

# Damage to the ventromedial prefrontal cortex reduces interpersonal disgust

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**Disgust for contaminating objects (core disgust), immoral behaviors (moral disgust) and unsavory others (interpersonal disgust), have been assumed to be closely related. It is not clear, however, whether different forms of disgust are mediated by overlapping or specific neural substrates. We report that 10 patients with damage to the ventromedial prefrontal cortex (vmPFC) avoided behaviors that normally elicit interpersonal disgust (e.g. using the scarf of a busker) less frequently than healthy and brain-damaged controls, whereas they avoided core and moral disgust elicitors at normal rates. These results indicate that different forms of disgust are dissociated neurally. We propose that the vmPFC is causally (and selectively) involved in mediating interpersonal disgust, shaping patterns of social avoidance and approach.**

**Keywords:** disgust; emotions; social cognition; prefrontal cortex

## INTRODUCTION

Disgust is an emotion motivating withdrawal from offensive stimuli (Rozin *et al.*, 2000). Across cultures, humans experience disgust for contaminating objects, including rotten food, and animal and body products, such as feces, vomit and saliva (i.e. core disgust). Core disgust is characterized by a real or perceived threat of oral incorporation, and is functional to protect the body and avoid disease (Rozin *et al.*, 2000; Oaten *et al.*, 2009). Research using functional magnetic resonance imaging (fMRI) has shown that in humans (core) disgust has specific neural substrates, distinct from those associated with other negative emotions, involving the insula, the amygdala and the medial prefrontal cortex (Phillips *et al.*, 1997; Calder *et al.*, 2000; Moll *et al.*, 2005; Schaich Borg *et al.*, 2008).

Humans' feelings of disgust, however, are not limited to objects, but extend to persons and behaviors. Rozin and colleagues have theorized the existence of additional categories of disgust elicitors, including moral disgust and interpersonal disgust elicitors (Rozin *et al.*, 2000). Moral disgust arises for behaviors violating the dignity of others, such as unfairness, hypocrisy, betrayal, corruption and revealing 'a lack of normal human motivation', such as incest or pedophilia (Rozin *et al.*, 2000). Interpersonal disgust arises at the thought of contact and intimacy with individuals who are not intimates, especially if they are unsavory, belong to a socially deviant group, have a misfortune or a disease or are tainted by immorality (e.g. homeless, drug addicts) (Rozin *et al.*, 2000). For example, people exhibit revulsion toward wearing clothing from or sharing possessions with strangers or otherwise indesirable persons (Rozin *et al.*, 1994). Notably, interpersonal disgust remains if the clothing is sterilized (Rozin *et al.*, 1994), indicating that it goes beyond disease concerns to index more subtle a threat: a contamination of the self, deriving from being in contact, hence somehow 'associated', with individuals perceived as lower than the self in purity and social status (Hodson and Costello, 2007). Thus, just as core disgust protects the body by discouraging contact with contaminating substances, moral disgust and interpersonal disgust may protect individuals' soul and identity, discouraging the endorsement of immoral actions and maintaining social order, distinctiveness and hierarchies (Rozin *et al.*, 2000).

Although traditionally viewed as a disease-avoidance mechanism, disgust may therefore serve a more general function of signaling 'contaminating' objects, behaviors or persons that are to be avoided in order to maintain 'purity', be this of the body, the soul or the society (Rozin *et al.*, 1999, 2000). Accordingly, core disgust and moral disgust share disgust-related facial activity (Chapman *et al.*, 2009). Moreover, disgust is associated strongly with condemnation of immoral behaviors (Schnall *et al.*, 2008; Moretti and di Pellegrino, 2010), and predicts negative attitudes toward out-groups (Hodson and Costello, 2007; Inbar *et al.*, 2009) and desire for social distance (Rozin *et al.*, 2000). Despite similarities in the broad evolutionary meaning of core, interpersonal and moral disgust, the relationship between different forms of disgust is under debate. Recent empirical work has provided evidence for the psychological distinctiveness of different forms of disgust. For example, core disgust responses dissipate over time, whereas socio-moral disgust responses intensify (Simpson *et al.*, 2006). Gender (Simpson *et al.*, 2006) and personality traits (Olatunji *et al.*, 2008) have different effects on core and socio-moral disgust. Notably, interpersonal disgust, but not core disgust, predicts attitudes toward deviant and low-status groups (Hodson and Costello, 2007).

One crucial question is whether different forms of disgust are mediated by overlapping or specific neural substrates. Little work has been done to investigate the neural correlates of disgust in social and moral contexts. A recent fMRI study showed that core and moral disgust engaged a common network of brain regions, but also unique neural correlates (Schaich Borg *et al.*, 2008). One of these was the ventromedial prefrontal cortex (vmPFC). vmPFC (BA 10 and BA 32) was significantly more activated by socio-moral disgust elicitors than by core disgust elicitors. In another fMRI study, activity in vmPFC (BA 10) was lower for individuals from stigmatized groups typically associated with (interpersonal) disgust, such as homeless people and drug addicts, than for socially desirable individuals, whereas it was not modulated by the degree to which objects are disgusting (Harris and Fiske, 2006, 2007). The vmPFC is long known to be implicated in social cognition, and tuned to the evaluation of social information (Amodio and Frith, 2006). In monkeys, ablation of the medial prefrontal cortex decreases interest in social stimuli, while not affecting valuation of objects (Deaner *et al.*, 2005; Rudebeck, 2006). In humans, vmPFC is implicated in evaluation (Assmus *et al.*, 2007; Quadflieg *et al.*, 2009), preference (Mitchell *et al.*, 2006) and understanding of others (Lewis *et al.*, 2011). Together, these findings suggest that vmPFC may be a unique neural correlate of social (as opposed to core) forms

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of disgust. fMRI studies alone, however, do not settle whether the areas activated in response to elicitors of different forms of disgust are crucial to mediate disgust for those stimuli, and the ensuing avoidance behavior. We overcame this limitation using the lesion method.

Patients with focal damage to vmPFC, and brain-damaged and healthy control individuals considered scenarios that required deciding whether or not to engage in a behavior that resulted in a material gain but also elicited disgust. Scenarios were designed such that disgust may originate from contact with repulsive objects (core disgust scenarios), strangers and socially deviant individuals (interpersonal disgust scenarios) or immoral behaviors (moral disgust scenarios). For comparison purposes, subjects also evaluated scenarios eliciting anger (anger scenarios). Given the prominent role of vmPFC in the evaluation of social information (Amodio and Frith, 2006), we expected vmPFC patients to show reduced interpersonal disgust, being abnormally prone to accept contact with strangers and individuals from marginalized groups, but preserved core disgust. vmPFC patients were also expected to exhibit preserved moral disgust, avoiding contact with norm-violating behaviors, in line with evidence that vmPFC patients may have largely preserved moral knowledge (Saver and Damasio, 1991; Blair and Cipolotti, 2000) and condemn voluntary harm at normal rates (Young *et al.*, 2010, Ciaramelli *et al.*, 2012).

