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Can the emotion of disgust be harnessed to promote hand hygiene? Experimental and field-based tests

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ABSTRACT

Two studies carried out in Sydney, Australia explored whether inducing disgust may be a useful addition to hand-hygiene interventions. Experiment 1 employed a novel laboratory measure of hand hygiene, and tested whether a brief (3-min) video-based intervention using disgust/education, improved hand hygiene relative to education alone and a control condition. On test, a week later, the disgust intervention significantly exceeded the education and control condition combined, although the effect size was modest. Experiment 2 examined the generality of this effect in a field study. During a baseline period, soap and paper towel use in a series of washrooms were covertly monitored. This was followed by an intervention period, in which two washrooms received disgust/education-based posters and a further two, educational posters, exhorting participants to wash their hands. A follow-up period, after the posters were removed, was also monitored. The disgust-based intervention was significantly better at promoting hand hygiene. These findings suggest that even brief disgust-based interventions may be successful and that these can be tested and developed under laboratory conditions.

Introduction

Hand hygiene has a central role in preventing the transmission of gastroenteritis and respiratory illnesses, both in industrialised and developing nations (Luby et al., 2005). Estimates based upon meta-analysis suggest that improved hand hygiene reduces rates of gastrointestinal illness by 31% and respiratory illness by 21% (Aiello, Coulborn, Perez, & Larson, 2008). Prevention through hand hygiene is therefore a *potentially* easy, effective, and low-cost defence. However, hand hygiene is often neglected and observational and self-report studies suggest it rarely exceeds 50% in either the community (Guinan, McGuckin-Guinan, & Sevareid, 1997) or in professional domains (Pittet et al., 2004).

Health concerns have been found to have little impact on hand-hygiene behaviour (O'Boyle, Henly, & Larson, 2001). It is difficult for individuals to recognise the association between preventive behaviour and adverse outcome, because inadequate hand hygiene does not always result in illness and the consequences may be delayed (Pinfold, 1999). Several factors that influence hand-hygiene behaviour have been identified. These include: (i) gender, with females more likely than males to engage in post-toileting hand washing (Guinan et al., 1997); (ii) hand-hygiene habits, which are mostly acquired in childhood and are difficult to change (Whitby, McLaws, & Ross, 2006); (iii) social facilitation, with increased hand washing in the presence of another person in the washbasin area (Drankiewicz & Dundes, 2003); (iv) modelling, with hand hygiene improving among health-care workers when senior medical staff practice hand hygiene (Pittet et al., 2004); and (v) environmental barriers, where lack of facilities or inconvenience prevent hand hygiene (Scott, Curtis, Rabie, & Garbrah-Aidoo, 2007).

It has been suggested that the emotion of disgust may be a further factor involved in the chain of events leading to an act of hand hygiene (Curtis, Garbrah-Aidoo, & Scott, 2007). The disgust elicitors most closely linked to hand hygiene are bodily secretions such as faeces and mucus, items that look soiled, and certain animals (Curtis & Biran, 2001). Many disgust elicitors are rich sources of pathogens so, from an evolutionary perspective, disgust can be viewed as an adaptive emotional response to protect people from disease (Oaten, Stevenson, & Case, in press). Whitby et al. (2006) suggest that the emotional concepts of dirtiness and cleanliness are closely linked to disgust and drive individuals to clean visibly soiled hands. However, it has also been observed that objects (e.g. food) that come into contact with a disgust elicitor (e.g. an insect) can acquire disgust-evoking qualities. In this case the object becomes 'invisibly dirty', or ideationally contaminated, and hence disgusting (Curtis & Biran, 2001).

To date, two studies have included disgust components in hand-hygiene interventions. The first was a full-scale national campaign

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conducted in Ghana (Curtis et al., 2007). The campaign's television advertisement made contamination visible following toileting. The contaminant was seen to be transferred from a mother to her child's meal during food preparation. Reported hand washing after toileting increased by 13%, and before eating by 41% (Curtis et al., 2007). The second was a social marketing campaign conducted in Burkina Faso, in which disgust also served as an element in several components of the intervention. Here, hand washing after toileting increased by a similar amount (16%; Curtis et al., 2001). Whilst these findings are suggestive, both studies employed a variety of marketing tools not all of which contained an element of disgust – making it difficult to determine the unique contribution disgust made to the increase in hand washing.

Unpublished disgust-based hand-hygiene interventions have also been described. Cedars-Sinai Medical Centre in Los Angeles used an image of a physician's bacteria-ridden hand as a screen saver on hospital computers, making the previously invisible contamination of the hand visible. Hand-hygiene compliance was reported as increasing to nearly 100% (Dubner & Levitt, 2006). Similarly, a school included pictures of bacteria-ridden items that students frequently touched in its hand-hygiene campaign. This significantly increased students' use of hand gel before eating lunch (du Pré, 2005). Additionally, anti-smoking campaigns have employed the emotion of disgust by showing graphic images, such as gangrenous toes, in advertisements and on cigarette packets. These techniques appear to work (Mackinnon & Nohre, 2006).

Although the emotion of disgust prompts hand hygiene primarily when dirt is visible (Whitby et al., 2007), there appears to be no research testing whether contact with dirty objects that leave the hands visibly clean can prompt hand hygiene. Clearly, this is of practical significance. Many instances where hand washing is needed involve touching objects that leave no visible dirt but that have been in contact with core-disgust elicitors. Disgust may have an important part to play in promoting hand hygiene on these occasions. Consequently, Experiment 1 tested whether the disgust-evoking qualities of objects that are dirty (i.e. ideationally contaminated) but leave the hands clean, can trigger hand-hygiene behaviour.

