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State of the Science: Disgust and the Anxiety Disorders

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State of the Science: Disgust and the Anxiety DisordersBenjamin J. Mitchell¹ & Bunmi O. Olatunji²¹*Department of Psychological Science, Kent State University, Kent, OH United States*²*Psychological Sciences, Vanderbilt University, Nashville, TN United States***Authors Note:**

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Highlights

- Emerging literature has increasingly implicated disgust in certain anxiety-related disorders.
- Research has accumulated evidence identifying processes linking disgust to these disorders.
- Processes include trait-level vulnerabilities, cognitive processes, and learning mechanisms.
- Research is needed that leverages a guiding framework that informs treatment development.

Abstract

Anxiety disorders have long been conceptualized as disorders of fear, while other emotions have largely been overlooked. However, an emerging literature has increasingly implicated disgust in certain

anxiety-related disorders, including obsessive-compulsive disorder, specific phobias (e.g., spider phobia), health anxiety, and post-traumatic stress disorder. Roughly two decades of research has accumulated evidence identifying various mechanisms linking disgust-related phenomena to these disorders. In the present “State of the Science” review, we sought to summarize the current state of the literature with respect to disgust-related mechanisms in anxiety disorders, including trait-level vulnerabilities (e.g., disgust proneness), cognitive processes (e.g., biases of attention and memory), and associated learning mechanisms (e.g., evaluative conditioning). Research in these areas has revealed important ways in which disgust differs from fear-related phenomena, which have important treatment implications. From there, we sought to summarize research on laboratory interventions that attempt to target and attenuate disgust, as well as the early research on formal cognitive-behavioral treatments that integrate disgust-related interventions for anxiety disorders. Although the past two decades of research have revealed important insights related to the role of disgust in psychopathology, much remains to be learned in this area. We propose some future directions, emphasizing the importance of a guiding framework that highlights studying disgust-related mechanisms across different levels of analysis.

Keywords: disgust, anxiety disorders, disgust proneness, evaluative conditioning, cognitive behavioral therapy

State of the Science: Disgust and the Anxiety Disorders

Owing to its historical precedence in affective science, fear stands out as one of the most comprehensively examined emotions, with an expansive literature on its behavioral, physiological, and neural bases (Ohman & Mineka, 2001). Research on fear has been instrumental in advancing our understanding of the nature and treatment of anxiety disorders. In stark contrast to fear, disgust only began acquiring a small (but enthusiastic) research literature in the 1980s (Rozin & Fallon, 1987). This early work on disgust focused on its structure and function. Whereas fear is thought to be a response to imminent threats (e.g., predators), disgust’s primary function is to motivate the avoidance of sources of germs and contamination (Oaten et al., 2009). Early in the emerging disgust literature, it was hypothesized that disgust might play a critical role in certain forms of psychopathology due to its aversive, visceral phenomenology and its promotion of behavioral avoidance (Haidt et al., 1994). By 1998, Phillips and colleagues announced that disgust was “the forgotten emotion of psychiatry” and set forth a series of hypotheses about its role in disorders like obsessive-compulsive disorder (OCD), phobias, eating disorders, and other forms of psychopathology (e.g., depression). Since the year 2000, research on disgust has soared and outpaced other emotions, including fear (Tybur et al., 2018), with increased attention toward its role in psychopathology (Olatunji & McKay, 2007).

It is now well-established that disgust plays an important role in anxiety disorders—beyond fear—including disorders like OCD, specific phobias, health anxiety, and even post-traumatic stress disorder (PTSD; Knowles et al., 2018). At this stage, the field has made substantial progress toward explicating the different mechanisms linking disgust and anxiety disorders. Moreover, the field is in the early stages of investigating methods for effectively attenuating disgust reactions in the laboratory and—

even earlier stages—of integrating these methods into evidence-based treatments for disgust-related symptoms and disorders. In this “State of the Science” review, we aim to summarize the current state of the literature with respect to important mechanisms of disgust in anxiety disorders. This will include a discussion of disgust proneness, cognitive processes, and behavioral and learning mechanisms. Then, we will summarize and describe the research on interventions to target disgust—most of which comes from laboratory research focused on non-clinical (or clinical analogue) samples. We will also discuss the nascent literature in which researchers have integrated a focus on disgust in formal treatments for some disorders. Lastly, we will propose some future directions, with an emphasis on leveraging the Research Domain Criteria (RDoC; Insel et al., 2010) as a framework for advancing research on disgust in psychopathology.

