

# Acquisition and maintenance of disgust reactions in an OCD analogue sample: efficiency of extinction strategies through a counter conditioning procedure

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## Research article

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# Abstract

## Background

If obsessive-compulsive disorder (OCD) has long been considered as an anxiety disorder, disgust is the dominant emotion in contamination-based OCD. However, disgust seems resistant to exposure with response prevention partly due to the fact that disgust is acquired through evaluative conditioning. The present research investigates a counter-conditioning intervention in treating disgust-related emotional responses in two groups of individuals with high (HDCC, n = 25) and low (LDCC, n = 23) contamination concerns.

## Methods

The two groups completed a differential associative learning task in which neutral images were followed by disgusting images (conditioned stimulus; CS+), or not (CS-). Following this acquisition phase, there was a counterconditioning procedure in which CS + was followed by a very pleasant US, while CS- remained unreinforced.

## Results

Following counterconditioning, both groups reported significant reduction in their expectancy of US occurrence and reported less disgust with CS+. For both expectancy and valence, reduction was lower in the HDCC group than in the LDCC group. Disgust sensitivity was highly correlated with both acquisition and maintenance of the response acquired, while US expectation was predicted by anxiety.

## Conclusion

Desensitization to disgust handled by counter-conditioning procedure reduces both expectations and conditioned valence.

## Highlights

- Disgust is an understudied emotion in contamination-related disorders.
- Behavioral exposure strategies failed to achieve complete remission of pathological disgust.
- Disgust desensitization is better addressed by counter-conditioning procedure.
- Predictive and evaluative conditioning do not rely on the same emotional process
- Counter-conditioning reduces both expectation and conditioned valence.

## Background

OCD is a psychological disorder whose prevalence is estimated between 1.5% and 3.5% of the world population. This disorder affects all cultural and ethnic groups and is considered by the World health organisation as one of the 10 most disabling mental health disorders (Ruscio, Stein, Chiu, Kessler, 2008). Behavioral and pharmacological treatments for OCD have been repeatedly demonstrated to be effective, leading to large and sustained reductions in OCD symptoms (Richard, Lauterbach, & Gloster, 2007). The Cognitive Behavioral Therapy program with the most empirical support for its efficacy is exposure with response prevention (ERP), even in the most severe cases (Farell et al., 2013). However, even if ERP is an evidence-based treatment for treating OCD, not all patients achieve treatment successfully and many patients continue to experience moderate to high levels of symptoms and/or co-occurring behavioral and emotional problems following treatment (e.g., 75–80% of patients respond, only 40–52% achieve remission) (Farris et al. 2013).

From a theoretical point of view, ERP is based on the cognitive-behavioral model in which the mechanisms of fear acquisition through Pavlovian Conditioning play an important conceptual role in explaining the development and the maintenance of the symptoms. (Abramowitz, Taylor, & McKay D, 2009). It has been proposed that the main reasons of ERP's failure include patients' lack of motivation in reducing rituals and the presence of comorbid disorders, specifically in contamination-based OCD (knoop, 2013).

In addition to these variables, there is a compelling argument recent research has pointed out the key role of various negative emotions such as shame, embarrassment, frustration, anger and contempt and more particularly disgust in the maintenance of contamination-related OCD (Cisler, Olatunji, & Lohr, 2009). Nonetheless, until recently, how disgust is acquired and how it can be extinguished has received very little empirical attention from researchers working in the development of more effective strategies for treating OCD (Ludvik, Boschen & Neumann, 2015).

Disgust is an emotional response to stimuli that have the ability to pollute, and are considered offensive, soiled or depreciated (Woody, Teachman, 2000). Disgust has long been under-researched compared to other emotions (Phillips et al., 1998), such as anger, fear or sadness. Since the 90s however, authors have examined this emotion further and it is clear today that it is involved in a wide range of previously conceptualized disorders within the exclusive framework of anxiety, such as specific phobias and especially fear of spiders (Tolin, Lohr, Shawshuk, & Lee, 1997), blood phobias and injections (Page & Tan, 2009), post-traumatic stress disorder (Engelhard, Olatunji, & De Jong, 2010) and more particularly contamination related OCD (C-OCD) (Cisler et al., 2009; Olatunji, Sawshuk, Lohr, & Dejong, 2004). Current research indicates that behind the word « disgust » two notions must be distinguished : Disgust Sensitivity (DS, i.e., how aversive it is for an individual to feel disgust) and Disgust Propensity (DP, i.e., trait disgust or the tendency to experience disgust frequently and intensely) (Fergus & Valentiner, 2009; Van Overveld, de Jong, Peters, Cavanagh, & Davey, 2006). Regarding, the relationship between disgust and OCD contamination symptoms, high DP was found to be significantly higher in individuals with C-OCD than in individuals with other subtypes of OCD (Woody & Tollins, 2002). Studies have also reported

that increased sensitivity to disgust was strongly correlated with self-reported contamination symptoms (Mancini, Gragnani, & D'Olimpio, 2001).

