Behaviour Research and Therapy 51 (2013) 152–160

Contents lists available at SciVerse ScienceDirect

Behaviour Research and Therapy

journal homepage: www.elsevier.com/locate/brat

Suppressing disgust related thoughts and performance on a subsequent behavioural avoidance task: Implications for OCD

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ARTICLE INFO

Article history:
Received 29 March 2012
Received in revised form
30 November 2012
Accepted 30 November 2012

Keywords:
Thought suppression
Disgust
Cognitive inhibition
Obsessive–compulsive disorder
Behavioural test

ABSTRACT

We tested whether suppressing disgust related thoughts, compared with no suppression, differentially affected target thought frequency and emotional responses, and whether this was related to participants' cognitive inhibition abilities. We also tested whether different control instructions during a thought control task would affect performance on a subsequent behavioural avoidance task involving disgust related stimuli. Sixty university students, pre-selected on their level of disgust propensity/sensitivity, were instructed to either suppress or not to suppress all target-related thoughts following viewing of a disgust-related film fragment. Thought suppression immediately reduced target thought frequency, but only for participants with good inhibitory control. Thought suppression led to sustained thought frequency and levels of disgust after suppression was lifted, whereas a significant drop was observed for these measures in the no-suppression group. Thought control instructions did not affect performance on the behavioural avoidance task at the group level. However, regression analyses showed that changes in thought frequency during thought suppression interacted with beliefs concerning importance of thoughts and thought control when predicting fear and disgust reactions during the behavioural task.

Introduction

According to cognitive theories of Obsessive Compulsive Disorder (OCD), appraisals of intrusive thoughts as threatening, inappropriate or personally meaningful in some way, lead to neutralisation and other counterproductive coping strategies that can escalate and maintain the disorder (Rachman, 1997, 1998; Salkovskis, 1985; Salkovskis, Forrester, & Richards, 1998). Thought suppression is one such coping strategy that is frequently used by individuals with OCD (Freeston & Ladouceur, 1997; Purdon, Rowa, & Antony, 2007). There is evidence that suppression of a neutral thought can paradoxically make the thought more interfering or increase its frequency during suppression (i.e. immediate enhancement of thoughts; Wegner & Erber, 1992; Wegner, Schneider, Carter, & og White, 1987) or after suppression ceases (thought rebound; Wegner et al., 1987). According to the ironic processes theory of mental control (Wegner, 1994), two cognitive processes are at work during thought suppression: a capacity-limited, attention demanding operating process that searches for distracters to promote suppression; and an automatic monitoring process that is relatively independent of cognitive capacity, keeping track of suppression failures. Immediate enhancement of suppressed thoughts occurs when the operating process is disrupted (e.g. with cognitive load imposed by a concurrent task), but a rebound of thoughts is observed when the monitoring process continues its vigilance when the operating process stops (Wegner, 1994; Wenzlaff & Wegner, 2000).

Even though thought suppression is part of the clinical presentation of OCD, experimental results are not clear regarding its role in the escalation of intrusive thoughts. A meta-analysis of results from 28 studies revealed no overall immediate enhancement from thought suppression but a small but significant rebound effect (Abramowitz, Tolin, & Street, 2001). In studies more relevant to OCD, several studies have found either immediate enhancement or rebound effects from suppression of negative intrusive thoughts in non-clinical samples (McNally & Ricciardi, 1996; Salkovskis & Campbell, 1994; Trinder & Salkovskis, 1994), while others have not (Belloch, Morillo, & Giménez, 2004; Corcoran & Woody, 2009; Grisham & Williams, 2009; Purdon, 2001; Purdon & Clark, 2001).

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http://dx.doi.org/10.1016/j.brat.2012.11.008

Only a few studies have been conducted on OCD patient samples and those have shown little evidence for either paradoxical or immediate enhancement effects of thought suppression (Janeck & Calamari, 1999; Najmi, Riemann, & Wegner, 2009; Purdon, Rowa, & Antony, 2005).

Although currently there is little evidence for the role of suppression in obsessional problems through increased thought frequency above non-suppression, suppression may be a complicating factor that aggravates obsessional problems. Repeated suppression of thoughts puts load on the individual by taxing cognitive resources that can make thought control and self-regulation more difficult (Najmi & Wegner, 2009). The importance of cognitive resources in successful thought suppression may have been underestimated (Wenzlaff & Wegner, 2000). This pertains particularly to immediate enhancement effects that result from reduced efficiency of the capacity limited operating process. Studies show that competition for available cognitive resources by imposing cognitive load with a concurrent cognitive task (e.g. memory task) or cognitive demands (e.g. time pressure), diminishes thought control and the material to be suppressed becomes more accessible and influential (Wegner & Erber, 1992; Wegner, Erber, & Zanakos, 1993; Wenzlaff & Bates, 1998). Only a few studies have assessed cognitive ability in relation to thought suppression, but there is some support for the role of working memory capacity in general, and resistance to proactive interference in particular, in the effectiveness of suppression. Working memory capacity represents the ability to simultaneously store and process material for later retrieval (Conway & Engle, 1994; Rosen & Engle, 1998) that requires relevant material being kept active while irrelevant material is inhibited (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). Such inhibitory control or cognitive inhibition (i.e. suppression of a previously activated cognitive representation; Harnishfeger & Bjorkland, 1993) is implicated in working memory capacity with studies showing that greater capacity is related to the ability to resist proactive interference (interference from previously but no longer relevant material; Kane & Engle, 2000; Rosen & Engle, 1998; see also Redick, Heitz, & Engle, 2007). Frequency of neutral (Brewin & Beaton, 2002) and negative thoughts (Brewin & Smart, 2005) during thought suppression is negatively correlated with a measure of working memory capacity, indicating that efficient suppression relies on flexible and goal-directed control of attention. Results from a recent study by Bomyea and Amir (2011) suggest that inhibition of irrelevant information may be particularly important in this respect. In this study, participants that underwent working-memory training that required good inhibitory control because of high levels of proactive interference during the training, showed greater improvements in working-memory capacity and fewer intrusions during thought suppression, compared to participants that underwent working-memory training that required low inhibitory control because of lower levels of proactive interference (Bomyea & Amir, 2011). Cognitive ability in the form of control over irrelevant material (e.g. proactive interference) may therefore moderate the effect thought suppression has on thought frequency in a way that better resistance to this interference results in more efficient suppression.