Individual Differences in Disgust Proneness

Much of the early work in this area examined associations between trait measures of disgust vulnerabilities and symptoms of anxiety disorders. Most research has focused on disgust *propensity* (the tendency to be easily disgusted), but research has also examined the role of disgust *sensitivity* (a dislike of the experience of disgust; van Overveld et al., 2010). Disgust sensitivity is not unlike anxiety sensitivity (the belief that anxiety or arousal sensations can have harmful consequences), a major risk factor for anxiety-related psychopathology (Naragon-Gainey, 2010). However, research has shown that disgust sensitivity predicts anxiety symptoms even when controlling for anxiety sensitivity (i.e., Winder et al., 2021). Disgust propensity and disgust sensitivity can be conceptualized as indicators of a higher order vulnerability termed ‘disgust proneness’. There is research suggesting that half of the variation in disgust proneness is due to genetic effects (Sherlock, Zietsch, Tybur, & Jern, 2016). However, the etiology of disgust proneness is likely very complex and may arise as a function of dimension-specific and non-specific etiologic factors in conferring risk for anxiety and related disorders (Olatunji, Taylor, & David, 2019). A major aim of existing research, however, has been to determine whether disgust proneness accounts for unique variance in symptoms beyond broader measures of anxiety or negative affect. Evidence for this relationship was found for symptoms of several anxiety disorders, including specific phobias, OCD, health anxiety, and PTSD (Knowles et al., 2018).

Specific Phobias. The earliest research on disgust proneness in psychopathology focused on specific phobias, like blood-injection injury phobia (BII) and spider phobia. For example, disgust proneness was shown to be higher in participants with BII or spider phobia compared to healthy controls (Tolin et al., 1997). In addition, this study found that BII-relevant stimuli were rated as primarily disgusting, and spider-related stimuli were rated as both fearful and disgusting. Subsequent research has consistently found associations between disgust proneness and spider phobia (e.g., Muris et al., 2008), and BII phobia (e.g., Olatunji et al., 2007), even when controlling for measures of negative affect. Since then, disgust proneness has also been shown to be associated with emetophobia (fear of vomiting; e.g., Verwoerd et al., 2015), and even more recently, misophonia (negative reactions to normal oral or nasal sounds, like slurping or breathing; Barahmand et al., 2021). Indeed, these phobias match the disease avoidance model of disgust, as the feared stimuli (e.g., spiders, blood, vomit, noises denoting the movement of bodily fluids) are plausible sources of disease (e.g., Curtis & Birans, 2001) and contain physical features known to elicit disgust (e.g., slimy, hairy, moist, etc.; Stevenson et al., 2019).

Taken together, disgust proneness has clear associations with certain forms of specific phobias. However, very limited research has investigated prospective associations between disgust proneness and phobia symptoms. Therefore, whether disgust proneness functions as an underlying risk or maintenance factor (or both) for these phobias lacks strong empirical tests. Future longitudinal research could help delineate prospective relationships between disgust proneness and various phobia symptoms. For example, specific phobias typically emerge before the age of 10 (Wardenaar et al., 2017). Therefore,

longitudinal tests of the causal role of disgust proneness in specific phobias could be integrated into larger cohort studies of risk factors for childhood anxiety disorders.

Obsessive-compulsive disorder (OCD): The disorder with perhaps the greatest level of evidence for its link with disgust proneness is contamination-based OCD (C-OCD). OCD is characterized by intrusive thoughts (obsessions) which are typically followed by compulsive acts. Although OCD is a highly heterogeneous disorder and manifests in several ways, over half of OCD patients present with worries about germs, dirt, or contamination, with excessive reliance on safety behaviors, like handwashing to avoid getting sick (Rachman, 2004). Given this pre-occupation with germs, C-OCD was an obvious candidate for classification as a “disgust-related” disorder. Indeed, dozens of studies have found that C-OCD symptoms are associated with higher disgust proneness in both healthy (e.g., Tolin et al., 2006) and clinical samples (e.g., Olatunji et al., 2017), even when controlling for measures of anxiety or negative affect. In fact, Tybur and colleagues (2020) found that the correlation between disgust proneness and C-OCD symptoms reflected overlapping genetic (54%) influences.

Cross-sectional relationships between disgust proneness and C-OCD symptoms are reliable and well-replicated, but the longitudinal literature is more mixed and nuanced. For example, Berle and colleagues (2012) found that disgust proneness predicted changes in overall OCD symptoms, but not contamination-based symptoms in adults with OCD. Other research found no longitudinal associations between disgust proneness and changes in C-OCD symptoms (e.g., Melli et al., 2019). However, more recent research has found prospective relationships between disgust proneness and C-OCD (but not other forms of OCD) in both non-clinical adults (Olatunji et al., 2019) and children with OCD (Georgiadis et al., 2020).

One possible explanation for these mixed results is that the proposed causal direction (disgust proneness predicting C-OCD) is wrong. Instead, greater C-OCD symptoms could increase disgust proneness over time, and therefore disgust proneness might be best conceptualized as a maintenance factor, rather than a risk factor (Melli et al., 2019). Indeed, Olatunji and colleagues (2023) conducted a cross lagged panel model of disgust proneness and C-OCD symptoms across four timepoints and found that C-OCD symptoms predicted higher disgust proneness—but not vice versa. In contrast, recent research has shown that disgust proneness is a highly temporally stable trait, with greater time invariant than time variant components (Olatunji et al., 2020). In addition, this study found that the time invariant components of disgust proneness were most predictive of overall OCD symptoms. Given the temporal stability of disgust proneness, it likely develops early in life, exerting risk for OCD as early as childhood (Olatunji et al., 2020). Indeed, one of the few investigations of disgust proneness as a predictor of OCD in children did find prospective associations between disgust propensity and C-OCD symptoms (Georgiadis et al., 2020). Moreover, they found that changes in disgust propensity during treatment predicted changes in overall OCD (but not specifically C-OCD) symptoms. Therefore, disgust proneness is likely both a risk and maintenance factor in childhood OCD, but additional research focusing on youth is necessary to replicate these findings.

