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General and specific abilities to recognise negative emotions, especially disgust, as portrayed in the face and the body

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We examined the ability of 150–166 undergraduate students to assign four negative emotions (sadness, fear, disgust, and anger) to five sets of emotion expression stimuli: a standard of face photographs expressing basic emotions, faces that were morphs of standards for these emotions, a special set of faces that was designed to detect different components of disgust expressions, and two sets of dynamic, video clips displays of emotions as described in traditional Hindu scriptures and used in classical Hindu dance. One of these sets presented the full body traditional displays (including hands and face), while in the second set, the same clips were used but the facial expressions were blocked out. Participants also completed an obsessive compulsive inventory and the disgust scale. Major findings are that: (a) there are some substantial individual differences in ability to correctly identify emotions; (b) the ability to detect facial emotions correlates substantially (.49) with ability to detect bodily emotions; (c) there is no evidence for specific deficits in the detection of any particular emotion; and (d) there is no relation between individual differences in obsessive-compulsive disorder (OCD) tendencies or disgust sensitivity, in a normal sample and the ability to detect disgust.

Research on emotion recognition has, understandably, focused on photographs of the face, and on establishing which facial features and feature combinations are identified with particular emotions by the majority of judges. There has been relatively little attention to bodily cues other than the face, dynamics over time, and to individual differences. In this paper, we address these issues. In addition, we explore the very interesting recent findings that suggest that some brain damaged individuals may show a deficit in recognising particular emotions, in

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particular, fear and disgust (reviewed in Adolphs, 2002; Berthoz et al., 2002; Rozin, 1997).

The idea of individual differences in recognition of specific emotions has been brought to the fore by recent neuropsychological studies, suggesting specific deficits in the recognition of fear associated with the amygdala (Adolphs, Tranel, Damasio, & Damasio, 1994, 1995; Calder, Young, Rowland, Perrett, Hodges, & Etcoff, 1996b; Young et al., 1995), and with disgust associated with damage to the basal ganglia and insula. In particular, individuals with Huntington's disease (Sprengelmeyer et al., 1996, 1997b), carriers of the gene for Huntington's disease (Gray, Young, Barker, & Curtis, 1998), and individuals diagnosed with Obsessive-compulsive disorder (OCD; Sprengelmeyer et al., 1997a) have been reported to have a specific deficit in recognition of facial photographs expressing disgust. Both OCD and Huntington's disease involve damage to the basal ganglia and frontostriatal areas (Abbruzzese, Ferri, & Scarone, 1997; McGuire, 1995; Rapoport, 1989). Although there has been some evidence from brain imaging and lesioned patients supporting this idea (Calder, Keane, Manes, Antoun, & Young, 2000; Phillips et al., 1997, 2000), there have also been failures to replicate this evidence (e.g., Milders, Crawford, Lamb, & Simpson, 2003). Milders et al. (2003) and Rapcsak et al. (2000) have noted problems with deficit assessment, in particular, the possibility that more difficult discriminations may be those that show deficits in brain damaged individuals. Thus, fear and surprise are particularly difficult to discriminate, such that inclusion of surprise in the emotion set may cause fear to be the most difficult emotion to recognise in this context.

Recently, evidence has been presented indicating a deficit in disgust detection from facial expressive stimuli in psychopaths (Kosson, Suchy, Mayer, & Libby, 2002), and for deficits in both fear and disgust for individuals diagnosed with mania (Lembke & Ketter, 2002).

There is an obvious link between disgust and at least the ''cleaning'' variety of OCD, since sensitivity to dirt and excessive concern with hygiene are components of disgust (Haidt, McCauley, & Rozin, 1994; Rozin, Haidt, & McCauley, 2000). However, surprisingly, the patients who participated in the Sprengelmeyer et al. experiment exhibited checking, rather than the cleaning symptoms of OCD.

The verdict is still out on the nature and degree of specific deficits related to brain damage, but this work has called attention to the possibility of specific deficits, even in a normal population. Specific emotion recognition deficits have important psychological implications. Recognition of emotion is generally considered to be an important promoter of socialisation, such that specific recognition deficits might be expected to produce serious and psychologically interesting socialisation deficits. Disgust, in particular, plays an important role in early socialisation, since many of the sensitivities of culture and civilisation are supported by disgust responses (Miller, 1997; Rozin et al., 2000).

We decided to examine ability to recognise negative emotions (anger, disgust, fear, sadness, and, in some cases, contempt) in general, and to look for specific emotion deficits, in a fairly large sample of normal individuals (154–166 college students). We added to the standard set of static facial photographs of emotion (Ekman & Friesen, 1978), a set of video clips of full body dynamic displays of anger, disgust, fear, and sadness as described in detail in the ancient Hindu Natyasastra (approximately AD 200), which are currently performed in Hindu classical dance (Hejmadi, 2003). Hejmadi, Davidson, & Rozin (2000) have generated short, silent video segments that separately show three variants of the expression (as specified in the Natyasastra and later sources) of each of the four negative emotions, and neutral displays from the same sources. These emotions are surprisingly well identified by both Indian and American participants (Hejmadi et al., 2000). We also exposed participants to an identical set of full body dynamic displays in which the face is covered, so that only the body/hands display is seen. Even these displays are well recognised, in most cases, by American and Indian participants (Hejmadi, Rozin, & Davidson, 2003).