The principal aim, however, of the two studies reported here, was to directly test the assertion that the emotion of disgust may be especially useful as an intervention strategy in promoting hand hygiene (e.g. Curtis, Voncken, & Singh, 1999). This was examined under laboratory conditions (Experiment 1) where we developed a novel procedure to assess hand hygiene, and in a more naturalistic field-based study (Experiment 2). We did not attempt to assess the source of any effect – for example whether disgust may facilitate attention to the message or become associated with invisible dirt – as our interest at this stage was simply to determine if it was more effective than control conditions. This appeared a reasonable goal given the lack of prior work on this topic.

Experiment one

Experiment 1 set out to explore three things. First, it attempted to develop and evaluate a novel laboratory-based behavioural measure of hand hygiene derived from research on disgust (see Rozin, Haidt, McCauley, Dunlop, & Ashmore, 1999). Self-report measures of hand hygiene alone were considered insufficient because it is well documented that desirable behaviours are often over-reported and vice versa (e.g. Biran et al., 2008). Second, it also assessed whether the disgust-evoking qualities of dirty objects can trigger hand hygiene even when they leave the hands visibly clean. Third, it assessed whether a disgust-evoking intervention would be more successful than comparable control conditions, all of which were presented on video.

Participants attended two sessions, one week apart. The first session included baseline self-report measures and then an intervention. Assignment to the intervention was random, so as to control for individual differences in hand-hygiene behaviour. However, participant gender was employed as an independent variable, not only as this is known to affect hand hygiene, but because females are also more disgust sensitive (e.g. Curtis, Aunger, & Rabie, 2004) and so might respond differently to disgust interventions relative to men. The second session, a week later, assessed the intervention effect, both in terms of self-report (i.e. had behaviour changed in the intervening week?) and on the new experimental measure.

Method

Participants

Participants were drawn from an Australian urban center. Of the 103 participants who started the experiment, data from seven were excluded. Five failed to return for Session 2, one reported suffering from obsessive-compulsive disorder, and one failed to comply with the instructions (refused to touch certain test items). Of the 96 participants remaining, 62 were undergraduates recruited via the subject pool and 34 responded to campus advertisements. There were 39 males and 57 females, aged between 16 and 59 years ($M = 21.8$, $SD = 6.9$). There were no significant differences between the conditions in terms of age, gender (i.e. distribution across conditions), disgust sensitivity, and employment in a health-care or food-based setting. Both studies reported here were approved by the Macquarie University Ethics committee. Participants were informed that the study concerned emotion and hygiene behaviour, but no further details were provided. Participants were given more details in a post-experiment debriefing. Finally, all testing took place between April and June 2007.

Experiment one: laboratory-based test

Session 1. In Session 1, one to three people were tested at a time, each for an average of 30 min, seated facing away from each other. Demographic data were obtained, followed by the hand-hygiene questionnaire. The few available validated questionnaires that ask about hand-hygiene practice were not suitable for this study because the questions were specific to particular settings. As a more general measure was needed, the Hand Hygiene Scale (HH-Scale), an inventory for measuring routine hand-hygiene behaviour, was employed. The HH-Scale is a 17-item subset of the 50-item self-report Hygiene Behaviour Inventory (HBI; Stevenson, Case, Hodgson, Porzig-Drummond, & Oaten, in press). A preliminary analysis revealed that both the HBI and the HH-Scale have good internal consistency ($\alpha = 0.85$) and that both correlate significantly with the Disgust Scale (DS; Haidt, McCauley, & Rozin, 1994), 0.59 for DS and HBI, and 0.46 for DS and HH-Scale. The 17 questions of the HH-Scale were classified into four domains: time spent on hand washing (1 question); frequency of hand washing (1 question); technique when washing hands (6 questions); and occasions leading to hand washing (9 questions). Answers were given on 4-point scales, with higher scores denoting higher levels of hygiene. Participants then completed the Disgust Scale (Haidt et al., 1994).

To determine whether the disgust-inducing hand-hygiene video intervention did indeed induce disgust, a self-report emotion scale was administered before and after viewing each intervention video. Although disgust was the emotion of interest, the six basic emotions (Ekman, 1992) were included to determine the specificity of any change. Participants indicated how much they experienced happiness, surprise, fear, sadness, disgust and anger at that moment. Each emotion was rated using a 7-point scale, from 1 (*not at all*) to 7 (*very*).

Participants were then randomly allocated to watch one of the three intervention videos (Disgust video, Education video, Control video). The Education video set out to primarily convey hand-hygiene knowledge whereas the Disgust video aimed to simultaneously instil hand-hygiene knowledge in a disgusting context. Thus the two videos communicated the *same* information, but differed in terms of explicitness and disgust-eliciting content. Both videos explained the chain of events leading to the spread of disease – for example, a person sneezing into their hand and then touching a door handle followed by someone else touching the door handle and then using the same hand to eat chips. However, whilst the Education video showed a person sneezing, the Disgust video showed the same sneezing scene together with an image of nasal secretions on the person's hand. Thus, both videos showed how transmission could have been stopped if the second person had washed their hands before touching the chips, but the disgust video always made the transmission component explicit. Both videos were of similar length, just under 3 min each, and each featured the same locations, actors and narrator.

