Dirt, Disgust, and Disease

is hygiene in our genes?

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> *. . . pus, vomit, urination, menstruation, sexual fluids and so on—all substances and acts that, for some reason, many cultures tend to see as repellent and, despite their constant presence in human life, as abnormal.*
>
> **—A. K. Reinhart (1990)**

Introduction

Anthropologists have long puzzled over why certain objects and activities are avoided, reviled, or proscribed in many cultures. Numerous theories have been proposed, but as Reinhart (1990) suggests above, a full explanation remains elusive. Psychologists recently have begun to explore the nature of the revulsion that is occasioned by the sight of excreta, rotten food, slime, and bugs. They have described and categorized the emotion of disgust and have even proposed a location in the brain where disgust may be seated. However, the total body of research into disgust is so scant that it has been described as the "forgotten emotion of psychiatry" (Phillips et al. 1998).

Our interest in disgust has its roots in a decade of work exploring hygiene behavior in Africa, India and Europe. The failures of the health education

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approach in promoting hygiene has drawn attention to the need to understand existing motivations and practices more fully. Although there is much variation in the behaviors that are considered acceptable and appropriate in different societies, we found signs of a consistent pattern. We found that hygiene was important to all of the people that we worked with, and that hygienic behavior often was motivated by the desire to avoid or remove things that were found disgusting. Review of the anthropological, psychological, historical, and medical literature suggests a wide variety of explanations for hygienic behavior. However, few writers offer explanations for the origins of hygiene or consider how it might be related to the disgust emotion. This paper explores the nature of disgust and argues that it can best be understood as a mechanism for defense against infectious disease.

WHAT IS DISGUST?

Disgust is a powerful emotion and is thought to be a human universal. Darwin (1872) counted it as one of the six basic emotions. The manifestations of disgust include a particular facial expression (wrinkling of the nose, pulling down the corners of the mouth), characteristic neurological signs (lowered blood pressure, lowered galvanic skin response, and nausea) and characteristic actions (stopping, dropping the object of disgust, shuddering or saying "yuk!") (Rozin et al. 1993). The facial expression of disgust has been found to be recognizable across cultures (Ekman and Friesen 1986; Mesquita and Frijda 1992). Disgust apparently is distinguishable from fear in that disgust involves a suspension of activity, while fear heightens activity in preparation for fight or flight (Phillips et al. 1998). Recent magnetic resonance imaging studies have proposed a specific neurological substrate for disgust, located in the anterior insular cortex (Phillips et al. 1997).

ELICITORS OF DISGUST

Though the details of what constitutes a disgusting stimulus may vary to some degree from culture to culture (Davey et al. 1998) and from individual to individual, there appear to be some prototypical objects of disgust. Phillips and colleagues (1998) suggest that these are waste products of the human body, while Rozin and Fallon (1987) see the key source of disgust as "the prospect of [oral] incorporation of an offensive object." Rozin and Fallon continue: "The offensive objects are contaminants; that is, if they even briefly contact an acceptable food they tend to render that food unacceptable." According to Rozin, substances of animal origin, poor hygiene, violations of the body envelope, and death are disgust stimuli. Disgust is also elicited by physical contact with unpleasant or unknown people (Rozin and Fallon 1987). Furthermore, disgust appears to have a cultural domain and can be elicited by immorality and violations of social rules (Miller 1997; Rozin et al. 1999b).

Our program of qualitative field work exploring the motivation for hygiene behavior generated sets of objects and events that were found to be disgusting from five studies in Africa, India, the Netherlands, the United Kingdom, and in an international airport. These are reproduced in Tables 1 through 5, and the data sources are described in the notes. Asking people what disgusts them pro-

TABLE 1 INDIA

feces	worn clothes	dead rat
urine	flies	dead cricket in food
toilets	insects	rotting flesh
sweat	maggots	parasitized meat
menstrual blood	lice	wet cloth
spilled blood	mice	stickiness
cut hair	mouse in curry	decaying waste
impurities of childbirth	rats	garbage dump
vomitus	dogs	sick person
smell of urine	stray dog	hospital waiting rooms
open wound	meat	beggars
saliva	fish	touching someone of lower caste
dirty feet	pigs	crowded trains
eating with dirty hands	fish smell	lower castes
food cooked while menstruating	dog or cat saliva	alcohol
bad breath	lizards	nudity
smelly person	flies on feces	kissing in public
yellow teeth	liquid animal dung	betrayal
nose picking	soap that has been used for the latrine	
dirty nails	dead animal	

Note: Data collected in six focus group discussions about hygiene with women in the town of Lucknow and surrounding villages, Uttar Pradesh, in 1998, and from 50 short essays on the subject of "impurity" by teenage school girls. Discussions conducted and transcribed in Hindi, later translated; essays written in English. Texts analyzed with QSR NUD*IST (Curtis 1999).