Health Anxiety. Another form of anxiety for which disgust likely plays an important role is health anxiety (or illness anxiety disorder), which is characterized by a severe overestimation of the risk and consequences of getting sick (Asmundson et al., 2010). Again, this form of anxiety fits the disease avoidance model of disgust well. However, evidence for disgust proneness as a unique risk factor for health anxiety is mixed. Research has shown that disgust proneness is associated with health-related anxiety and behavioral avoidance (e.g., Davey & Bond, 2006; Fan & Olatunji, 2013), and several studies have found that health anxiety is associated with similar disgust reactions and avoidance as seen in other disgust-related disorders, like C-OCD (e.g., Goetz et al., 2013). Moreover, research during various disease outbreaks has shown that disgust proneness is associated with greater anxiety about being infected and greater engagement in preventative health behaviors to avoid infection (COVID-19: Cox et al., 2020;

H1N1: Brand et al., 2013; Ebola: Blakey et al., 2015). However, studies focused on the relationship between health anxiety symptoms and disgust proneness have not consistently found unique associations when accounting for other variables (e.g., anxiety sensitivity; Brady et al., 2014). Moreover, Weck and colleagues (2014) found that a clinical sample of patients with hypochondriasis did not report higher disgust proneness than patients with other anxiety disorders. On balance, disgust proneness very likely plays an important role in certain presentations of health anxiety (Knowles et al., 2018). However, its importance relative to other anxiety-related factors in the development and/or maintenance of health anxiety has not been fully delineated.

PTSD. An emerging literature has established various mechanisms through which disgust-related processes, including trait disgust vulnerabilities, are likely to influence symptoms of PTSD. Indeed, many potentially traumatizing events involve exposure to common disgust-eliciting situations and stimuli, including gruesome injuries and sexual violence (Badour & Feldner, 2018). For example, adolescent survivors of sexual assault reported high levels of disgust, and reports of disgust were stronger in sexual assault survivors compared to victims of other forms of physical abuse (Feldner et al., 2010).

Researchers have argued, based on a diathesis-stress model, that pre-trauma disgust proneness may serve as a vulnerability factor for developing PTSD following a potentially traumatizing event (Knowles et al., 2018). Indeed, in a study that included healthy college students, disgust proneness predicted a greater frequency of intrusive cognitions following a distressing film clip (Bomyea & Amir, 2012). However, direct relationships between measures of disgust proneness and PTSD symptoms have not consistently been observed. A recent study did find that sexual assault survivors with PTSD reported greater disgust proneness than survivors without PTSD and healthy controls (Olatunji et al., 2023). However, Engelhard and colleagues (2011) found no relationship between disgust proneness and PTSD symptoms. Instead, self-reported peritraumatic disgust predicted PTSD, particularly for those with higher disgust *sensitivity*. Thus, the presence of disgust-related symptoms in PTSD may depend on whether disgust was elicited at the time of the traumatic event (e.g., peritraumatic disgust: Badour & Feldner, 2018). Moreover, the aversiveness of the disgust-evoking event likely depends on individual differences in how the experience of disgust is interpreted (i.e., disgust sensitivity). Indeed, additional research has shown that *lower* disgust sensitivity was protective against PTSD in trauma-exposed veterans (Olatunji et al., 2014). Thus, within the diathesis-stress model, higher disgust sensitivity is likely a vulnerability factor, whereas lower disgust sensitivity may be a protective factor (Badour & Feldner, 2018).

The strongest evidence for a link between disgust and PTSD comes from laboratory research, particularly investigations of peritraumatic disgust as a predictor of PTSD symptoms (e.g., Badour et al., 2013), as well as research on posttraumatic disgust reactions to trauma-relevant inductions (e.g., script-driven imagery inductions: Matson et al., 2023). In addition, research has found that trauma survivors often experience both “mental contamination”—referring to an internal sense of dirtiness without having made physical contact with a contaminant (Rachman, 2004)—as well as self-focused disgust (Badour et al., 2013). Indeed, self-focused disgust has been shown to be particularly common in survivors of sexual trauma (Olatunji et al., 2023). Following a sexual assault, a survivor might feel as though their body has been contaminated by the experience resulting in both self-disgust and mental contamination (Badour & Feldner, 2018).