## METHODS

### Subjects

Participants included 22 patients with brain damage and 24 healthy individuals (Table 1). Patients were recruited at the Centre for Studies and Research in Cognitive Neuroscience, Cesena, Italy and the Spedali Riuniti, Brescia, Italy. Patients were selected on the basis of the location of their lesion evident on MRI or CT scans.

Ten patients had lesions centered on the vmPFC (vmPFC patients; Figure 1), defined as the medial one-third of the orbital surface and the ventral one-third of the medial surface of the frontal lobe (Stuss and Levine, 2002) and adjacent basal forebrain area. Lesions were the results of the rupture of an aneurysm of the anterior communicating artery (six cases), traumatic brain injury (TBI) (three cases) and brain tumor (one case). Lesions were bilateral in all cases. Twelve patients were selected on the basis of having damage that did not involve the mesial orbital/vmPFC and frontal pole, and also spared the amygdala in both hemispheres (non-FC patients). Lesions were unilateral (left: 5 cases, right: 7 cases), caused by stroke (10 cases) or brain tumor (2 cases), and included the lateral aspect of the temporal lobe and adjacent white matter (7 cases), the inferior parietal lobule (5 cases) and the premotor cortex (5 cases).

Included patients were at least 6 months post-morbid, not receiving psychoactive drugs and had no other diagnosis likely to affect cognition (e.g. significant psychiatric disease, alcohol abuse, history of cerebrovascular disease). There was no significant difference in lesion volume between vmPFC patients and non-FC patients, 55.8 vs 47.0 cc,  $P=0.60$ . Patients' general cognitive functioning was generally preserved, as indicated by the scores they obtained in the Mini-Mental State Examination (Folstein *et al.*, 1983), the Raven Standard Matrices

and the digit span test, which were within the normal range in all cases (Spinnler and Tognoni, 1987; Table 1).

The healthy control group comprised 24 individuals matched to patients on mean age, gender and education. Control participants were not taking psychoactive drugs, and were free of current or past psychiatric or neurological illness as determined by history. Participants gave informed consent according to the Declaration of Helsinki (International Committee of Medical Journal Editors, 1991) and the Ethical Committee of the Department of Psychology, University of Bologna.

### Lesion analysis

For each patient, lesion extent and location were documented by using the most recent CT or MRI scans. Lesions were traced by a neurologist with experience in image analysis on the T1-weighted template MRI scan from the Montreal Neurological Institute provided with the MRIcron software (Rorden and Brett, 2000). The scan is normalized to Talairach space. Superimposing each patient's lesion onto the standard brain allowed us to estimate the total brain lesion volume. The location of lesions was identified by overlaying the lesion area onto the Automated Anatomical Labeling template provided with MRIcron. Figure 1 shows vmPFC patients' brain lesions. These involved BAs 10, 11, 24, 25, 32 and, in a few cases, extended to BAs 46 and 47. Regions of maximal overlap were BAs 10, 11 and 32.

### Materials

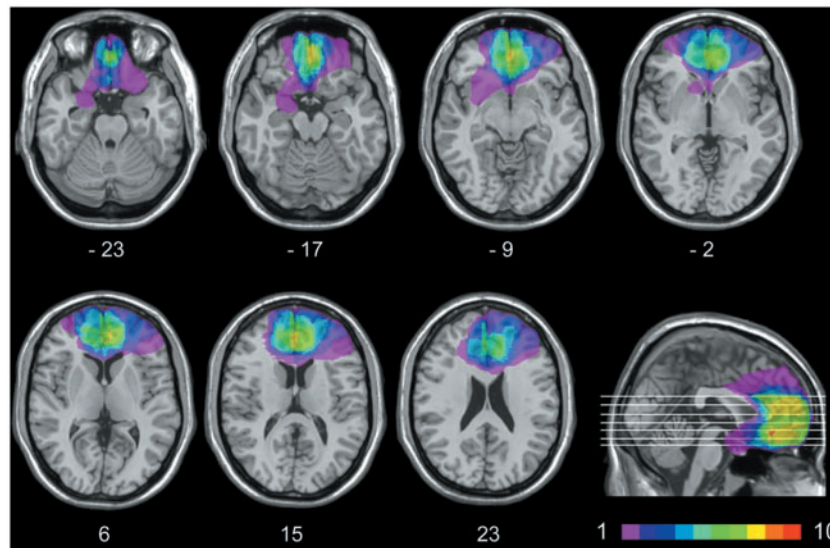
In 44 hypothetical scenarios, subjects were to decide whether they would or would not choose a behavioral option that resulted in a material gain but also elicited a negative emotion. In 33 of the 44 scenarios, the emotion elicited was disgust. Disgust scenarios were subdivided according to the type of disgust elicitor into core disgust scenarios ( $n=11$ ), interpersonal disgust scenarios ( $n=11$ ) and moral disgust scenarios ( $n=11$ ).

Core disgust elicitors were contaminating and revolting objects, including rotten food, animals (e.g. ants, mice) and body fluids (e.g. vomit, urine). Our core disgust category also included two items involving deformity and corpse. We note that whereas some authors include body envelop violations and corpses into a core (or pathogen, or primary) disgust category (Marzillier and Davey, 2004; Simpson *et al.*, 2006; Tybur *et al.*, 2009), as we did, others consider them to belong to a distinct, 'animal-nature' disgust category (Rozin *et al.*, 2000). While there are theoretical reasons supporting either taxonomy (Rozin *et al.*, 2000; Tybur *et al.*, 2009), we note that our results would not change if we remove these items from the core disgust elicitors. An example core disgust scenario required deciding whether or not to buy a pizza with some ants on it if you are starving (see Appendix 1 for the whole list of scenarios). Interpersonal disgust elicitors included contact or intimacy with strangers, unsavory others (e.g. homeless, alcohol addicts, drug addicts, etc) and individuals belonging to socially deviant (e.g. transsexuals) or marginalized groups (e.g. circus tenants, buskers) (Rozin *et al.*, 2000). An example interpersonal disgust scenario required

**Table 1** Participant groups' demographic and clinical data

Group	Sex (M/F)	Age (years)	Education (years)	Lesion volume (cc)	MMSE	SRM	DS
vmPFC ( $n=10$ )	9/1	52.9 (15.5)	10.9 (5.3)	55.7 (31.9)	27.5 (2.3)	28.2 (6.7)	5.2 (1.4)
non-FC ( $n=12$ )	7/5	54.6 (14.5)	10.1 (4.9)	47.0 (44.6)	28.8 (1.0)	28.5 (5.7)	5.4 (1.2)
HC ( $n=24$ )	20/4	55.0 (19.9)	11.4 (4.4)	—	—	—	—

vmPFC, patients with lesions in the ventromedial prefrontal cortex; non-FC, patients with lesions outside the frontal lobe; HC, healthy controls; M, male; F, female; MMSE, Mini Mental State Examination; SRM, Standard Raven Matrices (corrected score); DS, digit span forward (corrected score). The values in parentheses are standard deviations.