Despite increased evidence of the contribution of disgust to C-OCD (Brady, Adams, & Lohr, 2010), the literature remains unclear on the processes underlying disgust extinction. Indeed, there are compelling arguments taken from laboratory studies showing that, in contrast to fear, disgust is resistant to extinction and that exposure in vivo treatments are less effective in reducing disgust compared to fear (Mason & Richardson, 2010, 2012).

Several factors could explain disgust's resistance to extinction processes. First, pathogen-related threats are not clearly detectable for the naked eyes, making it difficult to determine the severity of the risk. Considering doubt as crucial in obsessive-compulsive psychopathology (O'Connor, Aardema, 2011), the appraisal of the risk will be enhanced by relying on existing cognitive processes (Teachman, 2006). Next, there is a probabilistic component in the risk of being ill: we do not always become sick when we come into contact with a pathogen, and neutralization (through handwashing or checking) may reduce the probability. Again, intolerance to uncertainty could reinforce the severity of the perceived threat. Moreover, pathogen-related illnesses occur with inconsistent reinforcement, and Skinner shows from 1938 that this form of learning is much harder to extinguish. In addition, there is a time component that is different from most forms of learning: if we come into contact with a pathogen, we may not get sick for hours or days afterwards, which is not the case in traditional forms of associative learning. For example, an individual who has been ill after ingesting a food (even if the food was not responsible) continues to experience nausea or disgust for the food long after the disease has passed (Schafe & Bernstein, 1996). And finally, a learning model has been proposed that abnormal disgust reactions can be maintained through the process of evaluative conditioning (EC) (Ludvik et al., 2015). EC involves the transfer of valence from an unconditional stimulus to a conditional stimulus so that the conditional stimulus acquires the aversive characteristics of the unconditional stimulus regardless of its relation to the unconditional stimulus.

Even if there is considerable evidence to support, similarly than fear, the role of traditional classical operant conditioning mechanisms in the acquisition of disgust. Recent research has suggested that evaluative conditioning effect (EC) could be central in the learning of disgust (Ludvik et al., 2015, Mason & Richardson, 2010). Although EC resembles Pavlovian conditioning procedurally, it differs in being less susceptible to extinction (Diaz, Ruiz, & Baeyens, 2005; Vansteenwegen, Francken, Vervliet, De Clercq, & Eelen, 2006, Hofman et al, 2010; Mason & Richardson, 2012).). Whereas prediction is central in Pavlovian conditioning, it's not the case in EC which is characterized by transfer of affective valence.

If disgust is relatively resistant to extinction due to evaluative conditioning, it may be important to consider incorporating additional exposure trials (McKay, 2006; Smits et al., 2002) or disgust-focused exposure exercises into treatment for some individuals (Hirai et al., 2008). Indeed, targeted disgust exposure has resulted in improvement over traditional fear/anxiety-focused exposure in terms of both symptom-specific and global health indicators in the treatment of blood-injection injury phobia.

Consideration of adjunctive or alternative treatments may also be warranted. Basic research also suggests that approaches such as counterconditioning or reappraisal of unconditional stimulus may be useful alternatives to traditional exposure when targeting reduction of evaluatively conditioned responses (De Houwer, Thomas, & Baeyens, 2001) to reduce both valence and expectation issues. However, research has still to specifically examine whether evaluatively conditioned disgust responds to these approaches.

In this study we decided to focus on the potential utility of a counter-conditioning procedure in reducing learned disgust reactions. The counter-conditioning procedure implies pairing the CS with a US of an opposite valence from the original US. Although this procedure has been studied in animals (Dickinson & Pearce, 1977), only few studies have observed its impact on evaluative learning. Baeyens, Eelen, Van den Bergh, and Crombez (1989) were the first to observe that the conditioned positive or negative valence of a CS can be eliminated or even reversed by pairing it with a new valenced US. This technique could be effective for two reasons. First, by reducing the effects of the negative evaluation attributed to an item by granting it the valence of the new representation. Secondly by reducing the expectation of the conditioned response as it can be through simple exposure techniques by replacing the old aversive association. Importantly, several positive results have been observed in studies using self-reported measures, emotional priming tasks, as well as behavioral tasks (Engelhard, 2014, Kerkhoff et al., 2011). However, despite the fact that the participants underwent a conditioning procedure with disgusting unconditional stimuli, these authors did not directly assess the disgusting aspect of their conditioned stimuli, limiting the scope of the conclusions that can be drawn from it.

