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Disgust-specific modulation of early attention processes

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ABSTRACT

Although threatening images are known to attract and keep our attention, little is known about the existence of emotion-specific attention effects. In this study (N = 46), characteristics of an anticipated, disgust-specific effect were investigated by means of a covert orienting paradigm incorporating pictures that were either disgust-evoking, fear-evoking, happiness-evoking or neutral. Attention adhesion to these pictures was measured by the time necessary to identify a peripheral target, presented 100, 200, 500, or 800 ms after picture onset. Main results showed that reaction times were delayed for targets following the disgust-evoking pictures by 100 and 200 ms, suggesting that only these pictures temporarily grabbed hold of participants' attention. These delays were similar for ignore- and attend-instructions, and they were not affected by the participants' anxiety levels or disgust sensitivity. The disgust-specific influence on early attention processes thus appeared very robust, occurring in the majority of participants and without contribution of voluntary- and strategic-attention processes. In contrast, a smaller and less reliable effect of all emotional (arousing) pictures was present in the form of delayed responding in the 100 ms cue-target interval. This effect was more transitory and apparent only in participants with relatively high state-anxiety scores. Practical and theoretical consequences of these findings are discussed.

It is well known that emotionally salient stimuli are preferentially processed and attract more attention resources than neutral stimuli, particularly when these stimuli signal threat and immediate danger (Yiend, 2010). This bias towards negative or threatening information is believed to originate from evolutionary pressures and to occur in a highly reflexive manner (Öhman, Flykt, & Esteves, 2001; Vuilleumier, 2005). Indeed, from a survival viewpoint it is important to quickly spot an angry face in the crowd (Fox, Lester, Russo, Bowles, & Dutton, 2000; Hansen & Hanse, 1988) or to swiftly direct attention to the location of a dangerous animal (Öhman et al., 2001). Yet, although this sounds relatively straight forward, the effects of negative emotion and threat on attention are much more dynamic and complex than a first reading of these observations suggests. To understand some of this complexity, the current study examined the influence of four potentially critical factors and their interactions, relating to: (1) emotion-specific effects, (2) the time course of attention effects, (3) contribution of voluntary or task-related attention, and (4) state-dependent effects. With reference to these factors, we were particularly interested in specifying the conditions that may restrict our previous conclusion stating that "disgust- but not fear-evoking images hold our attention" (Van Hooff, Devue, Vieweg, & Theeuwes, 2013).

First, most experimental studies in this field so far, have used stimuli (words, pictures) that varied in valence or arousal level and primarily focussed on the emotion fear. Recent reports however suggest that stimuli evoking disgust produce different attention effects than those eliciting fear, even when these stimuli are equally arousing and similarly negative (Carretié, Ruiz-Padial, López-Martín, & Albert, 2011; Chapman, Johannes, Poppenk, Moscovitch, & Anderson, 2013; Van Hooff et al., 2013). More specifically, results from these studies suggest that attention bias effects are exclusively present or are much larger for disgust- as compared to fear-evoking pictures. Likewise, more distraction and greater attentional blink effects have been found for disgust- as compared to fear-related words (Charash & McKay, 2002; Cisler, Olatunji, Lohr, & Williams, 2009). Together, these results suggest that the specific kind of threat implied by a negative stimulus determines the magnitude of the attention effect observed, presumably because the emotions fear and disgust are associated with different action tendencies (Susskind et al., 2008) and/or different cost/benefit analyses (Carretié et al., 2011). Indeed, a differential attention effect for fear- and disgust-evoking images would make sense given that the sight of, for example, an aggressive animal or a pointed gun requires urgent action at the cost of being killed, while, on the contrary, noticing a bleeding injury or a rotten piece of meat calls for a more detailed evaluation with less immediate costs attached to it. In other words, only in the latter, more disgust-related cases one can permit oneself to narrow attention (Gable & Harmon-Jones, 2010) and/or to direct (temporarily) more attention resources towards the "threatening" stimulus (Carretié et al.,

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2011; Van Hooff et al., 2013). Regardless of interpretation, the single fact that different attention effects are observed for disgust- and fear-related stimuli signifies that it is important to design studies that allow for the investigation of emotion-specific effects, as clearly not all results can be explained by arousal or emotional salience alone. This may be particularly relevant for studies that incorporate images from the International Affective Picture System (IAPS), which is organized along valence and arousal dimensions (Lang, Bradley, & Cuthbert, 2008) and not by the type of emotion elicited. Moreover, it is important to recognize that many unpleasant, high-arousing IAPS pictures, which are often labeled as highly threatening (e.g., mutilated bodies or burn victims), are typically considered to be more disgusting than fearful (Libkuman, Otani, Kern, Viger, & Novak, 2007; Mikels et al., 2005). Consequently, this restricted category of "high-threat" images may affect attention not only because they are highly arousing but perhaps also because they elicit (strong) feelings of disgust.

