On the role of goal relevance in emotional attention: Disgust evokes early attention to cleanliness

Article

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Disgust evokes early attention to cleanliness

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Abstract

Prior evidence has shown that aversive emotional states are characterized by an attentional bias towards aversive events. The present study investigated whether aversive emotions also bias attention towards stimuli that represent means by which the emotion can be alleviated. We induced disgust by having participants touch fake disgusting objects. Participants in the control condition touched non-disgusting objects. The results of a subsequent dot probe task revealed that attention was oriented to disgusting pictures irrespective of condition. However, participants in the disgust condition also oriented towards pictures representing cleanliness. These findings suggest that the deployment of attention in aversive emotional states is not purely stimulus-driven but is also guided by the goal to alleviate this emotional state.

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Numerous studies showed that attention is preferentially deployed to emotional events. This bias is commonly attributed to the bottom-up guidance of attention by specific characteristics of emotional stimuli such as their negativity (Pratto & John, 1991), threat value (Öhman, Flykt, & Esteves, 2001), or high arousal level (Schimmack, 2005; Vogt, De Houwer, Koster, Van Damme, & Crombez, 2008). Such bottom-up driven biases are thought to be highly adaptive. For instance, rapidly detecting potential threats might guarantee survival and becoming aware of highly arousing stimuli such as potential mates can result in possibilities for reproduction. Hence, these biases are supposed to be due to hard-wired processes that evolved during the evolution of the human species (e.g., Lang, Bradley, & Cuthbert, 1997).

Another important source of the attentional deployment is the goals an individual holds. This is well-established for the strategic deployment of attention (see Yantis, 2000, for an overview). Particularly relevant in the present context, it is also increasingly recognized that top-down settings influence even early stages of the attentional deployment and cause attentional biases (Folk, Remington, & Johnston, 1992; Vogt, De Houwer, Moors, Van Damme, & Crombez, 2010). Folk et al. (1992), for example, demonstrated that having the goal of detecting colored targets leads to unintentional shifts of attention to task-irrelevant, non-informative cues that were briefly presented before the targets, provided that these cues shared the critical target feature (i.e., were colored). Related to this, Rothermund, Wentura, and Bak (2001) let participants perform a lottery game that induced the goal of winning money. Participants attended to stimuli that were relevant to this game (e.g., stimuli signaling the chance to win money) even when these stimuli were presented as distractors.

The role of temporary goals has until recently been largely ignored in research on emotional attention (for exceptions see Hahn & Gronlund, 2007; Rothermund, Voss, & Wentura, 2008). However, a lot of evidence shows that the current emotional-motivational state of an

individual influences the attentional deployment to emotional events. For instance, attending to aversive events is mainly found when individuals experience the corresponding aversive emotion. As an example, Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, and van IJzendoorn (2007) showed that threat biases are most clearly present in high state or trait anxious individuals. Attentional influences by emotional state have most commonly been explained by the mood-congruency hypothesis (e.g., Bower, 1981). According to this account, the experience of an aversive emotion is accompanied by the activation of emotion-related knowledge representations. These knowledge representations guide the deployment of attention to stimuli that match the activated representations and hence also the currently experienced emotion. This assumption fits well with evidence showing that attention is deployed to events in the environment that correspond to activated knowledge (Roskos-Ewoldsen & Fazio, 1992; Desimone & Duncan, 1995; Soto, Hodsoll, Rotshtein, & Humphreys, 2008). Alternative accounts suggest that an aversive emotion sensitizes the individual for aversive events because aversive emotions signal that the individual needs to be alert for potential dangers (e.g., Mogg & Bradley, 1998).

