores and time spent on washing hands with Induction Group as the independent variable. Finally, the effect of the reminder of the induction during the second dot probe task was assessed using separate mixed ANOVA's on the disgust and anxiety VAS scales administered before and after the reminder with Time (pre-post induction) as the within-subject factor and Induction Group as the between-subject factor.

In order to test the hypothesis that current OCD symptoms affect selective attention, we performed a separate mixed ANOVA for each selective attention measure (i.e., attentional bias, attentional interference, and attentional bias variability) with Time (pre- and post-induction) and Valence (OCD-related or generally negative) as within-subject factors and Induction Group as a between-subject factor.

Finally, in order to test whether baseline selective attention is able to predict an increase in symptoms after the OCD induction, separate linear regressions were performed per OCD symptoms measure after the induction (i.e., feelings of dirtiness, urge to wash, time spent on hand washing, internal negative emotions, external negative emotions, DOCS, VAS negative, and VAS positive) with baseline selective attention (i.e., attentional bias, attentional interference, and attentional bias variability) for OCD-related and negative pictures as independent variables. In the analyses with VAS positive and negative mood we corrected for baseline scores. In these analyses only participants in the OCD symptom induction group were included, as we only expected an increase in symptoms after this induction.

3.3. Results

3.3.1. Sample Characteristics

See Table 4 for the means and standard deviations of the sample characteristics. None of the baseline sample characteristics were significantly different between groups (all t's(66) < 1.58, all p's > .120). Furthermore, in this sample 50% experienced a previous non-consensual sexual encounter (e.g., an unwanted kiss), but this did not differ per group ($\chi^2(1) = 0.06$, $p = .808$).

Table 4.

Means and standard deviations on demographic and baseline ratings for OCD symptom induction (OCDI) and neutral induction (NI) from study 2

	OCDI (*n* = 35)		NI (*n* = 33)	
	M	*SD*	*M*	*SD*
Age	22.60	3.81	22.24	2.41
Impulsiveness	5.77	3.10	4.52	3.47
MASQ depression	27.17	9.06	27.85	8.26
Baseline positive mood	56.83	17.09	52.59	16.14
Baseline negative mood	15.62	16.27	18.24	14.88
Ease to imagine the scenario	72.75	14.80	75.11	17.18
PI-R washing subscale	5.46	5.14	5.64	4.11
PI-R total	35.46	17.79	37.39	16.31

Y-BOCS	5.06	4.62	4.73	4.02

Note. MASQ = Mood and Anxiety Symptom Questionnaire, PI-R = Padua Inventory-revised, Y-BOCS = Yale-Brown Obsessive–Compulsive Scale.

3.3.2. Manipulation Checks

In order the check whether the manipulation was successful scores from the MCR, VAS negative and positive mood, DOCS and time spent on hand washing were analyzed (see Table 6). There was a significant difference in induction groups for all measures of the mental contamination report and the DOCS, in which participants consistently reported less kiss desirability, a larger difference between pre- and post-physical dirtiness of the man and more symptoms in the OCD induction group than in the neutral induction group. Furthermore, repeated measures ANOVA's showed that there was a significant interaction between Induction Group and Time. Follow-up paired samples *t*-tests showed that there was no difference in induction groups in reported positive or negative mood before the induction (positive mood: $t(66) = 1.05$, $p = .296$; negative mood: $t(66) = 0.69$, $p = .491$), but there was a significant difference between induction groups after the induction (positive mood: $t(66) = 2.21$, $p = .031$; negative mood: $t(47.77) = 5.31$, $p < .001$). After the induction participants in the OCD induction group reported less positive and more negative mood than the neutral induction group (see Table 5). The only measure that did not reveal a significant difference between induction groups was time spent on hand washing.

Table 5.