TABLE 2 BURKINA FASO, WEST AFRICA

feces	dirty latrine	dirty food
unswept yard	diarrhea	impure substances associated with birth
flies on food	sores	sexual relations before a child is weaned
rubbish in the yard	worms	
smelly drain	dirty clothes	
rubbish heap	sick person	
pigs	vomit	

Note: Data collected in 12 focus group discussions about hygiene with mothers of small children in the town of Bobo-Dioulasso in 1989 to 1992. Original interviews in Dioula, translated into French and analyzed manually (Kanki et al. 1994).

TABLE 3 NETHERLANDS

feces	cats	aphids in lettuce
hairs	dogs	pollution
vermin	dog hairs	drug users
vomit	dog saliva	drunkenness
dust	rotten waste	fat people
sweat	bad-smelling food	insulting behavior
stickiness	food leftovers	politicians
offal	worms	dirty old men
fish monger's hands	flies	

Note: Data collected in in-depth interviews with mothers of small children in Gelderland and Eindhoven, Netherlands. Data analyzed with QSR NUD*IST (Curtis 1999).

duced a very diverse set of objects, events, actions, and sensations. However, some patterns can be discerned. First, disgust is elicited by substances that include sweat and vomit, by certain living organisms such as snails and lice, by sick people, and by corpses. Second, things that have been contaminated with material of a disgusting nature elicit disgust. These include toilets, stained sheets and fishmongers' hands. Third, a number of sensory cues elicit disgust, especially the damp, the slimy, and the stinky. Finally, we see the type of disgust that is reserved for politicians, injustice, prejudice, vulgarity, and abuse of power. This last category, which we refer to as moral disgust, is discussed in the second half of this paper.

While the lists are neither exhaustive nor entirely congruent, they do show some similarities. We suggest that the objects or events which elicit disgust can be placed in the following five broad categories:

TABLE 4 UNITED KINGDOM

feces	stained kitchen	dirty hotel
dog shit	flies	dirty cafeteria
cat shit	dead sparrow	dirty play area
dog diarrhea	rotten food	drunks
child shit on the sofa	mouldy food	drunken louts
vomit	rank smell of old grease	rude people
wounds	dirty nails	foul language
maggots	eating with mouth open	man beating a woman
sweaty person	eating a burger that a stranger had bitten into	cruelty to a horse
body parts in jars	cleaning another's false teeth	wounding of an old lady
stained toilet		

Note: Data collected from short essays on the topic of "disgust" provided by 26 members of Unilever's consumer panel in Cheshire in 1999. Paper in preparation.

TABLE 5 INTERNATIONAL AIRPORT SAMPLE

dog feces in the street; feces; dirty baby diapers; animal saliva; sputum; spitting; bogies (nasal mucus); sweat; people who do not brush their teeth; yellow teeth; vomit; seeing someone vomit; smokers; rotten food; rotten things in the refrigerator; rubbish everywhere; dirty hands before a meal and before bed; no oral hygiene; bad smells (body odor, drains, mushrooms cooking); bad body smell; smelly feet; stinky feet; bad breath; passing wind; body odor; picking nose in public; bad breath; if someone doesn't blow his nose but sniffs, especially in public transport; mucus; eaten alive by insects; cockroaches in my bed; millions of bugs clustered together; insects; cockroaches; grasshoppers; snakes; childbirth; all kinds of pigeons and birds; seagulls; dirty toilets; dirty washbasin; dirty showers; dirty fingernails; dirty glass; dirty rooms; dirty sheets; dirty environment generally; dirty beach; dirty camp site; dirty people; dying person; too much beer; eating with mouth open; wet people; wet shoes; dirty dishes; dirty clothes; old cars; sea weed; when someone has a cut finger; London Underground; pollution; rude Europeans; all Americans; Serbian government; politicians; people who eat dogs, snakes, etc.; violent verbal abuse; physical abuse; smoking when children are around; smoking in non-smoking areas; lies; spite; killing animals; animal maltreatment; injustice; [being] ripped off for being a tourist; poverty; child abuse; masturbation in public; people who don't want to learn things from others; British society in general (materialism, inequality, teenager getting pregnant to get money from the state, housing allocation for single mums in the inner cities, no tenderness with child, pornography, arrogant people breaking the traffic law, people I don't like, pickpocket, fighting, lack of respect)

