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Physiological and behavioral responses to strangers compared to friends as a source of disgust

Ming Peng [a], Lei Chang [a,*], Renlai Zhou [b,c]

[a] Department of Educational Psychology, The Chinese University of Hong Kong, Hong Kong, China
[b] Beijing Key Lab of Applied Experimental Psychology, School of Psychology, Beijing Normal University, Beijing, China
[c] State Key Laboratory of Cognitive Neuroscience and Learning (Beijing Normal University), Beijing, China

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ABSTRACT

Known as the source effect, feelings of disgust have been found to differ depending on the source of the disgusting material, with that emanating from oneself and familiar others eliciting less disgust than that of strangers. We tested the source effect on self-report of disgust feelings (Study 1), physiological response in heart rate (Study 2), and behavioral response in terms of approach–avoidance movement (Study 3). The results showed significantly higher levels of disgust feelings, more reduced heart rates, and faster avoidance behavior when processing disgusting material associated with strangers compared to that of familiar persons. Together these findings support the evolutionary view that disgust, as part of the human behavioral immune system to drive avoidance from disease-carrying agents, will likely be activated more intensely and quickly in response to unfamiliar as compared to familiar conspecifics who carry common germs more defendable by our shared physical immunity.

1. Introduction

Communicable diseases have posed formidable threats to the survival of animal species. To promote adaptive responses to potential disease, humans and other animals have developed sophisticated physical and behavioral immune systems to fight diseases both inside and outside the body. The human behavioral immune system is particularly well developed that is characterized by the acute emotion of disgust to drive disease-aversive behaviors (Neuberg, Kenrick, & Schaller, 2011). Because diseases are imperceptible to the naked eye, the behavioral immune processes are not sensitive to diseases *per se* but are elicited by morphological and olfactory cues that heuristically connote the presence of diseases (Case, Repacholi, & Stevenson, 2006; Curtis, 2007). Examples of morphological indicators include decaying waste, open wounds displaying suppuration and blood, and waste products (Curtis & Biran, 2001). Other heuristic cues are conspecifics whose appearance deviates from the norm (Curtis & Biran, 2001). Research has shown that the behavioral immune system that is often mediated by the feeling of disgust responds to such bodily deviations as deformity, amputation (Haidt, McCauley, & Rozin, 1994), and blemished skin (Stevenson & Repacholi, 2005), and by such norm-deviating individuals as the disabled (Park, Faulkner, & Schaller, 2003), the disfigured (Ackerman et al., 2009; Rumsey, Bull, & Gahagan, 1982), the obese (Park, Schaller, & Crandall, 2007), and the elderly (Duncan & Schaller, 2009).

The disgust felt towards some of these potential sources of disease should differ depending on the extent to which an individual is already exposed to them. Common germs shared by people living together are less harmful to an individual than foreign germs carried by strangers because one is more likely to have developed antibodies against the former than the latter. People living together or having frequent contact with one another develop common microbial flora (Stevenson & Repacholi, 2005), and this reduces the disgust which would otherwise be felt towards disease elicitors (Stevenson & Repacholi, 2005). Because individuals living in close proximity develop similar antibodies, interactions between them generally pose less risk of disease transmission than interactions between biologically related individuals who do not live together (Navarrete & Fessler, 2006; Fincher & Thornhill, 2012). Because of a potentially different immunity against familiar *versus* unfamiliar diseases, the behavioral immune system is expected to respond differently by activating more or less disgust towards those potential disease bearers who are either unfamiliar or familiar to the individual.

Known as the source effect, feelings of disgust have been found to differ depending on the source of the disgusting material, with the self and familiar others eliciting less disgust than strangers (Curtis, Aunger, & Rabie, 2004). Stevenson and Repacholi (2005) reported increased levels of disgust and negative affect when body malodors emanated from a stranger rather than from oneself. The source effect was especially pronounced when the participants perceived a higher risk of disease transmission (Stevenson & Repacholi, 2005). A recent

* Corresponding author. Department of Educational Psychology, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong. Tel.: +852 2609 6936; fax: +852 2603 6921.
E-mail address: leichang@cuhk.edu.hk (L. Chang).

