Motivation and Emotion (2024) 48:51–65
https://doi.org/10.1007/s11031-023-10054-x

ORIGINAL PAPER

A sight for sore eyes? Attention allocation to obsession-provoking stimuli and stimuli reflecting compulsion completion

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Accepted: 9 December 2023 / Published online: 16 December 2023

Abstract
Research on attention allocation in OCD has exclusively used obsession-provoking threat stimuli, showing sustained attention over neutral ones. Recently, however, a study contrasting neutral stimuli with stimuli depicting the completion of compulsive acts (end-states stimuli), which is associated with a reduced anxiety (negative reinforcement), showed similar results. Yet, as relative to neutral stimuli end-state stimuli were also OCD-related, these results may still reflect obsession-related distress rather than relief brought on by stimuli signaling compulsion completion. Also, end-states stimuli were not systematically validated. In Study 1, participants rated the subjective discomfort experienced when viewing traditional obsession-provoking threat pictures and novel end-states pictures. We first compared participants with high (HOC) and low (LOC) levels of obsessive-compulsive symptoms, and then clinically diagnosed OCD participants and matched healthy controls. In study 2, we compared gaze patterns of HOC and LOC participants while freely viewing 2-by-2 matrices directly contrasting two threat and two end-state stimuli. Study 1 showed a larger difference in experienced discomfort when viewing the end-state stimuli, compared to threat stimuli, for both OC groups compared with their respected control groups. Study 2 showed that while LOC participants demonstrated no difference in dwell time on threat vs. end-state pictures, the HOC group allocated more attention toward the latter. Both groups were more prone to fixate first the threat pictures. Task reliability was high. Attention allocation in OCD may also be affected by cues signaling the completion of compulsive acts.

Keywords Obsessive compulsive disorder, attention allocation · Eye-tracking · Obsessions · Compulsions

Introduction

Cognitive models of obsessive-compulsive disorder (OCD) suggest that interpreting benign or otherwise "normal" intrusive thoughts as signaling personal responsibility for causing/preventing harm to oneself or others contribute to the development and maintenance of the disorder (Pleva & Wade, 2006; Salkovskis et al., 1998, 1999). These misinterpretations result, in turn, in attention allocation patterns favoring stimuli related to one's obsessions (Cohen et al., 2003). For example, an individual with contamination obsessions might show increased attention allocation to dirty looking objects in one's surroundings, maintaining intrusive obsessions and driving ensuing compulsive behaviors (Salkovskis, 2003). In line with this suggestion, extant eye-tracking research in OCD has shown evidence for biased attention allocation in the disorder (for a systematic review and meta-analysis see Basel et al., 2023). Theoretically, biased attention allocation can manifest in different attentional aspects, including both *vigilance* (i.e., the ease or speed in which a certain stimulus is detected) and *maintenance* (i.e., the degree to which attention is held by a specific stimulus, once detected), which may operate conjointly at different stages of the attentional process (Lazarov et al., 2019). Using the above-given example, an individual with OCD may be quicker in detecting the dirty looking object among an array of other objects, and/or allocate heightened attentional resources to that object, once detected, compared with a healthy person without OCD. Operationally, vigilance is determined by measures of first fixations,

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namely, the latency and/or the location of the initial eye movements occurring immediately after stimulus onset. Shorter latencies to first fixate a specific cue, or a greater proportion of first fixations on that cue, compared with an alternative one, reflects facilitated cue detection (Waechter et al., 2014). Sustained attention is usually indicated by increased dwell time (i.e., total duration of all fixations) on that cue (vs. an alternative one) during stimulus presentation (Basel et al., 2023). In OCD, while some studies have found evidence for attentional vigilance, most studies support attentional maintenance (for a systematic review and meta-analysis see Basel et al., 2023). One common feature of extant research in the field is the usage of threat-related OCD stimuli – stimuli assumed to provoke obsessions (and hence anxiety), and the ensuing need to perform compulsive acts. For example, a picture of a turned-on stove may provoke obsessions reagrding personal responsibility or safety (e.g., "*I might be responsible for starting a fire, which will be harmful for my family*"), thereby increasing anxiety and motivating the performance of checking-related behaviors. Recently, however, Basel and colleagues (Basel, Magen et al., 2023) explored attention allocation to stimuli that signal "end-states" of compulsive behaviors – stimuli that reflect the completion of compulsive acts (e.g., a picture of a clean and shiny sink rather than of a clearly dirty one). The authors reasoned that these stimuli may also affect the attention allocation of OC individuals, as for OC individuals the completion of compulsive acts is associated with a rewarding feeling of reduced anxiety or relief (i.e., negative reinforcement), echoing the phenomenology of the disorder (Baker et al., 2004; Koob, 2013; Kwak et al., 2006; Parvaz et al., 2021). Indeed, prior research on attention allocation has shown that stimuli that were previously negatively rewarded can later capture one's attention (Anderson, 2016; Failing & Theeuwes, 2018; Hertz-Palmor et al., 2023). Specifically, participants with high and low levels of obsessive compulsive (OC) symptoms freely view 30 different 2-by-2 matrices of pictures, two OCD-related pictures and two neutral pictures. Importantly, participants completed two versions of this task – one with OCD-related threat stimuli, as used in previous research in the field (e.g., Cludius et al., 2019; Mullen et al., 2021) and one with OCD-related pictures depicting end-states of compulsive behaviors. Results showed that while no group differences emerged in the traditional task version, participants with high OC symptoms spent significantly more time fixating on the end-state stimuli compared to participants with low OC symptoms. Participants also rated the end-states stimuli as provoking less discomfort than the traditional threat ones, with this difference being significantly larger among those with high OC symptoms. Finally, the task was found to be psychometrically sound, strengthening confidence in emergent results (Lazarov, Basel et al., 2021; Lilienfeld & Strother, 2020; McNally, 2019; Parsons et al., 2019). Although advancing our knowledge on attention allocation processes in OCD, two important limitations of the above-described study need to be further addressed. First, as end-states stimuli are still OCD-relevant relative to neutral stimuli (even if to a lesser extent than the traditional OCD-related threat stimuli; Basel et al., 2021), they may have still evoked obsession-related distress among high OC participants, biasing their attention accordingly (Aardema et al., 2008; Audet et al., 2020; Basel, Magen et al., 2023). Using the above-mentioned example, a spotless sink may have still instigated cleaning related obsessions. Per this possibility, results were driven by "traditional" threat-related processes, reflecting increased threat sensitivity to OCD-related stimuli (Cludius et al., 2019; Mullen et al., 2021). Alternatively, however, as described above, OC participants' sustained attention on end-state stimuli may also reflect the (negatively) rewarding nature of these stimuli. Put differently, as end-states pictures depict the completion of compulsive acts, among OC individuals only, they are also associated with the ensuing reduction in anxiety, possibly serving as negatively rewarded stimuli, which in turn can affect one's attention allocation (Association & Association, 2013; Denys, 2011; Grant, 2014)[1]. According to this possibility, high OC participants' attention allocation was biased toward end-state stimuli due to their negative reinforcing nature, a claim that is line with research on reward-related attention allocation (Anderson, 2016; Awh et al., 2012; Failing & Theeuwes, 2018). Directly contrasting traditional threat and end-states stimuli within a single attentional task may assist in teasing apart these two possibilities. Second, unlike traditional OCD-related threat stimuli which were taken from well-validated OCD picture data sets (Mataix-Cols et al., 2009; Simon et al., 2012), the end-state stimuli were prepared specifically for the purpose of the above-described study (Basel, Magen et al., 2023). While results showed that compared with control participants, those with high levels of OC symptoms experience greater reductions in subjective distress when viewing the end-states stimuli vs. the traditional threat stimuli, the validity of the end-state stimuli needs be further established. The present study was designed to address these two limitations.

