That's Disgusting! Conceptual Reorientation Tested through Eye-Tracking Data

by

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Certificate of Approval

This is to certify that the accompanying thesis by Owen Crabtree has been accepted in partial fulfillment of the requirements for graduation with Honors in Psychology.

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Abstract

Our study investigated the effectiveness of conceptual reorientation in reducing disgust by measuring dwell time using eye-tracking technology and participant's self-reports of disgust. Previous research has shown that disgust is resistant to corrective information (Rozin et al., 1986), perhaps because it is elicited by the concrete sensory properties of a stimulus, rather than its abstract meaning (Royzman et al., 2013). Our study measures willingness to pick up disgusting objects, but not willingness to orally incorporate them. Conceptual reorientation is modeled by having participants view images of poop and a rock, learn that the images taken are of fake poop and a rock, be allowed to hold the fake stimulus objects, and then view the stimulus images again. The current study finds that conceptual reorientation of disgusting objects has significant diminishing effects on both self-reported disgust and dwell time of those objects. The current study demonstrates that disgust can be attenuated by corrective information and is partially determined by the meaning of a stimulus, at least with low risk contact. These results suggest that conceptual reorientation may be an effective tool in reducing disgust in anxiety disorders.

Keywords. disgust, eye tracking, anxiety disorders

That's Disgusting! Conceptual Reorientation Modeled through Eye-Tracking Data

Disgust has been recognized as a fundamental aspect of human behavior for decades, yet research on disgust has only recently begun. Disgust has been studied through different lenses: as a functioning part of the behavioral immune system (Schaller & Park, 2011), as an evolutionary adaptation for determining the value of stimulus contact (Tybur, J. M., Lieberman, D., Kurzban, R., & Descioli, P., 2013), and as an enforcer of social values and hierarchy or reaction formations to morality and shame (Miller, 1998; Nussbaum, 2001). Darwin described disgust as "something revolting, primarily in relation to the sense of taste, as actually perceived or vividly imagined and secondarily to anything which causes a similar feeling" (Miller, 1998), while Angyl held that disgust is revulsion at the prospect of oral incorporation of a potentially harmful stimulus (Apicella et al., 2017). Rozin et al. (1986) combine these perspectives to form their own definition, called *core disgust*, in which a disgusting object can contaminate another object through a touch, however brief, and render the touched object disgusting. The primary function of disgust, then, is to render food inedible after contact with disgusting objects. However, most theories of disgust have yet to be adequately tested. Multiple theories of disgust predict that people will be disgusted by objects that look like potentially infectious or harmful objects, even if they know that the objects are fake, a phenomenon that inspired Rozin, Millman, and Nemeroff 's (1986) "law of similarity". For example, Rozin and colleagues (1986) found that disgust towards feces-shaped stimuli is unaffected by knowledge that the stimuli were fake. These results imply that disgust is impervious to reason, and that the cognitive reframing of a stimulus would not work as a means of therapy for reducing disgust. The current study tests the theory that

disgust is impervious to cognitive reframing using a more comprehensive assessment of disgust than in prior studies.

Disgust: Definitions and Theories

Disgust reactions in humans have both behavioral and physiological components. The behavioral component of disgust is manifested as a distancing from or rejection of a stimulus, whereas the physiological components of disgust include nausea, puckering of the mouth, the tensing of facial muscles, and even laughter (Rozin, Haidt, & McCauley, 2008). This behavior is usually accompanied by an unpleasant psychological sensation. The most prevalent elicitors of disgust are food and bodily fluids, though the specific foods or substances one may find disgusting depends on culture. For example, people living in western cultures rarely worry about the background of the individuals preparing their food, while for individuals living in some eastern cultures, the "wrong" cook preparing the food may elicit disgust (Rozin, et al., 2008).

The facial expression of disgust can be elicited at birth by bitter or sour foods. However, this "distaste reflex" is distinct from the emotion of disgust, which targets the meaning of a stimulus, rather than its concrete sensory properties. Disgust is thought to be a largely food-related emotion, yet can also be elicited by contagion threats and by the reminder of one's mortality and animal nature (Rozin et al., 2008). Disgust as an emotion emerges between ages two and four as children begin rejecting food on the basis of its nature or origin. Disgust tends to broaden and change during child and adolescent development toward a wider variety of stimuli such as bad smells and bodily fluids, as well as a wider range of contact, including non-oral touch (Rozin et al., 2008). As individuals reach adulthood, certain stimuli once regarded as disgusting (such certain

foods and sexual acts) cease to register as disgusting. However, disgust is hard to eliminate because of its complex and deep rooted biological and cultural influences. Therefore, a successful framework for eliminating disgust will have important implications for the treatment of individuals with disgust and anxiety disorders.

Disgust is not contained solely to Western culture; it is demonstrated to have universal applications across cultures. Contagion sensitivity, also referred to as *magical contagion*, is the process by which the unobserved passage of properties between entities via physical contact takes place (Apicella, 2017). Contagion sensitivity, along with disgust, has been been proposed to be part of a biologically-evolved system designed to reduce exposure to pathogens by increasing the avoidance of "contaminated" objects. This system has been shown to be universal in human populations (Apicella, 2017). While there may be some cultural variability, certain bodily products (e.g., feces) and other elicitors are considered more or less universally contaminating.

