8-2011

Imagery and Contamination Aversion

Thomas Grover Adams
University of Arkansas, Fayetteville

Imagery and Contamination Aversion

Imagery and Contamination Aversion

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Arts in Psychology

By

Thomas G. Adams, Jr.
University of Wisconsin-Milwaukee
Bachelor of Arts in Psychology, 2005

August 2011
University of Arkansas

Abstract

Contamination-based obsessive-compulsive disorder (OCD) is the most common form of OCD. Recent research indicates that the emotion of disgust may play a primary role in the etiology and maintenance in contamination-based OCD (CB-OCD). However, little is known about the effects of disgust on compulsive behaviors related to CB-OCD (e.g.,, hand-washing). The present study utilized an imagery-priming paradigm to test the effects of experienced disgust on compulsive hand-washing. Seventy-eight participants were selected for high or low symptoms of CB-OCD. Following response training, participants were submitted to a disgust or neutral imagery task. Following the imagery task, participants rated their subjective fear and disgust. Participants were then allowed to wash their hands and time spent washing was recorded. Results indicated that participants in the high CB-OCD group responded with more disgust and fear following the disgust and neutral imagery task. However, there were no differences in time spent washing regardless of script or severity of CB-OCD symptoms. These findings suggest that experienced disgust may not affect hand-washing behaviors. Limitations and future directions are discussed.

This thesis is approved for
recommendation to the
Graduate Council

Thesis Director:

_____

Jeffrey M. Lohr, Ph.D.

Thesis Committee:

_____

Matthew T. Feldner, Ph.D.

_____

William H. Levine, Ph.D.

Thesis Duplication Release

I hereby authorize the University of Arkansas Libraries to duplicate this thesis when needed for research and/or scholarship.

Agreed _____

Thomas G. Adams Jr.

Table of Contents

List of Tables

List of Figures

Imagery and Contamination Aversion

Introduction

Obsessive-compulsive disorder

Obsessive-compulsive Disorder (OCD) is a chronic condition that is characterized by severe obsessions and/or compulsions that cause an individual significant functional impairment [American Psychiatric Association (APA), 2000]. The content of obsessions vary among individuals with OCD; however, most obsessions pertain to fear of causing undo harm to oneself or others. Compulsions can be overt (e.g., hand-washing) or covert (e.g., mental rituals) acts that are repeatedly carried out in an attempt to prevent harm or assuage negative affect that results from obsessions. Among individuals with OCD, symptoms are usually severe (Kessler, Chiu, Demler, & Walters, 2005), chronic, and disabling in nature (Eisen & Steketee, 1998). The lifetime prevalence of OCD is estimated to be between 1% and 1.6% (Kessler, Berglund, Demler, Jin, Merikangas, & Walters, 2005), although some estimates are as high as 3.3%, which would make OCD the second most common anxiety disorder and the fourth most common psychiatric illness (Karno, Golding, Sorenson, & Burnam, 1988).

The two most commonly accepted diagnostic manuals – the fourth revision of the Diagnostic and Statistical Manual (DSM-IV-TR; APA, 2000) and the tenth revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10; World Health Organization, 2007) – both describe OCD as a homogenous construct. However, recent experimental analyses indicate that OCD is a heterogeneous disorder (McKay, Abramowitz, Calamari, Kyrios, Radomsky, Sookman, et al., 2004), comprised of multiple subtypes. Some of these subtypes may represent unique "disorders" in and of

themselves (e.g., hoarding symptoms; Abramowitz, Wheaton, & Storch, 2008). It has been suggested that a focus on specific symptom dimensions will improve the field's understanding of the development and treatment of OCD (Abramowitz, McKay, & Taylor, 2005). A majority of OCD sub-typing research has focused on the taxonomy of overt symptom presentations, appropriately labeled OC symptom clusters or symptom dimensions. Most research suggests that there are 4 symptom dimensions [excluding hoarding symptoms (Bloch, Landeros-Weisenberger, Rosario, Pittenger, & Lechman, 2008; McKay et al., 2004)]; including 1) contamination obsessions and washing compulsions; 2) harming obsessions and checking compulsions; 3) symmetry obsessions and ordering and counting compulsions; 4) intrusive sexual or immoral thoughts and mental compulsions. The most consistent and prevalent of these symptom dimensions is contamination-based (CB) (McKay et al., 2004; Rasmussen & Eisen, 1992), with 55% of individuals with OCD reporting CB symptoms (Rasmussen & Tsuang, 1986) and 47% of treatment seeking patients reporting CB symptoms as their primary complaint (Ball, Baer, & Otto, 1996).

Contamination-based obsessive-compulsive disorder

Rachman (2004) succinctly defined CB-OCD as "compulsive cleaning [that] is driven by fears of contamination. It is an attempt to clean away a perceived contaminant in order to reduce or remove significant threat posed by the contaminant" (pp. 1127). Individuals with CB-OCD usually endorse primary fears that fall into two categories; 1) fear of illness or disease and 2) fear of affectively arousal and physical discomfort (e.g., disgust and anxiety) associated with being contaminated (Cougle, Wolitzky-Taylor, Lee, & Telch, 2007; Feinstein, Fallow, Petkkova, & Liebowitz, 2003). As a result of these

fears, individuals with CB-OCD habitually avoid objects that are perceived as potentially contaminated (e.g., chemicals, bodily fluids, dirt) and engage in a variety of compulsive behaviors to prevent harm and discomfort when contact is unavoidable. These compulsions typically include cleaning behaviors such as hand-washing, sanitizer use, or showering. Traditionally, CB-OCD has been characterized as a disorder of chronic and pathological fear and anxiety (see Rachman, 2004). Although fear and anxiety undoubtedly play crucial roles (Cisler, Reardon, Williams, & Lohr, 2007; Olatunji, Williams, Lohr, Connolly, Cisler, & Meunier, 2007), recent research suggests that the emotion of disgust may be of greater or equal importance (Olatunji, Cisler, McKay, & Phillips, 2010). In order to appropriately understand the relative importance of disgust in CB-OCD, one must first appreciate the complexities involved in defining emotion.

Defining emotion

A number of theoretical models have attempted to define the construct of emotion. One of the most empirically-driven and commonly accepted of these models is Lang's bio-informational model of emotion (1968). Lang defined emotion according to three separate but related response systems: the physiological, verbal-cognitive, and motoric-behavioral. This level of analysis is akin to Rachman's (1978; 1998) three systems of fear, which defines fear according to the covariation of cognitive, behavioral, and physiological responses. According to the bio-informational theory of emotion, the emotional experience is conceptualized as a motor and conceptual "program" for responding to external stimuli (Lang, 1979). This "program" is akin to a blueprint that maps out the appropriate physiological, verbal, and motor response systems to prepare the individual for overt responding (Lang, Levin, Miller, & Kozak, 1983). The activation

of any given response system is dependent on the supposed function of the affective response, meaning that affective response systems are activated to prepare the organism for appropriate behavioral responding. For example, if the physical integrity of an organism is threatened, then appropriate response systems (e.g., increased heart rate) are activated to prepare the organism for an appropriate behavioral response (e.g., escape).

Disgust

Disgust is a universal emotion that serves the primary function of disease prevention (Oaten, Stevenson, & Case, 2009). Originally understood as a gustatory response, disgust was first conceptualized as a means for protecting the organism from the ingestion of potentially harmful substances (Rozin & Fallon, 1987). Accordingly, the response systems that are related to disgust can all be conceptualized within the framework of disease prevention and avoidance of oral incorporation.

The facial expressions associated with disgust – which are components of the motoric-behavioral response system – provide clear evidence that disgust is a food related emotion. In response to disgust eliciting stimulus (e.g., vomit), most humans will display several facial movements that are unique to disgust. The most characteristic facial expression associated with disgust is the gaping of the mouth and protraction of the tongue (Ekman, 1975). This expression is reliably expressed in both primates and non-primate mammals (e.g., rats; Parker, 2009). Specific facial actions include retracted upper lip, raised lower lip, wrinkling of the nose and a deepening of the nasolabial folds (Izard, 1971; Vrana, 1993). These characteristic features occur in response to foul tasting substances (e.g., quinine) and non-oral proprioceptive exposure to disgusting stimuli (e.g., the sight of soiled underwear; Chapman, Kim, Susskind, & Anderson, 2009).

