OCD: obsessive–compulsive … disgust? The role of disgust in obsessive–compulsive disorder

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Recent research has identified the important role of disgust in the symptomatology of obsessive–compulsive disorder (OCD). Exaggerated and inappropriate disgust reactions may drive some of the symptoms of OCD, and in some cases, may even eclipse feelings of anxiety. This paper reviews behavioural and neuroimaging research that recognizes the prominent role of disgust in contributing to OCD symptoms, especially contamination-based symptoms. We discuss how elevated behavioural and biological markers of disgust reported in OCD populations support the need for alternative clinical treatment strategies and theoretical models of OCD.

Introduction

Obsessive–compulsive disorder (OCD) is a chronic and debilitating disorder characterized by the presence of obsessions and compulsions that cause substantial distress and functional impairment, or that are time-consuming. Traditionally, OCD has been considered an anxiety disorder, but recent research has demonstrated that anxiety may not be the primary emotional process that drives the symptoms of OCD, as there are considerable phenomenological differences between OCD and other anxiety/fear disorders (see the review by Bartz and Hollander[1]). Indeed, in the most recent edition of the *Diagnostic and Statistical Manual of Mental Disorders*, OCD was removed from the anxiety disorders section and classified under its own section.[2] Additionally, the amygdala, an important region in the fear and anxiety circuitry, is not commonly implicated in the pathophysiology of OCD.[3] There are, however, several lines of evidence, both behavioural and neurofunctional, that point to a significant role of disgust in the symptomatology of OCD, as many patients report that they experience intense feelings of disgust during symptom provocation and often describe symptom-relevant stimuli as "disgusting" rather than "frightening."[4]

Disgust is a universal emotion characterized by the feeling of revulsion or profound disapproval of something unpleasant or offensive.[5] Disgust was originally hypothesized to have an evolutionary function of contamination and disease avoidance, associated with rejecting bad tastes to avert the ingestion of toxins and pathogenic microbes,[6,7] though it is now hypothesized to serve a more general protective function.[8,9] Disgust is characterized by a distinct facial expression (raising of the upper lip and wrinkling of the nose and brows), which may serve to protect the eyes and nose from contaminants. The stimuli that evoke disgust are perhaps the most diverse of any human emotion,[7] ranging from dirty restrooms to unappetizing food to much broader conceptualizations, including responses to poor hygiene, violations of the normal body envelope and moral transgressions. Disgust is also characterized by aversion behaviour and the tendency to distance oneself from the offensive stimulus. It can also involve activation of the parasympathetic nervous system, resulting in physiologic manifestations (e.g., nausea).[7]

Patients with OCD often exhibit exaggerated judgments with regards to infection and contamination vulnerabilities, which elicits washing and cleaning compulsions. Contamination worries are one of the most common themes associated with OCD, accounting for approximately 55%–65% of concerns reported by patients.[10] Since disgust involves the appraisal of objects for their potential to be harmful, contamination-based OCD may represent a dysfunction in this appraisal process, resulting in a false contamination alarm and an overestimation of the consequences of contacting contaminants. These dysfunctional cognitive appraisals may then motivate individuals with OCD to engage in compulsive avoidance and/or neutralizing behaviours (e.g., excessive washing), which temporarily alleviates the distress associated with the obsessions, causing the compulsions to become negatively reinforced.[11] Alternatively, it has been proposed that some patients with OCD who have contamination worries are not fearful that contamination will cause

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harm, but instead engage in avoidance and neutralizing behaviours to eliminate the feeling of disgust,[12] thus emphasizing the difference between harm avoidance and disgust avoidance. The following sections will highlight behavioural and neuroimaging research that demonstrates the role of disgust in patients with OCD. Disgust may also play a significant role in other OCD symptom dimensions, but this paper will primarily focus on contamination-based OCD owing to the plethora of disgust research on this symptom dimension.

