

Varieties of Disgust Faces and the Structure of Disgust

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In 3 facial expression identification studies, college students matched a variety of disgust faces to verbally described eliciting situations. The faces depicted specific muscle action movements in accordance with P. Ekman and W. V. Friesen's (1978) Facial Action Coding System. The nose wrinkle is associated with either irritating or offensive smells and, to some extent, bad tastes. Gape and tongue extrusion are associated primarily with what we call *core* or *food-offense* disgust and also *oral irritation*. The broader range of disgust elicitors, including stimuli that remind humans of their animal origins (e.g., body boundary violations, inappropriate sex, poor hygiene, and death), a variety of aversive interpersonal contacts, and certain moral offenses are associated primarily with the raised upper lip. The results support a theory of disgust that posits its origin as a response to bad tastes and maps its evolution onto a moral emotion.

Since the writings of Darwin (1872/1965), facial expression has been at the core of the description of the emotions. The idea of fundamental, universal emotions is supported by some cross-cultural invariance in the assignment of certain faces to specific emotions (Ekman, 1971, 1989; Izard, 1971). The focus of research on facial expression in recent decades has been documentation of the linkage between prototypical faces and emotions. A second aim has been to achieve a level of greater complexity by examining faces that show elements of more than one fundamental emotion. Researchers have devoted surprisingly little attention to looking at the variations within faces associated with one fundamental emotion with the aim of understanding the structure of elicitors of that emotion.

The expressive component of disgust has been studied almost entirely with reference to the face. The features of the prototypical disgust face have been described by Darwin (1872/1965), Izard (1971), and Ekman (Ekman, 1971; Ekman & Friesen, 1975). All agree that a set of facial movements around the mouth and nose are central to disgust, but there is not a complete consensus on the precise set of movements. Darwin emphasized the gape (Ekman & Friesen's [1978] Facial Action Coding System [FACS] Action Unit [AU] 26) but also referred to retraction of the upper lip (AU 10) and, to some extent, the nose wrinkle (AU 9), dropping of the mouth corners (AU 15), and various other movements. Izard (1971) also focused on the gape and the upper lip retraction, along with some additional movements, whereas Ekman and Friesen (1975) focused on upper lip retraction and nose wrinkle along with a raising of the chin (AU 17).

Darwin (1872/1965) wrote, "As the sensation of disgust primarily arises in connection with the act of eating and tasting, it

is natural that its expression should consist chiefly in movements around the mouth" (p. 257). The gape (and tongue extension) has obvious functional significance in expelling mouth contents, and the nose wrinkle may function to retard inhalation of odors. The upper lip raise may have a weaker retarding effect on odor inhalation, or it may have no functional significance with respect to oronasal rejection.

The list of fundamental emotions has varied somewhat over the last 100 years, but it usually has included 6–10 emotions and, from Darwin onward, has always included disgust. Disgust seems to have had a unique cultural evolutionary trajectory, which has been mapped out by Rozin, Haidt, and McCauley (1993). It seems to originate in the "distaste" facial response of infants to bitter tastes. Later it becomes (both in development and, we believe, cultural evolution) more an indication of revulsion at the prospect of oral incorporation of an offensive substance (Angyal, 1941; Rozin & Fallon, 1987).

At this point, it is an ideational form of food rejection and is conceptually separable from the response to bad tastes (Rozin & Fallon, 1987; Rozin et al., 1993). The most potent elicitors of core disgust are body waste products (Angyal, 1941) and animals and their products, when considered primarily as potential foods. The domain of disgust expands, so that for adults in many cultures it is involved with violation of body borders at points other than the mouth and has clear links to sex, gore, poor hygiene, and death (Haidt, McCauley, & Rozin, in press; Rozin et al., 1993). These latter linkages, when added to the excretory and ingestive foci of core disgust, are all indicators of animal functions.

We have suggested that, at a second level of elaboration beyond core disgust, disgust reflects the human concern to be distinguished from other animals or to not be considered as an animal at all (Haidt et al., in press; Rozin & Fallon, 1987; Rozin et al., 1993). What we call *animal-origin disgust* reflects a rejection of any suggestion that humans are animals. The desire not to be considered an animal may itself have as its root a concern with death, an animal property shared by humans that is particularly unsettling and one that we try to put out of our minds (Becker, 1973; Haidt et al., in press; Rozin et al., 1993).

We have identified two possible further expansions of disgust, which do not have a close conceptual relation to either core or

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animal-origin disgust. One is *interpersonal contamination*, a disgust elicited by physical contact, directly or indirectly, with strangers or undesirable people (McCauley, Rozin, & Markwith, 1993; Rozin, Markwith, & McCauley, in press). A second area of expansion is the moral domain of disgust, wherein Americans frequently describe actions such as child abuse, infidelity, and incest as disgusting (Haidt et al., in press; Rozin et al., 1993).

All of these varied disgust elicitors may have in common simply that we reject them from the self. They may simply represent the attachment (in cultural evolution and development) of a powerful rejection/offense system to an expanding set of undesirable entities.

In spite of this richness, disgust has received very little attention from psychologists (with the exception of Angyal, 1941; Tomkins, 1963) until recently (see Izard, 1977; Levenson, Ekman, & Friesen, 1990; Rozin & Fallon, 1987; Rozin et al., 1993, for an overview). Disgust has a particular advantage for research in that it is easy to elicit in the laboratory in a realistic way—without presenting serious ethical problems. The richness in the eliciting conditions allows a great deal of information to be communicated in disgust expressions. Appropriately, with all the variations in the descriptions of basic emotions over the years, the most common addition has been (on a number of independent occasions) the split of disgust into contempt and disgust (e.g., Ekman & Friesen, 1986; Izard, 1971). Izard (1971), in his extensive cross-cultural studies on emotion, sometimes divided what has traditionally been called *disgust* into three distinct emotions: *contempt-scorn* (characterized by cocked eyebrow and uplifted head), *disgust-revulsion* (characterized by wrinkled nose, raised upper lip, and protruded tongue), and *disgust-contempt* (unilateral raising of the upper lip; Izard, 1971, pp. 236–245). However, in most of his (and other's) research, the distinction between disgust-revulsion and disgust-contempt is collapsed. Tomkins (1963) identified a separate disgust response to bad smells.