Our main objective was to test the efficiency of a counter-conditioning procedure on a response of acquired disgust in two groups of participants high (HDCC) and low (LDCC) in contamination concerns, using a differential associative learning task that dissociated predictive learning from evaluative learning. The second objective was to observe if disgust sensitivity and propensity predict the valence attributed to the conditioned stimulus. We hypothesized that group with high concerns will (a) score significantly higher on the disgust scale and (b) will be more prone to acquired disgust response and less able to disengage from the evaluative learning, (c) we assumed that the counter-conditioning procedure would succeed in reducing US expectation and the valence attributed to the CS.

## Methods

### 2.1 Participants

One hundred and sixty-two lay people were tested using Padua's inventory contamination subscale (PI-C, Sanavio et al, 1998), to identify people with low and high contamination-related concerns. In line with other studies (Armstrong, 2017, Deacon & Maack, 2009, Deacon & Olatunji, 2007). Conform to Armstrong's work (2016), individuals with scores greater than 13 (77 : 47.53% of the sample tested) were considered eligible for the group with high concerns about dirt and contamination (HDCC) and individuals with scores below 7 (42 : 27.92% of the sample tested) were considered eligible for the group with low concerns regarding dirt and contamination (LDCC). In order to maximize the distinction between groups

we then started recruiting participants with highest and lowest scores. Our final sample comprised 25 participants in the HDCC group and 23 participants in the LDCC group.

## 2.2 Measures

In addition to the PI measure used to allocate participants to experimental groups, we used various measures to assess disgust tendencies (disgust propensity and sensibility scale (DPSSRf-10) (Novara et al., 2019)), Dimensional obsession compulsion scale (DOCS) (Abramovitz, 2009), Obsession compulsion inventory (OCI-R) (Foa et al., ), State and trait anxiety inventory (STAI B) (Spielberger, 1970) and positive and negative affect schedule (PANAS) (Watson, Clark, and Tellegen, 1988).

We also used the unipolar version of the empirical valence scale (EVS, Lishner, Cooter, & Zald, 2008) to collect subjective response of perceived valence and US expectation during the task. EVS is a labeling scale designed to rate the magnitude of subjective experiences. Participants rate the state of their disgust response to the CS and US, and their US expectation during the CS presentation. The unipolar version of the scale contains the following labels and associated values: not at all (0), barely (7), slightly (12), averagely (24), moderately (38), strongly (70), extremely (85), the most imaginable (100). These labels are placed on a line (without the corresponding numeric values). Scores are made by clicking on the line using a mouse.

## 2.3 Material

The CSs consisted of two neutral abstract images, respectively pink and blue, representing lines and circles (480x480p.). CS allocation was counter-balanced between participants in each group so that in one condition, for half of the participants of the whole group (N=24), image #1 was CS +, and image #2 was CS- and for other half vice versa. The US consisted of eight different disgusting images (824x618p.) depicting spoiled food (2), waste / body secretions (3), unhygienic environments (3) that have been selected from the DIRT database (Haberkamp et al., 2017), and data resources online. The same eight US were used for each participant. We used multiple US to limit habituation. The stimuli were presented on a screen using the Eprime 2.0 software control stimuli presentation and data collection.

## 2.4 Procedure

The Ethics Committee of the Psychological Faculty of Montpellier 3 University approved the study, and all participants provided written informed consent. Participants then completed the measures (PI-C, DPSS-R, DOCS) as well as a collection of general information (age, gender, level study, professional status). The participants then completed the computer task, adapted from the work of Armstrong & Olatunji, 2016 which consisted of three phases:

*Habituation phase.* First, participants see eight non-reinforced presentations (6 s) from each CS. CS are preceded by a cross (1.5 s) and followed by an inter item interval (ITI) that varies between 12 and 18 seconds. CS appears in the center of the screen.