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study identified the source effect when comparing strangers with parents, partners, friends, and acquaintances (Buželková & Išová, 2010). When associated with these four categories of familiar people, participants found bodily secretions, sexual conduct, hygiene, and violations of the body envelope to be less disgusting. The most illuminating finding comes from a study that investigated mothers' reactions to their infant's disgust elicitors such as vomit, urine, and feces (Case et al., 2006). Mothers regarded their own baby's fecal smell as less disgusting than that from someone else's baby. This source effect was sustained when mothers were given concealed samples of their own baby's feces-soiled diapers and those of someone else's baby. However, mothers have also been found to prefer the smell of their biological children over that of their stepchildren (Weisfeld, Czilli, Phillips, Gall, & Lichtman, 2003), suggesting a biological rather than an exposure effect.

However, these few studies have only used self-reports of disgust even though emotions are registered both by subjective and physiological representations (Stark, Walter, Schienle, & Vaitl, 2005; Weinberger, Schwartz, & Davidson, 1979). Results based on explicit subjective reports may also be tempered by social desirability concerns (Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005), whereas physiological expressions of emotions can be more accurately studied. Because disgust is related to the parasympathetic system (Ekman, Levenson, & Friesen, 1983; Levenson, 1992), it is associated with a reduced heart rate (Woody & Teachman, 2000). Several studies have documented decreased heart rates that were associated with the subjective feelings of disgust (Boiten, 1996; Ekman et al., 1983; Lang, Greenwald, Bradley, & Hamm, 1993; Prkachin, Williams-Avery, Zwaal, & Mills, 1999; Stark et al., 2005). The reduced heart rate is a precursor anticipating and preparing for adaptive behavior which the emotion is intended to drive. An evolutionary investigation of emotion should also examine such functional outcomes which, in the case of disgust, are behavioral withdrawal and avoidance of diseases. Reduced heart rate, feelings of disgust, and avoiding and withdrawing behavior represent a series of adaptive responses set in motion by the behavioral immune system to fight a pathogen before it enters the body (Neuberg et al., 2011). The purpose of the present study was to test the source effect of disgust by examining both self-report, as a subjective expression of disgust, and heart rate, as a physiological expression of disgust, and the approach–avoidance movement which is expected to be functionally driven by the experience of disgust. These aspects have hitherto been neglected by researchers.

2. Study 1: Self-Report

The purpose of this study was to replicate the previous findings (Stevenson & Repacholi, 2005; Case et al., 2006) that participants reported less disgust when the source of the disgusting material was someone they knew rather than someone they did not know.

2.1. Participants

A total of 56 students (27 females, average age = 19.52, $SD = 0.71$) from a university in central China participated in the study. They were randomly assigned to one of two experimental conditions, namely, the familiar group, or the stranger group.

2.2. Disgust stimuli

Thirty disgusting sentences (*e.g.*, someone looks for the key in vomit; someone urinates in the swimming pool) and 30 neutral sentences (*e.g.*, someone takes a taxi home after work; someone walks in the park after supper) were used in the study. These sentences were rated on a 6-point scale by an independent group of 27 students not involved in the main study. The average disgust score for the neutral sentences was 0.43 ($SD = 0.65$) and, for the disgusting sentences, 4.09 ($SD = 1.12$). The difference between these two types of sentences was statistically significant ($t_{26} = 16.97$, $p < 0.001$).