[1] To clarify, per this alternative, end-state stimuli have no rewarding nature in their own right – their rewarding nature is due to their association with a reduction in experiences discomfort/anxiety which follows the completion of compulsive acts, echoing the phenomenology of OCD (Association & Association (2013). Diagnostic and statistical manual of mental disorders: DSM-5. *Arlington, VA*; Denys (2011). Obsessionality & compulsivity: a phenomenology of obsessive-compulsive disorder; *Philosophy, Ethics, and Humanities in Medicine*, *6*(1), 1–7; Grant (2014). Obsessive–compulsive disorder. *New England Journal of Medicine*, *371*(7), 646–653).

Study 1 was designed to validate our set of end-state pictures. Specifically, we assessed the subjective discomfort experienced by participants when presented with each stimulus type (traditional vs. end-state). We first compared individuals with high and low levels of OC symptoms, and then patients with OCD and healthy control participants. We predicted greater reductions in experienced subjective discomfort among OC participants compared to control participants (i.e., high vs. low OC participants; OCD vs. healthy control participants). In Study 2 we compared the attention allocation patterns of high and low OC participants when presented with matrices directly contrasting the two OCD-related stimulus types, thereby creating a direct attentional competition between the two. As both traditional threat and end-states stimuli are OCD-related, we reasoned that favoring the latter over the former among high OC participants, compared to low OC participants, would suggest the involvement of negative-reinforcement processes. The opposite attention allocation pattern would suggest the involvement of traditional threat-related processes. Based on our previous study with similar threat and end-state stimuli (Basel, Magen et al., 2023) we hypothesized that compared with LOC participants, HOC participants would dwell longer on the end-state stimuli than on the traditional threat stimuli, reflective of sustained attention. We had no specific hypothesis for first fixation measures of vigilance as our prior study found no such evidence (Basel, Magen et al., 2023) as did prior attentional research in OCD (for a review see Basel et al., 2023).

Study 1

Method

Participants

Student sample Six hundred and eighty students were screened using the Obsessive–Compulsive Inventory-Revised (OCI-R; Foa et al., 2002). Those scoring at the top of the OCI-R distribution comprised the high OC (HOC) group, contingent on scoring > 21 – the clinical cutoff score of this scale (Foa et al., 2002). The low OC (LOC) group consisted of those scoring ≤ 15, reflecting minimal obsessive-compulsive symptoms (Abramovitch et al., 2020). The final sample included 108 participants: Sixty in the HOC group (*M*age = 23.40 years, *SD* = 1.77, range = 2131 years; 45 women) and 58 in the LOC group (*M*age = 23.25 years, *SD* = 1.65, range = 19–27 years; 47 women). Demographic and psychopathological characteristics (see Measures below) by group are presented in Table 1.
The study was approved by Tel-Aviv University Institutional Review Board. Participants provided written informed consent and received course credit for completing the study.

Clinical sample Participants were 37 individuals with a clinical diagnosis of OCD. Thirty age-, sex-, and education (years)-matched participants with no lifetime psychiatric disorders were recruited as a healthy control (HC) group. Demographic and psychopathological characteristics (see Measures below) by group are presented in Table 2.

Participants were recruited via online advertisement, local media, and community postings. Interested participants were phone-screened using the OCI-R (n = 94), with those scoring > 21 invited for a full diagnostic interview conducted in the lab (n = 43). Primary and co-morbid psychiatric diagnoses were assessed by a trained PhD-level clinical psychologist using the Mini-International Neuropsychiatric for DSM-5 (MINI; Sheehan et al., 1997, see Measures below) – a well-validated structured interview for psychiatric diagnoses (Lecrubier et al., 1997; Sheehan et al., 1997). Severity of OCD, depression, and anxiety was further assessed using the clinician-rated Yale-Brown Obsessive Compulsive Scale (Y-BOCS; Goodman et al., 1989), the Montgomery–Asberg Depression Rating Scale (MADRS; Montgomery & Åsberg, 1979), and the Hamilton Anxiety Rating Scale (HAM-A; Hamilton, 1959; Shear et al., 2001), respectively,

Inclusion criteria for the OCD group were: (a) primary diagnosis of OCD; (b) OCI-R score > 21; (c) Y-BOCS score > 16 (the recommended cut-off score of this scale,

Table 1 Demographic and clinical characteristics by group – student sample (Study 1)

Measure	LOC group (n = 58)		HOC group (n = 60)	
	M	*SD*	*M*	*SD*
Age	23.40[a]	1.77	23.25[a]	1.65
Gender ratio (M:W)	11:47[a]	-	15:45[a]	-
OCI-R	7.31[a]	4.51	36.98[b]	11.21
DASS-21				
Depression	1.19[a]	2.12	5.80[b]	5.61
Anxiety	0.81[a]	1.16	5.80[b]	4.81

Note. Different superscripts signify differences between groups at $p < .001$. LOC, low obsessive-compulsive tendencies; HOC, high obsessive-compulsive tendencies; OCI-R, Obsessive–Compulsive Inventory-Revised; DASS-21, Depression, Anxiety and Stress Scales-21

Table 2 Demographic and clinical characteristics by group – clinical sample (Study 1)

Measure	Control group (n = 30)		OCD group (n = 37)	
	M	*SD*	*M*	*SD*
Age	29.43[a]	8.90	27.17[a]	7.43
Education	13.60	1.51	13.60	1.85
Gender ratio (M:W)	8:22[a]	-	12:25[a]	-
OCI-R				
Total Score	5.77[a]	4.02	40.38[b]	11.77
Washing	0.50[a]	0.86	5.95[b]	3.77
Obsessing	0.37[a]	0.72	8.92[b]	2.89
Hoarding	1.33[a]	1.39	5.11[b]	3.38
Ordering	2.40[a]	2.01	7.59[b]	3.21
Checking	0.93[a]	1.14	7.30[b]	3.50
Neutralizing	0.23[a]	0.62	5.51[b]	3.28
DASS-21*				
Depression	0.63[a]	0.99	7.03[b]	4.71
Anxiety	0.47[a]	0.82	6.49[b]	4.09
Y-BOCS*	-	-	26.26	5.72
MADRS*	2.73[a]	2.84	23.34[b]	9.00
HAM-A*	1.90[a]	2.46	24.63[b]	10.50

Note. Different superscripts signify differences between groups at $p < .001$. OCD, obsessive-compulsive disorder; OCI-R, Obsessive–Compulsive Inventory-Revised; DASS-21, Depression, Anxiety and Stress Scales-21; MADRS = Montgomery–Asberg Depression Rating Scale, HAM-A = Hamilton Anxiety Rating Scale, Y-BOCS = Yale-Brown Obsessive-Compulsive Scale

* Scores of three OCD participants are missing (n = 34)

indicative of at least moderate OCD; Goodman et al., 1989); and (d) 18–60 years of age. Exclusion criteria were: (a) current or past psychosis; (b) clinically significant suicidal ideation or behavior; (c) current unstable or untreated medical illness; (d) current or past organic mental disorder, seizure disorder, or brain injury.

