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Editors

Handbook of Emotional Development

 Springer



Developing Disgust: Theory, Measurement, and Application

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Abstract

Disgust is a complex and uncharacteristic emotion. Despite being frequently classified as a “basic” emotion, disgust has a wide range of elicitors, many competing functional theories, and a protracted developmental trajectory. This chapter first reviews several ultimate explanations of disgust, highlighting how scholars historically privileged symbolic explanations, while most contemporary researchers believe disgust to be an adaptive pathogen avoidance mechanism. After a brief discussion of techniques for measuring disgust, we describe the current knowledge of the development of disgust, with special attention to the ways in which disgust influences food choice and contributes to contamination sensitivity. While certain aspects of disgust may be universal, its emergence is largely enculturated and its expression is

highly variable. We conclude by discussing the ways in which the study of disgust carries practical implications for the diagnosis and treatment of psychopathologies, for nutrition, and for the implementation of public health initiatives. Although scholarly interest in disgust has greatly increased during recent years, there is still much room for further exploration of this enigmatic emotion.

Jessica feels nauseous at the smell of putrid beef and decides not to eat it, thus saving herself from a potentially fatal case of botulism. Michael feels revulsion toward two men kissing, and this leads him to shout obscenities in their direction. Their infant daughter, Amy, lacks a deep appreciation for either experience, but over the course of her childhood, she will gradually develop the multi-faceted capacity to experience disgust across a wide range of situations. How will this trajectory unfold, and what functions will this new competence serve? What stimuli will begin to elicit disgust in Amy, and how can we be certain that she is experiencing revulsion rather than trepidation or annoyance? What consequences will feelings of disgust have for Amy’s life and for the lives of those around her? In this chapter, we explore the current knowledge that can be brought to bear on these and related questions.

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Defining Disgust

Disgust is generally classified as one of six basic emotions; it is claimed to have a unique adaptive function, a distinctive neural substrate producing an inimitable phenomenology, and a characteristic facial expression that is recognized in disparate cultures around the world (Ekman, 1992; Izard, 1994). This characterization has been recently challenged with the advent of the constructionist paradigm, which considers emotions to arise from situation-specific combinations of more rudimentary psychological states (Barrett, 2017). Arguments against the universality and discreteness of disgust typically invoke findings that the prototypical disgust expression is not recognized as such around the world (Russell, 1994) and also invoke demonstrations that claims about the neural localization of disgust (and other “basic” emotions) have been overstated (Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012). Some have even claimed that disgust is more appropriately characterized as a feeling or a basic drive, thus being more akin to states like hunger or pain than to true emotions like anger or fear. In particular, its reflexive triggering by concrete elicitors and its cognitive impenetrability contrasts with the profile of other emotions, which typically have abstract elicitors and flexible responses that are somewhat amenable to reason (Royzman & Sabini, 2001).

Furthering the case for disgust being difficult to circumscribe, disgust serves multiple functions and cannot be easily classified as a unitary emotion (Simpson, Carter, Anthony, & Overton, 2006; Strohminger, 2014; Wilson, 2002; Yoder, Widen, & Russell, 2016). Additionally, disgust is not often experienced in isolation. Instead, it is frequently concomitant with other negative emotions, such as fear (Muris, Mayer, Borth, & Vos, 2013; Muris, Mayer, Huijding, & Konings, 2008), anxiety (Viar-Paxton et al., 2015), and anger (Nabi, 2002; Russell & Giner-Sorolla, 2013), and it may frequently blend into these other emotional states. Although generally characterized as having negative valence, disgusting objects are sometimes a source of fascination and even pleasure, as exemplified by dirty jokes and grotesque forms of art (Bloom, 2004; Strohminger, 2014).

Additionally, researchers disagree about the necessary and sufficient features of disgust. Some scholars liberally define disgust as any psychological mechanism that functions to prevent contact with parasites and thus extend the capacity across a vast range of animal species (e.g., Curtis, 2013). Most other scholars argue that disgust is considerably more complex and specific and should be distinguished from behavioral avoidance or mere distaste. This more common view suggests that disgust involves a range of sophisticated cognitive appraisals and a particular phenomenological state that is likely unique to humans (e.g., Kelly, 2011; Rozin, Haidt, & McCauley, 2016).

In this chapter, we will generally adhere to conventional practice by treating disgust as if it were a singular, distinguishable emotion that is largely constrained to humans. However, readers should remain aware that this treatment will gloss over some of the difficulties involved in differentiating disgust from other affective states, as well as disagreements about the phylogenetic recency of the emotion. We will review the current state of knowledge on the proximate and ultimate origins of disgust, while identifying key areas for application and future exploration. Because empirical research on the development of disgust has proceeded primarily from particular theoretical stances on its adaptive nature, we will first review the classic and modern perspectives on the function of disgust.

Theories of Disgust

Scholarly investigations into disgust have identified a rich variety of theorized origins and functions of this emotion. Many of these theories characterize disgust as emanating from conceptual considerations about highly abstract construals of the eliciting stimuli. According to these theories, it is not the physical nature of pus, rot, feces, and other forms of slime and ooze that directly trigger disgust, but rather the symbolic meaning that is socially affixed to these substances (see Royzman & Sabini, 2001). More recent theories instead focus on the direct ties

between the physical nature of disgust elicitors and their direct relevance for biological fitness (see Curtis, 2013). Here, we briefly review this theoretical landscape.

Disgust as a Mechanism for Disavowing Desired Objects

The study of disgust is one remaining bastion of psychology in which it would be amiss to not give credit to Sigmund Freud in a general overview. Freud argued that disgust was a central product of civilization and cultural norms, directly resulting from features that differentiate humans from other animals – in particular, the upright posture that places our eyes and noses further from the sights and smells of reproductive and excretory organs (see Menninghaus, 2003). Freud's astute observation that bipedalism reduces contact with urine, menstrual blood, feces, and sexual organs led him to the much more tenuous inference that humans must consistently suppress the purported sexual stimulation that bodily fluids and orifices elicit, thus producing repression and neurosis and giving rise to societal taboos involving bodily functions (Freud, 1905/2017).

Freud characterized children's fascination with their feces and their pleasure in excretion as a major facet of toddlerhood (Freud, 1905/2017). According to Freud's psychosexual theory of development, children must learn to control these libidinous urges when they undergo toilet training, as they are no longer able to obtain immediate erogenous pleasure by excreting at will. Thus, the anal stage is partially characterized by acquiring the disgust response as a reaction formation involved in the rejection of anal pleasure (Freud, 1905/2017). Freud's prediction that toilet training is a central experience in the acquisition of the disgust response, while still compelling to some (e.g., Rozin et al., 2016; Rozin & Fallon, 1987), has remained largely untested. In general, while Freud's psychodynamic analysis of disgust has been eschewed (along with most of his other ideas), his ideas were influential for many theorists who focused on the symbolic nature of the emotion (e.g., Kolnai, 1929/2004).

According to Freud's view that disgust is a neurotic symptom of suppressing sexual motives, disgust would be expected to be entirely absent at birth and would then begin to emerge as a defensive process during the first few years of life, specifically as a reaction formation produced by repressed sexual excitation during the earliest stages of development. By the time the superego develops early in childhood, thus burdening the child with the restrictive expectations of civilization, disgust should be fully intact – and this emotion should be particularly exacerbated for individuals with extreme repression of their base desires.