**Fig. 1** Location and overlap of brain lesions in the 10 patients with vmPFC damage projected on the same seven axial slices and on the mesial view of the standard Montreal Neurological Institute brain. z-Coordinates of each axial slice are given. The color bar indicates the number of overlapping lesions. Maximal overlap occurs in BAs 10, 11 and 32. In axial slices, the left hemisphere is on the left side.

deciding whether or not to use the scarf of a busker if you are really cold. Moral disgust elicitors included behaviors violating the dignity of others, such as unfairness, hypocrisy, betrayal, corruption and revealing a lack of normal human motivation, such as incest or pedophilia (Rozin *et al.*, 2000). An example moral disgust scenario required deciding whether or not to work for a corrupted politician if it will improve your career. For comparison purposes, disgust scenarios were contrasted with 11 scenarios eliciting anger (anger scenarios). An example anger scenario required deciding whether or not to sit beside two noisy persons if that is the only free seat left at the movie-theatre.

Care was taken to avoid contamination between different classes of disgust. Although contamination/disease concerns are central to core disgust, interpersonal disgust may also have a contamination/disease concern component, because contact with others opens us to contact with their body products (Olatunji *et al.*, 2008). To minimize the overlap between core and interpersonal disgust, we excluded from the interpersonal disgust elicitors individuals with infectious diseases, such as AIDS and tuberculosis. Another potential issue pertains to morality. Although moral conduct is the focus of moral disgust, a moral taint is known to exacerbate interpersonal disgust (Rozin *et al.*, 2000). To minimize the overlap between moral and interpersonal disgust, we designed our scenarios such that the characters in moral disgust scenarios were individuals well-integrated socially (e.g. workers, professionals) who exhibited morally inappropriate behaviors in the context of the scenario. In contrast, the characters in interpersonal disgust scenarios were strangers or socially deviant individuals who did nothing wrong in the scenario. Thus, in moral disgust scenarios, the target of disgust was individuals' (immoral) behavior, whereas in interpersonal disgust scenarios the target of disgust was individuals' physical presence and identity (Harris and Fiske, 2006). Additionally, we excluded from the interpersonal disgust category individuals patently associated with immorality (e.g. murderers).

An independent group of 65 healthy individuals (15 females), matched for age (mean = 52.12, range = 30–78), education (mean = 11.89, range = 5–18) and gender with participants in the main experiment considered the behavioral option proposed in each scenario (e.g. using the scarf of a busker), and indicated the emotions it evoked, selecting one or more of the following options: fear, disgust,

happiness, anger and sadness. Subjects selected 'none' if none of the above emotions was at all appropriate to describe their emotions in response to the proposed option. Individuals also rated the proposed options for overall unpleasantness, on a scale from 0 (not unpleasant at all) to 4 (very unpleasant).

In designing the scenarios, we sought to match costs and benefits, such that behavioral options eliciting intense aversive emotions were also those that warranted the largest material gains. Piloting confirmed that participants were equally likely to accept the proposed option across classes of scenarios, and that acceptance rates were not at floor or ceiling levels in any class of scenario.

Scenarios were on average 87-word long. There was no significant difference in the number of words per scenario,  $F(1,3) = 1.63$ ,  $P = 0.19$ , number of phrases per scenario,  $F(1,3) = 2.11$ ,  $P = 0.11$  and number of words per phrase,  $F(1,3) = 0.71$ ,  $P = 0.54$ , across types of scenarios.

## Procedure

Each scenario was presented as text through two screens. The first screen described the scenario, and the second screen posed a question about whether or not to accept a behavioral option related to that scenario (e.g. Do you buy the slice of pizza?). Participants responded 'yes' or 'no' by pressing one of the two buttons. For all scenarios, 'yes' responses implied commitment to a behavioral option that elicited a negative emotion but also resulted in a material gain. The order of presentation of the scenarios was randomized for each participant.

## RESULTS

### Validation of the emotional profile of different classes of scenarios

Mean emotion assignments to the different classes of scenario are displayed in Table 2. Emotion ratings violated in some cases the normality assumption and therefore data were analyzed using non-parametric tests. We conducted Mann–Whitney U-tests on mean ratings for each of the 5 emotions probed (disgust, anger, sadness, fear, happiness), for all 6 combinations of the type of scenario pairs, reporting the significant differences below a threshold of  $P < 0.0016$ , i.e. the Bonferroni-corrected  $\alpha$ -level for 30 comparisons (0.05/30). Disgust

**Table 2.** Emotional profile of different classes of scenarios

Type of scenario	Type of emotion					Overall unpleasantness
	Disgust	Anger	Sadness	Fear	Happiness	
Core disgust	0.73 (0.06)	0.11 (0.02)	0.12 (0.05)	0.11 (0.04)	0.02 (0.01)	3.17 (0.13)
Interpersonal disgust	0.39 (0.06)	0.05 (0.02)	0.15 (0.04)	0.16 (0.03)	0.13 (0.03)	2.32 (0.16)
Moral disgust	0.32 (0.02)	0.47 (0.06)	0.31 (0.03)	0.09 (0.04)	0.04 (0.01)	3.10 (0.14)
Anger	0.04 (0.01)	0.79 (0.03)	0.11 (0.02)	0.03 (0.01)	0.03 (0.01)	2.99 (0.08)

The table presents the mean frequency with which different classes of scenarios elicited different emotions, and the mean unpleasantness ratings for each class of scenarios. Values represent mean and standard error of the mean (in parentheses).

scenarios elicited disgust more frequently than anger scenarios, and this held for either core disgust:  $U=0$ ,  $P<0.001$ ; interpersonal disgust:  $U=1.5$ ,  $P<0.001$ ; and moral disgust scenarios:  $U=0$ ,  $P<0.001$ . Conversely, anger scenarios elicited anger more frequently than core disgust:  $U=0$ ,  $P<0.001$ ; interpersonal disgust:  $U=0$ ,  $P<0.001$ ; and moral disgust scenarios:  $U=5$ ,  $P<0.001$ . These results support the validity of our main subdivision between disgust and anger scenarios.

The results also revealed differences in the emotional profile of different types of disgust. Core disgust scenarios elicited disgust more frequently than moral disgust scenarios:  $U=10$ ,  $P<0.001$  (see also Marzillier and Davey, 2004; Simpson *et al.*, 2006), and, though marginally, interpersonal disgust scenarios,  $U=16$ ,  $P=0.002$ , with no difference between interpersonal and moral disgust scenarios,  $P=0.65$ . Moral disgust scenarios, on the other hand, elicited anger more frequently than core disgust scenarios,  $U=10$ ,  $P<0.001$  (see also Marzillier and Davey, 2004; Simpson *et al.*, 2006) and interpersonal disgust scenarios,  $U=4$ ,  $P<0.001$ , with no difference between core and interpersonal disgust scenarios,  $P=0.09$ . There were no significant differences in sadness, fear and happiness among disgust scenarios.

Ratings of overall unpleasantness were distributed normally, and therefore data were subject to analysis of variance (ANOVA), with Scenario (core disgust, interpersonal disgust, moral disgust, anger) as factor. There was a significant effect of Scenario,  $F(1,40)=8.56$ ,  $P=0.002$ . Newman–Keuls post hoc comparisons showed that interpersonal disgust elicitors were rated as generally less unpleasant than core disgust, moral disgust and anger elicitors,  $P<0.005$  in all cases (Table 2).