The range of disgust elicitors suggests a possible differentiation of disgust faces that might have both functional and communicative value. In advance of this study, we considered the following two hypotheses about the differentiation of disgust.

1. Because disgust is a rejection-from-self emotion, the facial expression might reveal the offended modality. Peiper (1963) presented evidence that strong stimulation of a particular sensory modality (visual, oral, or olfactory) would generate a face in which closure of the appropriate entry point was most salient (e.g., nose wrinkle in response to negative odors and closed eyes in response to bright light), with some radiation of this response to other parts of the face. To test this hypothesis, we included in this study situations involving experience of unpleasant tastes or odors. The situation with both taste and smell is complex, because both are incorporative senses, that is, they involve taking substances into the body. Hence, whereas "closing" the sense off will prevent the entry of new stimuli (molecules), it will not get rid of molecules already in place. Indeed, the response for the mouth of ridding the self of an undesirable taste, that is, gape along with tongue extension, is the opposite of what one might do to prevent access to the mouth. Nonetheless, we predicted that the source (olfactory-oral) of the disgust elicitor would be reflected in the facial expression.

2. Insofar as disgust takes on moral tones, it may come to

share some properties of anger, a central moral emotion. In particular, the upper lip raise, a component of the expression of anger, may become a salient part of the disgust expression under such conditions. Therefore, we predict that upper lip retraction will be less associated with bad tastes and smells, or core disgust, and more associated with animal origin and especially moral disgust.

In addition, in considering the development of disgust, we noted that the classic pursed lips face of infants, attributed to stimulation by sour tastes (Peiper, 1963; Rosenstein & Oster, 1988; Steiner, 1977), also occurs in adults. Since the other negative infant "taste-face," the gape associated with bitter, seems to have been co-opted by the disgust system, we wondered about the fate of the "sour" expression. Pursed lips or pressed lips faces and a variety of sour-face-eliciting situations were included in the protocol of this study.

The precise componential analysis of disgust expressions was made possible by the classic methodological work of Ekman and Friesen (1976, 1978; including recent changes: Friesen & Ekman, 1993), whose FACS allows for the description of the state of activation of all of the facial muscles from a still photograph. The stimuli for this study were posed faces designed to present relatively isolated disgust component facial AUs. We compared the situations attributed to the action of each AU and never presented the subjects with a "full" disgust face that combines them all.

Experiment 1

Method

Subjects

The subjects for this study were 45 paid student volunteers taking an introductory psychology course at the University of Pennsylvania. Data were collected from two groups of students who remained after class on 2 days. Each student was given four answer sheets and four face sets to rate. The entire procedure took less than 1 hr.

Posed Faces

Four persons posed by making 12 specific facial gestures, and the sets of photographs generated were used as stimulus materials. Posers were selected to include two men and two women, with one of each gender of college student age and the other of middle age. Posers were also required to be able to manipulate their facial muscles on command (to a degree that would eliminate a majority of people) and to be willing to have their photographs used in the research.

Photographs were taken outdoors, with flat lighting. Posers were instructed to make specific facial expressions with specific muscle movements. When a satisfactory face had been achieved, the picture was taken. Approximately 36 pictures were taken of each poser, including a neutral face, which was necessary for FACS coding of the faces. Two of the face sets were photographed under the supervision of Paul Ekman, and one additional set was taken of Paul Ekman himself. Professor Ekman also generously agreed to FACS code all of the pictures that were candidates for use in the study. Figure 1 presents the 12 faces of one of the posers in the exact form that they were provided to the subjects. The caption of the figure indicates, for each face, the ideal expression that was sought, in words and in AUs. Minor departures from the ideal (addition of an occasional uncalled-for AU) occurred for a few posings of each poser. These were uncommon and were different for different posers.



Figure 1. Display of faces for one poser (L) as actually seen by subjects. From left to right, top to bottom, each display is described verbally, then by the ideal facial actions in the Facial Action Coding System (FACS) that were the target of the display, and then by the actual FACS coding of the face. L1, fear (ideal: Action Units [AUs] 1, 2, 4, 5, and 20; actual for L: 1, 2, 5, 12, and 20); L2, surprise (ideal: AUs 1, 2, 5, and 26; actual: 10, 20, 5, and 26); L3, nose wrinkle (ideal: AU 9; actual: AUs 9 and 25); L4, upper lip raise (ideal: AU 10; actual: AUs 7, 10, and 25); L5, upper lip raise and gape (ideal: AUs 10 and 26; actual: AUs 7, 10, and 26); L6, unilateral smirk (ideal: unilateral AU 14; actual: AU unilateral 14 + AU 12); L7, purse (ideal: AUs 18 and 24; actual: AUs 17, 18, and 24); L8, gape with tongue extension (ideal: AUs 19 and 26; actual: AUs 19 and 26); L9, unilateral upper lip raise (ideal, unilateral AU 10; actual, unilateral AU 10); L10, upper

The 12 photographs of each poser were arrayed in a 4-row \times 3-column matrix, as in Figure 1. Multiple high-quality xeroxes were made from these four originals, and each subject was provided with an 8.5- \times 14-in. page of photographs for each of the posers. Photographs were numbered, for convenience in reference, in terms of their position in the array, with a letter indicating the identity of the poser (see Figure 1).

The faces selected were of two types: standard expressions of three fundamental emotions that might be confused with disgust (fear, anger, and surprise; corresponding to pictures L1, L12, and L2 in Figure 1, respectively) and nine expressions of specific facial AUs that were hypothetical components of disgust. These are indicated in Figure 1 and its caption and include relatively isolated occurrences of nose wrinkle (L3 in Figure 1), gape (L5), and upper lip raise (L4), along with various combinations of these and other AUs.

Questionnaire Form and Procedure

Subjects filled out a separate questionnaire form for each poser. Each form included questions on the subject's gender and age and also the identity of the poser being rated. Subjects were handed four forms, each with a set of photos clipped to the front. The order of the four posers varied randomly between subjects. Subjects were instructed to complete the top form for the top set of photographs, then proceed to the second set, continuing on until all four sets were completed.