The psychophysiology of disgust is characterized by a complex interaction between the parasympathetic and sympathetic nervous systems (Rohrmann & Hopp, 2008). The most robust cardiovascular index of disgust is increased heart rate variability (HRV; Rohrmann & Hopp, 2008). Several other physiological indices of disgust include increased salivation (van Overveld, de Jong, & Peters, 2009), increased gastrointestinal motility (Harrison, Gray, Gianaros, & Critchley, 2010), and increased skin conductance levels (SCL; van Overveld et al., 2009); although increased SCL is more related to autonomic arousal than any specific emotion. Lastly, the neural substrate most clearly associated with disgust is the anterior insula cortex (Calder, Lawrence, & Young, 2001; Phillips, Young, Senior, Brammer, Andrew, Calder, et al., 1997). However, disgust is also associated with activation of numerous other brain regions, including the basal ganglia, thalamus, somatosensory cortex (Calder, Beaver, Davis, Van Dithzhuijzen, Keane, & Lawrence, 2007), right superior temporal gyrus, bilateral parahippocampal gyri, right putamen, right globus pallidus, left middle occipital cortex, left posterior cigulate gyrus, and the right dorsolateral prefrontal cortex (Phillips, Young, Scott, Calder, Andrew, Giampietro, et al., 1998).

Behaviorally, disgust motivates three classes of behaviors, aversion, escape, and avoidance (Adams, Brady, & Lohr, in press). Aversion is characterized as the rejection of a stimulus away from the organism (Adams et al., in press). For example, animal will reliably expel foul tasting substances away from its mouth (Parker, 2009). If it is not feasible for the organism to reject a disgust-inducing stimulus from itself, then escape from the stimulus is to be expected. For example, most individuals will flee from a foul smelling room or back away from disgusting stimuli such as bugs, blood, and feces.

Moreover, organisms will reliably avoid situations and stimuli that have previously elicited disgust reactions (Garcia & Kimeldorf, 1955).

The assessment of avoidance is traditionally accomplished by testing participant willingness to engage in a given task. Accordingly, these tasks are frequently labeled behavioral *avoidance* tasks. However, it is clear that such procedures have been designed to quantify the amount of *approach* behavior an individual performs relative to a prepared stimulus. Given this consideration and the fact that avoidance as a behavior must be inferred from the failure to continue with subsequent steps of the procedure the more appropriate label for these assessments is behavioral approach task (BAT).

The measurement of disgust-specific approach, avoidance, escape, and rejection is lacking within the experimental literature. One disgust-specific study of behavioral approach has been conducted (Rozin, Haidt, McCauley, Dunlop, and Ashmore, 1999). In this study, Rozin and colleagues showed that disgust sensitivity (the degree of distress associated with feeling disgusted) predicted less behavioral approach of disgusting and not neutral stimuli.

Disgust in contamination-based OCD

Symptoms of CB-OCD are highly related to self-report trait disgust (Woody & Tolin, 2002), even after controlling for trait anxiety and negative affect (Olatunji, Sawchuk, Arrindell, & Lohr, 2005). Individuals with elevated symptoms of CB-OCD also report significant amounts of disgust and fear when presented with disorder-relevant stimuli (Deacon & Olatunji, 2007). Moreover, self-reported disgust reactions to disorder-relevant stimuli are predictive of phobic avoidance of said stimuli (Deacon & Olatunji, 2007). Disgust may also operate as a risk factor for the development of CB-OCD.

Olatunji (2010) reported that changes in disgust sensitivity prospectively predicted changes in CB OC symptoms over a 12-week period.

Studies focused on psychophysiological reactions in CB-OCD are sparse and difficult to interpret. This is likely due to the fact that this research preceded current knowledge regarding disgust in CB-OCD and thus did not attempt to differentiate between fear and disgust reactions (Cisler & Olatunji, 2009). Individuals with CB-OCD experience increases in pulse rate variability (PRV; a less refined alternative to heart rate variability) after coming into contact with a contaminated object and experience decreases in PRV following the completion of a washing ritual (Hodgson & Rachman, 1972). Other research has shown that individuals with CB-OCD experienced significant increases in heart rate and fluctuations in SCL in anticipation to touching contaminants (Hornsveld, Kraaimaat, & van Dam-Baggen, 1979). These data suggest that individuals with CB-OCD become affectively aroused in anticipation of and following contact with a contaminant. They also suggest that compulsive hand-washing results in decreases in arousal. However, these data do not provide evidence in support of any one emotional state underlying said affective arousal.

Shapira, Liu, He, Bradley, Lessig, James, and colleagues (2003) compared neural activation of individuals with CB-OCD to those with other symptoms of OCD (e.g., checking). They found that participants with CB-OCD showed greater activation of the anterior insula in response to disgusting pictures. However, another study found no insula activation among participants with CB-OCD following the visual presentation of contamination-relevant stimuli (van den Heuvel, Veltmen, Groenewegen, Dolan, Cath, Boellaard, et al. 2004). The availability of neurological data on CB-OCD is limited and

without additional research it is difficult to discern what neurological structures – and their emotional correlates – underlie the pathogenesis and maintenance of this CB-OCD.

Studies investigating disgust-related cognitive processes in CB-OCD have provided mixed results. Cisler and Olatunji (2010) found that individuals who are high in symptoms of CB-OCD have difficulty disengaging their attention away from disgusting (e.g., soiled toilet) and fearful (e.g., knife) images. Similarly, Armstrong, Olatunji, Sarawgi, and Simmons (2010) showed that individuals with elevated symptoms of CB-OCD have a biased attention orientation toward fearful faces when compared to individuals with minimal symptoms of CB-OCD. Individuals with elevated symptoms of CB-OCD also showed increased maintenance of attention toward disgusting and fearful faces. Cougle, Wolitzky-Taylor, Lee, and Telch (2007) reported that 41% of a sample of analogue CB-OCD participants endorsed that their primary fear-appraisal was being overwhelmed by disgust while 37% endorsed their primary fear was the contraction of illness.

Following their review of the neural, physiological, and cognitive processes related to CB-OCD, Cisler, Olatunji, and Lohr (2009) conclude that CB-OCD is predominantly a disorder of disgust, a claim that contrasts dominant theories of contamination (see Rachman, 2004). Clearly, the extant literature suggests that disgust is important to the etiology and maintenance of CB-OCD. However, there are a limited number of studies that have explicitly investigated how disgust is related to behavioral symptoms of CB-OCD (Deacon & Olatunji, 2007). Deacon and Olatunji (2007) showed that disgust propensity predicts avoidance of contamination stimuli. Similarly, Cougle and colleagues (2007) showed that self-reported disgust following a contamination

behavioral approach task (BAT) was predictive of urge to wash. However, no studies have investigated how disgust-based reactions motivate escape or rejection behaviors associated with CB-OCD (e.g., hand-washing).

It has been proposed that affective arousal following perceived or actual contamination motivates compulsive hand-washing, which subsequently relieves arousal (Rachman, 2004; Hodgson & Rachman, 1972). If symptoms of CB-OCD are predicted by disgust, then one function of compulsive hand-washing might be the alleviation of disgust-based feelings. To test this proposition, a disgust prime for individuals with CB-OCD would then be followed by a measurement of hand-washing. One such method for emotional priming is directly related to the bio-informational model of emotion.

Bio-informational theory of emotional imagery

According to the bio-informational theory of emotion, emotional experiences are conceptualized according to their information structure that can be conceived of as a propositional network of responses (Lang et al., 1983). Propositions are internal associative connections that are activated by external stimuli. These propositions are similar to linguistic, "if... then..." propositions of prediction and causation (Lang, 1979). Lang (1979) separated propositions into three parts, stimulus propositions, response propositions, and meaning propositions (Lang et al., 1983). Stimulus propositions are the associations between the emotion eliciting stimuli and the context that they occur in. Response propositions are defined as the associations between the stimulus-context and response components (e.g., efferent outflow, overt actions, expressive, and visceral responding). Lastly, meaning propositions refer to the verbal-lexical appraisals(s) (e.g., like-dislike) that an individual makes regarding the stimulus and response (see Figure 1).