The Control video featured none of the above educational elements or disgust stimuli. Instead it comprised a 3-min excerpt from a nature documentary *Beneath Southern Seas*. All of the videos were viewed on computer and with audio via headphones. Immediately after viewing the video the emotion scales were completed for a second time.

Session 2. Participants returned for Session 2 on average one week (range 6–9 days) after completing Session 1. Each participant was tested individually in Session 2, taking an average of 20 min. The tester and participant sat at a table in such a way that the tester was at the 3 o'clock position and the participant at 6 o'clock. In order not to cue participants to clean their hands, antibacterial wipes (Wet Ones® 110-sheet dispenser) and hand gel (Aqium Gel® 375-ml dispenser bottle) were placed within reach at the end of the table, in view, but not directly so. At the beginning of each session, participants were casually alerted to the fact that they could use the sink, hand wipes or hand gel if they wished. Unbeknownst to participants, use of any of these items counted as a 'hand-hygiene event'.

The behavioural hand-hygiene measure (BHHM or behavioural hygiene) was developed for this study in an attempt to reproduce part of the chain of pathogen transmission and thus to test whether participants would engage in hand hygiene before eating food in order to prevent potential infection. The measure was loosely based on a technique developed to validate the Disgust Scale (Rozin et al., 1999). The behavioural test was composed of eight trials. During the first trial, the participant was presented with a computer mouse in a clear plastic bag and asked to remove it from the bag and touch it with both hands. He or she then filled in the emotion scale (see above). Following this, the participant was instructed to pick up a small salted cracker from a plate and eat it. Of critical interest was whether the participant engaged in hand hygiene after handling the object and *before* eating the food. The participant was then asked to rate the cracker in terms of liking. At the end of the trial, the researcher returned the object, in this case the computer mouse, to a plain cardboard box.

This same basic procedure was employed on all trials, with objects presented in a fixed order: (1) an old computer mouse; (2) a used five-dollar note; (3) a used cat collar; (4) a stained fly swat; (5) a stained kitchen cloth; (6) a used toilet brush; (7) a used-looking tissue; and (8) potting mix. Objects 1–7 were presented in clear plastic bags and the potting mix in a plastic container. The order in which items 1–7 were presented was based on their disgust-inducing properties, beginning with the most innocuous, the computer mouse, as established by a prior pilot study ($n = 7$). The rationale for presenting the objects in the above sequence was to prevent carry-over effects (i.e. a 'stronger' stimulus first might precipitate hand-hygiene acts on all subsequent trials), and this approach of presenting progressively more disgusting stimuli paralleled that used by Rozin et al. (1999).

The potting mix had special status. Although it was not the most disgusting item, it was presented last (trial 8) because it was the only item that left hands visibly dirty. The potting-mix trial therefore served as a measure to detect any non-responders, that is participants who did not wash their hands even when they were visibly dirty and who would, arguably, never wash their hands under laboratory conditions.

Participants were free to clean their hands at any time during the trials but were never prompted to do so. As well as recording whether participants engaged in a hand-hygiene act, if they did the time spent engaged in each act was also recorded. The tester noted the time unobtrusively, so that participants were not aware that they were being timed.

To avoid contamination from previous participants, objects 1–7 were cleaned where possible with antibacterial wipes after each session. Therefore, if participants did not clean their hands after having touched an object, they were not subject to any health risk. However, participants were not told about this procedure; to them, the items could have been touched by others and were possibly contaminated. To avoid contamination from the potting mix, which could not be cleaned, the tester waited until the participant was holding a cracker and only then, if they had not cleaned their hands, encouraged them to do so before offering a new cracker. In sum, three measures were obtained from the behavioural test: whether the participant ever washed their hands on trials 1–7 (binary variable); the total number of hand-hygiene acts engaged in (varying from 1 to 7); and the mean amount of time they spent on each act (total time in s/number of acts). Finally, when all eight trials had been completed, participants again filled in the HH-Scale.

Results and discussion

Induction of disgust

To determine if the disgust-based intervention was successful, two scores were generated for each participant. The first was the change in disgust rating from before the intervention video to after it. The second was the change over the same period in other negative emotions combined (fear, anger and sadness). Using ANOVA, these two change scores then served as a repeated measures variable (Emotion change; disgust vs other negative emotions), with Gender (male vs female) and Condition (disgust vs education vs control) as between-participant factors. The crucial interaction, between Condition and Emotion change was significant, $F(2, 90) = 16.21$, MSE = 1.43, $p < 0.001$, eta-squared = 0.27. The difference between the change in disgust and the other negative emotions was largest in the disgust intervention ($M = 2.4$, SD = 2.1), with the education condition ($M = 1.2$, SD = 1.7) intermediate between the control ($M = 0.0$, SD = 0.8) and disgust conditions. Post-hoc pairwise comparisons (with Bonferroni corrected alpha) indicated that all possible contrasts were significant. Finally, there was also a significant effect of intervention, but this was of little interest given the interaction above.

Disgust and hand washing

To determine if the tasks in the behavioural hand-hygiene test were graded in order of increasing disgust, we examined whether there was a significant linear trend across disgust ratings for each task, by task order. This was the case, with rated disgust increasing linearly across trials, $F(1,93) = 175.24$, MSE = 2.67, $p < 0.001$, eta-squared = 0.65. We then determined whether there was

Table 1
Mean (and standard deviation) number of hand-hygiene acts and disgust rating for each of the tasks in the behavioural hand-hygiene measure for Experiment 1.