Note: Data collected from 251 passengers at Athens International Airport replying to an open written question of what they find disgusting. Sample consisted of 70 undifferentiated Europeans, 104 Greeks, 19 Americans, 10 Middle Easterners, and 5 Africans (Tsagkamilis 1999).

1. Bodily excretions and body parts
2. Decay and spoiled food
3. Particular living creatures
4. Certain categories of "other people"
5. Violations of morality or social norms

Bodily secretions are the most widely reported elicitors of the disgust emotion. Feces appear on all of the lists, while vomit, sweat, spittle, blood, pus, and sexual fluids appear frequently. Body parts, such as nail clippings, cut hair, intestines, and wounds, evoke disgust, as do dead bodies. Certain animals are repeatedly mentioned, in particular pigs, dogs, cats, fish, rats, snakes and worms, lice, cockroaches, maggots, and flies. Spoiled food, especially meat and fish, and other decaying substances, such as rubbish, are disgusting to many respondents. Certain categories of other people are also found disgusting, notably those who are perceived as being either in poor health, of lower social status, contaminated by contact with a disgusting substance, or immoral in their behavior.

The sensory cues that can evoke disgust include smell; the feel of something moist, clammy, sticky, or lukewarm; and the sight of something that looks like one or many disgusting objects. Material that is seen to be "dirty" or contaminated, such as a stained toilet, clothes, sheets, or teeth, or rubbish on a beach, also cued disgust. Some substances are capable of transmitting their disgusting nature to other objects. For example, food leftovers that may have been touched by saliva, salad that has had insects in it, and food that has been cooked by a menstruating woman can become disgusting by actual or imagined contact.

EXPLAINING DISGUST

A number of writers have provided explanations for the disgust emotion. The foremost writer on disgust, Paul Rozin, suggests that disgust developed from the distaste response. He proposes that an omnivorous species such as the human benefited from a disgust response, as this reduced the likelihood of ingesting the harmful microorganisms that might be present in decayed meats, certain animal parts, and feces (Rozin and Fallon 1987). Rozin's explanation for disgust of non-food items is that it is a response to actual or threatened harm to the soul, that it arises when humans are reminded of their animal origins, and that disgust helps people to avoid confronting fears of mortality. He suggests that disgust operates by the two laws of sympathetic magic: the law of contagion (once in contact, always in contact), and the law of similarity (appearance is reality) (Rozin et al. 1999a). In a similar vein, Miller's (1997) cultural history of disgust concludes that it serves to defend both the body and the soul from pollution.

In their exploration of Darwinian medicine, Nesse and Williams (1995) suggest that an instinctive disgust may motivate the avoidance of feces, vomit, and people who may be contagious, and that disgust is one of the mechanisms crafted by natural selection to help us keep our distance from contagion. Pinker (1998) proposes that disgust is "intuitive microbiology," and that this explains our aversion to objects that have been in contact with disgusting substances: "Since germs are transmissible by contact, it is no surprise that something that touches a yucky substance is itself forever yucky."

Can we explain the extraordinary variety of the insalubrious, the revolting, the repulsive, and the downright disgusting in our collection? We believe that the line of argument proposed by Nesse and Williams and by Pinker, which explains disgust as an adaptation to the threat of disease, holds the key to the puzzle.

Microbes and parasites have always provided a potent selective force driving the evolution of the defenses of higher organisms. Whether micro-parasites, such as viruses, bacteria, and protozoa, or macro-parasites, such as internal worms or external arthropods, these organisms play a role analogous to that of predators in driving adaptation in animal populations (Anderson and May

1979). In the arms race between animals and their parasites, parasite attackers have evolved to exploit all the available ports of entry. Their hosts have evolved to protect these ports with all available defenses.