Thought suppression may also complicate conditions by interfering with the processing of thoughts and emotions. Suppression results in smaller reduction in frequency of OCD-relevant thoughts, compared with no suppression (Belloch et al., 2004; Corcoran & Woody, 2009; Grisham & Williams, 2009; Purdon, 2001), indicating that it may interfere with the normal processing of thought material that would be expected to take place after repeated exposure to thoughts (Clark, 2004, p. 127). Similar effects have been observed for negative mood within a thought suppression task (Najmi et al., 2009; Purdon, 2001). Such suppression may influence the rate of habituation to thoughts or emotions, which could increase subsequent avoidance and compulsive behaviours that have the goal of reducing emotional distress and likelihood of feared outcomes. Any influence of thought suppression on subsequent avoidance and compulsive behaviours has, to date, not been studied. Because thought suppression can enhance attentional biases on cognitive tasks (Lavy & van den Hout, 1994; Tolin, Abramowitz, Przeworski, & Foa, 2002, Experiment 2) and attentional training involving threat material can influence avoidance behaviour on a behavioural approach task (Najmi & Amir, 2010), thought suppression can be expected to influence performance on a subsequent behavioural avoidance task (BAT) by either increasing avoidance and/or strengthening affective and cognitive responses. Thought suppression may also increase avoidance behaviour through perceived failures in thought suppression. Negative appraisals of failed suppression attempts (i.e. thought reoccurrences associated with undesirable personality characteristics and future negative events) can increase negative mood (Purdon, 2001; Purdon et al., 2005). Research results show that beliefs in the importance of thoughts and thought control are among the types of meta-cognitive beliefs that characterize OCD patients (OCCWG, 1997, 2005). Failed suppression attempts should be particularly detrimental for those holding these types of beliefs and can be expected to influence emotional responding and fuel subsequent avoidance and compulsive behaviours.

There is mounting evidence that disgust plays a role in certain types of OCD symptoms, in particular washing and contamination related symptoms (for a comprehensive review see Olatunji, Cisler, McKay, & Phillips, 2010). Although longitudinal studies are lacking on the role of disgust in OCD, the evidence suggests that disgust propensity and/or sensitivity predict washing symptoms independently of anxiety and depression (Olatunji, Sawchuk, Arrindell, & Lohr, 2005). Further, the evidence also suggests that they mediate the relationship between contamination related symptoms and negative affectivity (Olatunji, Lohr, Sawchuk, & Tolin, 2007) and avoidance during a behavioural avoidance task involving disgust eliciting stimuli (Deacon & Olatunji, 2007). The emotion of disgust may therefore play a causal role in contamination related OCD with increased disgust propensity or sensitivity acting as a vulnerability factor for the development and maintenance of OCD symptoms. No studies have been carried out on suppression of disgust invoking stimuli to date but, as noted earlier, suppression of fear/anxiety related thoughts has resulted in sustained or increased levels of negative mood (Najmi et al., 2009; Purdon, 2001). Since suppression terminates exposure to the thought being suppressed, thought suppression should interfere with emotional processing of disgust evoking material, resulting in both increased recurrence of thoughts and levels of disgust, motivating behavioural avoidance in line with previous studies of the avoidance function of disgust in OCD (Deacon & Olatunji, 2007; Olatunji et al., 2010).

The current aims

The main objectives in the present study were to investigate the effect of thought control instructions (suppression vs. do not suppress) on thought frequency, emotions and performance on a behavioural avoidance test and to see if cognitive ability (resistance to proactive interference) interacted with thought suppression in this relationship. We studied this for participants that differed in their level of vulnerability to disgust related material by selecting participants that were either high or low in disgust propensity and sensitivity and showed them a disgust-inducing

film clip. This allowed us to construct a behavioural test that was directly related to the stimuli used in the thought suppression task.

Our prediction was that instructions to suppress disgust related thoughts, would lead to sustained or increased frequency of thoughts when suppression was lifted, but that reduced frequency during the second interval of the thought suppression task would be seen for those participants who did not suppress thoughts. It was expected that the effect of suppression would be particularly pronounced for participants high in disgust propensity/sensitivity. Given that thought suppression is a demanding cognitive task involving inhibition (Wegner & Erber, 1992; Wenzlaff & Wegner, 2000), we expected that the immediate enhancement effect of thought suppression would be observed in participants with poor inhibition abilities. Finally, we predicted that thought suppression would increase avoidance behaviour on a subsequent task and induce stronger self-reported negative affective and cognitive responses during the task.

Method

Participants

Sixty students at the University of Iceland, participated (43 females). Their age ranged from 19 to 54 years ($M = 27.93$; $SD = 8.25$). Initially, 996 students responded to an email sent to all students at the University of Iceland ($n \approx 10{,}000$) where they were asked to answer the Disgust Propensity Sensitivity Scale-Revised (DPSS-R) over the Internet. Of those 996, 402 agreed to be contacted regarding participation in a related study. To select participants high or low in disgust propensity/sensitivity, a tertile split was performed on the DPSS-R total scores of these 402 respondents and participants in the upper ($n = 116$) and lower ($n = 158$) tertiles were contacted via email. Two reminders were sent and recruitment ended when 30 participants had been recruited from each group. The difference between the mean DPSS-R scores was significant ($M = 47.37$ ($SD = 4.57$) and $M = 26.90$ ($SD = 2.21$)) in the high and low disgust groups respectively ($t(41.96) = 22.08$, $p < .001$). Participants in each group were randomly assigned to groups with one of the two types of thought control instruction. Participants were paid 1,500 ISK (approx. 10 €) for participation.