Disgust as a Response to "Matter Out of Place"

Mary Douglas' classic work *Purity and Danger* (1966) paralleled Freud's conviction that disgust was a product of socialization but instead argued that disgust operates in order to repel people from the symbolic threat of disorder. Specifically, Douglas suggested that the realm of disgust is simply anything that disrupts the particular order that exists within a given social or ecological system. According to Douglas, the long list of dietary restrictions in Leviticus can be explained by reactions to anomalous objects that pose contradictions or threats to classification systems with which we are comfortable. For instance, Douglas points out that most ruminants have cloven hooves and also chew their cud and suggests that the anomaly of having one but not both of these category-defining features – as is the case for pigs and camels – leads an animal to be considered disgusting and forbidden from consumption. Similarly, because we think of birds as prototypical flying creatures and fish as prototypical swimming creatures, insects and eels disgust us because they fly and swim in ways that significantly depart from these taxonomic exemplars. While Douglas' (1966) idea has stirred the imagination of many scholars during the past half-century, the theory has not gained much empirical support. Exceptions abound; sugar gliders and dolphins present anomalies similar to

insects and eels, and yet are generally regarded as adorable, and many other category violations (e.g., animals dressed as people) are weird but not disgusting (Bloom, 2004). Douglas' theory does not make clear developmental predictions, although it could be posited that disgust should develop alongside categorical reasoning, which begins to emerge during the first year of life (see Rakison & Oakes, 2003).

Disgust as an Existential Barrier

Seen through the lens of the terror management theory, disgust is thought to protect humans from confronting the horrors of mortality (Becker, 1973; Goldenberg et al., 2001). According to this view, disgust helps people to avoid existential fears of death and the confrontation of a disordered, threatening world that is constantly spiraling into greater entropy and ambiguity. Disgust is thus thought to shield us from our vulnerabilities and to prevent us from seeing ourselves as mere animals (Herz, 2012; Miller, 1997; Nussbaum, 2004). This theory suggests that disgust regulates the boundaries of the self, explaining why it tends to be experienced when the borders of the body are breached, since exposing our biological insides causes us to realize that we have fundamental similarities with other animals – including having an ephemeral existence. This theory also posits that people find decomposing material, including human bodies and animal flesh, disgusting because they serve as a potent reminder of human mortality (Rozin et al., 2016). However, recent empirical evidence does not bear out the predictions of this theory, indicating that reminders of our mortal, animal natures (i.e., being told: “Human beings ... are born, eat, procreate, live, and eventually die like any other animal”) do not actually elicit disgust (Kollareth & Russell, 2017). There have been no clear developmental predictions made by proponents of the theory that disgust helps us to avoid confronting our animal nature. However, given that children both understand and fear death by 5–7 years of age (Slaughter & Griffiths, 2007; Speece & Brent, 1984), it is likely that disgust would be hypothesized to emerge as a helpful psychological tool by this point in development.

Disgust as Rejecting Offensive Substances

Building from the idea that disgust protects the bodily self, Rozin and colleagues have suggested that disgust may primarily facilitate the oral rejection of offensive, contaminating substances (e.g., Rozin & Fallon, 1987). The etymology of disgust suggests that it functions to prevent bad tastes, and accordingly some have proposed that disgust emerged from distaste (i.e., the visceral reaction to experienced bitter tastes) as a way of rejecting orally ingested substances that are cognitively appraised as contaminants or toxins (Darwin, 1872/1965; Rozin et al., 2016). This is reminiscent of Angyal's (1941) theory proposing that disgust primarily functioned to prevent the ingestion of bodily waste, as these substances are perceived as debased or dangerous to consume. The idea that disgust is primarily a guardian of the mouth is supported by evidence that the classic “gape face” and feelings of nausea associated with the disgust response present clear mechanisms for expelling contaminants from the oral cavity (Darwin, 1872/1965), and aversive reactions are most intensely experienced when undesirable substances enter the mouth as opposed to contacting other parts of the body (Rozin, Nemeroff, Horowitz, Gordon, & Voet, 1995).

Most proponents of this theory argue that substances can be regarded as gross for conceptual reasons related to the history of the substance, rather than solely on the substance's perceivable sensory qualities. For example, survey research has found that a number of Americans have a strong disgust reaction toward purified wastewater and express that they would be absolutely unwilling to drink it even if it is made substantially more germ-free than typical bottled water (Rozin, Haddad, Nemeroff, & Slovic, 2015). Furthering the notion that contamination can exist at a highly abstract level, adults are hesitant to wear clothing that previously belonged to a sick or evil source (e.g., Hitler), even when they acknowledge that no actual germs would be transmitted (Nemeroff & Rozin, 1994). Thus, disgust is not specifically attuned to physical dangers, but extends to ideational harms. Again, this theory

makes no clear predictions about the developmental trajectory of disgust, except that it likely requires the sophisticated ability to conceptualize abstract notions of “offensiveness” and some form of social learning (see Rozin et al., 2016).

Disgust as Preventing Pathogens

As the study of disgust has gained broad traction, so has the argument that disgust should be explained by its adaptive, rather than symbolic, significance. The theory that disgust functions primarily as a disease avoidance response has become more prominent in recent years (Curtis, 2013; Curtis, de Barra, & Aunger, 2011; Oaten, Stevenson, & Case, 2009). According to this increasingly dominant view, disgust serves as a primary behavioral support mechanism for the human immune system. Behaviors promoting pathogen avoidance – such as migrating to clean pastures, avoiding sick prey, and grooming – can be observed throughout the animal kingdom (e.g., Hart, 1990; Kiesecker, Skelly, Beard, & Preisser, 1999; see Curtis, 2014; Curtis et al., 2011). This is particularly the case for avoiding diseased conspecifics, as these are the most common source of infection (see Curtis, 2014; Fincher & Thornhill, 2012). However, it is possible that the human response to disease vectors has unique features. One possibility is that, while adaptations for avoiding poisons and adaptations for avoiding pathogens are both present throughout the animal kingdom, they have been fused into a single psychological mechanism only in the human species (Kelly, 2011). Because harmful pathogens are too small to be directly perceived, people must rely on indirect and imperfect sensory cues of their existence, such as noxious smells, slimy textures, morphological abnormalities, and observable behavioral symptoms of disease (Curtis, 2013; Kurzban & Leary, 2001; Park, Schaller, & Crandall, 2007). The desire to avoid these indirect indications of the presence of pathogens must be weighed against the potential benefits from coming in contact with other individuals, ranging from basic social affiliation to procreation (Tybur & Lieberman, 2016).

This pathogen avoidance theory is well supported by evidence that many substances that trigger disgust are associated with veridical threats of infectious disease (Curtis, 2011). This includes other people who are perceived to be unhealthy or unhygienic based on morphological asymmetries or disfigurements, which could be overgeneralized responses to typical signs of disease (Oaten, Stevenson, & Case, 2011). One study presented nearly 40,000 participants (primarily from the United Kingdom) with pairs of matched images that either did or did not contain disease-relevant features and found that the photographs with disease vectors (e.g., lesions and bodily secretions) were rated as more disgusting than the matched controls (Curtis, Aunger, & Rabie, 2004), suggesting that humans have the capacity to detect real disease threats and that these cues tend to elicit disgust. Nonetheless, the reliance on indirect cues to the presence of pathogens leaves open the possibility for both misses and false alarms.

Despite the compelling and intuitive link between disgust elicitors and disease vectors, there is less evidence for this theory at the level of individual differences. Specifically, there is only mixed evidence of a relationship between individuals’ tendencies to experience disgust and their susceptibility to pathogen-borne illnesses. One study of Australian undergraduates found a weak positive correlation between a general propensity to experience disgust and the incidence of contracting infectious diseases (Stevenson, Case, & Oaten, 2009), but a similar study of young adults living in rural Bangladesh failed to find any association between disgust sensitivity and the frequency of infections contracted in either childhood or adulthood (de Barra, Islam, & Curtis, 2014). Another study has found a modest correlation between undergraduates’ disgust sensitivity and their feelings that they are vulnerable to contracting harmful pathogens (Tybur, Lieberman, & Griskevicius, 2009).