In humans, the airways, the gut, the genitals, and the skin are the four main routes of entry for parasites seeking nourishment and reproductive opportunity. Each portal has evolved multiple defenses. The gut, for example, has physical, chemical, and biological protection. Closing orifices, lysozyme in saliva, hydrochloric acid in the stomach (at a pH of between 1.5 and 2.5 the stomach is almost sterile), continual shedding of the intestinal epithelium, digestive enzymes, macrophages, and lymphocytes and their cytotoxic secretions prevent microbial invasion and destroy most penetrants. The normal gut flora also contribute to the defeat of invaders by occupying available niches on the walls of the alimentary tract and by secreting antibiotics. Similarly, the respiratory tract, the genitourinary tract, and the skin have multiple defenses that evolved as a result of competition with micro- and macro-parasites.

Disease occurs when parasitic competitors debilitate us by taking too great a share of our resources. Our multiple defensive adaptations provide evidence of the importance of this competition as a selective force. If the selective force of the pathogens was sufficient to modify our physiology, it is reasonable to suggest that the same forces were at work on our behavioral traits. Any tendency towards practices that prevented contact with, or incorporation of, parasites and pathogens would have carried an advantage for our ancestors. If the emotion of disgust can motivate the avoidance or rejection of potential sources of infection, then we have a candidate explanation for its function.

If this explanation is correct, a close correlation should exist between the objects and events that evoke disgust and the sources of infection faced by our ancestors. We do not have a good record of the ancestral disease threat; however, we do have a proxy in the well-documented patterns of modern infectious disease. We therefore examined the description of the routes of transmission of each modern infectious disease according to the standard work on the subject (Benenson 1995), excluding those that were described as rare or of low pathogenicity. We compared these with our set of disgust elicitors. For every disease (bar those in one class of infection, to which we will return), one or more elicitors of disgust was mentioned as playing an important role in transmission (see Table 6).

Feces are prime objects of disgust and are also the source of over 20 known bacterial, viral, and protozoan causes of intestinal tract infection. Vomitus is a further source of these diarrhea-inducing pathogens. Foods contaminated with these pathogens, if ingested, can carry them right inside the body. Spoiled foods may also contain neuro- and entero-toxins, produced by organisms such as *Clostridium botulinum* and *Bacillus cereus*, that can poison the eater. Droplets in breath, saliva, and nasal secretions can contain millions of viral and bacterial pathogens that gain entry via the respiratory tract, such as the measles virus,

TABLE 6 THE MAIN INFECTIOUS DISEASES OF MODERN HUMANS, CLASSIFIED BY DISGUST ELICITORS

Disgust Elicitor	*Disease/Pathogen*
Feces	Infectious intestinal disease (IID), caused by at least 20 known viral bacterial and protozoan pathogens, including *Salmonella typhi*, *E.coli*, *Shigella*, *Rotavirus*, *Giardia*; also ascariasis, hepatitis A and E, polio, amoebiasis, hookworm, pinworm, whipworm cholera, tetanus
Vomit	IID as above, viral diarrheas, cholera
Spoiled food	Intoxication from the products of *Staphyloccocus spp.*, *Clostridium spp.*, *Bacillus cereus*, etc., and infection from IID pathogens as above
Blood	Arboviral fevers, AIDS, CMV infection, hepatitis B, C, and D, lassa fever, syphilis, trench fever, trypanosomiasis
Breath (droplets)	Measles, scarlet fever, cryptococcosis, influenza, measles, meningitis, mumps, whooping cough, pneumonia, chicken pox, smallpox, tuberculosis
Nasal secretions	Viral pharyngitis, leprosy, whooping cough, pneumonia, rubella, tuberculosis
Saliva	Herpes, actinomycosis, glandular fever, syphilis, mumps
Contact	Impetigo, chickenpox, smallpox, diptheria, thrush (candidiasis), ringworm, influenza, leprosy, meningitis, rubella, scabies, yaws
Skin lesions	Staphyloccocal diseases (boils, pneumonia, toxic septacemia, etc.), chicken pox
Hair	Ringworm, head lice, pubic lice
Sexual fluids	Chancroid, chlamydial infection, herpes, CMV, gonorrhea, syphilis, trichomoniasis
Rats/mice	Arenaviral hemorrhagic fevers, capillariasis, lassa fever, rat-bite fever
Animals	Anthrax, brucelosis, campylobcter enteritis, cat scratch disease, clonorchiasis, cryptosporidiosis, tapeworms, hantaviral diseases, lung fluke disease, plague, rabies, tetanus, toxoplasmosis, tularemia, balantidiasis
Fish	Anisakiasis, fish tapeworm
Ticks	Flavivirus (e.g., tick-borne encephalitis), Bunyavirus (e.g., Crimea-Congo hemorragic fever), reoviruses (e.g., Colorado tick fever) and other unclassified tick-borne viral infections, Babesosis, Lyme disease, Ehrlichiosis, typhus fever, relapsing fever, tularemia
Fleas	Plague, typhus fever
Lice	Louse-borne relapsing fever, typhus fever, trench fever
Snails, slugs	Angiostrongliasis, schistosomiasis
Flies	IID infections, trachoma
Worms	Taeniasis (tape worms), dracunculiasis (guinea worm)