Materials

Disgust propensity and sensitivity

The *Disgust Propensity and Sensitivity Scale Revised* (DPSS-R; van Overveld, de Jong, Peters, Cavanagh, & Davey, 2006) was used to measure the general tendency to experience disgust (i.e. disgust propensity) and negative appreciation of this emotion (i.e. disgust sensitivity). The Icelandic translation of the DPSS-R has good psychometric properties (Ólafsson, Emmelkamp, Kristjánsson, & Olason, in preparation). In the present study, the Cronbach's alpha for the total score was good, or .91.

Anxiety and depression

The *Hospital Anxiety Depression Scale* (HADS; Zigmond & Snaith, 1983) is a 14 item self-report questionnaire assessing symptoms of anxiety and depression with two seven-item subscales. The Icelandic translation has shown good psychometric properties (Magnússon, Axelsson, Karlsson, & Óskarsson, 2000; Schaaber, Smári, & Óskarsson, 1990). The internal consistency of the anxiety and depression scales in the present study was .82 and .73 respectively.

OCD related questionnaires

The *Obsessive Compulsive Inventory-Revised* (OCI-R; Foa et al., 2002) was used to assess distress related to OCD symptoms. The Icelandic translation of the OCI-R has demonstrated good psychometric properties (Smári, Ólason, Eyþórsdóttir, & Frölunde, 2007). OCD related beliefs and assumptions were assessed with the *Obsessive Beliefs Questionnaire-44* (OBQ-44; OCCWG, 2005). The psychometric properties of the Icelandic version of the OBQ-44 have been found to be good for a sample of university students (Pétursdóttir, 2008). Internal consistency of the total score of the OBQ-44 ($\alpha = .95$), and the inflated responsibility/threat estimation ($\alpha = .89$), perfectionism/need for certainty ($\alpha = .93$) and importance of thoughts/need to control thoughts ($\alpha = .81$) subscales was good in the present study. Fear of contamination was measured with the 10 item contamination obsessions and washing compulsions subscale (COWC) of the *Padua Inventory-Washington State University Revision* (PI-WSUR; Burns, Keortge, Formea, & Sternberger, 1996). The Icelandic version of the PI-WSUR has acceptable psychometric properties (Jónsdóttir & Smári, 2000). Here, the internal consistency of the scale was .87.

AB–AC paired associates test

The AB–AC test, devised by Rosen and Engle (1998), was used to measure pro-active inhibition (i.e. cognitive inhibition). This task has been used to measure inhibition of information in working memory (see Redick et al., 2007), which has been connected with repetition of unwanted thoughts in previous studies (Friedman & Miyake, 2004; Verwoerd, Wessel, & de Jong, 2009). E-Prime was used for task presentation on a 15 inch monitor (see Wessel, Overwijk, Verwoerd, & de Vrieze, 2008 for detailed description).[1] Here, two lists with paired associates were constructed with 12 word pairs on each list. The 12 cue words came from six categories (tools, metals, body parts, sweets, drinks and instruments), two words from each category. For the AB list compound words were selected to form pairs with strong associations (for example piano and chair form a single word in Icelandic (*píanóstóll*) so piano (*píanó*) served as cue and chair (*stóll*) as target in the AB list). All targets were single syllable words. For the AC list, we selected 12 target words that were unrelated to the cue words to form pairs with weak associations. The target words in this list came from six categories (milk products, animals, vehicles, vegetables, furniture and sports) and were all single syllable words (for example piano (*píanó*) was associated with lettuce (*kál*) as target in the AC list). The task started with a practice phase and the AB and AC stages then followed. Both stages consisted of a study phase where each cue word and its target were presented together on the computer screen once. This was then followed by a test phase where each cue word was presented on the screen in a fixed random order and participants had to name the target word within 1.3 s from cue presentation. Three correct responses were required before any given cue stopped appearing. An experimenter coded the response using a serial response box as: correct response = correct target word within time limit; no response = no target word named within the time limit; intrusion = target word B named instead of target C (coded in the AC list stage only); other = other incorrect targets or words. The number of AB list intrusions during the AC learning phase (i.e. number of B responses when C was correct), was used to measure proactive interference.

[1] We thank Johan Verwoerd for providing us with the program of the AB–AC task for E-Prime.

Emotional state following film viewing

Following viewing of the disgust-inducing film, participants were asked to indicate, on a nine point scale, how they felt using 14 emotion labels representing seven emotion categories: 1) joyful, merry ($\alpha = .98$); 2) angry, irritated ($\alpha = .68$); 3) disgusted, repulsed ($\alpha = .93$); 4) anxious, stressed ($\alpha = .66$); 5) neutral, disinterested ($\alpha = .47$); 6) sad, downhearted ($\alpha = .92$); and 7) surprised, amazed ($\alpha = .91$). Scores for each emotion category were computed by summing across emotion labels within the category.

Thought suppression task questionnaire

After each of the two intervals in the thought suppression task, participants answered a short questionnaire assessing affective reactions by indicating on a nine point scale (1 = not at all, 9 = very much) how anxious, tense, disgusted, repulsed, sad and downhearted they felt right now. They also rated their suppression effort (How hard did you try to suppress the thoughts during the task?) serving as a manipulation check. Suppression group participants also rated suppression difficulty following the first interval (How difficult was it to suppress the thoughts?). Effort and difficulty was rated on a 100 mm VAS scales with anchors (Did not try at all/Not difficult at all and Tried very hard/Very difficult).

Behavioural task rating scale

A Behavioural Task Rating Scale (BTRS; see Olatunji et al., 2007) was used to assess participants' responses during the behavioural avoidance task. The BTRS consists of eight statements about subjective, motoric, physiological and cognitive appraisals related to fear and disgust during the task. Participants gave their ratings immediately following the task on an 11-point scale ranging from 1 (not at all true) to 11 (very true). We added one statement at the end of the rating scale to assess participants urge to wash and clean oneself (During the task I felt the urge to wash my hands or clean myself).

