

Disgust Theory Through the Lens of Psychiatric Medicine

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Abstract

The elicitors of disgust are heterogeneous, which makes attributing one function to disgust challenging. Theorists have proposed that disgust solves multiple adaptive problems and comprises multiple functional domains. However, theories conflict with regard to what the domains are and how they should be delineated. In this article, we examine clinical evidence of aberrant disgust symptoms in the contamination subtype of obsessive-compulsive disorder, blood-injury-injection phobia, and posttraumatic stress disorder to adjudicate between two prevailing theories of disgust. We argue that the pattern of disgust sensitivities in these psychiatric disorders sheds new light on the domain structure of disgust. Specifically, the supported domain structure of disgust is likely similar to an adaptationist model of disgust, with more subdivisions of the domain of pathogen disgust. We discuss the implications of this approach for the prevention and treatment of psychiatric disorders relevant to disgust.

Keywords

disgust, emotion, evolutionary psychology, psychiatry, psychopathology

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Disgust is a basic emotion that affects diverse areas of the human experience. Its features, including its associated facial expression, are most likely shared and understood among all humans across cultures (Ekman et al., 1987). During an individual's development, culture plays a large role in shaping the types of stimuli that activate disgust (Haidt, Rozin, & McCauley, 1997). Despite the malleability of disgust, its diverse elicitors are somewhat consistent across cultural contexts. Bodily fluids, mutilation, nonnormative or immoral behaviors, insects or other small animals, inappropriate food, and maladaptive sexual behaviors elicit disgust reactions across cultures (Curtis, de Barra, & Auger, 2011). Given this diversity of elicitors that spans the physical, social, and moral realms, disgust affects many areas of human life, including political and legal decision making (Capestany & Harris, 2014; Nussbaum, 2010), moral judgment (Chapman & Anderson, 2014; Schnall, Haidt, Clore, & Jordan, 2008),

person perception (L. T. Harris & Fiske, 2007), and public health (Curtis, 2011).

Disgust has been called “the forgotten emotion of psychiatry,” and numerous psychiatric disorders have been suggested to have underlying disgust abnormalities, including obsessive-compulsive disorder (OCD), specific phobias, depression, eating disorders, and body dysmorphia (Phillips, Fahy, David, & Senior, 1998). Disgust psychiatry scholars have since established that aberrant disgust plays a prominent role in these predicted psychiatric disorders and others (Olatunji, Armstrong, & Elwood, 2017; Olatunji & McKay, 2007, 2009). Despite the clear evidence of its relevance for

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psychiatry in the literature, disgust is not included in the Negative Valence Systems Domain of the Research Domain Criteria (RDoC), published by the National Institute of Mental Health (Insel et al., 2010). The RDoC serves as a research framework for new approaches to studying mental health and determines priorities for research and funding. The exclusion of disgust is a shortcoming of the RDoC that reduces its effectiveness for addressing the psychiatric disorders in which disgust plays a contributive role. Even after decades of research, disgust is still the forgotten emotion of psychiatry.

In this article, we propose that psychiatry is an underappreciated tool for disgust research. Perhaps one reason that disgust is not included in the RDoC is the disagreement that still remains among basic researchers about the function and operationalization of disgust. No consensus has been reached about the optimal theoretical framework for disgust research. One particular challenge for a comprehensive theory of disgust is accounting for the heterogeneity of adaptive functions required to explain all of the disgust elicitors. Basic emotion theorists subscribe to the notion that a given emotion has universal antecedent events commensurate with a particular adaptive challenge faced over a species' evolutionary history (Ekman, 1992; Tooby & Cosmides, 2008). For instance, fear is generally viewed as an adaptive response to immediate physical (or sometimes psychological) harm (Ekman & Friesen, 1975). Thus, even fear elicitors as disparate as snakes, weapons, an angry face, and standing at the edge of a building can be unified under a single functional heading. However, disgust is associated with such a wide variety of potential elicitors that it becomes difficult to create a comprehensive theory of the evolutionary function of disgust. For instance, because stimuli as superficially unrelated as political skullduggery, nonnormative sexual acts, excreta, and mutilated limbs all elicit a disgust response, the evolutionary function of disgust is likely complex or multifactorial. Numerous scholars have proposed theories of disgust function to address this question, and reaching consensus among these conflicting theories will expedite future investigations into the relationship between disgust and mental health.

Here, we propose that research on psychiatric disorders can clarify and inform the debate about disgust function. We use evidence about aberrant disgust responses in the contamination subtype of OCD (contamination OCD), blood-injection-injury-specific phobia (BII phobia), and posttraumatic stress disorder (PTSD) to adjudicate between two influential theories of disgust. Furthermore, by integrating clinical evidence into the basic science debates, we can establish a psychiatrically useful theory of disgust that can be incorporated into the RDoC. A theory of disgust with validity

for psychiatry could even facilitate searches for biomarkers related to distinct subtypes of disgust and create targeted interventions for particular kinds of psychiatric disorders related to disgust.

Debates About the Evolutionary Function of Disgust

In this review, we focus on two prominent theories of disgust, to which we have assigned the terms *cultural evolution model* and *adaptationist model*. Although certain readings of these theories are not necessarily mutually exclusive, they are incompatible in certain critical ways that place limits on their utility for clinical applications (for an expanded discussion of these controversies, see Rozin & Haidt, 2013; Tybur, Lieberman, Kurzban, & DeScioli, 2013). Note that both of these theories purport to explain the same set of elicitors (see Fig. 1), which allows for a direct comparison.

Cultural evolution model

Rozin and colleagues generated the cultural evolution model of disgust, which arguably dominates the field to the present day and has been most commonly applied to the study of disgust in psychiatric disorders (Haidt, McCauley, & Rozin, 1994; Haidt et al., 1997; Olatunji & Sawchuk, 2005; Rozin & Fallon, 1987; Rozin, Haidt, & McCauley, 2008). According to this account, the uniquely human emotion of disgust emerged out of a phylogenetically ancient capacity for distaste, the rejection of potential food items based on inherently noxious sensory characteristics. The cultural evolution model suggests that the distaste mechanism was coopted via the process of biological evolution to respond to the challenges of omnivorousness; because a huge variety of plants and animals became potential food items, it was necessary to develop a mechanism to acquire an avoidance response to poisonous, contaminated, or spoiled items. The result was *core disgust*, a response to learned cues that a food source could cause illness, such as indications of decay (e.g., maggots). Core disgust departs from distaste in that it can be elicited in the absence of a negative sensory stimulus because of certain ideational elements such as the knowledge that an otherwise innocuous item has once come into contact with something disgusting or a conceptual or perceptual similarity between an otherwise innocuous item and a disgusting item. Rozin et al. (2008) linked this ideational dimension of disgust to a construct borrowed from anthropology known as sympathetic magic, which encompasses the idea of contact contamination ("once in contact, always in contact"). The cultural evolution model further proposes that core