Streptoccocus pneumoniae, and *Mycobacterium tuberculosis*. These cause severe and sometimes fatal systemic disease.

Another excellent route for pathogens to reach new hosts is via the sexual organs during copulation. Gonorrhoea, for example, still affects an estimated 2 to 3 million people worldwide. Furthermore, sexually transmitted infections may have had a disproportionate selective effect on the human genome because they also tend to cause sterility.

The agents of bubonic plague and typhus, the classic plagues of history, are injected through the skin by skin parasites such as lice and fleas. Rats and other rodents are zoonotic hosts of these and other human diseases, while worms come in parasitic varieties which debilitate an estimated third of the world's population (Warren et al. 1991).

Thus bodily secretions such as feces, phlegm, saliva, and sexual fluids, as well as blood, wounds, suppuration, deformity, and dead bodies, are all potential sources of infection that our ancestors are likely to have encountered. So too are certain living creatures. The practice of avoiding these things could therefore carry a selective advantage. An aversion to contact with others, varying with the degree of familiarity, might also be advantageous. Although close family often share a common microbial flora, outsiders to the group may carry pathogens to which the insider is not yet immune. Disgust serves as an excellent trigger to their avoidance. Our data show hints of gradations of disgust. One Dutch respondent explained that "other people's dirt is dirtier than my own," while some women in the U.K. study explained that they could change their own child's nappies happily, while those of a sister's child were more problematic and those of a stranger's child hard to contemplate changing at all.

Knowing that an object has been in contact with disgusting substances renders it disgusting. The dirty bathroom may suggest splashes of bodily fluids, the clothes that have been worn and the used sheets may have soaked up secretions, and half-eaten food leftovers are suspected of having been in contact with saliva. In the Netherlands one respondent, a librarian, described how she sprayed disinfectant on books returned by a "dirty old man." A hamburger eaten unwittingly after it had been bitten into by an unknown stranger was so disgusting it caused nausea in another U.K. respondent.

If it is hard to countenance a plastic turd or one's own spit in one's own glass (Rozin and Fallon 1987), this is likely to be because of the operation of strong visual cues of a disgust object. Furthermore, if it is a good defensive reaction to avoid parasitic worms in food, then the visual cues produced by all worm-like objects may trigger disgust. Earthworms are harmless to health but may be aversive because they are long, wriggly, and slimy, and resemble intestinal helminths.

Of course, disgust has to be suspended in some cases. We could not reproduce without bodily contact; we could not bring up children without handling their bodily fluids; and we could not contemplate ourselves with equanimity if we worried about what was contained within us.

We said that there was one category of diseases that appeared not to fit the pattern described above. The exception to the pattern of revulsion aroused by the agents of disease is the class of airborne biting insects, vectors of infections such as malaria. In India and Africa, where the plasmodium-infected mosquito is common, the mosquito is not regarded as disgusting (except perhaps when laden with blood). Other airborne biting insects, such as the anopheline and sandfly vectors of dengue, filariasis, yellow fever, and trypanosomiasis, may also fail to elicit disgust. Swatting or slapping of biting insects to lower the risk of infection may be motivated by reflexes or emotions other than disgust. More data on the universality and variability of disgust of macroparasites are needed.

AN OLD THEORY IN NEW CLOTHES?

