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Attentional Biases of Vigilance and Maintenance in Obsessive-Compulsive Disorder: An Eye-Tracking Study

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Abstract

Background and objectives: Attentional biases play an important role in the development and maintenance of obsessive-compulsive disorder (OCD). Previous studies using reaction time tasks in OCD have produced inconsistent results. This is the first study to measure attentional biases in patients with several subtypes of OCD using eye tracking.

Methods: Twenty-eight patients with OCD and 21 healthy controls were assessed using a free-viewing paradigm, incorporating contamination-related, checking-related, and neutral stimuli. Attentional patterns were measured using an eye tracker. A possible vigilance bias was assessed using entry time, and a possible maintenance bias was assessed using dwell time.

Results: Patients with checking-related symptoms of OCD showed a maintenance bias but no vigilance bias in regard to checking-related compared to neutral stimuli. No differences in attention were found in patients with contamination-related symptoms.

Limitations: Internal validity is restricted due to a high overlap between subgroups, the lack of negative (not OCD-related) control stimuli, and the absence of a clinical control group.

Conclusions: Patients with checking-related symptoms of OCD showed a maintenance bias to checking-related stimuli. Due to methodological limitations, the results should be considered preliminary and should be replicated before firm conclusions can be drawn.

Keywords: Obsessive-compulsive disorder, attentional bias, eye tracking, eye movements

Introduction

Current cognitive models of obsessive-compulsive disorder (OCD) claim that OCD develops due to the misinterpretation of otherwise normal intrusive thoughts. It is presumed that this misinterpretation has several effects, such as selectively focusing attention on the intrusions themselves or on triggers in the environment (Salkovskis & McGuire, 2003). For example, patients with checking-related symptoms of OCD may scan the environment for a dangerous situation such as a fire, whereas patients with contamination-related symptoms of OCD may look for blood stains. Furthermore, keeping attention on a stimulus is thought to reflect the goal-directed system of attention (Corbetta & Shulman, 2002). This may be associated with the misinterpretation of intrusive thoughts as relevant or dangerous (Rachman, 2002; Salkovskis & McGuire, 2003). Similar to overvaluing intrusions, individuals with checking-related symptoms of OCD may overfocus on OCD-related stimuli at later stages of information processing. For example, individuals with checking-related symptoms of OCD may keep their attention on a stove to check whether it is turned off. Attentional biases in OCD are believed to increase the reoccurrence of intrusions as well as to maintain obsessional beliefs. This further motivates neutralizing behavior such as compulsive checking or washing compulsions (Salkovskis & McGuire, 2003).

For decades, reaction time (RT) tasks such as the emotional Stroop task (Williams, Mathews, & MacLeod, 1996) or the modified dot-probe paradigm (MacLeod, Mathews, & Tata, 1986) have been used to assess attentional biases in various disorders. In studies on attentional biases in OCD, the findings are inconsistent. Some studies have found evidence for attentional biases in clinical and subclinical samples of OCD (emotional Stroop task: e.g., Foa, Ilai, MCCarthy, Shoyer, & Murdoch, 1993; Rao, Arasappa, Reddy, Venkatasubramanian, & Reddy, 2010; modified dot-probe: Amir, Najmi, & Morrision, 2009; Tata, Leibowitz, Prunty, Cameron, & Pickering, 1996), but a larger number of studies did not find any difference between participants with OCD and healthy samples (emotional Stroop task: e.g., Kampman,

Keijsers, Verbraak, Näring, & Hoogduin, 2002; Kyrios & Iob, 1998; Moritz et al., 2004, 2008; van den Heuvel et al., 2005; modified dot-probe: Harkness et al., 2009). One explanation for these differing results may be that RT tasks are not reliable enough to be useful in detecting attentional biases. The modified dot-probe task has been particularly criticized for its low reliability, which makes the interpretation of previous results almost impossible (Rodebaugh et al., 2016; Waechter, Nelson, Wright, Hyatt, & Oakman, 2014).

Another limitation posed by RT tasks is that they cannot assess the underlying mechanisms of attentional biases. Two competing hypotheses regarding attentional components have been proposed (Fox, Russo, Bowles, & Dutton, 2001). The *vigilance hypothesis* proposes that individuals with anxiety disorders allocate attention to threat-relevant stimuli more quickly (attentional vigilance) and shift their attention towards threat more often at an early period of attention. The *maintenance hypothesis* suggests difficulty shifting attention away from threatening stimuli once they have been attended to. The vigilance hypothesis is associated with a stimulus-driven shift of attention that depends on sensory salience. The maintenance bias is thought to be related to a goal-directed system and thus is influenced by voluntary shifts of attention that depend on the individual's ongoing plans (Corbetta & Shulman, 2002). RT tasks cannot assess more complex and dynamic patterns of attention, whereas eye-tracking technology provides indices of continuous eye movement and offers the opportunity to assess attentional processes over a longer period of time. This makes it possible to assess the vigilance and the maintenance biases independently through continuous measurement of fixations and saccades (Weierich, Treat, & Hollingworth, 2008). The vigilance bias is usually measured by the speed of the first fixation or the amount of first fixations on threatening stimuli, whereas the maintenance bias is assessed by the amount of time looking at a threatening stimulus (dwell time). Moderate reliabilities have been found for measures of vigilance in previous studies, but measures of maintenance, especially dwell times of five seconds, have been found to show excellent reliabilities

(Waechter et al., 2014). Even though eye tracking can be used to differentiate between vigilance and maintenance, it cannot be used to assess all underlying processes. For example, it cannot measure covert processes of attention (Weierich et al., 2008). In a meta-analysis (Armstrong & Olatunji, 2012), anxious individuals (including analogue and clinical samples of OCD and post-traumatic stress disorder) oriented their gaze towards threat-related stimuli more frequently compared to non-anxious individuals, supporting the vigilance hypothesis. However, the results were mixed, with some studies showing a vigilance bias (e.g., Schofield, Johnson, Inhoff, & Coles, 2012; Stevens, Rist, & Gerlach, 2011) and some studies reporting no difference in first fixations between the anxious and non-anxious groups (e.g., Fernandes et al., 2017; Liang, Tsai, & Hsu, 2017). Findings regarding the maintenance hypothesis in anxiety disorders are mixed, with some studies showing longer dwell times (e.g., Lazarov, Abend, & Bar-Haim, 2016; Liang et al., 2017) and others finding no difference between groups (e.g., Fernandes et al., 2017; Schofield et al., 2012).