There is some disagreement about the developmental predictions of the pathogen avoidance account of disgust. Some argue that it should take several years for disgust to emerge because children need to come into contact with a range

of pathogens in order to strengthen their immune systems – such that contact with pathogens early in development is actually important to promote health (e.g., Herz, 2012). Others agree that disgust should take years to develop but instead suggest that learning is required to know the unique array of common poisons and pathogen vectors within a particular ecological context; thus, children must develop the expertise to discern which substances in their environment should be avoided and which should be considered food (Cashdan, 1994). Additionally, some researchers posit that sophisticated cognitive capacities may be needed for children to understand the idea of invisible pathogens or toxins at all (Au, Sidle, & Rollins, 1993; Blacker & LoBue, 2016; Kalish, 1998; Rozin & Fallon, 1987; Stevenson, Oaten, Case, Repacholi, & Wagland, 2010). Finally, some suggest that young children do not require disgust, as historically they were exclusively breastfed during the first years of life, and they are often carried around such that caregivers are able to regulate their contact with disease vectors (Curtis & Biran, 2001; Tybur, Lieberman, Kurzban, & DeScioli, 2013). However, the World Health Organization has estimated that pathogen-borne diseases are the most deadly during the first 5 years of life and that communicable illnesses cause over half of deaths in young children across the world (Bryce, Boschi-Pinto, Shibuia, Black, & the WHO Child Health Epidemiology Reference Group, 2005), which would suggest a much earlier need for disgust. Overall, although predictions about the necessity of disgust for avoiding pathogens during infancy and toddlerhood are unclear, it seems that this theory would expect young children to develop disgust soon after weaning, perhaps by 3 years of age (see Rottman, 2014; Rottman, DeJesus, & Gerdin, 2018). It is likely that there would be a gradual tapering of the disgust response as the immune system becomes more robust (and is thus better able to serve as an additional line of defense), although it is unlikely that disgust would ever disappear given the benefits of the “behavioral immune system” (Schaller, 2011; Schaller & Park, 2011).

Disgust as Regulating Social Interactions

Another adaptationist theory of disgust posits that this emotion evolved in part to facilitate social standing – specifically by leading people to avoid interacting with low-status individuals or members of outgroups (Rottman et al., 2018). This theory points to evidence that disgust has the power to create social boundaries and to facilitate aversion toward individuals who fall outside of these boundaries. Food taboos can serve as important markers of group identity (Meyer-Rochow, 2009), as some foods are especially hard to accept among individuals who did not grow up eating them (Peryam, 1963), and even infants and young children associate food choices with cultural groups and form social evaluations on the basis of their food choices (DeJesus, Gerdin, Sullivan, & Kinzler, 2019; Liberman, Woodward, Sullivan, & Kinzler, 2016).

Disgust additionally serves as a highly effective signaling mechanism for indicating social disapproval (Kelly, 2011; Kupfer & Giner-Sorolla, 2017; Tybur et al., 2013). Across cultures and throughout history, beliefs about purity and cleanliness have been used to identify desirable social interaction partners (Speltini & Passini, 2014). Some forms of partner choice and social exclusion may be rooted in basic pathogen avoidance (Faulkner, Schaller, Park, & Duncan, 2004; Kurzban & Leary, 2001; Navarrete & Fessler, 2006). However, recent evidence indicates that White Americans implicitly conceptualize White individuals with significant facial rashes as similar to healthy individuals from a different ethnic group (Petersen, 2017), thus indicating that features signaling poor health and features signaling outgroup membership may be implicitly considered to be functionally equivalent.

Many contemporary scholars acknowledge that many disgust elicitors do not involve pathogen threats (Haidt, Rozin, McCauley, & Imada, 1997) and sometimes include moral violations of norms related to purity and sanctity (Cannon, Schnall, & White, 2011; Rozin, Lowery, Imada, & Haidt, 1999), bodily norms (Russell & Giner-

Sorolla, 2013), and fairness norms (Cannon et al., 2011; Chapman, Kim, Susskind, & Anderson, 2009). Additionally, elevated disgust sensitivity at a trait level is weakly correlated with political conservatism (Inbar, Pizarro, & Bloom, 2009; Inbar, Pizarro, Iyer, & Haidt, 2012) and is moderately correlated with stronger moral condemnation of purity-based moral transgressions (Wagemans, Brandt, & Zeelenberg, 2018). Yet, the involvement of disgust in moral judgment is controversial (see Strohminger & Kumar, 2018). There have been some indications that experimental inductions of disgust amplify moral judgment, even when they are untethered to the issues being evaluated (Schnall, Haidt, Clore, & Jordan, 2008; Wheatley & Haidt, 2005). However, a meta-analysis suggests that these findings are likely false positives (Landy & Goodwin, 2015), and it is probable that induced disgust must be directly linked to the target being evaluated in order to effectively influence moralization (Wisneski & Skitka, 2017). Others have argued that disgust is merely a metaphor when applied to the moral domain and, despite being a common cross-linguistic metaphor, it only applies to sociomoral elicitors in a figurative sense (Royzman & Sabini, 2001). Determining the extent to which moral disgust is merely a proxy for anger will be best accomplished by examining the relative importance of anger and disgust for moral evaluations, particularly when people are judging acts that are not confounded by pathogenic threats. Current evidence is mixed, with some research indicating that feelings of disgust are better predictors of some moral judgments than feelings of anger, even when pathogen cues are not present (e.g., Rottman, Kelemen, & Young, 2014), and other research indicating that anger predominates over disgust even for judgments of nonpathogenic defilement and desecration (e.g., Royzman, Atanasov, Landy, Parks, & Gepty, 2014).

Overall, this theory suggests that disgust *primarily* functions to promote withdrawal from undesirable interaction partners, regardless of whether they are healthy or infected (Rottman

et al., 2018). This departs from the more widely accepted pathogen avoidance theory of disgust, which posits that regulating social interactions is a secondary function of disgust, which was co-opted from its primary purpose of precluding pathogen contact (Chapman & Anderson, 2012; Curtis, 2011, 2013; Kelly, 2011; Rozin, Haidt, & Fincher, 2009; Tybur et al., 2013). If social regulation is indeed a primary function of disgust, rather than an incidental by-product, disgust should be predicted to fully develop around the time when children begin to engage in outgroup derogation (as distinct from ingroup favoritism), between 5 and 7 years of age (Aboud, 2003; Buttelmann & Böhm, 2014).

Section Summary: Theories of Disgust

Although the field is moving toward a consensus view that disgust is adaptively suited for preventing contact with pathogens, there remain many competing theories explaining the function of disgust. Some of these theories are multifaceted, suggesting that disgust has had a protracted evolutionary trajectory in humans and possibly earlier primate ancestors, such that it initially evolved from distaste to prevent contact with pathogens, then broadened to additionally hide us from our creatureliness, and finally broadened to promote the condemnation of moral transgressions (Rozin et al., 2016). A similar account that relies more heavily on an adaptationist approach posits that disgust evolved separately to avoid pathogens, to avoid certain kinds of sexual contact, and to avoid moral violations (Tybur et al., 2013). More research on development will bring us closer to determining which of these theories is most compelling. This will in part depend on techniques for accurately assessing whether children and adults are experiencing disgust and, if so, the extent to which their experiences of disgust are conceptually similar. In order to consider how humans experience disgust across the lifespan, we now turn to an examination of existing methods to measure disgust.

Measuring Disgust

Disgust has primarily been studied in adult samples, using a range of different methodologies. In some cases, existing methods reflect the theoretical background and assumptions of the researchers (e.g., basic emotions theorists are more likely to search for distinctive physiological responses), which can powerfully shape the conclusions that are drawn. Because any developmental account is only as good as the available methodologies, and the ability to detect disgust in childhood is greatly impacted by the methods used, here we review the strengths and weaknesses of various measurement techniques for detecting disgust.

Disgust is most commonly measured by self-report, often in the form of questionnaires designed to measure stable individual differences. Participants are typically asked to imagine a variety of potentially revolting experiences (e.g., seeing mold; touching a dead body) and then report whether they would feel disgusted or bothered by each experience. A 32-item Disgust Scale (Haidt, McCauley, & Rozin, 1994), which has been shortened and modified into the 25-item Disgust Scale-Revised (Olatunji et al., 2007), has been widely used in adult samples. This scale measures individual differences in propensities to experience disgust or discomfort toward food, animals, bodily substances, unusual sexual practices, corpses, and contaminants. Representative items include asking participants to express their agreement to items such as “It bothers me to hear someone clear a throat full of mucous” and asking participants to rate their disgust toward scenarios such as “You are about to drink a glass of milk when you smell that it is spoiled.” A number of alternative scales exist to assess disgust sensitivity and/or propensity (e.g., Tybur et al., 2009; Van Overveld, de Jong, Peters, Cavanagh, & Davey, 2006).