Inclusion criteria for the HC group were: (a) 18–60 years of age; and (b) OCI-R score ≤ 15, reflecting minimal obsessive-compulsive symptoms. Exclusion criteria were: (a) current or past diagnosis of OCD or any psychiatric disorder; (b) current or past organic mental disorder, seizure or brain injury; and (c) current unstable or untreated medical illness.

The study was conducted in accordance with ethical guidelines of the Declaration of Helsinki and approved by Tel-Aviv University Institutional Review Board, with study participants providing written informed consent prior to participation. Participants received a small monetary compensation for completing the study.

Measures

Student sample

Obsessive–compulsive symptoms Obsessive–compulsive symptoms were measured using the OCI-R (Foa et al., 2002), an 18-item self-report questionnaire assessing obsessive-compulsive symptoms. Participants indicate their level of distress associated with each symptom on a 5-point Likert scale ranging from 0 (not at all) to 4 (very much), for a 0-to-72 total score. The OCI-R has good validity, test-retest reliability, and internal consistency in both clinical (Foa et al., 2002; Lazarov et al., 2014; Lazarov, Oren et al., 2021) and non-clinical samples (Hajcak et al., 2004; Lazarov et al., 2020). Internal consistency (Cronbach's α) in the present study was 0.96.

Depression and anxiety symptoms Symptoms of depression and anxiety were measured using the Depression, Anxiety and Stress Scales-21 (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 is a 21-item self-report questionnaire assessing dimensional components of depression, anxiety, and stress. Each individual item is rated on a 4-point scale ranging from 0 (the item does not apply to me at all) to 3 (the item applies to me very much or most of the time), on which participants indicate how much each statement applied to their experience over the past week. The DASS-21 has high reliability, validity and internal consistency in both clinical and non-clinical groups (Antony et al., 1998; Henry & Crawford, 2005; Lazarov, Oren et al., 2021; Lovibond, 1998; Lovibond & Lovibond, 1995). Cronbach's α in the present study was 0.94 for both the depression and anxiety subscales.

Clinical sample

Obsessive–compulsive symptoms Obsessive compulsive symptoms were assessed using the OCI-R questionnaire (see description above), with internal consistency of 0.96 in the present sample. Severity of OCD symptoms was further assessed using the Y-BOCS (Goodman et al., 1989), a semi-structured, clinician-rated scale, assessing symptom severity over the prior week. The Y-BOCS assesses the severity of both obsessions and compulsions, with each individual item rated from 0 (*no symptoms*) to 4 (*extreme symptoms*), for a total score of 0–40. The scale's inter-judge reliability

is reported as 0.85, and Cronbach's alpha as 0.89 (Woody et al., 1995). Cronbach's α in the current sample was 0.83.

Depression symptoms Depressive symptoms were assessed using the depression subscale of the DASS-21 (see description above), with internal consistency of 0.93 in the present sample. In addition, clinician-evaluated levels of depression were assessed using the Montgomery–Asberg Depression Rating Scale (MADRS; Montgomery & Åsberg, 1979), a 10-item scale assessing core depressive symptoms during the past week, with each item scored between 0-to-6 (signaling *no evidence* to *pervasive evidence* of symptoms). The MADRS has high inter-rater reliability, convergent validity, and comparable rates of sensitivity to change as other measures of depression (Khan et al., 2002, 2004; Montgomery & Åsberg, 1979). Cronbach's α in the current sample was 0.92.

Anxiety symptoms Anxiety symptoms were assessed using the anxiety subscale of the DASS-21 (see above), with internal consistency of 0.86 in the present sample. Clinician-rated anxiety was also measured using the HAM-A (Hamilton, 1959), a 14-item questionnaire measuring anxiety symptoms over the past week. The HAM-A was administered using the Structured Interview Guide for the Hamilton Anxiety Rating Scale (SIGH-A; Shear et al., 2001), which has higher inter-rater and test-retest reliability compared with the regular format (Shear et al., 2001). Cronbach's α in the current sample was 0.95.

Primary and co-morbid diagnoses Primary and co-morbid diagnoses were assessed using the DSM-5 version of the MINI, a structured diagnostic interview for psychiatric disorders. The MINI takes approximately 20 min to administer and is considered a valid and time-efficient alternative to the Structured Clinical Interview for DSM Patients (SCID-P) and the Composite International Diagnostic Interview (CIDI), showing good reliability, sensitivity, and specificity (Lecrubier et al., 1997; Sheehan et al., 1997).

OCD-related stimuli

Traditional OCD-related threat stimuli Traditional OCD-related threat images were chosen from two well-validated picture datasets – the Maudsley Obsessive-Compulsive Stimuli Set (MOCSS; Mataix-Cols et al., 2009) and the Berlin Obsessive Compulsive Disorder-Picture Set (Simon et al., 2012). In total 36 stimuli were selected, consisting of 12 pictures per OCD category (i.e., checking, cleaning, ordering).

End-states OCD-related stimuli Pictures were retrieved from the internet, aiming to find images that are clearly OCD-relevant, but that signal end-states of compulsive behaviors (rather than pictures that instigate obsessions and anxiety as in traditional OCD-related threat images). For example, for a picture of a dirty sink, a matching image would be that of a shiny clean one, and a picture of a turned-on gas knob would be mirrored by a picture with a clearly visible "off" sign. First, 42 pictures per OCD-theme were selected (for a total 126 pictures). Next, two psychologists with vast expertise in diagnosing and treating OCD independently rated each individual picture according to its relevance to each OCD theme, namely, checking, cleaning, and ordering, on a 0-to-10 scale. The final pool of 36 pictures (12 per category) included those rated as highest per OCD theme (when averaging the ratings of both raters), while ensuring low scores on the two alternative themes.

For each OCD-related stimulus type (traditional threat, end-state), we focused on three OCD themes – checking, cleaning, and ordering/symmetry. Two reasons guided our decision. From a phenomenological perspective, these themes are considered to be among the most prominent symptoms of the disorder (Basel, Magen et al., 2023; Clark, 2019). From a practical perspective, these themes are also more readily visualized, especially the end-states stimuli, as they usually include clear behavioral compulsive acts. For example, visualizing a turned-off stove or a perfectly cleaned sink is more feasible than visualizing a mental compulsion such as a counting or a neutralizing thought.