The degree to which the propositional network or given components of the propositional network are activated is directly related to the learning history and salience of the emotional experience (Lang et al. 1983). For instance, stimulus propositions that are particularly salient to socially anxious individuals (e.g., angry facial expressions) may be of less salience to a non-socially anxious individual.

A majority of research based on the bio-informational theory has utilized imagery methods as a means for studying emotions (Lang et al., 1983; Lang, Kozak, Miller, Levin, & McLean, 1980; Lang, Melamed, & Hart, 1970; Prkachin, Williams-Avery, Zwall, & Mills, 1999). Imagery priming methods (as opposed to *in vivo* priming) have been utilized due to their ease of manipulation, thus making them more amenable to the experimental analysis of intra-individual propositional structures and the study of specific emotional states. Specifically, manipulation of the input variables – stimulus and response propositions within the imagery script – has been used to dictate the affective and behavioral responses of participants. As such, scripts that contain emotion specific propositions have been shown to elicit their intended emotion and not other emotions (Prkachin et al., 1999). For example, script driven imagery tasks containing disgust specific response cues have been utilized to elicit primarily disgust-based responses (Prkachin et al., 1999). Furthermore, depending on the propositional structure of an imagery script, the degree to which output variables – self-report, physiological, and behavioral responses – occur during and following a given imagery script provides indirect insight into the propositional structure at the inter- and intra-individual level. For example, phobic individuals, when compared to non-phobic individuals, reported greater fear in response to imagery scripts that contained fear-relevant response propositions

(Lang et al., 1983) or disorder-relevant stimulus propositions (Lang et al., 1970). Application of these imagery tasks has also differentiated between specific phobic groups (i.e., speaking vs. snake) by manipulating the stimulus content of the script and holding the response propositions relatively constant (Lang, et al., 1983).

Given the findings of Prkachin and colleagues (1999), it may be possible to differentiate between disordered and non-disordered individuals with imagery scripts even if the emotional reaction of interest is not fear. If CB-OCD were a disorder that is predominated by disgust, then one would expect a differentiation between those low and high in contamination aversion when utilizing imagery scripts that contain disgust-based response propositions. Moreover, when considering Lang's theoretical model (1979) and the proposed functional relation between disgust and washing compulsions in CB-OCD, one should expect that an imagery script that contains disgust specific response propositions should elicit disorder relevant motoric-behavioral responses, such as hand-washing. In summary, if CB-OCD is characterized as a disorder of disgust, then a disgust-specific imagery script should elicit greater disgust-based reactions and, in turn, more washing behaviors among individuals with elevated symptoms of CB-OCD as compared to individuals with minimal symptoms of CB-OCD.

Current Study

Based upon Lang's (1979) theoretical model, the present study will investigate whether responses to a script driven imagery task that contains contamination-relevant stimulus propositions and disgust-relevant response propositions can: 1) reliably elicit an intended emotion (i.e., disgust), 2) differentiate between individuals with high and low symptoms of contamination aversion based on emotional reactivity, and 3) differentially

effect behavioral expressions associated with CB-OCD (i.e., hand-washing). This will be accomplished with a 2 (group) x 2 (condition) factorial design in which participants will be selected for either high or low symptoms of CB-OCD (group) and are assigned to an experimental condition that contains either a neutral or disgust imagery script (condition).

It is predicted that the "disgust" imagery will elicit greater amount of disgust than fear in all participants. It is also predicted that, following disgust imagery, individuals who are high in symptoms of CB-OCD will endorse greater amounts of subjective disgust relative to individuals who are low in symptoms of CB-OCD. Lastly, it is predicted that following the disgust script, individuals who are high in symptoms of CB-OCD will wash for a longer period of time when compared to individuals who are low in symptoms of CB-OCD (see Figures 2 and 3).

Method

Participants

Participants were selected for both high and low symptoms of CB-OCD based on their score on the Padua Inventory contamination obsessions and washing compulsions (PI-COWC) subscale (Burns, Keortge, Formea, & Sternberger, 1996; see Measures section for more details). Sixty-nine[a] participants were selected from undergraduate psychology courses at a large southern university based on the PI-COWC scores, and all participants received partial course credit in exchange for their participation. The average age of the participants was 19.38 (*SD* = 3.78), there was no significant difference in age between participants in the high CB-OCD and low CB-OCD groups, F (1, 62) = 2.03, p = .16. A majority of the participants were Caucasian (74%, n = 51), 4 were Hispanic, 6 were African-American, 3 endorsed "other" race, and 5 participants did not endorse a

race; there was no significant difference in racial distribution between participants in the high CB-OCD and low CB-OCD groups, X^2 (5) = 6.05, p = .30. A majority of the participants were female (54%, n = 37). There was a significantly different gender distribution between the high CB-OCD and low CB-OCD groups, X^2 (1) = 13.69, p< .001, with 28 females in the high CB-OCD groups and 9 females in the low CB-OCD group[b].

Measures

The *Padua Inventory Contamination Obsessions and Washing Compulsions subscale* (PI-COWC; Burns et al., 1996) is a 10-item measure of contamination obsessions and washing compulsions. Participants rate their level of agreement on a 5-point Likert-type scale ranging from 0 = "*Not at all"* to 4 = "*Very much*." The PI-COWC has evidenced adequate convergent validity with other measures of OCD and adequate discriminant validity from measures of little relation to OCD (e.g., worry; Burns et al., 1996). The PI-COWC has good test-retest reliability over a six to seven month period, r = 0.72, and very good internal consistency, α = 0.85 (Burns et al., 1996). Internal consistency was high within the present sample (α = 0.96). Consistent with prior research (Deacon & Olatunji, 2007; Olatunji, Lohr, Sawchuk, & Tolin, 2007; Olatunji, Wolitzky-Taylor, Willems, Lohr, & Armstrong, 2009) participants who scored ≥ 14 on the PI-COWC subscale were selected for the high CB-OCD group and participants who scored ≤ 6 on the PI-COWC subscale were selected for low CB-OCD group.

Visual Analogue Scale (VAS; Freyd, 1923) is a self-report scale that assesses subjective experiences such as pain, emotion, and mood. The present study requested that participants rate subjective fear and disgust. The VAS is composed of a 100 mm

horizontal line that is anchored by two extreme emotional descriptions (i.e., “no disgust” to “extreme disgust” and “no fear” to “extreme fear”). Participants are asked to mark on the line to discern the amount of emotion they are currently experiencing. The VAS has been widely used in emotion induction research and is sensitive to changes in affect (Hornblow & Kidson, 1976). Furthermore, the VAS has been used in previous research to differentiate between fear and disgust (Villemure, Slotnick, & Bushnell, 2003). Given that the VAS is a single item measure that is intended to measure state dependent affect, there are no available data supporting its reliability (e.g., test re-test or internal consistency).

Shortened Version of Bett's Questionnaire Upon Mental Imagery (QMI-R; Sheehan, 1967) is a thirty-five item self-report scale that measures vividness of mental images across seven sensory modalities. Participants are asked to create eight different images and rate the clarity of specific facets of the image based on a seven-point Likert-scale. A lower overall score is indicative of a greater ability to imagine. The QMI-R is highly correlated with the original version (r =0.92 and r = 0.98) and is thus able to measure participant's overall image ability (Sheehan, 1967). The internal consistency of the QMI-R was high in the present sample ($\alpha = 0.95$).

Materials

All imagery scripts were played over external speakers that were attached to a Dell P3 personal computer. All directions that were not verbally delivered by the experimenter were displayed on the computer’s 17-inch monitor. Two imagery scripts were utilized in the present experiment, a neutral script (Appendix A) and a disgusting script (Appendix B). Imagery scripts were designed by the author and were intended to

elicit specific emotional responses by manipulating the content of the imagery scripts. Specifically, the imagery scripts were designed to be contamination-relevant and disgusting or contamination-irrelevant and affectively neutral. Prior to beginning the present study, the author piloted the imagery scripts with 59 non-selected undergraduate participants. Results from this piloting indicated that the disgusting script elicited more fear and disgust than the neutral script, $p < .05$. Additionally, the disgusting script elicited more disgust than fear, $p < .05$. The results from this pilot study support the use of the neutral and disgust scripts for their intended purposes.