Although these measures of trait disgust have been widely used in adults, they are only beginning to be adapted for children. Some of these measures are direct variants of adult disgust scales, with minor modifications to items in order to make them more age-appropriate (e.g., Muris et al., 2012). One measure of self-reported dis-

gust in childhood, the Child Disgust Scale (Viar-Paxton et al., 2015), has been developed with items meant to be directly applicable to 5- to 13-year-olds, rather than directly adapting an existing adult measure. This scale asks children to rate their agreement to 14 items (e.g., “If a dog licked my popsicle I would still eat it”) that load onto two factors: Disgust Avoidance (measuring children’s predicted behavioral responses to disgust elicitors) and Disgust Affect (measuring children’s imagined affective responses to disgust elicitors). It has demonstrated acceptable reliability as well as convergent and discriminant validity. Additionally, one study has asked parents to report on their children’s disgust responses, which has allowed for some measure of disgust propensities in very young children (Stevenson et al., 2010). Another potential approach is to develop scales that rely less on verbal measures. The Food Disgust Picture Scale is one such attempt to create a disgust-sensitivity scale that uses pictures of foods, rather than verbal descriptions and vignettes (Ammann, Hartmann, & Siegrist, 2018). Though this scale was not developed for children specifically and focuses on food (rather than other disgust elicitors), its use of pictures may provide opportunities to test children and adults from different linguistic and cultural backgrounds using similar measures.

Problematically, most self-report measures do not ensure that they are specifically measuring the experience of disgust, as opposed to general negative affect or other related emotions such as fear or anger. Some studies have also asked children to identify stimuli as disgusting or not disgusting, either by endorsing a label or by judging the appropriateness of a disgust expression (e.g., Danovitch & Bloom, 2009). However, because the number of response options that are made available can impact the nature of such findings (Cameron, Lindquist, & Gray, 2015), it is crucial to allow participants the ability to report a number of other emotional experiences in addition to disgust. Furthermore, self-report measures are generally only possible for children who are sufficiently verbal and who understand the word “disgust,” precluding research with infants and toddlers. As such, most research on the development of disgust has not included very young children.

Other research has moved beyond verbal report to focus on behavioral indicators of disgust, which has various strengths including broadening the possible age range of participant samples into infancy. As disgust is associated with rejection and withdrawal, several studies have measured children's willingness to come into contact with a variety of contaminated or otherwise disgusting objects, such as maggots, a dirty sock, and ice cream covered in ketchup (Fallon, Rozin, & Pliner, 1984; Stevenson et al., 2010). In one study, children were directly given these items, and their willingness to touch and interact with the items was coded (Stevenson et al., 2010). Despite the enhanced ecological validity and other advantages of this methodology, avoidance reactions themselves cannot be taken as definitive evidence for the existence of disgust, as a range of other proximate mechanisms can also produce these behaviors (see Rozin & Fallon, 1987). At least in adults, food neophobia (i.e., rejection and behavioral withdrawal from unfamiliar foods) is potentially driven by fear rather than disgust (Raudenbush & Capiola, 2012). Measures of behavioral avoidance may therefore need to be combined with other methodologies to better ensure that researchers are truly measuring disgust.

Because disgust produces a characteristic facial expression (Darwin, 1872/1965; Ekman, Sorenson, & Friesen, 1969; Izard, 1994; but see Reizenzein, Studtmann, & Horstmann, 2013; Russell, 1994; Widen, Pochedly, Pieloch, & Russell, 2013), some researchers have focused on coding people's facial expressions and the movement of their facial muscles to assess the presence or absence of disgust. The expression that is typically described as the "disgust face" is primarily produced by the operation of the levator labii muscle, which is active when a person raises her upper lip and wrinkles her nose. This facial expression can be detected by the naked eye and categorized as indicating disgust through the Facial Action Coding System (Ekman & Friesen, 1976), and facial coding has been successfully used with children (e.g., Stevenson et al., 2010) and newborn infants (Rosenstein & Oster, 1988). A more objective method for detecting and mea-

suring activity of the levator labii is through facial electromyography (EMG), which has been reliably used in adults (e.g., Cannon et al., 2011; Chapman et al., 2009; Shenhav & Mendes, 2014), but has not been attempted in child samples to our knowledge.

However, coding of infants', children's, and adults' facial expressions as indicating disgust is often unreliable (Izard, Huebner, Risser, & Dougherty, 1980; Lewis, Sullivan, & Vasen, 1987). Some evidence suggests that the physiological indicators of disgust measured by EMG may not reliably correlate with subjective feelings of disgust (Stark, Walter, Schienle, & Vaitl, 2005), and accurately categorizing the disgust face is heavily dependent on contextual cues (Aviezer et al., 2008). Additionally, because the disgust expression is often used as a signaling mechanism, communicative motives can determine the extent to which it is displayed (Kupfer & Giner-Sorolla, 2017). Certain social settings facilitate signaling feelings of disgust, such that the facial expression is produced more strongly in social settings than in private (Jäncke & Kaufmann, 1994). In one study in which undergraduates were asked to smell urine and rancid sweat, and were covertly filmed while they were otherwise alone in a room, naïve coders were unable to accurately code participants' facial expressions as indicating disgust (Gilbert, Fridlund, & Sabini, 1987). Conversely, in social settings where signaling disgust would violate social norms or be considered impolite, children and adults have been found to successfully suppress or mask their facial expressions of disgust (Soussignan & Schaal, 1996). Because the disgust face is not reflexively produced upon experiencing disgust but is rather heavily influenced by the social context – as may be the case for facial expressions more generally (Crivelli & Fridlund, 2018) – third-party observation of the disgust face may be an inconsistent means of reliably measuring disgust (also see Barrett, 2017).

Neuroimaging methods have also been utilized to detect disgust. Functional Resonance Magnetic Imaging (fMRI) studies have typically indicated that disgust is associated with increased

activity in the anterior insula (e.g., Jabbi, Bastiaansen, & Keysers, 2008; Vytal & Hamann, 2010). However, this does not indicate that insular activity is either necessary or sufficient for producing an experience of disgust. This brain region is also active when viewing facial expressions of disgust, suggesting that it may be involved in other components of disgust processing beyond the immediate visceral experience (Phillips et al., 1997). Furthermore, there are other emotional states such as fear that elevate insular activation, and there are other brain regions outside the insula that are activated when experiencing disgust (Schaich Borg, Lieberman, & Kiehl, 2008; Schienle et al., 2002). Indeed, there is unlikely to be such a simple mapping of localized neural activation to the experience of disgust (Chapman & Anderson, 2012; Lindquist et al., 2012). Additionally, this methodology does not lend itself well to developmental research and has not been used to measure disgust in children. Similarly, electrogastrography (EGG), which involves recording gastric muscle contractions by placing electrodes on the abdomen, has been successfully used to measure biological markers of disgust in adults (Meissner, Muth, & Herbert, 2011; Shenhav & Mendes, 2014) but, to our knowledge, has never been used as a measure of disgust in infants or children.

While feelings of disgust are often measured as a dependent variable, several studies have attempted to elicit disgust as an independent variable in order to examine its effect on other phenomena. Compared to other emotions, disgust is both easy and ethical to elicit artificially, and it has been experimentally produced by stimuli ranging from film clips to fart spray (e.g., Schnall et al., 2008). This body of research has focused almost exclusively on adults, although a handful of studies have involved child participants (Rottman & Kelemen, 2012; Rottman, Young, & Kelemen, 2017), and it is reasonable to expect that these methods would be possible even for infants.