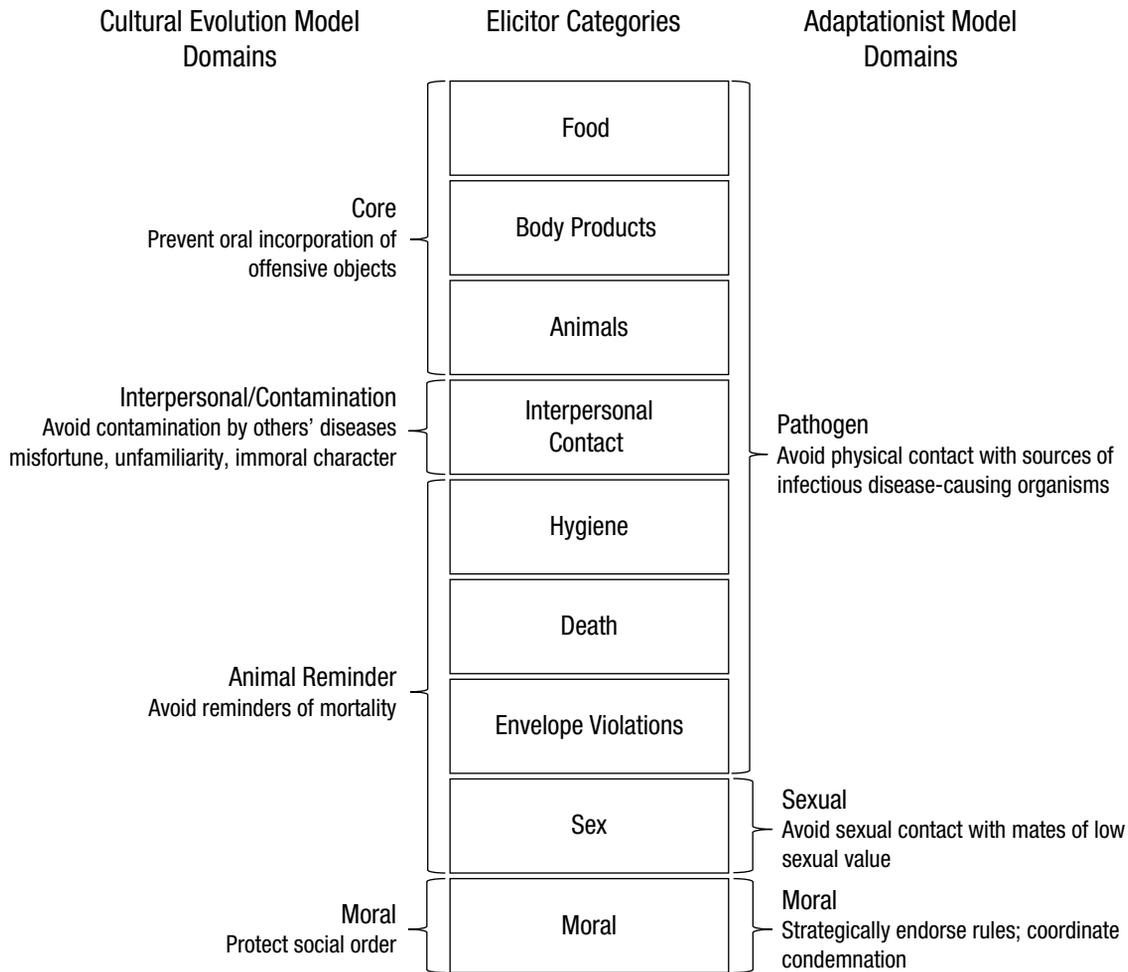


Fig. 1. Breakdown of elicitor categories into functional domains under the cultural evolution and adaptationist models (figure adapted from Tybur, Lieberman, Kurzban, & DeScioli, 2013).

disgust was coopted once again, this time via the process of cultural evolution, to address morally relevant stimuli (*moral disgust*), the potential risk inherent in contact with other people (*interpersonal disgust*), and uncomfortable reminders of our animal nature (*animal-reminder disgust*).

In total, the cultural evolution model understands disgust in terms of nine elicitor categories: food, body products, animals, violations of the body envelope (e.g., mutilation), sex, poor hygiene, death, interpersonal disgust, and moral disgust. These elicitor categories are then assigned to the four superordinate domains described above on the basis of their purported functional relationship. For instance, sex is assigned to the domain of animal-reminder disgust because it is thought to constitute a distressing reminder of humans' animal, and therefore mortal, nature. These four functions of disgust represent the functional domains of disgust according to the cultural evolution model (see Fig. 1).

The authors developed a questionnaire alongside this theory called the Disgust Scale (Haidt et al., 1994; for a discussion of psychometric concerns with their approach, see Olatunji, Williams, et al., 2007). They found higher correlations within items related to a single elicitor category (e.g., items related to body products) than among disgust domains, consistent with a set of subscales mapping onto the seven of the nine elicitor categories with one additional subscale that tracked notions of sympathetic magic across multiple categories of elicitors. The Disgust Scale has a revised form (Olatunji, Williams, et al., 2007) that eliminates the sexual-disgust items because of their skewness and factors the remaining items into three subscales: one reflecting the core domain, one reflecting the animal-reminder domain (represented solely by items about body-envelope violations and death), and one elicitor-general subscale labeled as a contamination factor that is characterized as tracking the contact-contamination

facet of sympathetic magic. Like the original form, the Disgust Scale–Revised suggests that disgust is multidimensional, and the idea that the domains can vary independently of one another has persisted.

In sum, the cultural evolution model formulates the multifactorial nature of disgust as emerging from the interaction of two evolutionary processes: one biological and one cultural. The putative core form of disgust is thought to have come about through biological evolution; a more basic capacity to avoid inappropriate food was exapted to address the increased threat of infection or poisoning threat that comes with omnivorousness (see also Kelly, 2011). Other domains of disgust (such as animal-reminder disgust) are thought to have come about via the process of cultural evolution, in which the core-disgust system was extended to respond to different kinds of elicitors.

Adaptationist model

As researchers of disgust became increasingly concerned with articulating the emotion's ultimate adaptive functions (Nesse, 1990; Tooby, 1985; Tooby & Cosmides, 2008), new theoretical models of disgust critiqued the cultural evolution model and proposed alternate functional explanations grounded in evolutionary psychology. One such adaptationist model was put forward by Tybur and colleagues (Tybur, Lieberman, & Griskevicius, 2009; Tybur et al., 2013). This model is consistent with the overarching premise of the cultural evolution model that a response to a basic threat of disease was coopted to address other functional concerns. However, the adaptationist model departs from the cultural evolution model by situating the diversity of functions of disgust in biology and focusing much less on cultural evolution. The adaptationist model suggests that what the cultural evolution model calls core disgust, as well as most of the domain of animal-reminder disgust, can be more parsimoniously explained as pathogen disgust: a response to cues of potential disease.

Whereas the cultural evolution model categorizes sex as one of several elicitors of animal-reminder disgust, the adaptationist model labels sexual disgust as its own specific domain, responding to cues related to maladaptive mate choice, including cues of kinship and poor genetic quality. As in the cultural evolution model, the adaptationist model proposes that sociomoral disgust stands alone and motivates an individual to strategically endorse moral norms that increase his or her fitness (for instance, someone engaging in a monogamous reproductive strategy might signal disgust at infidelity; see Tybur et al., 2013). In other words, whereas the cultural evolution model suggests that the functional diversity of disgust is due to cultural elaboration

of a core-disgust response, the adaptationist model suggests that this functional diversity can be explained by biological evolution, deemphasizing (although not dismissing) the role of culture.

The Three Domains of Disgust Scale (TDDS), which measures domain-specific sensitivities to disgust, was developed using the adaptationist model as a theoretical foundation. Few studies have yet used the TDDS to study the relationship between disgust and psychiatric symptoms (see Olatunji, Ebesutani, & Kim, 2015). Instead, because the cultural-evolution model was the prevailing view of disgust for decades, most examinations of disgust-related psychiatric disorders to date use the Disgust Scale or the Disgust Scale–Revised. Given the theoretical differences between the cultural evolution model and adaptationist model, it is worth exploring which theory and associated psychometric scale, if any, is more appropriate for psychiatric application. Ultimately, the theories differ regarding the ways in which elicitors should be grouped to explain the unifying functions of the emotion of disgust, and we propose that the validity of these groupings can be tested using psychiatric research.

Using Psychiatric Research to Test Disgust Models

Domains of disgust (as delineated by extant theories) have been found in the past to relate to psychiatric symptoms. Olatunji, Haidt, McKay, and David (2008) noted that individual differences in response to each of the domains per the cultural evolution model differentially predicted psychiatric symptoms. This finding represents a proof of principle that sensitivity to a specific domain of disgust may be related to a specific kind of psychopathological symptom (see also Olatunji et al., 2017). Here, we expand this concept, using the proposed relationship between psychiatric symptom and individual differences in disgust to explore the functional dissociations within disgust. We proceed from several premises to guide this process.

1. Psychiatric symptoms result from perturbations of latent neurocognitive mechanisms. In other words, when some such mechanism (or set of mechanisms) is performing abnormally, the result is a set of maladaptive behaviors and/or cognitions that might then be assigned a psychiatric label (or one of several labels). This perspective is consistent with the Research Domain Criteria framework proposed by the National Institute of Mental Health (see Insel et al., 2010).
2. If disgust is made up of a group of basic functional elements that evolved or were coopted for

specific purposes (i.e., the disgust domains), and these domains are each associated with a specific set of elicitors, then individual differences in the propensity to be disgusted by one of the elicitors within that set are expected to generalize to the other elicitors within the set (see Olatunji, Williams, et al., 2007). This concept follows from the way each theory empirically established its domains in the first place, which was by identifying clusters of elicitors for which individual differences in disgust sensitivity tended to covary (Haidt et al., 1994; Olatunji, Williams, et al., 2007; Tybur et al., 2009). For example, if animal-reminder disgust exists as a unified response to a unique adaptive problem, then a person's sensitivity to one of the animal-reminder elicitors (e.g., death) will correlate with others within the set (e.g., sex, hygiene, and body-envelope violations) and not necessarily with those from other sets (e.g., elicitors pertaining to moral disgust).

3. Aberrant disgust responses may be a risk factor for the development of some psychiatric disorders or for an increase in their severity (Olatunji et al., 2017).
4. If a particular psychiatric disorder is related to a disruption in disgust responding to particular elicitors (e.g., heightened disgust response to hygiene disgust), but that disruption does not generalize to other elicitors within the same disgust domain (e.g., another elicitor in the animal-reminder domain, such as sexual disgust), it challenges the validity of that domain structure.