Only a small number of eye-tracking studies have investigated selective attention in accordance with the cognitive model of OCD (Salkovskis & McGuire, 2003), and these have produced mixed results (Armstrong, Olatunji, Sarawgi, & Simmons, 2010; Armstrong, Sarawgi, & Olatunji, 2012; Bradley et al., 2016). One study found a vigilance bias in participants with subclinical contamination fears (Armstrong et al., 2012). In this study, participants high in contamination fear more often oriented their gaze during initial fixations on contamination-related pictures compared to participants low in contamination fear when viewing a stimulus array containing contamination-related, general threat, neutral, and pleasant pictures. Two studies found evidence for a maintenance bias but not a vigilance bias. However, the study of Armstrong et al. (2010) incorporated facial expressions rather than OCD-related pictures. Participants high in contamination fears maintained their gaze for a longer time on disgusted and fearful facial expressions. In a study by Bradley et al. (2016), the severity of OC symptoms in a non-clinical sample predicted a higher frequency and duration

of fixation on OCD-related images (checking, washing, ordering, hoarding) but not on aversive (not OCD-related) or neutral images (Bradley et al., 2016). Even though these studies on subclinical OCD were important first steps in the assessment of attentional biases, no study has assessed *patients* with OCD in an eye-tracking experiment.

One challenge in assessing attentional biases in OCD is the heterogeneity of the disorder. The stimuli eliciting concerns in individuals can be idiosyncratic in nature but can roughly be classified into several subtypes: contamination and washing, checking, and hoarding, as well as symmetry and ordering (e.g., Mataix-Cols, Conceicao do Rosario-Campos, & Leckman, 2005). Two of the three previous studies have been limited to assessing one subtype of OCD (contamination symptoms; Armstrong et al., 2010; Armstrong et al., 2012) However, the vast majority of patients display symptoms of more than one subtype, and evidence supporting a specificity effect in attentional biases in OCD is lacking (Pergamin-Hight, Naim, Bakermans-Kranenburg, van IJzendoorn, & Bar-Haim, 2015). Individuals with checking-related symptoms do show some unique characteristics; for example, they have an inflated sense of responsibility for harm (Foa, Sacks, Tolin, Prezworski, & Amir, 2002) and a higher guilt sensitivity (Melli, Carraresi, Poli, Marazziti, & Pinto, 2017). To account for this difference between the different subtypes, interventions have recently been developed to target distinctive features inherent in individuals with checking-related symptoms of OCD (Alcolado & Radomsky, 2016; Radomsky, Shafran, Coughtrey, & Rachman, 2010). However, more research is necessary to test whether these interventions are superior to more established psychotherapies.

The aim of the present study was to assess the vigilance and maintenance bias in patients with several subtypes of OCD using eye-tracking technology. The study was designed to assess whether an attentional bias is specific to each subtype of OCD or is instead a general bias to OCD-related material. Therefore, patients with various subtypes of OCD, including patients with contamination-related and checking-related symptoms of OCD, were

assessed as well as a healthy control group. Furthermore, to enhance ecological validity compared to one of the previous studies (Armstrong et al., 2010), OCD-related pictures (contamination- and checking-related) were used. A free-viewing paradigm was implemented because the most robust findings for the vigilance and maintenance hypothesis in anxiety disorders have been achieved using free-viewing tasks (Armstrong & Olatunji, 2012). In line with the cognitive model of OCD (Salkovskis & McGuire, 2003) and with previous eye-tracking studies in subclinical samples of OCD, sub-type specific attentional biases were hypothesized. Namely, it was hypothesized that patients with contamination-related symptoms of OCD would look at contamination-related stimuli more quickly (vigilance bias) and for longer (maintenance bias) than would healthy controls and that patients with checking-related symptoms of OCD would show a vigilance bias and a maintenance bias for checking-related material.

Methods

Participants

Twenty-eight patients with OCD were recruited in the context of a larger study (Külz et al., 2014). Recruitment was conducted through OCD and anxiety wards of psychiatric clinics, psychotherapists seeing patients on an outpatient basis, disorder-specific online fora, and newspaper advertisements. Participants were excluded if they were younger than 18 or older than 70 years or had been diagnosed with any severe neurological disorder (e.g., stroke, epilepsy), mania, psychotic disorder, borderline personality disorder, current severe depressive episode, acute suicidality, current substance or alcohol dependence, or mental retardation (IQ < 70).

The diagnosis of OCD and possible comorbidity was assessed using the Mini International Neuropsychiatric Interview (M.I.N.I.; Sheehan et al., 1998). As the M.I.N.I does not assess specific phobia, the section on specific phobia of the Structured Clinical Interview for DSM-IV-TR (SCID) was also administered (First, Spitzer, Gibbon, & Williams, 2002). To

classify patients into the two subgroups (contamination and checking) and to assess the severity of the OC symptoms, the German version of the Yale-Brown Obsessive Compulsive Scale (Y-BOCS; Hand & Büttner-Westphal, 1991) was used (see below). To assess the distress caused by OC symptoms the Obsessive Compulsive Inventory Revised (OCI-R; Gönner, Leonhart, & Ecker, 2007) was used (see below).