2.3. Familiar Group vs Stranger Group

Half of the participants (n = 28) were randomly assigned to the familiar group and the other half were assigned to the stranger group (n = 28). In these two groups, a participant was required to rate the 30 neutral and the 30 disgusting statements as though they were stated either by someone the participant was close to and familiar with (familiar group) or someone who was a total stranger to the participant (stranger group). The Subjective Closeness Inventory (SCI; Berscheid, Snyder, & Omoto, 1989), a two-item inventory that measures relationship closeness (from 0 = not at all close to 10 = very close) and the Inclusion of Other in the Self Scale (IOS; Aron, Aron, & Smollan, 1992), an one-item pictorial measure of relationship closeness (from 1 = least close to 7 = most close), were used to verify relationship closeness between the participant and his or her chosen target person. The average score of the two SCI items was 7.98 ($SD = 1.54$) and 7.83 ($SD = 1.77$), and the average IOS score was 5.52 ($SD = 1.15$). According to the literature, SCI reaching 7.5 (Schug, Yuki, & Maddux, 2010) and IOS reaching 4.5 (Weidler & Clark, 2011) suggest close relationships. Our results exceeded these required levels, suggesting a high degree of closeness between a participant and the person the participant is thinking of. For the stranger group, participants were asked to think of a name that was not the same as that of anyone they knew. All participants complied.

2.4. Procedure

After arriving at the testing site, a participant was asked to think of a person similar in age to themselves who was either very close (familiar group) or who was a total stranger (stranger group) to the participant and then to enter the person's name into the computer. For the stranger group, participants were asked to use a name that was not familiar to them and was not that of anyone they knew. The participants were then asked to rate the 60 sentences on an 11-point scale that ranged from −5 to 5 indicating the extent of negative or disgust (−5 to 0) to positive feeling (0 to 5). With a mixed order of presentations, the 60 statements appeared on the computer screen one by one with the participant's chosen name as the subject of each statement. After rating the 60 sentences, participants in the familiar group answered the SCI and IOS, as discussed above.

2.5. Results and discussion

A 2 (familiar group *vs* stranger group, between participants) × 2 (disgusting *vs* neutral sentences, within participants) mixed ANOVA yielded a significant interaction effect ($F_{1,\ 54} = 4.09$, $p = 0.04$, $\eta_p^2 = 0.07$). Whereas there was no significant difference between the stranger group ($M = 2.35$; $SD = 1.68$) and the familiar group ($M = 2.28$; $SD = 1.85$; $t_{54} = 0.17$, $p = 0.87$) for the neutral sentences, there was a significant difference for the disgusting sentences between the stranger group ($M = -2.76$; $SD = 1.09$) and the familiar group ($M = -1.63$; $SD = 1.80$; $t_{54} = -2.85$, $p = 0.006$).

Consistent with previous studies (*e.g.*, Stevenson & Repacholi, 2005; Case et al., 2006), these results confirm the source effect on felt disgust. As an adaptation to ward off diseases, the arousal of the disgust emotion differs depending on the carrier of the potential disease. Strangers, who are more likely than familiar conspecifics to carry diseases for which one has not acquired immunity, should thus elicit a stronger disgust emotion to ward off potentially more dangerous germs. If such a source effect exists, it should be more directly observed in our physiological response compared to our verbal expression of disgust.

3. Study 2: Physiological response

In Study 2, we examined heart rate as one such physiological response. We expected heart rate to decrease from a base line rate upon reading disgust sentences and we expected the heart rate decrease to be more pronounced when the statements were made by strangers compared to those made by persons who were familiar and close to the participants.

3.1. Participants

A total of 55 students (29 females, average age = 21.72, $SD = 2.74$) from a university in northern China participated in the study. All participants had normal or corrected-to-normal vision, reported no history of mental illness, head injury, or heart disease, and were not currently taking any medication. The same method and design were used as in Study 1, except that, participants read only 30 disgust statements but not the neutral statements and, instead of having participants self-report their felt disgust, their heart rate was taken while the they read the disgust statements. This heart rate was compared to a baseline heart rate of the participants.

3.2. Heart rate recording and analysis

Heart rate was taken by using Biopac equipment (Biopac Systems, Inc.) and the Acknowledge 4.1 data acquisition and processing software. Electrocardiogram (ECG) was collected by using three disposable electrodes, placed on the participant's left forearm 10 cm above the wrist. Electrodes were placed after the skin was wiped with alcohol and scrubs. ECG was recorded with an ECG100C amplifier with a band pass ranging from 0.5 Hz to 35 Hz and a gain of 1000 Hz. The ECG was converted offline to heart rate (HR) in beats per minute.