Following the conceptual frameworks of these two theoretical models, we made predictions about how disgust influences individual susceptibility to particular disorders. Specifically, we propose that, under a model that differentiates between domains, an individual may be considered at risk for a particular psychiatric disorder (or set of disorders) if he or she has markedly elevated (or compromised) disgust responding in a domain relevant to that disorder. Along similar lines, if disgust comprises several independently varying, adaptively functional domains, sensitivity to one elicitor within a domain should predict sensitivity to other elicitors within that domain; therefore, sensitivity to any elicitor within a domain may predict risk of the disorder(s).

Below, we describe an approach that applies psychiatric research to the debate on disgust function. To illustrate the potential value of this approach, we examined three psychiatric conditions for which a disordered disgust response is implicated: contamination OCD, BII phobia, and sexual-trauma-based PTSD. We selected these three disorders because the two focal disgust theories make incompatible predictions related to these

disorders; that is, evidence from these disorders would help us to parse the domain boundaries of the two theories. We first evaluated the evidence that disgust contributes to the disorder. We discuss predictions based on the grouping of functional domains under the cultural evolution model and adaptationist model. Finally, we discuss the predictions for these focal psychiatric disorders under each model and consider to what degree existing evidence thus far concurs with one or more of the theoretical predictions.

Contamination OCD

OCD is a condition marked by aversive and intrusive cognitions (obsessions) and compulsive behaviors that can be either mental or physical in nature. Obsessions are commonly related to sexual content, aggressive content, moral/religious content, or contamination; compulsions often include behaviors such as counting, cleaning, arranging, and seeking reassurance. Often, the compulsions are performed to alleviate the distress associated with the obsessions, regardless of whether the compulsion has any rational relationship to the obsession (American Psychiatric Association, 2013).

Given the general agreement among disgust theories that at least one function of disgust is to avoid contamination, contamination OCD is an obvious candidate for a disorder involving disgust and is accordingly the most extensively studied psychiatric disorder in relation to disgust. Indeed, disgust is disordered in patients with contamination OCD (for recent reviews, see McKay & Moretz, 2009; Olatunji et al., 2017). Disgust propensity and sensitivity (based on the Disgust Propensity and Sensitivity Scale–Revised; van Overveld, de Jong, Peters, Cavanagh, & Davey, 2006) are correlated with the symptoms of contamination-based OCD in nonclinical participants (Olatunji et al., 2010) and clinical participants (Berle et al., 2012). In a nonclinical sample, changes in OCD symptoms reflect changes in disgust sensitivity over time, independent of changes in negative affect over the same period¹ (Olatunji et al., 2010); however, over a longer period in a clinical sample, changes in disgust were not significantly associated with changes in OCD symptoms (Berle et al., 2012). Scores on the Disgust Scale are directly related to the washing and contamination concerns associated with contamination OCD, without any mediation by trait anxiety (Moretz & McKay, 2008). In fact, the recent reclassification of OCD as a disorder unique from other anxiety disorders was due in part to the findings that patients with OCD experience emotions other than anxiety in response to their triggers, including disgust (Krzanowska & Kuleta, 2017).

A hyperactive disgust response is a specific defining feature of contamination OCD. McKay (2006) found that, compared with patients with other subtypes of

OCD, patients with contamination OCD are slower to habituate to disgusting stimuli that were not associated with anxiety reactions (stimuli included sticky/greasy food, cigarette ashes, trash, and dirty water, many of which are challenging to place in the cultural evolution model's domain structure). However, no difference was observed between the two groups in rates of habituation to anxiety-evoking stimuli, suggesting that disgust plays a unique role in contamination OCD (McKay, 2006). In addition, Woody and Tolin (2002) found that patients with OCD with washing symptoms had significantly higher average total Disgust Scale scores than nonanxious control subjects and marginally higher Disgust Scale scores than nonwashing patients.

Given the evidence that disgust plays a role in the symptoms of contamination OCD, we expect that the predictive framework that we proposed above may be applied to contamination OCD. The cultural evolution model predicts that scores on the subscales of the Disgust Scale that fall into the core domain will predict contamination-OCD risk (Olatunji, Sawchuk, de Jong, & Lohr, 2007). Following our conceptual framework, because core disgust encapsulates contaminants such as body products, under the cultural evolution model, all core-disgust subscales, including food, body products, and animals, should also covary with contamination-OCD risk, but other subscales of the Disgust Scale should not. We also expect any associations between general disgust sensitivity or overall scores on the Disgust Scale to be mediated by scores on the core subscale. Alternatively, under the adaptationist model, we expect that contamination-OCD risk would be predicted by sensitivity to pathogen disgust, but not sexual or moral disgust, as measured by the TDDS or the subscales of the Disgust Scale with relevance for pathogen-disgust sensitivity. Any associations between contamination-OCD symptoms and general disgust sensitivity or overall TDDS scores are predicted to be mediated by scores on the pathogen subscale.

A complex body of research has focused on the predictive value of sensitivity to specific domains of disgust for contamination-OCD symptoms, and this literature provides an opportunity to test some of the predictions that the theories would make. In general, scores on the Disgust Scale as a whole correlate with contamination-OCD symptoms and contamination fear, but Disgust Scale subscales that are most correlated with contamination-OCD symptoms are inconsistent. In fact, in some cases, there is no differential relationship between specific domains and contamination-OCD symptoms at all but, rather, a relationship between symptoms and all subdivisions of disgust (Moretz & McKay, 2008; Olatunji, Ebesutani, & Kim, 2016; Olatunji, Sawchuk, Lohr, & de Jong, 2004; see also Olatunji,

Williams, et al., 2007), with the exception of behavioral avoidance of contact with envelope violations. Woody and Tolin (2002) agreed with Olatunji et al. (2004) and Olatunji, Lohr, Sawchuk, and Tolin (2007) that body products and animals are important predictors of contamination OCD, and both of these subscales fall within the core-disgust domain. However, sensitivity to food disgust (another core elicitor) is not highly correlated with contamination OCD. Tolin, Woods, and Abramowitz (2006) and Olatunji et al. (2004; Olatunji, Williams, et al., 2007) found a relationship between sensitivity to hygiene-related disgust elicitors and contamination sensitivity, but Woody and Tolin (2002) did not. Olatunji et al. (2004) presented the only evidence supporting that sensitivity to death-related elicitors is correlated, but overall, no animal-reminder elicitors besides hygiene were consistently found to have special importance for contamination OCD in these three studies.

The Disgust Scale-Revised (Olatunji, Williams, et al., 2007) has also been used to predict contamination-OCD symptoms, and all three subscales of the Disgust Scale-Revised have been found to be significantly correlated with symptoms across several different measures of contamination sensitivity (Olatunji, Ebesutani, Haidt, & Sawchuk, 2014; Olatunji et al., 2016). In an investigation of therapeutic interventions into contamination OCD (Athey et al., 2015), baseline readings of all three factors on the Disgust Scale-Revised were marginally related to contamination-OCD symptoms. In other words, although there was a relationship between disgust and contamination OCD, there was no differential domain sensitivity to contamination symptoms. However, postintervention reductions in core and contamination-based disgust, but not animal-reminder disgust, were associated with changes in symptoms. Olatunji, Williams, Lohr, and Sawchuk (2005) found that symptoms related to contamination OCD were associated with core disgust but were negatively associated with animal-reminder disgust. Note that this relationship was assessed before the development of the Disgust Scale-Revised in its final form, and this formulation placed hygiene in core disgust (as opposed to the animal-reminder domain, where the cultural evolution model later placed it). In summary, the studies using the Disgust Scale-Revised suggested that core disgust may have better predictive value for contamination OCD than animal-reminder disgust, especially if hygiene is considered within the core-disgust domain, as in the study by Olatunji, Williams, et al. (2005).

Relating these results to the predictions above, evidence modestly supports the prediction that core disgust, as measured by the Disgust Scale and Disgust Scale-Revised, is related to contamination OCD. Contrary to the cultural evolution model prediction, the

subscales of the Disgust Scale that are most commonly associated with contamination OCD span the core and animal-reminder domains, including some—but not all—subscales from these two domains. Meanwhile, other subscales, including food, death, envelope violations, and sex, have little to no unique importance for contamination-OCD risk or symptoms. From these patterns, we surmised that the predictive value of general disgust sensitivity for contamination OCD is not mediated by elicitors within a single disgust domain as delineated by the Disgust Scale but, rather, by a cluster of elicitors that spans domains.