In consideration of the recent evidence for disgust-specific deficits, and our own particular interest in disgust and disgust recognition, we proposed to explore in more detail the possibility of deficits in disgust recognition, and possible links to OCD and disgust sensitivity. For this reason, we included two sets of faces that focused on disgust expressions; one set was a subset of the morphed faces used by the Sprengelmeyer group, and a second used a set of FACS coded faces (Ekman & Friesen, 1978) that we had used in a previous study analysing the components of the disgust face (Rozin, Lowery, & Ebert, 1994) and the moral implications of contempt, anger, and disgust (''CAD''; Rozin, Lowery, Imada, & Heidt, 1999). These stimuli included presentation of some of the separate components of the disgust, anger, and contempt face, along with some faces representing other negative emotions. In addition, all participants completed the Disgust Scale (a measure of disgust sensitivity developed by Haidt et al., 1994), and the Obsessive-Compulsive Inventory (OCI) developed by Foa and colleagues (Foa, Kozak, Salkovskis, Coles, & Amir, 1998).

METHOD

Participants

A total of 166 participants took part in this experiment as an exercise in their introductory psychology class at the University of Pennsylvania. The analyses reported were based on *n*s between 136 and 166, depending on the variables and the number of missing values. Participants were 63% female, 68% white, with 27% Jewish, 22% Catholic, and 18% Protestant. Mean age was 18.2 years, and mean religiosity (on a scale from 0 to 3) was 1.77. As a group, University of Pennsylvania students score very highly on the SAT, and come from all over the world, with the largest representation from the northeastern/midAtlantic section of the United States.

Materials

Emotion recognition tests. We created a measure for recognition of basic negative emotions. The test consists of 97 representations of expressions of emotion divided into five sections. The first three sections were presented in slides and the last two in video clips. In the first two sections, participants were presented with a slide of a person making a facial expression of one of five emotions: disgust, anger, contempt, fear, and sadness or neutral expressions. An answer sheet was given to the participants producing a fixed report of the five emotions and ''none of the above'' as choices. The first section was slides taken from the JACFEE, a set of emotion expressions created by Matsumoto and Ekman (1988; see also Biehl et al., 1997). Each emotion (including neutral) was presented in four different faces, two male and two female, and one of each of these was Caucasian, and the other Japanese. These four stimuli, with the above constraints, were selected randomly from the eight available stimuli for each emotion in the JACFEE slide set. The second section (described as ''CAD'' for contempt-anger-disgust) presented colour slides prepared for our prior studies of the recognition of the disgust face (Rozin et al., 1994, 1999). There were 8 slides showing disgust, 6 anger, 6 contempt, 4 fear, and 4 showing other facial expressions. The disgust, anger, and contempt slides intentionally varied the particulars of expression (e.g., mouth open or closed for both disgust and anger).

The third section (described as ''Morph'') was made up of 15 items (out of a great many items) from a test created by Young and colleagues used in the study of Huntington's Disease and OCD deficits described above (Calder, Young, Perrett, Etcoff, & Rowland, 1996a). These slides showed computer generated images that blended to varying degrees the same poser making two different facial expressions of emotion (e.g., one slide was a morphed 70% fear, 30% disgust face). The participants were given the same choices of emotion as above, excluding contempt. There were 4 slides showing expressions that were 70% disgust , 2 that were 70% anger, 2 that were 70% fear, and 4 that were 70% sad. There were 3 slides that were an equal blend of emotions and were therefore not included in the accuracy scores. The last two sections, created by Hejmadi (Hejmadi 2003, Hejmadi et al., 2000, 2003) were video clips of Indian dance that signify four emotions: disgust, fear, sadness, anger, and neutral. Hejmadi is a professional Hindu (Odissi) classical dancer, and expressed these emotions using her face, body, and hands. In the first 15 clips (described as ''Hindu body''), the dancer wore a mask so that her facial expressions could not be seen. In the last 15, the mask was removed (described as ''Hindu total''). In both of these sections, there were three clips of the dancer portraying each emotion. Each of the three portrayals of any emotion differed from the others, and were specifically described in detail as variants in the Natyasastra. Participants indicated the emotion being portrayed, from the fixed choice of: anger, disgust, fear, sadness, and neutral. All slides and video clips were randomly ordered within section. Each slide was displayed for 5 seconds and video clips ranged in length from 5 to 10 seconds.