*Acquisition phase.* CSs are presented for 6 seconds in the center of the screen. Immediately after the presentation of the CS +, the US is presented for 3 sec. After the presentation of the CS-, the test continues with the ITI. CSs are preceded by a fixation cross (1.5) and followed by an ITI that varies between 12 and 18 sec. There are eight presentations of the CS- and 8 presentations of the CS +, in pseudo-random order (no more than four consecutive presentations of the same CS).

*Counter-conditioning phase:* the acquisition procedure is repeated but CS+ is followed by very pleasant US extracted from the IAPS and public online resources, while CS- remains unreinforced. Pleasant US were eight images representing landscapes (2), family (1), animals (2), baby (1), laughing children (2).

At the end of each phase, participants use the empirical valence scale (EVS) to retrospectively score the disgust felt for CS “How much do you find this picture disgusting?” and how much they expect the disgusting US to follow CS “How much do you expect this picture to be followed by a disgusting picture”. For each rating, stimuli and scale are presented simultaneously until a response is given.

## 2.5 Statistical Plan

Following the work lead by Armstrong and Olatunji in 2016, analyses were conducted separately for each stage of the procedure (habituation, acquisition, counter-conditioning (CC)). Consequently, we did not correct for multiple comparison across stages. For the valence ratings and the US expectancy ratings, a 2(CS: CS+; CS-) x2 (group: HDCC; LDCC) mixed-effect ANOVAs were conducted. Significant CS x group interaction were followed by independent sample t-test in order to compare between groups the ratings of the CS+ and the CS- separately. To observe the evolution of the ratings between acquisition and counter-conditioning stages, we added the within-subject factor of stage (acquisition, counter-conditioning) to the ANOVA model that included the CS and group factors. Stage by CS interaction was examined to observe the decrease in valence and US expectancy ratings. Using paired sample t-test we probed this interaction by contrasting the CS+ and the CS- between acquisition and counter-conditioning.. The stage by CS by group interaction was also examined. We conducted independent sample t-test comparing the groups on changes scores in which responding at CC was subtracted from responding at acquisition for each CS. Regression analyses was then conducted through a step by step procedure including the whole of the 7 sub-dimensional factors assessed by scales.

# Results

## 3.1 Group characteristics

Groups with strong (HDCC) and low (LDCC) concerns about dirt and contamination did not show significant differences in age, gender, and socio-professional category. As expected, the HDCC group had significantly higher levels of behavioral contamination-related symptoms (PI-C:  $p < .001$ ; DOCS contamination  $p < .001$ ; OCI-R contamination  $p < .001$  ) was higher in sensitivity and disgust propensity ( $p < .001$ ) and had significantly higher levels of anxiety ( $p = .004$ ) and negative affect ( $p = .04$ ). The HDCC group also rated the

disgusting US after the acquisition phase as significantly more disgusting than the LDCC group did ( $p < .001$ ) (See Table 1).

**Table 1.** Group characteristics

	HDCC (N=22)	LDCC (N=23)	95% CI	sig
<b>Age</b>	31 (11.86)	37 (14.96)	[-13; 99]	$p=.15$
<b>Genre % Female</b>	68.18%	60.86%		$\chi^2=.26, p=.60$
<b>occupation % students</b>	40.90%	30.43%		$\chi^2=4.36, p=.35$
<b>MEASURES</b>				
<b>PI-C</b>	22.43 (4.78)	3.89 (1.99)	[16.09; 20.99]	$t(43)= 15.39, p<.001$
<b>DPSSf-10 Propension</b>	20.15 (2.87)	15.43 (3.66)	[3.03; 7]	$t(43)= 5.09, p<.001$
<b>DPSSf-10 sensibility</b>	10.31 (3.95)	6.60 (2.27)	[1.78; 5.63]	$t(43)= 3.87, p<.001$
<b>DOCS Contamination</b>	7.81 (3.06)	3.30 (1.76)	[3.01; 6.01]	$t(43)= 6.08, p<.001$
<b>OCI-R Contamination</b>	5(2.07)	.35(.71)	[3.72; 5.57]	$t(43)=10.16, p<.001$
<b>STAI-B</b>	49.33(10.10)	40.67(8.38)	[2.87; 14.45]	$t(43)=3.02, p=.004$
<b>PANAS negative affect</b>	15.92(3.27)	14.04 (2.68)	[.08; 3.68]	$t(43)=2.11; p=.04$
<b>Mean US evaluation</b>	76.96 (9.57)	49.87 (2.97)	[16.69; 37.47]	$t(43)= 5.25, p<.001$