Of course, the hypothesis that disease avoidance is responsible for certain behaviors is not new. In 1841, for example, Kellog proposed that the Mosaic dietary laws, such as the avoidance of the meat of the pig, could be explained by the need to avoid parasites. A century later, Tylor (1958) proposed that ritual pollution in primitive cultures must have had practical health functions. In 1966, Mary Douglas labeled such arguments "medical materialism" and suggested they had little value because the transmission of disease was not understood at the time in question. She proposed instead that dietary rules in different cultures could be explained by the way in which cultures classify the world. She argued that for a society to function, it has to have an agreed cosmology—a set of organizing principles that provides explanation and purpose, such as a religion or an ideology. Exceptions to those organizing principles are anomalies that threaten the system itself, and these are therefore cast out and designated dirty and impure. Waste products transgress body boundaries and are neither live nor dead, and so count as dirty; social marginals become "dirty old men." Both threaten the coherence of the system and are cast out.

Much anthropological theorizing since Douglas has been devoted to explaining the many and varied food aversions that are encountered worldwide. Levi-Strauss (1970) pointed out that food tastes are culturally shaped and socially controlled and that what is eaten has symbolic and metaphorical meaning. More recently, Harris (1985) has proposed that food aversions are related to economic factors. Harris suggests that insects, for example, were rejected in many cultures because they were not a cost-effective food source, and horses because they were needed by the cavalry for war-making. Anthropologists and psychologists have written much about the variability of food-related aversions, but have not pointed out cross-cultural similarities. Nor have they offered much in the way of explanation for other elicitors of disgust.

Evolutionary explanations for aspects of human behavior have an advantage over their predecessors in that they are based on causal theory, the theory of evolution by natural selection. This presents a means by which beneficial

behaviors can arise without the need for a conscious understanding of the link between behavior and benefit. It also allows the nature of the benefit to be stated explicitly in terms of a greater number of surviving genes. However, the use of evolutionary theory as a means of explaining human behavior has not been embraced by many current writers on disgust. Rozin suggests that disgust may have arisen as a mechanism for avoiding spoiled food, but he rejects the hypothesis that disease prevention is at the heart of disgust on the grounds that not all decayed substances evoke disgust and that certain animal species exhibit coprophagy (Rozin and Fallon 1987). We would contend that one would expect a gradation in the disgust of decayed objects according to the threat they pose. For example, decaying meat is far more likely to contain the microbes that pose a risk of infection or intoxication than withered lettuce, and thus it is far more aversive. Coprophagy generally serves to extend the limited length of the digestive tract of certain herbivores (Hörnicke and Björnhag 1979), and it may be limited to the ingestion of the animals' own feces and not those of other animals. According to Hart (1990), there is evidence that sheep, horses, cattle, felids, canids, baboons, and mangabey monkeys display aversion to the ingestion of faecal material.

Though Miller (1997) categorically rejects any evolutionary origins for disgust, he describes the conditions that evoke the emotion thus: "Temperature, it seems, disgusts precisely in those ranges in which life teems, the temperatures must be sufficient to get the old life soup bubbling, seething, wriggling and writhing, but not so great as to kill it." What better description could we have of the conditions necessary for the survival and multiplication of pathogenic organisms in the environment?

A further objection to our hypothesis is that disgust cannot be innate, since infants do not appear to develop a disgust reaction till they are between two and five years of age (Rozin and Fallon 1987). However, a later appearance does not mean that the emotion is not innate. It may be present as a predisposition (Seligman 1971), in much the same way that attraction to the opposite sex begins during puberty (whatever the efforts made in a diversity of cultures to suppress it). It is well established in the human autonomic conditioning literature that it is easier to extinguish conditioned reactions to neutral objects, such as flowers and geometric figures, than to spiders and snakes (Mineka and Cook 1993). There may be similar predispositions in children, such that, for example, a disgust of feces is easily conditioned, while conditioning a disgust of sweets would be much harder. Mineka and Cook have shown how fear conditioning in monkeys takes place in response to seeing another monkey exhibit fear of specific objects (snakes and crocodiles, but not flowers or a toy rabbit). Repacholi's (1998) finding that children learn disgust of specific objects by seeing their mothers disgust face suggests that something similar may take place in human infants.

If disgust does not appear early, it may be because it is not needed. Hrdy

(1999) suggests that children were generally carried about by and maintained close contact with their mothers to a much more advanced age in our evolutionary past than at present. A mother's disgust response could protect both from infection until the child became independent, with a disgust response of its own. Cashdan (1994) suggests that a lag in the development of the disgust response may provide a window of opportunity from birth to age two in which to learn local food preferences. This ability to learn from others what is good for us and what not is one of the tricks that has allowed humans to inhabit hugely varied ecological zones.