We derived scores for each section of the expression test, keeping in mind that we needed to consider false positives as well as false negatives. The natural measure to represent this is the contingency coefficient, arraying in a 2×2 matrix, target hits in the cell A, target misses in cell B, false positives in cell C, and correct designation of nontargets in cell D. However, in this study the target emotion (e.g., disgust) is one fourth to one sixth of trials, so there is a strong preponderance of negative (nondisgust) targets. A result of this is that if a participant always guesses an emotion other than the target, the D cell will be maximised, and there will be an apparent correlation. To compensate for both response bias and unequal cell size, we employ Wagner's (1993) Hu statistic. This statistic is $(A/(A+B)) \cdot (A/(A+C))$, that is, the percentage of all target hits of the total target stimulus presentations, multiplied by the percentage of all target hits of the total number of target responses. Considering the five alternative Hindu emotion presentations (three of each target emotion, with five choices), a person who identified all of the target stimuli and never responded with the target emotion to the wrong stimulus would score 1.00. A person who never identified the target emotion properly (A=0) would score 0. A person who always guessed the target emotion would score .20 (contingency coefficient would be the same .20), while a person who never guessed the target emotion would get a score of 0.00 (contingency coefficient score here would be .80!). On the other hand, a shortcoming of this statistic is that a random pattern of guessing, such that, for example one quarter of all disgust stimuli were labelled as disgust and one quarter of all nondisgust stimuli were labelled as disgust would produce a score, in the pattern of stimuli that we are using of .08 (instead of zero; the contingency coefficient for this same random guessing pattern would be .65!) (Table 1).

TABLE 1
Matrix from which the recognition score was calculated[a]

	Actual target face (e.g., disgust)	*Actual face: other (e.g., not disgust)*
Guessed target (e.g., disgust)	A	B
Guessed other (e.g., not disgust)	C	D

Note: Formula used for disgust (and other emotion) recognition score (Wagner, 1993): Hu = $(A/(A+B)) \cdot (A/(A+C))$. In these studies, A varies from 3 to 5, depending on the subtest.

[a] Example of Disgust score for the 24-face standard facial photo (JACFEE) tests.

Measurement of OCD tendencies. In order to measure the obsessive-compulsive tendencies of the participants, we used Foa's Obsessive-Compulsive Inventory (OCI), a self-report measure. This test has been shown to have satisfactory reliability and validity (Foa et al., 1998). The OCI consists of 42 items comprising seven subscales: cleaning, checking, doubting, obsessing, ordering, and mental neutralising. Each item is rated on a 0–4 scale for both frequency and the distress that it causes.

Disgust sensitivity measurement. Disgust sensitivity was measured by the Disgust Scale created by Haidt et al. (1994). The Disgust Scale contains 32 items, and has eight subscales corresponding to sensitivity to seven different types of elicitors of disgust plus magical thinking.

RESULTS

Expression measures and comparison of the subtests. The emotion recognition test had five different components, which we will call subtests: standard facial photos, CAD (disgust oriented), morphed faces, Hindu body, and Hindu all. We created an overall accuracy score for each subtest by averaging the Hu (Wagner, 1993) scores for each of the emotions represented in that subtest. The means and standard deviations for each subtest are presented in Table 2, and correlations between the subtests are presented in Table 3. Note that disgust, anger, sadness, and fear are equally represented in the JACFEE faces and two Hindu emotion series. However, the JACFEE series also includes

TABLE 2
Mean recognition scores for each subtest and each emotion (n=162)[a]

	Presentation											
	Anger		*Contempt*		*Disgust*		*Fear*		*Sadness*		*Row M*[b]	
Subtest	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*
JACFEE	0.70	(0.29)	0.22	(0.26)	0.63	(0.28)	0.81	(0.23)	0.81	(0.24)	0.74	(0.18)
CAD	0.42	(0.20)	0.13	(0.15)	0.38	(0.18)	0.36	(0.26)			0.39	(0.38)
Morphed	0.41	(0.30)			0.35	(0.31)	0.77	(0.29)	0.72	(0.29)	0.56	(0.21)
Hindu all	0.79	(0.25)			0.72	(0.26)	0.76	(0.26)	0.63	(0.21)	0.72	(0.18)
Hindu body	0.59	(0.26)			0.20	(0.21)	0.44	(0.25)	0.58	(0.31)	0.45	(0.16)
Column *M*[c]	0.58	(0.16)	0.18	(0.18)	0.46	(0.14)	0.63	(0.16)	0.68	(0.19)		

[a] All values (except contempt and column for CAD) are significant at $p < .001$ with a two-tailed t-test, assuming 0.125 as the expected value for a random relationship (0.125 is the average value for the Wagner statistic if there is a random relation between target stimulus and target response).

[b] Mean of the four shared emotions, anger, disgust, fear, and sadness (without sad for CAD).

[c] Mean across all available subtests.

TABLE 3
Relations among different measures of emotion recognition ability (N = 162)[a]

Subtest	*JACFEE*	*CAD*	*Morphed*	*Hindu all*	*Hindu body*
JACFEE		.21	.06	.22	.17
CAD	.40		.30	.26	.20
Morph	.44	.32		.18	.09
Hindu all	.51	.38	.43		.20
Hindu body	.49	.29	.34	.54	

Note: Total emotion accuracy scores only include combined results from anger, disgust, fear, and sadness.