Instructions on the form were as follows:

Select the picture that most clearly depicts the reaction you would expect in the situation described, and then place that picture's number in the space provided at the left of each item. Now, using the following scale, rate your confidence in the picture you've chosen: that is, how closely do you feel that picture actually reflects the given situation. Finally place your confidence rating in the space provided to the right of the situations.

Confidence rating scale: 4 = *perfect*; 3 = *very good*; 2 = *fair*; 1 = *a poor depiction but better than any of the others*.

The 55 situations were selected to include negative sensory stimulation of mouth (sour or bitter), nose, and eyes; more ideationally offensive stimuli entering through different sensory modalities; a variety of food and nonfood prototypical disgust situations (including sex, gore, poor hygiene, death, interpersonal contamination, and moral offenses [Rozin, Haidt, & McCauley, 1993]); some situations designed to be prototypical for related emotions (fear, anger, embarrassment, surprise, and skepticism); and one-word emotion labels (e.g., *disgust*, *contempt*, *skeptical*, and *embarrassed*). The full item list is presented in the caption for Figure 2, in the ordering suggested by the multidimensional scaling analysis. The items were presented to the subjects in a randomized order for half of the subjects and in the reverse of this randomized order for the other half.

Of 45 subjects who participated in the survey, one neglected to rate the faces for one poser. The sample for data analysis is the other 44 subjects; there were few missing values across the 220 (55 \times 4) responses for each of these subjects. For each item, the distribution of 12-face selections for each poser was tabulated along with the average confidence rating.

Results

Consistency Across Posers

For each situation and for each poser, there is a frequency distribution of the number of the 44 selections (44 subjects each

make 1 selection) across each of the 12 faces. An indication of the consistency of ratings across the different posers is the correlation of the distribution of the 44 judgments across the 12 faces for each pair of posers. Given 4 posers, there are 6 possible pairings for each situation, or a total of 330 (55 questions \times 6 pairings of posers) correlations. These correlations are extremely high. The mean correlation is .67; 35% of correlations are above .80, and only 8% are below .30. The items with the lowest correlations are "feeling shame" (mean of the 6 correlations is .27) and "having a toothache" (mean is .34). In neither case had we selected posers' faces to match the appropriate emotions. The high degree of consistency justifies our combining the data from all targets into one frequency distribution.

Correlation of Facial Selection Patterns for Different Items

The data used for this and subsequent analyses is the frequency distribution of 176 responses across the 12 faces for each of 55 situations. We constructed a correlation matrix by calculating Pearson product-moment correlations (as measures of similarity and not for the purpose of evaluating statistical significance) between the distribution of responses for every pair of the 55 situations. Each correlation would have as entries the corresponding numbers of responses for each of the 12 faces for two situations. Thus, for the 12 selected situations presented in Table 1, the correlation between sex-15/90 and morgue would be calculated by entering 12 and 25 as the first pair (frequencies of response in each situation for the nose-wrinkle face) followed by 35 and 43 for the upper-lip-raise face, and so on through the remaining 12 faces. The Pearson correlations between neighboring situations are also presented in Table 1.

We then subjected this (55 \times 55) similarity matrix to multidimensional scaling, using the Kruskal method with a maximum of 50 iterations and a Euclidean metric (SYSTAT, 1990). A one-dimensional analysis accounted for 47% of the variance, with various forms of core and expanded disgust at one end and contempt, skepticism, embarrassment, and anger at the other end. The two-dimensional analysis (displayed in Figure 2) accounted for 71% of the variance. The first (horizontal) dimension resembles the one-dimensional analysis and clearly distinguishes disgust situations, at the right, from other emotions (anger, surprise, fear, skepticism, and embarrassment) on the left. All of the items with an a priori relation to disgust appear on the right of this figure. The only items on the right half (and near the center) that are not disgust related are "feeling pain," "looking at a very bright light," and "eating a lemon" ("injection" can be thought of as disgust related, as a body violation). The significance of the vertical dimension is not clear. Within the disgust half of the array, it seems to move from chemical-sense, food-specific, proximal stimuli at the bottom to the other and more distal (visual, sex, and gore) aspects of disgust toward the top. A three-dimensional scaling accounted for 88% of the variance, with a very similar first dimension. The second dimension seemed to represent, facially, eyes closed or open, with

lip raise and lip stretch (ideal, AUs 10 and 20; actual, AUs 7, 10, and 20); L11, pressed lips (ideal: AUs 6, 17, and 24; actual: AUs 6, 12, 17, and 24); L12, anger (ideal: AUs 4, 5, 7, 17, 23, and 24; actual: AUs 1, 7, 17, 23, and 24).