Procedure

Participants were tested individually in a quiet room at the university. After providing informed consent, participants were told that during the next time period they will be presented with different pictures, one after the other, and were asked to rate each picture based on the degree of discomfort they felt while viewing it (i.e., "how much discomfort did you experience when viewing the picture"). Specifically, each picture was displayed in color on the computer monitor, followed by a 100-mm computerized Visual Analog Scale (VAS), anchored with "much discomfort" on the right side and "no discomfort" on the left, with the VAS's slider positioned at the VAS mid-point. Participants were asked to place the moving slider at the position that best described the way they felt, with a small window appearing above the scale showing the numerical score corresponding to the slider's current position ("50" at the starting position). As participants moved the slider along the scale, the corresponding numerical score changed accordingly. The VAS score was measured in millimeters from the left anchor of

the scale to the slider's position (Elias et al., 2021), for a score of 0-to-100 per picture, with higher scores indicating higher levels of experienced discomfort.

Participants were presented with the 72 OCD-related pictures – 36 per stimulus type (threat, end-states), each comprised of 12 picture per OCD theme (cleaning, checking, ordering). Order of presentation was randomized across participants. Total scores for each picture type (threat, end-states) were computed by averaging the scores of the corresponding 36 pictures, for a total score ranging from 0 to 100. We termed this questionnaire the Subjective Discomfort Questionnaire (SDQ). Following the completion of the SDQ participants filled out the additional measures, as indicated above, and were then thanked and debriefed.

Data analysis

A power analysis was performed using G*Power 3.1.9.4 (Faul et al., 2007). Based on an effect size reported in a previous study validating an OCD-related stimuli-set among clinical OCD patients ($\eta^2_p = 0.13$, Simon et al., 2012), a sample of 58 has a power of 80% to detect a Group-by-stimulus type (traditional threat, end-state) interaction at an alpha level of 0.05. Hence, 30 participants per group (OCD, HC) was determined as the target sample size for the clinical sample. For the student sample, as HOC participants constitute an analog sample of OCD, we calculated the minimal number of participants needed to detect the same effect size but at a power of 95%. This yielded a minimal sample of 92 participants (46 participants per group; HOC, LOC).

Independent samples t-tests compared between-groups descriptive characteristics, with a chi-square test used to compare groups on gender distribution.

To examine group differences on SDQ scores we performed a 2-by-2 repeated measures ANOVA, with group (student sample – HOC, LOC; clinical sample – OCD, HC) as a between-subjects factor and stimulus type (traditional threat, end-state) as within-subject factor (for a similar analysis see Simon et al., 2012). To address OCD subtyping, we conducted an exploratory analysis in which we repeated the main analysis while using specific OCD-subtypes scores from the OCI-R as the grouping variable, rather than the OCI-R total score, and SDQ scores to corresponding stimulus types as the dependent variable (see supplementary material for a detail description of group composition and criteria; for a similar data analysis plan, see (Basel, Magen et al., 2023; Cludius et al., 2019). Specifically, we explored the three main OCD subtypes, namely, cleaning, checking, and ordering. Accordingly, three separate repeated-measures ANOVAs were carried out, one per OCD subtype, with group (per sub-type) as a between-subjects factor, and the corresponding stimulus type (traditional threat, end-state) as a within-subject factor.

The reliability of the SDQ was assessed for both stimulus types. Internal consistency was examined using Cronbach's α treating each single picture as a single item, and was calculated for the entire sample, and separately within groups.

All statistical analyses were conducted using SPSS (IBM; version 25.0) and were 2-sided, using α of 0.05. Effect sizes are reported using partial eta-squared (η^2_p) for ANOVAs and Cohen's d for mean comparisons.

Results

Data of this study are openly available in Open Science Foundation (OSF) at https://osf.io/mkwpx/?view_only=73ac1f835bf44d0d86d601652da04fd3 (see Project named "Traditional vs. End-states Stimuli"; File name "OSF_study1_Final").

Demographic characteristics

Demographic and clinical characteristics of both samples (student, clinical) are described in Table 1 and in Table 2, respectively. For both samples, significant group differences were noted on all clinical measures, all $ps < 0.001$, with no significant differences between groups on age, education or gender distribution.

Subjective discomfort scores (SDQ)

Students sample The Group (HOC, LOC)-by-Stimulus type (traditional threat, end-state) interaction was significant, $F(1, 116) = 9.89$, $p = .002$, $\eta^2_p = 0.08$. Follow-up within groups simple effects analyses showed that both HOC and LOC participants experienced less discomfort when viewing the end-sate stimuli compared with the traditional threat stimuli (HOC: $M = 59.52$, $SD = 16.08$; $M = 22.45$, $SD = 12.55$; $t(59) = 18.58$, $p < .001$, *Cohen's d* $= 2.39$; LOC: $M = 43.93$, $SD = 20.60$; $M = 15.79$, $SD = 12.33$; $t(57) = 13.95$, $p < .001$, *Cohen's d* $= 1.83$), with this difference being larger among HOC participants. Our exploratory within-block analyses are reported in full in the Supplementary Material.
Internal consistency of the SDQ was high for both stimulus types. For the traditional threat OCD stimuli, Cronbach's α was 0.97, 0.96 and 0.96, for the LOC group, HOC group, and for the full sample, respectively. For the end-state stimuli, Cronbach's α was 0.95, 0.93 and 0.94, for the LOC group, HOC group, and for the full sample, respectively.

Clinical sample The Group (OCD, HC-by-Stimulus type (traditional threat, end-state) interaction was significant, $F(1, 65) = 7.81$, $p = .007$, $\eta^2_p = 0.11$. Follow-up within

groups simple effects analyses showed that both OCD and HC participants experienced less discomfort when viewing the end-sate stimuli compared with the traditional threat stimuli (OCD: $M = 61.11$, $SD = 16.97$; $M = 22.57$, $SD = 13.61$; $t(36) = 11.99$, $p < .001$, *Cohen's* $d = 1.97$; HC: $M = 37.19$, $SD = 26.20$; $M = 13.27$, $SD = 11.39$; $t(29) = 5.62$, $p < .001$, *Cohen's* $d = 1.03$), with this difference being larger among OCD participants. Results of the per-block exploratory analyses are reported in full in the Supplementary Material.

Internal consistency of the SDQ was high for both stimulus types. For the traditional threat OCD stimuli, Cronbach's α was 0.98, 0.95 and 0.98, for the HC group, OCD group, and for the full sample, respectively. For the end-state stimuli, Cronbach's α was 0.93, 0.93 and 0.94 for the HC group, OCD group, and for the full sample, respectively.

Study 2

Method

Participants

Three hundred and thirty-seven students were screened using the Obsessive–Compulsive Inventory-Revised (OCI-R; Foa et al., 2002). Those scoring at the top of the OCI-R distribution comprised the high HOC group, contingent on having a score ≥ 27, which is well above the clinical cutoff score on this scale (OCI-R = 21; Foa et al., 2002) denoting severe OCD (Abramovitch et al., 2020). The LOC group consisted of those scoring ≤ 15, a score reflecting minimal obsessive-compulsive symptoms (Abramovitch et al., 2020).