Task (in order presented)	Hand washing acts Mean (SD)	Disgust rating Mean (SD)
1. Old computer mouse	0.2 (0.4)	1.6 (0.9)
2. Used $5 note	0.1 (0.4)	1.8 (1.3)
3. Used cat collar	0.3 (0.5)	2.6 (1.6)
4. Stained fly swat	0.4 (0.5)	2.8 (1.7)
5. Stained kitchen cloth	0.4 (0.5)	3.0 (1.7)
6. Used toilet brush	0.5 (0.5)	3.9 (1.9)
7. Used-looking tissue	0.5 (0.3)	4.0 (1.8)
8. Potting mix	0.9 (0.3)	3.3 (2.1)

a correlation between the mean disgust score for each task (7 tasks) and the mean number of times participants engaged in an act of hand hygiene for that task (see Table 1). As predicted, hand-hygiene events increased linearly with the degree of task disgust, $r(7) = 0.98$ – the more disgusting participants found handing a particular item the more likely that they were to engage in an act of hand hygiene.

Effect of the intervention on behavioural hygiene

Using logistic regression, we examined whether the occurrence of any hand-washing event across the seven tasks (i.e. a binary variable), could be predicted by participant Condition (serving as an indicator variable), Gender or the interaction of Gender and Condition. The overall model was significant, $\chi^2(4) = 12.74$, $p < 0.02$, Nagelkerke $R^2 = 0.17$, and two variables were significantly predictive: Disgust vs Other conditions (i.e. control & education), Wald statistic = 6.44, $p < 0.01$, and the Gender by Condition interaction, Wald statistic = 4.57, $p < 0.05$. Examination of participants' responses readily identified the source of these effects. In the disgust condition, 83.3% of men, and 71.4% of women washed their hands at least once. In the education condition, 50% of men, and 50% of women washed their hands. In the control condition, 23% of men and 66.6% of women washed their hands, and it is this control condition gender difference that appears to be the principal source of the interaction effect. As logistic regression (Condition, Gender, Condition by Gender) failed to reveal any significant effects when the Education and Control conditions were contrasted, we collapsed these categories, and then compared the Disgust condition with the Other conditions combined, with Gender and Gender by Condition, as predictor variables. The overall model was significant, $\chi^2(3) = 9.97$, $p < 0.02$, Nagelkerke $R^2 = 0.13$, and only the condition effect (disgust vs combined) was significantly predictive, Wald statistic = 4.10, $p < 0.05$. Thus disgust appears to boost hand washing on this task, relative to the control and education conditions, and independent of gender.

We then examined only the subset of participants who washed their hands at least once in each condition, to determine if they washed their hands on more tasks in the disgust condition, and for longer. It was not possible to explore the interaction effects here of Gender by Condition, because there were only 3 males in the control condition who washed their hands more than once. To get around this problem, we tested (independent *t*-tests) whether the Education and Control conditions differed in number of hand washes or length of time spent washing. They did not, and so these two conditions were collapsed. Univariate ANOVA, with Gender and Condition (Disgust vs Other) as between factors, and number of hand washes as the dependent variable, revealed no difference by Condition, but female participants washed their hands more frequently ($M = 4.4/7$, SD = 2.0) relative to male participants ($M = 3.0/7$, SD = 1.8), $F(1,92) = 3.90$, MSE = 5.74, $p < 0.05$, eta-squared = 0.04. The same ANOVA design was then employed on the average time spent washing. This revealed a significant main effect of Condition, $F(1,92) = 13.32$, MSE = 5.80, $p < 0.001$, eta-squared = 0.13, with participants in the disgust condition washing longer on average ($M = 5.0$ s, SD = 2.2) than the other conditions ($M = 3.7$ s, SD = 1.4).

Effect of the intervention on hygiene scale ratings

The posttest score for the four hand-hygiene measures was entered into a MANCOVA, with pretest scores serving as covariates and Intervention and Gender as between-participant factors. The MANCOVA revealed only one significant effect, that of Intervention, $F(8,174) = 2.39$, Wilks' Lambda = 0.81, $p < 0.02$, eta-squared = 0.10. Adjusted posttest mean scores, collapsed across the four hand-hygiene measures, by Intervention, were highest for Disgust ($M = 2.32$, SD = 0.22), then Education ($M = 2.24$, SD = 0.21), and lowest for Control ($M = 2.16$, SD = 0.22). There was a significant linear trend by Intervention (i.e. Disgust > Education > Control; $p < 0.01$) suggesting that the disgust intervention was superior to education, which in turn was superior to the control. Examination of the univariate *F*s revealed no significant effects for Gender or interactions between Gender and Intervention. For Intervention, only one significant univariate *F* was obtained, that for change in the length of time spent on individual acts of hand hygiene. Yet again, this was highest for Disgust ($M = 2.54$, SD = 0.66), then Education ($M = 2.30$, SD = 0.64), and lowest for Control ($M = 1.90$, SD = 0.64). There was a significant linear trend by Intervention (i.e. Disgust > Education > Control; $p < 0.001$) suggesting again that the disgust intervention was superior, to education, which in turn was superior to the control. Finally, there was a significant correlation between the change in time spent hand washing on the self-report measure and the time measure on the behavioural task, $r(96) = 0.22$, $p < 0.05$.