Film stimuli

The film clip used to elicit disgust was a 2.5 min excerpt from an educational TV episode available on the internet showing small larvae under human skin that were being squeezed out and maggots crawling and eating away at a piece of meat and a rotting buffalo cadaver.

Behavioural avoidance task

Participants had to approach a piece of meat in a small non-transparent plastic box. The box was covered with a white cloth and was placed on a table about 3 m away from participants. The meat was fresh but had been made to look like it was old and rotting. Participants were told that the meat had been kept at room temperature for approximately 10 days which is the usual time required for maggots similar to the ones in the film clip to start to forming in the meat. The task was to approach the table and touch the meat in the box, either with the fingers or a pencil. An experimenter observed the participants' performance, registering which steps were completed: 1) participate in the task; 2) approach the table, 3) remove the cloth from the box, 4) open the container, 5) touched the meat with pencil, 6) touched the meat with fingers.

Procedure

The study was reported to the Data Protection Authority of Iceland and approved by the National Bioethics Committee. On arrival, participants filled in the self-report questionnaires in a fixed order (DPSS-R, OCI-R, COWC, OBQ-44, HADS) and performed the AB–AC paired-associates test. They were then seated in front of a computer screen to watch the film clip and rated their emotional state following the clip before participating in the thought suppression task. The task consisted of two 5 min thought intervals and followed the general procedures described in previous studies (Corcoran & Woody, 2009; Purdon, 2001; Purdon & Clark, 2001; Purdon et al., 2005; Salkovskis & Campbell, 1994; Salkovskis & Reynolds, 1994). Participants within the low and high disgust groups were randomly assigned to receive either suppression or no-suppression instructions in the first interval of the task, leaving 15 participants in each condition within each group. All participants received the same no-suppression instructions in the second interval of the task. The task instructions were modelled after Salkovskis and Campbell (1994). Participants in the suppression group were told before the first interval that they should monitor their thoughts and for the next 5 min they could think of anything they liked but if their thoughts related to the subject of the film clip, for example larvae or maggots or something that they lived in, they should press the counter in their hand and try as hard as they could to suppress the thoughts. They were to keep on doing this until the experimenter re-entered the room. Participants in the no-suppression group received highly similar instructions but were asked not to suppress the thoughts but let them flow freely. Similar no-suppression instructions were given to both groups before the second interval. Immediately following both intervals, participants filled in the thought-suppression task questionnaire. Following the second interval, the experimenter introduced the behavioural avoidance task and asked participants if they would be willing to participate. The experimenter then registered the steps they completed. The BTRS was then administered, and participants received payment for participation.

Statistical analysis

SPSS 19 was used for all statistical analyses. Hierarchical regression analyses were conducted with an SPSS macro called PROCESS (Hayes, 2012a). PROCESS is intended for mediation and moderation analysis and their combination (path-analysis based conditional process modelling, Hayes, 2012b).

Results

Preliminary analyses

Group membership and symptom measures

To verify assignment of participants to disgust groups based on their scores from the internet survey, a univariate 2×2 ANOVA was conducted with total DPSS-R as dependent variable and group membership (high vs. low in disgust) and type of instruction (suppression vs. do not suppress) as independent variables (see Table 1). A significant main effect of group membership was found, $F(1, 56) = 105.94$, $p < .001$, but not of instruction type nor was there an interaction between the two ($p > .10$). This means that assignment to disgust groups and random assignment to instruction conditions was successful.

Group differences on the symptom measures were investigated with univariate ANOVA's with group membership and instruction type as factors (see Table 1 for means and standard deviations). There were no significant differences between type of instruction

Table 1
Means (standard deviations) by group for the questionnaire measures.

	Low disgust group		High disgust group	
	Do not suppress ($n = 15$)	Suppress ($n = 15$)	Do not suppress($n = 15$)	Suppress ($n = 15$)
DPSS-R	27.87 (3.44)	27.13 (3.18)	42.4 (7.02)	41.2 (6.68)
HADSanx	5.27 (3.10)	3.80 (2.54)	6.80 (3.19)	6.67 (3.70)
HADSdep	2.40 (2.29)	1.87 (1.36)	2.87 (3.25)	3.33 (2.69)
OCI-R	9.20 (4.72)	9.33 (4.32)	20.64 (6.48)	19.93 (9.81)
COWC	2.87 (1.81)	3.13 (2.85)	10.20 (6.14)	5.93 (4.70)
OBQ-44	106.40 (28.51)	103.07 (32.29)	144.60 (41.73)	135.07 (35.17)

Note: DPSS-R = Disgust Propensity and Sensitivity Scale-Revised total score; HADSanx = Hospital Anxiety Depression Scale anxiety score; HADSdep = Hospital Anxiety Depression Scale depression score; OCI-R = Obsessive–Compulsive Inventory-Revised total score; COWC = Padua Inventory Washington State University Revision fear of contamination score; OBQ-44 = Obsessive Beliefs Questionnaire-44 total score.

on any of the symptom measures ($p > .07$ in all cases) nor were depression scores different between disgust groups ($p > .10$). The main effect of group membership was significant on the anxiety subscale of the HADS, the OCI-R and OBQ-44 total scores ($p < .05$ in all cases). The main effect of group membership on the fear of contamination scale (COWC) was also significant, $F(1, 56) = 9.78$, $p < .001$, but was qualified by a significant interaction between group membership and instruction type, $F(1, 56) = 4.3$, $p < .05$. *T*-tests showed that, in the high disgust group, the mean on the COWC was significantly higher in the no-suppression group than in the suppression group, $t(16.41) = 4.44$, $p < .001$, but the difference was not significant in the low disgust group, $t(28) = 1.97$, $p = .06$ (see Table 1).