Behavioural research

People vary in the degree to which they are likely to experience revulsion in response to disgusting stimuli, termed disgust propensity (DP; i.e., the frequency and/or intensity of which one generally responds with disgust). Individuals with elevated disgust propensity are more likely to be easily disgusted by a range of objects and situations.[13] Disgust sensitivity (DS) refers to the degree of negativity associated with the elicitation and experience of disgust. Increased sensitivity to disgust would have the effect of increasing the salience of the disgust response and would therefore increase the motivation to avoid situations in which disgust is possible.[14] Together, DP and DS are 2 distinct types of disgust-based vulnerabilities that have been hypothesized to contribute to the development and maintenance of contamination-based obsessions and compulsions.[15]

Studies have found that both DS and DP are significantly higher in OCD groups[16,17] than in anxious and nonanxious controls,[18] whereas other studies have reported that either DS[13,15] or DP[19–21] alone is higher in patients with OCD. Medium-strength associations have been reported between measures of DS, DP and OCD severity, even when controlling for anxiety.[22] In an effort to further determine the extent to which disgust vulnerabilities underlie OCD, Olatunji and colleagues[19] compared disgust scores among patients with OCD, patients with generalized anxiety disorder (GAD) and healthy controls. Although patients with OCD and GAD did not differ significantly in DS, they both had significantly higher DS than healthy controls. Disgust propensity on the other hand, was significantly higher in the OCD group than the GAD and control groups. This difference could suggest that elevated DS is associated with anxiety in general, but that DP is more specific to OCD and may therefore serve as a better diagnostic indicator of OCD. Furthermore, DP has been found to be reduced after successful behavioural treatment, with reductions in OCD severity correlating with reductions in DP scores.[19] Correlated reductions in DP and contamination-based symptoms have been replicated by other studies.[21,23]

Although many studies have examined disgust vulnerability in patients with contamination-based OCD, it remains unclear how DS and DP relate to the other symptom dimensions. Studies have reported that disgust scores significantly correlate with OCD symptoms of checking and symmetry/ordering, but it is unknown why this is the case.[20,24–26] Perhaps in patients with symmetry/ordering symptoms, feelings of disgust may be associated with perceived messiness or disorganization. Furthermore, individuals with sexual/religious obsessions may experience self-directed moral disgust in response to unwanted mental intrusions, triggering the performance of compulsions and counterproductive attempts at thought suppression. Indeed, DS appears to be a predictor of religious obsessions,[27] and scores on morality-based disgust domains are strongly associated with the religious/sexual symptom dimension.[28] In a study assessing moral rigidity in patients with OCD, increased DS and DP scores were associated with increased likelihood of choosing utilitarian solutions to personal dilemmas, demonstrating the role of self-disgust in shaping behaviours and decisions in this clinical population.[29] Taken together, this information suggests that the relevance of DS and DP is not limited to contamination-based OCD; rather, DS and DP may act as vulnerability factors for the development and maintenance of all symptom subtypes, though more research in this area is needed.