Thirty-four HOC and 35 LOC participants were found eligible for the study. However, one HOC participant and two LOC participants were excluded from analyses – the HOC and one LOC due to calibrations difficulties and one LOC due to loss of data related to the eye-tracking apparatus. The final sample included 66 participants: Thirty-three in the HOC group (*M*age = 23.55 years, $SD = 3.96$, range = 19–43 years; 24 women), and 33 in the LOC group (*M*age = 23.24 years, $SD = 1.42$, range = 21–27 years; 28 women). Participants provided informed consent and received course credit for participation.

The study protocol was approved by the Research Ethics Council of Tel Aviv University. We only invited participants with normal or corrected-to normal vision, excluding usage of multi-focal eyewear to prevent eye-tracking calibration difficulties.

Measures

Participants were assessed for obsessive compulsive symptoms using the OCI-R (Foa et al., 2002), and for depression and anxiety using the corresponding sub-scales of the DASS-21 (Lovibond & Lovibond, 1995). For a full description of these scales see Study 1. Internal consistency in the present study was 0.96 for the OCI-R, and 0.94 and 0.90 for the DASS-21 depression and anxiety subscales, respectively.

Attention allocation task

Gaze patterns were assessed using a recently established eye-tracking task designed to explore attention allocation to OCD-related stimuli, showing acceptable psychometric properties (Basel, Magen et al., 2023). The task was designed and executed using the Experiment Builder software (version 2.1.140; SR Research Ltd., Ottawa, Ontario, Canada).

The task included three separate blocks with theoretical relevance for OCD – a checking block, a cleaning block, and an ordering/symmetry block – delivered in a counterbalanced manner across participants within each group. For each block, 12 traditional OCD-related threat and 12 end-state OCD-related pictures were used (see Study 1), from which 30 different 2-by-2 matrices were prepared, with each matrix contrasting two traditional threat stimuli and two end-state stimuli (see Fig. 1 for a matrix example per block). Each stimulus extends 255-by-225 pixels, including a 10-pixel white margin frame, for an overall matrix size of 550-by-550 pixels. Each picture appeared 5 times per block. Single pictures appeared randomly at any position within the matrix while ensuring that each picture appeared only once in each matrix.

Each trial of the task began with a centrally presented fixation-cross mandating a 1-second fixation for the matrix itself to appear. Then the matrix appeared for 8 s, followed by a 2-second inter-trial-interval. Participants were instructed to look freely at the matrix until it disappeared. A 2-minute break was introduced between blocks to reduce fatigue. Each block was preceded by a 5-point eye-tracking calibration followed by a 5-point validation procedure.

Eye-tracking measures

Fixations were defined as at least 100ms of stable fixation within 1-degree visual angle. For each matrix we defined two Areas of Interest (AOI's) – a traditional threat AOI (i.e., the OCD-related traditional threat pictures) and an end-state AOI (the OCD-related pictures depicting end-states of compulsive acts).

Fig. 1 An example of a single matrix [Checking block (left), Cleaning block (middle); Ordering block (right)]. Each Matrix included two stimulus types (each comprised of two stimuli) – traditional OCD-related stimuli and end-stats OCD-related stimuli. Each stimulus type was considered a separate area of interest (AOI).

Three gaze indices of attention allocation were calculated (Basel et al., 2023). Sustained attention (i.e., the degree to which attention is held by a specific type of stimulus, once detected) was indexed via *total dwell time*, calculated by summing the total fixation duration on each AOI across matrices (in seconds). Vigilance, also referred to as facilitated cue detection (i.e., the ease or speed in which specific stimuli is detected) was indexed by two complimentary measures as customary in eye-tracking research (Basel et al., 2023). *First fixation latency*, the speed of stimuli detection, was calculated by averaging the latency to first fixations, in milliseconds, per AOI. *First fixation location* was measured by counting the number of times the first fixation was located in each AOI. A greater proportion of first fixations on one type of stimulus over the other, or shorter latencies to first fixate that stimulus type, are considered evidence of vigilance (Basel et al., 2023; Waechter et al., 2014).

Eye tracking apparatus

Eye-tracking data was collected and recorded using the remote head-free high-speed EyeLink Portable-Duo apparatus and the Experiment Builder software (SR-research, Ottawa, Ontario, Canada). Participants were seated approximately 700 mm away from the screen. Real-time monocular eye-tracking data was recorded at 500 Hz, with a 1920 × 1080-pixel display resolution. Eye-tracking data was processed using EyeLink Data Viewer software (SR-research, Ottawa, Ontario, Canada).

Procedure

Participants were tested individually in a quiet room at the university. After providing informed consent, they were seated in front of the eye-tracking apparatus and told that during this task they would be presented with different matrices of different stimuli, appearing one after the other. They were also informed that before the appearance of each matrix a fixation cross would be shown at the center of the screen, on which they should fixate to make the matrix itself appear. They were then presented with a demonstration of this contingency. Next, participants were instructed to look freely at each matrix in any way they choose until it disappears, and then the task commenced. Following the completion of the task participants completed the different questionnaires and were thanked and debriefed.

Data analysis

A power analysis using G*Power 3.1.9.4 (Faul et al., 2007) showed that a sample of 68 has a power of 80% to detect a group difference in attention allocation to end-state stimuli at an alpha level of 0.05 and based on an effect size of 0.69 – the effect size for the same group difference found in the study of Basel et al. (Basel, Magen et al., 2023) – the only study to date to explore attention allocation using end-states stimuli.

Independent samples t-tests compared between-groups descriptive characteristics, with a chi-square test used to compare groups on gender distribution.

To examine group differences on the different eye-tracking measures, we performed a 2-by-3-by-2 repeated measures ANOVA for each measure, with group (HOC, LOC) as a between-subjects factor, and Block (checking, cleaning, ordering) and AOI (threat, end-state) as within-subject factors. To address OCD subtyping and related attentional allocation to corresponding stimulus types, we conducted an exploratory analysis using a similar approach to that

described in Study1 (see supplementary material for a detail description of group composition and criteria; for a similar data analysis plan, see (Basel, Magen et al., 2023; Cludius et al., 2019). Here, too, we explored the three main OCD subtypes, namely, cleaning, checking, and ordering. Accordingly, three separate repeated-measures ANOVAs were carried out, one per block, with group (per sub-type) as a between-subjects factor, and the corresponding AOI (threat, end-state) as within-subject factor.

All statistical analyses were conducted using SPSS (IBM; version 25.0) and were 2-sided, using α of 0.05. Effect sizes are reported using partial eta-squared (η^2_p) for ANOVAs and Cohen's d for mean comparisons. Bonferroni correction was applied to multiple comparisons.

Results

Data of this study are openly available in OSF at https://osf.io/mkwpx/?view_only=73ac1f835bf44d0d86d601652da04fd3 (File name "OSF_study2_Final").

Demographic characteristics

Demographic and clinical characteristics of the groups are described in Table 3. Significant group differences were noted on all clinical measures, all $ps < 0.007$. No group differences emerged for age or gender distribution.