Twenty-two participants served as healthy controls and were comparable as to age, gender, and education relative to the entire OCD sample (see Table 1) as well as to patients with contamination-related symptoms of OCD, *p*s > .37, and patients with checking-related symptoms of OCD, *p*s > .25. Additional exclusion criteria for healthy controls were a lifetime diagnosis of OCD or of any current psychiatric diagnosis, which was verified with the M.I.N.I. The study was approved by the Ethics Committee of the Freiburg University Medical Center. All participants gave written informed consent prior to study participation. The required sample size for the main analyses was calculated using G*Power (Faul, Erdfelder, Buchner, & Lang, 2009). Based on the study by Armstrong et al. (2012), we used an effect size of partial $\eta^2 = 0.08$ for our calculations. To achieve 95% test-power at an error rate of $\alpha = .05$ with a partial $\eta^2 = 0.08$ and an assumed correlation of $r = 0.70$, the power analysis revealed a total of 20 necessary participants for each group.

Patients with OCD and healthy controls did not differ on any of the demographic variables. As expected, OCD patients scored significantly higher on all relevant psychopathological ratings, including OC symptoms and depressive symptoms (see Table 1). Based on the Y-BOCS checklist, four patients affirmed having only checking-related symptoms of OCD and six patients affirmed having only contamination-related symptoms. Fourteen patients showed both contamination-related as well as checking-related symptoms of OCD. The remaining four patients showed additional symptoms of OCD, for example, aggressive or sexual obsessions or repeating rituals. Therefore, the subgroups consisted of 20 patients with contamination-related symptoms of OCD and 18 patients with checking-related

symptoms of OCD. The subgroup with checking-related symptoms was similar to the subgroup with contamination-related symptoms in regard to demographic and psychopathological scores (see Table 1). However, the two subgroups could not be statistically compared due to the high overlap between them. Fifteen patients fulfilled at least one comorbid diagnosis based on the M.I.N.I. and the SCID section for specific phobia (major depression: n = 8, dysthymia: n = 5, panic disorder: n = 2, agoraphobia: n = 4, social anxiety disorder: n = 2, generalized anxiety disorder: n = 2, specific phobia: n = 3). Fourteen patients reported no use of psychopharmacological medication. The remaining patients stated that they used one antidepressant (n = 10) or a combination of an antidepressant and a neuroleptic agent (n = 4).

----- Please insert Table 1 about here -----

Measures

The Yale-Brown Obsessive Compulsive Scale (Y-BOCS; Hand & Büttner-Westphal, 1991) is a semi-structured interview consisting of two parts. The symptom checklist asks for the occurrence of past and present symptoms of obsessions and compulsions and was used to separate patients into the two subgroups. Factor analyses revealed that whereas cleaning and contamination items load on one factor, checking compulsions load on the same factor as, for example, sexual, religious, and somatic obsessions (Bloch, Landeros-Weisenberger, Rosario, Pittenger, & Leckman, 2008). Therefore, all items relating to contamination obsessions, washing, or cleaning compulsions were classified as contamination-related symptoms of OCD, whereas only the item "Checking locks, stove, appliances etc." was classified as checking-related symptoms of OCD in this study. Less specific items (e.g., checking that nothing terrible did/will happen) were discarded because of their high overlap with other factors of OCD (Bloch et al., 2008). Patients could be classified with both checking-related and contamination-related symptoms, which led to an overlap between the two subgroups. The

second part of the interview served to assess the severity of the patients' obsessions and compulsions. The German version of the Y-BOCS has shown good internal consistency and inter-rater reliability (Jacobsen, Kloss, Fricke, Hand, & Moritz, 2003).

The OCI-R (Gönner, Leonhart, & Ecker, 2007) is a self-report measure comprising a total score and the following six subscales: washing, checking and doubting, obsessing, mental neutralizing, ordering, and hoarding. The scale assesses distress caused by OC symptoms and shows good validity and excellent reliability on all but the neutralizing subscales (Gönner, Leonhart, & Ecker, 2008).

Because depression is a common comorbidity of OCD, the severity of depressive symptoms was assessed using the Beck Depression Inventory (BDI-II; Kühner, Bürger, Keller, & Hautzinger, 2007).

Free-Viewing Task

The free-viewing task consisted of viewing pictures with OCD-related (checking- and contamination-related) and neutral content. For the expert rating of stimuli, pictures were chosen from the International Affective Picture System (Lang, Bradley, & Cuthbert, 1999) and the Berlin Obsessive Compulsive Disorder-Picture Set (Simon, Kischkel, Spielberg, & Kathmann, 2012) and were complemented by pictures from flickr.com used in prior studies on OCD (Moritz, von Mühlenen, Randjbar, Fricke, & Jelinek, 2009) and smoking (Wittekind, Feist, Schneider, Moritz, & Fritzsche, 2015). Ten psychologists with expertise in diagnosing and treating OCD rated the pictures according to the following criteria: relevance for checking- and contamination-related OCD, personal valence, and amount of details depicted. Twenty pictures that were high on OCD relevance (contamination- and checking-related) with a range of scores in valence and 20 that were low in OCD relevance and neutral in valence were selected for the free-viewing task. For an overview of the expert rating, see Table 2, and for examples of the pictures used in the free-viewing task, see Table 3. Efforts were undertaken to match the pictures according to the amount of details they presented. All of the