A goal perspective would also predict that attention is preferentially deployed to aversive events. Motivational accounts of emotions (Roseman, 1984; Buck, 1985; Frijda, 1986) state that aversive emotions interrupt the individual's current behavior and activate goals that imply alleviating the aversive emotion. This goal then guides the subsequent behavior. For instance, in fear, the goal would be to reach safety (e.g., Roseman, Wiest, & Swartz, 1994). Aversive events represent a major obstacle to this goal and, therefore, need to be avoided. Attending to aversive events is consequently functional because it helps the individual to avoid these events effectively. Based on a goal account, however, one would expect that attention is not only biased towards obstacles and thus towards aversive events. Successful goal pursuit should in particular

focus on stimuli that are *instrumental* in achieving a goal. Goal research emphasizes therefore the importance of means in goal pursuit (e.g., Kruglanski et al., 2002). According to a goal perspective and diverging from the above mentioned accounts, attention should also be deployed to stimuli that represent means and allow the individual to alleviate the aversive emotion directly (cf. Derryberry & Tucker, 1994).

What mechanism would allow goals to influence early stages of attentional processing? According to prominent models of attention and goal pursuit, the influence of goals on attention is mediated by the activation of goal representations in long-term and especially working memory (Desimone & Duncan, 1995; Moskowitz, 2002; Moskowitz, Li, & Kirk, 2004). A goal representation can be understood as the mental representation of a desired end state that an individual aims to achieve (Austin & Vancouver, 1996). This representation includes in particular *means* that allow achieving this end state (Kruglanski et al., 2002). Similar to the above mentioned matching accounts, activated goal representations are assumed to bias the attentional selection process to prefer matching stimuli in the environment (Moskowitz et al., 2004; Soto et al., 2008; Vogt et al., 2010). Although such effects have never been shown for the deployment of attention in aversive emotional states, one can assume that similar processes operate in this case.

In order to test this hypothesis, we examined the influence of disgust on the orienting of attention to disgust and cleanliness. Disgust is regarded as a basic emotion that serves the adaptive function of protecting the organism from contact with and incorporation of noxious or contaminated stimuli (Izard, 1977; Rozin, Haidt, & McCauley, 2000). One way of alleviating disgust is physical cleaning (Nemeroff & Rozin, 1994; Zhong & Liljenquist, 2006; Schnall, Benton, & Harvey, 2008). Therefore, we hypothesized that getting in touch with disgusting objects evokes the goal to be clean. From this perspective, disgusting stimuli represent obstacles

to this goal whereas stimuli representing cleanliness represent means to it. Thus, both kinds of events should receive attention. In order to induce disgust, participants in the disgust condition were asked to touch fake disgusting objects (e.g., plastic faeces) and participants in the control condition touched neutral objects (e.g., a tape role).

We used a dot probe task (MacLeod, Mathews, & Tata, 1986) to examine the orienting of attention. In this task, two pictures were simultaneously presented at two different locations on the screen, immediately followed by a target. If individuals selectively orient to a particular picture, responses should be faster to targets at the location previously occupied by that picture. We included trials comparing neutral pictures to pictures representing cleanliness and expected an attentional bias to pictures of the latter category only in the disgust condition. Moreover, we compared disgusting pictures to neutral pictures in order to investigate the attentional processing of disgusting pictures. Additionally, we included trials showing disgusting pictures as well as pictures representing cleanliness. Pictures were presented for 350 ms in order to investigate the deployment of attention at an early stage of information processing. To verify the effectiveness of our disgust manipulation in eliciting the goal to be clean, we offered participants the opportunity to wash their hands and expected that more participants would do so in the disgust condition than in the control condition.

Method

Participants

Forty-one female students at Ghent University participated to fulfill course requirements or were paid 8€. The sample was restricted to female participants because it has been shown that disgust is easier evoked in women than in men (Druschel & Sherman, 1999). Participants were randomly assigned to the disgust or control condition. After data trimming, the disgust condition consisted of 20 participants and the control condition of 19 participants.