3.3. Procedure

As in Study 1, participants were randomly assigned either to the familiar group (n = 27) or the stranger group (n = 28). After signing the informed consent form, participants were given instructions on how to use the psychophysiology equipment. As in Study 1, they were then asked to think of a stranger or someone familiar and to enter the name of the person into the computer. The measurement devices were subsequently attached to the participants who were then asked to sit in the chair quietly for five minutes, during which their heart rate was recorded as a baseline measure. The participants were then asked to remember a series of sentences to be presented on the computer screen, which were the same 30 disgust sentences used in Study 1. Each sentence appeared on the screen for 4000 ms with an interval of 1000 ms between the sentences. After the experiment, participants in the familiar group answered the SCI and IOS, as discussed in Study 1. The two SCI item means were 8.22 ($SD = 1.35$) and 8.29 ($SD = 1.69$) and the average IOS score was 4.85 ($SD = 1.52$). These results suggest that participants were close to the person assumed to be making the statements. For the stranger group, participants were asked to think of a name that was not familiar and was not that of anyone they knew.

3.4. Results and discussion

A 2 (emotional state: baseline *vs* disgust, within participants) × 2 (group: stranger *vs* familiar group, between participants) ANOVA yielded a main effect of emotional state ($F_{1,\ 53} = 7.53$, $p = 0.008$, $\eta_p^2 = 0.12$) and the significant interaction ($F_{1,\ 53} = 4.50$, $p = 0.039$, $\eta_p^2 = 0.08$). For the stranger group, heart rate associated with the disgust state ($M = 75.27$; $SD = 7.53$) was significantly lower than the baseline state ($M = 77.44$; $SD = 8.43$; $t_{26} = 3.42$, $p = 0.002$), whereas for the familiar group heart rate associated with the disgust state ($M = 76.98$; $SD = 7.22$) was not significantly lower than the baseline ($M = 77.26$; $SD = 7.55$; $t_{26} = 0.44$, $p = 0.66$). A t test was also conducted to compare the stranger group to the familiar group on the heart rate differences by subtracting the baseline heart rate from that under the disgusting condition. The difference or decrease in heart rates was larger in the stranger group ($M = -2.17$; $SD = 3.36$) than the familiar group ($M = 0.28$; $SD = 3.26$; $t_{53} = -2.12$, $p = 0.039$). This result supports our hypothesis that a stronger physiological reaction was associated with strangers rather than with familiar persons as bearers of disgusting material. This result is also consistent with existing physiological findings that heart rate decreases in response to disgust stimuli (Ekman et al., 1983; Stark et al., 2005).

4. Study 3: Approach avoidance

Study 1 and Study 2 demonstrated the source effect in terms of self-reported feelings of and physiological reactions to disgust. Our functional hypothesis predicts avoidance behavior as the outcome driven by disgust emotion. The purpose of Study 3 was to investigate the source effect of disgust with respect to approach–avoidance movement.

4.1. Participants

A total of 66 students (48 females, average age = 21.55, $SD = 2.02$) from a university in central China participated in the study. They were randomly assigned to one of two experimental conditions, namely, the familiar group, or the stranger group. All participants had normal or corrected-to-normal vision and no physical handicap or body injury.