[a] Pearson *r*s for Wagner Hu scores for total emotion recognition scores (lower left) and specific disgust recognition scores (upper right).

contempt, making the discrimination of disgust more difficult. The morphed faces and CAD subtests do not have equal exemplars of each emotion, and favour disgust, with contempt and anger prominent in the CAD subtest, and sadness in the Morph subtest. Accuracy for subtests cannot be directly compared, since the emotions represented were different in frequency and in some cases, kind (e.g. presence or absence of contempt) across subtests, and some subtests focused on maximally confusable stimuli (Morph and CAD). The only directly comparable pair is the Hindu emotions, with and without the face masked. As would be expected, performance was better without the face mask (M = 0.72, SD = 0.18) as opposed to with the mask, M = 0.45, SD = 0.16; t(161) = 18.33, $p < .001$. Examination of the overall means for each subtest (leaving out contempt, Table 2) indicates that the JACFEE (M = 0.74, SD = 0.18) and the Hindu all (unmasked) (M = 0.72, SD = 0.18) emotion accuracy was highest, and the CAD lowest (M = 0.39, SD = 0.38). CAD was significantly lower, by paired t-test, than every other subtest ($p < .001$ for all comparisons). This makes sense because the CAD set is primarily variations of different expressions of anger, contempt, and disgust, which have many common elements.

Relations among performances on the different subtests: A general emotion recognition ability. All five of the subtests correlated substantially with one another, averaging r = .41 (range .29–.54) for the 10 pairs of scores (Table 3). All of the 10 correlations were significant at least at the .01 level. Our measures include one that involves a standard set of static facial expressions (JACFEE) and a new one that involves only bodily (including hand) expressions of the same set of emotions, except for contempt (present in JACFEE but not Hindu body). Hence, there is no overlap in information between these two measures. The correlation between the JACFEE face subtest accuracy score and the face-masked Hindu emotions (across the four common negative emotions) is .49 ($p < .001$).

We also calculated a specific emotion detection ability for each of the four critical emotions (anger, disgust, fear, and sadness), averaged across the five subtests. All the emotion specific scores correlate substantially with the others, averaging an r = .53 (range .42–.62 for the six pairings of four emotions).

These substantial positive correlations, between subtests and between specific emotions argue for individual differences in a general ability to recognise emotions, presented in the visual modality.

Difficulty in identifying specific emotions. The difficulty in identifying any emotion depends on the particular exemplars used, and the alternative emotions under consideration. Thus, the results we present here are only suggestive, as derived from this particular set of stimuli and alternatives. The emotions varied in their level of difficulty. In three of the measures (JACFEE/static face, and the two Hindu presentations), the four emotions of anger, disgust, fear, and sadness were each represented with the same number of stimuli. On these three presentations, the mean accuracy scores were lowest for disgust (M = 0.52, SD = 0.17), then fear (M = 0.67, SD = 0.18), then sad (M = 0.67, SD = 0.19), with anger as the most accurate (M = 0.70, SD = 0.20) (related numbers are presented in Table 2, but these include all subtests, not just the three with comparable stimuli). Looking across all five subtests, contempt is by far the most difficult to identify (0.18) with disgust next (0.46) (Table 2). But again, these emotions are known to be highly confusable and were both a part of the most difficult CAD subtest.

The three most difficult emotions to discriminate from one another, as exemplified in the CAD series, are contempt, anger and disgust. If we examine all the errors on identifying these emotions (except for the Morph series, which involved emotion blends), we find that the most common error for a disgust face was contempt (11% of errors when contempt was a possibility). When contempt was not a possibility, the highest level of confusion for disgust was anger (10%). (with neutral as a response 17% of the time). Contempt is the only emotion for which the correct response did not occur for a majority of the exposures. Contempt was correctly answer in 28% of cases, with neutral recorded as the response in 47% of cases. Anger was identified with great success (65% of presentations), with contempt the highest frequency error when it was available as a choice (15%), and no particular emotion error among the standard other three emotions.

Possible deficits in the recognition of specific emotions. Is there any evidence that individuals are deficient in recognising certain emotions while being satisfactory or even especially skilled at recognising others? We averaged the Hu (Wagner, 1993) score for the three balanced subtests (JACFEE and two Hindu) for each participant, and each of the four emotions: anger, disgust, fear, and sadness, and calculated standardised z-scores based on the distribution of these emotion specific means for each emotion. Even though the subtests are not completely comparable in difficulty or representation of the set of emotions (only JACFEE, of the three, included contempt), *relative* ability scores should be comparable across the subtests. To distinguish between those who had a general deficiency and those that had a specific deficiency, each participants' lowest score of the four emotions was subtracted from their highest. We found 34 people (21% of the sample) with a difference of at least two *z*-units (2 standard deviations) between their highest and lowest scores. For 12 of these participants (7% of the sample) there was a difference of greater than 1.0 *z*-unit between the lowest and the next lowest score, so some case can be made for an isolated lowest score. To evaluate the expected number of cases (with 162 participants) for which the lowest score would be at least 1 standard deviation below the next lowest, we randomly sampled one *z*-score from each of the four emotions, and did this 125 times. In this randomised set of four *z*-scores, there were 39 cases (31%) in which the lowest score was at least one standard deviation less than the next lowest. The observed number, 12 (7%), is significantly *lower* than would be expected by chance χ^2 $(1, N = 287) = 37.87$, $p < .001$. The reason the observed number is below the expected number is that in our random, simulated sample, we chose the four values independently for each participant. However, in fact, there are strong general individual differences in ability to recognise emotion, as we show in this paper. The positive correlation of the four emotion scores would reduce the probability of producing an outlier.