*Note: HDCC: High dirtiness and contamination concerns group, LDCC: Low dirtiness and contamination concerns group. DPSSf-10: disgust propension and sensibility scale, DOCS: dimensional obsessional compulsion scale; OCI-R: obsession compulsion inventory revised; STAI-B: State and trait anxiety inventory; PANAS: positive and negative affect schedule).*

### 3.2 Habituation

#### US expectation rating

The main effects of CS,  $F(1,43) = 2.15, p = .15, n^2_p = .04$ , the main effect of group,  $F(1,43) = 0.02, p = .87, n^2_p = .001$ , and the interaction between the group and CS  $F(1,43) = 0.43, p = .51, n^2_p = .01$  did not reach significance. Thus, there were no differences before acquisition in the susceptibility of CSs to provoke US expectation for none of the groups (Table 2, Figure 1).

#### Valence Ratings

The main effects of CS  $F(1,43) = 1.04$ ,  $p = .31$ ,  $n_p^2 = .02$ , group  $F(1,43) = .03$ ,  $p = .17$ ,  $n_p^2 = .04$ , and group interaction with the CS  $F(1,43) = .42$ ,  $p = .61$ ,  $n_p^2 = .006$ , were all insignificant. Thus, before the acquisition, CSs do not differ in their ability to elicit disgust (see Table 2).

**Table 2.** Mean (SD) of direct evaluation on US expectation and valence ratings on Empirical valence scale (100 points)

EVALUATION	CS	PHASE		
		Habituation	Acquisition	Counter-conditioning
<b><u>HDCC</u></b>				
EXPECTATION	CS+	31.13 (32.10)	91.13 (11.01)	31.59 (32.42)
	CS-	41.81 (33.98)	2.09 (2.36)	7.31 (15.56)
VALENCE	CS+	5.18 (14.75)	11.18 (18.09)	8.22 (16.46)
	CS-	5.95 (14.75)	1.81 (2.10)	1.81 (2.10)
<b><u>LDCC</u></b>				
EXPECTATION	CS+	35.69 (30.79)	94.69 (14.37)	11.39 (20.86)
	CS-	39.78 (28.61)	1.26 (1.25)	10.34 (20.85)
VALENCE	CS+	1.26 (1.25)	2.78 (5.06)	1 (0)
	CS-	1.52	1.26 (1.25)	1 (0)

*Note:* HDCC: High dirtiness and contamination concerns group, LDCC: Low dirtiness and contamination concerns group.

### 3.4 Acquisition

#### US expectation ratings

The main effect of CS was significant  $F(1,43) = 2206.36, p < .001; n^2_p = .98$ . Participants rated the US expectancy occurrence significantly higher for CS + than CS-, so participants learned contingency during the acquisition process. The main effect of group  $F(1,43) = .50, p = .48, n^2_p = .01$ , and the interaction between the CS and the group  $F(1,43) = 1.27, p = .26, n^2_p = .02$  were both insignificant, indicating that there was no difference in groups in potential predictability of unconditional stimulus occurrence following CS + (Table 2). Both groups learned the predictive association between the CS + the and disgusting pictures.

### **Valence ratings**

The main effect of CS  $F(1,43) = 8.20, p = .006; n^2_p = .16$  was significant. Participants experienced more disgust in response to the CS+ compared to the CS-. The main effect of group  $F(1,43) = 4.75, p = .03, n^2_p = .10$  was significant, and qualified by a significant CS by group interaction  $F(1,43) = 4.25, p = .04; n^2_p = .09$ , indicating that the evaluative conditioning effect took place. A t-test reveals that only conditioned CS (CS +) was significantly assessed as causing disgust in the HDCC group who associated the aversive properties of the CS from the acquisition phase  $t(43) = 5.17, p = .02, 95\% \text{ CI } [-.47; 1.5]$  (see Table 2). Thus, the HDCC group reported experiencing more disgust to the CS+ following the acquisition stage.