Disgust has also been thought to function as an enforcer of social values and hierarchy. Nussbaum (2001) proposed that shame and disgust are inherently linked. He views shame as a form of disgust which functions as a sort of alarm system, alerting an individual when they break a social norm relevant to their position in society. Shame also alerts one if they have dipped below their place in the social hierarchy, therefore helping to ensure general social order and personal social status. Freud also lumped shame and morality with disgust, treating them "as a reaction formation whose function it is to inhibit the consummation of unconscious desire" (Miller, 1998). This view of disgust implies that "it is culture, not nature, that draws the lines between defilement and purity, clean and filthy" (Miller, 1998). Disgust therefore organizes and internalizes attitudes

towards moral, social, and political domains, and helps the individual maintain these and other internal social categories such as gender, identity, religion, and sexuality (Nussbaum, 2001).

Harmful Disgust

As a human reaction, disgust has the ability to protect oneself from harm but also has the potential to be harmful in many ways. It plays a big role in many obsessive compulsive disorders, as well as in phobias and anxiety disorders. For example, individuals with contamination based obsessive compulsive disorders may go to debilitating lengths to prevent certain substances and germs from entering or exiting their home, touching their skin, and so on. Individuals with these disorders may be prone to excessive, irrational fear of stimuli, as seen in those with spider or snake phobias, or the phobias or disorders may be derived from excessive, irrational disgust. Disgust has has also been used to dehumanize and marginalize various social, religious, and racial groups throughout history. For example, pre Civil War propaganda utilized racist stereotypes to portray African Americans as deranged and animalistic, eliciting out-group and mortality based disgust. Furthermore, as climate change and population continue to grow, the elimination of disgust may play a large role in beginning to live more sustainably, by eating bugs, drinking recycled wastewater, and other eco-friendly but initially disgusting measures.

Can You Change Disgust?

Psychologists, philosophers, and anthropologists have all noted that disgust is resistant to extinction (Miller, 1998). The stubborn nature of disgust can be partially explained by the laws of sympathetic magic. Disgust has been determined to function in

accordance with the laws of sympathetic magic, which originate from anthropological studies of "essences." Early research found that members of some non-industrialized societies believed that essences could be transferred via either the law of similarity, in which an object that resembles another object can take on the essence of the latter object, or the law of contagion, whereby objects can acquire the essence of other stimuli after coming into contact with them. Later research found that Western students at elite universities act in accordance with these same laws (Rozin et al., 2008).

Rozin, Millman, and Nemeroff (1986) conducted a study on the law of contagion and the law of similarity in the context of disgust. They measured the law of contagion by dipping sanitized roaches into juice cups, and found that participants were significantly less willing to try the juice after the roach had been dipped, even when they were told that the roach was entirely cleaned and harmless. Individuals' unwillingness to try the juice implies that, from the participants' point of view, the essences from the roaches had been magically transferred to the juices upon coming into contact with them. Rozin et al. (1986) demonstrated the law of similarity using square pieces of fudge and dog poop shaped pieces of fudge. They found that even when participants were told that the dog poop shaped fudge was merely fudge, they were overwhelmingly unwilling try it. These results suggest that rethinking the nature of disgusting objects will not work, because if the root of disgust lies in the appearance of a stimulus, reframing the meaning of that stimulus will not affect how disgusting it is.

This first seminal study by Rozin et al. (1986) cast disgust as a stubborn, irrational emotion. Another perspective on the stubborn, irrational nature of disgust comes from Schaller and Park (2011), who conceptualize disgust as a component of the "behavioral

immune system." While the bodily immune system works to prevent pathogens from entering and attacking the body upon contact, the behavioral immune system works to prevent contact with disgusting or harmful stimuli in the first place. This behavioral immune system could explain why in the participants Rozin et al.'s (1986) study were unwilling to eat the dog poop shaped fudge. Despite knowing that it was safe to eat, their behavioral immune systems continued to label the stimulus as threatening, and thus their disgust remained. Schaller and Park theorized that such a system would consist of psychological mechanisms that (1) detect stimuli that suggest the presence of infectious pathogens, (2) trigger disease-relevant emotional and cognitive responses, and thus (3) initiate behavioral avoidance of the possibly infectious stimuli (Schaller & Park, 2011). One characteristic of the behavioral immune system is the "smoke alarm principle"--that false positives are significantly less costly than false negatives, and thus humans will be disgusted by things that do not warrant a disgust response. For example, the reduction in hunger that comes from eating an apple riddled with holes is easily outweighed by the potential multi-day sickness that could also result from its consumption. A behavioral immune system sensitive to detecting any stimulus that could lead to infection or illness leads to stubborn disgust. In other words, disgust being resistant to meaning-altering information about a stimulus is an evolutionary byproduct of an overly sensitive behavioral immune system.