For the 12 participants who showed a lowest score at least one standard deviation below all others, the ''deficient'' emotions were spread across the four possibilities rather evenly: 4 had the most difficulty with identifying anger, 3 each with sad and fear, and 2 with disgust. We also examined the performance of the 12 extreme low participants on the two remaining tests, the morphed faces and the CAD faces, to see if the same emotion was lowest on these two series. There were no sad faces in the CAD series, so we could only evaluate 9 lowest emotions; in 5 of these 9 cases, the lowest emotion was the same in the CAD series as in the combined JACFEE-Hindu *z*-scores (the expected value would be 3, but the chance of 5 or more is 0.35). For the Morph series, the result was that in 5 of 12 cases, the deficit emotion matched in the JACFEE/Hindu and Morph series (the expected value here is 3, not significantly different from 5 by binomial calculation).

There is, thus, not even suggestive evidence from among our 162 normal participants, of someone who is poor at recognising one negative emotion, but good at recognising all other negative emotions. However, there is substantial evidence for individual differences in the general ability to recognise emotions, based on the moderate-to-high correlations of accuracy scores across both subtests and emotions (Table 3).

Another test of the existence of general deficits involves isolating the participants with less than -1.90 z-score on the three standard emotion subtests (JACFEE and two Hindu), across all four emotions combined. Six participants qualified, three of whom had z-scores less than 3.00, with two others between -1.9 and -2.0 (overall $M = -2.95$). The mean overall accuracy z-score for these individuals on the Morph was -1.47 and on CAD it was -1.50. These results support the claim that there are individuals in the normal population with severe deficits in emotion recognition.

OCD, disgust, and emotion recognition. Total scores of frequency and distress on the OCI were correlated with the disgust scale with $r = .28$ and $r = .26$ respectively (both $p < .001$). The highest correlation of all of the OCI subscales, as expected, was with cleaning ($r = .27$ for frequency and $r = .28$ for distress; $p < .001$). Correlations with the checking subscales were slightly lower ($r = .21$ for frequency and $r = .22$ for distress; both $p < .01$; see Table 4).

We tested for a link between the ability to recognise expressions of disgust and obsessive-compulsive tendencies in two ways. First, we computed correlations between the participant's total frequency and distress scores on the OCI and the participant's ability to recognise each of the specific four emotions and overall recognition ability (mean of the anger, disgust, fear, and sad z-scores for JACFEE, Hindu masked, and Hindu unmasked) (Table 4). There were 30 correlations (four emotions and overall emotion by six measures of OCD: OCI frequency and distress scores overall and for the two subscales of

TABLE 4
Correlations of disgust sensitivity, OCI scores, and ability to identify emotion expressions (n = 138–159)

	Scale					
Scores	*D-scale*	*Disgust z*[a]	*Anger z*[a]	*Fear z*[a]	*Sadness z*[a]	*Total*[b]
D-scale total		.05	−.11	.02	−.03	−.02
D-scale magic		.04	−.08	.02	.02	.00
D-scale hygiene		.07	−.03	.10	.10	.08
OCI total frequency	.28**	.15	.04	.05	−.01	.07
OCI total distress	.26**	.16	.04	.07	.03	.10
OCI clean frequency	.27**	.06	−.06	.03	−.03	.00
OCI clean distress	.28**	.10	−.02	.06	.03	.05
OCI check frequency	.21*	.10	.07	.01	−.04	.05
OCI check distress	.22*	.08	.04	−.08	−.07	.01

[a] Emotion recognition z-scores averaged across the three equal-frequency subtests: JACFEE and two Hindu series.

[b] Average of anger, disgust, fear, and sadness Wagner Hu scores.

* $p < .01$; ** $p < .001$.

washing and checking). Only one of the 30 correlations was significant (Table 4), varying from $-.08$ to .16. (Correcting for multiple tests, none were significant.) However, it is notable that the two highest correlations (.16, $p <$ .05, and .15) were between disgust emotion recognition ability and the overall scores for frequency and distress of the OCI. These two suggestive correlations are in the *opposite* direction from what one would expect from the Sprengelmeyer et al. data on OCD, but are in the direction one might predict given the nature of OCD. There was also no relation between disgust sensitivity (DSCALE score) and ability to recognise any emotion (anger, disgust, fear, sad, or overall for the four), with correlations ranging from .05 to -12 (but disgust detection was the highest of these, at .05). One might expect higher correlations between the two most relevant D-scale subscales, and either disgust detection or OCD tendencies. In fact, the correlation of D-scale magic (including contagion) with disgust recognition was only .04, and the correlation of D-scale-hygiene with disgust recognition was only .07 (Table 4). Finally, the correlations of magic and hygiene subscales with OCD frequency were .27 ($p < .001$) and .18, respectively, and with OCD wash frequency they were .19 ($p < .05$) and .36 ($p < .001$). Hence, there does seem to be a particular relation between cleaning OCD and disgust/hygiene sensitivity, as would be expected.