Apparatus and Materials

Stimuli for the Induction Procedure

Ten stimuli were chosen for each induction procedure (see Appendix A for an overview of all implemented stimuli). We used disgusting objects that were fake because of ethical and hygienic reasons. Previous research demonstrated that similarity to disgusting objects is sufficient to evoke disgust (Rozin, Millman, & Nemeroff, 1986). None of the stimuli were actually wet or sticky. The neutral stimuli for the control condition were chosen to match the disgusting stimuli visually and qua texture as much as possible.

Pictorial Cues

For each picture category (disgusting, clean, neutral) ten pictures were selected (see Appendix B for an overview of all pictures). A sample of 40 disgusting and 73 clean pictures was pretested in a group of 23 female students. Clean pictures were rated on how much they represented cleanliness (1 = *not at all* to 9 = *very much*). The ten chosen pictures were given a mean rating of 7.83 (*SD* = .34). Disgusting pictures were rated for how disgusting they were (1 = *not at all* to 9 = *very much*), the ten chosen picture had a mean rating of 7.73 (*SD* = .57). Ten neutral pictures were selected from the International Affective Picture System (Lang, Bradley, & Cuthbert, 1999)[1].

Questionnaire

In order to administer disgust propensity (the dispositional proneness to feel disgust) we used the Disgust Scale-Revised (DS-R; Olatunji et al., 2007; see also Olatunji et al., 2009). This questionnaire measures the disgust propensity of an individual across seven domains of disgust elicitors. In the first part of this questionnaire, participants rate their agreement to 13 statements (e.g., “If I see someone vomit, it makes me sick to my stomach”) on a 5-point likert scale (0 = *not at all* to 5 = *very true*). In the second part, participants are required to rate how disgusting

they consider 12 experiences (e.g., "You see maggots on a piece of meat in an outdoor garbage pail") on a 5-point likert scale (0 = *not disgusting* to 5 = *extremely disgusting*).

Procedure

Overview

The experiment was programmed and presented using the INQUISIT Millisecond software package (Inquisit 2.0, 2005) on a Dell Dimension 5000 computer with an 85 Hz, 17-inch CRT monitor. Participants were seated approximately 60 cm from a computer screen. The study was presented as a set of independent experiments and was conducted by a female experimenter. Instructions were presented on the screen and during the induction procedure repeated by the experimenter. All participants first performed a practice dot probe task with words as cues. This practice task consisted of 72 trials and was introduced as a separate experiment. Actually it was only included to familiarize participants with the dot probe task procedure so that the crucial dot probe task could start immediately after the emotion induction without an additional practice phase. The emotion induction took place after the practice dot probe task. All participants reported their disgust level immediately after the induction. Next, the crucial dot probe task was presented. Participants then reported again their disgust level. Hereafter, participants were told that they could wash their hands if they wished to. The laboratory had a washbasin equipped with soap and paper towels. Finally, participants filled in the questionnaire.

Induction Procedure

To induce disgust, we used a modification of the procedure by Marzillier and Davey (2005). First, participants were informed that a disgust induction procedure would take place. They were encouraged to try to evoke as much disgust as possible during this procedure but to answer honestly when asked to indicate their disgust level. Participants were presented the

disgusting objects one by one in a fixed order (see Appendix A). For each object, participants were asked to look and smell at it, to touch it if possible for them, and to imagine that it is real. After being exposed to all objects, they had to choose the most disgusting one. They were again exposed to this object and asked to touch it. Moreover, they were guided through an imagination of a situation where they came into touch with this object. Hereafter, they had to indicate how much disgust they felt at this moment (1 = *not at all* to 9 = *very much*).

Participants in the control condition passed through a procedure that was matched as closely as possible. This procedure was introduced as a neutral mood induction. Participants were encouraged to try to come into a neutral mood during this procedure. The neutral objects were as well presented one by one in a fixed order (see Appendix A). For each object, participants were asked to look at it, to touch it, and to image a neutral situation in which they use it. After being exposed to all objects, they had to choose the most neutral one. They were again exposed to it and asked to touch it. Also here, the experimenter guided participants through an imagination of a situation where they came in touch with this object. At the end of this procedure, the participants in the control condition also rated their disgust level.