pictures were fitted to the same size. The free-viewing task involved the presentation of 20 trials. Each trial consisted of a slide containing two pictures, with one picture presented on the right side and one on the left side of a computer screen. In the "checking" slides (n = 10), one picture was related to checking-related symptoms of OCD (e.g., a key lying in the grass), and in the "contamination" slides (n = 10), one picture was related to the contamination-related symptoms of OCD (e.g., a toilet). The second picture on all slides was of neutral content. In half of the trials, the OCD images were presented on the left side of the screen, and in the other half they were presented on the right side of the screen. Two parallel versions were created in which neutral and OCD-related pictures were counterbalanced by side. The entry time served as a measure of the location of the first glance in the free-viewing task because lower entry times in one area of interest indicated that the particular picture was the first that was looked at. This is in line with previous studies testing vigilance biases in anxiety disorders (Armstrong & Olatunji, 2012). Table 4 shows internal consistencies (Cronbach's α) for each Relevance x Stimulus Type combination (OCD, neutral pictures on contamination- and checking-related trials) for each dependent variable (entry time and dwell time). Internal consistencies for each trial type varied between unacceptable and good but were acceptable or good in patients with OCD. The results are comparable to internal consistencies that have been described in previous eye-tracking studies in anxiety disorders (Waechter et al., 2014).

----- Please insert Tables 2 and 3 about here -----

Procedure

The eye-tracking experiment followed the demographic and psychopathological assessment. Participants placed their chin in a chin rest, with their forehead touching a crossbar. The chin rest was positioned so the eyes were 50 cm away from a 22-inch widescreen monitor (Dell P2213). Pictures were presented against a white background using SensoMotoric Instruments' Experiment Center™ software (version 3.5.169) with a resolution

of 1680 x 1050 pixels (32 bit), and a refresh rate of 59 Hz. Eye movements were recorded using the iViewX RED-II system from SensoMotoric Instruments, with a sampling rate of 120 Hz and a spatial resolution of approximately < 0.5°. The eye-tracking procedure started with a calibration and validation. Before the free-viewing task began, participants were told that the eye-tracking cameras would measure pupil dilation during the task. This was done to conceal the recording of the gaze in order to reduce demand effects (Armstrong et al., 2010). The slides were presented to each participant for a duration of five seconds each and in random order. During the stimulus presentation, participants were asked to look at the pictures without further instructions or constraints. The intertrial interval was two seconds, during which the participants were asked to look at a fixation cross in the middle of the screen.

After completing the free-viewing task, participants were asked to rate the presented pictures by valence and OCD-relevance ("For me personally, the picture is . . .") on a scale consisting of "positive and relevant for my obsessions or compulsions," "positive," "neutral," "negative", and "negative and relevant for my obsessions or compulsions." After the rating, participants were debriefed and told that not only their pupil dilation but also their gaze direction had been recorded.

----- Please insert Table 4 about here -----

Eye Movement Data Reduction and Data Analysis

The standard settings of BeGaze 3.5.101 software from SensoMotoric Instruments, were used to define eye movement events. Fixations were classified as having a minimum duration of 80 ms and a maximal dispersion of 100 pixels. The OCD-related and neutral picture on each slide were each defined as one area of interest. Trials were excluded if the gaze was not directed at the fixation target at the picture onset, if the gaze moved away from the fixation region within 80 ms of picture onset, or if no eye movements occurred during the trial (Armstrong et al., 2010). Due to technical issues, data from one healthy participant was

not recorded in the eye-tracking experiment. First, two 2 Picture Type (OCD-related, neutral) x 2 Group (patients, healthy controls) repeated measures ANOVAs were conducted for entry time and dwell time that compared the entire OCD sample to healthy controls. Second, similar repeated measures ANOVAs were computed separately for entry time and dwell time for the two subgroups of patients (patients with contamination-related symptoms of OCD and patients with checking-related symptoms of OCD) compared to the healthy controls using the respective subtype-specific slides (i.e., ten contamination slides in analysis assessing patients with contamination-related symptoms of OCD and ten checking slides for patients with checking-related symptoms of OCD). Pearson correlations were computed within each subgroup (patients with contamination-related symptoms and patients with checking-related symptoms of OCD) to investigate the association of attentional biases with scores on the Y-BOCS and the subtype-specific subscales of the OCI-R. Effect sizes for the ANOVA results were expressed as follows: $\eta_p^2 \approx .01$, representing a weak effect, $\eta_p^2 \approx .06$, representing a medium effect, and $\eta_p^2 \approx .14$, representing a large effect.

Results

Ratings of the Stimuli

In order to analyze group differences in ratings of the stimuli, a repeated measures ANOVA with Group (patients, healthy controls) as the between-subject factor and Stimulus Type (contamination-related, checking-related, neutral) as the repeated factor was conducted. The main effects of Stimulus Type and Group were significant but were modified by a significant Stimulus Type x Group interaction, $F(2, 47) = 6.69$, $p = .003$, $\eta_p^2 = .22$. Follow-up t-tests (Bonferroni-corrected) revealed that patients rated both contamination- and checking-related pictures, but not neutral pictures, as more negative and more relevant to their OC symptoms than did the healthy control group (see Table 5). To assess the specific ratings of each subgroup of patients, paired-samples t-tests were used. Both subgroups of patients rated contamination- and checking-related stimuli as more relevant to their OC symptoms and more

negative compared to neutral stimuli, *p*s < .003. The amount of contamination-related and checking-related stimuli rated as relevant to OC symptoms did not differ (*p*s > .22) for patients with contamination-related symptoms (contamination: *M* = 4.20, *SD* = 2.69; checking: *M* = 3.30, *SD* = 2.68) nor for patients with checking-related symptoms (contamination: *M* = 3.44, *SD* = 2.94; checking: *M* = 4.00, *SD* = 3.22). However, only patients with contamination-related symptoms of OCD rated contamination-related stimuli (*M* = 4.15, *SD* = 0.48) as more negative than checking-related stimuli (*M* = 3.62, *SD* = 0.58), *t*(19) = 3.95, *p* = .001, *d* = 0.88, whereas patients with checking-related symptoms did not differ in their ratings of contamination-related (*M* = 4.06, *SD* = 0.58) and checking-related stimuli (*M* = 3.84, *SD* = 0.67), *t*(17) = 1.12, *p* = .28, *d* = 0.27. Notably, all but four patients showing checking-related symptoms also reported contamination-related symptoms of OCD.