Manipulation check

To test whether participants followed instructions, a 2 × 2 × 2 mixed ANOVA assessed suppression effort (see Table 2) as a function of interval (interval 1 vs. interval 2; a within subjects factor), group membership (high vs. low disgust) and instruction type (suppression vs. do not suppress). The main effect of interval, $F(1, 56) = 58.85$, $p < .001$, was significant, but qualified by a significant interval by type of instruction interaction as expected, $F(1, 56) = 24.40$, $p < .001$. The interval by group interaction was not significant, which indicates that suppression effort was successfully manipulated with instruction.

Table 2
Means and standard deviations by group for measures in the thought suppression task.

	Suppress ($n = 30$)		Do not suppress ($n = 30$)	
	Interval 1	Interval 2	Interval 1	Interval 2
High disgust group ($n = 30$)				
Suppression				
Effort	54.17 (36.56)	13.11 (19.86)	27.50 (20.66)	13.33 (13.62)
Difficulty[a]	30.89 (37.39)			
Thought frequency	8.33 (7.68)	8.47 (8.90)	9.87 (5.59)	6.40 (4.79)
Emotions				
Disgusted/repulsed	5.13 (5.26)	4.60 (4.79)	4.60 (2.87)	3.20 (2.27)
Anxious/tense	4.60 (3.04)	4.00 (3.34)	4.27 (2.12)	3.07 (1.28)
Sad/downhearted	2.53 (1.60)	2.20 (.41)	2.93 (2.12)	3.13 (2.95)
Low disgust group ($n = 30$)				
Suppression				
Effort	42.83 (32.77)	6.44 (6.40)	11.78 (13.20)	9.17 (13.23)
Difficulty[a]	31.17 (28.58)			
Thought frequency	6.33 (5.63)	6.60 (5.34)	9.20 (5.10)	7.40 (5.11)
Emotions				
Disgusted/repulsed	2.00 (.00)	2.00 (.00)	2.47 (1.13)	2.13 (.52)
Anxious/tense	2.87 (1.46)	2.47 (1.13)	2.80 (1.08)	2.20 (.56)
Sad/downhearted	2.00 (.00)	2.00 (.00)	2.00 (.00)	2.00 (.00)

[a] Suppression difficulty was only rated in the suppression group after interval 1.

Emotions following the film clip

Emotional reactions following the film were analysed using MANOVA with group membership and instruction type as factors and the seven subscales of the emotional reactions questionnaire as dependent variables. The main effect of group membership was significant, $F(7, 50) = 3.39$, $p < .05$, but the main effect of instruction type and the interaction between the two was not ($p > .10$). Inspection of the between-subjects effects on each emotion scale and the corresponding means of the high vs. low disgust groups, revealed significant differences on joyful/merry ($M = 8.47$, $SD = 4.84$ vs. $M = 12.53$, $SD = 2.90$), angry/irritated ($M = 2.90$, $SD = 1.90$ vs. $M = 2.03$, $SD = .18$), disgusted/repulsed ($M = 8.30$, $SD = 5.78$ vs. $M = 3.53$, $SD = 2.22$), anxious/stressed ($M = 4.97$, $SD = 3.78$ vs. $M = 2.77$, $SD = 1.45$), depressed/downhearted ($M = 2.57$, $SD = 1.25$ vs. $M = 2.03$, $SD = .18$) and surprised/amazed ($M = 6.20$, $SD = 3.50$ vs. $M = 3.77$, $SD = 3.70$) but not on neutral/disinterested ($M = 5.63$, $SD = 3.45$ vs. $M = 5.53$, $SD = 3.35$).

Thought suppression task

Thought frequency

The data were logarithmically transformed to reduce positive skew in the thought frequency data. Raw frequency means and standard deviations are reported in Table 2.

To examine the impact of thought suppression and group membership on thought frequency by thought interval, a mixed ANOVA was conducted with group-type (high vs. low disgust) and instructions (suppress vs. do not suppress) as between-subject factors and thought interval (interval 1 vs. interval 2) as within-subject factor. The within-subjects main effect of interval was significant, $F(1, 56) = 9.82$, $p < .01$, qualified by a significant interval by instruction-type interaction, $F(1, 56) = 9.07$, $p < .01$ (Fig. 1, left panel). Frequency of disgust related thoughts declined between intervals for the monitoring group but no significant decline was observed for the suppression group. Other interactions were not significant ($p > .10$). Similar analyses with HADS depression and anxiety scores as covariates, did not change the main results, nor with COWC scores as covariate.

We also investigated the percentage of participants showing thought rebound on the thought control task. Simple difference scores were computed by subtracting frequency of thoughts during the first interval from frequency of thoughts in the second interval. The product is an index of change in thought frequency during the task that takes a positive value for a thought rebound (greater frequency of thoughts in the second interval). Based on this index, thought rebounds were found for 17 (56.7%) participants in the thought suppression group compared to only 4 (13.3%) in the no-suppression group. This association between instruction and thought rebound was significant, $X^2(1) = 12.38$, $p < .001$. There was no association between disgust group and thought rebound ($p > .10$).

Cognitive inhibition was hypothesised to influence thought frequency during suppression such that poor inhibitory ability would result in higher frequency, especially in the thought-suppression group. To use cognitive control as indexed by the level of intrusions on the AB–AC task in the following analysis, two categories were created with those having no intrusions on the task (high cognitive inhibition; $n = 30$) and those having one or more intrusions on the task (low cognitive inhibition; $n = 30$). An ANOVA with type of instruction, type of disgust group and cognitive inhibition (low vs. high) as between subject factors and frequency of thoughts in the first interval as the dependent variable revealed