Dot Probe Task

All stimuli were presented against a black background. Each trial started with the presentation of a black fixation cross (5 mm high) on a white background in the middle of the screen along with two white rectangles (9.4 cm high x 7.2 cm wide) above and below the fixation cross (Figure 1). The middle of each of these peripheral rectangles was 5.7 cm from the fixation cross. Cues and targets were presented within the rectangles. The fixation remained on the screen throughout the trial. After 500 ms, two picture cues (9.3 cm high x 7.1 cm wide) appeared for 350 ms. Immediately after cue offset, a target consisting of a black square (0.8 cm x 0.8 cm) appeared in one of the two peripheral rectangles. Responses required locating the target

by pressing one of two keys (“q”, “m”) with the left and right index finger on an AZERTY keyboard. The assignment of keys to target locations was counterbalanced between participants. A trial ended after a response was registered or 1500 ms had elapsed since the onset of the target. The following trial started after 200 ms.

In order to reduce strategic monitoring of one area of the screen by the participants, digit trials were included. On these trials, the fixation cross was followed only by a randomly selected digit between one and nine presented for 100 ms in the location of the fixation cross. Participants were instructed to provide the digit presented. Given the short presentation duration of the digit, monitoring of only one area of the screen would cause a high error rate on these trials.

The dot probe task consisted of 250 trials. These were 240 test trials (80 trials for each of the three trial types: disgust vs. neutral, clean vs. neutral, clean vs. disgust), and ten digit trials. Each picture category predicted the target location correctly on half of the trials of a trial type. Also, each picture category was presented equally often in the upper cue location and in the lower cue location. For each picture category, all ten pictures were presented equally often. It was randomly determined which picture of a picture category was presented in a trial. The task was programmed in such a way that each picture of a picture category had to be shown once before a picture was shown again. The order of trials was determined randomly and for each participant separately.

Results

As inclusion criterion for the disgust condition we chose a disgust level of above the midpoint of the scale which was five. For that reason, we excluded the data of two participants in the disgust condition who only reached a disgust level of five.

Manipulation Checks and Control Comparisons

The disgust level was significantly higher in the disgust condition right after the induction procedure (M = 7.75, SD = .79) than in the control condition (M = 1.58, SD = 1.26), $t(37) = 18.44$, $p < .001$. After the dot probe task, the disgust level did not differ significantly between disgust (M = 5.25, SD = 2.51) and control condition (M = 4.16, SD = 2.17), $t(37) = 1.46$, *ns*. Nevertheless, significantly more participants washed their hands after the dot probe task in the disgust (N = 9) than in the control condition (N = 1), $\chi^2 = 8.07$, $p < .006$.

Individuals in the disgust and control condition did not differ significantly in disgust propensity (DS-R), M = 54.60, SD = 9.27, and M = 57.47, SD = 9.89, respectively, $t(37) = 0.937$, *ns*.

Dot Probe Task

Trials with errors were removed (3.2%). Following Ratcliff (1993), the medians of the reaction times were used for the analyses. We performed three separate ANOVAs, one for each type of dot probe trial with congruency (congruent, incongruent) as within factor and condition (disgust, control) as between factor. For each trial type, we calculated attentional bias indices (see Table 1). A positive index indicates selective attention for a specific type of information, whereas zero indicates no attentional preferences. In order to test whether an index differed significantly from zero, we performed one-sample *t*-tests. Means and standard deviations of dot probe task responses can be found in Table 1.

The first analysis on trials comparing the disgusting pictures to neutral pictures revealed a main effect of disgust congruency, $F(1, 37) = 6.05$, $p < .02$. The interaction between condition and disgust congruency was not significant, $F < 1$. The attentional bias index of the whole sample (M = 11 ms, SD = 28 ms) differed significantly from zero, $t(38) = 2.50$, $p < .02$, revealing an attentional bias to disgusting pictures in both conditions.