Perhaps because of the newness of the adaptationist model relative to the cultural evolution model, only two studies have investigated the utility of the TDDS in predicting OCD symptoms (Olatunji et al., 2015; Poli, Melli, & Radomsky, 2019). Consistent with predictions, Olatunji and colleagues (2015) found that pathogen disgust consistently correlates with common OCD symptoms such as washing and contamination fear, whereas the relationship between sexual disgust and moral disgust is less consistent. Poli and colleagues (2019) partially supported the adaptationist model's domain structure with respect to explaining clinical variation as well: As expected, the pathogen subscale predicted feelings of contact contamination in patients with OCD, and feelings of mental contamination (i.e., an intrinsic sense of the dirtiness of the self) were predicted by the sexual-disgust subscale.

Here, we also consider how the findings from the studies that use the Disgust Scale (discussed above) can be translated to the adaptationist model framework. The three subscales for which a link to contamination OCD is best supported—body products, animals, and hygiene—are categories that would be subsumed by the pathogen-disgust domain of the adaptationist model, consistent with the prediction. However, not all of the pathogen-relevant subscales of the Disgust Scale are flagged as equally important or predictive. For example, envelope violations and death are categories in the cultural evolution model that, according to the adaptationist model, should also be included in the pathogen domain, but neither of these has particular importance for contamination OCD across the studies mentioned. The promising results of the first study of contamination-OCD symptoms using the TDDS combined with the results of the existing Disgust Scale literature highlight the potential utility of the adaptationist model for future inquiries into the relationship between disgust and contamination OCD.

It is worth noting that although contamination OCD arguably demonstrates the strongest relationship to disgust, disgust propensity also correlates with multiple other dimensions of OCD in clinical participants with

a principal OCD diagnosis. In addition to contamination-relevant OCD symptoms, disgust propensity also correlates with other OCD subtypes characterized by checking and just-right symptoms (Berle et al., 2012). Disgust is also implicated in scrupulosity, a subtype of OCD comprising religious and/or moral obsessions and compulsions, on the basis of a study in a nonclinical sample (Olatunji, Tolin, Huppert, & Lohr, 2005). Thus, disgust may cause or influence obsessive and compulsive symptoms with more complexity than simply by causing overactive aversion to contamination in patients with contamination OCD.

In sum, the literature on the relationship between disgust and contamination OCD suggests that distinct sensitivities to particular kinds of disgust elicitors do in fact relate differentially to contamination-OCD symptoms (Tables 1 and 2). If domain-specific disgust sensitivities should predict psychiatric disease, the relationship between contamination OCD and sensitivity to certain elicitors within a disgust domain (e.g., hygiene) but not others (e.g., animal-reminder elicitors other than hygiene) calls into question the domain structure as described in the cultural evolution model. Future investigations of the role of disgust in contamination OCD may benefit from incorporating other theories of disgust. For example, the pathogen-disgust domain of the adaptationist model may provide more predictive value for the study of contamination OCD, as suggested by Olatunji et al. (2015), who put forth the adaptationist model as a tractable theory of disgust.

BII Phobia

BII phobia is considered a specific phobia within anxiety disorders and is described as a marked, consistent, and persistent fear or anxiety about a specific object or situation related to blood, needles, invasive medical procedures, and/or related objects or situations that causes clinically significant distress or impairment in social, occupational, or other important areas of functioning (American Psychiatric Association, 2013). BII phobia first drew the attention of disgust researchers because of its unique co-occurrence with fainting (Ost, 1992). Although initial theoretical accounts suggested a role for disgust in the vasovagal syncope that often accompanies BII (Connolly, Hallam, & Marks, 1976; Page, 1994, 2003), recent work has suggested that any link between disgust and fainting is probably indirect and mediated by fear (Olatunji, Sawchuk, de Jong, & Lohr, 2006; Simon, Meuret, & Ritz, 2017; Viar, Etzel, Ciesielski, & Olatunji, 2010). Other studies have suggested that disgust does make important contributions to BII in addition to fear, and researchers found that scores on the Disgust Scale correlate with measures of

Table 1. Summary of Predictions and Findings for the Contamination Subtype of Obsessive-Compulsive Disorder (Contamination OCD)

Domain subscale	Associated with contamination OCD?		
	Cultural evolution model prediction	Adaptationist prediction	Finding in literature
Food	+	+	
Body products	+	+	+
Animals	+	+	+
Interpersonal/contamination/sympathetic magic	+	+	+
Hygiene		+	+
Death		+	
Envelope violations		+	
Sex			
Moral disgust			

Note: Table outlines predicted domain-specific disgust sensitivity for contamination OCD under the cultural evolution model and adaptationist model, compared with a general synthesis of the findings in the literature. + represents a positive correlation or relationship between symptoms and propensity to a given disgust category that was interpreted as notable by study authors. For details on the findings of individual studies, see Table 2.

BII phobia (de Jong & Merckelbach, 1998; Olatunji et al., 2017; Sawchuk, Lohr, Tolin, Lee, & Kleinknecht, 2000; Tolin, Lohr, Sawchuk, & Lee, 1997). Individuals with BII phobia demonstrate an emotional response that integrates and aggregates both disgust and fear, as evidenced by high positive correlations between ratings of disgust and fear in response to phobic stimuli (Sawchuk, Lohr, Westendorf, Meunier, & Tolin, 2002). In addition, disgust ratings given by people with either BII phobia or spider phobia to phobic-specific stimuli were predictive of membership in their particular phobic groups, whereas fear ratings of these images did not predict their membership (Sawchuk et al., 2002).

Considering initial findings that disgust is likely involved in the development of BII phobia (Tables 3 and 4), we put forth here several predictions for domain-specific disgust sensitivities under each of the two models of interest. Under the cultural evolution model, we expect that BII-phobia symptoms and/or risk will be predicted by elevated scores on the body-envelope-violation subscale of the Disgust Scale, given the relevance of envelope violations for injections and other injuries or mutilations that compose phobic stimuli in patients with BII phobia. Likewise, elevated sensitivity to all elicitors within the animal-reminder domain, namely, within the hygiene, death, and sex subscales, should predict BII-phobia risk and symptoms. Any associations between BII phobia and general disgust sensitivity measures should be mediated by scores on the animal-reminder subscale. Alternatively, we predict under the adaptationist model that elevated scores on the TDSS pathogen-disgust subscale, or on

cultural evolution model subscales with relevance for pathogen disgust, should predict BII-phobia risk or symptoms. Pathogen-disgust sensitivity should mediate any associations between BII phobia and general disgust sensitivity.

Several studies have attempted to clarify how specific domains of disgust contribute to BII phobia. On the surface, researchers agree that animal-reminder disgust contributes substantially to BII phobia. In studies that indicated that individuals with BII phobia have higher average Disgust Scale scores than nonphobic control subjects, authors have also typically concluded that the most remarkable differences between individuals with BII phobia and nonphobic control subjects are in animal-reminder domains (Sawchuk et al., 2000), including, specifically, body-envelope violations and death (de Jong & Merckelbach, 1998; Olatunji, Williams, Sawchuk, & Lohr, 2006; Tolin et al., 1997).

However, after deeper examination of these studies, the predictive value of animal-reminder disgust sensitivity as a unified construct becomes less clear. If the subscales of animal-reminder disgust, namely, death, hygiene, envelope violations, and sex, compose a meaningful functional realm of disgust, then hygiene and sex subscales of the Disgust Scale should also correlate with BII phobia, but this is not what the studies found. In fact, hygiene and sex subscales are typically very weakly related to BII-phobia symptoms or risk (de Jong & Merckelbach, 1998; Olatunji, Williams, et al., 2006; Tolin et al., 1997). Another study that found support for the importance of animal-reminder disgust used only a death-relevant stimulus to measure animal-reminder sensitivity and did not test other types of

Table 2. Summary of All Studies Included in the Synthesis: Contamination OCD

Article	Disgust Scale										Disgust Scale–Revised			Three Domains of Disgust Scale		
	Food	Core	Anim	Contam	Death	Env	Sex	Symp	Core	Anim	Contam	Path	Sex	Moral		
Woody & Tolin, 2002	0	+	+	0	0	0	0	+								
Olatunji, Sawchuk, Lohr, & de Jong, 2004	+	+	+	++	+	+	+	++								
Olatunji, Tolin, et al., 2005	++	+	+	++	++	+	+	+								
Tolin, Woods, & Abramowitz, 2006	+	+	+	++	+	+	+	+								
Olatunji, Lohr, et al., 2007	+	++	++	++	+	+	+	+								
Olatunji, Ebesutani, Haidt, & Sawchuk, 2014									+	+	++					
Olatunji, Ebesutani, & Kim, 2015												++	+	0		
Olatunji, Ebesutani, & Kim, 2016												+	+	+		

Note: Contamination OCD = contamination subtype of obsessive-compulsive disorder; Anim = animal reminder; Contam = contamination; Env = envelope violations; Symp = sympathetic magic; Path = pathogen. 0 = no relationship; + = positive correlation or relationship; ++ = positive statistical relationship interpreted as notable by the authors; – = negative correlation or relationship.