### Damage to vmPFC impairs behavior in interpersonal disgust scenarios selectively

Figure 2 presents acceptance rates for the proposed behaviors (i.e. the frequency with which subjects endorsed behaviors resulting in gains but also eliciting negative emotions) by the participant group and the type of scenario. Acceptance rates obeyed the normality assumption, and therefore comparisons were performed using parametric tests. An ANOVA on acceptance rates with Group (vmPFC patients, control patients, healthy controls) and Scenario as factors revealed a significant effect of Group:  $F(2,43)=3.75$ ,  $P<0.05$ , and a significant effect of Scenario:  $F(3,129)=13.03$ ,  $P<0.001$ . The main effects were qualified by a significant Group  $\times$  Scenario interaction,  $F(6,129)=2.36$ ,  $P<0.05$ . Newman–Keuls post hoc comparisons showed that vmPFC patients were more likely to accept behavioral options eliciting interpersonal disgust than were healthy controls,  $P<0.005$ , and non-FC patients,  $P<0.005$ , whereas no difference was found between healthy controls and non-FC patients,  $P=0.98$ . In contrast, acceptance rates for core disgust, moral disgust and anger scenarios did not vary significantly as a function of group,  $P>0.11$  in all cases. These results show that vmPFC patients were disproportionately less reluctant than controls to endorse behaviors entailing contact with individuals that

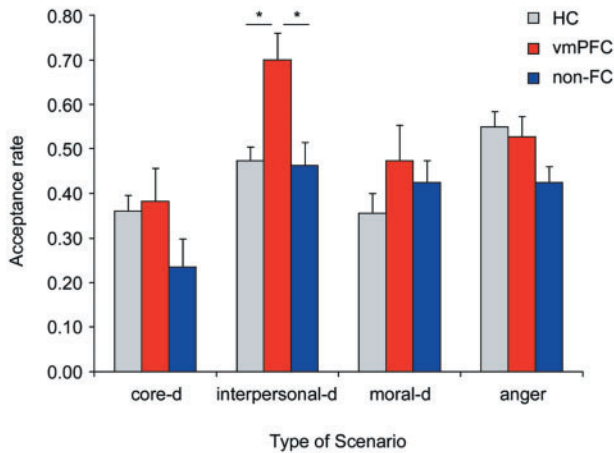
normally elicit disgust, indicating a reduced sensitivity to interpersonal disgust.<sup>1</sup>

As discussed earlier, interpersonal disgust elicitors had lower emotional intensity compared to core disgust, moral disgust and anger elicitors. Even though, in our scenarios the intensity of the aversive emotion and that of the benefit were roughly matched, we conducted an additional analysis to confirm that the selective increase in acceptance rates for interpersonal disgust scenarios in vmPFC patients did indeed depend on the type, and not the intensity, of the emotion probed. We divided each set of scenarios in a low- ( $n=6$ ) and a high-emotion subset ( $n=5$ ) through a median split. We then contrasted participants' behavior in high-emotion interpersonal disgust scenarios to that in low-emotion core disgust scenarios, low-emotion moral disgust scenarios and low-emotion anger scenarios. These subsets of scenarios were matched for overall valence (mean emotional intensity: for core disgust scenarios, 2.91; for interpersonal disgust scenarios, 2.81; for moral disgust scenarios, 2.82; for anger scenarios, 2.81,  $F(1,3)=0.11$ ,  $P=0.95$ ), while retaining similar emotional profiles to the original sets. We confirmed our results. There was a significant interaction between Group and Scenario,  $F(6,129)=3.43$ ,  $P<0.005$ . vmPFC patients exhibited higher acceptance rates than healthy controls (0.64 vs 0.34,  $P<0.01$ ) and non-FC patients (0.64 vs 0.35,  $P<0.01$ ) in interpersonal disgust scenarios, but not in core disgust (vmPFC patients: 0.36; non-FC patients: 0.26; healthy controls: 0.44), moral disgust (vmPFC patients: 0.50; non-FC patients: 0.37; healthy controls: 0.40) and anger scenarios (vmPFC patients: 0.43; non-FC patients: 0.38; healthy controls: 0.56),  $P>0.36$  in all cases.

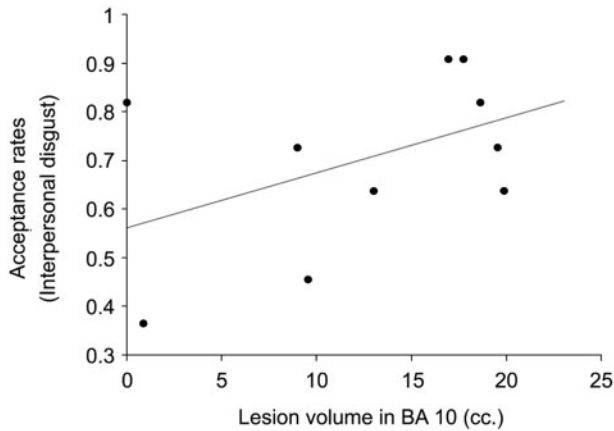
### Behavior in interpersonal disgust scenarios is related to lesion volume in BA 10

For each class of scenarios, we investigated the relation between acceptance rates and lesion volume in each region lesioned in vmPFC patients, i.e. BAs 10, 11, 32, 24, 25, 46, 47, partialling out the effect of lesion volume in the other BAs. Lesion volume in BA 10 correlated positively with acceptance rates in interpersonal disgust scenarios,  $r=0.96$ ;  $P<0.05$ , two tailed (Figure 3). The larger the lesion, the more pronounced the tendency to accept contact with individuals who normally elicit disgust. Interestingly, lesion volume in BA 11 correlated negatively with acceptance rates in interpersonal disgust

<sup>1</sup>The vmPFC patient group included three patients with TBI. Although included TBI patients have documented damage to vmPFC, additional diffuse axonal injury cannot be ruled out. Thus, in order to assure that vmPFC patients' performance is to be attributed unambiguously to damage in vmPFC, we re-ran the ANOVA excluding TBI patients from the vmPFC patient group. We confirmed our results. There was a significant effect of Scenario,  $F(3,120)=11.00$ ,  $P<0.001$ , and a significant Group  $\times$  Scenario interaction,  $F(6,120)=2.47$ ,  $P<0.05$ . To probe this interaction, we conducted separate ANOVAs on acceptance rates for different scenarios. For interpersonal disgust scenarios, a significant effect of Group emerged,  $F(2,40)=3.7$ ,  $P<0.05$ . Newman–Keuls post hoc comparisons revealed that vmPFC patients were more likely to accept behavioral options eliciting interpersonal disgust than were healthy individuals and non-FC patients ( $P<0.05$  in both cases), with no difference between healthy and brain-damaged controls ( $P=0.87$ ). In contrast, acceptance rates for core disgust scenarios, moral disgust scenarios and anger scenarios did not vary significantly as a function of participant group,  $P>0.06$  in all cases.