The second analysis on trials comparing pictures representing cleanliness to neutral pictures revealed a marginally significant interaction between cleanliness congruency and condition, $F(1, 37) = 3.26$, $p = .079$. The main effect of cleanliness congruency did not reach significance, $F < 2.24$, $p = .143$. In order to test our a priori hypotheses, we performed for each condition separately an ANOVA with cleanliness congruency as within factor. The main effect of cleanliness congruency in the control condition was not significant, $F < 1$. In the disgust condition, we did find a significant main effect of cleanliness congruency, $F(1, 19) = 4.46$, $p < .05$. The attentional bias index ($M = 9$ ms, $SD = 20$ ms) differed significantly from zero, $t(19) = 2.11$, $p < .05$, indicating an attentional bias to clean pictures in the disgust condition.

The third analysis was performed on trials comparing disgusting pictures to clean pictures. None of the main effects or interactions reached significance, Fs < 1.[2]

Interindividual Differences

We repeated these analyses with disgust propensity (above, below the cut-off point) added as between factor using a median split. The analyses revealed a significant interaction between cleanliness congruency, condition, and disgust propensity, $F(1, 35) = 5.39$, $p < .03$. No significant main effects or interactions were found in the control condition, Fs < 1. In the disgust condition, however, we found a significant interaction between cleanliness congruency and disgust propensity, $F(1, 18) = 5.84$, $p < .03$. The attentional bias index for clean pictures of participants scoring below the median on the disgust propensity scale differed significantly from zero, $M = 17$ ms, $SD = 16$ ms, $t(12) = 3.63$, $p < .004$. In contrast, the attentional bias index for clean pictures of participants scoring above the median on disgust propensity did not differ significantly from zero, $M = -4$ ms, $SD = 21$ ms, $t(6) = -.479$, *ns*. For the two other trial types, none of the other interactions with disgust propensity reached significance, Fs < 2.12, *ns*, and none of the conclusions reported in the preceding paragraphs were changed.

Discussion

The aim of our study was to examine whether the induction of disgust leads to the deployment of attention to disgusting pictures and in particular to pictures representing cleanliness. The results are as follows. In line with our hypotheses, we found that participants in the disgust condition displayed an attentional bias to pictures representing cleanliness whereas participants in the control condition did not display this bias. In trials comparing disgusting pictures to neutral pictures, both conditions showed an attentional bias to disgusting pictures. This effect did not emerge when disgusting pictures were compared to pictures representing cleanliness.

Our results extend in an important way functional views on the link between attention and emotion. It is often assumed that attentional biases are limited to fixed classes of emotional stimuli that gained motivational relevance during evolution and that in particular threatening stimuli are prioritized by the attentional system (e.g., Öhman et al., 2001). According to our results, temporary goals evoked by aversive emotions are crucial in the guidance of attention and direct attention to stimuli that are *instrumental* in alleviating the aversive emotional state. Thus, the attentional effects of aversive emotional states are not restricted to stimuli that need to be avoided in order to alleviate this emotion. Interestingly, this effect was found at an early level of information processing, suggesting that top-down influences bias attention in a rapid and flexible way reflecting the demands of the current context (cf. Rothermund et al., 2001).

The present evidence also relates to recent models and evidence on emotion regulation. Theoretical accounts of emotion regulation (Philippot, Baeyens, Douilliez, & Francart, 2004; Gross & Thompson, 2007; Koole, 2009) consider the (automatic) deployment of attention as a primary mechanism through which people regulate emotion. However, previous research focused primarily on (strategic) attending to emotion-unrelated events as a way to distract oneself from

the source of the emotional experience or the emotional experience (see Koole, 2009, for an overview). The present research hints to a more basic and probably emotion-inherent way of regulating. That is, attenuating a negative emotion by pursuing the goal that the emotion itself evokes and which aims to solve the problematic and emotion-causing situation (cf. Lazarus & Folkman, 1984).