----- Please insert Table 5 about here -----

Error Rates

Trials in which invalid first fixations occurred (i.e., the gaze was not directed at the fixation target during picture onset or the gaze moved away from the fixation region within 80 ms of picture onset) were removed (OCD patients: 2.95% of trials; healthy controls: 3.57%). No trials occurred in which the participants fixated on neither of the pictures presented. Notably, in previous studies using eye tracking in OCD, the percentages ranged between 5% and 11% (Armstrong et al., 2010, 2012).

Attentional Bias in All Patients Combined

The ANOVA analyzing the vigilance bias using entry time data from all patients compared to healthy controls revealed a significant main effect of Stimulus Type, $F(1,47) = 5.04$, $p = .030$, $\eta_p^2 = .10$, but no main effect of Group or a Group x Stimulus Type interaction (all other *p*s > .14). Follow-up t-tests showed a quicker entry time for OCD-related than for

neutral pictures, $t(48) = 2.45$, $p = .02$, $d = 0.35$. Similarly, when analyzing the maintenance bias using dwell time, a main effect of Stimulus Type emerged, $F(1,47) = 13.63$, $p = .001$, $\eta_p^2 = .23$. The main effect of Group and the Group x Stimulus Type interaction was not significant (all other *p*s > .30). Follow-up t-tests showed a longer dwell time for OCD-related pictures than for neutral pictures, $t(48) = 3.87$, $p < .001$, $d = 0.56$.

Subtype-Specific Attentional Biases

With regard to our hypothesis that patients with contamination-related symptoms of OCD would show a vigilance bias of subtype-specific material by quicker orientation towards contamination-related compared to neutral material, an ANOVA analyzing average entry times of patients with contamination-related symptoms of OCD and healthy controls showed no significant main effect or interaction (all *p*s > .12). When analyzing data assessing a potential maintenance bias (i.e., a longer dwell time) in patients with contamination-related symptoms and healthy controls, a significant main effect of Stimulus Type emerged, $F(1,46) = 5.76$, $p = .02$, $\eta_p^2 = 1.11$. Follow-up t-tests showed a longer dwell time for neutral compared to contamination-related pictures, $t(47) = 2.19$, $p = .02$, $d = 0.52$. However, neither the main effect for Group nor the postulated interaction of Stimulus Type x Group was significant (*p*s > .27).

The ANOVA assessing entry times of patients with checking-related symptoms of OCD and healthy controls did not reveal any significant main effects or interactions (all *p*s > .19). The ANOVA computing maintenance bias using dwell times from patients with checking-related symptoms of OCD and healthy controls revealed a significant main effect of Stimulus Type, $F(1,37) = 17.36$, $p < .001$, $\eta_p^2 = .32$. Most importantly, the expected Stimulus Type x Group interaction was significant, $F(1,37) = 4.87$, $p = .034$, $\eta_p^2 = .12$, with a medium to large effect. Bonferroni-corrected follow-up t-tests ($\alpha = .025$) showed that patients with checking-related symptoms maintained their gaze significantly longer on checking-related ($M = 2333.05$, $SD = 466.15$) compared to neutral material ($M = 1846.36$, $SD = 319.92$), $t(17) =$

3.42, $p = .003$, $d = 0.93$, with a large effect. Healthy participants did not show a difference in dwell time between checking-related ($M = 2145.39$, $SD = 370.94$) and neutral stimuli ($M = 1995.61$, $SD = 383.15$), $t(20) = 2.09$, $p = .05$, $d = 0.46$.

Correlational Analyses

No significant correlation emerged for either subgroup of patients (those with contamination-related or checking-related symptoms of OCD) between attentional bias scores (difference between contamination-related or checking-related and neutral stimuli for entry and dwell time) and the Y-BOCS scores or the relevant subscale (contamination or checking) on the OCI-R, rs < .14, ps > .20.

Discussion

The aim of this study was to assess attentional biases in patients with several subtypes of OCD using a free-viewing paradigm. A representative sample of treatment-seeking individuals with OCD was included. Patients with different symptoms were recruited in order to assess whether attentional biases are specific for two prevalent subtypes of OCD or reflect a general tendency in OCD to quickly direct attention to or dwell longer on OCD-related stimuli. Two subgroups were formed to assess whether different subtypes of OCD (contamination, checking) would show attentional biases for subtype-specific stimuli. Because most patients showed both contamination-related and checking-related symptoms, the two subgroups overlapped substantially; however, this pattern is typical of clinical OCD samples, which show various different compulsions. Consistent with the cognitive model of OCD (Salkovskis & McGuire, 2003) and in line with the results of previous eye-tracking studies on attentional biases in non-clinical samples of OCD (Armstrong et al., 2010, 2012; Bradley et al., 2016), we hypothesized that patients with contamination-related symptoms of OCD would show both a vigilance bias and a maintenance bias for contamination-related material and that patients with checking-related symptoms of OCD would show both a vigilance bias and a maintenance bias for checking-related material.