Second, perception and attention develop over time and thus attention capture and engagement by fearful and disgusting images may depend on the timing and duration of successive emotional and neutral (target) stimuli. For example, in our previous study we found that task irrelevant disgust-evoking pictures delayed subsequent, peripheral target identification *exclusively* when these targets were presented 200 ms after picture onset and not after 500, 800, or 1100 ms (Van Hooff et al., 2013). Likewise, Ciesielski, Armstrong, Zald, and Olatunji (2010) reported that the enhanced attentional blink effect for emotional stimuli rapidly declined from short (200 ms) to longer time lags (400 ms and 600 ms) and even reversed for the longest time lag of 800 ms (i.e., enhanced instead of diminished target processing following negative images). Bocanegra and Zeelenberg (2009) also demonstrated that negative word cues impaired subsequent target identification at short (50 and 500 ms) inter stimulus intervals (ISIs), but improved target identification at a longer ISI of 1000 ms. Together, these results suggest that primary task performance deteriorates only, or foremost, when emotional distracters and task-relevant targets are presented in close temporal proximity. One likely explanation for this would be that with short ISIs the competition for processing resources is higher. What "short" means however may again depend on the specific type of emotion elicited. For example, our previous findings suggest that disgust-evoking pictures compete maximally with targets for attention resources at around 200 ms and not thereafter (Van Hooff et al., 2013). For fear-evoking images however, this may occur at an earlier point in time because, as argued before, only quick registration of their rough contents is necessary to trigger the appropriate (fight–flight) reaction. This suggestion is supported by results from Koster, Crombez, Verschuere, Vanvolsem, and De Houwer (2007), who found attention capture effects for highly threatening pictures in an exogenous cueing task when these pictures were presented for 100 ms, but not when they were presented for 28, 200 or 500 ms. Moreover, Cisler et al. (2009), using an RSVP task, reported that probe detection rate dropped when it was directly preceded (120 ms) by a fear-related word but not by a disgust-related word. In contrast, when there were two or three intervening items between the probes and the emotion target words (>240 ms), then probe detection rate was more affected by the disgust-related words than the fear-related words (i.e., a reversed pattern), albeit only when targets were made relevant to the task (see next). Thus, taking the first two factors together, emotion specific attention effects may exist both in terms of magnitude (i.e., disgust larger than fear) *and* in relation to temporal course (i.e., fear earlier but more transitory than disgust). To allow for the presence of a very quick and brief impact by fearful stimuli on attention, it is thus necessary to also include experimental conditions with very brief stimulus durations or very short ISIs (≤100 ms), something we did not do in our previous study (Van Hooff et al., 2013).

Third, priority access and attention (dis)engagement are guided not only by the nature and emotional saliency of the eliciting stimuli but also by current task goals and situational (attention) demands. For example, using a spatial cueing task, Okon-Singer, Tzelgov and Henik (2007) demonstrated that emotion effects were solely present when attention was oriented towards the location at which the emotional items were presented. Moreover, even in tasks in which neutral and emotion pictures were presented at fixation, thus already in focus of attention, it was found that negative images interfered with task performance more when the primary task included just a few instead of many distracting items (Erthal et al., 2005; Okon-Singer et al., 2007). This was explained by the notion that (emotional) distraction may occur only when the primary task does not consume all attention resources (i.e., when perceptual load is low). The modulating role of task-related and voluntary attention is furthermore supported by results from event-related potential (ERP) research, showing much larger brain activation differences between negative- and neutral images when participants' attention is directed towards the contents of these images than when they were just viewing them (Schupp et al., 2007) or when their attention is directed towards a concurrent perceptual decision task (Wiens, Sand, Norberg, & Andersson, 2011). It is as yet unclear however, whether the effects of such attention manipulation would depend on the type of negative emotion elicited, either directly or as a result of the time course of enhanced processing. More specifically, it is feasible that a potentially modulating effect of directed attention would be particularly present at the later, more strategic processing stages (Schupp et al., 2007), and according to our reasoning above, such effect would thus overlap or interact more with the expected attention adhesion effects for disgust-evoking images than with that for fear-evoking images. Indeed, results from Cisler et al.'s (2009) RSVP study, as mentioned earlier, provided some evidence for this suggestion. More specifically, their results showed that the relatively late effects for disgust-related words (i.e., probe position after two or three intervening items) occurred only when these words were made task relevant. In contrast, the early effects for the fear-related words (no intervening items) occurred regardless of top-down attention. The attention effects of fear thus seemed to occur more automatically than those of disgust. This claim however needs further investigation as we clearly found a detrimental effect of disgusting images, with a quick onset and while their contents were ignored (Van Hooff et al., 2013, see also Carretié et al., 2011; Krusemark & Li, 2011).

Finally, attentional biases for threat are more pronounced in anxious individuals (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & IJzendoorn, 2007) and the internal state of the participant seems to play a determining role in early visual selection (Rossi & Pourtois, 2012). Moreover, several studies as cited in Bar-Haim et al. (2007) found evidence for increased orienting towards- and/or impaired disengagement from threat-related stimuli exclusively in high anxious participants. In this review paper however, no distinction is made between the effects for fearful or disgusting stimuli. At first glance, it seems that individual differences in disgust sensitivity are less crucial for finding robust attention effects for disgust-evoking stimuli (Van Hooff et al., 2013; Vogt, Lozo, Koster, & De Houwer, 2011) although Cisler et al. (2009) have claimed the opposite. In the latter study, an attentional bias for task-irrelevant, fear-related words was found among all participants, whereas a similar effect for disgust-related words was observed in disgust-prone individuals only. Perhaps this discrepancy is due to the fact that Cisler and colleagues used words instead of pictures. In general, it is easier to elicit emotions from pictures, and arguably this may be more easily done for disgust-related pictures as compared to fear-related ones. All in all, it shows that attention (dis)engagement effects for disgust- and fear-related images may differ with respect to magnitude, time course, voluntary attention contributions, and dependency on internal state factors.

1. The present study

Taking these four factors together, the current experiment was developed to achieve the following aims. First, to investigate the existence and characteristics of emotion-specific attention effects, different types of photographical images from the IAPS data base were included in a