Moreover, our study supports the idea that emotion regulation can occur automatically in the sense of fast and unintentionally (cf. Philippot et al., 2004; Mauss, Bunge, & Gross, 2009; Koole, 2009). Our findings suggest that orienting to means for emotion regulation is fast because pictures were presented for only 350 ms in the dot probe task. This implies that the attentional deployment must have taken place during this short period of time. Our findings therefore contradict earlier accounts which proposed that orienting to aversive events occurs rapidly whereas orienting to relieving stimuli is limited to later stages of attention (e.g., Derryberry & Reed, 2003). The conclusion that the deployment of attention was unintentional is supported by the fact that the probe task did not require nor encourage participants to orient attention towards pictures representing cleanliness. Although it is difficult to exclude the possibility that (some) participants did attend intentionally to these pictures (e.g., in order to regulate their emotional state or because of demand compliance), several arguments can be raised against it. First, because of the brief presentation time of the pictures it is unlikely that participant had the time to intentionally direct their attention to pictures representing cleanliness. Second, none of the participants in the disgust condition seemed to have realized that pictures representing cleanliness were presented in the dot probe task. In contrast, when asked about their idea of the aim of the dot probe task, the majority speculated that the task examined the effects of disgusting pictures (in comparison to neutral pictures). Nevertheless, future research should further investigate the automaticity of the deployment of attention to stimuli that are relevant for

emotion regulation (e.g., by presenting stimuli subliminally). Another, separate issue is whether the emotion regulation goal (i.e., the goal to become clean) was automatically or strategically activated and/ or pursued. For instance, participants might have strategically thought about possibilities to reach the goal of becoming clean after the disgust induction. This might have caused the (automatic) allocation of attention to stimuli representing cleanliness. Future research could examine whether automatically activated and pursued emotion regulation goals (e.g., emotion regulation goals activated through priming, cf. Mauss, Cook, & Gross, 2007) cause similar attentional effects.

As outlined in the introduction, we assume that clean stimuli cause an attentional bias in the disgust condition because touching disgusting objects evokes the goal to be clean. The activated representation of this goal guides the deployment of attention to matching and hence goal-relevant stimuli in the environment, including stimuli representing cleanliness which are means to this goal. Alternatively, one might argue that clean stimuli were attended to because inducing disgust activates knowledge that is related to disgust such as the concept of cleanliness. In this case, the concept of cleanliness would be activated and would guide attention not because it is part of a goal representation but because of its potential semantic relation with disgust. However, the fact that many participants actually washed their hands in the disgust condition strongly suggests that a goal was activated because a semantic activation only should not be accompanied by (goal-relevant) behaviour.

According to the proposed goal account, it makes sense that participants in the disgust condition attended also to disgusting stimuli. For instance, when having touched disgusting objects and aiming to be clean, further disgusting events represent obstacles in order to reach cleanliness and need to be avoided. Therefore it is functional to be alert for these events. In a related vein, Kruglanski and colleagues (2002) argue that the representation of a goal contains

information about obstacles to a goal. However, it should be noted that our data allow no conclusion whether the attentional bias to disgusting pictures in the disgust condition was caused by their goal relevance. This effect could also be driven by the aversiveness of these events or because they match the currently experienced emotion.