Section Summary: Measuring Disgust

Although disgust is most commonly measured with self-report, this presents difficulties for studying very young children and preverbal infants. Additionally, because many scales for measuring disgust sensitivity in childhood are directly adapted from adult research, without consideration of whether disgust manifests differently across the lifespan or whether the nature of disgust elicitors is different in childhood and adulthood, retaining validity may be problematic (Viar-Paxton et al., 2015). To date, measurements of disgust in infancy and toddlerhood have been limited to analyzing facial expressions (Rosenstein & Oster, 1988), avoidance behavior (Stevenson et al., 2010), and responses to the facial expressions of others (Ruba, Johnson, Harris, & Wilbourn, 2017).

Overall, there is no gold standard for measuring the experience of disgust. Every methodology carries inherent flaws, and different methodologies will tend to produce different conclusions about the prevalence of the disgust response across situations and even different conclusions about the human uniqueness of disgust. Thus, convergent evidence from varied research designs is important for making strong conclusions about the emergence of disgust during childhood.

Disgust Across the Lifespan

Research on the ontogeny of disgust remains in its infancy. A majority of research on disgust has focused on adults, with only a small body of literature examining its initial emergence (see Rottman, 2014). Even less research has been conducted on how disgust changes across age, particularly during adolescence and old age (see Sawchuk, 2009). The present section reviews research that has been conducted with infants, toddlers, and young children and explains how a developmental perspective can expand our understanding of this emotion.

The Nature and Nurture of Disgust

Disgust is simultaneously universal and culturally diverse. Some components of disgust appear to be canalized and invariant across diverse environments, while other components appear to be highly variable and require protracted learning. Certain disgust elicitors, such as feces and urine, are often said to be widespread, existing in perhaps all human societies (Angyal, 1941; Curtis, 2013; Curtis et al., 2011). However, anthropological and archeological evidence indicates that there are exceptions; for example, there are ethnographic accounts of Inuit people bathing in urine and Hazda people casually gathering baobab seeds from baboon feces to prepare for meals (see Speth, 2017). Indeed, many disgust elicitors that are often assumed to be widespread may in fact be primarily constrained to modern Europeans and Americans. Although rotting flesh is thought to be a universal disgust elicitor (Curtis, 2013), deliberately putrefied meat was likely perceived as desirable rather than disgusting by most human societies throughout history, including many modern hunter and gatherer societies in the arctic and subarctic (Speth, 2017). In addition, there is a great diversity in many other disgust elicitors, as exemplified by the wide range of food taboos seen across societies (Harris, 1985; Meyer-Rochow, 2009). There are many examples of substances that are celebrated as delicacies in some cultures but that are considered taboo (e.g., beef, pork) and/or disgusting to consume (e.g., pungent blue cheese, nattō, tripe) in other cultures. Some research has indicated that foods which are likely to harbor bacteria or toxins are particularly likely to be tabooed (Fessler & Navarrete, 2003; Henrich & Henrich, 2010), supporting the disease avoidance theory of disgust and again pointing toward the possibility of underlying universals in disgust elicitors.

Focus group discussions and interviews with adult respondents from three continents suggest that most disgust elicitors can be categorized as bodily substances, rot/decay, animals, other people, or moral violations (Curtis & Biran, 2001). Interviews with American children suggest that this is not constant across development; in particular, a large proportion of children identify fresh

vegetables as being disgusting (DeJesus, Rottman, & Gerdin, unpublished data). Overall, even though disgust reliably emerges around the world, it seems to be largely the product of enculturation. However, the extent to which this learning is innately constrained is currently unknown, as are the specific causes of the development of disgust.

Overview of Developmental Trajectory

Aversions to malodorous and bitter stimuli are evident in newborns (Soussignan, Schaal, Marlier, & Jiang, 1997), but few would classify these basic responses as constituting disgust given that they are confined to direct sensory stimulation and operate reflexively (Rozin et al., 2016; but see Sawchuk, 2009). Despite these early-emerging aversions, it seems that full-fledged disgust develops considerably later than all other basic emotions. While some studies have found evidence that children as young as 2.5 years avoid some disgust elicitors (e.g., Stevenson et al., 2010), most research has identified the emergence of disgust as occurring years beyond this, perhaps around the age of 5 (see Rottman, 2014; Rozin et al., 2016; Rozin & Fallon, 1987).

In the most comprehensive study of the development of disgust to date, Stevenson and colleagues (2010) mapped the developmental trajectory of children's reaction to a variety of disgust elicitors, including "core" (i.e., bodily or pathogenic) elicitors (e.g., a dirty sock, the odors of fertilizer and fermented shrimp paste), animal elicitors (e.g., maggots, touching a glass eye), and sociomoral elicitors (e.g., stealing from a person with a disability, and the marriage between a man and a much older woman). Children ranging in the age from 2 to 10 were presented with these disgust elicitors, and their behaviors (e.g., willingness to touch the item) and facial reactions (e.g., expression of the disgust face) were recorded. A convergence of multiple methods found that children began to exhibit disgust toward bodily fluids and rotten foods around 2.5 years of age, followed by disgust toward animals and

animal products by 4.5 years of age, and disgust toward sociomoral elicitors by 7 years of age. This study highlights the possibility that a conceptual understanding of disgust evolves over childhood and may be unnecessary for early emerging disgust reactions. Although the capacity for sociomoral evaluation has been documented in infancy (Hamlin, Wynn, & Bloom, 2007; Steckler et al., 2018; Van de Vondervoort & Hamlin, 2018), it appears that the connection between sociomoral judgments and disgust unfolds over a lengthy developmental period.

Development of Distaste and Avoidance

From the perspective of disgust as a food-related emotion (Rozin & Fallon, 1987), distaste is an important and early emerging precursor to a fuller understanding of disgust. As soon as the infant diet begins to expand beyond exclusively milk and formula, infants express distaste for some foods (Birch, 1990, 1999; Ventura & Mennella, 2011). A dislike for bitter flavors, and subsequent rejection of bitter foods, is observed in human infants and a variety of species, including nonhuman primates and rats (Grill & Norgren, 1978; Mennella, Pepino, & Reed, 2005; Steiner, Glaser, Hawilo, & Berridge, 2001). This early and widespread rejection response is thought to have evolved to prevent the ingestion of toxic substances, many of which are characterized by bitter flavors and are carried by plants (Keeler & Tu, 1991; Reed & Knaapila, 2010). In line with this theory, infants demonstrate an early tendency to avoid touching plants and selectively learn about the edibility of plants from other people (Wertz & Wynn, 2014a, 2014b; but see Kochanska, Tjebkes, & Forman, 1998). Infants and young children also view disliked food as a potential contaminant – in two related studies, 18- to 26-month-old and 4- to 6-year-old children rejected foods that they otherwise typically enjoyed if that food came into contact with foods that they disliked (Brown & Harris, 2012; Brown, Harris, Bell, & Lines, 2012). Moreover, children and adults avoid foods that they associate with

illness, even if they can identify a different cause of those sick feelings, such as chemotherapy (Bernstein, 1978, 1994).

Despite these early emerging tendencies to avoid dangerous or toxic items and to extract social meaning from demonstrations of liking and disliking foods (e.g., Liberman et al., 2016), infants and very young children demonstrate a surprising willingness to make food choices that older children and adults would not make. Retrospective parental reports suggest that children younger than 2 years of age are particularly cavalier in their receptivity to eating novel substances (Cashdan, 1994). Although food neophobia and picky eating behaviors tend to peak shortly thereafter (see Lafraire, Rioux, Giboreau, & Picard, 2016), young children remain willing to consume some substances that are generally considered disgusting by adults, as has been demonstrated by several classic studies. When children between the ages of 3 and 12 were presented with hypothetical vignettes, children rejected foods based on distaste earliest, and only later rejected foods on the basis of potential for harm (e.g., a poisoned beverage) or potential contamination (e.g., a beverage containing an insect or feces). Younger children also required fewer steps to consider contamination to have been abated. For example, they expressed willingness to drink a glass of milk immediately after a grasshopper was removed from the glass, rather than requiring the glass to be thoroughly washed (Fallon et al., 1984). Similar results indicating young children's willingness to consume potentially dangerous or contaminating items have been found when children were presented with real items (e.g., Rozin, Fallon, & Augustoni-Ziskind, 1985). In one study, a majority of toddlers (ranging from 16 to 29 months of age) were found to be surprisingly willing to put disgusting or dangerous items in their mouths, such as imitation feces (crafted from peanut butter and limburger cheese) and imitation dish soap (Rozin, Hammer, Oster, Horowitz, & Marmora, 1986). This evidence has been taken to suggest that development in the food domain has a protracted timeline and consists of learning what is *not* edible (Rozin, 1990; but see Bloom, 2004).