Non-responders

Of 96 participants, 9 did not clean their hands on the final potting-mix trial (3 from each condition) when their hands were visibly dirty, suggesting that even with the tester present (i.e. experimental demand), some participants will not engage in hand hygiene.

Experiment two: washroom field test

Experiment 2 examined whether the modest benefits from a disgust induction observed on Experiment 1 would be sustained in a field-based setting. In particular, we chose to see whether placing graphic disgust-inducing posters in washrooms increased rates of hand washing more than posters with similar information, but without graphic disgust-inducing content. In this Experiment, the key dependent variables were the use of paper hand-towels and soap, which formed our proxy indicators of hand washing.

Method

Design

Four washrooms were used in this study and these were matched as closely as possible in terms of size, facilities, location and patronage, so that the experiment could be conducted over the same period of time to control for any cohort effects. Consequently, we chose to use two sets of washrooms (male & female), which were located on one floor of the University library. Students principally use this floor, as staff have their own washroom facilities on the floor above. The washrooms that were randomly allocated to the Disgust condition each had two washbasins and those in the Education condition three. Each washroom had just one soap dispenser and one paper towel dispenser.

Manipulations

In the Education condition, materials were intended to convey hand-hygiene information; in the Disgust condition the aim was to simultaneously instil hand-hygiene knowledge and to induce the emotion of disgust. For this purpose, two posters were designed: an Education poster and a Disgust poster. The posters communicated the same message about the spread of gastrointestinal illnesses and its prevention through hand hygiene, but the posters differed in their use of disgust-eliciting stimuli. The Education poster employed informative language to describe the transmission process, and showed an image of a clean hand. The Disgust poster used emotive language and pictured a long bread roll containing faeces as a filling, capturing the chain of disease transmission in the image. Although both posters mentioned the transmission process, a subject that is generally disgust eliciting (e.g. Curtis et al., 2004), disgust stimuli were minimised in the Education poster and maximised in the Disgust poster. The image of the 'faeces sandwich' was based on Rozin, Haidt, and McCauley's (2000) findings that the prospect of ingesting body products elicits disgust.

Measures

In order to determine the effectiveness of the poster manipulation, both posters were shown to 70 participants who had completed Experiment 1. These participants were asked to rate how disgusting they found each poster on a 7-point scale, from 1 (*not disgusting at all*) to 7 (*very disgusting*).

To measure hand hygiene we adopted a behavioural measure employed by Bittner, Rich, Turner, and Arnold (2002): measuring soap and paper towel usage. To assess paper towel usage, the functional diameter of paper left on the rolls was measured six times a week and from these measurements the amount of paper used was calculated. Soap usage was measured twice a week due to the small amount dispensed on each occasion. Soap sachets were weighed on a digital scale and the amount of soap in each sachet recorded.

In order to be able to average paper towel and soap usage across the number of people using the toilet facilities, each washroom door was fitted with an electronic people counter. Each device consisted of an analogue counting unit installed in a small metal box behind the door, and of a switch that was attached to the top of the doorframe, activating the counter when the door opened and closed. The daily count for each unit had to be divided by four (two counts upon entering and two counts upon leaving) to obtain an estimate of daily traffic.

Procedure

Over approximately a six-week period (August/September 2007), each washroom was attended for about 10 min daily from Sunday to Friday. Saturday to Sunday were counted as one day due to the decreased traffic. There were 15 'days' of baseline data collection, 12 'days' of intervention data collection, and 10 'days' of follow-up data collection. There was no significant change in patronage in any facility within or between baseline ($M = 283.7$, $SD = 107.2$) and intervention ($M = 301.9$, $SD = 104.1$); for all washrooms, traffic was stable. However, more participants used the education condition washrooms in the follow-up phase relative to baseline and intervention (M diff $= 90.4$, $SD = 105.2$). Overall, the female washrooms ($M = 335.2$, $SD = 106.2$) were frequented more than the male washrooms ($M = 302.4$, $SD = 95.1$), and the education washrooms ($M = 366.9$, $SD = 113.3$) had a higher patronage than the disgust washrooms ($M = 271.0$, $SD = 79.0$). All soap and paper towel usage data are expressed in per capita units.

The following procedures were carried out on attended days: recording people counter readings; resetting counters to zero; replacing paper towels with full rolls; and recording the functional diameter of paper left on removed rolls (paper used was then calculated from an empirically derived graph of diameter vs length). Additionally, the liquid soap sachets were weighed every Monday and Thursday, and replaced when necessary. The procedure remained the same throughout the Baseline, Intervention, and Follow-up periods. During the Intervention period, Education posters were mounted in one male and one female washroom and Disgust posters were mounted in the other two. The following number and size of posters were used: two A4-posters above sinks, one A3-poster on the inside of each cubicle door, and one A3-poster above the urinals. During the follow-up period all posters were removed.

Analysis

Soap data, which were obtained twice weekly and reflect grams used per participant, yielded five measures over the baseline period, four measures during the intervention period, and three measures during the follow-up period. That is 12 data points per washroom. Data for paper towel usage, calculated as metres per person, were averaged across the same set of days as the soap usage measures, thus also yielding 12 data points per washroom. Both these sets of data were normally distributed and suitable for MANOVA. For purposes of analysis, Gender (Male washrooms vs Female washrooms) and Treatment (Disgust washrooms vs Education washrooms) were treated as within-participant factors, as these washrooms were deliberately matched in terms of location, user similarity, etc. Measure (Soap vs Paper towel use) served as a further within-participant factor. The 12 data points per washroom served as a surrogate for cases, with Time (baseline [5 data points] vs intervention [4 data points] vs follow-up [3 data points]) as a between factor. Finally, we note that it was not possible to control for the effects of repeat visits to the same toilet facilities, however we suggest that at least over the baseline and intervention period, traffic data imply this remained constant across conditions.