## **3.5 Counter-conditioning**

### **US expectation rating**

The results show a main effect of CS  $F(1,43) = 7.36, p = .01, n^2_p = .14$ . Participants rated the US expectancy occurrence significantly higher for CS + than CS-. The interaction effect between CS and group  $F(1,43) = 6.19, p = .01, n^2_p = .12$  was significant. A t-test reveals that, compared to the LDCC group, the HDCC group reported greater anticipation of the US during CS+ presentation  $t(43) = 2.49, p = .01, 95\% \text{ CI } [3.88; 36.51]$ . In the analysis of the evolution of the conditioned response according to the stages of the procedure (acquisition, counter-conditioning), we observed a significant interaction effect of CS with phase  $F(1,43) = 241.82, p < .001, n^2_p = .73$ . Paired t-tests revealed that the US expectation associated with CS + decreased significantly from post- acquisition to post-counter-conditioning procedure  $t(43) = 5.04, p = .005, 95\% \text{ CI } [7.61; 39.90]$ , whereas the US expectation for CS- did not change significantly  $t(43) = 2, p = .46, 95\% \text{ CI } [-14.40; 6.68]$ . The counter-conditioning procedure thus has extinguished the conditioned US expectation response in both groups of participants. The CS by phase interaction was further qualified by a CS by stage by group interaction,  $F(1,43) = 7.46, p = .008, n^2_p = .08$ . Compared to the LDCC group,  $M = 59.54, SD = 30.40$ , the HDCC group reported a smaller reduction in the US expectation occurrence following CS + from post-acquisition to post-counter-conditioning,  $M = 83.30, SD = 22.94, t(43) = -2.96, p = .005, 95\% \text{ CI } [7.61; 39.90]$ . A similar effect was not observed for the CS-, (HDCC:  $M = 9.08, SD = 20.09$ ; LCC:  $M = 5.22, SD = 14.35, t(43) = 0.44, p = 0.66 [-14.40; 6.68]$ ). Thus, the HDCC group exhibited reduced extinction of US expectancy for the CS+, specifically.

### **3.6 Valence ratings**

We observe a main effect of the CS  $F(1,43) = 4.82$   $p = .03$ ,  $\eta^2_p = .10$ . Participants experienced more disgust in response to the CS+ compared to the CS-. The main effect of group  $F(1,43) = 12.98$   $p = .001$ ,  $\eta^2_p = .23$  was significant and qualified by an interaction effect between the CS and the group  $F(1,43) = 4.82$   $p = .03$ ,  $\eta^2_p = .10$ . Compared to the LDCC group, the HDCC group reported more disgust in response to the CS+  $t(43) = 2.10$   $p = 0.04$ , 95% CI [0.30; 14.4], but not the CS-,  $t(43) = 1.86$   $p = 0.07$ , 95% CI [-0.06; 1.70]. In the analysis of the evolution of the conditioned response according to the stages of the procedure (acquisition, counter-conditioning), we observe a CS by stage interaction,  $F(1,43) = 8.20$   $p < .001$ ,  $\eta^2_p = .12$ . Paired samples t-tests revealed that disgust during the CS+ decreased from post-acquisition to post-counter-conditioning,  $t(43) = 2.19$ ,  $p = 0.03$ , 95% CI [0.19, 4.51], whereas disgust for the CS- did not change,  $t(43) = 0.44$ ,  $p = 0.66$ , 95% CI [-0.47, 0.73]. The CS by stage interaction was not qualified by a significant CS by stage by group interaction,  $F(1,43) = 4.25$   $p = 0.05$ ,  $\eta^2_p = .09$ . Thus, partial extinction of disgust to the CS+ occurred: the valence reported for the CS+ decrease significantly for the HDCC group but remain significant (see Table 2, Figure 1).

### **3.7 Correlations between the unconditional disgust and the evolution of conditioned disgust learning and US expectation**

The results of the bivariate correlational analysis between the different measures and learning phases of the CS+ for the entire sample show the constant importance of disgust's sensitivity factor as measured by the DPSSF-10 which appears as a major factor in both acquisition and maintenance of the valence acquired through evaluative conditioning. Bonferroni correction was applied for correlations resulted in a lowering of the p value required for significance to 0.0029.

### **3.8 Regression analyses between acquisition and desensitization of US expectation and evaluative learning**

A regression analysis was performed, entering simultaneously as predictor variables scores, Disgust propensity and sensitivity, dimensional OCD symptoms, contamination concerns, negative affects and anxiety trait scores. Furthermore, a Bonferroni adjusted significance level of  $p < 0.003$  was applied in the regression analyses to control for problems in multiple testing. Together, the thirteen predictor variables explained a significant proportion of the variance in expectancy acquisition of the conditioned CS ( $r^2 = .47$ ,  $F(1,40) = 11.5$ ,  $p = .002$ ) and the negative valence acquisition ( $r^2 = .45$ ,  $F(1,40) = 10.62$ ,  $p = .002$ ) assessed with the EVS.