Tybur, Lieberman, Kurzban, and Descioli (2013) agreed with the theory that disgust evolved as a mechanism for the avoidance of possibly harmful stimuli and proposed an information-processing mechanism through which disgust functions. This mechanism is responsible for integrating cues that indicate the probability of harm upon

contact with the stimulus with the expected value of contact. For example, if the stimulus is an apple, the harm-indicative cue might be how rotten the apple is, or if it appears to be partly eaten by another organism, while the expected value would be its nutritional value. Applied to Rozin et al.'s (1986) study, the unconsciously calculated probability of harm from eating the poop shaped fudge outweighs the expected value (nutrition, pleasure) of consumption. This proposed mechanism is also affected by modulators, such as how hungry or aroused one is at the moment of perceptual contact with the stimulus. For example, if one has gone days without eating, he or she may eat an apple ridden with holes. Tybur et al. (2013) suggest that curiosity may also function as a modulator of disgust, and that it can be beneficial to 'inspect' a disgusting stimulus to gather information about it.

Another take on the stubbornness of disgust comes from Royzman and Sabini (2001). Their main take is the cognitive impenetrability hypothesis, in which disgust arises as a function of concrete, not abstract, inhibitors. Concrete inhibitors are sensory properties of stimuli, whereas abstract inhibitors are states of affairs in the world. According to this hypothesis, one cannot cognitively reframe their perception of poop, for example, and reduce disgust because poop has concrete sensory properties, not cognitive propositions. Royzman and Sabini argued that disgust itself is an object-focused "dyspepsia" tied to concrete stimulus features, not the meaning of a stimulus. They claim that disgust is stubborn because it operates with a set of fixed reactions associated with elicitors, versus more flexible responses that emotions need to possess. Therefore, disgust cannot be eliminated because reappraisal does not work. For example, you cannot reframe poop as non-disgusting because disgust does not rely on propositional thoughts.

Their work also ties in with the aforementioned concept of 'sympathetic magic' (Rozin et al., 1986), where the image equals the object and can elicit the same disgust response. They argue that the image equals the object because disgust is about appearance and sensory qualities, not about propositional thoughts about a state of affairs in the world (Rozin et al., 1986). Overall, Royzman and Sabini claim that other disgust researchers are ignoring basic facts about disgust in order to categorize it as an emotion. Disgust is hard to change, in Royzman and Sabini's view, because it is not in fact an emotion, and is therefore not flexible or malleable.

Clinical psychologists have also observed that a disgust response is difficult to change. Mason and Richardson (2010) found that disgust is resistant to extinction, which is the process believed to underlie successful exposure therapy for anxiety-related disorders. In comparison, fear responds quickly to exposure therapy methods, showing a much greater rate of extinction than disgust responses, which extinguished at a much slower rate. Disgust does not respond to extinction and exposure therapy as disgust involves a different type of learning than the learning of fear responses. However, evaluative conditioning, composed of learning likes and dislikes, has been applied to disgust. Some argue that disgust learning is characterized by evaluative conditioning, involving a "hedonic shift" in which the conditioned stimulus acquires the valence of the unconditioned stimulus (Apicella, 2017). One strategy found to be useful in reducing these evaluative responses has been counterconditioning, in which a behavior that is incompatible with a habitual undesirable pattern is induced. It is possible that counterconditioning and exposure therapies may be useful to modify disgust responses, as it seeks to change one's responses to a stimulus (Mason & Richardson 2012).

Mason and Richardson (2012) suggest that, despite evidence implying that disgust is resistant to cognitive interventions, there could still be cognitive strategies that influence feelings of disgust. Instead of focussing on *why* a stimulus is disgusting, these strategies focus on *what* the stimulus is through conceptual reorientation (Mason & Richardson, 2012). For example, if someone sees rotten milk, but upon closer inspection realizes they are actually looking at vanilla yogurt, they will almost certainly be less disgusted upon having this realization. In this example the person does not address the reasons why the stimulus is disgusting, but rather reframes the stimulus entirely as something non-disgusting in the first place. Conceptual reorientation can render previously non-disgusting stimuli disgusting as well. For example, for many people, eating meat and then finding out that it is horse meat and not beef will elicit an immediate disgust response (Rozin & Fallon, 1987). Conceptual reorientation is a promising method of disgust reduction, but it has yet to be tested rigorously.

The Current Study

The goal of the current study is to test the theoretical claim that disgust is impervious to cognitive input by determining whether conceptual reorientation can reduce disgust. We will induce conceptual reorientation by showing participants an image of dog poop that appears real and then providing them with the knowledge that the poop is made of plastic. In a prior study, we collected eye-gaze and self-report data to measure disgust before and after this conceptual reorientation procedure (Armstrong et al., 2013). Eye-gaze data have been used in prior disgust research studies as a valid way to measure disgust, as eye-gaze data provides information about exactly where participants are looking, and where they are not (ocular avoidance), when stimuli are presented

(Armstrong et al., 2013). The eye-gaze data showed a robust decrease in how disgusting participants' found the poop after conceptual reorientation, measured by a decrease in dwell time. Those data showed that repeated exposure alone did not reduce oculomotor avoidance of disgust, and that conceptual reorientation was necessary to reduce disgust. However, the self-report data showed only a mild effect of reduction in disgust. This discrepancy between self-report and oculomotor data could mean that reductions in oculomotor avoidance do not actually reflect reductions in disgust, but instead reflect an increase in curiosity in the disgusting stimulus. But people may be more willing to make certain forms of perceptual contact with disgusting stimuli than others. In other words, our self-report items may not have adequately elicited mental contact with the poop. In this follow up study, we again collected self-report and eye-gaze data as measures of disgust. However, based on Tybur et al.'s (2013) theory that curiosity may function as a modulator of disgust we added a questionnaire test item: 'how willing would you be to pick up this object with your bare hands?' that we administered before and after conceptual reorientation. This item may create a mental scenario in which the contact is not merely perceptual, and the costs of such contact will outweigh curiosity. We also added a more equivalent control intervention to make sure that conceptual reorientation was responsible for any observed differences across conditions.