Research on these phenomena has moved beyond cross-sectional designs by using ecological momentary assessment (EMA) to investigate experiences of trauma-related symptoms, disgust, and mental contamination in daily life. For example, a recent study found that momentary changes in PTSD symptoms across a week of sampling covaried with changes in reports of self-disgust while controlling for overall negative affect. However, lagged analyses did not find that disgust predicted subsequent changes in PTSD, or vice versa (Olatunji et al., 2023). Similarly, another study found concurrent, but not prospective associations between mental contamination and state disgust within and between days of a

two-week sampling period (Brake et al., 2021). Thus, the current research suggests that experiences of disgust, mental contamination, and PTSD symptoms co-occur rather than one causing the other over time. However, future research could investigate these processes within shorter windows of time (e.g., hourly sampling), as any prospective or causal relationships between state-level indicators such as these might only be evident within shorter timescales.

Disgust Proneness Conclusion: Research on disgust proneness in anxiety disorders culminated in two meta-analyses that found that: 1) individuals with higher anxiety disorder symptoms reported higher disgust proneness than those with lower anxiety disorder symptoms (43 samples; large effect size), and 2) anxiety disorder symptoms were correlated with disgust proneness (83 samples; moderate effect size; Olatunji et al., 2017). Importantly, in both cases, the effect of disgust proneness was largest for anxiety disorder symptoms thought to be “disgust-related” (e.g., C- OCD, specific phobias, PTSD) compared to other forms of anxiety (e.g., panic disorder, generalized anxiety disorder). In addition, the correlation seen in the second meta-analysis remained robust when controlling for negative affect. By contrast, the relationship between non-disgust-relevant anxiety disorder symptoms and disgust proneness became non-significant once controlling for negative affect. These results provide strong support for a unique role of disgust proneness in the aforementioned anxiety disorders.

Cognitive Mechanisms

A growing body of research has investigated cognitive mechanisms that might facilitate the development and maintenance of disgust-related anxiety disorders. In a systematic review, Knowles and colleagues (2019) summarized findings from 98 studies on biases in memory, attention, interpretation, and expectancy judgments in disgust, all as possible mechanisms for disgust in psychopathology. Among these, there is evidence for a disgust-specific memory bias, such that disgusting stimuli are more easily recalled and recognized than fearful or neutral stimuli (e.g., Chapman et al., 2013; Schienle et al., 2021). Given disgust’s evolved function as a disease avoidance mechanism, this memory bias is likely essential for effectively identifying and then proactively avoiding contact with sources of infection or contamination. Although a disgust-related memory bias might generally be adaptive, disgust-prone individuals are more likely to interpret ambiguous cues as threatening, which could result in a high number of “false positives” (e.g., interpreting benign cues as contamination threats; Charash & McKay, 2009). Therefore, the combination of disgust-related interpretive and memory biases might enable maladaptive avoidance of benign cues that is observed in anxiety and related disorders.

Based on their review of the literature, Knowles and colleagues concluded that attentional biases may be the most robust in disorders characterized by excessive disgust reactions. The authors summarized the literature with respect to attentional orienting, maintenance, and avoidance biases. An orienting bias for disgust (e.g., attending more rapidly to disgust-relevant cues at the onset of their presentation) has been identified via a number of methods, including dot-probe (and related) tasks (e.g., Chapman et al., 2013) and eye-tracking studies (e.g., Armstrong et al., 2012). In addition, researchers have used electroencephalogram (EEG) methods to investigate event-related potentials (ERPs) to delineate temporal differences in attentional responses to disgust- versus fear-evoking stimuli. Although the results of this literature have been somewhat mixed, Knowles and colleagues concluded that there is likely a more general initial orientation toward threatening stimuli that is present in both anxious and disgust-prone individuals. This orienting response toward disgusting stimuli has been shown via larger P2 amplitudes in ERP studies (e.g., Lu et al., 2016), which reflect quick, automatic orientation toward emotional stimuli (Carretié et al., 2004).

At the time of their review, there was limited evidence for a maintenance bias for disgust (e.g., preferentially maintaining attention on disgust-related cues; Knowles et al., 2019). However, since then, a study using a dot-probe task with eye tracking found that participants had slower reaction times for and

longer fixations on disgusting images compared to neutral or fearful images (Fink-Lamotte et al., 2022). Moreover, this effect was strongest for those with higher contamination fears commonly observed in OCD. This finding supports a maintenance attentional bias toward disgusting cues, which may reflect a motivation to examine objects (e.g., food) for evidence of contamination prior to approaching or consuming (Carretié et al., 2011).

Lastly, Knowles and colleagues concluded that there is robust evidence for an attentional avoidance bias that is unique to disgust. For example, conditioning studies have found that a visual avoidance response to a neutral stimulus can be conditioned via its pairing with a disgusting stimulus (Armstrong et al., 2014; Mason & Richardson, 2010). This conditioned visual avoidance response was not observed in a group that was conditioned with generally threatening (non-disgust) stimuli, suggesting it was unique to disgust (Armstrong et al., 2014). In both studies, visual avoidance was greater in disgust prone individuals and was resistant to extinction. In addition, a recent investigation found that visual avoidance of disgusting stimuli increases with time spent with the stimuli—and that there was greater visual avoidance of disgusting stimuli compared to other unpleasant stimuli (Armstrong et al., 2022). Thus, this visual avoidance response is likely a strategic response that is initiated consciously via top-processes (Knowles et al., 2018). This attentional avoidance of disgusting stimuli has been further demonstrated in disgust-related phobias, like spider and BII phobia (Armstrong & Olatunji, 2012).