Table 3. Summary of Predictions and Findings for Blood-Injection-Injury-Specific Phobia (BII Phobia)

Domain subscale	Associated with BII phobia?		
	Cultural evolution model prediction	Adaptationist model prediction	Finding in literature
Food		+	
Body products		+	
Animals		+	
Hygiene	+	+	
Death	+	+	+
Envelope violations	+	+	+
Sex	+		
Moral			

Note: Table outlines predicted domain-specific disgust sensitivity for BII phobia under the cultural evolution model and adaptationist model, compared with a general synthesis of the findings in the literature. + represents a positive correlation or relationship between symptoms and propensity to a given disgust category that was interpreted as notable by study authors. For details on the findings of individual studies, see Table 4.

elicitors within the domain (Bianchi & Carter, 2012). In other words, animal-reminder disgust generally predicts BII-phobia symptoms, but this relationship is likely driven by high scores on the death and body-envelope-violation subscales. Higher correlations with the other animal-reminder subscales (hygiene and sex) would be expected if animal reminder were truly a functional domain of disgust.

The unique predictive value and co-occurrence of disgust sensitivity to body-envelope violations and death in individuals with BII phobia suggest that there may be some grouping of these elicitors in a functional area of disgust. Specifically, the prompts within the death and body-envelope-violation subscales of the Disgust Scale questionnaire may be eliciting the activation of a specific functional area of disgust. This suggestion is consistent with initial validations of the Disgust Scale, in which an exploratory factor analysis suggested that the death and body-envelope-violation subscales should be combined (Haidt et al., 1994). Alternatively, death and body-envelope-violation stimuli may elicit disgust alongside another emotion such as fear or anxiety in a unique way with particular salience for individuals with BII phobia.

Taken together, the literature on domain-specific disgust sensitivity in contamination OCD and BII phobia suggests that the cultural evolution model's grouping of elicitor categories into the animal-reminder domain is not meaningfully applied to psychopathology, raising questions about its broader utility. In addition, the pathogen-disgust domain of the adaptationist model may be too broad; instead, pathogen disgust may respond to elicitors only within the cultural evolution

model subcategories of body products, animals, and hygiene. According to the literature on these two disorders, the remaining subscales—death and envelope violations—seem to form their own unique and independently useful elicitor category. Following this suggested delineation of disgust domains, death and envelope violations certainly have relevance for pathogen transmission, but the avoidance of mutilation, gore, and death may instead be selected for adaptive reasons other than disease avoidance. Given our proposed interpretive framework of the evidence, researchers should consider whether and how elicitors as functionally related as mutilation (an envelope violation) and blood (a body product) might be dissociated from other elicitors in the domains predicted by the cultural evolution and adaptationist models and explore other contexts in which body-envelope violations and body products occur, which would be expected to elicit responses consistent with BII phobia (e.g., menstruation) but may not. Such delineations would suggest the possibility that selective pressures other than or in addition to pathogens may explain disgust in response to body-envelope violations and death and may highlight the importance of considering cultural practices in response to disgust elicitors in contributing to a domain distinct function (e.g., practices toward menstruation, death).

Disgust and PTSD

PTSD is classified as a trauma- and stressor-related disorder and is characterized by exposure to traumatic events (occurring to either the self or someone else),

Table 4. Summary of all Studies Included in the Synthesis: BII Phobia

Article	Disgust Scale										Disgust Scale-Revised		
	Food	Core	Anim	Contam	Death	Env	Sex	Symp	Core	Anim	Contam		
Olatunji, Babson, Smith, Feldner, & Connolly, 2009	+	+	+	+	+	+	0	+					
Olatunji, Williams, Sawchuk, & Lohr, 2006	+	+	+	+	++	++	++	+					
de Jong & Merckelbach, 1998	0	0	0	0	+	+	0	0					
Sawchuk, Lohr, Westendorf, Meunier, & Tolin, 2002	0	+	+	+	+	+	0	+					
Sawchuk, Lohr, Tolin, Lee, & Kleinknecht, 2000	0	+	+	0	+	+	+	+					
Tolin, Lohr, Sawchuk, & Lee, 1997	+	+	+	+	++	++	0	+					
Olatunji, Sawchuk, de Jong, & Lohr, 2006	+	+	+	+	+	+	0	+					
Woody & Tolin, 2002	0	0	0	0	0	+	0	0					
Hirai & Vernon, 2012									+	+	+		

Note: BII = blood-injection-injury-specific phobia; Anim = animal reminder; Contam = contamination; Env = envelope violations; Symp = sympathetic magic; Path = pathogen. 0 = no relationship; + = positive correlation or relationship; ++ = positive statistical relationship interpreted as notable by the authors; - = negative correlation or relationship.

Table 5. Summary of All Studies Included in the Synthesis: Posttraumatic Stress Disorder

Article	Disgust Scale–Revised			Three Domains of Disgust Scale		
	Core	Anim	Contam	Path	Sex	Moral
Engelhard, Olatunji, & de Jong, 2011	0	0	0			
Arocho, 2015	++	NR	NR	++	NR	0
Ojserkis et al., 2014				0	0	0
van Delft, Finkenauer, Tybur, & Lamers-Winkelmann, 2016				0	++	–

Note: Anim = animal reminder; Contam = contamination; Path = pathogen; NR = not reported. 0 = no relationship; + = positive correlation or relationship; ++ = positive statistical relationship interpreted as notable by the authors; – = negative correlation or relationship.

intrusive psychological symptoms such as flashbacks or nightmares, avoidance of traumatic cues, and negative cognitive and affective outcomes following the event (American Psychiatric Association, 2013). PTSD was introduced in the second edition of the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 1968) under the heading of anxiety disorders. Although the most recent edition of the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 2013) reclassified PTSD under the new heading of trauma- and stressor-related disorders, PTSD has historically been viewed through the lens of fear and anxiety models. Nevertheless, the emotional experience in PTSD symptoms is fairly heterogeneous (Hathaway, Boals, & Banks, 2009). Power and Fyvie (2013) found that anxiety was the primary emotion for less than 50% of PTSD cases surveyed, and some research has suggested that fear is not even a necessary precursor for the development of PTSD (O'Donnell, Creamer, McFarlane, Silove, & Bryant, 2010). Coyle, Karatzias, Summers, and Power (2014) found that disgust was reported significantly more than fear, anger, sadness, or happiness by survivors of childhood sexual abuse. In addition, individual differences in state and trait disgust have been found to predict future intrusive cognitions following laboratory analogues for trauma (Bomyea & Amir, 2012; Weidmann, Conradi, Gröger, Fehm, & Fydrich, 2009). All of this evidence suggests a relationship between PTSD and disgust. Given recent research linking self-disgust and suicidality in people with PTSD (Brake, Rojas, Badour, Dutton, & Feldner, 2017), a better understanding of the potential disgust-PTSD link may be a matter of some urgency.

Despite the evidence of some kind of link between disgust and PTSD, the literature taken as a whole is at times inconsistent (Table 5). Although some previous work suggested that disgust has discriminant validity in predicting PTSD symptoms (Foy, Sippelle, Rueger, & Carroll, 1984), Dewey, Schuldberg, and Madathil

(2014) found that peritraumatic disgust (i.e., disgust experienced during the traumatic event) either did not predict or performed poorly in predicting certain PTSD symptoms, relative to other emotions such as fear and anger. Likewise, Ojserkis et al. (2014) found no straightforward relationship between trait disgust and PTSD symptoms in a subclinical sample (in fact, finding a surprising negative correlation between moral disgust and PTSD symptoms). Engelhard, Olatunji, and de Jong (2011) found no relationship between trait disgust and PTSD symptoms, although they did see a relationship between PTSD and peritraumatic disgust.

One possible reason for these conflicting findings may be that the relationship is specific to a particular disgust domain. However, to our knowledge, only three peer-reviewed studies and one doctoral dissertation have examined the relationship between PTSD indices and the subscales of the Disgust Scale, Disgust Scale–Revised, or TDDS, and their results were inconsistent. Whereas Engelhard et al. (2011) found no correlation among any of the subscales of the Disgust Scale–Revised and PTSD symptoms, Arocho (2015) found a positive relationship between core disgust and PTSD symptoms. Findings for the TDDS are also contradictory: Pathogen disgust either has no relationship to PTSD (R. Ojserkis, personal communication, February 15, 2018; van Delft, Finkenauer, Tybur, & Lamers-Winkelmann, 2016) or a positive relationship (Arocho, 2015), sexual disgust has either no relationship or a positive relationship to PTSD (R. Ojserkis, personal communication, 2017, and van Delft et al., 2016, respectively), and moral disgust either does not correlate or has a negative relationship with PTSD symptoms (Arocho, 2015; Ojserkis et al., 2014; van Delft et al., 2016).