4.2. Measuring approach–avoidance movement

Existing studies of approach–avoidance movement show contradictions about movement–cognition congruence. Some authors argue movement–cognition congruence is represented by approach or moving toward the actor and away from the target (e.g., pulling rather than pushing a lever) which will be impeded when the actual cognition contradicts with the approach movement (e.g., Cacioppo, Priester, & Berntson, 1993; Miller & Maner, 2011; Mortensen, Becker, Ackerman, Neuberg, & Kenrick, 2010; Priester, Cacioppo, & Petty, 1996), whereas others believe such movement represents movement–cognition incongruence (e.g., Wentura, Rothermund, & Bak, 2000; Markman & Brendl, 2005; Lavender & Hommel, 2007). Given this controversy, Eder and Rothermund (2008) proposed a principle which is that moving closer toward the target is movement–approach congruent and moving further away from the target is movement–avoidance congruent. We followed this principle by devising two response buttons. One was attached to the computer screen where the disgusting statements were shown and the other was tied to the participant's chest away from the disgust stimuli. The two buttons were positioned at the same height. The distance between the two buttons was one-and-a-half upper arm's length of an individual participant. The participants had to touch either of these two buttons. Movement to the button attached to the computer screen closest to the stimuli represented approach, and the movement toward the button tied to the participant's chest further away from the stimuli represented avoidance. Following the literature (e.g., Cacioppo et al., 1993; Mortensen et al., 2010), we used the difference score by subtracting the reaction time of avoidance movement from that of approach movement to represent avoidance or withdrawal from the source stimuli. Thus, a larger difference score indicated greater avoidance of and withdrawal from the source of disgust.

4.3. Procedure

As in Study 1 and Study 2, participants were randomly assigned either to the familiar group (n = 34) or the stranger group (n = 32). They were asked to think of a stranger or of someone emotionally close and then to memorize 60 statements made by this person. Each trial started with a 500 ms presentation of a small white cross placed on a black screen. Then a disgust or neutral statement, authored either by a familiar or unfamiliar person, appeared on the computer screen for 4000 ms, and was followed either with a circle or a triangle which appeared for 75 ms. Participants were asked to identify the shape by moving their hand from the center position either towards the screen or away from it in order to touch one of the two buttons, which were attached either to the screen or to the participant's chest. Half of the participants were asked to touch the button attached to the screen when a circle appeared and to touch the button attached to the chest when a triangle appeared. The instruction was reversed for the other half of the participants. As in Study 1 and Study 2, the participants in the stranger group were asked to use a name that was unfamiliar and was not that of anyone they knew to author the statements. The participants in the familiar group answered the SCI and IOS. The two SCI items were 8.57 ($SD = 1.02$) and 8.78 ($SD = 1.04$) and the IOS score was 5.00 ($SD = 0.95$).

4.4. Results and discussion

Only correct responses were included in the analyses (accuracy = 98.70%). Trials in which reaction times were more than 2000 ms (1.81%) or less than 300 ms (none existed) were removed. The difference score by subtracting the reaction time of approach from that of avoidance was used in the analysis. A 2 (neutral *vs* disgusting sentences, within participants) × 2 (stranger group *vs* familiar group, between participants) mixed model ANOVA yielded a significant interaction ($F_{1, 64} = 4.55$, $p = 0.037$, $\eta_p^2 = 0.07$). Whereas there was no significant difference in the neutral sentences between the stranger group ($M = 55.18$; $SD = 59.39$) and the familiar group ($M = 45.42$; $SD = 79.60$; $t_{64} = 0.56$, $p = 0.58$), there was a significant difference in the disgust sentences between the stranger group ($M = 86.27$; $SD = 73.23$) and the familiar group ($M = 42.46$; $SD = 73.16$; $t_{64} = 2.43$, $p = 0.018$) (Fig. 1).

This result supports our hypothesis that, when associated with strangers rather than familiar persons, disgust propelled stronger avoidance away from the source of the disgust stimuli. In terms of using the approach–avoidance paradigm to investigate disease avoidance independent of the source effect, previous studies also reached the same conclusion as ours which is that participants took shorter time to stay clear of pathogen or disease indicators or carriers (Mortensen et al., 2010; Miller & Maner, 2011). However, as mentioned earlier, these studies used the reversed movement–cognition congruence whereby pushing a lever toward rather than pulling it away from the stimuli represented movement–avoidance rather than movement–approach congruence. Pushing and pulling a lever involve muscle extension and flexion (Miller & Maner, 2011) which represent separate cognitive embodiment in addition to the arm movement. We used only arm movement by having participants touch one of the two buttons placed either close to or away from the disgust stimuli. Thus, our method which complies with Eder and Rothermund (2008)'s principle more directly uncovered the disease avoidance function of disgust in addition to its source effect.