We hypothesize that conceptual reorientation of images of poop (specifically, presenting participants with the knowledge that the poop they are viewing is made out of plastic) will render the poop images less disgusting, both in eye-gaze (people will look more at the poop) and self-report data. If our results support our hypotheses they will

imply that, contradictory to Rozin et al.'s (1986) previous research, the image does not always equal the object, and disgust is not as stubborn as previously believed.

Method

Participants

Participants in our study were 99 students from Whitman College, a small liberal arts college located in Walla Walla, Washington. Of the 99 participants, 57 identified as female, 36 percent identified as male, and six preferred not to identify. Seventy percent of participants identified as White, seven percent identified as Asian, five percent identified as Hispanic/Latinx, two percent as Black, and four percent identified as mixed race. Twelve percent identified as another racial or ethnic group, or preferred not to identify. The average age of participants was 19.2 years. The participants were randomly assigned (about 50 per group) into either the cognitive-experiential or control group.

Materials and Apparatus

We used plastic poop and a plastic rock ordered from Amazon.com as our disgusting and neutral stimuli. These objects were photographed in grass so as to appear as realistic as possible to participants. For the control intervention we used two small containers similarly weighted to each other with metal ball bearings. To record oculomotor data we used an Eye Tribe eye tracker running at 60hz, controlled by Pygaze toolbox in OpenSesame (Dalmaijer, Mathôt, &; Van der Stigchel, 2014). We used a plastic chin rest to reduce head movement during exposure to the stimuli.

Procedure

We obtained informed consent from all participants at the beginning of the study. Participants then answered a series of demographic questions. Upon completing the

demographics measure, participants began the experiment, having been randomly assigned to either the control or cognitive-experiential group upon entering the study.

Participants in both groups began the experiment by rating a series of images of the poop and rock based on how disgusting and pleasing they found them. Then, after calibrating the Eye Tribe eye tracker (which they were told tracked pupil size, not eye-movement, to reduce demand characteristics), they were told to look however they wanted at 16 image pairs, each appearing for 12 seconds. Each of the 16 image pairs consisted of the poop and the rock appeared randomly on either side of the screen to control for left-to-right viewing bias. After the first round of image pairs concluded, participants rated the images for how disgusting they found them on a likert scale. To increase the salience of the disgusting stimulus and to account for the possible confound of curiosity, they were asked "How willing would you be to pick up this object?" for both the poop and the rock. They answered this question on a likert scale.

After they rated the images, the intervention took place. The controls were handed two containers identically weighted with lead balls, and asked to report which was heavier. Though empirically irrelevant, this sham intervention ensured that the control group protocol was as similar to the experimental group protocol as possible. Those in the experimental group were told that the poop and rock were made out of plastic, ordered from Amazon.com, and were shown and instructed to touch the plastic poop and rock. After the intervention, these participants were asked how real or fake they found both objects before and after intervention on a likert scale, and then viewed another series of the same 16 image pairs. After the second and final series of image pairs, they were prompted to rate the images based on how disgusting and pleasing they found them, and

were once again asked “how willing would you be to pick up this object?” for both the poop and the rock on a likert scale. Controls were told that the poop and rock were fake only after the second round of image pairs. They then answered real/fake questions and rating questions including “how willing would you be to pick up this object” for both the poop and the rock. All participants were then given a debriefing form and a chance to ask any questions.

Results

Manipulation Check

In order to ensure that participants perceived the stimuli as real pre-intervention and perceived them as fake post-intervention, we performed a 2 (object: poop, rock) x 2 (time: pre, post intervention) x 2 (condition: treatment, control) mixed-factor ANOVA on the realness ratings. Consistent with our predictions, we found a main effect of time on realness ratings, $F(1, 95) = 476.31$, $p < .001$, $\eta^2_p = .834$.