After controlling for the other variables, the amount of unique variance of DS as a predictor for evaluative acquisition score is statistically significant ( $\beta = 1.52$ ,  $t = 3.4$ ,  $p = .002$ ). Whereas, expectation ratings after counter-conditioning procedure are better predicted by anxiety score as assessed by the STAI B ( $r^2 = .78$ ,  $F(5,36) = 11.21$ ,  $p < .001$ ), in a model that also include DOCS contamination subscale, unacceptable thoughts and discomfort, and contamination concerns of the OCI-R.

## **Discussion**

The present study sought to test the effects of a counter-conditioning procedure on disgust extinction in two groups of participants high (HDCC) and low (LDCC) in contamination concerns, using a differential associative learning task that dissociated predictive learning from evaluative learning. We also tested the hypothesis that the evaluative learning of disgust that could characterize the preoccupation about dirtiness and contamination is predicted by high levels of disgust propensity and/or sensitivity.

The main findings can be summarized as follows: First, as hypothesized, the results shown that the conditioned disgust response (the valence acquired by the conditioned CS) is correlated with self-reported level of disgust. Then, as hypothesized, the counter-conditioning procedure was successful to reduce the intensity of the valence acquired by the conditioned CS and was successful to completely extinct the US expectation.

The results show that the current differential conditioning procedure was successful in enhancing the disgust response toward the CS + for the HDCC group but not for the LDCC group. Unlike the work conducted by Armstrong in 2017, differences between groups could be seen as soon as the conditioned response was acquired. The group with strong concerns significantly attributed to the neutral image a more negative valence as a result of its association with disgusting images. However, Schienle et al. (2001) has already described in a blood phobia sample that some disgust sensitive people may be more prone to acquire disgust reaction than controls. This is also consistent with some work suggesting that attentional biases and pre-sensory learning would be an important trait in people with OCD and could foster learning and facilitate creation of disgust conditioned response, whereas people who do not have OCD may not perceive anything. This may increase their susceptibility to disgust (McKay, 2006). The differences with Armstrong's work could also be partly attributed to the descriptive characteristics of our sample which is not exclusively made of students, and with equal proportion of males and females. Moreover, the CS used by Armstrong were faces whereas we used abstract pictures tested in a previous pilot study.

Next, we found that the most robust predictor of disgust acquisition and maintenance of disgust response is not disgust propensity but disgust sensitivity, even when anxiety and negative affect are controlled. Yet it has been previously shown that disgust propensity was highly correlated with OCD, while disgust sensitivity was more generally associated with anxious disorders and inability to regulate emotion (Olanuji, Lohr, Jasper, Sawchuck & Patten 2009). That being said, as mentioned above, many studies that have investigated this issue only evaluated DP and did not include a measure of DS in their assessments (Cisler, Reardon, Williams & Lohr, 2007; Rozin, Taylor, Ross, Bennett & Hejmadi, 2005). The impairment of meta-emotional processes could thus represent a promising perspective of investigation.

From the standpoint of US expectation, both groups have acquired and were desensitized by counter-conditioning procedure in the same way. The learning of the occurrence of an unpleasant stimulus is therefore not specifically acquired by people with a strong sensitivity regarding dirtiness and contamination. Which is in line with Pavlovian conditioning theories: the repetition of co-occurrences produce the expectation of the unconditional stimulus following a conditioned stimulus and the repeated

exposure without consequences deconstructs the expectation. Yet, the absence or the presence of occurrences can be easily noticed, which is not the case with attributed valence. This knowledge must rely on associative network.

However, an important result was highlighted by the regression analyses which reveals that the US expectation and acquired valence do not rely on the same emotional processes: the US expectation is not explained by self-reported disgust but is independently explained by anxiety level, while valence acquired is exclusively explained by disgust sensitivity. Furthermore, the US expectation is totally extinguished by the counter-conditioning procedure. Thereby, the results underline the importance of the distinction between expectation learning and evaluative learning (Herman et al, 2002): the counter-conditioning procedure reduced the evaluative conditioning effect although the levels of disgust attributed to conditioned CS remain high in the HDCC group. Whereas the US expectation as is explained by the anxiety level is more completely extinguished by the procedure. Which is consistent with the fact that mere exposure succeeds to reduce it.