Means and standard deviations for manipulation checks for the OCD symptom induction (OCDI) and neutral induction (NI) from study 2

	OCDI (*n* = 35)		NI (*n* = 33)	
	M	*SD*	*M*	*SD*
Perceived kiss desirability	5.14	13.31	48.15	28.19
Difference pre- and post-physical dirtiness of the man	51.46	27.47	0.09	9.03
Feelings of dirtiness	46.77	31.77	3.94	6.75
Urge to wash	48.61	31.25	14.15	19.86
Internal negative emotions	32.42	21.84	3.57	3.74
External negative emotions	48.46	22.25	2.85	5.56
VAS Negative Mood post	31.80	23.07	8.98	10.36
VAS Postitive Mood post	42.98	20.31	53.16	17.47
DOCS	3.51	2.44	0.70	1.10
Time spent hand washing (in seconds)	18.51	6.29	16.99	4.76

Note. MASQ = Mood and Anxiety Symptom Questionnaire, PI-R = Padua Inventory-revised, Y-BOCS = Yale-Brown Obsessive–Compulsive Scale.

Table 6.

Results manipulation check

	Main effect of Induction				Main effect of Time				Induction x Time interaction			
Variables	*F*	*df*	*p*	η_p^2	*F*	*df*	*p*	η_p^2	*F*	*df*	*p*	η_p^2
Mental Contamination Report												
Perceived kiss desirability[a]	65.93	1, 66	< **.001**	.50								
Difference pre- and post-physical dirtiness of the man[a]	104.63	1, 66	< **.001**	.61								
Feelings of Mental Contamination[b]	38.16	4, 63	< **.001**	.71								
VAS												
Negative Mood[c]	7.48	1, 66	**.008**	.10	3.80	1, 66	.056	.05	51.45	1, 66	< **.001**	.44
Positive Mood[c]	0.58	1, 66	.448	.01	12.14	1, 66	**.001**	.16	14.34	1, 66	< **.001**	.18
Other measures												
DOCS[a]	36.81	1, 66	< **.001**	.36								
Time hand washing[a]	1.25	1, 66	.268	.02								

Note: DOCS = Dimensional Obsessive-Compulsive Scale. [a] Represents results of univariate ANOVA's; [b] Represents results of MANOVA with feelings of dirtiness, urges to wash, internal negative emotions, and external negative emotions as dependent variables representing feelings of mental contamination; [c] Represents results of 2 (Induction group) x 2 (Time) Mixed ANOVA's.

3.3.3. Manipulation Check Reminder Induction

In order to determine whether the Reminder of the induction was successful, a separate mixed ANOVA was performed on the anxiety VAS scales and disgust VAS scales administered before and after the reminder with Time (pre-post reminder) as a within-subject factor and induction group as a between-subject factor. These analyses showed significant Time x Induction Group interactions (disgust: $F(1,64) = 70.20$, $p < .001$, $\eta_p^2 = .52$; anxiety: $F(1,64) = 30.53$, $p < .001$, $\eta_p^2 = .32$). Follow-up paired samples *t*-tests showed that this effect was due to no significant change in disgust or anxiety for the neutral induction group (anxiety: $t(31) = 0.13$, $p = .896$; disgust: $t(31) = 0.55$, $p = .589$) while there was a significant increase in anxiety ($M_{diff} = 22.85$, $SD_{diff} = 21.79$) and disgust ($M_{diff} = 37.12$, $SD_{diff} = 22.93$) in the OCD induction group (anxiety: $t(33) = 6.12$, $p < .001$; disgust: $t(33) = 9.44$, $p < .001$). There was also a main effect of Time (disgust: $F(1,64) = 61.76$, $p < .001$, $\eta_p^2 = .49$; anxiety: $F(1,64) = 29.38$, $p < .001$, $\eta_p^2 = .31$) and Induction Group (disgust: $F(1,64) = 39.17$, $p < .001$, $\eta_p^2 = .38$; anxiety: $F(1,64) = 13.23$, $p = .001$, $\eta_p^2 = .17$). However, these effects were qualified by the aforementioned Time x Induction group interaction effect.