Development of Contamination Beliefs

Understanding contamination is particularly important from the perspective that disgust functions to avoid pathogens (Curtis, 2013; Oaten et al., 2009). However, avoiding disease vectors, either from contaminated foods or sick people, appears to take several years of life to develop. Some evidence of contamination sensitivity has been observed around preschool age (Raman & Gelman, 2008; Siegal, Fadda, & Overton, 2011; Siegal & Share, 1990; Toyama, 2016), and even infants view disliked foods as contaminants (Brown & Harris, 2012). However, other studies have indicated that this competence is not fully developed until later in childhood, perhaps because young children tend to have difficulties understanding mechanisms of contamination and illness (Fallon et al., 1984; Legare, Wellman, & Gelman, 2009; Solomon & Cassimatis, 1999). In one study that examined children's sensitivity to contamination across childhood, participants were offered one food that appeared to be clean and one food that appeared to be contaminated by a sick person's germs. In this study, 5- to 8-year-old children ate more of the clean food and rated the clean food as tasting better than the contaminated food, while 3- to 4-year-old children did not differentiate between the two foods (DeJesus, Shutts, & Kinzler, 2015). Similarly, another study found that 6- and 7-year-old children avoided contact with sick adults, whereas 4- and 5-year-old children did not (Blacker & LoBue, 2016). The ability to make predictions about illness was a better predictor of children's avoidance behavior than age, suggesting that conceptual knowledge about illness serves as a catalyst for contamination avoidance.

Despite what are often considered to be evolved mechanisms to prevent young humans from consuming dangerous items and to promote "defensive eating" (Reed & Knaapila, 2010), the developmental evidence suggests that avoiding disgusting or contaminated items unfolds over a protracted period of time. This may be because an understanding of contamination is supported by the emergence of abstract cognitive abilities,

such as the ability to think about causal entities like bacteria that are not visible to the naked eye (Rozin et al., 1985). Although disgust may exist independently of an explicit understanding of contamination (Stevenson et al., 2010), folk biological knowledge of contaminants certainly contributes to a mature competence.

Enculturation of Disgust

Beyond the innate avoidance of bitter flavors, which is generally described as evidence of distaste rather than disgust and which is largely transmitted through genes such as TAS2R38 (Mennella et al., 2005; see Reed & Knaapila, 2010), much of what is avoided for being disgusting is heavily contingent upon cultural learning (see Feder, 2015). Children's food preferences are largely shaped through social influences such as modeling (see Birch, 1999; Shutts, Kinzler, & DeJesus, 2013), and even infants are attuned to the food choices that are made by ingroup rather than outgroup members (Shutts, Kinzler, McKee, & Spelke, 2009). Parent-child interactions are important sources of information about disgust (Stevenson et al., 2010), and children often look to adults to learn disgust toward specific objects or entities (Askew, Çakır, Pöldsam, & Reynolds, 2014). Although chili peppers and other piquant foods are rejected by many other species (e.g., Galef, 1989), human children can be enculturated by the food practices of their community and learn to enjoy the flavor of spicy food (Rozin & Schiller, 1980). Beliefs about contamination and explanations for illness also vary across cultures (Hejmadi, Rozin, & Siegal, 2004; Legare, Evans, Rosengren, & Harris, 2012; Legare & Gelman, 2008, 2009), as does the production of disgust responses (Camras, Bakeman, Chen, Norris, & Cain, 2006).

Most theorists have assumed that children use caregivers' emotional expressions of disgust to learn about what is disgusting. However, this is unlikely to be an effective mechanism given children's difficulty in identifying the disgust expression (see Widen & Russell, 2013). Although even 10- and 18-month-olds are capable of perceptu-

ally distinguishing disgusted faces from angry faces, as measured by the amount of time that infants look at different faces (Ruba et al., 2017), it is not clear that these infants recognize the disgust face *qua* disgust, particularly as other evidence indicates that it takes many years for children to fully appreciate the meaning of the facial expression of disgust (Widen & Russell, 2013). Children are generally unable to specifically identify the disgust face as expressing disgust before the age of 9 (Widen & Russell, 2008), typically labeling it as instead expressing anger (Gagnon, Gosselin, Hudon-ven Der Buhs, Larocque, & Milliard, 2010; Mancini, Agnoli, Baldaro, Ricci Bitti, & Surcinelli, 2013; Widen & Naab, 2012). This stands in stark contrast to children's ability to recognize other basic emotional expressions (e.g., happiness, fear), which are recognized early and with stability across childhood (Camras & Allison, 1985; Rodger, Vizioli, Ouyang, & Caldara, 2015).

Although parents' vocalizations of disgust (e.g., "yuck!"), in combination with gestures conveying avoidance, are associated with their children's tendencies to display disgust responses (Oaten, Stevenson, Wagland, Case, & Repacholi, 2014), young children also do not appear to be prepared to associate vocalizations of disgust with prototypical disgust elicitors. Rather, 3-year-olds are equally likely to orient to rotten foods and to snakes when hearing adults express disgust (Stevenson, Oaten, Case, & Repacholi, 2014), suggesting that children may interpret these vocalizations as indicative of fear or general negativity, rather than as specifically indicating disgust. However, emotive demonstrations of disgust may reveal important commonalities between parents and their children; parents of young children were more emotive when presented with disgust elicitors alongside their children, and children's disgust reactions were correlated with their parent's reactions (Stevenson et al., 2010).

Given the ambiguity of nonverbal cues toward disgust, it is possible that children rely heavily upon linguistic cues when learning what is disgusting. Children are highly susceptible to adults' verbal testimony when determining what

to eat (Lumeng, Cardinal, Jankowski, Kaciroti, & Gelman, 2008), and testimony about the disgustingness of various stimuli has been shown to be more effective than nonverbal cues in socializing disgust in 8- to 12-year-old children (Muris et al., 2013). Children also readily learn novel moral proscriptions from adults' testimony that harmless actions are disgusting and gross (Rottman et al., 2017).

Beyond shaping first-person preferences, humans glean third-person social information from the food rejections of other people from an early age. Infants expect food preferences to align with patterns of social affiliation. After watching videos of two people who either shared food preferences (both demonstrated positive affect towards the same food) or had inverse preferences (one person demonstrated positive affect toward a food and the other person demonstrated negative affect toward that food), 9-month-old infants expected people who shared food preferences to affiliate with each other and people who did not share food preferences to turn away from each other (Lieberman, Kinzler, & Woodward, 2014). Babies also draw the reverse inference; one study found that 14-month-old infants expected people who affiliated with each other or spoke the same language to share food preferences, but did not expect people who did not affiliate with each other or spoke in different languages to share food preferences (Lieberman et al., 2016). In a series of studies with 5-year-old children, children expected cultural ingroup members (i.e., individuals who spoke the child's native language) to eat common food combinations (e.g., hot dogs with mustard, milk with chocolate syrup) and cultural outgroup members to eat uncommon combinations of common foods (e.g., milk with mustard, hot dogs with chocolate syrup), rather than the reverse pattern. However, children's own ideas about what is commonly eaten in their culture influenced their judgments of other people; they negatively judged individuals who ate unconventional foods, nonfoods, and disgust elicitors, even when those individuals were from a different cultural group (DeJesus et al.,

2019). These studies provide evidence that, regardless of their ability to understand or express disgust, infants and young children already demonstrate remarkable capabilities to make inferences about the relationship between food and social structures, which may provide an important foundation for the enculturation of disgust in early development.