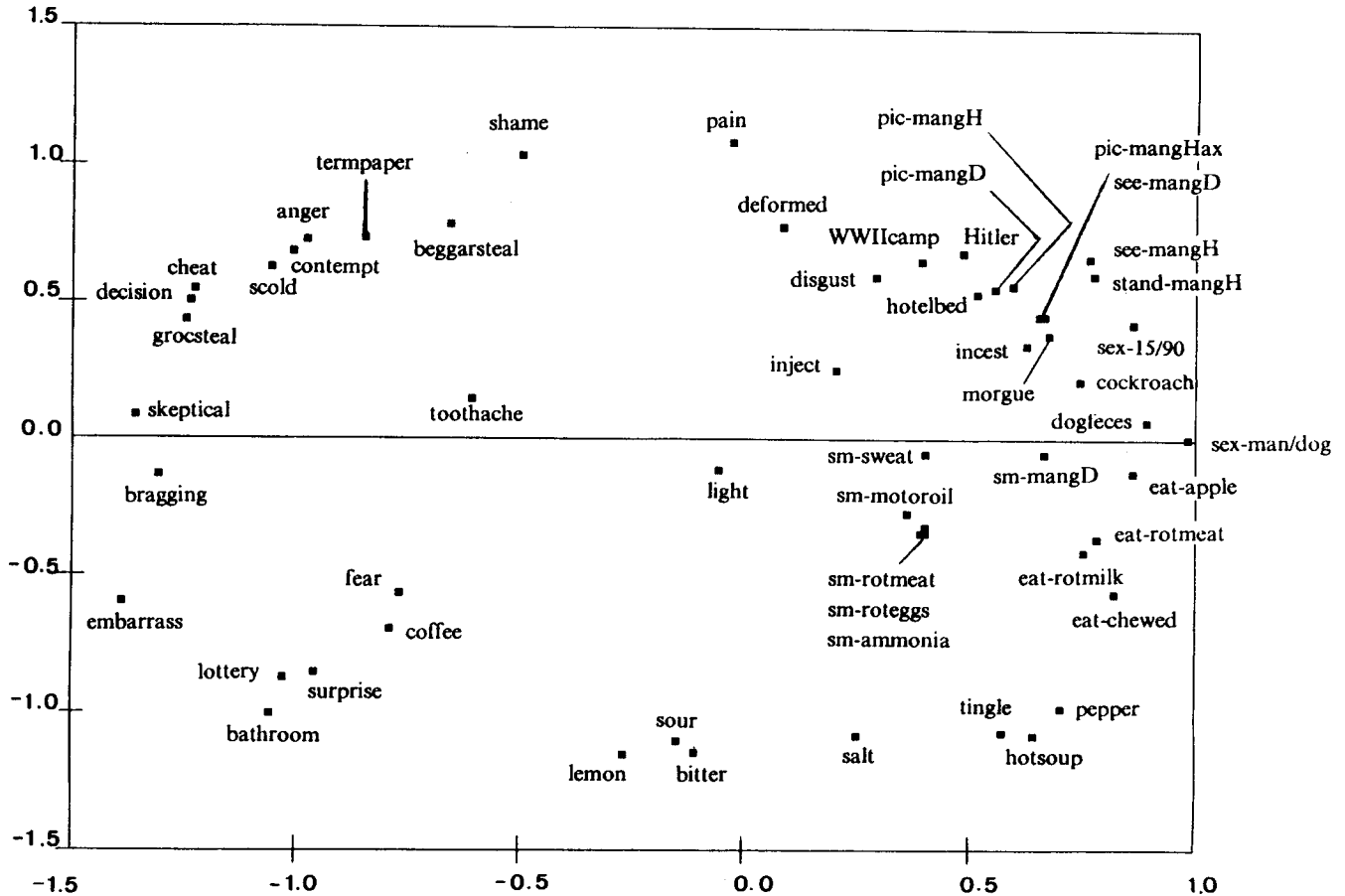


Figure 2. Two-dimensional multidimensional scaling of similarities of facial expression choices for 12 display faces (summed across four posers) to 55 situations. Abbreviations and full description of each situation (as presented to subject) follow, in the groupings represented by the multidimensional scaling, and as discussed in the text, beginning at the bottom center of the display. **BAD TASTES.** *lemon*: eating a lemon; *sour*: eating something sour; *bitter*: eating something very bitter; *salt*: eating a half teaspoon of salt. **ORAL BURN/IRRITATION.** *tingle*: eating something that makes your mouth tingle and burn; *hotsoup*: drinking from a cup of scalding hot soup; *pepper*: eating a half teaspoon of hot pepper. **BAD SMELLS.** *sm-ammonia*: smelling ammonia; *sm-roteggs*: smelling a pure chemical in a bottle that smells like rotten eggs; *sm-rotmeat*: smelling the odor of rotten meat; *sm-motoroil*: smelling motor oil; *sm-sweat*: smelling the sweat of a person you are standing next to on the subway; *sm-mangD*: seeing and smelling the remains of a mangled dog that was just hit by a car as you walk past it on the road; *light*: looking at a very bright light. **CORE DISGUST (in mouth).** *eat-chewed*: eating food after it has been chewed by someone else; *eat-rotmilk*: starting to drink a glass of milk and discovering that it is spoiled; *eat-rotmeat*: eating a piece of rotten meat; *eat-apple*: thinking about the fact that yesterday you ate an apple with a worm in it. **EXPANDED DISGUST.** *sex-man/dog*: watching intercourse between a man and a dog; *dogfeces*: reacting to stepping in dog feces; *cockroach*: looking at a plate of food with a cockroach on it; *sex-15/90*: watching a fifteen-year-old and ninety-year-old have sex; *morgue*: watching a body in a morgue being dissected; *incest*: thinking about your best friend engaging in incest; *see-mangH*: through the window of your own car looking at a mangled human body, just having been hit by a car; *stand-mangH*: standing over a mangled human body just after it was hit by a car; *see-mangD*: on the road while driving seeing a mangled dog, just having been hit by a car; *pic-mangHax*: looking at a picture of a mangled body that resulted from an axe murder; *pic-mangH*: looking at a picture of a mangled human body that was just hit by a car; *pic-mangD*: seeing a picture of a mangled dog that was just hit by a car; *Hitler*: wearing Adolph Hitler's sweater; *WWIIcamp*: looking at pictures of the slaughter at a World War II concentration camp; *hotelbed*: sleeping in a hotel bed on which the linens have not been changed; *disgust*: feeling disgust; *deformed*: seeing a deformed person; *pain*: feeling pain; *inject*: watching someone get an injection with a big needle. **ANGER/SHAME/CONTEMPT.** *shame*: feeling shame; *beggarsteal*: watching someone steal money from a blind beggar's cup; *termpaper*: reacting to someone who sabotaged a friend's term paper before it was handed in; *anger*: feeling anger; *contempt*: feeling contempt; *scold*: scolding a little child; *cheat*: watching someone cheat on an exam; *decision*: trying to make an important decision; *grocsteal*: watching someone steal groceries from the shelves of a supermarket; *skeptical*: feeling skeptical; *bragging*: reacting to someone bragging of accomplishments that you doubt he/she carried out; *toothache*:

Table 1
Frequency Distribution of Selected Situations by Face Type

Situation	Nose wrinkle	Lip raise	Unilateral lip raise	Lip raise and stretch	Lip raise and gape	Tongue out and gape	Unilateral dimpler	Lip press	Pucker	Fear	Surprise	Anger	Pearson <i>r</i> for neighboring rows
Eating something sour	39	6	2	3	1	13	2	51	52	5	2	0	.97
Eating something very bitter	28	6	4	10	7	17	3	40	50	4	7	0	.08
Drinking from a cup of scalding hot soup	2	1	0	17	24	75	0	15	10	25	2	5	.97
Eating a half teaspoon of hot pepper	6	1	0	16	19	99	1	5	2	17	1	8	-.08
Smelling a pure chemical in a bottle that smells like rotten eggs	118	14	12	4	8	8	0	6	0	2	4	0	1.00
Smelling ammonia	113	18	9	4	10	5	2	6	1	5	3	0	.63
Eating a piece of rotten meat	50	16	1	9	36	47	1	7	6	2	0	1	.77
Thinking about the fact that yesterday you ate an apple with a worm in it	26	36	20	6	21	49	3	7	1	3	2	0	.65
Watching a 15-year-old and 90-year-old have sex	12	35	22	6	33	22	6	4	3	7	3	23	.66
Watching a body in a morgue being dissected	25	43	13	27	27	16	2	2	1	10	4	5	.67
Sleeping in a hotel bed on which the linens have not been changed	18	46	45	10	17	22	7	4	3	3	0	1	-.09
Feeling anger	7	11	28	13	6	0	0	1	20	2	86	1	

Note. The situations presented in this table are arranged roughly according to their relative positions on the multidimensional scale. *N* = 44 (across the four target posers).

fear-surprise at one end and bright light, bad smells, and contempt at the other. The third dimension was anchored by bad tastes at one end and moral offenses at the other.

The groupings of situations displayed in the two-dimensional analysis (Figure 2) were confirmed by a hierarchical cluster analysis on the same similarity matrix. Referring to Figure 2, starting at the 6 o'clock position and moving counterclockwise, lie the following groups: bad tastes (sour, bitter, and salt); oral burn and irritation; bad smells (irritating or decay); ingestion of

used or decayed food; a residual, large expanded disgust category (emphasizing sex, gore, visually upsetting scenes, deformity, and the word *disgust*); a very poorly defined category in the center having to do with fear and pain; shame (one item); an anger-contempt cluster; and small clusters for skeptical, embarrassment, and surprise.

The most striking results of this analysis are the clear separation of disgust from other emotions, including contempt (which sorts with anger), and the subdivision of disgust into a number

having a toothache. FEAR/EMBARRASSMENT/SURPRISE. *embarrass*: feeling embarrassed; *lottery*: being told that you won a large sum of money in a lottery; *bathroom*: walking into a public bathroom of the opposite sex by accident and running into a person leaving; *surprise*: feeling surprise; *coffee*: watching a person who doesn't like coffee drink a cup of very strong black coffee; *fear*: feeling fear.

of coherent categories. In the next section, we discuss the specific linkages between each of these groups and specific facial expressions.

Components of the Disgust Face: Situation–Face Correspondences

The sour face. Two poses, pressed lips (Face L11 in Figure 1) and pursed lips (Face L7), represent what might be called a *classical sour face*, with the purse being more typical. The distinction between these two faces is blurred because an element of lip pucker was introduced by two of the posers into the tight-lipped display. These two expressions accounted for 59% of the responses to “eating something sour” and 62% of responses for “eating a lemon.” Hence, our subjects do associate the classic sour face with a sour taste. The surprising finding here is that the selection for “eating something bitter” was 51% for the two “sour” faces, with only 14% of subjects showing the supposedly classic gape (Face L5 or Face L8 in Figure 2). Hence, in terms of recognition, adults tend to use the “infant sour lip press or purse” expression to indicate a bad, sour, or bitter taste. A strong salt taste shows a less clear profile and a less well-defined location in the multidimensional scaling, with strong components of both lip press or purse (34%) and gape with tongue extension (31%).

Oral burn and irritation. The gape, with or without tongue protrusion or upper lip raise, which we expected to be the bitter face and the foundation of the disgust expression, was much more clearly associated with unpleasantly strong nongustatory stimulation of the mouth. The combination of gape and tongue protrusion dominates the response to “eating something that makes mouth tingle and burn” (47%), “drinking scalding hot soup” (43%), and “eating a teaspoon of hot pepper” (56%). Hence a second, gape-based cluster of disgust responses has to do with negative nongustatory oral stimulation.

Bad smells. A third category is bad smells, in which, appropriately for Peiper’s analysis, nose wrinkle is the dominant response. This holds whether the odor is “disgusting,” for example, from decay (“smelling rotten meat,” 70% nose wrinkle; “smelling rotten eggs,” 67% nose wrinkle) or irritating (e.g., “ammonia,” 65% nose wrinkle). Four other items show a highest frequency for nose wrinkle, including “smelling motor oil” (45%), “looking at a bright light” (52%, probably because of the co-occurrence of squinting with nose wrinkle), smelling sweat (34%), and smelling the remains of a dead dog (36%).

Eating used or decayed food. This category of four items includes “drinking spoiled milk,” “eating rotten meat,” “thinking about the fact that you ate an apple with a worm in it,” and “eating food after it was chewed by someone else.” The category shares with oral burn and irritation the gape component but also includes a significant representation of nose wrinkle.

Elaborated disgust: Animal origin, interpersonal, and moral disgust. This diverse set of 17 items that group together in the multidimensional scaling encompasses most of disgust in the broad (non-ingestion-related or beyond core disgust) sense. The cluster is most associated with upper lip raise, an action that has more of an anger–offense connotation than a “rid-it-from-the-mouth” function. The item “feeling disgust” loads most heavily on upper lip raise (30%), with unilateral upper lip raise and gape with tongue extension the next most common responses. Of the

17 items, 14 load most heavily on upper lip raise (Face L4) and three on gape plus upper lip raise (Face L5). The two items with the highest upper lip raise and gape score have to do with dogs (human–dog intercourse and stepping in dog feces), whereas the two items most dominant for upper lip raise alone are “seeing a deformed person” and “looking at pictures of the slaughter in a World War II concentration camp.”

Overall, the 16 items (other than “feeling disgust”) that invoke a prominent upper lip raise can be classified as follows: (a) gore and death (6 instances of mangled human or dog bodies, concentration camp, and morgue dissection), (b) sexual “violations” (bestiality, inappropriate age, and incest), (c) interpersonal contamination (Hitler sweater and dirty hotel linen), (d) animal disgust substances (cockroach on plate and stepping in dog feces), and (e) deformity (seeing a deformed person). These examples cover the taxonomy of disgust-eliciting situations developed by Haidt et al. (in press) in the development of a disgust scale. With the exception of interpersonal contamination, they fit neatly into the “humans are not animals” frame that we propose as the second level of elaboration of disgust (Haidt et al., in press; Rozin & Fallon, 1987; Rozin et al., 1993).