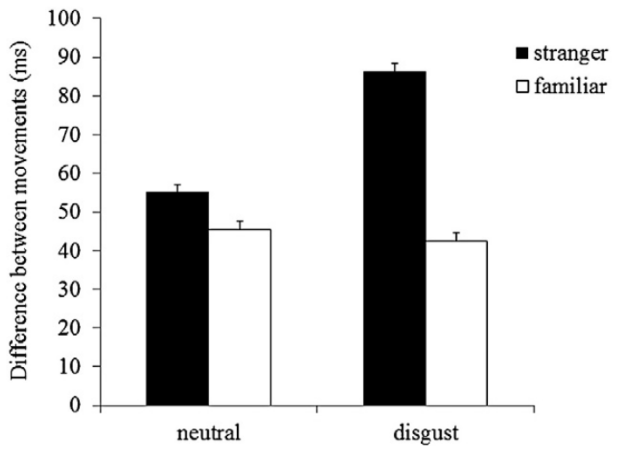

Fig. 1. Difference scores by subtracting RT of avoidance from RT of approach.

5. General discussion

As a basic emotion, disgust has such autonomic expressions as the heart rate (Porges, 1997), subjectively felt negative feelings, and well-organized avoidance behaviors (Toronchuk & Ellis, 2007), all of which serve to prompt people to stay away from potential diseases and disease carriers (Neuberg et al., 2011). We investigated all three components of the disgust emotion as functions of the source of the disgust elicitor. The results showed that participants experienced more intense feelings of disgust, showed reduced heart rates, and were more ready to execute avoidance compared to approach arm movement when reading disgusting statements made by unfamiliar rather than by familiar others. These results confirm the source effect of disgust supporting the evolutionary view that disgust as part of the human behavioral immune system to drive avoidance from disease-carrying agents should be activated more intensely in response to unfamiliar compared to familiar conspecifics; this is because they are potential carriers of diseases differently defendable by our physical immunity.

A functional view of emotion sees a particular emotional experience as the driver to activate adaptive behavior to solve specific adaptive problems (Cosmides & Tooby, 2000). The function of disgust is to drive avoidance behavior in order to stay away from potential sources of disease before the actual contact with such material. The disease avoidance function of disgust as part of the human behavioral immune system has been supported by cross-cultural evidence (Curtis et al., 2004), thereby showing that disgust is universally elicited by disease-salient contact stimuli such as bodily secretions, viscous substances, and conspecifics whose appearance deviates from the norm. Feelings of disgust are also modulated by the knowledge about the source of the elicitor (Oaten, Stevenson, & Case, 2009). Specifically, disgust is reduced when the elicitor is associated with familiar conspecifics as compared to strangers (Curtis, Aunger, & Rabie, 2004). This modulation effect reflects the possibility that the human behavioral immune system is active particularly in areas where the physical immunity is vulnerable so that more disgust is induced to ward off foreign germs carried by strangers rather than common germs against which people living together are likely to have developed antibodies (Stevenson & Repacholi, 2005). Known as the source effect, this particular cognitive influence on disgust (Toronchuk & Ellis, 2007) is also related to conforming to ingroup norms about hygiene and food preparation as effective ways to ward off diseases (Faulkner, Schaller, Park, & Duncan, 2004; Wu & Chang, 2012). Such group knowledge adds to the differentially felt disgust toward elicitors associated with familiar and ingroup members compared to those of outgroup strangers.

There are several limitations to our study. The main one is that we used the same material as disgust elicitors which restrict the generalization of our findings. We also only used words to cue familiar and unfamiliar relationship. However, verbal cues served the purpose of our study because we were mainly interested in the source effect resulting from the cognitive knowledge of the closeness of the relationship. Future studies could employ different perceptual

modalities by showing photographs of familiar and unfamiliar persons. We did not test or control participants' disgust sensitivity which may have an interaction effect with source of disgust. Future studies can look into source effect at different levels of disgust sensitivity. Despite these limitations, being among the first to examine physiological, subjective, and behavioral expressions of disgust as functions of the source of disgust, this study should add to the understanding of the disgust emotion as part of the human behavioral immune system.

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