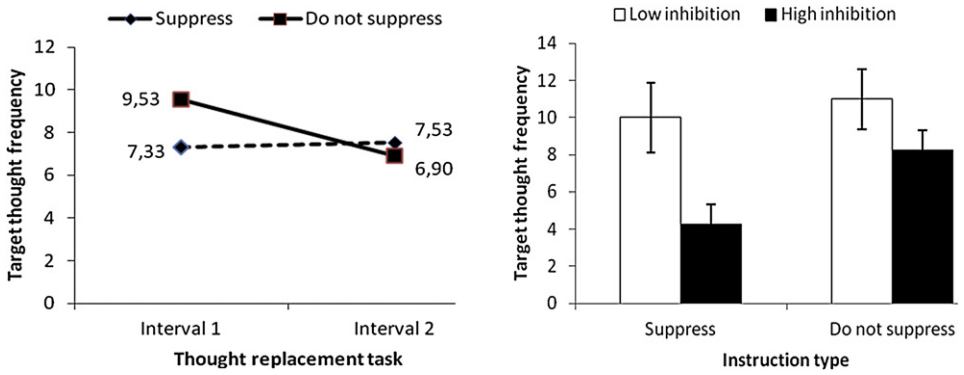

Fig. 1. Target thought frequency in the thought suppression task. Note: Left panel shows frequency of target thoughts by thought control instruction during both intervals of the thought suppression task. Right panel shows target thought frequency during the first interval by instruction type and inhibition ability.

a significant main effect of instruction type, $F(1, 52) = 5.18$, $p < .05$, which reflected lower thought frequency in the suppression group as revealed in the previous analyses. The main effect of cognitive inhibition was also significant, $F(2, 52) = 6.71$, $p < .05$ where low inhibition ability was associated with greater thought frequency ($M = 10.47$, $SD = 6.79$) than high inhibition ability ($M = 6.40$, $SD = 4.52$). The interaction between type of instruction and cognitive inhibition showed a trend towards significance, $F(2, 52) = 3.06$, $p = .086$ (Fig. 1, right panel). An inspection of the means indicated that lower thought frequency in the suppression group was observed for participants with high ($n = 14$, $M = 4.29$, $SD = 3.99$) but not low ($n = 16$, $M = 10.0$, $SD = 7.52$) cognitive inhibition abilities. In the no-suppression group, thought frequency was comparable for low ($n = 14$, $M = 11.0$, $SD = 6.08$) and high ($n = 16$, $M = 8.25$, $SD = 4.25$) inhibitors. Independent sample t-tests confirmed that the difference between good and poor inhibitors was significant in the suppression group, $t(28) = -2.94$, $p < .01$, but not in the no-suppression group, $t(28) = -.80$, $p > .10$. Cohen's d (Cohen, 1988), as a measure of the magnitude of the differences between means, showed a medium sized difference in the suppression group (Cohen's $d = .48$) but a very small difference in the no-suppression group (Cohen's $d = .15$). Including COWC scores as a covariate in the analyses did not change the results. These results indicate that thought suppression only affected thought frequency for participants with good cognitive inhibition abilities.

Emotional responding

Means and standard deviations by group and instruction-type for the three emotional reaction scales (anxious/stressed, disgusted/repulsed and depressed/downhearted) are shown in Table 2. Explorations of the distributions within each group revealed little or no variance in state emotion scores in the low disgust group (see standard deviations in Table 2). The analyses were therefore only carried out for the high-disgust group, using three 2 × 2 mixed ANOVA's with type of instruction and interval as factors. Logarithmic transformations were used to correct for positive skew. With disgusted/repulsed as the dependent variable, a significant main effect of interval was observed, $F(1, 28) = 16.44$, $p < .001$, qualified by a significant interval by instruction-type interaction, $F(1, 28) = 6.31$, $p < .05$. With anxious/stressed as the dependent variable, a significant main effect of interval was observed, $F(1, 28) = 20.84$, $p < .001$, but the interaction was not significant ($p > .10$). No significant effects were observed with sad/downhearted as the dependent variable ($p > .10$). When including COWC scores as a covariate, the interval by instruction interaction was marginally significant ($p = .062$) with disgust/repulsed as the dependent variable. This means that suppression leads to sustained disgust levels throughout the task. This pattern seems to be specific to disgust and repulsion reactions compared to anxiety and stress. As before, repeating the same analyses with HADS depression and anxiety scores as covariates did not affect the results.

Behavioural avoidance test

Avoidance behaviour

All observers agreed to participate in the behavioural task. In total, 29 (48.3%) participants finished the task and touched the meat with their fingers, while 27 (45.0%) participants finished five steps of the task by touching the meat with a pencil. The remaining four (6.7%) participants all finished three steps and removed the table-cloth but did not go further. We divided the observers into two categories, those who completed the task and those who did not, and computed 2 × 2 frequency tables with chi-square analyses to investigate the relationship between task performance, disgust group and instruction-type. Only 5 participants (16.7%) of the 30 in the high disgust group compared to 24 (80.0%) of the 30 in the low disgust group finished the task, $X^2(1) = 24.09$, $p < .001$. There was no significant association between instruction-type and task performance ($p > .10$).

Participant responses during the behavioural avoidance task

Fear and disgust reactions during the BAT were investigated by adding fear and disgust scores across the four response domains on the BTRS. Two separate 2 × 2 ANOVA's with group and instruction-type as factors tested whether participants' responses during the task depended on trait disgust and suppression instructions. Fear reactions for the high disgust group ($M = 13.97$, $SD = 10.81$) were stronger than for the low disgust group ($M = 5.80$, $SD = 3.29$), $F(3, 56) = 15.21$, $p < .001$. This was also the case for disgust reactions, $F(3, 56) = 23.30$, $p < .001$, where the high disgust group scored higher ($M = 16.23$, $SD = 10.58$) than the low disgust group ($M = 6.43$, $SD = 3.48$). No other effects were significant. Including COWC scores as a covariate did not change the results. Greater trait disgust levels were, in other words, associated with increased disgust and fear reactions during the BAT, but this was not influenced by suppression instructions.