Unilateral upper lip raise (Face L9) may be a strong indicator of disgust and appears in Izard’s (1971) example of disgust–contempt. It was not chosen very frequently in this study, when in competition with other potential disgust faces; the highest frequency of choice for this item was 26%, for “sleeping in a hotel bed on which the linens have not been changed.” This is an interpersonal contamination item, a link that may be significant, because the second highest loading on this expression (20%) is “wearing Adolph Hitler’s sweater.”

Anger and contempt. Eight items, headed by “feeling anger” (49%), show a highest loading on the classical anger face. Many of these items (but not the “trying to make an important decision” item) also score heavily on unilateral upper lip raise, an expression sometimes associated with contempt or disgust in the literature. It is notable that in this collection of faces, contempt appears much more like anger than like disgust. Unilateral smirk (Face L6 in Figure 2) does not typically connote contempt in this study. The anger face is the clearly dominant response (35%).

Other emotions. The basic emotions of fear, surprise, and anger map onto their respective faces with high consistency and with the highest three confidence scores in the study.

Discussion

The consistency of reports across targets, and the high rate of agreement in identification of fundamental emotion faces (fear, surprise, and anger) argue for the validity and sensitivity of the measures used and put this study in agreement with prior studies on the recognition of facial expressions of basic emotions. The lack of clarity of the disgust face (“feeling disgust”) assignment results from the representation of many disgust faces in the 12 choices and the fact that a disgust face invoking all of the muscles that have been associated with disgust was intentionally not included in the set.

Our findings, in general, confirm the hypothesis that there are a variety of disgust faces and that both functionally and in terms of communication, these map in an orderly way onto eliciting situations. Of course, this is just one study, involving only rec-

ognition, limited to one procedure and a particular set of 12 faces. We take up the final limitations in the following two studies.

The infants' gape expression in reaction to bitter taste is not uniquely related to bitter; in fact, quantification of the faces made to different tastes shows a substantial frequency of sour taste purse faces made in reaction to bitter stimulants (Rosenstein & Oster, 1988). Through development, it appears that this relation may be further weakened, so that the sour taste purse face becomes the indicator of a strong or unpleasant gustatory input. This can be indicated by either lip pressing or pursing. This face does not appear to have taken on any other connotation, within or outside of disgust, in adulthood.

The bitter taste gape face seems to have been co-opted for another situation (all of this assuming recognition parallels production), that is, oral, nongustatory negative stimulation. These are the most reliable elicitors of gaping, in terms of adult facial recognition judgments. The tongue is more often extended than not under these conditions. Although this infantlike bitter-taste expression now connotes something else, it does not seem to be the core disgust face, although it may be at some point in development.

Roughly the same face, but with the nose wrinkle as well, seems to indicate ingestion of an item that is ideationally undesirable or has sensory properties (such as decay) that are acquired. In this regard, the gape is invoked in a classical disgust situation, indeed, perhaps the core situation from which disgust both develops and evolves (culturally).

Both offense and irritation to the olfactory or nasal irritation systems lead to a very specific nose-wrinkling response. This adaptive pattern seems to be similar whether the offending entity is irritating or has disgust properties. It is primarily tied to a modality of sensory offense, as are both the gape and pursing responses discussed above.

The wider range of disgusts, which we posit arise later in both development and cultural evolution, seems to center on the upper lip raise (Face L4 in Figure 2), sometimes unilaterally and sometimes in association with the gape (Face L5).

Our further studies are directed entirely at the basic finding of the first study: the apparently different interpretation placed by observers on the three separated components of the full disgust face.

Experiment 2

The fractionation of the disgust expression that we have reported results from a rather complex design, involving assignment of each of 55 situations to the most appropriate of 12 faces. Four of these faces had no direct relevance to disgust, and the others all included some possible components of a disgust response. The use of so many faces in an identification task is atypical for the face expression recognition literature, as is the use of an unbalanced face set, in which most (but not all) faces are variants of one basic emotional expression. There is every reason to believe that the particular results we report were in part a function of the design of the study. Indeed, Russell and Fehr (1987) have documented the importance of facial context, order, and other features of the facial expression identification experiment in determining the pattern of results. Our use of four posers, four different orders of faces in the 12-face display,

and two different orders of the situations in Experiment 1 goes some way toward eliminating serious experimental artifacts, but the possibility remains.

In this second study, we greatly simplified the design of Experiment 1. We used only three faces: nose wrinkle (Face L3 in Figure 2), upper lip raise (Face L4), and gape with tongue extension (Face L8), and reduced the number of situations to 18.

Method

Subjects

The subjects were 59 University of Pennsylvania student volunteers taking an introductory psychology class.

Stimuli (Faces)

Photographs of two posers from the first study were used in this study, one female student (L, see Figure 1) and one middle-aged man (P). The photographs of nose wrinkle, upper lip raise, and gape with tongue extension for each of these posers were used, again, in the form of high-quality xeroxes made from the color-print originals.

Procedure

The questionnaire was distributed in a classroom. Age and gender were reported on the survey by all subjects. Completion of the questionnaire took less than 10 min. Subjects received the three photographs of one of the posers on one page and another page that listed 18 of the 55 situations from Experiment 1. The 18 situations are listed in Table 2. There were four versions of the choice form. Half of the choice forms presented three pictures of poser L and half of poser P. For half of each of these subjects, a specific randomized order of the 18 situations was presented, and for the other half, the order was reversed. For all subjects, the array of faces was in the order nose wrinkle, gape with tongue extension, and upper lip raise, from left to right.

Instructions for the subjects were as follows:

Read through the list of situations and for each one, in the blank space provided to the left (of each situation description), place the number of the face-picture that you think best depicts that situation. Please indicate one face-picture for each situation, even if you think that the best possible face is not provided.

Results

The results are presented in Table 2 (middle columns) in terms of the percentage of subjects choosing each face for each situation. We evaluated significance with a goodness-of-fit chi-square, the expected values being an equal representation of each face for each situation. Significance levels for each situation are indicated in Table 2.