New Insights

The overall sample of patients with OCD showed neither a vigilance bias nor a maintenance bias in regard to OCD-related material compared to healthy controls. This may indicate that patients with OCD do not show a general attentional bias in relation to OCD-related stimuli. Furthermore, both, OCD as well as healthy participants turned their attention to OCD-related pictures more quickly and looked longer than they did with neutral pictures. This is in line with previous studies that have indicated that both unpleasant and pleasant pictures capture attention (e.g., Niu, Todd, & Anderson, 2012; Nummenmaa, Hyönä, & Calvo, 2006).

Neither patients with contamination-related symptoms of OCD nor patients with checking-related symptoms of OCD showed a vigilance bias for subtype-specific material. This is in line with most previous studies assessing subclinical OCD samples using eye-tracking technology (Armstrong et al., 2010; Bradley et al., 2016). In addition, patients with contamination-related symptoms of OCD did not show a maintenance bias when viewing contamination-related pictures. However, as hypothesized, patients with checking-related symptoms of OCD maintained their gaze longer on checking-related pictures compared to neutral pictures. Healthy controls also viewed checking-related pictures longer, with a medium effect size. However, this effect did not reach significance. One possible explanation for the difference between the two subtypes could be that checking-related stimuli (e.g., a fire or injuring others) may present a more urgent threat than contamination-related stimuli (e.g., a deadly disease such as AIDS). Thus, whereas patients with contamination-related symptoms may be able to ignore a stimulus, patients with checking-related symptoms may feel the urge to maintain attention on the checking-related stimulus to prevent immediate harm. Similarly, in individuals with subclinical fear of spiders, a maintenance bias was only found in an experiment using a real, live tarantula (Lange, Tierney, Reinhardt-Rutland, & Vivekananda-Schmidt, 2004) but not in those using mere images of spiders (e.g., Rinck & Becker, 2006).

However, due to several limitations, the results of this study should be interpreted very cautiously and considered preliminary.

Limitations

Several limitations need be considered. The internal validity is restricted for several reasons: the overlap between subtypes, the presentation of checking-related and contamination-related stimuli within the same experiment, and the lack of inclusion of a clinical control group or of negative control stimuli. First, most of the patients in this study showed both contamination-related as well as checking-related symptoms of OCD. On the one hand, including these patients enhances external validity as the majority of patients, especially patients with a chronic course of OCD, typically report symptoms from several subtypes and are more likely to report contamination-related symptoms of OCD (Subramaniam, Abdin, Vaingankar, & Chong, 2012; Visser, Van Oppen, Van Megen, Eikelenboom, & Van Balkom, 2014). On the other hand, this poses a threat to internal validity because it is possible that attentional biases are attributable not to the subtype but to other factors, such as the simultaneous occurrence of both subtypes. Moreover, as no data is available to assess whether checking-related or contamination-related symptoms are dominant for each patient, it is not possible to differentiate whether an attentional bias occurred in patients with checking-related symptoms because it was the dominant subtype or because the checking subtype has unique characteristics. Furthermore, as contamination concern or washing compulsions may not have been predominant in patients with contamination-related symptoms, no firm conclusions can be drawn about the absence of attentional biases in this subgroup. Second, both contamination-related and checking-related pictures were presented randomly within the same experiment. This probably also enhances external validity, as stimuli from both subtypes are usually present at the same time. For example, when a person enters a kitchen, he/she can look either at checking-related stimuli such as the stove or the window handle or at contamination-related stimuli such as rags or dish detergents. However,

because the pictures were analyzed separately for the two subgroups it cannot be ruled out that the context influenced the results. Another limitation is that no negative (OCD-irrelevant) items were included as control stimuli. Therefore, it is not possible to differentiate whether the attentional bias in patients with checking-related symptoms of OCD is specific to checking-related material or rather a general bias towards negative stimuli in general. Third, control groups such as patients with only one subtype of OCD or an anxiety disorder were not included. Thus, it remains unclear whether the attentional bias found in patients with checking-related symptoms is specific to that group. The inclusion of patients with an anxiety disorder and general measures of anxiety may be especially help in assessing the specificity of effects and in further supporting the differentiation between anxiety disorders and OCD in the *DSM-5* (American Psychiatric Association, 2013).

Another limitation related to the selection of patients is the difference in the number of items used for the allocation of the participants into the two subgroups. The two subtypes were differentiated according to items on the Y-BOCS checklist. To account for the lack of specificity of some of the items assessing checking compulsions, patients with checking-related symptoms of OCD were selected according to the only item specific to checking compulsions, which states, "Checking locks, stove, appliances etc." Patients with contamination-related symptoms were selected according to the category of contamination obsessions and washing compulsions on the Y-BOCS. Items include, for example, "Excessive concern with animals (e.g., insects)" or "Excessive ritualized handwashing." Even though the category for selecting patients with contamination-related symptoms of OCD was broader, this subgroup rated contamination-related stimuli as more negative than checking-related or neutral stimuli. Patients with checking-related symptoms only rated checking-related stimuli as more negative than neutral; they did not do so for contamination-related stimuli. This lack of specificity in explicit ratings is another limitation and should be further assessed in future studies.

Challenges Faced

The limitations discussed above occurred due to certain challenges specific to the research of OCD. OCD is a heterogeneous disorder; the content of the obsessions and the rituals performed to reduce distress may vary widely among individuals with OCD (Abramowitz & Jacoby, 2015; Hirschtritt, Bloch, & Mathews, 2017). The heterogeneity of symptoms poses a challenge for the selection of stimuli and participants. Previous research has mostly focused on the investigation of only one subtype without including stimuli from other subtypes (e.g., Armstrong et al., 2010). With such research designs, the question of specificity remains unanswered.