When trying to understand the role of disgust in OCD, the laws of sympathetic magic are very useful. Sympathetic magic is defined as implausible beliefs about how contaminants are transmitted and comprises 2 laws: the law of contagion and the law of similarity.[4] The law of contagion refers to the belief that brief contact with an object causes a permanent transfer of properties (e.g., refusing to eat from a plate that once had a worm on it, even though it has since been washed). The law of similarity suggests that mere resemblance to a disgusting object can cause a neutral object to carry an infectious threat value (e.g., refusing to eat chocolate because it is shaped like feces). Sympathetic magic beliefs have been found to be significantly elevated in patients with OCD. In one study, investigators touched a clean pencil to an object that patients with OCD identified as contaminated.[4] A second pencil was touched to the first pencil, a third pencil was touched to the second pencil, and this was continued for 12 pencils. Patients with OCD perceived a chain of contagion, in which successive degrees of removal from the original object did not diminish or dilute the contamination. Controls and individuals with panic disorder, on the other hand, demonstrated nearly 100% reduction in contamination beliefs across pencils. This experiment was repeated with a non-threat contamination trial in which pencils came into contact with a clean piece of candy instead of a contaminated object. All participants reported that the candy was not transmitted across pencils, indicating that the chain of contagion in patients with OCD is unique to contamination-related stimuli.[4] This suggests that individuals with OCD have a much higher threshold for deciding when something has been diluted sufficiently, so that the chain of perceived contamination can continue indefinitely. Nevertheless, even though patients with OCD may have exaggerated behavioural responses to disgusting stimuli, they may not have stronger physiologic disgust reactions than healthy controls. This was demonstrated in a study where medicated patients with OCD did not exhibit greater activity of the corrugator supercilii and levator labii superioris (muscles responsible for eyebrow furrowing and raising of the upper lip, respectively) than healthy controls in response to disgust-eliciting stimuli.[30] However, this study should be replicated in a larger, unmedicated sample before conclusive results are drawn.

Contamination-based OCD is commonly characterized by avoidance and escape behaviours, demonstrated in the literature using behavioural avoidance tasks (BATs). In a BAT study by Olatunji and colleauges,[31] fear and disgust habituation rates were compared in a sample of participants scoring high in contamination symptoms. The BAT consisted of 10 tasks increasing in difficulty, culminating with participants having to clean out a bedpan that they believed to be filled with urine. There were no significant differences between fear and disgust ratings at the start of the experiment. However, as the tasks progressed, there were significant reductions in fear, but interestingly, disgust levels did not significantly change.[31] These findings support research indicating that there are important differences in the course of fear and disgust in patients with OCD, with the experience of disgust being more resistant to extinction than fear.[32] This has direct implications on exposure and response prevention (ERP) therapy, which operates on the principle of habituation through the gradual exposure of feared stimuli and the extinction of corresponding compulsions via response prevention. It is estimated that 50% of patients do not respond, drop out or refuse ERP intervention,[33] and 75% of patients who do complete treatment exhibit residual symptoms. For those who do find ERP effective at reducing disgust reactions, gains are usually slow and are often not long-term.[34] These results highlight the importance of incorporating various facets of disgust into exposure-based treatments because clinically meaningful symptom reductions may depend on adequately extinguishing feelings of disgust. Several studies have reported significant associations between reductions in DP scores and symptom improvement in adults[21,35] and children[23] post-treatment. Therefore, identifying strategies that effectively target disgust may not only reduce symptoms, but may also reduce costs, dropout rates and duration of treatments. One such proposed strategy involves differentially using behavioural and cognitive strategies for patients who score high in DP and DS, respectively, to reduce heightened disgust reactions and the negative emotions related to disgust.[36] As well, Ludvik and colleagues[37] have suggested using counterconditioning and revaluation techniques, whereby conditioned and unconditioned stimuli, respectively, are paired with unconditioned stimuli of the opposite valence. However, the efficacy of these strategies has not been evaluated in OCD populations.[37]

Contamination-based OCD is also characterized by a relatively new construct, mental contamination. Mental contamination refers to the feelings of internal dirtiness and urges to wash that arise without contact with a physical contaminant.[38] The prevalence of mental contamination in patients with OCD has been reported in different studies to be 46.3%[39] and 61.9%,[40] with some patients reporting only mental contamination, only contact contamination, or both, illustrating the overlapping but distinct contamination constructs. Mental contamination has also been found to correlate significantly with measures of DP in patients with OCD, suggesting that mental contamination plays an important mediating role in contamination-based OCD symptoms[40,41] and therefore must be specifically targeted when developing treatment strategies.

