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# Competing for Attentional Priority: Temporary Goals Versus Threats

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Numerous studies have shown that attention is biased toward threatening events. More recent evidence has also found attentional biases for stimuli that are relevant to the current and temporary goals of an individual. We examined whether goal-relevant information still evokes an attentional bias when this information competes with threatening events. In three experiments, participants performed a dot probe task combined with a separate task that induced a temporary goal. The results of Experiment 1 showed that attention was oriented to goal-relevant pictures in the dot probe task when these pictures were simultaneously presented with neutral or threatening pictures. Whether goal-relevant pictures themselves were threatening or neutral did not influence the results. Experiment 2 replicated these findings in a sample of highly trait-anxious participants. Experiment 3 showed that attention was automatically deployed to stimuli relevant to a temporary goal even in the presence of stimuli that signal imminent and genuine threat (i.e., a colored patch signaling the presentation of an aversive noise). These findings further corroborate the conclusion that an individual's current and temporary goals guide early attentional processes.

*Keywords:* attentional bias, motivation, goals, emotion, threat, negativity bias

One of the major functions of the attentional system is the selection of motivationally relevant information (Corbetta & Shulman, 2002; Desimone & Duncan, 1995). In particular, a wealth of research has shown that events relevant to the survival motive attract attention (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Yiend, 2010). These studies have demonstrated that attention prioritizes various kinds of threatening stimuli such as angry faces (Fox, Russo, Bowles, & Dutton, 2001; West, Anderson, & Pratt, 2009), dangerous animals (Lipp & Derakshan, 2005; Öhman, Flykt, & Esteves, 2001), or violent scenes (Yiend & Mathews, 2001). Recent evidence has revealed that events relevant to an individual's temporary and current goals also attract attention, such as beautiful people when mating goals are activated (Maner, Gailliot, Rouby, & Miller, 2007) or neutral words that are relevant to the goal of winning points (Vogt, De Houwer, & Crombez, 2011). The latter findings further support and extend the motivational perspective on attention. At the same time, they raise new questions about the link between motivation and attention. Do all types of motivationally relevant events always attract attention? How is attention deployed when the visual field contains various relevant events? In the present article, we addressed these questions by investigating the allocation of attention when threatening and goal-relevant information was presented simultaneously.

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## Attentional Bias to Threatening Information

The attentional prioritization of threat is thought to be highly adaptive because it facilitates an appropriate response (i.e., fight or flight; Öhman, 2007). Evolutionary models therefore assume that the structures mediating the attentional bias toward threat evolved as the human species evolved (Kenrick, Neuberg, Griskevicius, Becker, & Schaller, 2010; Lang, Bradley, & Cuthbert, 1997; LeDoux, 1996; LoBue, Rakison, & DeLoache, 2010; Mogg & Bradley, 1998; Öhman, 2007). Accordingly, the attentional bias to threat is supposed to be hard-wired. This view is supported by studies demonstrating preferred attention to angry faces or snakes and spiders in unselected adults (e.g., Hodsoll, Viding, & Lavie, 2011; Lipp & Derakshan, 2005; West et al., 2009) and infants (for an overview, see LoBue et al., 2010). Consequently, many accounts emphasize that threat attracts attention in a bottom-up driven and automatic way (LeDoux, 1996; LoBue et al., 2010; Mogg & Bradley, 1998; Öhman, 2007; Vuilleumier & Huang, 2009). Öhman and colleagues (Öhman, 2007; Öhman et al., 2001; Öhman & Mineka, 2001; see also LoBue et al., 2010), for instance, have proposed the existence of a hard-wired fear module that is primarily activated by biologically prepared threatening stimuli such as snakes and spiders or angry faces. The activation of the fear module leads to the automatic deployment of attention to threatening events.