Another challenge posed when assessing attentional biases is the reliability of the tasks. Eye-tracking studies are probably more reliable than RT tasks to assess attentional biases (Waechter, Nelson, Wright, Hyatt, & Oakman, 2014), but the reliability of eye-tracking tasks in OCD and anxiety disorders is not well established. None of the previous studies that have assessed attentional biases using eye tracking in OCD reported reliability scores (Armstrong et al., 2010, 2012; Bradley et al., 2016).

Solutions

Several measures have been undertaken to account for some of the challenges faced in this study, but because this is the first study to assess attentional biases in patients with OCD using eye tracking, not all issues could be accounted for, and they therefore remain as limitations and are incorporated in our suggestions for future studies.

Because of the heterogeneity of the disorder, this study provides an important extension of the assessment of attentional biases in OCD by simultaneously including several types of stimuli relevant to different subtypes. However, even when assessing certain subtypes, symptoms can vary from patient to patient because obsessions and compulsions are idiosyncratic in nature. For example, contamination obsessions range from a feeling of disgust with bodily waste to repetitive concerns over spreading illnesses. Contamination-related

compulsions can include excessively washing one's hands but also wiping down all groceries brought into the kitchen. Obsessions and compulsions of individuals with checking-related symptoms can be similarly varied. They may feel anxiety that the stove is not turned off, which could cause a fire, but may also worry about losing their keys. Similarly, checking compulsions can vary from repeatedly checking locks and appliances to listening to the news to check that no fire had been caused (Abramowitz & Jacoby, 2015; Hirschtritt et al., 2017). To account for the overlap in symptoms and the difference in the content of obsessions and compulsions, future studies should use idiosyncratic material. To enhance internal validity, patients with only one subtype should be included. However, this approach is not free of problems because the results would not be applicable to clinical samples, which usually show more than one subtype. Another possibility to increase internal validity and to keep external validity high would be to assess which subtype is dominant for each patient and analyze the data according to the dominant subtype.

Our study is the first to assess the reliability of eye tracking in OCD. Unfortunately, the reliability scores in our study were only moderate. One study systematically assessed reliabilities of eye tracking in participants who were high and low in social anxiety and found low reliability scores for first-fixation scores and excellent scores for dwell times of at least five seconds (Waechter et al., 2014). The difference in our reliability scores may be attributable to the larger amount of stimuli in each category ($n = 10$ in our study compared to $n = 24$ in Waechter et al., 2014). In the free-viewing paradigm, random attentional patterns can reduce internal consistencies. This assumption is supported by the fact that reliability scores are higher in patients with OCD, which reflects a more consistent viewing pattern compared to healthy controls. Thus, our study underlines a problem inherent in attentional bias research. For an overview of the difficulties posed by unreliable measures of attentional biases, see Rodebaugh et al. (2016). Future eye-tracking studies should report reliability scores and include measures to adapt the eye-tracking methodology to enhance reliabilities

(Waechter et al., 2014). Reliabilities could also be increased by using idiosyncratic material. In the case of attentional biases, patients would be expected to show a consistent viewing pattern, which would increase internal consistencies.

Conclusion

This is the first study that uses eye-tracking technology to assess attentional biases in patients with OCD, including patients with checking-related and contamination-related symptoms of OCD. An attentional bias was only found in patients with checking-related symptoms of OCD, who gazed longer at subtype-specific compared to neutral pictures (maintenance bias). Results must be regarded as preliminary because the internal validity is restricted due to the high overlap between groups. Future studies should undertake measures to enhance internal validity, for example, by using idiosyncratic material and assessing dominant subtypes of OCD. Furthermore, to test whether an attentional bias is specific to checking-related symptoms of OCD, anxious control groups as well as negative (not OCD-related) stimuli should be included.

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Table 1

Demographic and Psychopathological Data: Mean (standard deviation) or frequency.

	OCD Patients (n = 28)	Healthy Controls (n = 22)	Statistics (comparison between patients and healthy controls)	Patients with checking-related symptoms of OCD (n = 18)	Patients with contamination-related symptoms of OCD (n = 20)
Demographic characteristics					
Age	39.29 (13.81)	40.09 (15.03)	$t(48) = 0.20$, $p = .85$	42.28 (15.32)	40.95 (14.19)
Education (years)	16.06 (3.11)	16.60 (2.84)	$t(47) = 0.64$, $p = .53$	15.24 (3.27)[c]	16.08 (3.42)[f]
Sex (m/f)	8/20	9/13	$\chi^2(1) = 0.84$, $p = .39$	(5/13)	(5/15)
Psychopathology					
Y-BOCS total	21.43 (6.74)	-	-	23.50 (6.00)	23.45 (5.78)
Y-BOCS obsessions	9.96 (3.56)	-	-	10.67 (3.85)	10.95 (2.95)
Y-BOCS compulsions	11.46 (4.00)	-	-	12.83 (2.75)	12.50 (3.43)
OCI-R total	24.32 (11.90)[a]	6.68 (6.37)	$t(45) = 6.21$, $p < .001$	29.94 (10.21)[d]	25.42 (12.20)[f]
OCI-R washing	4.76 (3.97)[a]	0.90 (1.77)	$t(45) = 4.19$, $p < .001$	6.06 (3.97)[d]	5.89 (3.78)[f]
OCI-R obsessing	5.40 (2.92)[a]	0.68 (1.25)	$t(45) = 7.04$, $p < .001$	5.63 (2.94)[d]	5.26 (3.12)[f]
OCI-R hoarding	2.29 (2.60)[b]	2.40 (2.68)	$t(44) = 0.15$, $p = .88$	2.87 (2.50)[e]	2.11 (2.37)[g]
OCI-R ordering	5.16 (4.34)[a]	1.27 (1.86)	$t(45) = 3.90$, $p < .001$	5.81 (3.92)[d]	5.11 (4.45)[f]
OCI-R checking	5.63 (4.13)[b]	1.36 (1.65)	$t(44) = 4.52$, $p < .001$	8.13 (3.04)[e]	5.89 (4.27)[g]
OCI-R neutralizing	1.79 (2.67)[a]	0.09 (0.29)	$t(45) = 2.97$, $p < .001$	2.60 (3.09)[e]	2.06 (2.86)[g]
BDI-II total	19.86 (9.36)[a]	5.00 (6.36)	$t(45) = 6.28$, $p < .001$	23.16 (9.00)[d]	20.08 (10.32)[f]