**Fig. 2** Mean acceptance rates by participant group (vmPFC = patients with lesions in the vmPFC; non-FC = patients with lesions outside the frontal lobe; HC = healthy controls) and type of scenario (core disgust, interpersonal disgust, moral disgust, anger). The error bars indicate the standard error of the mean. \* $P < 0.005$ , two tailed.



**Fig. 3** Scatterplot of the correlation between lesion volume in BA 10 and acceptance rates in interpersonal disgust scenarios.

scenarios,  $r = -0.95$ ;  $P < 0.05$ , two tailed. This finding may relate to BA 11’s involvement in reward processing (O’Doherty, 2004; Sellitto *et al.*, 2010). Large lesions in BA 11 may have led to reduced sensitivity to the reward associated with the scenarios, and, in turn, relatively lower acceptance rates. No other correlation was significant,  $P > 0.056$  in all cases. No significant correlation emerged between lesion volume and acceptance rates in core disgust, moral disgust and anger scenarios,  $P > 0.13$  in all cases.

These findings suggest that BA 10 of vmPFC plays a pivotal, and selective, role in mediating interpersonal disgust, consistent with fMRI evidence (Harris and Fiske, 2006, 2007). The results also confirm previous evidence of functional heterogeneity within vmPFC, with different regions tuned to social (BA 10) and non-social (BA 11) affective evaluation (Harris *et al.*, 2007).

**DISCUSSION**

Disgust is an aversive state motivating withdrawal from a variety of offensive stimuli, including contaminating objects, socially deviant and out-group individuals, and immoral behaviors. A critical question is whether our reactions toward this varied set of disgust elicitors arise

from a singular neural mechanism or, rather, distinguishable neural systems. Here, patients with damage to vmPFC, and brain-damaged and neurologically intact control subjects, decided whether or not to engage in behaviors eliciting core disgust, interpersonal disgust, moral disgust or, for control purposes, anger, in order to obtain a material gain.

Compared with healthy individuals, vmPFC patients showed pronouncedly higher acceptance rates of behavioral options that normally elicit interpersonal disgust. This finding was not due to a general impairment of decision-making (Leland and Grafman, 2005) or flattening of emotion in vmPFC patients (Blumer and Benson, 1975; Eslinger and Damasio, 1985). In core disgust scenarios, moral disgust scenarios and anger scenarios, indeed, vmPFC patients behaved normally. As well, abnormal behavior in interpersonal disgust scenarios is not a necessary consequence of brain damage, because control patients’ behavior was comparable to that of healthy individuals across classes of scenarios. The present findings, therefore, point toward a selective reduction of interpersonal disgust in vmPFC patients, in the face of a generally preserved ability to process the benefits and the emotional cost of complex situations.

The finding that core disgust was preserved in vmPFC patients is in line with converging evidence that vmPFC is prominently tuned to the evaluation of social information (Amodio and Frith, 2006). In monkeys, for example, ablation of the medial prefrontal cortex decreases interest in social stimuli, but does not affect valuation of objects (Deaner *et al.*, 2005; Rudebeck, 2006). In humans, vmPFC is more activated by socio-moral when compared to core disgust elicitors (Schaich Borg *et al.*, 2008), and its activity is modulated by individuals’—but not objects’—desirability (Harris and Fiske, 2006, 2007).

vmPFC patients also showed preserved moral disgust: like healthy controls, they wanted nothing to do with individuals that perpetrated immoral actions that harmed others. This finding is more intriguing because moral disgust (as well as anger) scenarios also involve social cognition and valuation. Moreover, vmPFC is known to be implicated in moral cognition (Eslinger and Damasio, 1985; Greene *et al.*, 2001). Previous evidence, however, has pointed out that vmPFC patients’ moral judgment may be largely preserved, unless it requires pitting potential benefits against causing harm directly (i.e. with one’s own hands) to another person (personal moral dilemmas; Greene *et al.*, 2001; Ciaramelli *et al.*, 2007; Koenigs *et al.*, 2007). This is not the case for our moral disgust scenarios, in which, by analogy with the other scenarios, subjects were to decide whether to accept contact with (i.e. endorse), and not enact themselves, morally inappropriate behaviors. The finding that vmPFC patients have preserved moral disgust is, therefore, in line with previous evidence that vmPFC patients judge (impersonal) moral violations (Ciaramelli *et al.*, 2007; Koenigs *et al.*, 2007), as well as voluntary moral transgressions (Young *et al.*, 2010; Ciaramelli *et al.*, 2012) as harshly as controls. It must be noted that immoral behaviors typically elicit anger and indignation, along with disgust (Rozin *et al.*, 2000), as confirmed in the emotion ratings in the present study. fMRI studies have shown that anger and indignation toward moral transgression are associated with activity in lateral orbitofrontal cortex, dorsolateral prefrontal cortex and anterior insula (Moll *et al.*, 2005), but not vmPFC. Together, these findings confirm that vmPFC is not necessary to mediate moral disgust.

Healthy individuals and control patients in the present study avoided others not only on the basis of what they did (moral disgust scenarios), but also on the basis of what they were (interpersonal disgust scenarios). It is here that vmPFC patients’ behavior diverged from that of controls. Despite able to take distance from morally inappropriate behaviors, vmPFC patients accepted contact with socially deviant and out-group individuals that normally elicit disgust more frequently than controls. What is the mechanism by which processing

in vmPFC may mediate interpersonal disgust? vmPFC may support a social appraisal system necessary to evaluate others on the basis of their identity. Consistent with this hypothesis, vmPFC is sensitive to the status others hold in a social group. Thirsty male monkeys forgo juice to view images of the males of high social status (Deaner *et al.*, 2005), and this behavior is abolished after medial prefrontal lesion (Rudebeck, 2006). In humans, BA 10 of vmPFC responds less intensely to undesirable persons that elicit disgust than to socially desirable persons (Harris and Fiske, 2006). Conversely, activity in vmPFC increases with the perceived similarity of others to the self (Mitchell *et al.*, 2006; Mobbs *et al.*, 2009; Volz *et al.*, 2009), and mediates preference for similar others (Mitchell *et al.*, 2006) and affiliative tendencies (Moll and Schulkin, 2009; Krienen *et al.*, 2010). Both the animal (Rudebeck, 2006; Noonan *et al.*, 2010) and the imaging (Behrens *et al.*, 2009) literature confirm that vmPFC assigns affective (friends or foes) value to other individuals. On the other hand, to the extent that disgust reactions connote the sense that one is better, purer and less offensive than the offending target (Hodson and Costello, 2007, p. 692); development of interpersonal disgust may demand a strong self-representation. The vmPFC is crucial for self-referential processing and the neural representation of self (Kelley *et al.*, 2002; Beer *et al.*, 2003; Macrae *et al.*, 2004; Moran *et al.*, 2006; Philippi *et al.*, 2012), and, therefore, damage to this region may further hinder mechanisms of social appraisal and comparison. Damage to vmPFC may compromise the ability to differentiate between desirable and non-desirable others, and trigger the appropriate degree of social engagement with either. In line with this hypothesis, lesion volume in BA 10 predicted the extent to which patients made contact with undesirable others during social interaction.