Restricting ourselves to situations in which the distribution of responses differed from random by $p < .01$ or better, a number of correspondences emerge. There is a preponderance of nose wrinkle for bad smells, and gape with tongue extension for oral burn and irritation, in confirmation of the results of Experiment 1. The preponderance of nose wrinkle responses to stepping in dog feces can reasonably be related, as well, to a bad smell. The predominant response to bad tastes (sour or bitter, with the sour faces not an available choice) was nose wrinkle and not gape with tongue extension. Among disgust situations, upper lip raise was the significant ($p < .01$) predominant re-

Table 2
 Subject Response Percentages for Experiments 1, 2, and 3

Situation	Experiment 1 ^a			Experiment 2 ^b			Experiment 3 ^c		
	9	19 + 26	10	9	19 + 26	10	9	19 + 26	10
Disgust									
Feeling disgust	28	10	62***	38	15	47*	29	11	60***
Reaction to stepping in dog feces	39	28	33	49*	31	20	37	38	26
Bad taste									
Eating something sour	52	29	19	61***	24	15	68***	18	14
Eating something very bitter	39	44	17	63***	15	22	62***	19	19
Oral burn irritation									
Eating a half teaspoon of hot pepper	2	98***	0	24	71***	5	12	82***	6
Bad smell									
Smelling ammonia	80***	1	19	68***	19	13	82***	9	9
Smelling the odor of rotten meat	81***	15	4	61***	14	25	76***	7	17
Eat used									
Thinking about the fact that yesterday you ate an apple with a worm in it	20	39	41	39	44*	17	27	42	31
Body violations									
Standing over a mangled human body just after it was hit by a car	12	32	56*	39	24	37	13	43	44***
Seeing a deformed person	5	5	90***	22	20	58***	15	21	64***
Watching a body in a morgue being dissected	29	13	58**	42	24	34	18	27	55***
Moral violations									
Looking at pictures of the slaughter at a WWII concentration camp	25	2	73***	27	15	58***	8	31	60***
Thinking about your best friend engaging in incest	32	8	60***	42	18	39	21	33	46**
Interpersonal disgust									
Sleeping in a hotel bed on which the linens have not been changed	22	12	66***	41	27	32	38	23	39*
Wearing Adolph Hitler's sweater	29	11	60**	32	41	27	22	22	56***
Anger									
Feeling anger	41	0	59*	34	3	46***	26	11	63***
Feeling contempt	42	0	58**	22	10	68***	22	7	70***
Watching someone steal groceries from the shelves of a supermarket	31	31	38	9	32	59***	12	45***	43

^a Total responses = 88 (44 subjects each rating 2 faces). We include only responses to the three target faces, which constitute between 18% and 80% of this total. ^b $n = 59$. ^c $n = 120$.

* $p = .05$. ** $p = .01$. *** $p = .001$.

sponse in two cases: "seeing a deformed person" and "looking at pictures of the slaughter at a WWII concentration camp," both clearly from the expanded domain of disgust. Upper lip raise was also the predominant response for anger, contempt, and rights violation (stealing), confirming its role in the anger expression. Thus, with the exception of the link between nose wrinkle and bad tastes, the major results of the choice test confirm the assignment of different meanings to the three components of disgust and affirm a link between upper lip raise and other moral emotions. Some of the results that do not meet the

.01 level of significance are consistent with the significant findings. The situation "eating an apple with a worm in it" shows gape with tongue extension ($p < .05$) as the predominant response. However, there is very poor differentiation between faces for the body violation, death, and moral items other than those reported above.

The L and P poser faces were identical in Experiments 1 and 2. To evaluate effects of method of presentation (12 vs. 3 faces), we recalculated the data on the three critical faces from Experiment 1 for L and P, for the 18 situations that were the same

across the two studies. These results are presented in Table 2 (first set of columns). The numbers in this table indicate the percentage of subjects in Experiment 1 who assigned each of the three L and P faces to each situation. We consider the responses to these three faces as the total for calculating the percentages, so that they add up to 100%; we ignore the responses subjects made in Experiment 1 to the other 9 faces.

In 11 of 18 situations, the same face was favored in both experiments. The exceptions are of interest. The bitter face maps predominantly onto gape in Experiment 1 (although nose wrinkle is a close second, and the predominant sour face responses have been ignored) and strongly onto nose wrinkle in Experiment 2. Almost all of the other disparities result from a clear pattern of upper lip raise predominance in Experiment 1 for the expanded disgust situations (other than core disgust), and a mixed and indeterminate pattern for Experiment 2 (except for the two cases mentioned above). Surprisingly, the differentiation of facial choices is poorer in Experiment 2 than in Experiment 1.

Discussion

In general, the simplified choice design in this study supports the results of Experiment 1 and indicates a mapping between nose wrinkle and bad smells, gape, and core disgust and irritating tastes, and upper lip retraction and animal-origin and moral disgust. However, there is a surprising amount of difference between the 3- and 12-face procedures, especially in the expanded areas of disgust. Disparities between the experiments in the faces associated with bitter taste can be attributed, in large part, to the elimination of the sour faces as choices in Experiment 2.

Experiment 3

The results of Experiment 2 indicate that experimental format does influence the pattern of results, but the basic mapping from three disgust components to three meanings remains intact. Our next aim is to refine the assignment of facial movement to meaning. The faces used in Experiments 1 and 2 are very good but not perfect representations of isolated disgust component movements. One problem has to do with imperfect posing. A more serious problem has to do with the fact that the facial movements in question are not totally independent. Nose wrinkle (Face L3) causes a certain amount of upper lip retraction (by pulling on the skin above the lip) and also results in an eye squint by raising the lower eyelids (Ekman & Friesen, 1976). These confounds are inherent in the structure of the face and its musculature.

In this study, to remove the confounds, we constructed isolated expressions by cutting out and reassembling segments of two sets of faces (G and M). In this way, we created three faces that were identical (within poser) except for the critical AUs. We then repeated the procedures of Experiment 2 using these two sets of isolated faces.

Method

Subjects

The subjects for this study were 121 University of Pennsylvania students taking an introductory psychology class. The questionnaire was

administered as part of a class project on the recognition of facial expressions of emotion. The results were shared with the class.