Table 7.

Effects of disorder-relevance and current OCD symptoms on selective attention

Variables	Main effect of Valence				Induction x Time interaction				Valence x Induction x Time interaction			
	F	*df*	*p*	η_p^2	*F*	*df*	*p*	η_p^2	*F*	*df*	*p*	η_p^2
Attentional Bias	1.59	1, 66	.212	.02	0.04	1, 66	.834	< .01	0.48	1, 66	.491	< .01
Attentional Interference	14.07	1, 66	**< .001**	.18	0.21	1, 66	.651	< .01	0.87	1, 66	.354	.01
Attentional Bias Variability	0.87	1, 66	.355	.01	1.71	1, 66	.196	.03	1.30	1, 66	.258	.02

Note: Represents results of hypothesis testing within a 2 (Induction group) x 2 (Time) x 2 (Valence) Mixed ANOVA's.

3.3.4. Effects of Disorder-Relevance and Current OCD Symptoms on Selective Attention

The results of the 2 (Induction group) x 2 (Time) x 2 (Valence) ANOVA's are presented in Table 7. The predicted effect of an influence of symptoms on selective attention by an Induction x Time interaction was not significant for any measure of selective attention. Furthermore there were no Valence x Induction x Time interaction effects and there was only an effect of the Valence of the pictures (OCD-related or generally negative) for attentional interference. On average participants showed more attentional interference after OCD-related pictures (M = 8.45 ms, SD = 10.05 ms) than after generally negative pictures (M = 3.02 ms, SD = 9.32 ms). Interestingly, there was also a Time x Valence interaction effect for attentional interference. Follow-up paired *t*-tests showed that the effect of valence was significant during the first dot probe task ($t(67) = 4.87$, $p < .001$), but not during the second dot probe task ($t(67) = 1.20$, $p = .235$) [3].

3.3.5. Predicting Symptoms based on Baseline Selective Attention

Linear regressions performed on feelings of dirtiness, urge to wash, external negative emotions, internal negative emotions, DOCS scores, time spent on washing hands and positive and negative mood did not show any significant effects (all *p*'s > .117). Baseline selective attention (i.e. attentional bias, attentional interference and attentional bias variability) for any type of picture did not predict the increase in symptoms after OCD symptom induction.

3.4. Discussion

The second study set out to examine the effects of an OCD symptom induction on subsequent selective attention to contamination-related stimuli and the ability of baseline selective attention to predict an increase in symptoms after OCD symptom induction. Importantly, the manipulation checks showed that the OCD symptom induction was successful for every measure except time spent on hand washing. Thus, the induction was successful in inducing feelings of mental contamination and intrusive thoughts, but this effect did not generalize to washing behavior in the lab. However, in the current study we did not check for mental rituals, which could have obfuscated a generalization to overt neutralizing behavior. Future research would benefit from including a measure of covert neutralizing behavior in order to be able to exclude this possibility. Moreover, the manipulation check of the reminder of the induction during the second task showed that this reminder was successful in maintaining the effects of the induction. These findings are important as they imply that, if

[3] Including padua contamination scores did not result in any state (group) x trait (PI-R scores) interactions.

selective attention is influenced by increased state contamination fear, we can expect increased selective attention to OCD-related stimuli after this induction.

The predicted increase in selective attention after OCD symptom induction was not significant. Therefore, the current study does not provide evidence for the view that selective attention to threat is highly responsive to state manipulation in the context of contamination fear. Furthermore, contrary to the view that attentional bias contributes to OCD symptoms, baseline selective attention was not able to predict an increase in symptoms after OCD symptom induction. Interestingly, participants showed more attentional interference for OCD-related stimuli than generally negative stimuli. Similarly, Morein-Zamir et al. (2013) found selective attention toward idiosyncratic pictorial stimuli in nonanxious individuals. Moreover, this finding corresponds to Pergamin-Hight et al. (2015) who found that attentional bias is specific for disorder-related stimuli. This valence-specific effect for attentional interference was only present during the first dot probe task (i.e., before OCD or neutral induction). This finding is in line with Amir, Najmi, and Morrison (2009), who demonstrated that attentional bias to idiosyncratic OCD-related stimuli habituated over the course of the experiment.