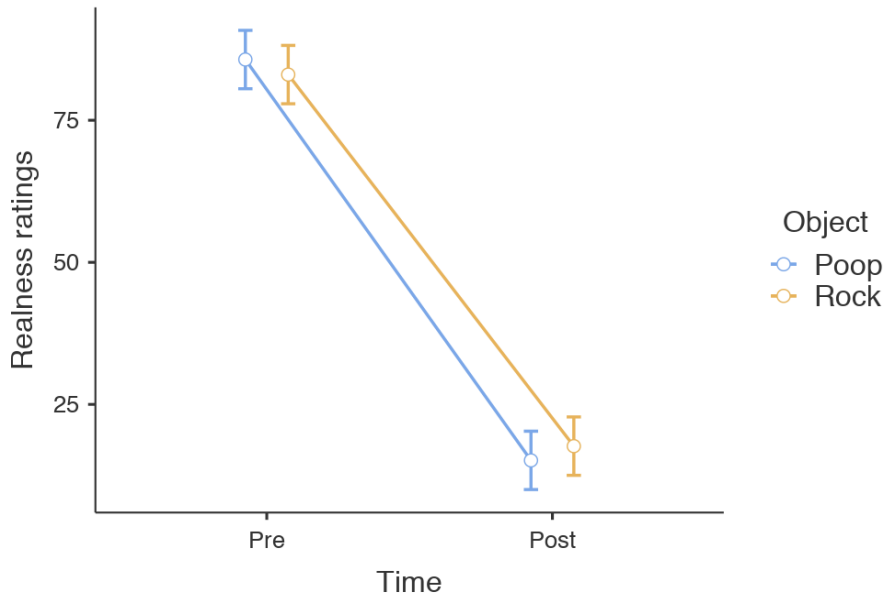

Figure 1. Manipulation check of participants perception of the poop and rock's realness before and after intervention, shown with 95% confidence intervals.

Effects of Conceptual Reorientation on Self-Report Indicators of Disgust

We performed a 2 (object : poop, rock) x 2 (time: pre, post intervention) x 2 condition (treatment, control) mixed-factor repeated measures ANOVA on willingness to pick up the objects and on self-reported disgust. The object by time by condition interaction was relevant to our hypotheses. For willingness to pick up the objects, there was a significant object by time by condition interaction $F(1, 97) = 135.7$, $p < .001$, $\eta^2_p = .583$. We then examined the object by time interaction in the separate groups. In the experiential group there was a significant interaction between object and time on self-reported disgust, $F(1,49) = 160.10$, $p < .001$, $\eta^2_p = .769$, but there was not one in the control group, $F(1,49) = 1.73$, $p = .195$, $\eta^2_p = .034$. As revealed in Figure 2, participants were much more willing to pick up the poop once they learned it was fake in the

experimental condition versus the control condition in which they did not learn that the poop was fake, which was consistent with our hypotheses. This finding suggests that our conceptual reorientation intervention had a pronounced effect on how disgusting participants found the poop.

For self-reported disgust there was also a significant object by time by condition interaction, $F(1, 97) = 28.3$, $p < .001$, $\eta^2_p = .226$. We then examined the object by time interaction in the separate groups. In the experiential group there was a significant interaction between object and time on self-reported disgust, $F(1,48) = 39.8$, $p < .001$, $\eta^2_p = .453$, but there was not one in the control group, $F(1,49) = .005$, $p = .943$, $\eta^2_p = .000$. As shown in Figure 3, once participants in the experimental condition learned that the objects were fake, disgust ratings of the poop dropped sharply while remaining constant for those in the control condition, as hypothesized. These results suggest that our conceptual reorientation intervention had a pronounced diminishing effect on how disgusting participants found the poop.

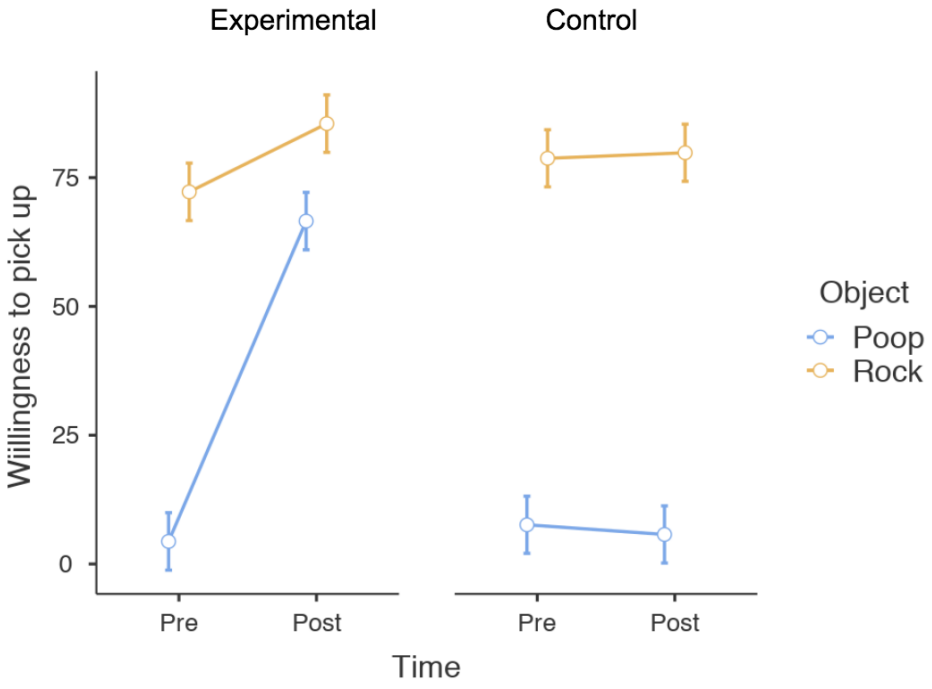

Figure 2. Willingness to pick up ratings of poop and rock in both conditions, shown with 95% confidence intervals.