Stimuli (Faces)

Photographs of the two posers (M and G) from Experiment 1 who were not used in Experiment 2 were used in this study. Three composite faces of each poser were created by combining a full-face, neutral photograph with an overlay, a cut-out photograph of the particular muscle movement(s) being isolated. Thus, the upper face section, including the eyes, remains the same (neutral) across the three pictures of each poser. For the nose-wrinkle face, a wrinkled nose was spliced onto the neutral photograph, with the same procedure used for the other two expressions. The resultant faces for one of the posers (M) are displayed in Figure 3. In this way, two sets of three isolated facial expressions were created.

Procedure

The procedure was identical to the procedure of Experiment 2. Half of the subjects received pictures of M and half of G, and the order of 18 situations was reversed for half of the subjects.

Results

The results are shown in the columns on the right of Table 2. There were significant departures from randomness in choices for most of the situations, with most results significant at $p < .001$. Nose wrinkle was the dominant response for both examples of bad smells and bad tastes (sour and bitter). The combination of gape and tongue extension was dominant for "eating a half teaspoon of hot pepper" and was also the (nonsignificantly) most frequent response for "eating an apple with a worm in it." Upper lip raise was the predominant response for disgust, and all of the indicators of expanded disgust (body violations and death, interpersonal disgust, and moral violations), with all effects (except the interpersonal effect of "sleeping in hotel bed on which the linens have not been changed") significant at $p < .01$ or better. Upper lip raise was also the dominant response for anger and contempt.

Discussion

The data generated by the isolated faces show a somewhat more distinct effect than the results from Experiment 2, with a clearer indication of the linkage between upper lip raise and expanded disgust. In general, the results support the three-component analysis.

General Discussion

The results from three different studies, involving four different posers and 3–12 face exemplars all indicate that the three principal components of the disgust expression carry different meanings. The nose wrinkle (Face L3 in Figure 1; Face 1 in Figure 3) communicates a bad smell, and to some extent, a bad taste. The functional value of this response for a bad smell is clear, but the functional value for a bad taste is not at all obvious. In general, the nose wrinkle seems to communicate a negative sensory event. The result is consistent with Peiper's claim for the nose, but not for the bad tastes, where one would predict a predominantly oral expulsive or closing response.



Figure 3. Face displays used in Experiment 3. For both posers (*M* shown here), the face on the left represents an isolated nose wrinkle (Facial Action Coding System Action Unit [AU] 9), the face in the middle an isolated gape (AU26) and tongue extension (AU19), and the face on the right an isolated upper lip retraction (AU10).

The combination of the gape and tongue extension (AUs 19 + 26; Face L8 in Figure 1 and Face 2 in Figure 3) is most clearly associated with oral irritation in all studies, a functionally reasonable interpretation. It also communicates core disgust, in the sense that spoiled or ideationally contaminated foods (food from someone else's mouth or a worm in the mouth) tend to be attributed to this expression. From the point of view of communication, this expression indicates oral expulsion.

Upper lip retraction (Face L4 in Figure 1; Face 3 in Figure 3), in all three studies, assumes the burden of communicating the presence of elicitors that would fit under expanded disgust: reminders of animal origins, interpersonal contamination, and moral offense. This effect is extremely clear in Experiments 1 and 3 and present but less compelling in Experiment 2. The linkage of the upper lip raise to anger and contempt in all three studies confirms a link between expanded disgust, including moral disgust, and these two other moral emotions.

Our variations in procedure produce variations in patterns of results, as suggested by Russell and Fehr (1987). However, the basic match between components of the disgust expression and reported eliciting situations is robust and rises above these variations.

The study also raises some interesting and unanticipated problems. Why is the nose wrinkle an indicator of bad taste? Why has the sour expression not taken on other meanings? Although disgust has expanded greatly in its domain of elicitors, most of these elicitors tie into a non-food-related response, upper lip retraction. This is a response that serves to bare the teeth in agonistic displays in other mammals and is a component of the human anger response. It seems to have been co-opted into the disgust system, as that system expands, appropriately, into a moral domain.

We think we have presented the beginnings of the fractionation of an emotional facial expression into components with different communicative values. However, this is just a first study, and further work would be necessary to determine whether the distinctions we propose are robust. This study was done only with American adults. It was a recognition study; we

do not know whether the production of disgust faces follows the lines suggested by the recognition results. Of course, it is a fact to be considered that people read these meanings into different expressive disgust components, but it would be more impressive if these readings were accurate.

The findings of this study clearly should be extended to subjects from other cultures and also into the domain of production as well as recognition. Assuming that a refined taxonomy of disgust develops in this way, the next step would be to explore the way in which a simple, innate infantile bad taste response has been co-opted and elaborated by culture, into a much broader and more meaningful system. Because of the facial markers, this might be an excellent arena in which to study a well-defined problem of cultural evolution of an emotion. In particular, the role of preadaptation (co-option of a system evolved for one purpose by another system: Mayr, 1960; Rozin, 1976) in cultural evolution may be particularly well illustrated in disgust. In this regard, we have suggested that expanded disgust may be a rather recent cultural innovation. We do not know whether the isolated upper lip retraction was at all common hundreds or thousands of years ago, and if it was, what it communicated.

It is likely that developmental studies would be very revealing, because core disgust (revulsion at oral incorporation of offensive substances) does not seem to appear in full form until the early elementary years (Fallon, Rozin, & Pliner, 1984; Rozin & Fallon, 1987), and we expect that expanded (e.g., animal origin) disgust may come in yet later. The study of the development of disgust has been hampered by the lack of a good nonverbal measure. This study may be the first step in providing such a handle.

We have demonstrated that Americans take different meanings from different components of the disgust expression. The communicative value of nose wrinkle and gape, which indicate the modality being offended, probably derives from the functional value of these responses, as described by Peiper (1963; see introduction to this article). The functional value of upper lip raise is less clear, and the type of offense (threat) that it indi-

cates is much less well defined than is the threat indicated by the other disgust components. One might ask why is it important to know the source of offense of another person? Perhaps the information provided by these expressions would allow different courses of action by the observer. For example, because the upper lip raise indicates an offense that is likely to be external to the body, it may recruit more action from the observer (because the observer is likely to encounter the elicitor) than would a gape, which informs about something in the mouth of the sender. What seems most certain is that disgust is used, in a cultural context, to internalize or socialize aversions and avoidances and that this process may include, as a fundamental component, observation of and reaction to disgust faces.

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