One hypothesis for why attentional avoidance is unique to disgust (versus fear) relates to the level of urgency assigned to different forms of threat (Knowles et al., 2019). Fear is a response to imminent threats to bodily safety, and thus, fear-related cues are often appraised as highly urgent, requiring sustained attention to coordinate immediate behavioral responses (e.g., fleeing). By contrast, signs of contamination—though threatening—may be perceived as less urgent, requiring less immediacy in the response. When perceived urgency is low, and an immediate response less necessary, attentional avoidance may be deemed an acceptable strategy to reduce unpleasant feelings of disgust (Armstrong & Olatunji, 2012). This tendency to visually avoid disgusting stimuli likely contributes to the maintenance of anxiety related disorders and symptoms in individuals with heightened disgust proneness, as avoidance of disgusting visual cues likely precludes the process of habituation or extinction (Knowles et al., 2019). However, little is known about the conditions that predict attentional maintenance versus attentional avoidance of disgusting stimuli. Carretié and colleagues (2011) proposed that attention toward disgusting stimuli might depend on the costs and benefits of exploring versus avoiding a stimulus. For example, when the threat of contamination is uncertain, and the stimulus resembles a potential fitness-enhancing opportunity (e.g., food), it would be advantageous to attend to the stimulus to further ascertain whether it poses a contamination threat or not. However, future research is needed to determine context factors that differentially facilitate attentional maintenance versus avoidance in disorders of disgust.

Disgust-related Behavior and Learning Mechanisms

Disgust related avoidance. Dominant theories of fear and anxiety disorders are based on a two-process model of fear and avoidance, where fears can be acquired through associative learning, which are then maintained via avoidance or escape behaviors that have a negatively reinforcing effect (Krypotos et al., 2015). Researchers have investigated the learning and behavioral mechanisms of disgust and found that they function like fear, but with important differences. First, disgust-related avoidance can take several forms. As noted throughout this review, disgust proneness is robustly associated with washing symptoms in C-OCD, which involve excessive washing of hands and surfaces, avoiding contact with potential contaminants (e.g., toilets), or avoiding places that could serve as potential sources of germs (e.g., public restrooms; Knowles et al., 2018). Like how social avoidance maintains fear in social anxiety disorder, disgust-related avoidance maintains disgust proneness. For example, Olatunji (2015) randomly assigned participants to either actively engage in health-related behavioral avoidance (e.g., carry anti-bacterial hand sanitizer, avoid touching public door handles, etc.) or behave as they normal would over a

three-week period. Those who engaged in the daily health-related behaviors reported increased disgust proneness over the subsequent weeks, and these changes were mediated by the frequency at which participants engaged in these health-related behaviors. Similar results have been found for contamination fears commonly observed in OCD (Deacon & Maack, 2008). In addition, laboratory studies have consistently shown that disgust proneness predicts avoidance of potential contaminants (e.g., Campbell et al., 2019). Thus, disgust-related avoidance and safety behavior use likely reinforce disgust proneness and disgust-related beliefs about the dangers of disgusting stimuli. This model of learned avoidance likely applies to all disgust-related anxiety disorders, including specific phobias (e.g., disgust motivating avoidance of spiders) and PTSD (e.g., avoiding disgust-inducing memories).

Disgust learning: As part of the two-process model of fear and avoidance, fear of a specific stimulus is thought to be acquired via classical conditioning. Fear conditioning occurs when a neutral stimulus (or conditioned stimulus; CS) is paired with an aversive, fear-evoking stimulus (or unconditioned stimulus; US). After the CS-US contingency is learned, the CS comes to elicit fear on its own via a learned expectancy that the US will follow it. Fear conditioning is an important mechanism involved in fear-related anxiety disorders (Duits et al., 2015). Indeed, some of the most important insights into the etiology, maintenance, and treatment of anxiety disorders comes from fear conditioning research. Research has shown that, like fear, disgust is rapidly acquired via classical conditioning (Mason and Richardson, 2010). In addition, research has found that disgust conditioning is an important process involved in disgust-related anxiety disorders, including C-OCD (Armstrong & Olatunji, 2017), blood-injection phobia (Olatunji et al., 2009), and likely PTSD (Badour et al., 2013).

Research on disgust conditioning has found that acquired disgust is resistant to extinction, particularly for disgust-prone individuals (Mason & Richardson, 2010) and individuals with high levels of disgust-related anxiety disorder symptoms (e.g., C-OCD; Armstrong & Olatunji, 2017). Extinction occurs when the CS is repeatedly observed absent any aversive event, which eventually results in a diminished conditioned response. This process results in inhibitory learning—the formation of a new association that the CS predicts the *absence* of an aversive outcome (Craske et al., 2014). In fear research, when inhibitory learning is achieved, the US is no longer expected to occur, and individuals can then effectively inhibit their fear response to the CS. However, disgust is thought to also be acquired via *evaluative conditioning*, which has been shown to be a more durable form of classical conditioning (Hofmann et al., 2010). Whereas traditional classical conditioning results in an expectancy of the US following the CS, in evaluative conditioning, the CS comes to acquire the valence of the US (Ludvik et al., 2015). Thus, in evaluative disgust conditioning, observation of the CS likely activates a mental representation of the US and its valence (Ludvik et al., 2015). Indeed, disgust conditioning research has shown that even when the US expectancy is attenuated, the CS continues to be evaluated as disgusting following extinction (Ludvik et al., 2015).