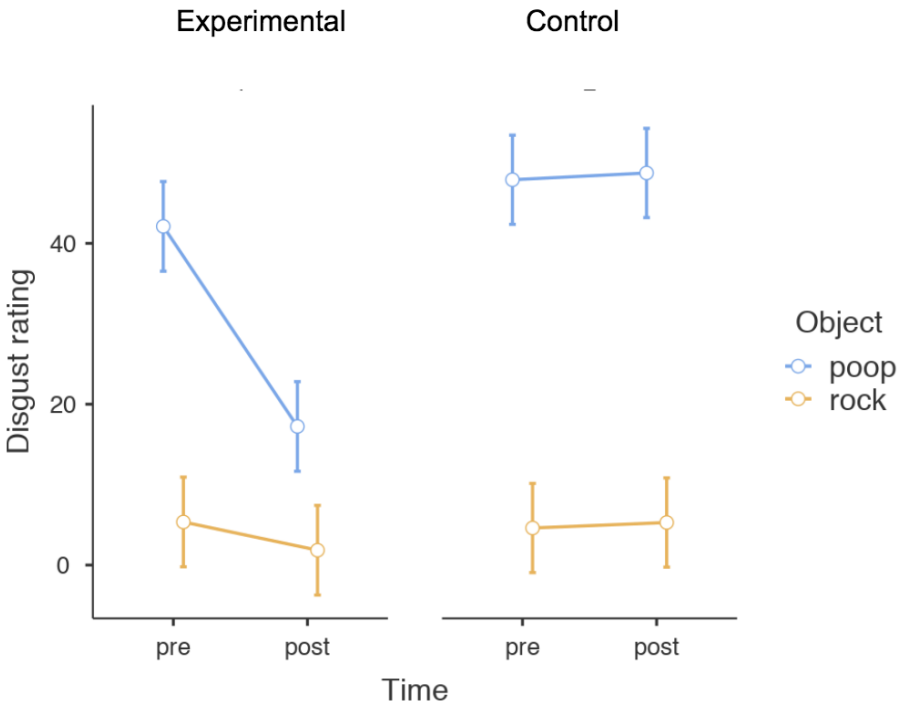

Figure 3. Disgust ratings of both poop and rock in both conditions, shown with 95% confidence intervals.

Effects of Conceptual Reorientation on Eye Movement Indicator of Disgust

We performed a 2 by 2 (object : poop, rock) x 2 (time: pre, post intervention) x 2 condition (treatment, control) mixed effect ANOVA on participants' dwell time. The object by time by condition interaction was relevant to our hypotheses. We found a significant object by time by condition interaction, $F(1, 92) = 5.43$, $p = .003$, $\eta^2_p = .089$. We then examined the object by time interaction in the groups separately. In the experimental group, we found a significant interaction between object and time on dwell time, $F(1,45) = 16.31$, $p < .001$, $\eta^2_p = .266$. In the control group we found no significant interaction between object and time on dwell time, $F(1,47) = .001$, $p = .974$, $\eta^2_p = .000$. As revealed in Figure 3, looking time at the poop and rock changed drastically post-intervention in the experimental group, while remaining constant in the control group after the sham intervention. Consistent with our hypotheses, participants in the experimental group looked equally long at the poop and rock post-intervention, while in the control group no such change occured. These results further suggest that conceptual reorientation had a pronounced diminishing effect on disgust.

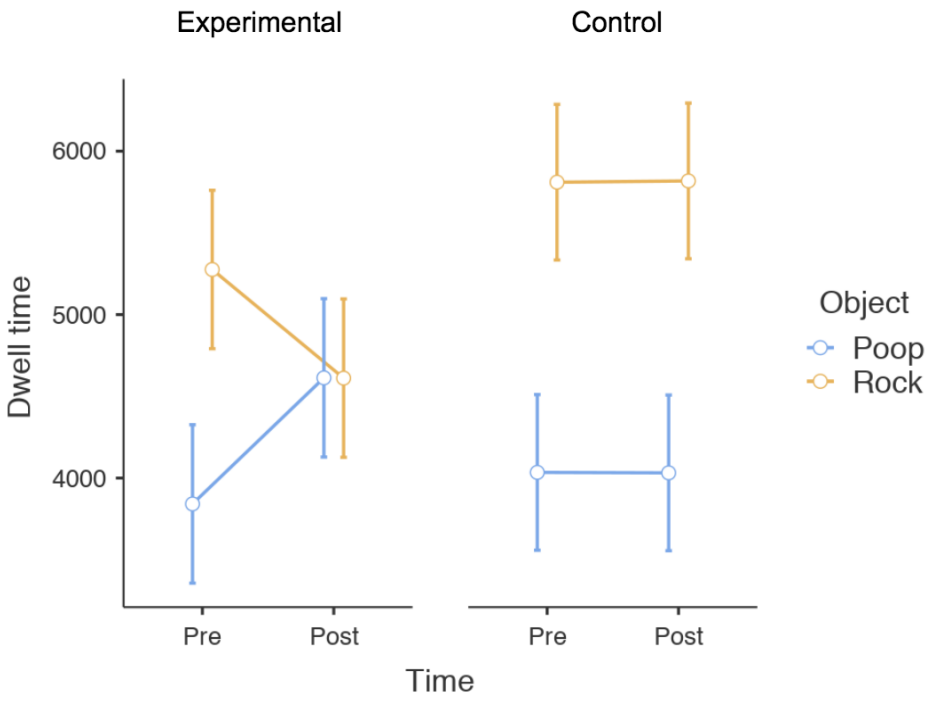

Figure 4. Dwell time of participants on poop and rock images, shown with 95% confidence intervals.