As hypothesized, our results show that the counter-conditioning procedure is successful at reducing both the acquired valence and the predictive value of the stimulus. The two consequences of conditioning are in this way addressed. However, the procedure's failure to completely turn the negative valence off could be explained by the strength needed by the positive new association. Indeed, research indicates that counter-conditioning requires an unconditional stimulus intense enough to be effective (Scwekendieck, 2013). These preliminary results are therefore promising but the implementation of this procedure would probably require suitable desirable unconditional stimuli for each individual's situation.

From a clinical point of view, exposure-based treatment incorporating counter-conditioning would thus be more effective than simple exposure treatment by addressing not only the predictive value of the unconditioned stimulus occurrence but also by modifying the valence attributed to the conditioned stimulus.

## **5. Limits and perspectives**

Although this study has addressed a certain number of limitations of previous studies such as the link between specific disgust evaluations with counter-conditioning procedure, a certain number of limits can be put forward and will have to be addressed in future studies. Firstly, the analogue sample used in this task may not be fully representative of the functioning of people with obsessive-compulsive disorder in its contamination dimension. Although there is strong evidence that subclinical contamination research may be relevant to generalize results to diagnosed patients (Abramowitz et al., 2009), research specifically targeting clinical populations will be needed.

Secondly, the present study does not directly compare the effects of the counter-conditioning procedure with the effects of other therapeutic strategies that have been described in the literature as potentially effective. Indeed, although disgust has been labeled as "resistant" to extinction, some works shade this statement by describing it as modifiable, though with difficulty (Olatunji, Smits, et al, 2007, Taboas,

Ojserkis, & Mc Kay, 2015). It might thus be necessary to test the differential influence of counter-conditioning by requiring the inclusion of a reference condition to be sure that any difference indeed could be attributed to differential sensitivity to counter-conditioning in people with high versus low contaminations concerns. Moreover, the re-evaluation of the unconditional stimulus has been proposed as an effective technique to desensitize reactions acquired by evaluative conditioning. However, this technique has not been directly tested on disgust. Future studies will have to take into account these different techniques by directly comparing their effects with those of the counter-conditioning.

In addition, the presence of common variance method (i.e., self-report) may have inflated the correlations among the study variables. Future studies would benefit from using less direct and less subjective observation techniques such as emotional priming, behavioral avoidance task or physiological measures.

Finally, counter-conditioning, as mere extinction, implies a new learning rather than desensitization or forgetfulness, and the conditioned response is always likely to return (Bouton, 2002, Craske, 2014). Because of the lack of empirical research evaluating the effects of long-term counter-conditioning, we do not know if the associations acquired by evaluative conditioning also retain this original association after this type of procedure.

## Conclusion

The heterogeneity of obsessive-compulsive disorder presentations encourages us to develop new approaches that lead to more targeted management of the various processes involved. Recognition of emotional influences beyond anxiety in OCD support the critical importance of a dimensional approach of psychopathology. The data obtained here, emphasizes that the inclusion of disgust and the specificity of its learning in the theoretical models of OCD, in particular C-OCD, may improve our understanding and treatment of this disorder.

## Abbreviations

**OCD**: Obsessive-compulsive disorder; **C-OCD**: Contamination related obsessive compulsive disorder; **EC**: Evaluative conditioning; **EPR**: exposition with response prevention; **DS** : Disgust sensitivity; **DP**: Disgust propensity; **US**: unconditional stimulus; **CS**: conditional stimulus; **HDCC**: High dirtiness and contamination concerns; **LDCC**: Low dirtiness and contamination concerns; **CC**: counter-conditioning

## Declarations

### Ethics approval and consent to participate

All participants gave their written consent to participate, and the study was approved by the local Ethics Committee (Laboratory Epsilon, Evolve Team #22062020-4) as conforming to the Declaration of Helsinki.

No animals were involved in this study

### **Consent to publish**

The Author transfers to BioMedCentral Psychiatry the publication rights and he warrants that her contribution is original and that she has full power to make this grant.

### **Availability of data and materials**

Complete Data is available on demand to corresponding author.

### **Competing interests**

There is no direct or indirect interests undermining the objectivity we must show in the work conducted.

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### **Authors' Contributions**

CN and SR conceived the experiment, CN and PT designed the experiments. CN conducted the experiments and

collected data. CL analyzed the results. CN, SR wrote the main manuscript text. All of the authors reviewed the manuscript.

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## Figures



**Figure 1**

Direct evaluation and US expectation ratings of the CS+. Note: HDCC : High dirtiness and contamination concerns group, LDCC : Low dirtiness and contamination concerns group.