An additional factor may help explain the selective involvement of vmPFC in interpersonal disgust. As anticipated, interpersonal disgust does not generally depend on the evaluation of the target's contingent behavior. For example, we tend to avoid contact with an alcohol addict even if he is being benevolent to us. This entails downplaying ongoing actions to favor other sources of information (e.g. inferences about past behavior, social status, stereotypes), which may signal a potential threat. This is not the case for moral disgust that is typically triggered by inadmissible behaviors already *in act* and their proximal (negative) consequences. Disgust-relevant concerns about interpersonal contamination, therefore, may be more crucially dependent on perspectives removed from one's current experience and abstract representations than are those about immoral behaviors. The vmPFC is embedded in a neural network enabling transcending the here-and-now, a core cognitive component of several mental activities, including projecting oneself in the past or the future, and taking another person's perspective (Buckner and Carroll, 2007; Liberman and Trope, 2008). Damage to vmPFC may impair patients' ability to go beyond their immediate experience, leaving them bound to evaluate others only on the basis of their ongoing behavior and its proximal consequences. This would not impede the development of moral disgust toward a bad doer, but would make blind to the 'social value' of the individuals whose current behavior is not apparently harmful or threatening. This proposal is speculative at the moment and requires empirical testing. For example, one would expect vmPFC patients to have problems in moral judgment that is critically based on psychologically distant representations, such as that toward immoral behaviors implemented in the remote past, or only planned. In line with this hypothesis, vmPFC patients appear to condemn immoral behaviors based on their outcomes and not the intentions behind (Young *et al.*, 2010; Ciaramelli *et al.*, 2012).

Theorists of disgust have argued that, although all originating from, and possibly still sharing, a common disgust avoidance mechanism, core, interpersonal and moral disgust have evolved to solve different adaptive problems, and therefore may rely on distinct processing and

neural systems (Schaich Borg *et al.*, 2008; Rozin *et al.*, 2009). Our results are consistent with this proposal. Damage to the vmPFC selectively decreased interpersonal disgust, by hindering social appraisal and perspective-taking systems, while leaving unimpaired systems for assessing other disgust elicitors as well as the (possibly common) disgust avoidance mechanism.

To conclude, we have shown that the vmPFC is causally, and selectively, involved in mediating disgust for, and active avoidance of, persons with a negative social connotation, such as deviant and out-groups individuals. The social aversion mediated by vmPFC appears driven exclusively from the appraisal of others' identity and social status and not their behavior. In marking individuals that do or do not deserve approach, vmPFC reveals crucial to sculpt the social space in which interpersonal relations are possible, forming social groups and protecting them from socially deviant individuals.

### Conflict of Interest

None declared.

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## APPENDIX 1

### CORE DISGUST SCENARIOS

- (1) You find yourself in a foreign country. You have not eaten for several hours, you are very hungry and feel weak. You go into a shop to buy some food but all you have is some loose change in your pocket. You realize that the only thing you can afford to buy with the money you have is a slice of pizza. You then notice some ants on the pizza dish, right next to the pizza itself, and some are crawling on it. Do you buy the slice of pizza?
- (2) You are at the airport, it is not long till boarding time, but you are forced to move away from the area because you need to go to the bathroom urgently. Unfortunately, however, only one of the toilet cubicles is free: some are out of order and the remaining two are being serviced. You go into the free cubicle and notice that someone has recently been sick there: the toilet seat and the floor are covered in vomit and the smell is very strong. Do you decide to use that toilet?
- (3) You arrive very late to an evening get-together with friends. You cannot wait to have a beer! You just manage to buy a glass at last orders, then the place closes. Outside, not far away, you and your friends find a bench to sit down and chat. One of your friends has a terrible cold, just sneezing and blowing his bunched up nose all the time filling up a lot of tissues with thick mucus. You just happen to prop your beer on the bench right at the very moment when your friend sneezes again and who cannot help but sneeze all over it. Do you decide to continue drinking your beer?
- (4) You are in a shop. You have found a swimming costume you rather like and want to try on. Unfortunately, all the shop's changing rooms are busy but you cannot afford to wait your turn as your parking ticket will run out soon and you run the risk of getting a fine. You see a small empty room at the back of the shop you could use to try on the costume. The floor carpet in this room seems to be giving off an acrid stench of urine. You cannot see any wet stains but the smell is very strong. Do you decide to stay in the room anyway?
- (5) You are in a queue at the Post Office and you have been waiting your turn for a long time. The Post Office will close in a few minutes: if you leave your place in the queue now you will have to return after your lunch break. An elderly man walks into the Post Office and stands in the queue behind you. The man coughs and continues to cough persistently, his breath catching your hair each time he does it. You turn around to face him and notice that the handkerchief he is using to cover his mouth with is covered with mucus and drops of blood. Do you decide to stay put in the queue?
- (6) You are at your Principal's house for dinner. For desert, his wife kindly serves a fruitcake. While you are breaking into the first slice of fruitcake with your fork, you notice that some white hairs are sticking out of it. Seeing as the Principal's wife has brown hair, you think that maybe the hairs are those of the family dog. After all, it has been sat near the table throughout

- dinner, after having run around in the garden during aperitifs. Do you decide to eat the piece of fruitcake with the hairs in it?
- (7) You have just arrived at your holiday retreat in the mountains after a long journey: you have driven for over 5 h; you are extremely tired and cannot wait to go to bed. As soon as you walk into the house, you see two large rats coming out of the utility room. The house has been locked up for a few months and it could be that the rats have used your bed to make their nest in: you see that the bed linen is in fact a little ruffled. Do you decide to sleep in your bed as it is?
- (8) You are at a film festival and you have just finished watching a film. You have a 15 min break before having to return to the cinema theatre for another 3 h, so you go in search for something to eat among the festival stalls. You see just one stall that sells food, and it is film themed. It is a gray composition in the shape of a monkey's brain, made from fruit, served in hairy cups that look like the head of a monkey with its eyes closed. Do you decide to eat that food?
- (9) You are on a crowded bus that is driving on a bumpy road and to avoid falling over, it is necessary to hold on to the bus hand-grips. A disfigured man gets on. His face is deformed: the skin on one half of his face sags limply, hanging well below his chin. The man walks over to where you are to share the same hand-grip. When the bus goes round a corner or brakes, the excess skin flaps often touching your shoulder. Do you decide to stay where you are on the bus?
- (10) You are waiting at the cinema. There are a lot of people and everyone is pushing to get in. The seats left available in the cinema theatre are shown on a display screen. You count the number of people in front of you and realize that if you do not stay where you are in the queue, you will not get in. In front of you, there is an obese, sweaty man, with a very thin shirt on; the crowd squashes you against his flabby, sticky back. The smell of this huge man in front of you is very strong and your t-shirt before long smells of his sweat. Do you decide to stay where you are in the queue?
- (11) You are in another city for work reasons. It is the afternoon and you have to find a room for the night. You go into a hotel and ask if they have any rooms free. Luckily, one has just been made available. The porter informs you that the room has just been made available because the gentleman that was using it had died. Turning around, you see some paramedics leaving the lift with a covered body on a stretcher. Do you decide to accept the room?