One might also expect that OCD is related to the predisposition to offer disgust as a response, whether correct or not. We calculated the total number of disgust responses from the three measures in which there was a balanced presentation of disgust and the other three negative emotions (JACFEE, Hindu masked, and Hindu unmasked). There were no significant correlations between this number and any of the measures of OCD tendency (*r*s in the range .03–.12), or with the disgust scale ($r = -.02$).

The second test we performed considered the possibility that the disgust deficit reported in the literature might only be manifested in cases of extreme obsessive compulsive tendencies, aligning with the fact that the prior work examined people diagnosed with OCD. Mean scores for patients diagnosed with OCD, in contrast with means for ''normals'' from the study validating the OCI (Foa et al., 1998) were used as a marker to distinguish individuals in the current study with OCI scores in the range for a clinical diagnosis of OCD, and another set with lower than average scores. Means from Foa et al.'s (1998) study validating the OCI were 66.33 distress and 66.36 frequency for individuals diagnosed with OCD and 25.25 distress and 34.15 frequency for the control sample. We identified the 26 participants who scored at least 66 on both the overall OCI frequency and distress. For comparison, we selected all participants who scored below the normal averages from Foa et al. (1998) on both frequency ($\leq = 34$) and distress ($\leq = 25$), generating 40 individuals (OCI scores for both groups are in Table 5). We computed the anger, disgust, fear, and sadness average recognition *z*-scores for these two groups,

TABLE 5
Comparison of high and low OCI subjects on emotion recognition[a]

	High OCD		*Low OCD*	
	M	*(SD)*	*M*	*(SD)*
OCID	83.0	(16.6)	10.3	(6.1)
OCIF	85.1	(15.6)	20.8	(6.9)
Disgust-*z*	0.10	(1.11)	−0.35	(0.98)
Anger-*z*	0.00	(1.15)	0.03	(1.14)
Fear-*z*	−0.05	(1.15)	−0.28	(1.16)
Sad-*z*	−0.14	(0.95)	−0.18	(1.03)
All emotions	−0.02	(0.86)	−0.20	(0.91)
Disgust CAD	−0.25	(1.01)	−0.02	(1.04)
Disgust Morph	−0.20	(0.94)	−0.03	(1.10)

Note: OCID and OCIF are raw scores, emotion scores are *z*-scores.
[a] High OCD, $n = 26$; Low OCD, $n = 40$.

based on the results from the JACFEE and two Hindu presentation subtests. Given the potential centrality of disgust in OCD, we also examined the disgust *z*-scores for the Young and CAD series, since both of these constitute more difficult tests of disgust recognition.

We computed the value of *t* for the difference between these two groups for recognition ability for each emotion and all emotions in general from the three balanced subtests, and the disgust scores from Morph and CAD. There were no significant differences (see Table 5). The difference that was closest to significance was for the predicted disgust recognition score: The high OCD participants were somewhat more accurate in recognising disgust, mean difference: .40 *z*-units, $t(64) = 1.704$, $p < .10$). The effect is in the direction predicted by common sense, but opposite to the findings of Sprengelmeyer and colleagues.

Examining just the disgust score for the morphed faces that were used in the original reports, the difference in scores between the two groups was insignificant, but opposite to the direction of effect reported by Sprengelmeyer et al. (Table 5).

Four participants reported that they had been diagnosed with OCD at some point in their lives. Their mean total disgust recognition *z*-score (from the standard three subtests) was 1.01 (range 0.40–1.55). This value is significantly higher than the value for the rest of the sample, $t(157) = 2.08$, $p < .05$. The four ‘‘OCD’’ individuals are not significantly different from the rest of the sample for anger, fear, or sadness.

The correlation between disgust scale score and ability to recognise disgust was positive but low ($r = .05$) and not significant.

DISCUSSION

This study provides substantial evidence that people vary in their general ability to recognise expressions of negative emotions. The correlations between scores for overall emotion recognition ability were quite high across subtests and across emotions (range of *r*s is .26–.62). Our most striking finding is the high correlation between abilities to recognise static facial emotion expression and bodily (without face) emotional expression; the correlation of the Hu scores was .49, although there is *no* overlap in information between the two sets of displays. Further research should be carried out to determine whether this ''general'' ability extends to recognition of vocal expressions of emotion, and to the production (as opposed to recognition) of emotional expressions. Accepting the idea of individual differences in recognising emotions would also depend on a demonstration that the positive correlations were not a result of a more general visual recognition ability or a test-performance ability.

Our study of a young normal adult American sample provides no evidence that there are individuals with deficits in recognising specific emotions. We uncovered a few cases that might be exemplars of this, but the differences reported may be due to chance. Of course, these results do not speak to the possibility that specific brain areas may mediate the recognition of specific emotions, since none of our participants would qualify for the indicated pathologies. It is also possible that specific emotion detection deficits do exist in the normal population, but at a level of incidence low enough so that a sample of 162 might be too small to reveal them.