Facial emotion recognition tasks are a common method for studying emotional deficits in clinical populations, including OCD. Several studies have reported that when compared with healthy controls and patients with panic disorder and GAD, patients with OCD exhibit impaired recognition of disgust, but normal recognition of other facial expressions, including fear,[42,43] which has been confirmed in a recent meta-analysis.[44] These results are counterintuitive, as one might expect that individuals with OCD would be very good at recognizing facial expressions of disgust, especially since they seem to experience disgust more readily than those without the disorder. One possible explanation is that patients with OCD learn to associate feelings of disgust with a broader range of facial expressions as they are more likely to perceive stimuli to be disgusting than people without OCD, which may decrease their ability to accurately appraise expressions of disgust. In another study, disgust recognition scores for a treated sample of patients with OCD were not only significantly better than those of an untreated OCD sample, but also equivalent to scores from a standardized nonclinical sample.[45] This implies that disgust recognition deficits can be improved following treatment.

Most facial recognition studies use nonambiguous facial expressions; however, ambiguous facial expressions are useful as they can reveal whether individuals have a perception bias toward a certain emotion. An interesting study by Jhung and colleagues[46] reported that when compared with controls, patients with OCD were significantly more likely to perceive disgust and less likely to perceive anger in ambiguous facial expressions even though there were no significant differences between the 2 groups when identifying nonambiguous facial expressions. Additionally, higher OCD severity and DS scores predicted whether patients perceived faces as disgusted.[46] Ambiguous expressions are more representative of everyday occurrences, and if patients with OCD perceive them as being disgusted, this may contribute to cognitive and behavioural responses, including obsessing and ritualizing.

Neuroimaging studies

Disgust

Functional neuroimaging studies have contributed substantially to the literature on emotions, allowing us to better appreciate the neuronal underpinnings of dysfunctional emotion processes. Initial research on disgust provided evidence that viewing the canonical disgust expression activated the anterior insula when compared with viewing neutral facial expressions (see the reviews by Chapman and Anderson[47] and Stein and colleagues[48]). This finding is very robust, with a meta-analysis of 105 fMRI studies confirming the association between disgust facial perception and activation of the anterior insula.[49] The importance of the insula in processing disgust is further strengthened by studies that have reported similar regions of the anterior insula are activated when participants view disgusting photos,[50] smell unpleasant odors[51,52] and taste unpleasant liquids.[50] For example, researchers found that inhaling offensive odors activated the same sites

on the anterior insula and anterior cingulate cortex (ACC) as watching video clips of disgusted facial expressions, suggesting that there is a common pathway for experiencing disgust and watching others experience it.[51] An investigation using unpleasant tastes produced similar results.[50] These matching patterns of activation in the insula, via mirror neurons, indicate that we understand others' emotions by activating similar emotions within ourselves. As well, different disgust categories (e.g., core disgust, blood-injury disgust, animal disgust) seem to result in partly overlapping activations of the insula, which might reflect a common disgust experience.[47] The insula is involved in emotional responses to potentially distressing cognitive stimuli, body sensations and interoceptive sensory stimuli, which could explain why the insula is activated in response to a broad range of disgust stimuli. It is part of the gustatory cortex and contains neurons that respond to pleasant and unpleasant tastes,[48] thereby playing a role in the avoidance of rotten food and bitter toxins. Because the insula responds to different sensory modalities, it is able to function as an all-purpose "disgust alarm centre." Additionally, the insula is interconnected with numerous cortical regions[53] that allow it to integrate information about the environment and the body's internal states.