The surge and control of thoughts during the suppression-task and its effect on responding in the behavioural avoidance task

Hierarchical regression analyses were conducted to further investigate the link between thought-suppression and the BAT. According to cognitive theories of OCD, reoccurrences of thoughts should be detrimental for those who place greater importance on

thoughts and thought control, meaning that control beliefs should moderate the relationship between thought reoccurrences and outcome. To test this, we used both the thought difference score calculated previously, the importance of and need to control thoughts subscale of the OBQ44 and the interaction between the two to predict fear and disgust reactions on the BAT. The predictors were mean-centred before computing their interaction term. Thought difference and OBQ44 importance of control were entered on the first step and the interaction term between the two on the second step. When predicting disgust reactions, the final equation showed a marginally significant main effect of importance of control, $B = .290$, $t = 1.92$, $p = .060$, but not of thought difference, $B = .139$, $t = .425$, $p > .10$. The interaction term between the two contributed significantly to the prediction of disgust reactions over and above what could be accounted for by the main effects, $B = .106$, $t = 2.42$, $p < .05$. When entering disgust group membership and instruction type on the first step, to control for these factors in emotional responding, this interaction was close to being significant, $B = .071$, $t = 1.81$, $p = .075$, and is shown in Fig. 2. Beliefs concerning importance of thoughts and thought control moderate the effect of changes in thought frequency on emotional responding during the BAT, such that greater thought rebound predicts greater disgust responses when control beliefs become stronger (Fig. 2, left panel). Simple slope analyses show that this effect is significant at high OBQ scores (>26.6, that are scores that fall at least .13 standard deviations above the mean in the sample, Fig. 2, right panel). These analyses were repeated with fear reactions as the outcome, yielding a similar pattern of results (data not shown). Thus, changes in thought frequency in the suppression task only predicted increased fear and disgust reactions during the BAT in interaction with greater subjective importance of thoughts and thought control.

Discussion

In the present study, it was investigated whether suppressing disgust related thoughts, compared with no suppression, differentially affected target thought frequency and emotional responses, and whether this was related to participants' cognitive inhibition abilities. Thought suppression immediately reduced thought frequency during suppression when compared to no-suppression. Reduction in target thought frequency during suppression has frequently been observed (e.g. Belloch et al., 2004; Corcoran & Woody, 2009; Grisham & Williams, 2009; Purdon, 2001). Wenzlaff and Wegner (2000) argue that immediate enhancement of thoughts is more likely when the operating process is disrupted. Extra cognitive load may therefore be needed to elucidate the immediate enhancement effect of thought suppression but cognitive load was not manipulated here. On the other hand, we measured cognitive inhibition ability and found that poorer cognitive inhibition was associated with higher thought frequency in the first interval of the thought suppression task, and that there was a marginally significant interaction between inhibition and thought control instructions. These findings are consistent with the hypothesis that poor inhibition abilities are associated with greater thought frequency during suppression than good inhibition ability. According to the ironic processes theory of mental control (Wegner, 1994), this is because immediate suppression relies on a capacity limited and attentional demanding operating process. The present findings may therefore indicate that a part of the capacity of this process reflects the ability to resist interference from prior irrelevant information, which reflects the working of inhibition mechanisms. Proactive interference has been studied as one aspect of cognitive inhibition (Friedman & Miyake, 2004; Kane & Engle, 2000; Rosen & Engle, 1998), measured with number of different tasks, such as negative priming. Inhibition in terms of negative priming may be reduced in OCD (Enright, Beech, & Claridge, 1995), although the evidence is not unequivocal (Moritz, Kloss, & Jelinek, 2010). The association found between proactive interference and thought suppression efficiency in the present study, falls nicely in line with the results of Bomyea and Amir (2011) who showed that working memory training under conditions of high proactive interference resulted in less immediate intrusions during a subsequent thought suppression task. Together, these findings suggest that there may be a causal relationship between cognitive inhibition ability and frequency of intrusive thoughts. Further investigations of this are needed before definite conclusions can be drawn. Given the emphasis placed on the detrimental effects of cognitive load on suppression (Wenzlaff & Wegner, 2000), executive control processes such as inhibitory control should also be investigated in conjunction with cognitive load during suppression. Given inconsistent findings on the role of cognitive inhibition in OCD, it will be particularly important to approach the question of the role of executive control in OCD with various tests, as every test has unique qualities that measure part of the construct under study, but not the construct as a whole. Complex tasks that measure controlled attention by including simultaneous storage and processing components (i.e. working memory capacity; Barrett, Tugade, & Engle, 2004) may be interesting to use given that this ability has been implicated in both negative priming (Conway, Tuholski, Shisler, & Engle, 1999) and resistance to proactive interference (Redick et al., 2007).

Thought suppression, in contrast to no-suppression, was associated with sustained thought frequency after suppression was lifted and thought rebounds were more frequent for the

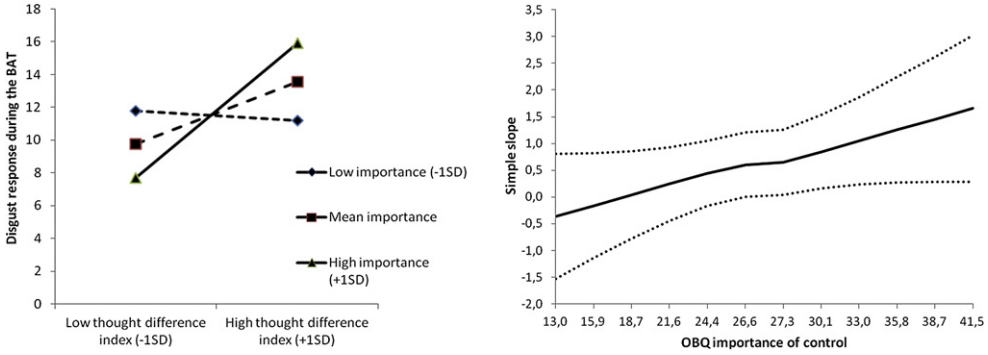

Fig. 2. Prediction of disgust reactions during the BAT. Note: Left panel shows interaction in linear regression between thought difference index (thought frequency during interval 2-thought frequency during interval 1 in the thought suppression task) and importance and control of thoughts subscale of the OBQ-44 when predicting disgust reactions during the behavioural avoidance task (BAT). Right panel shows the simple slopes with 95% confidence intervals for observed sample values of importance of control (the moderator) in this regression. The simple slope is significantly different from zero above values of 26.6 on the moderator.