#### INTERPERSONAL DISGUST SCENARIOS

- (12) You are on a holiday abroad and you have made a date to meet up with your friend at a tube station. There by your side is a middle-aged man playing the violin, busking, with a hat at his feet for passers-by to drop some money into. The wind starts to pick up and you shiver. Ten minutes pass and your friend still has not shown up and you start to feel quite cold. The middle-aged busker takes off his scarf and offers it to you. Do you decide to accept the scarf?
- (13) You are walking along the street in your town center, in the morning, when suddenly you realize that your nose is bleeding. You feel in your pockets for a handkerchief but unfortunately you do not have any. You continue your search while holding your nose with your other hand. Shortly after, a man staggers toward you, slurring incomprehensible words: he is obviously drunk. The man waves you a hankie and tells you to take it. Do you decide to accept and use the hankie?
- (14) It is a sunny day, it is the afternoon and you are in the park. It is really quite hot and you are very thirsty. You look around you in search of water but unfortunately you do not see any drinking water fountains and you do not have any money to buy bottled water. Sat on the bench in front of you, there is a man. You see him drink some water from a bottle with a straw and then you see him get up and go, leaving the bottle of water on the bench. You are pretty certain he will not be back for it. Do you decide to drink from that man's bottle of water?
- (15) It is very hot and so you have decided to get out of the house and go to the park to read a book, to enjoy the coolness provided by the shade of the trees. You head toward your favorite bench: it is in the shade of a tall, wide tree sat on the top of a hill from where you can look down over the whole of the park. However, you see that there is a tramp sleeping on that bench. The bench is a very long one though, and there is a good meter or so left free to sit on. Do you decide to sit next to the tramp on the bench?
- (16) You have just arrived at the swimming complex. The past few days have been very tiring and you really cannot wait to relax and have a good swim. You are in the changing room getting changed when you realize that you have left your swimming costume at home. You cannot buy one of those costumes that the complex sells because you do not have enough money: you only brought enough for the entrance fee. You are just about to leave when you see a swimming costume on one of the benches in the changing room. Someone must have forgotten about it and left it there yesterday. Do you decide to use that swimming costume?
- (17) You are in another city for a few months for work reasons. You are unpacking in your room when you see that you have forgotten to pack a towel. You ask your new neighbors if they could lend you one but they do not have any spare. Returning home later that evening, you see the people from the second floor, who are moving out. They tell you that they have some old linen that they will not be taking with them to the new house, and ask you if you would like some towels along with a bathrobe. Do you decide to accept their offer and use their old towels and bathrobe?
- (18) You are on the beach with a couple of friends. It is very hot and unfortunately you do not have a parasol. You look around you searching for some shade when two people nearby suggest you move your towel closer to them, so you can share their parasol. You notice that the person whom at first glance seemed a woman has a very masculine looking face and legs. Looking a little closer, you realize it is a transexual. Do you decide to move your towel closer to their parasol?
- (19) You are in a pizza restaurant with some friends. You have finished your pizza but you are still a little hungry and you are undecided as to what to do about it: you discuss with your friend if it is worth ordering another pizza or not. The man who sat at the table near yours, who is on his way out of the restaurant, hears you discussing this and offers you the pizza he has left. You see, in fact, that he has left half of his pizza untouched. Do you decide to eat that man's leftover pizza?
- (20) You are in a park on a beautiful day to relax a little. You see a boy sat on the ground not far from you, leaning against a tree, with a syringe in his arm. It seems like he is sleeping. He has probably just had a strong shot of some drug. Suddenly, a gust of wind blows your cap off your head, which ends up right next to that boy. He sees the cap and puts it on. Do you decide to get your cap back?



- (21) You are on a ferry boat and the journey will last for an hour. You walk around for a while looking for somewhere to sit but all the seating areas seem full. Finally, you find one that is free but you notice that the seat next to it is occupied by a man who lives in your area. You have often seen him walking in the street talking to himself loudly, gesturing and having full blown conversations with himself. You notice that even now he is mumbling something to himself while looking out of the window. Do you decide to sit next to that man?
- (22) You are walking along the street while eating an ice-cream when suddenly a youth bumps into you, making your ice-cream smear on to your t-shirt. You really did not need this: you will be out of the house for a few more hours yet and you have nothing to get changed into. The youth apologizes saying he tripped and how he would like to repay you by offering his t-shirt that he has in his rucksack. He is doing a round handing out leaflets for the circus that has just arrived in town and by the look of him, it seems he is from the circus too. Do you decide to accept and wear his t-shirt?