Eye-tracking measures

Sustained allocation (total dwell time) The omnibus Group (HOC, LOC)-by-Block (checking, cleaning, ordering)-by-AOI (traditional threat, end-state) interaction was not significant $F(2, 63) = 0.69$, $p = .50$. However, a significant Group-by-AOI emerged, $F(1, 64) = 4.25$, $p = .04$, $\eta^2_p = 0.06$, indicating differential dwell time patterns of the two groups for the threat and the end-state AOIs, across the three blocks. We therefore collapsed across blocks for the remaining analyses. This interaction remained significant after adding depression as a covariate, $F(1,63) = 4.19$, $p = .04$, $\eta^2_p = 0.06$. Within-groups simple effects analyses using dependent samples t-tests showed that HOC participants spent significantly more time fixating on the end-state AOI ($M = 307.71$, $SD = 50.76$) than on the traditional threat AOI ($M = 253.39$, $SD = 53.79$), $t(32) = 3.18$, $p = .003$, *Cohen's* $d = 0.55$. No significant difference was found for the LOC participants between the end-state AOI ($M = 289.28$, $SD = 34.42$) and the traditional threat AOI ($M = 276.15$, $SD = 32.53$), $t(32) = 1.26$ $p = .21$ (see Fig. 2). Results of the per-block exploratory analyses are reported in full in the Supplementary Material.

Internal consistency for total dwell time on each AOI was high for both stimulus types. For the traditional threat stimuli, Cronbach's α was 0.78, 0.86 and 0.82, for the LOC group, HOC group and for the full sample, respectively. For the end-state stimuli, Cronbach's α was 0.87, 0.95 and 0.93, for the LOC group, HOC group and for the full sample, respectively.

To explore the stability across time of this Group-by-AOI interaction we conducted an exploratory time-course analysis by adding Epoch as a second within-subject variable (i.e., Epochs 1 to 4). Specifically, we divided each 8-second trial into four 2-second time epochs (Basel, Magen et al., 2023). Results yielded no Epoch-related significant results. Specifically, the Group-by-Block-by-AOI-by-Epoch, and the Group-by-AOI-by-Epoch interaction effects were not significant, $F(6, 59) = 1.14$, $p = .35$, and $F(3, 62) = 2.17$, $p = .10$, respectively (see Fig. 3). These non-significant Epoch-related effects reflect a consistent pattern of attention allocation across matrix presentation.

Vigilance (first fixation measures) For latency to first fixation, the omnibus interaction was not significant $F(2, 63) = 0.91$, $p = .41$, as was the Group-by-AOI interaction,

Table 3 Demographic and clinical characteristics by group (Study 2)

Measure	LOC group (n = 33)		HOC group (n = 33)	
	M	*SD*	*M*	*SD*
Age	23.24[a]	1.42	23.55[a]	3.96
Gender ratio (M:W)	5:28[a]	-	9:24[a]	-
OCI-R				
Total Score	7.42[a]	4.72	38.42[b]	13.02
Washing	0.55[a]	0.62	5.73[b]	3.65
Obsessing	1.06[a]	1.37	8.24[b]	3.59
Hoarding	1.55[a]	1.60	5.88[b]	3.18
Ordering	1.88[a]	1.54	7.03[b]	2.68
Checking	2.12[a]	2.06	7.03[b]	2.83
Neutralizing	0.27[a]	0.67	4.52[b]	3.55
DASS-21				
Depression	1.39[a]	2.68	6.61[b]	5.97
Anxiety	0.88[a]	1.34	6.27[b]	5.29

Note. Different superscripts signify differences between groups at $p < .001$. LOC, low obsessive-compulsive tendencies; HOC, high obsessive-compulsive tendencies; OCI-R, Obsessive–Compulsive Inventory-Revised; DASS-21, Depression, Anxiety and Stress Scales-21

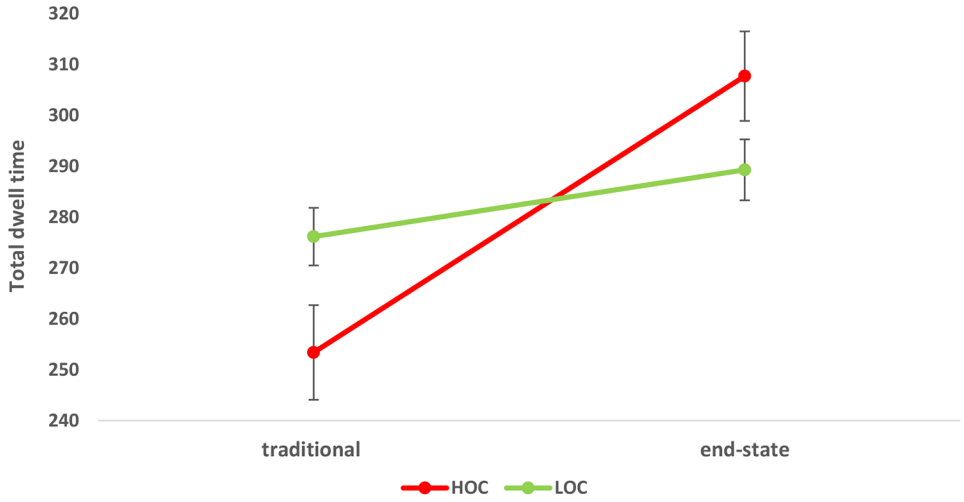

Fig. 2 Total dwell time (in seconds) by Area of interest (AOI) and Group. Error bars denote standard error of the mean. (*Note.* HOC, high obsessive-compulsive tendencies; LOC, low obsessive-compulsive tendencies)

