



Disgust- and not fear-evoking images hold our attention

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ABSTRACT

Even though disgust and fear are both negative emotions, they are characterized by different physiology and action tendencies. The aim of this study was to examine whether fear- and disgust-evoking images would produce different attention bias effects, specifically those related to attention (dis)engagement. Participants were asked to identify a target which was briefly presented around a central image cue, which could either be disgusting, frightening, or neutral. The interval between cue onset and target presentation varied within blocks (200, 500, 800, 1100 ms), allowing us to investigate the time course of attention engagement. Accuracy was lower and reaction times were longer when targets quickly (200 ms) followed disgust-evoking images than when they followed neutral- or fear-evoking images. For the other, longer interval conditions no significant image effects were found. These results suggest that emotion-specific attention effects can be found at very early visual processing stages and that only disgust-evoking images, and not fear-evoking ones, keep hold of our attention for longer. We speculate that this increase in early attention allocation is related to the need to perform a more comprehensive risk-assessment of the disgust-evoking images. The outcomes underline not only the importance of examining the time course of emotion induced attention effects but also the need to look beyond the dimensions of valence and arousal.

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1. Introduction

Through selective attention, our brain guides our behavior toward environmental stimuli that are relevant for survival, especially when they imply immediate danger (Vuilleumier, 2005). Evidence for this notion, comes from experimental and clinical studies that have used a variety of stimuli (e.g., pictures, faces, words) and paradigms that tap into different aspects of attention (for reviews see, Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van IJzendoorn, 2007; Cisler, Bacon, & Williams, 2009; Weierich, Treat, & Hollingworth, 2008; Yiend, 2010). Results from most of these studies suggest that there exists an attention bias toward threatening or fear-evoking stimuli, particularly in high-anxious individuals. Results however, do not conclusively indicate whether this attention bias constitutes facilitated attention toward threatening stimuli, impaired disengagement from them, or both (e.g., Fox, Russo, Bowles, & Dutton, 2001; Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2004; Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006). Methodological variables, such as stimulus duration and stimulus threat value, as well as individual differences in anxiety seem to modulate the

pattern of results (Cisler, Olatunji, Lohr, & Williams, 2009; Mogg & Bradley, 1998).

One remarkable observation in many of these studies is that researchers often refer to effects of ‘threatening’ or ‘fear-evoking’ information, while they have actually used stimulus materials that are ‘negative’ and ‘arousing’, according to the database they were selected from (e.g., Affective Norms for English Words – ANEW, Bradley & Lang, 1999; International Affective Picture System – IAPS, Lang, Bradley, & Cuthbert, 2008). While threatening words and pictures are evidently negative and most times arousing, not all negative stimuli are necessarily threatening or fear-evoking. Moreover, a large number of negative, arousing IAPS images that are typically classified as highly threatening (e.g., pictures showing injuries, mutilations, or burn victims) have in fact been found to elicit stronger feelings of ‘disgust’ than of ‘fear’ (Libkuman, Otani, Kern, Viger, & Novak, 2007; Mikels et al., 2005). It is therefore disputable whether the previously reported attention bias effects (particularly those with reference to IAPS pictures) can be attributed solely to fear and the purely threatening nature of the stimuli used. Indeed, in such cases, it is more appropriate to explain the observed effects in terms of the stimulus selection criteria applied, namely valence (e.g., Pratto & John, 1991) or arousal (e.g., Schimmack, 2005; Vogt, De Houwer, Koster, Van Damme, & Crombez, 2008). Nevertheless, this does not rule out the possibility that there are emotion-specific attention effects, which may be unique for fear- or disgust-evoking images.

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Given that the emotions fear and disgust activate different brain areas (Calder, Lawrence, & Young, 2001; Murphy, Nimmo-Smith, & Lawrence, 2003) and are linked to different action tendencies (Susskind et al., 2008), it is feasible that they also affect attention differentially. Moreover, while fear is believed to *enhance* sensory acquisition in order to deal quickly and efficiently with threatening circumstances, disgust more likely serves the function of *diminishing* environmental input in order to avoid contamination (Susskind et al., 2008). Furthermore, while the first process is believed to be *fast* and largely automatic, the latter presumably develops more *slowly* and depends more on focal attention (Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Santos, Iglesias, Olivares, & Young, 2008). Consequently, if fear- and disgust-evoking stimuli indeed affect attention differently then it seems unjustified to treat them as one single category. Moreover, an inconsistent use of negative, arousing stimulus materials that could be either, threatening, disgusting, or both, could have been responsible for some of the contrasting findings reported in the literature.