Recent research has confirmed that learned disgust is *more* resistant to extinction than fear (Mitchell et al., 2024; Zeng et al., 2021). In an experimental study, Zeng and colleagues (2021) found that conditioned fear responses were successfully attenuated following extinction trials, but conditioned disgust responses remained elevated. In addition, a recent meta-analysis compared the pooled effect sizes of extinction learning for disgust and fear using results from laboratory conditioning studies and found that, indeed, disgust was overall more resistant to extinction than fear (Mitchell et al., 2024). These findings have major treatment implications, as extinction and inhibitory learning are thought to underlie symptom reduction via exposure therapy techniques (Craske et al., 2014). Indeed, dominant treatments for disgust-related disorders emphasize exposure as a primary intervention (e.g., ERP for OCD: Foa et al., 2012; prolonged exposure for PTSD; Foa et al., 2007). However, the original formulation of these disorders and their treatments were based on our understanding of fear conditioning and extinction, and disgust has largely been overlooked in exposure treatment protocols (Pascal et al., 2020). Indeed, disgust may play a role in both short- and long-term treatment outcomes. For example, despite the overall

efficacy of exposure-based treatments for anxiety disorders, roughly half of patients are classified as non-responders (Springer et al., 2021), and a significant proportion of treatment responders (e.g., 14% to 23.8%) relapse within 12 months (Levy et al., 2021). It is possible (though currently uncertain) that the presence of disgust in anxiety disorders contributes to these therapy outcomes. In a meta-analysis, Pascal and colleagues (2020) found that the effect size of exposure-based interventions was smaller when disgust was the outcome variable compared to anxiety and emotional distress. Thus, additional efforts are necessary to optimize the extinction of disgust reactions when treating individuals with disgust-related psychopathology.

Along with disgust conditioning and extinction, research has recently begun to investigate the generalization of acquired disgust. Generalization refers to the transfer of a conditioned response to stimuli that resemble the CS (referred to as the GS+), which is a well-studied phenomenon in fear conditioning (Dymond et al., 2015). Several studies have now shown that during disgust conditioning, acquired disgust generalizes to the GS+ in a manner similar to fear (e.g., Berg et al., 2021; Olatunji & Tomarken, 2023). However, whether individual differences variables, like disgust proneness or disgust-related anxiety disorder symptoms, influence the degree of disgust generalization currently remains uncertain. Berg and colleagues (2021) found that disgust proneness predicted greater disgust generalization. Moreover, they found that disgust generalization during the conditioning task predicted greater avoidance during a subsequent avoidance task. However, Olatunji and Tomarken (2023) did not find any associations between disgust proneness and disgust generalization. This literature is young, but important insights into disgust-related anxiety disorders will likely come from further investigations into disgust generalization processes. For example, like past research on disgust conditioning and extinction, research using analogue (or clinical) samples could help determine whether disgust generalization is a mechanism distinguishing anxious from healthy individuals.

Interventions for Disgust

To overcome the challenge that disgust appears to be more difficult to attenuate than fear, Ludvik and colleagues (2015) recommended investigating methods that attempt to directly target the valence of the CS (e.g., counterconditioning) or the US (e.g., US revaluation) instead of the typical extinction learning (multiple unpaired presentations of the CS absent the US). Counterconditioning consists of pairing the CS (previously paired with a disgusting US) with a new positively valenced US. So far, a few investigations have found that counterconditioning significantly reduces acquired disgust (e.g., Engelhard et al., 2014; Novara et al., 2021). However, Chua and Sündermann (2023) found that while counterconditioning was effective at attenuating CS-US expectancy ratings, it was no more effective than extinction at attenuating disgust evaluations of the CS. US revaluation is a similar procedure that targets the US's natural valence, rather than the CS's conditioned valence. For US revaluation, the disgusting US would be paired repeatedly with a positively valenced US to modify its original valence. This revaluation is then hypothesized to transfer to the CS that was previously paired with the disgusting US. To date, only one investigation has applied US revaluation to conditioned disgust and found that, like counterconditioning, it was no more effective than extinction for attenuating disgust evaluations of the CS (Chua & Sündermann, 2023). Although additional research along these lines is needed, the paucity of existing studies suggest that counterconditioning and US revaluation are insufficient methods to enhance disgust extinction.