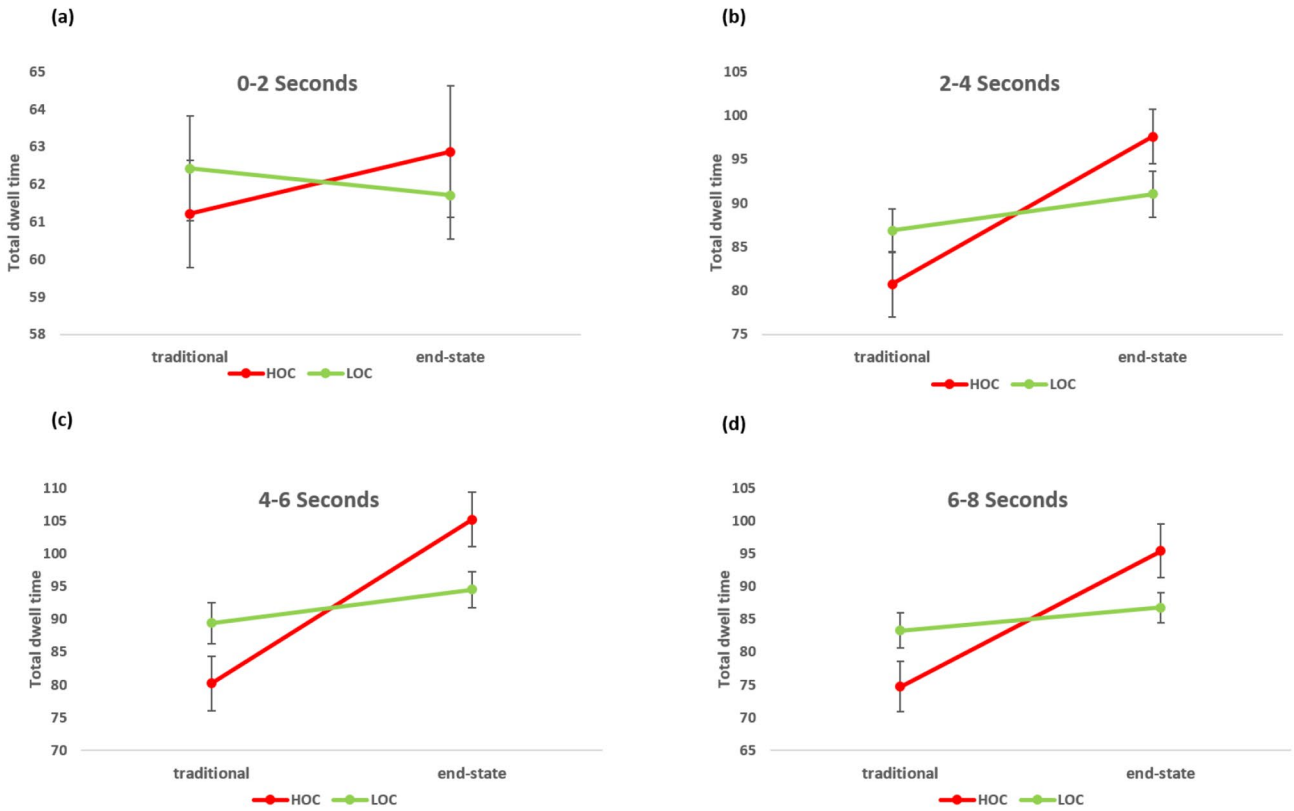

Fig. 3 Total dwell time (in seconds) by Area of interest (AOI), Epoch, and Group: (**a**) 0–2 s; (**b**) 2–4 s; (**c**) 4–6 s; and (**d**) 6–8 s. Error bars denote standard error of the mean. (*Note.* HOC, high obsessive-compulsive tendencies; LOC, low obsessive-compulsive tendencies)

$F(1, 64) = 0.00$, $p = .98$. No main effects emerged for Group or AOI.

For first fixation location, the omnibus Group (HOC, LOC)-by-Block (checking, cleaning, ordering)-by-AOI (traditional threat, end-state) interaction was not significant $F(2, 63) = 0.43$, $p = .65$, as was the Group-by-AOI interaction, $F(1, 64) = 1.53$, $p = .47$. However, a main effect of AOI emerged, $F(1, 64) = 10.27$, $p = .004$, $\eta^2_p = 0.14$, with both groups fixating more frequently on the traditional threat AOI ($M = 15.14$, $SD = 1.69$) than the end-state AOI ($M = 13.87$, $SD = 1.67$).

Discussion

The current study had two principle aims – to experimentally validate a set of OCD-related pictures signaling end-states of compulsive acts (Study 1), and to examine attention allocation to these stimuli when presented conjointly with traditional threat OCD-related stimuli (Study 2). Specifically, in Study 1, we assessed the subjective discomfort experienced when viewing the OCD-related end-states stimuli and traditional threat OCD-related stimuli – once comparing participants with high and low levels of obsessive-compulsive symptoms, and once comparing participants with clinically-diagnosed OCD and healthy control participants. In Study 2, we compared gaze patterns of participants with high and low levels of OC symptoms while freely viewing different matrices comprised of two OCD-related traditional threat and two end-state pictures.

Study 1 showed that both participants with high and low levels of obsessive-compulsive symptoms experienced significantly lower levels of subjective discomfort when viewing the end-state stimuli, compared to when viewing the traditional threat stimuli. Notably, however, those with high levels of OC symptoms showed a larger difference between the two. These results replicate previous findings with the same set of stimuli (Basel, Magen et al., 2023), while also elaborating them to clinical OCD, which also resulted in a larger effect size. From a clinical perspective, this larger difference in subjective distress among OC participants may be conceptualized as echoing the phenomenology of compulsive behaviors, which are usually performed to reduce obsession-related anxiety and/or distress, resulting in relief, even if short lived (Association & Association, 2013; Denys, 2011). The SDQ's good-to-excellent internal consistency further strengthens our confidence in these stimuli as well as in the eye-tracking-based results of Study 2.

Study 2 showed a differential dwell time pattern for the traditional threat and end-state pictures between high and low OC participants, which was unrelated to block (i.e., OCD theme). Collapsing across blocks showed that HOC participants spent significantly more time fixating the end-states stimuli, compared with the traditional OCD threat stimuli, reflective of attentional maintenance on end-state stimuli. Conversely, LOC participants showed no difference in dwell time between the two stimulus types. Results remained significant after controlling for depression symptoms, and were stable across different time epochs, reflecting an OCD-specific and stable attention allocation pattern. Here, too, good-to-excellent internal consistency emerged, both across and within groups, increasing our confidence in the emergent gaze patterns. Current findings echo the results of Basel et al. (Basel, Magen et al., 2023) who also showed group differences in attention allocation patterns toward end-states stimuli, but vs. neutral stimuli (favoring the former), compared with low OC participants. However, as in Basel et al. (2023) the end-states pictures were presented alongside neural non-OCD-related pictures, the emergent attentional preference for end-state stimuli could have arisen either due to increased threat sensitivity (end-state stimuli were also the only OCD-related stimuli; Cludius et al., 2019; Mullen et al., 2021) or to the relief brought on by pictures depicting end-states of compulsive acts (Denys, 2011). As in the present study both stimulus types were OCD-related, emergent findings seem to provide some support for the latter. Put differently, current findings may suggest that the biased attention allocation of OC participants toward end-state stimuli, reflective of sustained attention, was not simply a result of being OCD-related, but rather due to their depiction of the completion of compulsive acts. The results of Study 1 (i.e., greater difference in discomfort among OC participants between the two stimulus types) further support this suggestion.

Yet, one may still argue that the biased attention allocation of OC participants toward end-state over traditional threat stimuli is more reflective of attentional avoidance of the latter, rather than of an attentional preference for the former. However, this claim seems less plausible when considering the findings of Basel et al. (2023), which found no group differences (HOC vs. LOC groups) when examining attention allocation patterns toward *the same* traditional threat stimuli but when contrasted with neutral stimuli. If avoidance was the main driving process of current results, we would have expected an attentional allocation pattern favoring the neutral over the threat stimuli among HOC participants. Moreover, results of Basel et al. (2023) also showed that HOC participants were characterized by an attentional preference toward *the same* end-state stimuli when these were contrasted with neutral stimuli – stimuli one has no "reason" to avoid as they entail no threatening nature for HOC participants. Thus, taking together present results with those of Basel et al. (2023) suggests that present findings may be related to the negative-reinforcement rewarding nature of end-states stimuli, and not solely to avoidance of traditional threat stimuli.