It may be that this inconsistency is due to the relationship between disgust and PTSD varying by the nature of the initial traumatic event. One well-supported possibility is that the disgust-PTSD link is particularly strong in cases in which the precipitating trauma was of a sexual nature.² In a sample of adolescents who

had been assaulted, individuals whose assault was sexual in nature were 6 times more likely to report having felt peritraumatic disgust than those who had been assaulted in a nonsexual way (Feldner, Fraia, Badour, Leen-Feldner, & Olatunji, 2010). Likewise, Badour, Feldner, Blumenthal, and Bujarski (2013) observed that phenomenal characteristics of disgust—such as urges to wash, reported feelings of mental contamination, and feelings of dirtiness—increased following a script-driven reactivation of trauma memories, but only when the traumatic event was sexual in nature.

Other work has linked disgust or disgust-related cognitions to sexual trauma PTSD or severity of posttraumatic symptoms, albeit without comparing it with other types of traumatic stressors. Women with PTSD who were sexually assaulted as children report feeling more disgust at cues of their traumatic incident than do childhood sexual abuse survivors who did not develop PTSD (Shin et al., 1999). In addition, in a study by Badour and Feldner (2016), women with a history of sexual assault were treated using imaginal exposure therapy with disgust- and fear-relevant cues. For participants whose trial-by-trial anxiety was already decreasing as a result of the exposure, trial-by-trial changes in disgust predicted a decrease in PTSD symptoms. This finding suggests that changes in the disgust experience of trauma-exposed patients can increase the explanatory power of models predicting PTSD symptoms. In some cases, the relationship between disgust and PTSD symptoms following sexual trauma seems to be associated with feelings of “mental pollution” or “mental contamination”: persistent feelings of dirtiness despite no recurring physical contact (Fairbrother, Newth, & Rachman, 2005) that may arise from the internalization of disgust (or self-disgust) following sexual assault (Olatunji, Babson, Smith, Feldner, & Connolly, 2009). A study that focused only on women with a history of sexual assault found that disgust sensitivity predicted posttraumatic stress indirectly through mental contamination feelings (Badour et al., 2013). This finding accords with the study by Fairbrother and Rachman (2004), who found that sexually assaulted women reported urges to wash subsequent to their traumatic event and found a positive correlation between feelings of contamination and PTSD symptoms.

If disgust primarily plays a role in PTSD when the traumatic event was associated with sex, it is possible that this link can be isolated and investigated by looking at the individual difference in disgust propensity that is sensitive to sex: for the cultural evolution model, animal-reminder disgust, and for the adaptationist model, sexual disgust. If, for instance, sexual disgust is essentially the same construct as disgust at other elicitors of animal-reminder disgust (e.g., hygiene, mutilation), then

hyperactive disgust at any of the elicitors under the relevant umbrella might serve as a measure of risk factors for the development of PTSD following sexual trauma. In contrast, if sexual disgust is a construct distinct from moral and pathogen disgust, clinicians will be able to use an appropriately sensitive psychometric (e.g., the sexual-disgust subscale of the TDDS) to identify those recent sexual assault victims who are at special risk for developing PTSD, allowing targeted interventions early on. Future studies must account for the nature of the precipitating traumatic event and sample various subtypes of disgust to create a framework for the more effective treatment of PTSD.

Discussion and Conclusion

Prominent theories of disgust focus on elicitor categorization as an organizing principle, but given the current research, it remains unclear how to organize these elicitors most usefully into superordinate domains. In this review, we set out to investigate the following question: If individual differences in disgust influence the manifestation or severity of some subset of psychiatric disorders, how do these variable sensitivities to disgust correspond to the adaptive structure of disgust? On the basis of the synthesis above, we suggest that neither of two eminent theoretical models of disgust is wholly consistent with the aberrant disgust responses characteristic of three notable examples of psychopathology. If either model did, we would expect sensitivities to all of the elicitors within a given domain to covary together.

Instead, we saw that the psychiatric diseases discussed above related to sensitivities to some of the elicitors within a domain but not others. We propose a modification to the structure of disgust domains based on analysis of the three psychiatric disorders in this review (see Fig. 2). Specifically, organizing the disgust elicitors according to contamination OCD, BII phobia, and PTSD results in at least five covarying elicitor subsets (i.e., domains) that a comprehensive theory of disgust must account for: one that includes food; one that includes body products, animals, contamination/interpersonal contact, and hygiene; one that includes body-envelope violations and death; one that includes sex; and one that includes moral disgust. This proposed functional structure of disgust is somewhat consistent with the adaptationist model, except that it identifies multiple functional groupings within that theory's pathogen-disgust domain. Note that this conclusion is based only on a small subset of psychiatric disorders with relevance for disgust, for which research is largely still in nascent stages. Future work would be expected to provide more clarity to this debate. Notwithstanding,

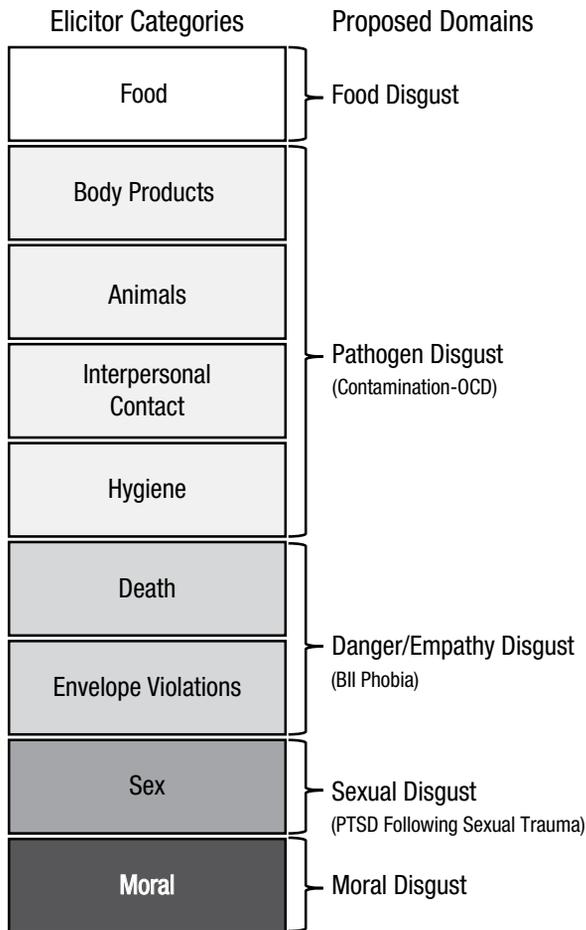


Fig. 2. Proposed domain structure of disgust according to the synthesis of clinical literature presented in this article. Shading corresponds to the proposed domains. c-OCD = contamination subtype of obsessive-compulsive disorder; BII phobia = blood-injection-injury-specific phobia; PTSD = posttraumatic stress disorder.

if future research further supports this conceptualization, it would have important clinical implications in that disorders for which disgust is a core component had been missed because of low scores on measures developed in accordance with the cultural evolution or adaptationist models (e.g., food disgust in avoidant restrictive food intake disorder; Harris et al., 2019).

The cultural evolution domain of core disgust, which suggests that the propensity to be disgusted by body products and interpersonal contact should covary with the propensity to be disgusted by food and animals but not hygiene violations, does not appear to correspond to the clinical literature on contamination OCD because contamination OCD is associated primarily with heightened sensitivity to core-disgust elicitors (except for food) and to hygiene-related elicitors of disgust (but much less so, or not at all, with the other animal-reminder elicitors). The adaptationist model does not fare much better: Whereas an adaptationist approach

would suggest that contamination OCD would be related to pathogen avoidance, the disease is frequently associated with some pathogen-disgust elicitors (animals, body products, hygiene, and interpersonal contact) but not reliably with others (food, body-envelope violations, or death). This confluence of elicitor-specific propensities in contamination OCD may suggest the existence of a latent mechanism that responds specifically to animals, body products, contamination, and violations of hygiene. One potential explanation for this cluster of heightened disgust propensities is the recently suggested domain of “contact” disgust, distinct from disgust at food (Lieberman & Patrick, 2018).

As Tybur and colleagues (2013) pointed out in the original formulation of the adaptationist theory of disgust, infection can occur by several routes, including ingestion and skin-to-skin contact. Curtis and de Barra (2018) found that disgust ratings at particular varieties of disease transmission tend to correspond to the specific disease-avoidance behavior that reduces infection risk. Such an idea is consistent with the perspective of the present review: It may be that there are unique domains for food disgust and a broader contact/hygiene domain (which would include animals and body products; see Fig. 2) because there is a disgust domain related to avoidance of ingestion and a distinct domain related to avoidance of contact.