It is important to realize that our findings are also to some extent in line with an alternative motivational account. Rather than assuming that these pictures evoke an attentional bias because they represent cleanliness, one might argue that attention is deployed to these pictures because they are positive. This idea is in line with the counter-regulation principle proposed by Rothermund and colleagues (e.g., Rothermund et al., 2008) according to which individuals regulate emotional states by focusing attention on events that are opposite in valence to this state (i.e., to positive stimuli when the emotional state is negative and to negative stimuli when the emotional state is positive). However, in contrast to our account, the counter-regulation account cannot explain why attention is also and to the same extent deployed to disgusting stimuli. Therefore, we consider a goal account to be the most parsimonious explanation for the current results. In future studies, one could further disentangle the two accounts by comparing the effects for positive pictures representing cleanliness and positive pictures that are not related to cleanliness.

A surprising finding was that disgust propensity did not seem to influence attention to disgusting pictures but did influence the deployment of attention to pictures representing cleanliness. More particularly, high disgust prone participants attended to clean pictures less than low disgust prone participants. This suggests that highly disgust prone individuals are less likely to attenuate disgust by attending to cleanliness-related stimuli. How could this finding be explained? One possibility is that these individuals experience disgust at such a strong level that regulating the emotion by solving the problematic and emotion-causing situation (e.g., washing

away the contamination) appears impossible to them (cf. Lazarus & Folkman, 1984). Consequently, these individuals will not orient attention towards stimuli representing means to this goal. Another hypothesis is that the strong and overflowing emotional experience leaves no capacity for the processing of clean stimuli (cf. Eysenck, Derakshan, Santos, & Calvo, 2007). Although attending to goal-relevant events such as means is shown to be automatic in the sense of fast and involuntary, it could be capacity demanding (Brisson, Leblanc, & Jolicœur, 2009) and thus less likely to occur when cognitive resources are depleted as the result of a strong emotional (disgust) experience.

Our conclusions need to be qualified to some extent. First, we did not find a bias to clean or disgusting pictures in trials comparing the two categories to each other. This makes sense for the disgust condition because here disgusting and clean stimuli are equally relevant. Taking into account that other studies failed to observe robust attentional biases to disgusting pictures in normal individuals (Charash & McKay, 2002; Charash, McKay, & Dipaolo, 2006; Cisler, Olatunji, Lohr, & Williams, 2009; Cisler & Olatunji, 2010), the null finding in the control condition is possibly due to the fact that a bias to disgusting events can only be found in comparison to a true neutral category. Second, our data do not allow drawing conclusions about men because all of our participants were women. We tested only women because they are known to be more sensitive to the effects of disgust induction (e.g., Druschel & Sherman, 1999). However, we are not aware of any theoretical arguments suggesting that either goals evoked by emotions or orienting to goal-relevant events are influenced by gender. Finally, the present version of the dot probe task does not allow for conclusions about whether the attentional biases to disgusting and clean pictures reflected facilitated engagement of attention to or impaired disengagement of attention from those stimuli (cf. Koster, Crombez, Verschuere, & De Houwer, 2004). Future research should investigate which components of attention are affected by these

events.

In conclusion, the present study demonstrated that the experience of an aversive emotion led to the deployment of attention to stimuli representing the goal to alleviate this state. Our study opens an exciting avenue for future research in which the role of goals in emotional attention can be examined.

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Appendix A

Overview of the Stimuli Used for Disgust and Neutral Mood Induction

An overview of the stimuli used for the disgust induction procedure in the disgust condition and for the neutral mood induction in the control condition. Small stimuli (stimulus numbers: 2; 3; 5; 6; 9; 10) were presented in plastic cubs.

Disgust Condition

(1) A plastic eye in a plastic water globe; (2) Crabs made of slippery plastic with naturalistic scent; (3) A plastic cockroach placed on a biscuit; (4) Plastic faeces; (5) Bugs made of slippery plastic with naturalistic scent; (6) Maggots made of slippery plastic with naturalistic scent; (7) A WC brush with dry coffee powder in it; (8) A transparent plastic bag filled with food mash resembling vomit; (9) Cotton swabs with dried mustard on it (resembling earwax); (10) A plaster with a dried mixture of ketchup and mustard on it (resembling pyic blood).