Our study shows a relationship between disgust sensitivity as identified by the Disgust scale and obsessive-compulsive tendencies, although neither of these variables relate significantly to the ability to recognise disgust expressions. This relationship may be especially strong between cleaning obsessions and compulsions and the Disgust scale. This makes intuitive sense; it seems logical that a person obsessed with washing would be more sensitive to disgust. The overall correlation we report between OCD tendency and disgust sensitivity confirms similar correlations reported in prior work (Tolin, Brigidi, & Foa, 1999).

Unlike the prior work of Sprengelmeyer et al. (1997a), we found no evidence for a deficit in recognising disgust associated with obsessive-compulsive tendencies; on the contrary, and consistent with common sense, we found a slight tendency for OCD tendencies in the normal population to be associated with greater accuracy in recognising disgust; this difference was marginally significant for the four participants who had been diagnosed with OCD.

Our negative finding on the OCD-disgust-recognition relation is in some conflict with the sharp deficits reported by Sprengelmeyer, Young, Calder and their colleagues. There are two ready accounts for this difference. Sprengelmeyer et al. examined only diagnosed OCD patients, in comparison to controls. A second and related possibility has to do with whether people diagnosed with

OCD in both studies were under treatment, particularly pharmacological treatment. Another difference between the studies was in the stimuli used to assess emotion recognition deficit. Both studies used many stimuli from the JACFEE, and our study used a small subset of the morphed faces used in the Sprengelmeyer et al. studies. In addition to using fewer of these stimuli, we excluded displays of the emotions of happiness and surprise in our emotion stimuli sets.

Our results, in combination with the results of Sprengelmeyer et al., raise a number of important empirical questions. We consider the existence of specific emotion recognition (and perhaps, expression) deficits worthy of study from the viewpoints of understanding the neural basis of emotion, certain types of psychopathology, and theories of emotion. With respect to the latter, basic relevant concerns have to do with the linkage of emotion appraisal, production, and recognition systems. From a developmental/socialisation perspective, the possibility of present-at-birth or early onset specific emotion deficits (as may be the case for individuals carrying the allele for Huntington's disease; Gray et al., 1998) is very promising. If we can identify individuals with specific deficits in emotion recognition (and perhaps expression), and if these deficits are present early in life, we can ask important questions about the role of the communication of particular emotions in socialisation; it is easy to imagine how an absence of ability to recognise disgust would affect socialisation, from toilet training to acquisition of some moral values.

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REFERENCES

Abbruzzese, M., Ferri, S., & Scarone, S. (1997). The selective breakdown of frontal functions in patients with obsessive-compulsive disorder and in patients with schizophrenia: A double dissociation experimental finding. *Neuropsychologia*, *35*, 907–912.

Adolphs, R. (2002). Neural systems for recognizing emotion, *Current Opinion in Neurobiology*, *12*, 169–177.

Adolphs, R., Tranel, D., Damasio, H., & Damasio, A. (1994). Impaired recognition of emotion in facial expressions following bilateral damage to the human amygdala. *Nature*, *372*, 669–672.

Adolphs, R., Tranel, D., Damasio, H., & Damasio, A. (1995). Fear and the human amygdala. *Journal of Neuroscience*, *16*, 7678–7687.

Berthoz, S., Blair, R. J. R., Le Clec'h, G., & Martinot, J.-L. (2002). Emotions: From neuropsychology to functional imaging. *International Journal of Psychology, 37*, 193–203.

Biehl, M., Matsumoto, D., Ekman, P., Hearn, V., Heider, K., Kudoh, T., & Ton, V. (1997). Matsumoto and Ekman's Japanese and Caucasian facial expressions of emotion (JACFEE): Reliability data and cross-national differences. *Journal of Nonverbal Behavior*, *21*, 2–21.

Calder, A. J., Keane, J., Manes, F., Antoun, N., & Young, A. W. (2000). Impaired recognition and experience of disgust following brain injury. *Nature Neuroscience*, *3*, 1077–1078.

Calder, A. J., Young, A. W., Perrett, D. I., Etcoff, N. L., & Rowland, D. (1996a). Categorical perception of morphed facial expressions. *Visual Cognition*, *3*, 81–117.

Calder, A. J., Young, A. W., Rowland, D., Perrett, D. I., Hodges, J. R., & Etcoff, N. L. (1996b). Facial emotion recognition after bilateral amygdala damage: Differentially severe impairment of fear. *Cognitive Neuropsychology*, *13*, 699–745.

Ekman, P., & Friesen, W. C. (1978). *Facial action coding system*. Palo Alto, CA: Consulting Psychologists Press.

Foa, E. B., Kozak, M. J., Salkovskis, P. M., Coles, M. E., & Amir, N. (1998). The validation of a new obsessive-compulsive disorder scale: The obsessive-compulsive inventory. *Psychological Assessment*, *10*, 206–214.

Gray, J. M., Young, A.W., Barker, W. A., & Curtis, A. (1998). Impaired recognition of disgust in Huntington's disease carriers. *Brain*, *120*, 2029–2038.