Likewise, BII symptoms are predicted by disgust propensity for body-envelope violations and death but not other animal-reminder elicitors (and not all pathogen elicitors). This finding may suggest that body-envelope violations and death elicitors form an independent domain of disgust, unique from other animal-reminder- or pathogen-related elicitors—a structure that is suggested by neither the cultural evolution model nor the adaptationist model. Recent work by Kupfer (2018) supports this idea. In a factor analysis of items from the TDDS as well as additional body-envelope-violation-related items, injuries were found to load onto their own factor separate from pathogen disgust. Kupfer goes on to argue that the label “disgust” is being applied to “unpleasant vicarious feelings of pain” (p. 967). Kupfer’s findings that the response to “disgusting” injuries is fundamentally different from the response to more straightforward pathogen vectors reinforce the findings from the literature on BII phobia.

If it is the case that body-envelope violations and death constitute a single domain, it raises an interesting challenge for theorists attempting to account for the evolutionary function of disgust: Specifically, what additional adaptive purpose is served by having an alternate mechanism to avoid pathogens that originate from body-envelope violations and death, uniquely from other pathogens? We suggest one possibility, which is

that the behaviors favored in situations involving elicitors of this putative disgust domain might involve fleeing danger in addition to avoiding parasites. Although other pathogen-relevant elicitors of disgust should be avoided, fleeing from elicitors in the categories of body products, hygiene, or animals may be distinctly maladaptive. Alternatively, events or scenes involving such elicitors as wounds, lesions, corpses, or dismembered limbs might stimulate some interaction of disgust with fear, and natural selection might favor a behavioral response that includes both avoidance of contact with potential pathogens and fleeing the immediate area. Note that Curtis and de Barra (2018) found that different kinds of responses to pathogens appeared to cluster into factors relating to the specific behavior deployed to avoid disease (as opposed to the transmission route of the pathogen). It is possible that as an affect that responds to danger, fear might easily be recruited to motivate adaptive behavior in the face of the situations precipitating a body-envelope violation.

Another, perhaps parallel, possibility is that an adaptationist theory of disgust need not have a specific functional account for each disgust domain. It is possible that body-envelope violation “disgust” is actually an evolutionary spandrel, or a phenotypic by-product of other traits with functional significance (Gould, 1997)—in this case, the capacity to mentally simulate pain. This idea is supported by the fact that Kupfer’s factor analysis generated one common factor for both bloody and nonbloody injuries (an example of the latter case is a badly twisted ankle). In other words, the response was still marshaled even when injuries were not direct pathogen vectors in and of themselves, a phenomenon not explained by a combined fear and disgust response.

Finally, our review found that sexual assault survivors who ultimately develop PTSD symptoms tend to have aberrant disgust responses to sexually relevant stimuli and not necessarily to nonsexual-disgust stimuli. The development of psychopathology is often described as following a *diathesis-stress* model (see Meehl, 1962): In other words, some psychiatric diseases emerge from the combination of a stressor (a life history event or series of events) and a diathesis (a predisposition, such as trait sensitivity, which renders the individual vulnerable to the disorder). PTSD has been described as following such a model (Bomyea, Risbrough, & Lang, 2012; McKeever & Huff, 2003). One reading of the literature discussed above is that sexual disgust is the diathesis for PTSD, and the stress is the traumatic sexual experience. Following the logic of our previous suggestions, it might be concluded that there is a disgust domain with a functional association with sex, per the adaptationist model. It is necessary for future work to

examine the selectivity of the disgust-PTSD relationship to support this assertion. At present, very few studies have examined the differences in disgust domains for people with PTSD, and only one study specifically deals with PTSD stemming from sexual trauma (van Delft et al., 2016); even then, the trauma was vicarious (symptoms in nonoffending mothers of sexually abused children). Notably, this last study found a positive association between sexual disgust and PTSD symptoms. Therefore, future work should not only assay the different putative disgust domains but also identify the nature of the traumatic event. If future PTSD research can be used to demonstrate that there is a sexual-disgust domain, we might expect it to be because sexual disgust corresponds to PTSD symptoms following sexual trauma.

We wish to address several potential objections to our line of thinking about the relationship between psychiatric symptoms and disgust propensity as measured by existing psychometric instruments. The first potential objection deals with the possibility that the epistemic differences between the two models make it challenging to use the psychometric instrument of one model to test the assumptions of the other. In other words, because the Disgust Scale was created under a different conceptual framework from the TDDS, the results from studies using the Disgust Scale do not explicitly test the adaptationist model, and the adaptationist model does not explicitly test the results from studies using the Disgust Scale.

A notable example of this potential problem is that most of the death and envelope-violation items on the Disgust Scale do not plausibly suggest an immediate pathogen threat but, rather, suggest a conceptual relationship to a potentially disgusting category (e.g., “I would go out of my way to avoid walking through a graveyard”). This discordance among the theories raises the question of whether the conceptual similarity of an item/stimulus to a disgusting category is what demarcates whether it belongs to a given disgust domain. Certain items on the Disgust Scale may not appropriately test the adaptationist model because they might fail to access the actual latent adaptationist model construct, and certain items on the Three Domains of Disgust Scale may not be appropriate tests of the latent constructs within the cultural-evolution model. This possibility is especially germane to the present analysis because we have argued above for a potential nonpathogen function for disgust at death/body-envelope violations: Can a nonpathogen-related death item be used to evaluate the membership of death disgust in a putative pathogen domain?

In one sense, our approach is limited by the inability to directly compare the models at all points. However,

in another sense, the data speak for themselves: If there is a relationship among items that are conceptually related to death and items that are related to potentially infectious envelope violations, then the adaptationist model would be strengthened by addressing the way conceptual associations realize ultimate adaptive functions or explaining why this relationship exists. In either case, the questions raised by the present analysis suggest important future directions in refinement of the theoretical models. For instance, it may be necessary to specify whether a given elicitor category always falls under the purview of a given domain; perhaps a death-related stimulus is disgusting for reasons of pathogen avoidance in some cases yet disgusting in other cases for other reasons, such as those we have delineated above. Tybur and colleagues (2013) somewhat anticipated this possibility in their formulation of the adaptationist theory by noting that the functional contexts of different disgust experiences may be more appropriate to focus on than elicitor clustering, despite the fact that these elicitor clusters tend to map onto functions. Considering our analysis, we encourage disgust theorists to move forward with this approach.

Another potential objection is that the relationship between disease and specific elicitors of disgust could be accounted for by a learned association between some psychiatrically relevant stimulus (e.g., trash, a syringe, sexual contact) and a feeling of disgust. In other words, it could be argued that an aberrant sensitivity to a particular kind of disgust does not render the individual vulnerable to the development of disease; instead, the heightened disgust response to certain objects comes about as the result of a learned association between disgust and the object. In cases in which this is true, it would not be appropriate to draw conclusions about how to parse disgust according to its evolutionary foundations because the relationship between disgust and psychiatric symptoms occurs within a person's life history. A disgust response at one particular elicitor can certainly be learned. For instance, a person may experience the unfortunate outcome of the Garcia effect after eating a previously enjoyed food and subsequently becoming sick (Garcia, Kimeldorf, & Koelling, 1955) without that disgust response necessarily generalizing to other elicitors within a latent disgust domain.

However, as long as predispositions to aberrant disgust domain sensitivities affect psychiatric disease risk, this learned disgust explanation does not threaten the structure of the argument that we are making. If a particular association between a kind of disgust elicitor and a particular psychiatric disease exists solely because the disgust response is conditioned in response to psychiatrically relevant stimuli, we do not necessarily

expect responses to other elicitors within that domain to covary with responses to the psychiatrically relevant elicitor. Rather, we expect that individual risk of psychiatric disorders results from an interaction between predispositions that result from individually variable innate general sensitivities (which covary according to an evolved domain structure), culturally transmitted sensitivities to specific stimuli, and individually learned and conditioned sensitivities to specific stimuli.

Given the large amount of cultural input in the shaping of individual disgust differences (Rottman, 2018), we expect that life histories of individuals play a large role in the etiology of the conditions discussed in this review and other disorders that involve disgust. In addition, individual variability in sensory perception, interoception, and any number of other steps in the pathway from encountering a disgust elicitor to recognizing the emotion in oneself could account for individual differences in disgust independent of the model we have proposed here. However, the evidence we have marshaled supports the idea that predispositions to respond aberrantly may indeed exert a causal influence on the development of psychiatric disorders (see also Olatunji et al., 2017).