suppression group than the no-suppression group (56.7% vs. 13.3%). Suppressing thoughts versus simply monitoring them differentially affected target thought frequency. This falls in line with previous studies where suppression interfered with habituation to thoughts, and led to either sustained thought frequency or a slower reduction in frequency compared to no-suppression (e.g. Belloch et al., 2004; Corcoran & Woody, 2009; Purdon & Clark, 2001). Suppression terminates exposure to the thoughts and associated emotions, which may prevent habituation. This fits with our finding that suppression led to sustained levels of disgust for participants high in disgust propensity/sensitivity when suppression was lifted, while no-suppression was associated with reductions in disgust. This suggests that participants in the suppression group showed less habituation to the disgust related material of the thoughts. This was not the case for anxiety, which shows specificity in emotional reactions to the thoughts. Previous results on effects of thought suppression upon emotions associated with thoughts are not consistent. Some studies show detrimental effects of thought suppression (i.e. Belloch et al., 2004; Purdon, 2001) while others do not (i.e. Corcoran & Woody, 2009; Grisham & Williams, 2009). One reason may be that different thoughts can elicit different emotions. Although thoughts involving danger and harm would be expected to elicit fear and anxiety, other thoughts often observed in OCD, such as blasphemous thoughts or thoughts of contamination, may also elicit feelings of guilt, shame and disgust. Future studies may benefit from incorporating a broader assessment of emotional responses during suppression.

Little is known about any causal role of thought suppression in OCD. We investigated the effect of thought suppression on responses to and performance on a subsequent behavioural task. This is a neglected, yet important area of research, given the cardinal role assigned to obsessions in compulsive behaviour. This is evident in both contemporary cognitive models (e.g. Rachman, 1998; Salkovskis et al., 1998) and current classification systems (APA, 2000). The hypothesis that thought control instructions would influence avoidance and responding during the task was not supported. Regression analyses showed, on the other hand, that changes in thought frequency during the task interacted with beliefs regarding importance of, and control of thoughts, when predicting disgust and fear during the BAT. This supports a moderating role of beliefs in the relationship between intrusive thoughts and compulsive behaviour, in line with cognitive conceptualisations of OCD that emphasize the importance of OCD-specific metacognitive beliefs in cognitive control (Clark, 2004; OCCWG, 1997). The present finding suggests that when beliefs in the importance of thoughts and thought control are high, reoccurrences of thoughts may be detrimental, perhaps because they are unexpected and evoke stronger emotional reactions. This could initiate further thought control attempts and motivate avoidance and compulsive behaviour. It should be noted that the interaction between thought rebound and control beliefs was marginally significant in the regression analysis after controlling for the main effect of instruction type and disgust group.

We hypothesized that high trait disgust would make participants more vulnerable to disgust related thoughts that would make the thoughts more difficult to control. However, no significant effect of trait disgust (the selection variable) on thought suppression was found. Group assignment seems to have been successful in the study, given significant differences between the high and low groups in trait disgust, reactions after the film clip and during the BAT. One possible explanation is that the DPSS-R questionnaire used in the study, measures the general tendency to experience disgust and react negatively to disgust, instead of assessing disgust reactions elicited by specific types or categories of stimuli. The disgust related material used (maggots) may therefore not have been as relevant for all participants in the high disgust group. But, assembling an adequately sized sample based on disgust elicited by a specific category may be unrealistic. Another explanation could be the use of the total score of the DPSS-R to form the groups, instead of subscale scores for propensity or sensitivity. We used the total score because the subscales are strongly correlated (Ólafsson et al., in preparation; van Overveld et al., 2006). The propensity and sensitivity subscales however, have shown different relationships with OCD related constructs in some studies although some inconsistencies exist (see review in Olatunji et al., 2010).

Given the link between disgust and contamination fear, changes in fear of contamination should, in future, be measured during the thought suppression task, which was not done in the present study. Also, a BAT that allows more detailed assessment of participants' approach/avoidance behaviour should be used in future studies since a majority of our participants completed either all steps on the BAT or five of the six steps, indicating a ceiling effect in performance on the task. It also deserves mentioning that we used a two-interval thought suppression task in the present study. Although the original version of the task includes three intervals with a monitoring interval before implementation of the experimental manipulation with thought control instructions, this first monitoring interval has also been dropped from the task in a number of important studies in the field (Corcoran & Woody, 2009; Purdon, 2001; Purdon & Clark, 2001; Purdon et al., 2005; Salkovskis & Campbell, 1994). Including a pre-monitoring interval can increase participants prior experience with the thought that may elicit spontaneous suppression reactions (i.e. practiced suppression; Corcoran & Woody, 2009) before the experimental manipulation is implemented. This can affect both thought frequency and emotional responding that are outcome measures in the task. Although the traditional three interval format of the task is a stronger design experimentally, as it provides a measure of pre-existing individual differences in target thought frequency, the two interval design is a more ecologically valid procedure as it captures more closely what actually happens during thought suppression (i.e. one does generally not start by observing distressing intrusive thoughts for some time before trying to suppress them), and was therefore used in the present study. Finally, the results are based on a relatively small student sample. There is need to replicate the present findings and to address their generalisation to clinical populations and older adults.

The present study adds to existing research on the role thought suppression and disgust play in OCD and the role cognitive abilities may have in control of intrusive thoughts. It also broadens the scope of previous studies of the subject by investigating effects that intrusive thoughts can have on performance on a subsequent behavioural task involving disgust related material. Future studies are needed to clarify this relationship, which may prove to be important for both theoretical formulations of OCD and treatment strategies aimed at reducing obsessions and compulsions.

Acknowledgment

This work was supported by a grant 100633021 from the Icelandic Research Fund, awarded to Jakob Smári and Paul M. G. Emmelkamp. Parts of this data were presented in 2011 at the 41st Annual Congress of the European Association for Behavioural and Cognitive Therapies in Reykjavík, Iceland.

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