Haidt, J., McCauley, C. R., & Rozin, P. (1994). A scale to measure disgust sensitivity. *Personality and Individual Differences*, *16*, 701–713.

Hejmadi, A. (2003). *Rasa or aesthetic emotion (As mentioned in the Natyasastra of Bharata).* Manuscript submitted for publication.

Hejmadi, A., Davidson, R., & Rozin, P. (2000). Exploring Hindu Indian emotion expressions: Evidence for accurate recognition by Americans and Indians. *Psychological Science*, *11*, 183–187.

Hejmadi, A., Rozin, P., & Davidson, R. (2003). *Channels of expression: Recognition, intensity and valence of face vs. hands/body movements in Americans and Hindu Indians.* Manuscript in preparation.

Kosson, D. S., Suchy, Y., Mayer, A. R., & Libby, J. (2002). Facial affect recognition in criminal psychopaths. *Emotion*, *2*, 398–411.

Lembke, A., & Ketter, T. A. (2002). Impaired recognition of facial emotion in mania. *American Journal of Psychiatry*, *159*, 302–304.

Matsumoto, D., & Ekman, P. (1988). *Japanese and Caucasian facial expressions (JACFEE) and neutral faces (JACNeut)*. San Francisco: San Francisco State University.

McGuire, P. K. (1995). The brain in obsessive-compulsive disorder. *Journal of Neurology, Neurosurgery, and Psychiatry*, *59*, 457–459.

Milders, M., Crawford, J. R., Lamb, A., & Simpson, S. A. (2003). Differential deficits in expression recognition in gene-carriers and patients with Huntington's disease. *Neuropsychologia*, *41*, 1484–1492.

Miller, W. I. (1997). *The anatomy of disgust*. Cambridge, MA: Harvard University Press.

Phillips, M. L., Young, A. W., Senior, C., Brammer, M., Andrew, C., Calder, A. J., Bullimore, E. T., Perrett, D. I., Rowland, D., Williams, S. C. R., Gray, J. A., & David, A. S. (1997). A specific neural substrate for perceiving facial expressions of disgust. *Nature*, *389*, 495–498.

Rapoport, J. L. (1989). The neurobiology of obsessive-compulsive disorder. *Journal of the American Medical Association*, *260*, 2888–2890.

Rapcsak, S. Z., Galper, S. R., Comer, J. F., Reminger, S. L., Nielsen, L., Kaszniak, A., W., Verfaellie, M., Laguna, J. F., Labiner, D. M., & Cohen, R. A. (2000). Fear recognition deficits after focal brain damage. A cautionary note. *Neurology*, *54*, 575–581.

Rozin, P. (1997). Disgust faces, basal ganglia, and obsessive-compulsive disorder: Some strange brainfellows. A comment on ''‘A specific neural substrate for perceiving facial expressions of disgust’ by Phillips et al.''. *Trends in Cognitive Sciences*, *1*, 321–322.

Rozin, P., Lowery, L., & Ebert, R. (1994). Varieties of disgust faces and the structure of disgust. *Journal of Personality and Social Psychology*, *66*, 870–881.

Rozin, P., Lowery, L., Imada, S., & Haidt, J. (1999). The CAD triad hypothesis: A mapping between the other-directed moral emotions, disgust, contempt, and anger, and Shweder's three universal moral codes. *Journal of Personality and Social Psychology*, *76*, 574–586.

Rozin, P., Haidt, J., & McCauley, C. R. (2000). Disgust. In M. Lewis & J. Haviland (Eds.), *Handbook of emotions* (2nd ed., pp. 637–653). New York: Guilford Press.

Sprengelmeyer, R., Young, A. W., Calder, A. W., Karnat, A., Lange, H., Holmberg, V., Perrett, D. I., & Rowland, D. (1996). Loss of disgust: Perception of faces and emotions in Huntington's disease. *Brain*, *119*, 1647–1665.

Sprengelmeyer, R., Young, A. W., Pundt, I., et al. (1997a). Disgust implicated in obsessive-compulsive disorder. *Proceedings of the Royal Society. Series B. Biological Sciences*, *264*, 1767–1773.

Sprengelmeyer, R., Young, A. W., Sprengelmeyer, A., Calder, A. W., Rowland, D., Perrett, D. I., Homberg, V., & Lange, H. (1997b). Recognition of facial expressions: selective impairment of specific emotions in Huntington's disease. *Cognitive Neuropsychology*, *14*, 839–879.

Tolin, D. F., Brigidi, B. D., & Foa, E. B. (1999, November). *Disgust sensitivity in obsessive-compulsive disorder*. Paper presented at the Annual Meeting of the Association for Advancement of Behavior Therapy, Toronto, Canada.

Wagner, H. L. (1993). On measuring performance in category judgment studies of nonverbal behavior. *Journal of Nonverbal Behavior*, *17*, 3–28.

Young, A. W., Aggleton, J. P., Hellawell, D. J., Johnson, M. , Broks, P., & Hanley, J. (1995). Face processing impairments after amygdalectomy. *Brain*, *118*, 15–24.