Control Condition

(1) A used stress ball; (2) Erasers with an intensive smell of gum; (3) A big black button and a smaller button; (4) A used role of brown tape; (5) Wooden dowels with an intensive smell of wood; (6) Matches; (7) A bath brush with a long arm; (8) A transparent plastic bag filled with oat flakes; (9) Ball pens colored in white and yellow; (10) A tissue.

Appendix B

Overview of the Content of the Pictures Used as Cues for the Dot Probe Task

Disgusting Pictures

A dirty toilet; An overflowed toilet; A cockroach; Vomit; A person vomiting; Maggots; The eyes of a person having abscesses around the eyes; A finger with a pyic blister; A mixture of human slime and blood (actually internal organs with a tape worm); A dead wild boar with its bloody organs on it.

Pictures Representing Cleanliness

Water drops falling into water; A water vortex; Hands holding soap; A washbasin; A shower head; A swimming pool; A person having a bath; The back of a person standing in a swimming pool under a water nozzle; A snowy landscape; A water fall.

Neutral Pictures

Mushrooms; Farmland; The front of a house with flowers; The branch of a tree; A fan; An electric iron; A pair of brown shoes; A white hair dryer; A bus; A clothes rack.

Footnotes

[1] The numbers of the pictures were: 5500, 5720, 5731, 5740, 7020, 7030, 7031, 7050, 7140, 7217. ($M_{valence}$ = 5.26; $SD_{valence}$ = 1.19; $M_{arousal}$ = 2.82; $SD_{arousal}$ = 1.99)

[2] Additionally, we split the data from the dot probe task into two blocks and repeated the reported analyses in order to investigate whether the effects changed during the task. Interestingly, the attentional bias to disgusting pictures in the control condition was only significant in the second block of the probe task (M = 14.68, SD = 22.65, $t(18)$ = 2.83, p = .011) but not in the first block (M = .68, SD = 27.50, $t(18)$ = .108, p = .915; Interaction disgust congruency x block, $F(1, 18)$ = 2.73, p = .116). The attentional bias to clean pictures in the disgust condition tended to be significant in both blocks of the task, ts > 1.75, ps < .097. The interaction between cleanliness congruency and block was not significant, F < 1.

Table 1

Mean RTs and Standard Deviations (in ms) as a Function of Trial Type and Congruence in Disgust and Control Condition

	Congruent[a]		Incongruent[b]		Attentional bias indices[c]	
Trial type	*M*	*SD*	*M*	*SD*	*M*	*SD*
Disgust condition						
Disgust vs. neutral	424	48	437	56	13	33
Cleanliness vs. neutral	418	46	427	48	9	20
Disgust vs. cleanliness	432	55	433	53	1	22
Control condition						
Disgust vs. neutral	412	47	421	52	9	21
Cleanliness vs. neutral	410	50	409	45	-1	15
Disgust vs. cleanliness	414	49	417	56	3	20

Notes. [a]Congruent refers to trials in which the target replaced the picture category first mentioned under trial type.
[b]Incongruent refers to trials in which the target replaced the picture category mentioned second under trial type.
[c]Attentional bias indices were calculated by subtracting RTs on congruent trials from RTs on incongruent trials.

Figure captions

Figure 1. Schematic overview of a trial in the dot probe task. A trial started with the presentation of a fixation screen for 500 ms, followed by the presentation of two cue pictures for 350 ms. Hereafter, the target (black square) was presented. Participants had to indicate the location of the target. A trial ended after a response was registered or 1500 ms had elapsed since the onset of the target. The following trial started 200 ms after a response was registered or the presentation of the target had ended. The upper cue in this example consists of a picture representing cleanliness and the lower cue of a neutral picture. Pictures cues were fully colored in the experiment. Because of copyright restraints of the IAPS, the neutral picture in the figure is not one of the original IAPS pictures used in the study but an example picture that resembles one of these pictures.

Figure 1.