Hardly any behavioral studies have directly compared attention effects for threat-related versus disgust-related stimuli, but those that have done so found larger attention biases for the latter. For example, using a modified Stroop task, Charash and McKay (2002) found that color-naming of disgust-related words (e.g., vomit) was delayed relative to neutral words (e.g., igloo), while a similar effect was not present for fear-related words (e.g., tumor). Using the same sets of words in a rapid serial visual processing paradigm (RSVP), Cisler, Olatunji, et al. (2009) found that probes were more difficult to detect following disgust targets than following fear targets. Results from both experiments suggest that attention disengagement is more difficult from disgust-related words than from fear-related words. In a recent event-related potential (ERP) study, similar results were found for pictorial stimuli (Carretié, Ruiz-Padial, López-Martín, & Albert, 2011). Participants in this study responded slower and less accurate in a digit categorization task when the targets were presented superimposed on disgust pictures than on fearful or neutral pictures. In addition, only the disgust pictures were found to elicit larger P2 components than the neutral pictures, suggesting that specifically these images, and not the fearful ones, received more attention during early perceptual processing. In contrast, Ciesielski, Armstrong, Zald, and Olatunji (2010) observed an equal drop in detection accuracy when targets were presented in a RSVP stream following fear- and disgust-image distracters as compared to neutral ones. In addition, for both types of negative images detection accuracy became gradually better with longer time lags, suggesting a similar development in attention allocation over time. Nevertheless, close inspection of their data also showed that at the shortest time lag (200 ms), accuracy was slightly lower following disgust- as compared to fear-images, suggesting somewhat greater attention allocation to the disgust pictures at early processing stages.

The main aim of the present study was to provide further evidence that fear- and disgust-evoking images produce different attention bias effects, perhaps not only in magnitude but also in onset and duration. First, we carefully selected our stimulus materials by means of an independent rating study, ensuring that the pictures (from the IAPS database) generated feelings of fear *or* disgust, while keeping their arousal and valence ratings constant. We then employed a covert orienting paradigm (modeled after Fox et al., 2001, Experiment 5) to investigate whether these two sets of negative pictures would hold participants' attention to different extent and/or at different times following picture onset. In Fox et al.'s paradigm, task-irrelevant affective cues were presented at fixation, in focus of attention, while participants were required to identify a target that was briefly presented in the surrounding of this cue after a brief interval. Difficulty with disengaging attention from the central image cue would result in prolonged target identification times. Indeed, while using a cue-target interval of 600 ms, Fox et al. (2001) found that anxious individuals took longer to

identify a peripheral target when they fixated on a threat-related word than when they fixated on a neutral or positive word.

In a novel adaptation of this paradigm, we systematically varied the time interval between cue onset and target presentation, which allowed us to investigate not only the existence and magnitude of attention (dis)engagement but also its time course. In general, the longer the cue-target interval, the more time participants have to disengage their attention from the central image cue. At relatively longer cue-target intervals, it can therefore be expected that response delays for the distinct emotion cues are no longer present or even show the opposite pattern, in case of attention avoidance (cf., Mogg, Bradley, Miles, & Dixon, 2004). In the current experiment, we used cue-target intervals of 200, 500, 800, and 1100 ms, respectively. These intervals were chosen to enable investigation of emotion-specific differences (fear versus disgust) in both early attention (dis)engagement and subsequent attention avoidance.

Based on previous research, we hypothesized that it would take longer to identify targets paired with negative image cues (both disgust- and fear-evoking) than those paired with neutral cues (e.g., Fox et al., 2001; Koster et al., 2006; Vogt et al., 2008). Furthermore, in accord with the findings by Carretié et al. (2011), such response delay was expected to be more prominent for the disgust-evoking images than for the fear-evoking images, reflecting superior attention holding capacities of the former. Finally, given the respective functions of fear and disgust (e.g., Susskind et al., 2008), we reasoned that attention engagement effects for fear-evoking images may be more transient to those of the disgust-evoking images (thus response delays more restricted to the shorter cue-target intervals) and less likely to convert into attention avoidance (thus no quicker target identification at the longest cue-target interval).

2. Method

2.1. Participants

Thirty female university students took part in this experiment, earning either course credits or 5€ for their participation. They were aged between 19 and 30 years ($M=21.0$ years). Only females were recruited because our stimulus selection procedure (see below) revealed significant gender differences as to how the IAPS pictures were rated in terms of arousal and valence (see also, Lang et al., 2008; Weinberg & Hajcak, 2010). In addition, previous studies have shown that women are characteristically more disgust sensitive than men (Charash, McKay, & DiPaolo, 2006) and display greater vigilance for threat-related information (Dickie & Armony, 2008). Using an all-female sample would therefore remove a confounding variable.

2.2. Stimulus selection

Forty IAPS pictures were selected for the experimental task on the basis of an independent rating study consisting of 160 IAPS pictures (Lang et al., 2008). For this rating study, 40 pictures were chosen based on their estimated likelihood of generating feelings of disgust. These pictures depicted dead animals, dirty toilets, contaminated food, crawling animals (e.g., cockroaches, maggots), and disgusting actions (e.g. vomiting). Forty other pictures were chosen based on their likelihood of eliciting feelings of fear. They depicted aggressive animals (e.g., dogs, sharks), pointed guns, violent actions, and dangerous scenes (e.g., riots, car accidents). Pictures that were believed to generate feelings of both fear *and* disgust (e.g., mutilation, spiders) were discarded. Finally, eighty neutral pictures were chosen, showing tranquil animals, household objects, peaceful scenes, and simple everyday actions (e.g., typing, reading). All pictures were adjusted into equally sized squares.

Twenty-seven independent judges (15 females, 18–24 years) were asked to rate arousal and valence of the 160 chosen IAPS pictures

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