Study 2 also showed that across both groups, participants' first fixation was more frequently located on the traditional OCD-related threat AOI than on the OCD-related end-state AOI, that is, participants more frequently first detected OCD-related threat cues, reflective of attentional vigilance to these cues (Basel et al., 2023; Lazarov et al., 2019). From an attentional perspective, considering both sets of results (i.e., total dwell time and first-fixation location) suggests that it is not vigilance that differentiates OC from non-OC individuals, but rather what transpires after cue detection, reflecting sustained attention on these stimuli. Considering this attention allocation pattern from a clinical perspective echoes well-known cognitive models of OCD (Rachman, 1993; Rachman et al., 1995; Salkovskis et al., 1998; Salkovskis & McGuire, 2003). Specifically, these models describe how normal distressing intrusive

thoughts or images, experienced by most people, may become obsessions through catastrophically misinterpreting the significance of these thoughts or images, leading to compulsive acts, perpetuating a vicious cycle of obsessions and compulsions (Hezel & McNally, 2016). For example, a person without OCD who has an intrusive thought of harming one's child would likely dismiss the thought as meaningless. However, a person with OCD would interpret the same thought as indicating that they are dangerous and a true threat to their child's wellbeing, making this thought a tormenting obsessional one (Hezel & McNally, 2016). Echoing this process, any person, obsessive or not, may be automatically vigilant toward such stimuli as an unlocked window or dirty dishes (LeDoux, 2000; Shechner et al., 2012). However, only those with high levels of OC symptoms may subsequently experience an increase in obsession-related distress and anxiety, affecting their ensuing attention allocation leading to a pattern of sustained attention on stimuli reflecting compulsion completion. Conversely, for those with low levels of OC symptoms these stimuli do not "carry" and special meaning following their detection, resulting in a more balanced attention allocation.

The current study has several limitations that need to be acknowledged. First, while the end-state pictures were validated among both subclinical (i.e., participants with high and low levels of obse4ssive compulsive symptoms) and clinical samples, attention allocation was explored among a subclinical sample only. Future research should now explore this in a clinical sample of OCD patients. Still, research has shown individuals with subclinical OCD to be characterized by significant impairments in various life domains, similar to those observed among OCD patients, conceptualizing subclinical OCD as a risk factor for later development of clinical OCD (Fullana et al., 2009). Furthermore, using samples of high and low scorers on measures of OCD has been shown to be relevant to the understanding of the disorder (Abramovitch et al., 2023; for a review see Abramowitz et al., 2014), and was proven useful in previous research conducted in our laboratory, including Study 1, in which results were later successfully replicated in clinical samples (Lazarov et al., 2014; Lazarov, Oren et al., 2021). Finally, participants in Study 2 had to score ≥ 27 on the OCI-R to be deemed eligible for the study, a score denoting severe OCD (Abramovitch et al., 2020). Second, following the procedure of Basel et al. (Basel, Magen et al., 2023), the attention allocation task included three separate blocks, one per OCD theme (i.e., cleaning, checking, ordering). While these are considered major OCD dimension they are also more readily visualized, a feature that is essential for the purpose of the present study, specifically in terms of the end-state stimuli. Thus, the entire OCD spectrum was not investigated in the present study. Future research may address this issue by more specifically tailoring the used stimuli to each participant's primary OCD theme (i.e., ideographically tailored stimuli). Although being more challenging to visualize, including additional OCD-relevant stimulus types may enhance the generalizability of current findings. Third, to increase ecological validity compared the previous research in the field that used general valenced stimuli such as emotional faces (Armstrong et al., 2010), the present study used OCD-specific picture stimuli. Yet, static pictures are still removed from actual actions, which is especially relevant for our end state stimuli used to single the completion of a compulsive act. In this regard, a previous research by Simon et al. (2012) explored the anxiety-provoking nature of two types on threat stimuli in OCD - short OCD-related video films ("dynamic" stimuli; a scene showing a stove being turned on and left that way) and OCD-related photos ("static" stimuli; a picture of a turned on stove), showing the former to be more anxiety provoking than the latter. Future research should further increase ecological validity by using dynamic OCD-related stimuli, of both types (traditional threat and end-states), which may increase the intensity of the traditional threat OCD-related stimuli and the corresponding relief signaled by end-states stimuli. Finally, as the present study conceptualized end-state pictures as stimuli associated with a reduction in anxiety/relief (due to depicting compulsion completion; i.e., negative reinforced stimuli), we focused solely on related negative reactions (i.e., discomfort VAS rating), not assessing their potential positive valence. Put differently, we did not explore whether end-state stimuli may not only be associated with less discomfort but may also evoke positive emotions in their own right. Future research should rectify this limitation by exploring this important aspect of end-states stimuli by, for example, adding an additional VAS assessing positively valenced emotions. Attention-wise, exploring positive subjective reactions to end-state stimuli would help elucidate the possible motivation underlying attention allocation away from traditional threat stimuli and toward end-state ones among OC participants. It is important to note at this juncture that the fact that all participants were more vigilant toward the threat-related stimuli (i.e., making more first fixations on these stimuli), but only OC participants subsequently diverted their attention away from these stimuli, strengthens our interpretation of the involvement of negative reinforcement processes.

Current results encourage a further and deeper investigation of attentional negative-reinforcement processes in OCD. From a clinical perspective, current findings may be especially relevant to the field of attention bias modification training (ABMT) in OCD, which, to date, included only OCD-related threat stimuli, showing no difference in symptom reduction compared to placebo conditions (Habedank et al., 2017; Harper, 2020; Rouel & Smith, 2018).

Importantly, however, these studies used ABMT procedures in which participants were trained toward neutral stimuli and away from threat stimuli. Based on current findings indicating an attentional avoidance of threat stimuli in favor of end-state stimuli, it may be beneficial to explore whether training individuals with OCD to maintain their attention on traditional threat stimuli, rather than to "escape" toward end-state stimuli, would give rise to better therapeutic effects. This toward-threat training clearly corresponds with exposure and response prevention (ERP) techniques for treating OCD, in which patients are purposely exposed to different stimuli which are normally avoided (e.g., avoiding using public restrooms due to contamination fears), while refraining from performing the ensuing compulsive act (e.g., repetitive hand-washing; Abramowitz et al., 2003; Foa et al., 2005; Hofmann & Smits, 2008). Put differently, ABMT could be construed as an attentional version of ERP, in which one is gradually encouraged to experience the discomfort provoked by the traditional threat stimuli, resisting the immediate urge to modify attention towards possibly less anxiety provoking ones, which may be seen as an attentional safety behavior. This training may, in turn, yield a corresponding decrease in symptoms severity. Indeed, previous studies on the potential augmentative effects of ABMT has shown positive results when added to cognitive behavioral therapy (CBT), with the combined deliverance of both CBT and ABMT being more effective than CBT alone (Hang et al., 2021; Lazarov et al., 2018).

Acknowledgements We greatly appreciate and thank the participants who participated in this study.

Declarations

Conflict of interest We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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