Disgust is clearly a part of our psychological makeup, and certain stimuli seem far more likely to become disgusting than others. Yet at least a number of the specific objects, acts, and events that occasion disgust vary from place to place and from individual to individual and are clearly plastic to social learning. To paraphrase Mineka and Cook (1993) on the fear of snakes: "disgust is an instinct that has to be learnt."

Though the idea that disgust evolved to protect against disease is not a new one amongst evolutionary psychologists (Nesse and Williams 1995), this hypothesis has not been examined in detail or taken beyond the complexities of the food aversions of different cultures (Pinker 1998). It is only when the full range of common disgust objects is juxtaposed with the full range of infectious disease that the pattern falls into place.

MORAL DISGUST

Though we may have a working hypothesis to explain the origins and function of the disgust emotion, we still have to explain the moral dimension of disgust. Miller (1997) suggests that vice is almost always met with disgust. He notes that vile, loathsome, abhorrent characters and deeds are condemned by a visceral instinctive reaction of disgust without recourse to higher-level moralizing. Why should cruelty, bad manners, vulgarity, rape, bragging, hypocrisy, torture, child abuse, racism, prostitution, pornography, politicians, the filthy rich, beggars, the dirty poor, and the lower castes provoke disgust, as he suggests? One possibility is that disgust is being used metaphorically to describe a sensation of moral outrage. However, we suspect that this is more than a coincidence, given the similar findings on different continents and the insistence by some respondents as to the congruence of the sensations.

Rozin, et al. (1999b), note that primate societies, particularly those of chimpanzees, bonobos, and humans, are markedly sensitive to violations of the social order and defections in dyadic relationships. They argue that this is the basis upon which human morality developed. Building on a proposal by Shweder, et al. (1997), that human social order is maintained by the three moral codes of community, autonomy, and divinity, Rozin, et al. (1999b), hypothesize that violation of these codes leads to the emotions of contempt,

anger, and disgust, respectively. He charges disgust with the task of protection of the human soul. This hypothesis makes interesting predictions that have found some support in laboratory experiments.

Our own hypothesis for the role of disgust in morality is more prosaic and hinges on selective advantage to an individual (or group). Morality is a defining feature of human culture and arises from the altruism, cooperation, and social norms that bind individuals together into societies (Dennet 1995). Evolutionary explanations for altruism have been proposed, using selection at the level of the individual and, more recently, at the level of the group (Hamilton 1964; Ridley 1996; Sober and Wilson 1999; Trivers 1971). Whatever the route by which it evolved, a strong moral sense of social justice is unquestionably present in modern humans. We cooperate, but we readily detect what is not fair, and we have an urge to punish defection from social contracts (Boyd and Richardson 1990). If disgust began as aversion to physical parasites, it may have come to serve an extended purpose, that of an aversion to social parasites. If overly selfish behavior such as cruelty, greed, bullying, rape, or child abuse is met with disgust, then avoidance of the perpetrator is a helpful reaction, one which may also serve to punish and ostracize the parasite.

CONCLUSIONS

Though disgust has been recognized as an emotion since the days of Darwin, it has only been seriously studied relatively recently. The cross-cultural variation in food aversions has led to much speculation among psychologists and anthropologists about why some foods are acceptable in one context but disgusting in others. Equally striking, however, is the similarity across cultures in the types of things that elicit disgust. Rozin and Fallon (1987) note the widespread disgust at animal products and suggest a universal human need to protect the human soul from reminders of the mortal and animal nature of the human body. We believe that these aversions can be better explained from an evolutionary perspective as evolved aversions to potential sources of disease which pose the threat not just of mortality, but of genetic extinction. We suggest that the disgust emotion polices the vulnerable portals of the body, defending them from the ingress of pathogens and parasites.

We also propose that the disgust emotion may extend to moral disgust at violations of social norms, and that this may serve to promote the avoidance of social rather than physical parasites.

Because our data are limited both in terms of the methods of collection and the number and variety of cultures investigated, we do not claim that they demonstrate the existence of universal categories of disgust elicitor. They do, however, suggest that this is an avenue worthy of further investigation.

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