Based on an inhibitory learning model of extinction, research has shown that expectancy violations help drive the extinction of fear. That is, when predictions about feared outcomes are disconfirmed during exposure to feared stimuli, inhibitory learning is enhanced (Craske et al., 2014). However, given the disease avoidance model of disgust, there is naturally a significant temporal gap between exposure to a contaminated or infectious stimulus and the onset of illness symptoms. Therefore, it is often difficult to set up clear, unambiguous expectancy violations within a given exposure session.

Bosman and colleagues (2016) therefore investigated whether adding safety information to the CS could enhance extinction learning. Specifically, after pairing food based CSs (e.g., pea soup) with disgusting USs, safety information was added by either allowing participants to interact with the CS (e.g., to examine it) or by having participants witness a confederate eat the CS. This added safety information resulted in increased willingness to eat the CS, as well as lower disgust evaluations during a one-week follow-up. Although not precisely an expectancy violation, adding safety information to the CS may also provide corrective information that enhances inhibitory learning. Based on this research, one simple and actionable strategy that clinicians could adopt is to engage in the exposures with their patients. Observing the clinician make physical contact with disgusting objects might be perceived as evidence of safety, which could motivate reluctant patients to engage in exposures.

Other research has investigated cognitive approaches to enhancing disgust extinction. Olatunji and colleagues (2017) had an analogue sample of participant high in C-OCD symptoms undergo disgust conditioning, and then randomly assigned them to either cognitive reappraisal training or a control task. In the cognitive reappraisal condition, participants were trained to find alternative ways of thinking about the CS and US, a standard technique seen in cognitive therapies. The next day, participants underwent additional disgust conditioning followed by extinction. Results showed that the cognitive reappraisal training attenuated the degree of additional disgust acquisition and enhanced the effectiveness of subsequent extinction training. Although it has been suggested that reappraising the meaning of a disgusting stimulus is futile, because disgust responding is based on concrete rather than abstract properties of a stimulus (Royzman & Sabini, 2001), results from this study are perhaps the most promising with respect to reducing disgust acquisition and then attenuating acquired disgust. Indeed, cognitive restructuring is a common component of cognitive-behavioral treatments for anxiety disorders that could be easily tailored toward restructuring beliefs about disgust and disgusting stimuli.

Although literature is mounting for interventions targeting disgust, very limited research has investigated formalized treatments for disgust-related disorders. To date (to the authors' knowledge), only two investigations have implemented and tested treatments that explicitly target disgust in disgust-related disorders. First, Salmani and colleagues (2022) recently conducted a randomized clinical trial investigating the efficacy of an "anti-disgust" treatment for C-OCD, and the results were promising. The anti-disgust intervention included initial psychoeducation, an anti-disgust cognitive intervention, nine sessions of exposure with response prevention, and a session focused on relapse prevention. The anti-disgust cognitive intervention involved psychoeducation about disgust's function and cognitive distortions related to disgust (e.g., magical thinking). This also included training for challenging beliefs about disgust with an overarching aim of increasing acceptance of feelings of disgust. Results indicated that the anti-disgust cognitive intervention resulted in significantly lower disgust proneness and significantly greater disgust acceptance prior to starting exposures compared to the standard CBT treatment group. In addition, this intervention appeared to reduce the dropout rate during the exposure phase. Further, exposure sessions resulted in significantly greater decreases in disgust proneness and OCD symptoms for the anti-disgust group compared to the standard CBT group, and greater sustained improvement at a three-month follow-up. This investigation was limited by relatively small sample sizes, but it provides very promising preliminary evidence for a disgust-specific treatment for C-OCD.

Another recent investigation incorporated a focus on disgust in a group-based CBT treatment for BII phobia (Mason et al., 2022). This included psychoeducation about disgust (versus fear) in BII symptoms and monitoring levels of both disgust and fear during exposure sessions. Results showed substantial reductions in disgust-based BII phobia symptoms, as well as marginal reductions in overall disgust proneness. Moreover, changes in disgust responses to BII stimuli were associated with overall reductions in BII phobia symptoms. These results suggest that disgust-related symptoms can be successfully treated with a combination of cognitive and behavioral interventions, but that treatments are enhanced when disgust is specifically addressed. It is important to note, however, that this investigation

did not include a control group (e.g., standard in vivo exposure without specific focus on disgust). Therefore, the reported treatment's relative efficacy for reducing disgust reactions above standard treatment methods for BII phobia remains unclear (Mason et al., 2022). To translate laboratory findings on disgust reduction strategies into practical therapeutic interventions, it will be crucial to assess these methods through comparisons with standard in vivo exposures in both experimental research and randomized controlled trials. Nevertheless, there is currently sufficient evidence to recommend incorporating disgust ratings and discussions of disgust-related processes when treating patients with disgust-related symptoms, as opposed to the traditional focus on fear or broader ratings of distress (e.g., SUDs). Thus, it is especially important for clinicians to assess for the specific emotions underlying symptom manifestations in order to provide more targeted treatment.