Results and discussion

Manipulation check

A paired-samples t-test was conducted on the poster disgust-scores. Participants found the Disgust poster ($M = 5.6$, $SD = 1.4$) more disgusting than the Education poster ($M = 1.3$, $SD = 0.7$), as intended, $t(69) = 24.84$, $p < 0.001$, $r^2 = 0.82$.

Soap and towel usage

These data were analysed using a four-way MANOVA, with Measure (soap usage and towel usage), Gender (male vs female washroom) and Intervention (disgust vs education washroom) as within-factors and Time (baseline vs intervention vs follow-up) as a between factor. The MANOVA revealed significant main effects for all variables, namely Time, $F(2,9) = 27.68$, MSE $= 0.0047$, $p < 0.001$, eta-squared $= 0.86$, Treatment, $F(1,9) = 30.18$, Wilks' Lambda $= 0.23$, $p < 0.001$, eta-squared $= 0.77$, Measure, $F(1,9) = 180.35$, Wilks' Lambda $= 0.05$, $p < 0.001$, eta-squared $= 0.95$, and Gender, $F(1,9) = 9.51$, Wilks' Lambda $= 0.49$, $p < 0.02$, eta-squared $= 0.51$. There was also an interaction between Gender and Treatment, $F(1,9) = 15.21$, Wilks' Lambda $= 0.37$, $p < 0.01$, eta-squared $= 0.63$, with a greater difference between male and female participant scores in the education intervention (Ms respectively, 0.25, 0.31) than between males and females in the disgust intervention (Ms respectively, 0.32, 0.31).

There was only one further significant effect, the interaction of Treatment and Time, $F(2,9) = 4.80$, Wilks' Lambda $= 0.48$, $p < 0.05$, eta-squared $= 0.52$. As can be seen in Fig. 1, there was a small but significantly greater increase for both dependent variables in the disgust intervention condition, relative to the education condition,

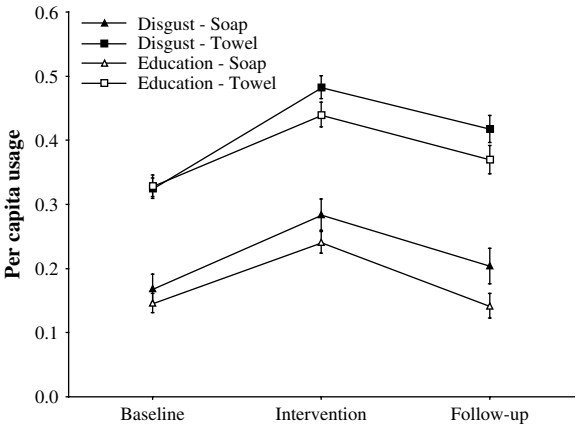

Fig. 1. Mean (and standard error) per capita usage of soap (in grams) and paper towels (in metres) in the disgust and education condition washrooms, during baseline, intervention and follow-up, in Experiment 2.

between baseline and intervention $t(7) = 2.72$, $p < 0.05$, $r^2 = 0.52$, but not between intervention and follow-up (planned contrasts). The disgust and education conditions did not significantly differ at baseline or follow-up, only during the intervention period, $t(3) = 3.32$, $p < 0.05$, $r^2 = 0.79$ (planned contrasts). In sum, these findings suggest that under more naturalistic conditions, a disgust intervention is significantly more efficient at increasing hand-hygiene behaviour than an education intervention.

General discussion

The studies set out to address two things. First, whether contact with dirty objects that leave the hands clean can cue hand hygiene. Second, whether disgust can be harnessed to promote more effective hand hygiene. Experiment 1 provided empirical support for the hypothesis that even in the absence of visible dirt on the hands, the disgust-evoking qualities of the contaminating object can trigger hand-hygiene behaviour. Furthermore, although potting mix was not rated as the most disgusting item (see Table 1), it prompted the most hand-hygiene acts, supporting findings by Whitby et al. (2006) that visible dirt is a strong hand-hygiene trigger. Based on these observations, it appears that in terms of disgust, at least two factors contribute to hand-hygiene behaviour: visible dirt, probably mediated by disgust and the unpleasant sensory experience of sticky hands, and ideational contamination, mediated by disgust.

As expected, a hierarchy of disgust elicitors was observed on the behavioural hygiene measure. The computer mouse and money, despite having been linked to disease in the educational part of both videos in Experiment 1, prompted the least number of hand-hygiene acts. The stained cloth, toilet brush and tissue, which were not mentioned in the educational part of the videos but which did allude to core-disgust elicitors like dirt, faeces, and mucus, prompted more hand-hygiene acts. This suggests that an emotional link to disease (via core disgust) may be more important in prompting hand hygiene than a cognitive link (via education), supporting Curtis et al. (1999) proposition that the emotion of disgust can further improve hand hygiene.