Exploratory Analysis

We ran a correlational analysis to determine if changes in self-reported disgust and willingness to pick up the poop following the treatment were associated with changes in dwell time following the treatment. Reductions in disgust to the poop were associated with increases in willingness to pick up the poop, (r = -.44, p < .001), suggesting that increased willingness to pick up the poop reflects changes in disgust.

Our results failed to yield a correlation between change in willingness to pick up and change in dwell time (r = -.09). This outcome is likely because post-intervention eye-movements cease to merely measure disgust, and begin to measure curiosity as well. After participants learn that the stimuli are fake, they may be inclined to gaze more at the poop in order to determine if they can tell that it is indeed not real.

Discussion

To our knowledge, this is the first study to successfully reduce disgust by way of an easily administered intervention, and to demonstrate that disgust is reliant on more than the mere sensory properties of a stimulus. We hypothesized that conceptual reorientation of disgust objects would render them less disgusting, as revealed by eye gaze and self-report measures. Our results confirmed these hypotheses, as learning that the dog poop was fake led participants to gaze more at the poop, and to report being less disgusted by the poop and more willing to pick it up. In addition, the changes in eye movements did not track the changes in self-report, suggesting that the intervention could potentially alter eye movements through a mechanism besides disgust reduction. These findings have important implications for both theory and treatment.

In terms of theoretical implications, our results imply that, contrary to Royzman and Sabini's (2001) claims, disgust is not solely elicited by the concrete sensory properties of a stimulus. Our data suggest that disgust is influenced by higher cognitive functions, such as reasoning about the meaning of a stimulus. In the experimental condition of our experiment, when the meaning of the poop changed, participants' reported disgust and dwell time changed. If disgust was elicited by the sensory properties of stimuli alone, then participants' dwell time and self-reported disgust would not have changed after conceptual reorientation, as the concrete features of the stimulus remained constant.

Our results also imply that, contrary to Rozin et al's (1986) results, the image does not always equal the object. That is, disgust is not merely reliant on the sensory properties of a stimulus. Participants' behavior suggests that the image equals the object

if given no information about a stimulus, however, when they are told a stimulus is fake (thereby reframing the stimulus), the image ceases to equal the object, as evidenced by the decrease in disgust ratings and increase in gaze time. These responses contradicts Rozin et al.'s (1986) results, in which participants refused to eat poop-shaped fudge, despite knowing that the fudge was merely fudge.

Our findings undermine the law of similarity, and the notion that the image equals the object. On the contrary, they suggest that beliefs about states of affairs in the world can break through and lessen disgust. In other words, our results demonstrate that disgust is not cognitively impenetrable. However, there may be specific conditions, or levels of contact, under which the law of similarity still holds, and disgust does function as cognitively impenetrable. In Rozin et al's study, stimulus contact was at the level of oral incorporation, the most extreme form of contact with disgusting objects. In our experiment, stimulus contact was merely at the level of imagined handling and perceptual engagement. The demonstrated contradiction implies that the strength of the law of similarity, and thus the potential efficacy of conceptual reorientation, depends on the level of stimulus contact. It also implies that conceptual reorientation may function well as an intervention for patients with mild to moderate OCD and phobias, but may fail to function for those with extreme disorders.

This salience of levels of contact in determining disgust pliability makes even more sense when one considers Tybur et al.'s (2013) cost-benefit mechanism theory. The potential costs of oral incorporation of a stimulus which looks like a disgusting object may simply be too high for conceptual reorientation to be of any use in manipulating disgust. That is, such costs may far outweigh any potential benefits that contact may

have, whether these benefits be information about the stimulus, nutrition, and so on. Though the meaning of a stimulus may function as a modulator in Tybur et al.'s (2013) proposed calculatory system of the value of stimulus contact, the modulating effects may be flimsy in comparison to the potential costs of orally incorporating a stimulus that contains the sensory properties of feces. That is, meaning may cease to penetrate disgust at the level of oral contact. Put in terms of the smoke-alarm principle, the costs of a false negative may be too high to risk oral incorporation, whereas the costs of a false negative may be low enough to risk picking up a disgusting object after considering all potential benefits of stimulus contact.

Tybur and colleagues (2013) model may also help us understand the discrepancy we found between the self-report and eye movement indicators of disgust. In a prior study, we found that conceptual reorientation eliminated oculomotor avoidance, but only marginally reduced self-reported disgust compared to a control condition. Although our improved self-report assessment in the current study revealed large, statistically significant reductions in disgust as the result of conceptual reorientation, differences in self-reported disgust of the poop and the rock were not completely eliminated, whereas differences in eye movements were completely eliminated. This fact suggests that a disgust reaction was no longer driving eye movements in the experimental group. Although not directly measured in the current study, it is possible that curiosity began to influence eye movements towards the poop after the intervention. After participants learned that the poop is fake, they may have increased dwell time on the poop image as their curiosity over the newfound knowledge of the poop being fake overrides any prior disgust they may have had. Participants may have attempted to spot the fakeness of poop

in the image, for example, or figure out how they were tricked. Curiosity may fit well into Tybur et al.'s (2013) model of disgust as a modulator. If one is curious about a disgusting stimulus, the benefits of stimulus contact become greater, thus decreasing the overall disgust response. This relationship between curiosity and disgust implies that curiosity could be an effective tool in decreasing disgust via conceptual reorientation. If an individual can become curious about the facts or history of a stimulus (feces, a snake, etc.) then an individual may become less disgusted by or afraid of that stimulus.