Procedure

All experimental procedures were completed on an individual basis in a small (12' x 6'), isolated room with a computer, sink, and one-way vision screen. Participants completed an informed consent at the beginning of the experiment. Next, all participants completed a 10-minute session of response training (see Appendix C), a method used to enhance imagery vividness and affective arousal (Lang et al., 1980). Response training sessions were an abbreviated version of the training module used by Kozak (1983) and were consistent with the protocol outlined by Lang and colleagues (1980). Following response training, each participant was seated and asked to complete pre-imagery VAS ratings for fear and disgust. The experimenter then turned on a sink and informed the participant that this would be explained in later instructions. Lastly, the experimenter asked participants to press the "enter" key on a keyboard to begin the imagery script. At this point the experimenter exited the room and watched the remainder of the experiment from behind a one-way vision screen.

Each participant was randomly assigned to either a disgust imagery or a neutral

imagery experimental condition. After completing the imagery task participants were instructed to turn over a sheet of paper and provide post-imagery fear and disgust ratings. After completing the post-imagery VAS form, each participant was informed that they "are free to wash your hands if you would like" via recorded instructions. This provided a mild experimental demand that would encourage participants to wash. The present study utilized similar experimental methodology as Jones and Menzies (1997) in order to utilize hand-washing as a dependent variable. Specifically, the sink was running at a constant flow and the experimenter recorded the wash time, in seconds, from behind the one-way vision screen. Participants were then instructed to complete the aforementioned questionnaires. Lastly, participants were debriefed, compensated course credit, and dismissed.

Results

A 2 (group) x 2 (imagery condition) multivariate analysis of variance (MANOVA) indicated that there were no differences between participants with high and low symptoms of CB-OCD on pre-imagery emotion ratings F (2, 64) = 1.41, p = .25. Additionally, there were no differences between participants in the neutral and disgust imagery conditions on pre-imagery emotion ratings F (2, 64) = .45, p = .64. Lastly, there was no group by condition interaction on pre-imagery emotion ratings, F (2, 64) = .2.23, p = .12. All pre-imagery emotion ratings are presented in Table 1. Next, a two-way analysis of variance (ANOVA) was carried out to compare imagery ability (QMI-R) between groups and across experimental conditions. Results indicated that there was no difference in imagery ability between groups F (1, 65) = .46, p = .50 or between conditions F (1, 65) = .34, p = .56. Lastly, there was no group by condition interaction on

imagery ability F (1, 65) = 1.67, p = .20 (see Table 1).

A one-way MANOVA, with post-imagery disgust and fear ratings as the dependent variables, was carried out to test for between group differences in emotional reactivity following the neutral imagery script. Results suggested that individuals who were high in symptoms of CB-OCD reacted with stronger emotion following the neutral imagery task, F (2, 30) = 2.51, p = .10, although this effect was only trending toward significance. A one-way MANOVA, with post-imagery disgust and fear ratings as the dependent variables, was carried out to test for between group differences in emotional reactivity following the disgust imagery script. Results suggested that participants who were high in symptoms of CB-OCD experienced greater emotional reactivity following the disgust imagery script, F (2, 33) = 3.29, p = .05. Contrasts revealed that, following the disgust imagery task, participants who were high in symptoms of CB-OCD experienced greater disgust F (1, 34) = 4.43, p = .04 and fear F (1, 34) = 5.53, p = .03 than participants who were low in symptoms of CB-OCD (Table 2). These results suggest that, following the disgust imagery task, participants who were high in symptoms of CB-OCD experienced more disgust and fear than participants who were low in symptoms of CB-OCD.

Four paired-sample t-tests were conducted to test if participants reacted with more fear or disgust following the imagery tasks. Following the neutral imagery task, participants who were low in symptoms of CB-OCD reacted with relatively similar amounts of disgust (M = 3.00, SD = 4.29) and fear (M = 1.27, SD = 2.09), t (14) = 1.72, p = .11, Cohen's d = .51. Following the disgust imagery task, participants who were low in symptoms of CB-OCD reacted with greater amounts of disgust (M = 46.75, SD = 28.32)

relative to fear (*M* = 16.13, *SD* = 20.86), *t* (15) = 4.486, *p*< .001, Cohen's *d* = 1.23. Following the neutral imagery task, participants who were high in symptoms of CB-OCD reacted with moderately greater amounts of disgust (*M* = 13.78, *SD* = 23.28) relative to fear (*M* = 7.28, *SD* = 13.15), *t* (17) = 2.02 *p* = .06, Cohen's *d* = .34; although this effect was only trending toward statistical significance. Following the disgusting imagery task, participants who were high in symptoms of CB-OCD reacted with greater amounts of disgust (*M* = 65.15, *SD* = 24.16) relative to fear (*M* = 37.55, *SD* = 31.24), *t* (19) = 4.29, *p*< .001, Cohen's *d* = .99. Overall, these tests show that the neutral and disgusting imagery tasks were both perceived as such. The latter two tests show that participants who were high in symptoms of CB-OCD reacted with more disgust than fear following both imagery tasks and this effect was much greater following a disgusting imagery task

A 2 (group) x 2 (imagery condition) ANOVA was carried out to test if participants who were in the disgust imagery condition and were high in symptoms of CB-OCD washed for a longer period of time relative to participants in the other experimental conditions. There was a non-significant group by condition interaction, *F* (1, 65) = .15, *p* = .70. Moreover, contrasts revealed that there were non-significant differences between participants who were high and low in symptoms of CB-OCD, *F* (1, 65) = 2.60, *p* = .11, and between disgust and neutral imagery conditions, *F* (1,65), = .03, *p* = .86. Taken as a whole, these results firmly indicate that that there was no difference in time spent washing between high and low CB-OCD groups or across imagery conditions (see Table 3).

Discussion

Elevated disgust propensity and sensitivity are both predictive of symptoms of

CB-OCD, as measured by self-report questionnaires and behavioral approach tasks. Moreover, neuroimaging data suggests that individuals with the contamination subtype of OCD show increased activation of regions associated with disgust reactivity (e.g., anterior insula cortex) when exposed to contamination relevant stimuli. These data suggest that increased disgust propensity is related to elevated symptoms of CB-OCD and increased avoidance of contamination-relevant stimuli. However, the relation between disgust and compulsive behaviors such as hand-washing is still unknown. Previous research suggests that individuals with elevated symptoms of CB-OCD wash for longer durations than non-washing obsessive-compulsives following contact with contaminants (Wahl, Salkovskis, & Cotter, 2008). Additional studies have also shown that disgust motivates washing behaviors (Porzig-Drummond, Stevenson, & Oaten, 2009). To date, no research has integrated these two bodies of research to test the effects of disgust on hand-washing behaviors among individuals with CB-OCD.

The present study was the first to experimentally test the effects of experienced disgust on hand-washing behaviors among individuals with elevated symptoms of CB-OCD. Following the disgusting imagery task, participants with elevated symptoms of CB-OCD reacted with greater amounts of disgust and fear compared to participants with minimal symptoms of CB-OCD and the amount of self-reported disgust was significantly greater than the amount of fear among participants with elevated symptoms of CB-OCD. The present study did not, however, reveal any statistically significant relations between CB-OCD symptom levels, disgust, and hand-washing behaviors. This finding is inconsistent with research that has shown that individuals with CB-OCD wash for longer than individuals with other obsessive concerns (Wahl et al., 2008) and experienced

disgust motivates hand-washing behaviors (Porzig-Drummond et al., 2009). There are several potential explanations for the present study's null findings.