While activation of the insula is one of the most consistent neuroimaging findings in the disgust literature, the basal ganglia — specifically the striatum — has also been implicated. Functional MRI studies of disgust facial perception have often reported activation of the caudate and putamen, in addition to the insula.[50,51] Increases in basal ganglia activity have been reported in fMRI studies using disgust-inducing photographs,[51,54] facial expressions of disgust[55,56] and in fMRI studies that encouraged participants to recall events that evoked feelings of disgust.[57] The importance of the basal ganglia in the recognition of disgust was also demonstrated in a study in which carriers and patients with Huntington disease, a disorder involving the striatum, displayed impairments in facial recognition of disgust, but not other emotions.[58] Impaired disgust recognition is also present in other conditions involving striatal dysfunction or damage, such as Wilson disease[59] and unmedicated Parkinson disease.[60] Other studies have also reported that some regions of the orbitofrontal cortex (OFC) increases activity in response to disgusting pictures and that, regardless of intensity, the OFC responds preferentially to unpleasant stimuli.[61] Taken together, the existing literature highlights the role of the insula and the cortico–striatal–thalamo–cortical (CSTC) circuits in mediating the processing of disgust, as well as in the interoceptive experience of disgust.

OCD

The most common neuroimaging findings in patients with OCD include hyperactivation of the OFC, ACC and basal ganglia (specifically the caudate), which are all hypothesized to be key regions in the pathophysiology of the disorder.[62,63] Meta-analytic results support the conclusion that OCD is primarily characterized by CSTC dysfunction.[64] Studies using fMRI and positron emission tomography (PET) have noted hyperactivation of the OFC, caudate and ACC during symptom provocation,[65–67] with activity normalizing to match those of healthy controls after successful treatment.[68–70] Increased insular activation during symptom provocation is also a common finding in patients with OCD,[71] especially among those with contamination-based obsessions.[68,72] For instance, in a provocation study patients were exposed to innocuous stimuli (e.g., tissue soaked in clean water) and disorder-relevant stimuli (e.g., tissue believed to be soaked in toilet water).[67] During the exposure to disorder-relevant stimuli, patients with OCD reported an increase in symptoms and exhibited increased blood oxygenation in the insula, OFC, ACC and caudate nucleus. Schienle and colleagues[72] reported similar findings: compared with controls, patients with OCD displayed greater insular activity in response to contamination-related pictures and general disgust-related pictures. In addition, subjective ratings of disgust, but not fear, have been found to correlate with anterior insula activation, as have individual differences in disgust vulnerabilities[53] and OCD symptom severity.[73] Furthermore, in a diffusion tensor imaging study, patients with OCD were found to have higher fractional anisotropy in the insular regions than healthy controls. The authors suggest that this could reflect increased connectivity of the neurocircuitry involved in disgust processing, thus playing a role in the expression of symptoms.[74] In addition, a novel pilot study demonstrated that volitional downregulation of the anterior insula can be learned by patients with OCD in the presence of disgust-inducing stimuli via real-time fMRI neurofeedback. Positive behavioural changes in disgust responses were also observed outside of the scanner, post-training, using BAT and picture rating tasks.[75] However, the sample size of this pilot study was very small (n = 3), and the effects were not assessed in the long term. Findings of increased insular activity also extend to other symptom dimensions of OCD. Harrison and colleagues[76] reported greater connectivity between the ventral caudate and anterior insula in patients with more severe sexual/religious obsessions, possibly reflecting the high levels of self-directed disgust that this group experiences.

These findings are interesting because the regions implicated in OCD pathophysiology (i.e., OFC, basal ganglia, insula) are also believed to be important in disgust processing. It has been hypothesized that the limbic circuits connecting the OFC to the ventral striatum and thalamus are associated with heightened emotional processing of visceral, offensive stimuli (i.e., disgust) and may therefore be implicated in the dysfunctional control of emotionally salient error awareness.[53,73] Notably, the amygdala, which is closely linked to fear and anxiety responses, is not commonly activated during OCD provocation paradigms, further demonstrating that anxiety may not be the principal emotion in individuals with OCD.[3,62] Furthermore, findings to date suggest that patients with OCD do not display abnormal neural activations in response to threatening or fearful stimuli, but instead have similar activation patterns as healthy controls. For example, in a study comparing the neural substrates of disgust and fear, patients with OCD and healthy controls were shown disgusting and threating stimuli. In response to the disgusting

stimuli, patients with OCD exhibited greater activation of the insula and frontal inferior regions than controls, whereas the patterns of activation in response to the threatening stimuli were similar for OCD and control participants.[54]