Treatment and Practical Implications

The current study has important implications for the potential treatment of those with disorders, specifically OCD based anxiety disorders or phobias. By demonstrating that disgust is not entirely cognitively impenetrable, the present study suggests that cognitive interventions may be appropriate for treating disgust. However, in the real world, disgusting or frightening objects do not always turn out to be fake. Thus, conceptual reorientation would need to target other aspects of the stimulus. For an individual with a phobia of snakes, conceptual reorientation may help them to rethink the nature of the snake to make them less threatening. For example, if the individual is able to reframe the snake as a object of fascination and wonder by learning about snake facts and history, they may begin to see the snake as a complex, interesting animal instead of as a dangerous, creepy predator. Conceptual reorientation could potentially also help those working disgusting jobs, such as sewage plant workers. By reframing the disgusting stimuli into a larger context of the logistics of sewage management and the challenges that creating such a system entails, workers may be able to reduce their disgust at work. It is important to reiterate, however, that Rozin et al.'s (1986) research suggests that

conceptual reorientation will be less effective, if at all, when attempting to function at the level of oral incorporation. Thus, conceptual reorientation may have less potential for treating food-related disgust in eating disorders.

Limitations

While our study used an improved control condition and other improvements, there are still limitations to our study. Our large sample size produced high power for our ANOVA tests as well as for full-sample correlations. However, in conducting correlations that compared dwell time and reported disgust, the correlation was split by condition leaving an N of 50 for each condition. As a result, these analyses were underpowered for detecting medium size correlations. The sample we recruited was fairly homogenous as well. While our sample was representative of Whitman College's population, it would be more advantageous to have a more diverse sample to determine if the effects founds can generalize to a wider age group as well as to other races and ethnicities.

Our study used only poop as the disgust stimulus, so we do not know if our effects found using poop as the disgusting stimulus can generalize to other disgusting stimuli. In future studies, it would be interesting to see if these effects generalize to other disgust elicitors such as vomit, wounds, or other elicitors of disgust that are commonly cited as universal (Apicella, 2017). The way in which we assessed disgust was also limited. Our study relied on self-report measures of disgust, which can be less than objective. In order to get a more standardized and objective measure of disgust, our studies could benefit from psychophysical measures using tools such as electrodes. Responses such as contractions of the levator labii, commonly used in facial expressions

of disgust, could then be objectively measured and compared to participants' self-reports of disgust.

Other limitations to our study include smaller variations such as how all research assistants administered the study. Our protocol followed a script and all research assistants were trained to carry out the script's specific directions. However, some slip ups have been reported where the eye tracker was accidently mentioned in front of a participant. Participants who were salient of the eye tracker's true nature could have been more aware and regulatory of where they were looking on the screen. While our effect was so strong it likely did not affect our overall results, it is something to keep in mind and be vigilant about.

Our findings relating to conceptual reorientation have led us to future questions regarding curiosity and exploring how it can be a possible modulator of disgust as described by Tybur et al (2013), as well as how conceptual reorientation can be utilized as a potentially effective and more convenient model to treat individuals with particular phobias or anxiety-related disorders. For example, we would like to know how well (or if at all) conceptual reorientation works in reducing disgust on different levels of contact. Conceptual reorientation may work on the level of contact used in our study (manipular contact), but not work on the level of oral contact (like in Rozin et al.'s (1986) study). Furthermore, we would like to know more about the potential role of curiosity in ameliorating disgust. In our study, curiosity led participants in the experimental group to look more at the poop. Those results led us to consider whether mean curiosity could help patients reframe objects of fear or disgust and if so, whether it would depend on the level of stimulus contact. Finding out as much would be a clear next step in determining the

usefulness of conceptual reorientation in reducing disgust and fear in anxiety and OCD based disorders. Curiosity as a means of reducing oculomotor avoidance becomes even more important as a potential treatment tool when one considers that disgust has been shown to be resistant to habituation and to reinforcement of opposite behavior (Armstrong et al., 2013). The tendency of disgust to be stubborn maintains avoidance and therefore anxiety towards disgusting stimuli by preventing reappraisal. Therefore, if curiosity can decrease oculomotor avoidance and bolster conceptual reorientation, it may well be an extremely effective tool in disgust and anxiety treatments.

Conclusion

To conclude, disgust is demonstrated to be not cognitively impenetrable, meaning that there is hope for treating individuals with anxiety or OCD-related disorders through methods such as conceptual reorientation. Treatments for disgust-based emotional responses have been elusive in clinical settings, and this study sheds new light on possibilities for effective treatment. It is possible to envision a future in which individuals with these disorders can receive effective and convenient treatment through conceptual reorientation.

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