Disgust-related hand-hygiene campaigns to date have tried to make invisible dirt on the hands visible by showing bacterial contamination on hands or objects. In the current study, dirt was made visible in the Disgust video in Experiment 1 by illustrating the chain of disease transmission with explicit images of bodily secretions, and in the Disgust poster in Experiment 2 with the image of the faeces sandwich. In Experiment 1, participants who had experienced the brief disgust-based intervention, were more likely to wash their hands on the behavioural test, more likely to wash them for longer if they did, and were also more likely to self-report washing for longer, than participants in the education and control conditions combined. However, these effects were not large and this has to be seen in the context of the design, in which just one 3-min intervention was used, the test session occurred one week later, and the Education condition also induced disgust. Presumably, increased frequency of exposure to varied disgust-related hand-hygiene stimuli would further augment effect size.

Whilst the results from Experiment 1 suggest that the disgust intervention generated these changes, this is not the only possible account. It could be argued that experimenter bias may have resulted in more hygiene acts in the disgust condition (perhaps subtle encouragement to wash hands via gaze or some other inadvertent cue) and longer hygiene acts, via more generous timing criterion for disgust condition participants. Two findings argue against these possibilities. First, the self-report measure would not be sensitive to these biases, yet the questionnaire time measure also revealed that participants in the disgust condition reported washing for longer. This also correlated with actual behaviour, albeit rather weakly. Second, and more conclusively, Experiment 2 involved no participant contact, yet there was evidence here that the disgust manipulation was also more successful at promoting hand-hygiene behaviour.

If, as we suggest, the disgust manipulation accounts for the findings in Experiment 1, a key question is how it achieves this effect. We suggest the following possibility. Educational information (non-emotive) provides the connection between a disgust elicitor, an object contaminated by it, and the hand that touches that object. Inducing disgust by showing the disgust elicitor then strengthens these associations, so that touching a contaminated object likely evokes a recollection of the contaminating core elicitor and hence feelings of disgust. This feeling of disgust then provides the motivation for participants to wash their hands. If correct, we might expect that participants in the disgust intervention of Experiment 1 might have regarded the objects in the behavioural hygiene measure, overall, as more disgusting (recall they evaluated this for each task) than participants in the education and control conditions. Indeed, an independent t-test confirmed this, with an overall greater disgust response to the objects used in the behavioural measure reported in the disgust intervention ($M = 3.1$) than in the other two conditions combined ($M = 2.6$; $t(94) = 2.03$). Thus we suggest that the basic phenomenon underpinning our findings may be a form of evaluative (i.e. hedonic) conditioning, where disgust serves as a potent unconditioned stimulus. Interestingly, this form of associative learning may occur rapidly, and is notably resistant to extinction (De Houwer, Thomas, & Baeyens, 2001), which might account for why even a brief intervention, tested a week later, can still produce detectable effects.

Needless to say this is not the only potential account of Experiment 1. It is equally plausible that participants simply found the disgust-related video that much more memorable than the other conditions. Alternatively, or in combination with the latter, participants in the disgust condition may also have been more explicitly aware of the experiment's purpose. A serious consideration for future experimental approaches would be to include a condition of equal memorability. This concern could also be extended to Experiment 2, whereby the arresting nature of the disgust-based posters may also have made them more memorable.

Experiment 2 provided further evidence for the greater effectiveness of a disgust-based intervention. In this more naturalistic study, evidence was obtained of increased per capita use of both soap and towels during the intervention period in the disgust

condition, relative to the education condition. These conditions did not significantly differ during the baseline or follow-up periods when the posters were not displayed. Although the absolute size of the increase was modest (i.e. in the disgust condition, paper towel use per capita *increased* by 15.8 cm and soap use by 0.12 g [the dispensers discharged 0.2 g per press]), the effect size was considerable, suggesting that the disgust intervention is a reliable means of encouraging hand-hygiene behaviour under naturalistic conditions. However, whilst these data are supportive, it is important to note that a cross-over design would have been methodologically superior to the matching approach used here, as it controls better for subtle differences in toilet design that might account for some of the observed difference. Nonetheless, we decided to use a matching approach to minimise the length of the experiment, so that traffic through the toilets would remain broadly constant (a constraint imposed by testing at a University where student attendance is 'seasonal'). This concern is reasonable, especially when considering the changes in patronage observed in the follow-up period as the exam season drew closer and the number of library users increased.

A final issue concerns the ethical implications of employing the emotion of disgust to impel positive health behaviours. Disgust/horror is widely used to change behaviour (Mackinnon & Nohre, 2006; e.g. Canada, US, Australia) and it has been employed in smoking (e.g. gangrenous toes), health and safety (e.g. horrific burns) and road safety campaigns (e.g. aftermath of a high-speed smash). By comparison, the type of stimuli used in these studies is relatively tame. Moreover, in both studies, participants could have anonymously contacted our Human Research Ethics committee to complain. Indeed, in Experiment 2 where several hundred people viewed these images, no complaints were received, even though each poster provided information on how to do so. Similarly, debriefing participants after Experiment 1 did not reveal any concerns about the stimulus materials. Obviously cultures differ, and so might reactions to using potentially confronting stimuli in health-related campaigns, but this did not appear to be an issue here.

In conclusion, this manuscript presents preliminary evidence that the disgust-evoking qualities of ideationally contaminated objects can trigger hand-hygiene behaviour. In addition, it also suggests that a disgust-evoking intervention can be more effective than comparable control conditions at promoting hand-hygiene behaviour. However, the best way of maximising this effect (e.g. more trials, more disgust etc.) and its psychological basis remain important questions to address.