One example worth highlighting is a study by Shin et al. (1999), who observed that among women exposed to the same class of potentially traumatic events (childhood sexual abuse), those who developed PTSD had higher rates of disgust at reminders of their traumatic event than those who did not. If the relationship between sexual disgust and PTSD following sexual trauma were solely a function of acquiring a particularly heightened association between sex and disgust as a result of childhood sexual abuse, we could predict that the whole population of individuals exposed to childhood sexual abuse would learn that disgust response to sex. Instead, the picture more resembles a population in which differing capacities to learn a disgust response to sex predict symptoms when the stress is held constant, which is consistent with the idea that a predisposition to elevated sexual-disgust sensitivity could play a causal role in the development of PTSD in this case.

Future work could consider how research on psychiatric disorders can contribute to a data-driven theory of disgust that can explain what unifies the diverse elicitors, following the principles and process that we have outlined. This proposed work will likely require developing or adapting metrics of disgust sensitivity and propensity for use in psychiatric populations on the basis of several alternate models of disgust function and evolution.

A major barrier to progress is that the field still lacks a comprehensive operational definition of disgust.

Currently, affective scientists differ in the criteria they use to classify a psychological or neurobiological phenomenon as an emotion, and consequently, disgust is empirically conceptualized in different studies at the expressive, physiological, and neural levels (Harrison, Gray, Gianaros, & Critchley, 2010; Vrana, 1993). To verify a particular clustering of disgust domains or to find whether a patient's disgust is responding to a clinical intervention, one must definitively measure when disgust is occurring in the first place. Such a consensus would simplify future inquiry in this field and might have broad-reaching implications for treatment and prevention of psychiatric disorders (McKay, 2006). Thus, a unified operational definition should be a goal of basic and clinical disgust researchers.

Another goal of future research should be to assess the role of taxonomies of disgust elicitors within a larger theory of disgust. Although the present models are based on accounting for the diversity of elicitors of disgust, other crucial elements of a comprehensive theory of disgust may not be extrapolated merely from an elicitor-clustering scheme, such as the putative relationship between disgust and sympathetic magic in general, and contamination in particular. For example, the cultural evolution model notes that disgust elicitors tend to impart a feeling of contamination, irrespective of the domain of disgust to which the elicitor belonged. In the cultural evolution model's psychometric instruments, contamination is treated as an additional domain of disgust by composing its own subscale, although it is different in kind from subscales based on the propensity to feel disgust at a given kind of elicitor. It is certainly useful to track the cognitive tendency to be sensitive to, or be likely to have, feelings of contamination, especially when assessing the relationship between disgust and psychiatric symptoms. For instance, Tolin, Worhunsky, and Maltby (2004) showed that patients with OCD and a primary obsession with contamination maintained an appraisal of contamination along a "chain of contagion" (i.e., a disgusting item is put into contact with a new item, which is then put in contact with a new item, etc.) to a greater degree than anxious patients without OCD and healthy control subjects. Because this symptom has discriminant validity for contamination-related OCD as opposed to other anxiety disorders, and because it represents potentially debilitating ramifications for the patient, it seems important that a comprehensive model of disgust incorporate contamination, even though contamination is not unique to any particular domain of disgust.

In addition, a better understanding of contamination and other cognitions as part of an elicitor-general dimension of a disgust model may help to more accurately characterize the elicitor domains. For example,

in some studies, a relationship has been shown between feelings of contamination and moral concerns or emotions: Melli et al. (2015) found that individual differences in disgust mediated the relationship between the morally valenced emotion guilt and contamination fear, despite the fact that moral disgust is not straightforwardly related to pathogen transmission. The cultural evolution model posits that a feeling of contamination can be imparted by disgust elicitors of any domain, so Melli and colleagues' finding is not surprising. However, if contamination is thought to be the purview of pathogen disgust in the adaptationist model, then it is perhaps unexpected that contamination fear is related to a moral emotion, via the mediator of disgust propensity. This relationship is particularly challenging for the adaptationist formulation of disgust in light of Poli and colleagues' (2019) finding that moral disgust does not show an association with sensitivity to contact contamination. In summary, if morally valenced stimuli are related to contamination concerns via individual differences in disgust, but moral disgust is not related to contamination concerns, it is difficult to characterize the relationship between moral disgust and contamination. This discrepancy could be resolved in future work by adaptationist theorists to more precisely describe the nature of the relationship between moral cognition and disgust: For example, why is it that certain morally valenced elicitors cause moral disgust, whereas others do not?

One important reason to ensure that a basic science framework of disgust is consistent with evolutionary theory is that an evolutionary paradigm can help to generate hypotheses about how psychological and psychiatric traits change over time, which can offer insights into interventions or treatments. In particular, many evolutionary medicine researchers have suggested that social changes may have caused an increase in the development of certain psychiatric disorders in a population (see Nesse & Williams, 1994). For example, changes to social norms, hygienic conditions, warfare tactics, and medical techniques may present new elicitors to which disgust systems did not evolve to respond. This mismatch between the evolved elicitors of disgust and the elicitors of disgust in the modern environment could be partially responsible for the prevalence of some disgust-related psychiatric disorders. The psychiatry of populations with more traditional lifestyles is not well understood compared with that of developed, industrialized cultures but could provide insight into these questions.

Finally, we point out that there is a potential reciprocal relationship between the basic science and psychiatry of disgust: Just as clinical science can help to evaluate and adjudicate theoretical models of disgust,

an improved understanding of the basic science of disgust may have exciting potential to further inform clinical research and interventions into disgust-relevant disorders. If we can elucidate the ultimate causes of disease, then efforts can be made to identify avenues of intervention for prevention and treatment. For example, on the basis of the predictions of a particular disgust theory, an individual with elevated disgust sensitivity to a particular set of elicitors may be at increased risk of developing a specific psychiatric disorder (or set of psychiatric disorders). If clinicians are aware of each patient's individual risk factors, they may be able to prevent progression of an at-risk patient to disordered symptoms.

Likewise, in populations with a high risk of exposure to stress or trauma, baseline disgust sensitivities may help predict which individuals would be vulnerable to the development of a disorder. In this example, it is possible to imagine interventions not only from the perspective of treating an individual but also in terms of policies or societal changes that could have broad-reaching effects (Nesse, 2001). Research on disgust and contamination OCD has led to many recommendations for treatment. Findings of slower rates of habituation to disgust in patients with contamination OCD should inform exposure treatments (McKay, 2006), and the findings of attentional bias studies suggest that attention training should constitute an important part of contamination-OCD treatments (Berle et al., 2012; Cisler & Olatunji, 2010). These observations in contamination OCD parallel the findings in the PTSD literature discussed above, in which decreasing disgust over the course of exposure treatments predicted decreasing posttraumatic stress symptoms in patients for whom anxiety was already decreasing (Badour & Feldner, 2016). Specific treatment of disgust, and perhaps of one disgust domain (if domains covary relatively independently), may have more successful outcomes for patients.

In sum, we argue in this review that clinical research and basic research on disgust have important contributions to make to one another. As new models of disgust function are developed, the clinical research community should evaluate whether such models extend any utility for understanding disgust sensitivities that accompany psychiatric disorders. Similarly, researchers of questions surrounding basic disgust function should consider how their theoretical claims apply to psychiatric populations because perturbed systems can offer particular insight into how systems function normally, and including psychiatric populations in research increases the available variation in disgust sensitivities compared with normal populations alone. Understanding the adaptive functions of disgust will make clear

how individual differences in disgust can be perturbed, to eventually target the specific domain of disgust that contributes to a disorder in treatment, a process that would be less easily instated if disgust domain boundaries are drawn too broadly or too specifically around elicitors. Clarifying the definition and theory of disgust through collaboration between psychiatric and theoretical disgust research will impose structure on the currently contentious and incomplete literature on disgust structure and function.

Action Editor

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Author Contributions

Authors are listed in alphabetical order. C. R. Amoroso and E. K. Hanna are joint first authors; they developed the study concept and wrote the manuscript. All of the authors provided conceptual feedback, contributed to editing the manuscript, and approved the final manuscript for submission.

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Notes

1. The RDoC framework focuses on negative affect as a primary dimension of psychopathology (Insel et al., 2010). That disgust can vary over time within an individual, independently of variation in negative affect within an individual over the same period (Olatunji et al., 2010), suggests that it may be useful for RDoC dimensions to focus on specific categories of emotional experience rather than on a global construct of negative valence.
2. Evidence suggests that PTSD and disgust can be linked in other contexts as well, most notably in the population of soldiers and combat veterans (e.g., Engelhard et al., 2011). The present review focuses on sexual trauma PTSD because of our aim of comparing the cultural evolution model and adaptationist model: Because sexual disgust is a construct in and of

itself for the adaptationist model framework, PTSD in the case of sexual trauma presents a useful case study for adjudicating between models. Furthermore, the existence of a link between sexual trauma, PTSD, and disgust does not preclude the possibility that PTSD and disgust might interact in other ways, some of which may be more relevant to the cases of PTSD in members of the armed forces.

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