Conclusions and Future Directions

It has been over 25 years since disgust was labeled “the forgotten emotion of psychiatry” (Phillips et al., 1998). Since then, a large body of literature has accumulated delineating the various mechanisms linking disgust to several anxiety disorders. At this stage, there are clear paths forward for basic and applied research on disgust in anxiety and related disorders. For example, more integrated approaches that seek to test models of disgust across different levels of analysis will be essential for advancing our understanding of the mechanism(s) that account for disgust in various disorders. Research along these lines will be vital to establishing additional targets for intervention. The Research Domain Criteria (RDoC) initiative may be a useful framework for furthering this research agenda. A major aim of the RDoC framework is to investigate the different disease mechanisms across different levels of analysis (e.g., behavioral, neural, genetic, etc.). Although several disgust-related mechanisms have been identified that have transdiagnostic implications, disgust is not included in the Negative Valence Systems Domain of RDoC. According to Amoroso and colleagues (2020), the exclusion of disgust is a limitation of the RDoC that reduces its effectiveness for fully understanding disorders in which disgust plays a contributive role. The absence of disgust from RDoC may be, in part, because the level of synchrony seen across different indicators remains largely untested, and few attempts have been made to formulate and test integrative models of the different disgust-related mechanisms. For example, while research suggests that individual differences in disgust proneness may be partially heritable (Olatunji et al., 2019; Sherlock et al., 2016), the underlying genes remain largely unknown. The findings of Kang and colleagues (2010) suggest that the dopamine receptor D4 and catechol-O-methyltransferase genes are likely candidates but these findings have yet to be replicated. Application of the RDoC framework to disgust across different levels of analysis ranging from genes to behavior may foster new research approaches that will lead to a better understanding of disorders that are characterized by heightened disgust reactions.

The RDoC also highlights several areas that can inform future research in psychopathology, including lifespan and development and environmental influences on disgust. For example, most of our current understanding of disgust in psychopathology comes from research in adults, and there is a relative paucity of research applying a developmental psychopathology approach. A better understanding of the developmental process (e.g., early learning, intergenerational transmission of vulnerabilities) of disgust is essential given that anxiety disorders tend to emerge in childhood (Beesdo et al., 2009). In addition, early work suggests that disgust has both biological and *social* functions (e.g., Keltner & Haidt, 2001). Given its various functions, disgust may have reach beyond the anxiety disorders. Indeed, there is growing research suggesting that disgust may be an important component of the psychopathology of eating disorders (Betkas et al., 2022). Despite the observed social function of the emotion, very limited research has also investigated differences in the experience of disgust across cultures and populations, and whether this has implications for the manifestation of psychopathology or its treatment. Thus, future research should begin investigating disgust-related processes in more diverse samples that include individuals from underrepresented groups to determine whether their links to psychopathology vary across groups.

An important path forward for applied research on the psychopathology of disgust is the development and dissemination of evidence-based treatments. There is now enough evidence to suggest that disgust should be explicitly targeted in treatment to enhance outcomes. Therefore, formalizing and testing disgust-focused treatments (or integrating disgust-focused components into existing treatments) is a necessary next step. Indeed, there remains a need for translational research to investigate whether disgust reduction strategies contribute to treatment efficacy for anxiety disorders. One novel area where this could be pursued is through the integration of disgust concepts into transdiagnostic treatments for emotional disorders, which are becoming more prominent. For example, the Unified Protocol emphasizes emotional appraisals as an important treatment target across emotional disorders, with modules focused on psychoeducation about emotions, their function, and building a more accepting attitude toward negative emotions (along with cognitive and exposure-based treatment components; Farchione et al., 2024). However, disgust is largely absent from current transdiagnostic treatments, potentially leading to the neglect or insufficient emphasis on crucial symptom areas. In addition, future research could seek to investigate disgust-related interventions from a prevention standpoint. Indeed, research has shown that anxiety disorder development can be prevented in some children through early intervention (e.g., Dadds et al., 1997). Given that disgust-related beliefs and avoidance likely develop in childhood (in part) through parental modeling (Reynolds & Askew, 2022), targets for prevention might include parental accommodation of disgust-related avoidance (Thompson-Hollands et al., 2014).

In general, research focused on interventions for disgust-related disorders can be informed by the Stage Model of behavioral intervention development which is composed of six stages (Onken et al., 2014): basic science (Stage 0), intervention generation, refinement, modification, and adaptation and pilot testing (Stage I); traditional efficacy testing (Stage II); efficacy testing with real-world providers (Stage III); effectiveness research (Stage IV); and dissemination and implementation research (Stage V). There is now good evidence on how basic research on disgust can directly inform intervention generation. For example, research has implicated anterior insula activation in disgust processing, which may be a link between disgust and C-OCD (Gan et al., 2022). Based on this evidence, Salvo and colleagues (2022) were able to attenuate disgust reactions and reports of moral rigidity via noninvasive brain stimulation targeting the insula. Moreover, this reduction of disgust was greatest for those with greater OCD symptoms. Thus, a greater understanding of the neural basis of disgust processing and its association to other levels of analysis will likely reveal important targets for treatment. Although our knowledge of the role of disgust in various disorders has advanced considerably over the past two decades, research along these lines remains uncharted territory that is well positioned to reveal new important insights.

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