References

Aiello, A. E., Coulborn, R. M., Perez, V., & Larson, E. L. (2008). Effect of hand hygiene on infectious disease risk in the community setting: a meta-analysis. *American Journal of Public Health, 98*, 1372–1381.

Biran, A., Rabie, T., Schmidt, W., Juvekar, S., Hirve, S., & Curtis, V. (2008). Comparing the performance of indicators of handwashing practices in rural Indian households. *Tropical Medicine and International Health, 13*, 278–285.

Bittner, M. J., Rich, E. C., Turner, P. D., & Arnold, W. H. (2002). Limited impact of sustained simple feedback based on soap and paper towel consumption on the frequency of hand washing in an adult intensive care unit. *Infection Control and Hospital Epidemiology, 23*(3), 120–126.

Curtis, V., Aunger, R., & Rabie, T. (2004). Evidence that disgust evolved to protect from risk of disease. *Proceedings of the Royal Society B: Biological Sciences, 271*(Suppl. 4), S131–S133.

Curtis, V., & Biran, A. (2001). Dirt, disgust, and disease: is hygiene in our genes? *Perspectives in Biology and Medicine, 44*(1), 17–31.

Curtis, V., Garbrah-Aidoo, N., & Scott, E. (2007). Masters of marketing: bringing private sector skills to public health partnerships. *American Journal of Public Health, 97*(4), 634–641.

Curtis, V., Kanki, B., Cousens, S., Diallo, I., Kpozehouen, A., Sangaré, M., et al. (2001). Evidence of behaviour change following a hygiene promotion programme in Burkina Faso. *Bulletin of the World Health Organization, 79*, 518–527.

Curtis, V., Voncken, N., & Singh, S. (1999). Dirt and disgust: a Darwinian perspective. *Medische Antropologie, 11*(1), 143–158.

De Houwer, J., Thomas, S., & Baeyens, F. (2001). Associative learning of likes and dislikes: a review of 25 years of research on human evaluative conditioning. *Psychological Bulletin, 127*, 853–869.

Drankiewicz, D., & Dundes, L. (2003). Handwashing among female college students. *American Journal of Infection Control, 31*(2), 67–71.

Dubner, S. J., & Levitt, S. D. (2006, September 24). Selling soap: the Petri-dish screen saver. *The New York Times*. Available from. http://www.nytimes.com/2006/09/24/magazine/24wwln_freak.html Retrieved 10.01.07.

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion, 6*, 169–200.

Guinan, M. E., McGuckin-Guinan, M., & Sevareid, M. S. (1997). Who washes hands after using the bathroom? *American Journal of Infection Control, 25*, 424–425.

Haidt, J., McCauley, C., & Rozin, P. (1994). Individual differences in sensitivity to disgust: a scale sampling seven domains of disgust elicitors. *Personality and Individual Differences, 16*(5), 701–713.

Luby, S. P., Agboatwalla, M., Feikin, D. R., Painter, J., Billhimer, W., Altaf, A., et al. (2005). Effect of handwashing on child health: a randomised controlled trial. *Lancet, 366*, 225–233.

Mackinnon, D. P., & Nohre, L. (2006). Alcohol and tobacco warnings. In M. S. Wogalter (Ed.), *Handbook of warnings*. Mahwah, NJ: LEA.

Oaten, M., Stevenson, R. J., & Case, T. I. Disgust as a disease avoidance mechanism. *Psychological Bulletin*, in press.

O'Boyle, C. A., Henly, S. J., & Larson, E. (2001). Nurses' motivation to wash their hands. *Applied Nursing Research, 14*, 136–145.

Pinfold, J. F. (1999). Analysis of different communication channels for promoting hygiene behaviour. *Health Education Research, 14*, 629–639.

Pittet, D., Simon, A., Hugonnet, S., Pessoa-Silva, C. L., Sauvan, V., & Perneger, T. (2004). Hand hygiene among physicians: performance, beliefs, and perceptions. *Annals of Internal Medicine, 141*(1), 1–8.

du Pré, A. (2005). *Communicating about health: Current issues and perspectives*. New York: McGraw-Hill.

Rozin, P., Haidt, J., & McCauley, C. (2000). Disgust. In M. Lewis, & J. M. Haviland-Jones (Eds.), *Handbook of emotion* (pp. 637–653). New York: Guilford Press.

Rozin, P., Haidt, J., McCauley, C., Dunlop, L., & Ashmore, M. (1999). Individual differences in disgust sensitivity: comparisons and evaluations of paper-and-pencil versus behavioural measures. *Journal of Research in Personality, 33*(3), 330–351.

Scott, E., Curtis, V., Rabie, T., & Garbrah-Aidoo, N. (2007). Health in our hands, but not in ours heads: understanding hygiene motivation in Ghana. *Health Policy and Planning, 22*(4), 225–233.

Stevenson, R., Case, T., Hodgson, D., Porzig-Drummond, R., & Oaten, M. *The hygiene behaviour inventory*, American Journal of Infection Control, in press.

Whitby, M., McLaws, M. L., & Ross, R. W. (2006). Why health care workers don't wash their hands: a behavioural explanation. *Infection Control and Hospital Epidemiology, 27*, 484–492.

Whitby, M., Pessoa-Silva, C. L., McLaws, M. L., Allegranzi, B., Sax, H., Larson, W. H., et al. (2007). Behavioural considerations for hand practices: the basic building blocks. *Journal of Hospital Infection, 65*(1), 1–8.