The protocol used in the present study was based on the methods used by Jones and Menzies (1997), but was novel in that it did not require actual exposure to contaminants prior to hand-washing. Instead, hand-washing was motivated by passive suggestion (i.e., "you are free to wash your hands if you would like"). It is possible that this minor manipulation was not powerful enough to motivate significant washing behaviors. Although individuals with CB-OCD will frequently wash following contact with a perceived contaminant – in the absence of any actual contact – it is likely that the present methods were not sufficient to motivate such behaviors. As such, washing may have been completed in response to a passive experimental suggestion and not in response to affective states or psychopathological factors. It is also possible that this method of hand-washing measurement is unreliable and invalid. This is supported by the elevated standard deviations that were observed within each experimental condition, which suggests wide variation and unreliable measurement (see Table 3). In summary, the most likely explanation for the aforementioned null findings is flawed methodology.

Future studies would benefit from the use of standardized methods of hand-washing measurement. To date, no such methodology has been validated within the extant experimental literature. Those studies that have reported significant between group differences in hand-washing duration (e.g., Jones & Menzies, 1997; Porzig-Drummond et al., 2009; Wahl et al., 2008) all included direct contact with a contaminant prior to washing measurement. It is probable that actual contamination – as opposed to perceived or imagined – increases output of washing behaviors. Therefore, future research would

likely benefit from the use of actual contact with contaminants prior to measurement of washing behaviors. This would improve the likelihood that contamination fears are activated and thus compulsive-like washing behaviors would be more probable.

Although VAS ratings suggest that the disgust prime that was used in the present study (script driven imagery) was effective, other methods could have been utilized to induce disgust reactions. These methods include olfactory priming (e.g., Soussignan & Shaal, 1996), auditory (e.g., Olatunji & Armstrong, 2009), visual (de Jong, Peters, & Vanderhallen, 2002), or gustatory (e.g., Eskine, Kacinik, & Prinz, 2011). It is possible that any of the aforementioned methods of disgust induction could have been more effective at motivating washing behaviors. However, it is largely unknown which of these methods most effectively and reliably activates disgust reactions, let alone which is most likely to motivate washing behaviors. This area of research requires further study and clarification.

Participants with elevated symptoms of CB-OCD reported elevated amounts of disgust and fear following the disgust-based imagery task while participants who endorsed minimal symptoms of CB-OCD reported large increases in disgust and minimal increases in fear following the disgust-based imagery task. One explanation for these findings is that participants with elevated symptoms of CB-OCD were more sensitive to feelings of disgust, and thus experienced the disgust prime as more distressing. This is supported by a body of literature that has consistently shown a strong association between symptoms of CB-OCD and disgust sensitivity (fear and distress in response to feelings of disgust). However, the present study did not measure disgust sensitivity, and, therefore, this interpretation is purely speculative. It is also possible that the script used in

the disgust imagery condition contained stimulus propositions (see Appendix A) that activated contamination-relevant fears (e.g., transmission of illness) among participants who endorsed greater symptoms of CB-OCD and not among participants who endorsed minimal symptoms of CB-OCD. This would be expected given that the former group openly endorsed fears of contagion and illness while the latter did not. Therefore, it is possible that the disgust-based imagery prime was not a "pure" disgust prime and was instead and disgust and contamination/illness prime. This is consistent with previous research, which showed that snake-based stimulus propositions (in the absence of response propositions) evoked fear reactions among snake phobic participants (Lang et al., 1983), while the addition of fear/anxiety propositions only increased affective reactions in comparison to stimulus only imagery. Taken collectively, these data and interpretations indicate that future research would benefit from the use of other, more pure, disgust primes (e.g., olfactory or gustatory) or the use of disgust-specific imagery scripts (e.g.,, van Overveld et al., 2009).

In closing, the present data show that individuals with elevated symptoms of CB-OCD, as compared to individuals with minimal symptoms of CB-OCD, experience more disgust and fear in reaction to a disgust-based script driven imagery prime. However, symptom severity and affective reactions did not appear to affect hand-washing behaviors. This null finding is likely an artifact of limitations in experimental methodology and should not be interpreted as indicating that CB-OCD and disgust are not associated with pathological washing behaviors. Future research would benefit from the use of more valid and reliable methods of disgust induction and hand-washing measurement.

Researchers interested in understanding psychological phenomena underlying compulsive hand-washing are encouraged to establish valid and reliable measures of hand-washing behaviors. Such methods would likely require direct contamination prior to washing. This would increase the probability that laboratory based methods for modeling compulsive washing behaviors are motivated by contamination concerns. This would also allow the experimenter to prime disgust using a more experimentally reliable and potentially valid methodology. Theory would suggest that, given disgust's oral and food-based origins, gustatory disgust primes would likely provoke the greatest disgust reactions. For example, participants could be asked to drink a bitter tasting substance during contact with a contaminant and prior to the onset of washing behaviors (see Eskine et al., 2011). Alternatively, given the biological relations between taste and smell, participants could complete a contamination and hand-washing task in a room that is made to smell foul (see Soussignan & Shaal, 1996). Both of these methodologies are likely to elicit stronger disgust reactions than those used in the present study and, pending empirical validation, the proposed method for hand-washing provocation and measurement may also be less error prone and more analogue to compulsive washing behaviors. Each of the aforementioned methods and procedures should first be tested with non-selected participants to: 1) validate, and 2) show the unique role of experienced disgust in motivating hand-washing behaviors. Pending results, these methods could then be used to compare high and low contamination fearful individuals. This would allow for a thorough test of the unique and complimentary roles of disgust and contamination-based psychopathology in the motivation of compulsive hand-washing behaviors.

References

Abramowitz, J., McKay, D., & Taylor, S. (2005). Special Series Subtypes of Obsessive-Compulsive Disorder. *Behavior Therapy, 36*, 367-369. doi:10.1016/S0005-7894(05)80118-2

Abramowitz, J. S., Wheaton, M. G., & Storch, E. A. (2008). The status of hoarding as a symptom of obsessive-compulsive disorder. *Behaviour Research and Therapy, 46*, 1026-1033. doi:10.1016/j.brat.2008.05.006

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (Revised 4th ed.). Washington, DC: Author.

Armstrong, T., Olatunji, B. O., Sarawgi, S., & Simmons, C. (2010). Orienting and maintenance of gaze in contamination fear: Biases for disgust and fear cues. *Behaviour Research and Therapy, 48*, 402-408. doi:10.1016/j.brat.2010.01.002

Ball, S. G., Baer, L., & Otto, M. W. (1996). Symptom subtypes of obsessive-compulsive disorder in behavioral treatment studies: A quantitative review. *Behaviour Research and Therapy, 34*, 47-51. doi:10.1016/0005-7967(95)00047-2

Bloch, M. H., Landeros-Weisenberger, A., Rosario, M. C., Pittenger, C., & Leckman, J. F. (2008). Meta-analysis of the symptom structure of obsessive-compulsive disorder. *The American Journal of Psychiatry, 165*, 1532-1542. doi:10.1176/appi.ajp.2008.08020320

Burns, G., Keortge, S. G., Formea, G. M., & Sternberger, L. G. (1996). Revision of the Padua Inventory of obsessive compulsive disorder symptoms: Distinctions between worry, obsessions, and compulsions. *Behaviour Research and Therapy, 34*, 163-173. doi:10.1016/0005-7967(95)00035-6

Calder, A. J., Beaver, J. D., Davis, M. H., van Ditzhuijzen, J., Keane, J., & Lawrence, A. D. (2007). Disgust sensitivity predicts the insula and pallidal response to pictures of disgusting foods. *European Journal of Neuroscience, 25*, 3422-3428. doi:10.1111/j.1460-9568.2007.05604.x

Calder, A. J., Lawrence, A. D., and Young, A. W. (2001). Neuropsychology of fear and loathing. *Nature Reviews Neuroscience, 2*, 352-363.