Model of OCD and disgust

The neurobiological model of the CSTC circuits comprises direct and indirect pathways, which activate and inhibit the thalamic system, respectively, serving as positive and negative feedback loops. Thus, these pathways have competing effects and exist in equilibrium; however, in individuals with OCD, it is hypothesized that a bias occurs in favour of the direct pathway, leading to overactivation of the OFC, ventromedial caudate and medial dorsal thalamus, resulting in the obsessions and compulsions characteristic of OCD.[70] How do dysfunctional disgust appraisals fit into this model, if disgust is indeed an important feature of OCD? It is possible that upon perceiving a potentially contaminated stimulus the insula is activated, which initiates the disgust response. From the insula, sensory information may then be projected to the OFC so that the stimulus can be analyzed for its threat value. The OFC plays an important role in processing information about aversive expectations,[61] and in patients with OCD its hyperactivity may lead to excessive representations of aversive stimuli, so that stimuli are viewed to be extremely contaminated. This may in turn lead to an autonomous and excessive triggering of a false contamination alarm, which manifests as intrusive and repetitive thoughts (i.e., obsessions). The OFC also plays an important role in integrating information about rewards and punishments when planning future behaviour, including learning appropriate responses to stimuli and switching responses when it is adaptive to do so.[61] The characteristic overstimulation of the OFC in individuals with OCD may impair its ability to execute flexible response patterns, resulting in rigid and stereotypic behaviours, including extreme hand-washing, cleaning, checking, and other compulsive behaviours. The caudate may also be important in the execution of overt compulsive behaviours related to the "false contamination alarm," thereby contributing to the intense desire to complete washing and cleaning rituals. Indeed, increased functional connectivity between the striatum and insula has been reported during symptom provocation.[73]

Conclusion

The recognition of emotional influences beyond anxiety in OCD follows the increased emphasis of taking a dimensional approach to psychopathology. Accumulating data suggest that the inclusion of disgust in theoretical models of OCD, especially contamination-based OCD, can enhance our understanding and treatment of the disorder. Ignoring disgust can be an impediment to treatment success, limiting clinical gains if treatments are solely focused on the reduction of anxiety. Adams suggests that assessments of disgust and fear should be obtained within and between treatment sessions to better target any lingering feelings of disgust and anxiety that hinder the treatment process.[77] Disgust-focused ERP is promising, as it has been shown to lead to reductions in subjective disgust reactions.[34] However, the extent to which abnormal activity in the disgust circuitry, as well as dysfunctional cognitive appraisals, can be normalized via treatment will require further research.

There are still many gaps in the literature regarding the role of disgust in OCD, which is not surprising given the difficulties of studying a complex emotion, especially in a clinical population. It would be valuable to further explore how disgust might be involved in some of the other symptom dimensions of OCD to potentially enhance our understanding of the differences between the symptom dimensions and why they have different risk factors and prognoses. Most of the neuroimaging research on disgust has been based on contamination; it would be informative to determine the neural activation patterns of patients with OCD who report feelings of self-disgust due to their religious/sexual obsessions, using stimuli depicting moral disgust. This would assist us to determine whether aberrant insular activity in patients with OCD is primarily associated with physical disgust involving contamination, or if it also encompasses the processing of more complex disgust, such as moral disgust, as previous research has suggested. Similarly, further research is needed to explain heightened disgust vulnerabilities reported in checking and symmetry/ordering symptom dimensions; studies are also needed to determine whether hoarders have normal perceptions of disgust.

Although more research is needed to further elucidate the role of disgust in OCD, there appears to be sufficient evidence to support the restructuring of theoretical models of OCD to include disgust. In light of the existing research and the apparent relevance of disgust in contamination-based OCD, it is justifiable to say that disgust has a significant role in eliciting and maintaining symptoms characteristic of OCD.

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