Note: m = male. f = female. OCD = Obsessive-Compulsive Disorder, WST = Test of Word Power, Y-BOCS = Yale Brown Obsessive Compulsive Scale, OCI-R = Obsessive-Compulsive Inventory Revised, BDI-II = Beck Depression Inventory-II, MINI = Mini International Neuropsychiatric Interview, SCID = Structured Clinical Interview for DSM-IV-TR.

[a] based on n = 25, [b] based on n = 24, [c] based on n = 17, [d] based on n = 16, [e] based on n = 15, [f] based on n = 19, [g] based on n = 18

Table 2

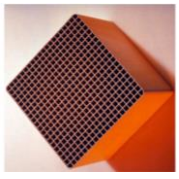
Range, Means and Standard Deviations of Expert Picture Ratings used in the Free Viewing Task.

Type of stimulus	Min – Max	*M* (*SD*)
OCD-relevance *(1 = very much to 4 = not at all)*		
Checking-related pictures	1.00 - 1.90	1.29 (0.29)
Contamination-related pictures	1.20 – 2.00	1.45 (0.29)
Neutral Pictures	2.30 – 4.00	3.62 (0.33)
Valence *(1 = very positive to 5 = very negative)*		
Checking-related pictures	2.90 - 4.30	3.43 (0.45)
Contamination-related pictures	2.80 - 4.50	3.91 (0.49)
Neutral Pictures	2.00 – 3.30	2.88 (0.31)
Details *(1 = many to 4 = none)*		
Checking-related pictures	1.90 – 3.00	2.41 (0.36)
Contamination-related pictures	1.40 – 3.10	3.91 (0.49)
Neutral Pictures	1.70 – 3.70	2.89 (0.57)

Note: OCD = Obsessive-Compulsive Disorder

Table 3

Examples of the Pictures Used in the Free Viewing Paradigm[1]*. OCD-related Pictures (left) are depicted with the Neutral Picture (right) shown on the same slide*

Contamination Neutral				
	(Simon et al., 2012)	(Wittekind et al., 2015)	(Simon et al., 2012)	(Wittekind et al., 2015)
				
	(Simon et al., 2012)	(Wittekind et al., 2015)	(Simon et al., 2012)	(Wittekind et al., 2015)
				
	(Simon et al., 2012)	(Lang, Bradley, & Cuthbert, 1999b)	(Simon et al., 2012)	(Wittekind et al., 2015)
Checking Neutral				
	(Simon et al., 2012)	(Lang et al., 1999b)	(Simon et al., 2012)	(130921_Bregenz _A 34 from weisserstier)
				
	(Simon et al., 2012)	(Lang et al., 1999b)	(Simon et al., 2012)	(Wittekind et al., 2015)
				

[1] The first author will gladly provide the remaining pictures upon request.

	(Simon et al., 2012)	(Lang et al., 1999b)	(Simon et al., 2012)	(Macbook Tasche von Waterkant Deichkönig from Sebastian Michalke)[3]

Note: [2]130921_Bregenz_A_34 by weisserstier, 2013
[https://www.flickr.com/photos/alfreddiem/10407980554/in/photolist-gRHC1A]
[3]Macbook Tasche von Waterkant Deichkönig, by Sebastian Michalke, 2013
[https://www.flickr.com/photos/56093900@N03/10950014856/in/photolist-hFBo1X-hFCBsc-hFCdD7-hFBG1q-hFCduj-hFBFVA]

Table 4

Internal Consistencies (Cronbach´s α) for Each Combination of Stimulus Type, OCD Relevance and Entry vs. Dwell Time in the Free-Viewing Paradigm

Dependent Variable	Stimulus Type	Relevance	Cronbach's α		
			Total sample	Patients	Healthy Controls
Entry	Contamination	OCD	α = .64	α = .65	α = .74
Entry	Contamination	Neutral	α = .64	α = .72	α = .70
Entry	Checking	OCD	α = .61	α = .59	α = .49
Entry	Checking	Neutral	α = .48	α = .67	α = .49
Dwell	Contamination	OCD	α = .59	α = .74	α = - .20
Dwell	Contamination	Neutral	α = .73	α = .81	α = .23
Dwell	Checking	OCD	α = .69	α = .74	α = .25
Dwell	Checking	Neutral	α = .25	α = .50	α = .47

Table 5

Means and Standard Deviations of Explicit Picture Ratings as a Function of Group and Stimulus Type (1= positive and relevant for my obsessions or compulsions, 2 = positive, 3 = neutral, 4 = negative, 5 = negative and relevant for my obsessions or compulsions)

Stimulus type	Group		Statistics
	OCD	Healthy controls	
Neutral	2.81 (0.28)	2.69 (0.17)	$t(48) = 1.67$, $p = .10$
OCD contamination-related	3.94 (0.58)	3.32 (0.25)	$t(48) = 4.65$, $p < .001$
OCD checking-related	3.65 (0.62)	3.14 (0.21)	$t(48) = 3.71$, $p = .001$

Note. OCD = obsessive-compulsive disorder.