Cisler, J. M., Olatunji, B. O., & Lohr, J. M. (2009). Disgust, fear, and the anxiety disorders: A critical review. *Clinical Psychology Review, 29*, 34-46. doi:10.1016/j.cpr.2008.09.007

Cisler, J. M., Olatunji, B. O., & Lohr, J. M. (2009). Disgust sensitivity and emotion regulation potentiate the effect of disgust propensity on spider fear, blood-injection-injury fear, and contamination fear. *Journal of Behavior Therapy and Experimental Psychiatry, 40*, 219-229. doi:10.1016/j.jbtep.2008.10.002

Chapman, H. A., Kim, D. A., Susskind, J. M., & Anderson, A. K. (2009). In bad taste: Evidence for the oral origins of moral disgust. *Science, 323*, 1222-1226. doi:10.1126/science.1165565

Cisler, J. M., & Olatunji, B. O. (2010). Components of attentional biases in contamination fear: Evidence for difficulty in disengagement. *Behaviour Research and Therapy, 48*, 74-78. doi:10.1016/j.brat.2009.09.003

Cisler, J. M., Reardon, J. M., Williams, N. L., & Lohr, J. M. (2007). Anxiety sensitivity and disgust sensitivity interact to predict contamination fears. *Personality and Individual Differences, 42*, 935-946. doi:10.1016/j.paid.2006.09.004

Cougle, J. R., Wolitzky-Taylor, K. B., Lee, H., & Telch, M. J. (2007). Mechanisms of change in ERP treatment of compulsive hand washing: Does primary threat make a difference?. *Behaviour Research and Therapy*, *45*, 1449-1459. doi:10.1016/j.brat.2006.12.001

Deacon, B., & Olatunji, B. O. (2007). Specificity of disgust sensitivity in the prediction of behavioral avoidance in contamination fear. *Behaviour Research and Therapy*, *45*, 2110-2120. doi:10.1016/j.brat.2007.03.008

de Jong, P. J., Peters, M., & Vanderhallen, I. (2002). Disgust and disgust sensitivity in spider phobia: Facial EMG in response to spider and oral disgust imagery. *Journal of Anxiety Disorders*, *16*, 477-493. doi:10.1016/S0887-6185(02)00167-6

Ekman, P., & Friesen, W. V. (1975). *Unmasking the face: A guide to recognizing emotions from facial clues*. Oxford England: Prentice-Hall. Retrieved from EBSCO*host*.

Eskine, K. J., Kacinik, N. A., & Prinz, J. J. (2011). A bad taste in the mouth: Gustatory disgust influences moral judgment. *Psychological Science, 22,* 295-301. doi: 10.1177/0956797611398497.

Freyd, M. M. (1923). The Graphic Rating Scale. *Journal of Educational Psychology*, *14*, 83-102. doi:10.1037/h0074329

Garcia, J. J., Kimeldorf, D. J., & Koelling, R. A. (1955). Conditioned aversion to saccharin resulting from exposure to gamma radiation. *Science*, *122*, 157-158. doi:10.1126/science.122.3179.1089

Haidt, J., McCauley, C., Dunlop, L., Ashmore, M., & Rozin, P. (1999). Individual differences in disgust sensitivity: Comparisons and evaluations of paper-and-pencil versus behavioral measures. *Journal of Research in Personality, 33*, 330-351. doi:10.1006/jrpe.1999.2251

Harrison, N. A., Gray, M. A., Gianaros, P. J., & Critchley, H. D. (2010). The embodiment of emotional feelings in the brain. *The Journal of Neuroscience, 30*, 12878-12884. doi:10.1523/JNEUROSCI.1725-10.2010

Hodgson, R. J., & Rachman, S. S. (1972). The effects of contamination and washing in obsessional patients. *Behaviour Research and Therapy, 10*, 111-117. doi:10.1016/S0005-7967(72)80003-2

Hornblow, A. R., & Kidson, M. A. (1976). The Visual Analogue Scale for Anxiety: A validation study. *Australian and New Zealand Journal of Psychiatry, 10*, 339-341. doi:10.3109/00048677609159523

Hornsveld, R. H., Kraaimaat, F. W., & Van Dam-Baggen, R. M. (1979). Anxiety/discomfort and handwashing in obsessive-compulsive and psychiatric control patients. *Behaviour Research and Therapy, 17*, 223-228. doi:10.1016/0005-7967(79)90037-8

Izard, C. E. (1971). *The face of emotion*. East Norwalk, CT US: Appleton-Century-Crofts. Retrieved from EBSCO*host*.

Jones, M. K., & Menzies, R. G. (1997). The cognitive mediation of obsessive-compulsive handwashing. *Behaviour Research and Therapy, 35*, 843-850. doi:10.1016/S0005-7967(97)00035-1

Karno, M., Golding, J. M., Sorenson, S. B., & Burnam, M. (1988). The epidemiology of obsessive-compulsive disorder in five US communities. *Archives of General Psychiatry*, *45*, 1094-1099. Retrieved from EBSCO*host*.

Kessler, R. C., Chiu, W., Demler, O., & Walters, E. E. (2005). Prevalence, Severity, and Comorbidity of 12-Month DSM-IV Disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry*, *62*, 617-627. doi:10.1001/archpsyc.62.6.617

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime Prevalence and Age-of-Onset Distributions of DSM-IV Disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry*, *62*, 593-602. doi:10.1001/archpsyc.62.6.593

Kozak, M. (1983). The psychophysiological effects of training on variously elicited imaginings. (unpublished dissertation)

Lang, P. J. (1968). Fear reduction and fear behavior: Problems in treating a construct. In J. M. Shlien, J. M. Shlien (Eds.), *Research in psychotherapy* (pp. 90-102). Washington, DC US: American Psychological Association. doi:10.1037/10546-004

Lang, P. J. (1979). A bio-informational theory of emotional imagery. *Psychophysiology*, *16*, 495-512. doi:10.1111/j.1469-8986.1979.tb01511.x

Lang, P. J., Levin, D. N., Miller, G. A., & Kozak, M. J. (1983). Fear behavior, fear imagery, and the psychophysiology of emotion: The problem of affective response integration. *Journal of Abnormal Psychology*, *92*, 276-306. doi:10.1037/0021-843X.92.3.276

Lang, P. (1980). Emotional imagery: Conceptual structure and pattern of somato-visceral response. *Psychophysiology*, *17*, 179-192. doi:10.1111/j.1469-8986.1980.tb00133.x

Lang, P. J., Melamed, B. G., & Hart, J. (1970). A psychophysiological analysis of fear modification using an automated desensitization procedure. *Journal of Abnormal Psychology*, *76*, 220-234. doi:10.1037/h0029875

McKay, D., Abramowitz, J. S., Calamari, J. E., Kyrios, M., Radomsky, A., Sookman, D., & Wilhelm, S. (2004). A critical evaluation of obsessive-compulsive disorder subtypes: Symptoms versus mechanisms. *Clinical Psychology Review*, *24*, 283-313. doi:10.1016/j.cpr.2004.04.003

Miller, G. M., & Chapman, J. P. (2001). Misunderstanding analysis of covariance. *Journal of Abnormal Psychology*, *110*, 40-48. doi:10.1037/0021-843X.110.1.40

Olatunji, B. O. (2010). Changes in disgust correspond with changes in symptoms of contamination-based OCD: A prospective examination of specificity. *Journal of Anxiety Disorders*, *24*, 313-317. doi:10.1016/j.janxdis.2010.01.003

Olatunji, B. O., & Armstrong, T. (2009). Contamination fear and effects of disgust on distress in a public restroom. *Emotion*, *9*, 592-597. doi:10.1037/a0016109

Olatunji, B. O., Cisler, J., McKay, D., & Phillips, M. L. (2010). Is disgust associated with psychopathology? Emerging research in the anxiety disorders. *Psychiatry Research*, *175*, 1-10. doi:10.1016/j.psychres.2009.04.007

Olatunji, B. O., Lohr, J. M., Sawchuk, C. N., & Patten, K. (2007). Fear and disgust responding to heterogeneous blood-injection-injury stimuli: Distinctions from

anxiety symptoms. *Journal of Psychopathology and Behavioral Assessment, 29,* 1-8. doi:10.1007/s10862-006-9025-x

Olatunji, B. O., Sawchuk, C. N., Arrindell, W. A., & Lohr, J. M. (2005). Disgust sensitivity as a mediator of the sex differences in contamination fears. *Personality and Individual Differences, 38,* 713-722. doi:10.1016/j.paid.2004.05.025

Olatunji, B. O., Williams, N. L., Lohr, J. M., Connolly, K. M., Cisler, J., & Meunier, S. A. (2007). Structural differentiation of disgust from trait anxiety in the prediction of specific anxiety disorder symptoms. *Behaviour Research and Therapy, 45,* 3002-3017. doi:10.1016/j.brat.2007.08.011

Olatunji, B. O., Wolitzky-Taylor, K. B., Willems, J., Lohr, J. M., & Armstrong, T. (2009). Differential habituation of fear and disgust during repeated exposure to threat-relevant stimuli in contamination-based OCD: An analogue study. *Journal of Anxiety Disorders, 23,* 118-123. doi:10.1016/j.janxdis.2008.04.006

Organization, W., (2004). *International Statistical Classification of Diseases and Health Related Problems*. Geneva: World Health Organization.