Theoretical Implications of Developmental Evidence

The delayed and protracted emergence of disgust can help to mediate between different theoretical explanations of the ultimate origins of disgust (Rottman, 2014). As reviewed previously, several theoretical accounts of disgust would strongly predict its emergence by the time children enter preschool. This is perhaps most notably true for the pathogen avoidance theory of the evolution of disgust. Given that disgust may emerge too late in development to be effective in meeting the acute need for evading pathogens and thus reducing the burdens of the underdeveloped immune system, it is possible that a full explanation of disgust may require moving beyond claims that it exclusively functions for evading disease (Haidt et al., 1997; Rottman, 2014; Rozin et al., 2016). For example, if disgust is at least partially adapted for regulating social interactions, its late emergence is more easily explained given the developmentally later need for maintaining social status (Rottman et al., 2018). In addition, evidence that disgust does not come online as a single package, but rather seems to emerge along distinct developmental trajectories for different types of elicitors (Stevenson et al., 2010), provides developmental support to theories that there are multiple instantiations of disgust (e.g., core disgust, moral disgust) serving different adaptive functions (Tybur et al., 2013). However, these claims must remain tentative until additional research more definitively maps out the developmental emergence of disgust. It is certainly possible that creative new methodologies will uncover indications that disgust is acquired

much earlier than current measurements are able to detect.

Section Summary: Disgust Across the Lifespan

The examination of disgust's developmental trajectory reveals both common, early expressions of disgust and aspects of this emotion that are revised across development and influenced by cultural backgrounds. These studies have primarily focused on children's eating behaviors and their avoidance of core disgust elicitors and sick individuals, and they do not investigate reactions to sexual behavior or violations of moral purity, given the inappropriateness of these topics and gaps in young children's knowledge base. However, this constrained focus raises broader questions as to whether disgust is experienced or understood differently by children and adults.

Although current evidence suggests that disgust is largely the product of sociocultural learning, other causal mechanisms are in need of investigation. Additionally, beyond further research on acquisition processes, it may be equally critical to examine how disgust can be extinguished – as it may be necessary to override feelings of disgust to successfully accomplish important goals such as caring for the sick or cleaning up garbage. Some work exists on habituation in adults, indicating that frequent exposure to disgust elicitors reduces the concomitant disgust response, particularly in mothers (Case, Repacholi, & Stevenson, 2006; Prokop & Fančovičová, 2016) and medical practitioners (Rozin, 2008; van Dongen, 2001). However, these processes have not yet been examined across child development.

Broader Implications

Most scholarly work on disgust can be classified as basic research on the nature, development, and elicitors of disgust. However, it is also critical to understand the potential applications of disgust research. In the present section, we discuss the

clinical and health-related implications of disgust, as well as its relevance for larger societal issues. We encourage researchers to take careful note of these domains of inquiry, as we believe that understanding the relevance of disgust for applied interventions could serve to meaningfully impact both the research literature and the wellbeing of clinical, underserved, and stigmatized populations.

Disgust and Disorders

Abnormal disgust sensitivity is characteristic of several neurological, developmental, and psychopathological disorders (see Olatunji & McKay, 2009). Elevated levels of disgust toward typical disgust elicitors may both cause and sustain symptoms of phobias and other anxiety-related disorders, as well as other disorders ranging from obsessive-compulsive disorder (OCD) to eating disorders (Davey, 2011; Muris, van der Heiden, & Rassin, 2008; Phillips, Senior, Fahy, & David, 1998). Heightened levels of disgust directed toward the self can also manifest in a range of psychiatric disorders, including body dysmorphic disorder (Neziroglu, Hickey, & McKay, 2010). In contrast, impaired or absent levels of disgust have been found in individuals diagnosed with Huntington's disease (Hayes, Stevenson, & Coltheart, 2007; Mitchell, Heims, Neville, & Rickards, 2005) and autism spectrum disorder (Kalyva, Pellizzoni, Tavano, Iannello, & Siegal, 2010). Some clinicians have successfully targeted disgust in therapeutic treatments for specific phobias (de Jong, Andrea, & Muris, 1997; Oar, Farrell, & Ollendick, 2015), suggesting an important potential for intervention in disgust-related research.

Although anxiety disorders and phobias are often discussed in relation to abnormally high levels of fear, they can also result from abnormally high levels of disgust. This is likely because heightened fear and heightened disgust are often tightly coupled. Spider phobia is associated with feeling greater disgust toward spiders (Sawchuk, Lohr, Westendorf, Meunier, & Tolin, 2002; Vernon & Berenbaum, 2002), beliefs that spiders are contami-

nating (de Jong & Merckelbach, 1998), and displaying both fearful and disgusted facial expressions in the presence of spiders (Vernon & Berenbaum, 2002). Similarly, blood-injection-injury (BII) phobia is associated with heightened trait disgust (de Jong & Merckelbach, 1998), increased contamination fears (Olatunji, Lohr, Sawchuk, & Patten, 2007), self-reported feelings of disgust in the presence of BII-related stimuli (Sawchuk et al., 2002; Tolin, Lohr, Sawchuk, & Lee, 1997), and increased facial expressions of disgust when watching videos of surgical incisions (Lumley & Melamed, 1992), as well as fainting due to the decreases in blood pressure and heart rate that are produced by disgust (Page, 2003). As specific phobias typically have an early onset (Oar et al., 2015), it is likely that this coupling of fear and disgust in the presence of certain animals or bodily injuries occurs in childhood. Indeed, conditioning 9–13-year-olds to experience disgust toward a novel animal also leads them to become more prone to fear the animal (Muris, Huijding, Mayer, & de Vries, 2012; Muris, Mayer, Huijding, & Konings, 2008). Similarly, the patterning of disgust implicated in anxiety disorders is found in both children and adults (Moretz, Rogove, & McKay, 2011).

Increased levels of disgust are also associated with OCD (Deacon & Olatunji, 2007; Muris et al., 2000; Tsao & McKay, 2004), and disgust often serves as a driving force for the compulsive avoidance of potential contaminants (Moretz & McKay, 2008; Thorpe, Patel, & Simonds, 2003). Disgust may also underlie the frequent and routinized washing and compulsive cleaning behaviors that are common in OCD (Brady, Adams, & Lohr, 2010; Foa & Kozak, 1995). People with contamination-related OCD symptoms also have strengthened beliefs that once an object has been contaminated, the object will always be contaminated (Tolin, Worhunsky, & Maltby, 2004). Elevated disgust sensitivity is correlated with OCD symptoms in both preadolescents and adults (Olatunji, Williams, Lohr, & Sawchuk, 2005).

Unsurprisingly, given its theorized role as a guardian of the mouth (Rozin & Fallon, 1987), heightened disgust may be implicated in eating disorders such as anorexia and bulimia (Davey, Buckland, Tantow, & Dallos, 1998), which is

perhaps exacerbated by the disgust reactions that are experienced toward overweight individuals (Harvey, Troop, Treasure, & Murphy, 2002). Disgust sensitivity can also predict picky eating (Kauer, Pelchat, Rozin, & Zickgraf, 2015), which, in extreme cases, can become clinically diagnosed as an avoidant restrictive food intake disorder (Zickgraf, Franklin, & Rozin, 2016).

Although clinicians will generally need to focus on techniques for attenuating disgust when treating phobias, OCD, and eating disorders, there are some cases in which therapeutic treatments may call for elevating levels of disgust. As was evocatively suggested in Burgess' *A Clockwork Orange*, disgust elicitors can be powerful unconditioned stimuli in aversion therapy. Similar techniques have been used for the treatment of people with alcohol dependence and sex offenders, indicating that capitalizing upon the disgust response – for example, by pairing photos of vomit with alcohol – may be a potent clinical tool for shaping behavior (see McKay & Tsao, 2005). In general, future research should investigate the various ways in which disgust can be leveraged to alleviate clinical disorders.