4. General Discussion

The current studies investigated the link between OCD symptoms and selective attention. Research regarding an attentional bias to OCD-related stimuli in the context of OCD has been mixed and characterized by several limitations. First, to date little research has been done on attentional bias as a dynamic process which can change over time. Second, from the current literature it is unclear whether attentional bias has an influence on OCD symptoms or whether state OCD symptoms influence attentional bias. Some cognitive models have proposed that attentional bias to threat is one of the mechanisms contributing to the development and maintenance of OCD (e.g., Bar-Haim et al., 2007; Muller & Roberts, 2005), while other models such as the ACT (Eysenck et al., 2007) have proposed a mutually reinforcing relation between attentional bias toward threat and anxiety. Therefore, selective attention to threat may increase after the induction of OCD symptoms. These limitations were addressed in two studies. The first study examined the difference between a HCF and LCF group in selective attention using a cross-sectional design. In the second study an experimental design was used in which selective attention was assessed before and after an induction designed to elicit symptoms similar to OCD. Furthermore, in the second study we investigated whether selective attention for OCD-related stimuli at baseline could predict an increase in symptoms after an OCD symptoms induction. In the current studies we found no evidence for either a trait-related presence of selective attention nor for influences of experimentally induced contamination fear. Moreover, baseline selective attention had no impact on subsequent OCD induction.

The findings that there was no effect of trait OCD and that baseline selective attention was not able to predict changes in OCD symptoms are in line with other studies that did not find an effect of trait OCD symptoms on selective attention (e.g., Harkness et al., 2009; Morein-Zamir et al., 2013; Moritz et al., 2008; Moritz & von Mühlenen, 2008). However, the results are in contrast with Bar-Haim et al. (2007) and other studies who did find an effect of selective attention in OCD (e.g., Amir et al., 2009; Moritz et al., 2009). The absence of a relationship between trait OCD and selective attention is also in contrast with cognitive models proposing that attentional bias to threat is one of the mechanisms contributing to the development and maintenance of OCD (e.g., Bar-Haim et al., 2007; Muller & Roberts, 2005). The finding that there was no effect of an OCD symptom induction on subsequent selective attention is in contrast with Cohen et al. (2003), who found a decrease in performance after OCD symptom induction. Furthermore, this finding suggests models such as the ACT

(Eysenck et al., 2007) proposing a mutually reinforcing relation between attentional bias toward threat and anxiety may not apply to OCD.

It is important to note that the sample size for these studies was based on a priori power analyses. These power analyses were based on meta-analytic findings on attentional bias where a medium effect size was observed (Bar-Haim et al., 2007). Thus we were underpowered to demonstrate small effect sizes, yet sufficiently powered to find medium effect sizes. Therefore it is unlikely that the current results are due to a lack of power. These results suggest, in line with Summerfeldt and Endler (1998), that selective attention may not play a pivotal role in the context of OCD. Another possibility is that the relationship between selective attention is more complex than a unidirectional relationship from either selective attention to OCD symptoms or from OCD symptoms to selective attention. For instance, Muller and Roberts (2005) have suggested cognitive variables might interact to influence OCD. Similarly, Hirsch, Clark, and Mathews (2006) posed the combined cognitive biases hypothesis, in which they suggest cognitive variables can influence each another and/or interact so that the effect of each variable separately is influenced by other cognitive factors. For instance, selective attention may interact with response inhibition or task switching. Future research is necessary in order to determine whether the relationship between OCD and selective attention is more complex or whether selective attention is not as important for OCD as it is for anxiety disorders (Summerfeldt & Endler, 1998).