Parker, L. A., Limebeer, C. L., & Rana, S. A. (2009). Conditioned disgust, but not conditioned taste avoidance, may reflect conditioned nausea in rats. In T. R. Schachtman, S. Reilly, T. R. Schachtman (Eds.), *Conditioned taste aversion: Behavioral and neural processes* (pp. 92-113). New York, NY US: Oxford University Press. Retrieved from EBSCO*host*.

Phillips, M.L., Young A.W., Scott, S.K., Calder, A.J., Andrew, C., Giampietro, V., Williams, S.C.R., Bullmore, E.T., Brammer, M., & Gray, J.A. (1998) Neural

responses to facial and vocal expressions of fear and disgust. *Proceedings of the Royal Society, 265*, 1809-1817.

Phillips, M. L., Young, A. W., Senior, C. C., Brammer, M. M., Andrews, C. C., Calder, A. J., & ... David, A. S. (1997). A specific neural substrate for perceiving facial expressions of disgust. *Nature, 389*, 495-498. doi:10.1038/39051

Porzig-Drummond, R., Stevenson, R., Case, T., & Oaten, M. (2009). Can the emotion of disgust be harnessed to promote hand hygiene?. Experimental and field-based tests. *Social Science & Medicine, 68*, 1006-1012. doi:10.1016/j.socscimed.2009.01.013

Prkachin, K. M., Williams-Avery, R. M., Zwaal, C., & Mills, D. E. (1999). Cardiovascular changes during induced emotion: An application of Lang's theory of emotional imagery. *Journal of Psychosomatic Research, 47*, 255-267. doi:10.1016/S0022-3999(99)00036-7

Rachman, S. (1978). Human fears: A three systems analysis. *Scandinavian Journal of Behaviour Therapy, 7*, 237-245. Retrieved from EBSCO*host*.

Rachman, S. S. (1998). A cognitive theory of obsessions: Elaborations. *Behaviour Research and Therapy, 36*, 385-401. doi:10.1016/S0005-7967(97)10041-9

Rachman, S. S. (2004). Fear of contamination. *Behaviour Research and Therapy, 42*, 1227-1255. doi:10.1016/j.brat.2003.10.009

Rasmussen, S. A., & Eisen, J. L. (1992). The epidemiology and clinical features of obsessive compulsive disorder. *Psychiatric Clinics of North America, 15*, 743-758. Retrieved from EBSCO*host*.

Rasmussen, S. A., & Tsuang, M. T. (1986). Clinical characteristics and family history in DSM-III obsessive-compulsive disorder. *The American Journal of Psychiatry, 143*, 317-322. Retrieved from EBSCO*host*.

Rohrmann, S., & Hopp, H. (2008). Cardiovascular indicators of disgust. *International Journal of Psychophysiology, 68*, 201-208. doi:10.1016/j.ijpsycho.2008.01.011

Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Review, 94*, 23-41. doi:10.1037/0033-295X.94.1.23

Shapira, N. A., Liu, Y., He, A. G., Bradley, M. M., Lessig, M. C., James, G. A., & Goodman, W. K. (2003). Brain activation by disgust-inducing pictures in obsessive-compulsive disorder. *Biological Psychiatry, 54*, 751-756. doi:10.1016/S0006-3223(03)00003-9

Sheehan, P. W. (1967). A shortened form of Bett's questionnaire upon mental imagery. *Journal of Clinical Psychology, 23*, 386-389. doi:10.1002/1097-4679(196707)23:3<386::AID-JCLP2270230328>3.0.CO;2-S

Soussignan, R., & Schall, B. (1996). Children's facial responsiveness to odors: Influences of hedonic valence of odor, gender, age, and social presence. *Developmental Psychology, 32*, 367-379. doi:10.1037/0012-1649.32.2.367

van den Heuvel, O. A., Veltman, D. J., Groenewegen, H. J., Dolan, R. J., Cath, D. C., Boellaard, R., & van Dyck, R. (2004). Amygdala activity in obsessive-compulsive disorder with contamination fear: A study with oxygen-15 water positron emission tomography. *Psychiatry Research: Neuroimaging, 132*, 225-237. doi:10.1016/j.pscychresns.2004.06.007

Villemure, C., Slotnick, B. M., & Bushnell, M. (2003). Effects of odors on pain perception: Deciphering the roles of emotion and attention. *Pain*, *106*, 101-108. doi:10.1016/S0304-3959(03)00297-5

van Overveld, W. M., de Jong, P. J., & Peters, M. L. (2009). Digestive and cardiovascular responses to core and animal-reminder disgust. *Biological Psychology*, *80*, 149-157. doi:10.1016/j.biopsycho.2008.08.002

Vrana, S. R. (1993). The psychophysiology of disgust: Differentiating negative emotional contexts with facial EMG. *Psychophysiology*, *30*, 279-286. doi:10.1111/j.1469-8986.1993.tb03354.x

Wahl, K., Salkovskis, P. M., & Cotter, I. (2008). 'I wash until it feels right' the phenomenology of stopping criteria in obsessive-compulsive washing. *Journal of Anxiety Disorders*, *22*, 143-161. doi:10.1016/j.janxdis.2007.02.009

Woody, S. R., & Tolin, D. F. (2002). The relationship between disgust sensitivity and avoidant behavior: Studies of clinical and nonclinical samples. *Journal of Anxiety Disorders*, *16*, 543-559. doi:10.1016/S0887-6185(02)00173-1

Footnotes

A. 78 participants completed the present study. However, 9 of these participants met inclusion criteria during screening but failed to meet inclusion criteria during a second administration of the PI-COWC following the actual experimental protocol (e.g., scored below the 14 point cut-off). These individuals could not be appropriately categorized as endorsing high or low in symptoms of CB-OCD. Therefore, these 9 participants were not included in the present analyses.

B. Although the distribution of gender significantly differed between groups, gender was not treated as a covariate. This would have modified the relations between groups in an inappropriate way and thus been an erroneous use of analysis of covariance (Miller & Chapman, 2001).

Table 1.

Pre-imagery emotion ratings and imagery ability M (SD).

Group	Imagery condition	Pre-disgust	Pre-fear	QMI-R
Low CB-OCD	Neutral	2.20(5.88)	5.27(7.13)	88.40(28.34)
	Disgusting	6.00(12.88)	4.63(8.62)	93.69(33.05)
High CB-OCD	Neutral	6.33(7.28)	8.56(12.93)	93.00(36.65)
	Disgusting	5.30(8.92)	9.40(12.29)	79.05(23.77)

Note. Bett's Revised Questionnaire of Mental Imagery (QMI-R).

Table 2.

Post-imagery emotion ratings.