Disgust, Nutrition, and Health

Research on disgust is not only broadly applicable for clinicians treating psychopathologies but also carries more widespread relevance in the context of everyday nutrition and health, as well as for facilitating more ecologically sustainable eating practices. The United Nations Food and Agriculture Organization recently published a report advocating for the consumption of insects as a sustainable solution for obtaining protein, with both environmental and nutritional benefits (van Huis et al., 2013). However, feelings of disgust toward eating insects, particularly in Western cultures, are an important barrier to this effort (Ruby, Rozin, & Chan, 2015). As such, the incorporation of insects into the Western diet will at least initially require the insect protein to be unseen to avoid reminding consumers that they are eating insects (Gere, Székely, Kovács, Kókai, & Sipos, 2017; Hartmann, Shi, Giusto, & Siegrist, 2015; Megido et al., 2016).

Eating insects is merely one of many ways in which common disgust responses can serve as a barrier to promoting physical and ecological health.

Scales developed to study disgust in children and adults (e.g., Haidt et al., 1994; Viar-Paxton et al., 2015) sometimes include food items, but these items are generally restricted to visibly rotten or contaminated foods or unusual food combinations, rather than healthy foods that children tend to reject (e.g., vegetables) or foods that carry pathogens or toxins but look perfectly safe to eat (e.g., romaine lettuce contaminated by *E. coli* or water contaminated by lead). Other researchers from a range of disciplines have studied the development of food preferences and picky eating, yet disgust is rarely studied directly in these investigations. For instance, the Child Eating Behavior Questionnaire, a validated and widely used questionnaire in studies of children's eating behavior (Wardle, Guthrie, Sanderson, & Rapoport, 2001), includes a Food Fussiness subscale that includes the rejection of foods on ideational grounds (e.g., "my child decides that s/he does not like a food, even without tasting it"), but few studies administer this questionnaire when considering children's experiences of disgust. This gap in knowledge regarding the relation between disgust, food intake, and health outcomes suggests an important opportunity for interdisciplinary collaboration.

In addition to potential links between disgust and eating behavior, studying disgust in the context of obesity stigma presents another potential link between disgust and health. Consistent with the studies described previously in the context of disgust as reifying social boundaries, there is considerable stigma surrounding obesity (Carr & Friedman, 2005; Puhl & Brownell, 2001; Puhl & Heuer, 2010; Schwartz, Chambliss, Brownell, Blair, & Billington, 2003; Strauss & Pollack, 2003) and people who are overweight are sometimes described as "disgusting" (Sandberg, 2007), potentially because obesity is implicitly associated with disease threats (Park et al., 2007). Not only do these patterns have implications for individuals' daily quality of life and well-being, but obesity stigma has also been shown to have negative implications for the quality of care people receive from healthcare providers and the

attitudes and stereotypes healthcare providers hold toward their patients (Malterud & Ulriksen, 2011; Phelan et al., 2015). Given that important links have been observed between psychosocial stress and weight gain (Knutson, Spiegel, Penev, & van Cauter, 2007; Lumeng et al., 2014), understanding the role of disgust in obesity stigma may have important consequences for individuals' health outcomes and interactions with healthcare providers.

Public Health Interventions

Disgust may provide humans and other species with a psychological mechanism that facilitates the behavioral avoidance of infectious substances, thus serving as a proactive defense that reduces burdens on the immune system for protecting against disease (Curtis & Biran, 2001; Schaller, 2011). Tragically, however, pathogen-borne diseases remain one of the primary causes of mortality worldwide, especially for children (Bryce et al., 2005). This suggests that, even if disgust does ward off some illnesses, it is not heavily effective in naturally preventing contact with many dangerous disease vectors. The ineffectiveness of disgust in avoiding pathogens in modern environments constitutes a crucial public health concern in which top-down interventions are needed to reduce engagement in many unhygienic behaviors. Could disgust, particularly in social contexts, be fruitfully leveraged as a tool in these interventions?

Historically, cleaning practices have been performed for purposes of spiritual purification rather than hygienic purposes. Therefore, norms of proper cleaning do not always effectively reduce the spread of germs. While most people in modern, industrialized societies stigmatize individuals with poor hygiene (Oaten et al., 2011), this has not always been the case. Indeed, there have been times when washing has been considered to produce spiritual *uncleanliness*, as touching oneself was considered impure according to Christian doctrine (Speltini & Passini, 2014). This symbolic, rather than health-related, understanding of cleanliness has presented difficulties for introducing hygienic practices into societies that do not engage in them.

Poor sanitation in heavily populated areas presents a significant public health risk for much

of the world's population. Entraining disgust responses to public defecation could present a low-cost solution to encouraging more people to utilize toilets when they are available. Indeed, some research has indicated that disgust can be an important mechanism for introducing social disapproval of poor hygiene. A sanitation and hygiene intervention in Nepal, which centrally involved disgust along with habit formation, reshaped local norms relating to hygienic hand-washing practices (McMichael & Robinson, 2016). Other successful interventions have similarly promoted disgust at evidence that washing without soap can leave residues of fecal matter on one's hands upon wiping oneself after defecating (Curtis, Danquah, & Aunger, 2009).

Social Justice

Characterizing outgroup members, social deviants, or enemies as "dirty" or "disgusting" is a common political tactic. This technique for marginalization and stigmatization has perpetuated atrocities throughout history, spanning from ancient Chinese, Egyptian, and Mesopotamian cultures through Nazi propaganda and into modern political discourse – and it seems to succeed in shaping perceptions of outgroup members as being less than human (Harris & Fiske, 2006; Hodson & Costello, 2007; also see Nussbaum, 2004; Smith, 2011). The extent to which people feel disgust toward outgroup members is reliably associated with prejudice toward marginalized groups, and this correlation remains intact even when statistically controlling for perceived vulnerability to pathogen-borne illnesses (Hodson et al., 2013). Disgust is felt toward individuals who are deemed to have bad moral character that causes them to be socially deviant (Giner-Sorolla & Chapman, 2017), toward individuals and ideas that are considered contaminating to one's ingroup (Cottrell & Neuberg, 2005), and, more generally, toward anybody who is not obviously a member of one's ingroup (Reicher, Templeton, Neville, Ferrari, & Drury, 2016). Thus, attempting to mitigate disgust responses in sociopolitical arenas could serve as a crucial tactic for promoting equity and basic human rights. As social biases against people who are unclean are intact by the age of five

(Rottman et al., 2019), it may be prudent for these interventions to focus on young children. Uncovering effective solutions for reducing disgust-fueled forms of prejudice and discrimination presents a ripe area for further research.

Section Summary: Broader Implications

Research increasingly indicates that disgust is critically associated with various psychopathologies, has profound implications for healthy eating, and could even carry the potential to save the lives of millions worldwide. While disgust may serve as a useful tool for increasing health benefits, particularly in leading to improved hygiene, it is also a double-edged sword (see Curtis, 2013). Individuals who lack access to sanitation, who are chronically sick, who are overweight or obese, or who have morphological abnormalities often trigger feelings of disgust in others, which tends to increase shame and ostracism. When experienced in excess, disgust can carry many negative consequences. Researchers and practitioners must take care in attempting to either attenuate or amplify disgust responses, and the costs and benefits of each should be a major focus of future research on the development of disgust. In addition, understanding how to intervene on disgust in a targeted way, rather than universally increasing or reducing disgust responses, is a particularly critical direction for future research, given that disgust may differentially impact various social judgments and health outcomes. For instance, it might be helpful to reduce disgust reactions to eating insects specifically (in order to promote the consumption of a sustainable protein), while preserving disgust toward bodily products (in order to promote bathroom handwashing).

Conclusion

Emotion researchers have often pooh-pooed disgust, choosing to focus their studies instead on sadness, anger, fear, and various other emotions. Here, we have provided evidence that dis-

gust is in fact a central component of human nature. Despite its protracted developmental trajectory and highly variable set of elicitors, disgust seems to reliably develop across cultures, thus comprising a human universal. Disgust may be among the most relevant psychological capacities for improving public health, given its central role in avoiding one of the top killers of humankind: pathogen-borne diseases. Conversely, disgust has dark implications for social justice, as it breeds dehumanization and bigotry. A better understanding of whether disgust should be championed or maligned will be deeply informed by developmental investigations of the emergence and unfolding of disgust in childhood.

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