### MORAL DISGUST SCENARIOS

- (23) You are a famous politician's aide. You admire him a lot, he has principles that you share fully, and you seriously believe that, if elected, he could do a lot of good for Italy. Apart from the admiration you hold for him, you also stand to gain from his election, because you would be given a very important post. During the election campaign, however, you realize that he is involved with disreputable people, people involved with criminals. Do you decide to continue working with him?
- (24) You manage a food production business. Over the years you have managed to attract important clients, guaranteeing good profits for yourself and your work force. Unfortunately, you are passing a difficult period now, and, to avoid laying off employees, you need to reduce production costs. You find a cheaper rubbish disposal company. You find out, however, that this new company uses disposal techniques that are a little dated, and are not guaranteed to be up to health and safety standards. Do you decide to hand over your rubbish to that company?
- (25) You are the owner of a textile firm. For years you have used the same supplier because you have always done good business with them. However, you have recently found out that for financial reasons, the owners have sacked their loyal, skilled labor workers who have worked for them for years, and are making unskilled labor work for cash-in-hand, paying them a miserable sum and making them work inhumane hours. In this economic climate buying from them would still prove advantageous. Do you decide to continue using this supplier?
- (26) You live in a war-torn nation and the enemy soldiers are taking capture of individuals of a particular race. One day you go to one of your acquaintances who is often more than generous with your food rations giving you more than the standard issue: it is thanks to him that you have been able to avoid starvation during this period of war. You have almost arrived when you hear him revealing to the enemy soldiers the secret hideouts of some of the people under persecution. Thanks to his giveaway these people will most certainly be captured. Do you decide to continue using this acquaintance for your food rations?
- (27) You are a young journalist at the beginning of your career. You have not been working for very long for an important newspaper and you know it is an occasion you cannot afford to waste. Your supervisor sends you a draft of his article regarding a recent political issue, of which he is very proud. He asks you to do the page layout and then send it to print. While reading it, you realize that he has changed the news content, lying about several aspects, making the article appeal only to readers of a certain political stance. Do you decide to send this article to print?
- (28) In just over a week's time you will be moving to another city, for work reasons, and you have to find an apartment. One of your friends who lives in that city offers to sublet you a room in his apartment. He tells you, among other things, that he is having a sexual relationship with an 80-year-old woman, even though he is only 33. He also tells you that more often than not she stays the night with him there. Do you decide to sublet a room in that apartment?
- (29) You run a modeling agency. You have recently hired a beautiful girl. She is classy and charming. A famous photographer asks you if he could use her in an advert campaign that he is doing and offers you a tidy sum for it. It would be an excellent deal for you and the model. During a business dinner, tying up contract details and the like, the photographer makes heavy jokes about the physical attractiveness of the model, and reveals to you that by hiring her he hopes to force her to have sex with him. Do you decide to sign the contract?
- (30) You are an ambitious publicist. You work for an important company, thanks to which you have become quite successful. The middle-aged company manager is a sector genius, but strange. For example, he is always telling you about his latest sexual encounters. The other day he spoke to you about his latest obsession: his partner's daughter, a girl of 15 years. You know he is only confided in you about this. You also realize that if you were to tell somebody else and your boss was to get wind of it, then that would probably be the end of your career with this company. Do you decide to keep quiet?
- (31) One of your best friends gets married. You are very happy, not least because he has decided to sell you his apartment at a bargain price. Similar apartments in your city cost around €50 000 more. You have got the keys already and you decide to go and see it. As soon as you enter the apartment, you hear noises coming from the bedroom. You see your friend's future wife in bed with another man. If your friend was to find out, the wedding would certainly be called off and you would not get the apartment. Do you decide to keep it to yourself?
- (32) You work for a large pharmaceutical company. You are about to finance the research for a cure for M Syndrome, a deadly disease. You are very happy because this research will bring prestige to the pharmaceutical house and will guarantee a promotion for you. Before signing, however, you find out that one of the patients does not have M Syndrome. The doctors diagnosed him just so that they could make up the numbers for the research study, in reality he is healthy. In a few days time, he will be told that the doctors were wrong but in the meantime the patient believes he has a deadly disease. Do you decide to finance those doctors?
- (33) You are in your favorite restaurant. You go there quite often: the food is excellent and the prices are good. That evening the owner's sister is there as well. You notice that whenever she is there, the owner is always moody. The waiter, whom is also your friend, tells you that it is because the restaurant owner and his sister have been having an incestuous relationship for quite some time, and they are arguing because she is jealous about his wife. Do you decide to continue going to that restaurant?

**ANGER SCENARIOS**

- (34) You are at the checkout at the supermarket. In front of you there is only one lady, whereas at the other checkouts there are long queues. While the lady sorts out her shopping on to the conveyor belt, her son, about 7 years old, is singing out loud at the top of his voice. You tell him to stop it and he does, only to start running around your trolley, often banging into it. You ask him to stop and he starts touching the things in your trolley. In a flash he grabs the eggs, they slip from his hand and smash all over the other food in your trolley. Do you decide to stay in that queue?
- (35) You are at the movie theater. You have managed to get the last two good seats in the middle of the central row: the other available seats are all in the first two rows, and watching the film from there would be too uncomfortable. Unfortunately, the stream of comments and guffaws from the two people sat next to you cause you to miss the jokes in the film, and you start to have difficulty following some of the scenes. You ask them to lower their voices, but one of them responds by saying he does not see a 'Do not speak!' sign anywhere. Do you decide to remain seated near them?
- (36) You have bought a new DVD player but it does not work. The shop said you had a month's guarantee during which time you could take it back if you had any problems. A month runs out in a few days and finally you find the time to go back to the shop. Everyone you ask sends you on to someone else. You wander around the various departments in the shop for three-quarters of an hour until a shop assistant tells you that the manager will not be back for another half hour. But you reckon that it will probably be longer than that and you are not sure that even then he will be able to sort the problem out once and for all. Do you decide to continue waiting around?
- (37) You have just arrived back in your hometown after a 3 h journey. Your friend said he would come and fetch you from the station. The alternative would have meant having to get two buses that would have taken you much longer to get home. You arranged to meet at 3 p.m. but it is 3.45 p.m. already and he has not arrived. You call him but he does not answer. Another half hour passes and you start to worry. You call him again and your friend answers with a calm voice saying how he would be forgotten but will arrive in an hour or so. Do you decide to continue waiting for him?
- (38) You have organized a birthday party for your best friend. You go to the bakers to pick up the cake you ordered. When you ask if it has been made without strawberries, they say no. You are allergic to strawberries and you distinctly remember telling them this more than once. The bakery assistant tells you that they could give you a cake made without strawberries but you will have to pay for both because the one you ordered has your friend's name on it and they will not be able to sell it on. Do you decide to buy both cakes?
- (39) You are on a very crowded train and you have gone to a lot of bother to find somewhere to sit but finally you have found a seat and you have sat down. You have a journey of 4 h in front of you. At the first stop, four teenage girls, of no > 15 years of age, come into the compartment you are in. They talk incessantly, burst out laughing together hysterically and shout when someone calls on the cell phone. Not only that their cell phones ring continuously. You are not able to read or get any sleep. Do you decide to stay seated in that compartment?
- (40) You are on a very crowded bus. You managed to find a standing place only. Your journey starts and will last for an hour. A man gets onboard and decides to stand right next to you. He is not able to keep his balance and jolts you continuously. At every turn he leans into you, stands on your foot and grabs on to your jacket. Also, when the bus brakes, he always collides into you, sometimes lightly, sometimes more violently. Do you decide to stay where you are on the bus?
- (41) By chance, you run into some acquaintances of yours at the supermarket. You have always regarded them as unpleasant and offensive. They cannot wait to tell you how they too will be spending their holidays in Sardinia, right next door to the house you always stay in. Only yesterday, you booked that beautiful villa that you have been going to for several years now for your relaxing family holiday. However, you realize now that the atmosphere will be ruined if these acquaintances are there. Do you decide to go anyway to the house in Sardinia?
- (42) You have booked in for a week in a cheap B&B just a stone's throw from the seafront. One of your friends, however, invites you to stay with him. You accept, thinking it would be nice to have some company and save a little as well. On the first morning, you are sleeping blissfully when at 7.30 a.m. your friend's wife bursts into your room without knocking, opens the window, shakes the rug and hoovers. The whole scene is repeated the following day. When you ask for some kind of explanation your friend tells you that's how things work in that house. Do you decide to stay as their guest?
- (43) You are in another city for work reasons. You and your colleague share a hotel room to save money, even though other single rooms are available. You are extremely tired and fall straight to sleep. After about an hour you are awoken by the sounds of shouting: it is your colleague sleepwalking. You try to get back to sleep, but he carries on sleepwalking and shouting. You stop him by waking him up and finally you are able to get back to sleep. After 10 min, however, it all starts up again: it will not be a quiet night. Do you decide to stay in the room with your colleague?
- (44) Your apartment needs redecorating. You find a painter with the cheapest rates around and hire him. You choose each room color together and the work starts. When you return home, you see that he has started painting the living room with the wrong color. You call him and he tells you he is sure it is the right color but that he will redo it as you want. The next day you see that he has repainted the living room. He has used the right color but the wrong shade. It is not the one that you chose together. Do you decide to let him continue painting your apartment?