Group	Imagery condition	Post-disgust	Post-fear
Low CB-OCD	Neutral	1.27(2.09)	3.00(4.29)
	Disgusting	46.75(28.32)	16.13(20.86)
High CB-OCD	Neutral	13.78(23.28)	7.28(13.15)
	Disgusting	65.15(24.16)	37.55(31.24)

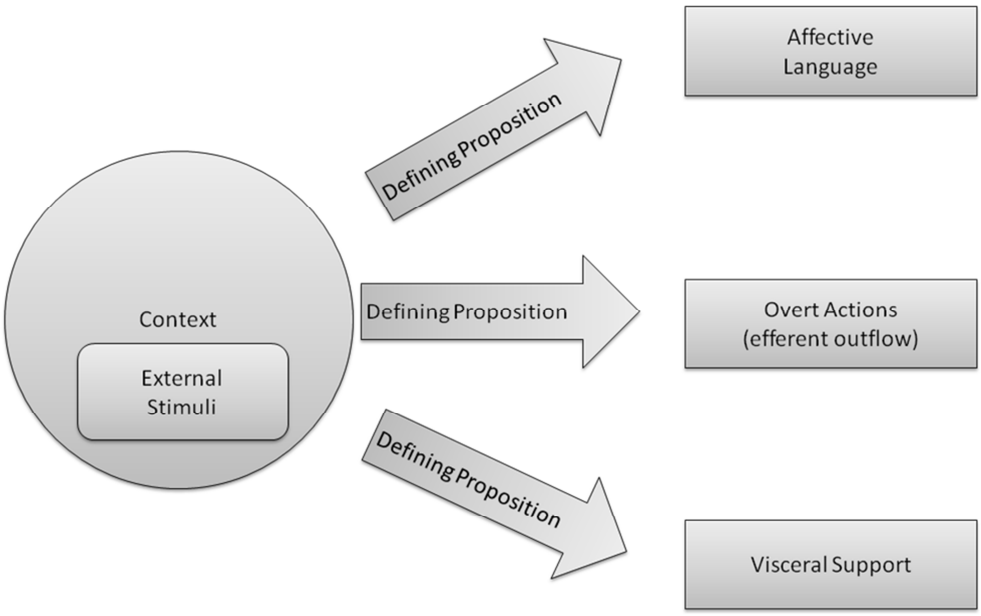
Table 3.

Time spent washing following imagery script.

Group	Imagery condition	Time Washing (in sec.)
Low CB-OCD	Neutral	13.20 (8.14)
	Disgusting	12.81 (9.30)
High CB-OCD	Neutral	9.50 (4.97)
	Disgusting	10.55 (7.77)

Figure Captions

Figure 1. Graphical representation of the relations between stimuli and response propositions



Appendix A

Disgust imagery script: Imagine you are sitting in the waiting room of a hospital. An older man stands up and begins walking toward you. Your eyes cautiously follow him as he approaches you. He stumbles into the chair beside you and starts talking to you. You lean back to avoid the stench of his breath. The smell causes your lip to curl upward and your face to scrunch in distaste. His appearance is haggard and you can smell body odor emanating from his armpits, which makes you nauseous. The man begins to explain that he is very sick and needs to see a doctor. This coupled with his smell causes you to break into a cold sweat. Finally, you see a nurse approaching the two of you. The man stands up and begins talking to the woman. He turns to say goodbye and reaches out to shake your hand. This reveals his arm, which is covered with blisters. The sight of his open sores turns your stomach. You cautiously extend your hand and notice a lump in your throat. As he shakes your hand you notice the feeling of his cold clammy skin, which makes your heart beat weakly and erratically. As he walks away you notice you are incredibly nauseous and feel as if you may vomit.

Appendix B

Neutral imagery script: Imagine you are sitting in the waiting room of a hospital. As you glance out the front door the sun gleams in and you feel the warmth of its rays on your skin. You squint to block out the bright light and notice an older man coming through the front door. Your eyes follow him as he crosses the room and approaches you. He arrives at the chair beside you and asks if the seat next to you is open as he sits down. He is well dressed and you enjoy the smell his cologne. The older man begins to explain that he is at the hospital to visit his daughter who is a nurse. He tells you that she is new to the hospital and that the two of them are going out to lunch today. After a while you see a nurse approaching the two of you. The man stands and hugs the woman. He introduces the two of you and then turns to say goodbye. He reaches out to shake your hand and reveals a unique looking watch. As you shake his hand you can feel the warmth from of his skin and you squeeze hard to return his firm handshake. As the man walks away you sit back down in your seat and pick up a magazine. As the man and his daughter leave the building you feel a cool breeze from the open door.

Appendix C

Response Training:

You recall that I mentioned that vivid imagery of scenes and events would be part of our experimental procedure. We will begin this phase of the experiment now. I'd like you to imaging some events. I'll be reading descriptions of the events to help you imagine them. It is just like daydreaming but I'd like you to bring this more under your control, to imagine specific events, for a given period of time. It will help you to do this if you start from a state of relaxation.

As you sit there, relaxed and calm, I'd like you to imagine some events. Try to imagine the situations as vividly as you can. By this I mean to try to involve yourself fully in the image as an active participant in the situation. For example, the first scene I will ask you to imagine involves reading a book; I want you to try to move your eyes while you imagine just as if you were actively scanning the words and lines of a real book. The idea of a vivid image is that you get the feeling of a real, actual experience.

Now I'll set up the image. As I describe the situation, create the image in your mind, reacting exactly as you would in the real situation. When I finish the description, keep imagining the scene until I tell you to stop. Then focus on relaxing your muscles. We're ready for the first image.

You are in the language laboratory listening to an assignment over headphones, and following the conversation with your book. The words flow too fast and you try to follow the script from line to line down the page. Your neck and shoulder muscles stiffen from being held so tensely in one position. Trying to concentrate, you tense the muscles

in your forehead and around your eyes, and feel a dull headache. You breathe deeply, wanting to get up for a break.

(30 sec. imagine)

Stop imagining the scene and focus on relaxing completely (15 sec. relax)

Now open your eyes.

How did you react during the image?

Did you move your eyes as part of the image?

Did you tense your muscles during the imagery?

Did you take the deep breath?

It's very important to do as part of your image what you would do in the real situation.

This means things like actually tensing your muscles, moving your eyes, and breathing deeply as part of the imagining process. Many of us aren't used to this way of imagining things vividly, and the point of these sessions is for you to learn and practice this kind of active involvement in your images. You must do as part of the image what you would do in the real situation. This can make the image feel more real to you.

All right, now that we've reviewed the idea of vividness, let's practice the same scene again. Don't worry if you didn't experience all the realistic reactions before. Some people are initially better than others at this, but practice will help all of your imaging events, feeling as if they were really happening.

Repeat scene.

Repeat questions.

Close your eyes and take a few seconds to get in a comfortable position and

relaxed again. We'll do another image. Remember, what we're trying to learn is vivid imagery through your active involvement in what you imaging. Just like with the last scene, this means doing just what the image requires. I want to expand this a little, this time. The first thing, is that I want you to use the physiological imagery involvement you have practiced to help you experience situations as real. Things like facial expressions, heart changes, sweating, and breathing changes are a part of the realistic reaction, and actively experiencing these things during your imagery can help you to really experience situations as real. So, as we practice the images today, I want you to have the same kind of physiological involvement as the last image, and to let this help you experience the image realistically, as much as you can.

Let's try an image now. Try to involve yourself in the image as much as you can, as if it were really happening.

You've gotten a low grade doing a project with a classmate who's been lazy about the work. As you wait to complain to the T.A., you overhear your partner telling the T.A., "I knew we wouldn't get it done on time because my partner was so dumb." As sweat breaks out on your forehead, you tense every muscle in your body to keep from bursting into the T.A.'s office and calling the other student a liar. You feel your heart pound and your breathing quickens as your partner walks our of the office door. (25 sec.)

Stop imagining and relax. Open your eyes.

How did you react during the image?

Did you breathe faster and tense your muscles?

Did you feel heart or sweating changes?

Close your eyes again and relax for a few seconds. Before we do the next image, I

want to remind you again of the purposes of the imagery practice; so that you let yourself react during the imagery task by involving yourself physically while you imagine. Okay, let's try the next image.

You breathe deeply as you run along the beach flying a kite. Your eyes trace its path as it whips up and down in spirals with the wind. The sun glares into your eyes from behind the kite and you tense the muscles in your forehead and around your eyes, squinting to block out the sun. Your heart pounds and you sweat heavily as you run along with the kite. (25 sec.)

Stop imagining the scene and relax again. (15 sec.) Open your eyes.

How did you react during the image?

Did you tense your muscles or move your eyes?

What about breathing and heart changes?

Did you feel any change in sweating?

Over the course of this training session you've practiced how to experience realistic imagery by physically involving yourself in the experience. Next you will be engaging in another imagery scene. I'd like you to remember the physical involvement techniques when you do the imagery next time. I think the practice has helped you into active, vivid, realistic imagery.

Questions?