A strength of the current studies was that they investigated attentional bias both as a dynamic process and as stable attentional bias and interference scores. Contrary to the traditional attentional bias and interference measures, the TL-BS measure of attentional bias variability has demonstrated good to excellent reliability and validity (Rodebaugh et al., 2016; Zvielli et al., 2015). Interestingly, we largely found the same results regardless of the specific measure of selective attention in our studies. Previous research has highlighted the need for the use of idiosyncratic stimuli in the investigation to attention (Muller & Roberts, 2005). Even within symptom dimensions OCD is heterogeneous in its triggers (Rufer, Grothusen, Maß, Peter, & Hand, 2005). Hence, general threatening stimuli may have little threat value for a specific individual. Therefore, a specific strength of the second study was that it included a procedure for idiosyncratic picture selection in order to ensure the personal relevance of the pictures.

These studies are characterized by several limitations. First and foremost, these studies used either a subclinical sample (study 1) or a convenience sample (study 2). Moreover, the convenience sample of study 2 was entirely female, which limits the generalizability of these findings. Interestingly however, one-sample *t*-tests showed that on average participants displayed an attentional bias (regardless of HCF or LCF), suggesting the possibility to examine attentional bias in a female convenience sample. Moreover, the utility of analogue samples in research on the mechanisms of OCD has been demonstrated extensively by Gibbs (1996) and Abramowitz et al. (2014). A second limitation is that although the induction of OCD symptoms was successful, it is possible that the pictures themselves already acted as an OCD symptom induction. However, it is likely that a separate OCD induction in study 2 would have a stronger effect on selective attention than pictures alone. A third limitation is that these studies focused on the contamination symptom dimension of OCD, which limits the generalizability of these findings to other symptom dimensions of OCD. Indeed, Harkness et al. (2009) suggested selective attention to be specific for the contamination symptom dimension. In order to draw conclusions about OCD in general, future research is necessary on the effect of trait and state OCD symptoms focusing on different symptom dimensions in OCD. Furthermore, the current studies did not take PTSD symptoms into account. Badour, Ojserkis, McKay, and Feldner (2014) demonstrated that both contact contamination and mental contamination are associated with PTSD symptoms in victims of sexual assault. In the second study 50% of participants reported that they had been victims of a non-consensual sexual encounter such as an unwanted kiss. However, as this prevalence rate was equal between the neutral induction and OCD symptoms induction condition, it is unlikely that this previous experience would have affected our results.

Limitations notwithstanding, the current studies were among the first investigating the link between OCD symptoms and selective attention considered as a dynamic process in time. In conclusion, there was little evidence for selective attention as a mechanism influencing OCD symptoms since selective attention to contamination-related stimuli was found in participants regardless of scoring high or low on contamination fear. Moreover, baseline selective attention did not predict increased OCD symptoms after an OCD symptom induction. Finally, we did not find evidence for an influence of state OCD symptoms on selective attention, since an OCD symptom induction did not affect subsequent selective attention. These results suggest that selective attention may not be as important for OCD as it is for anxiety disorders or that the relation between OCD and selective attention is more complex than an unidirectional relationship.

Role of Funding Sources

Funding for this study was provided by a Grant of the Special Research Fund (BOF) of Ghent University awarded to Laura De Putter (B/13811/01). BOF had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

Contributors

Laura M. S. de Putter and Ernst H. W. Koster designed the studies. Laura M. S. de Putter collected the data and conducted the statistical analysis. Laura M. S. de Putter wrote the first draft of the manuscript and Ernst H. W. Koster contributed to and has approved the final manuscript.

Disclosure Statement

All authors declare that they have no conflict of interest.

Acknowledgments

The authors would like to thank Corinna M. Elliott and Adam S. Radomsky for kindly sharing the audio scripts for the NCK induction and Laure Roeland and Jill van Put for their assistance with data collection.

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