Recent evidence has advanced the evolutionary view by showing that modern threats such as guns or knives are equivalent to evolutionary threats in biasing attention automatically (e.g., Brosch & Sharma, 2005). Moreover, stimuli that first become signals of threat in the experimental situation (e.g., through fear-conditioning) evoke an attentional bias (e.g., Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2004; Notebaert, Crombez, Van Damme, De Houwer, & Theeuwes, 2011; Smith, Most, Newsome, & Zald, 2006). Apparently, the current threat value of threatening events is more essential than how long these events have been associated with threat in the evolution of the human species or in the learning history of an individual. This might also explain why attention reflects individual differences in what is believed to be dangerous: For instance, stereotypes associating Black people with danger predict the automatic allocation of attention to black faces in White individuals (Donders, Correll, & Wittenbrink, 2008).

In line with the idea that the current threat value drives the attentional bias, attention to threat seems to be heightened in anxious individuals, especially when mildly threatening stimuli are presented (Bar-Haim et al., 2007). Most models propose that anxiety sensitizes the threat detection system, thereby leading to higher threat evaluations (Bar-Haim et al., 2007; Bishop, 2007; Mathews & Mackintosh, 1998; Mogg & Bradley, 1998; Öhman et al., 2001). Mogg and Bradley (1998), for instance, defined anxiety as a motivational state that prepares the cognitive system for potential dangers (see also Mathews, 1990; Oatley & Johnson-Laird, 1987). As a consequence, in anxiety, the automatic threat evaluation system appraises even low threats as highly threatening and thus as motivationally relevant, resulting in a dysfunctional bias of attention to all kinds of threatening information.

Motivational and contextual factors not only increase attention to threat but also appear to decrease the bias in some cases. For instance, some studies have suggested that an attentional bias to threat is not present when cognitive resources are absorbed by ongoing tasks (Pessoa, McKenna, Gutierrez, & Ungerleider, 2002; Yates, Ashwin, & Fox, 2010) or when participants are asked to focus on visual, nonemotional features of threatening stimuli (e.g., when they have to detect the eye color of angry faces, Van Dillen, Lakens, & Van den Bos, 2011; see also Hahn & Gronlund, 2007; Stein, Zwickel, Ritter, Kitzmantel, & Schneider, 2009). These findings suggest that attention to threat might depend on top-down factors such as the individual's current goals.

## Attentional Bias to Stimuli Relevant to the Temporary Goals of an Individual

The idea that the temporary goals of an individual are an important source of the attentional deployment closely fits with dominant models of attention (Allport, 1989; Corbetta & Shulman, 2002; Desimone & Duncan, 1995). These models propose that attention is deployed to events that are relevant to the current and temporary goals of an individual, but disregards events that are irrelevant to these goals (see also Most, Scholl, Clifford, & Simons, 2005; Vogt, De Houwer, Moors, Van Damme, & Crombez, 2010). What is the difference between temporary goals and evolutionary motives such as survival? Temporary goals can be understood as the cognitive representation of a desired end state that an individual aims to achieve (Austin & Vancouver, 1996). The goal representation is activated during the pursuit of a goal and impacts emotions, behavior, and cognitive processes (Fishbach & Ferguson, 2007). Although goals can be pursued for a very long time (e.g., a student studying for several years in order to obtain a university degree), goals are set at some point and individuals usually disengage from a goal when it is achieved or when goal achievement turns out to be impossible. In contrast, motives such as the survival motive are stable and therefore always present. It is important to note that, unlike for goals, it is assumed that motives and in particular the survival motive do not need to be activated in order to impact cognitive processes such as the attentional deployment (e.g., Hodsoll et al., 2011; Lang et al., 1997; LoBue et al., 2010; Mogg & Bradley, 1998; Öhman et al., 2001; Pratto & John, 1991; but see Kenrick et al., 2010; Wells & Matthews, 1994). In the present article, we used simple temporary goals (e.g., winning points in a computer task) that clearly differ from such evolutionary motives.

Particularly relevant in the context of the current research, the deployment of attention to events relevant to temporary goals seems to occur automatically (Folk, Remington, & Johnston, 1992; Moskowitz, 2002; Vogt et al., 2010; Vogt, De Houwer, & Moors, 2011). For instance, Mogg, Bradley, Hyare, and Lee (1998; see also Nummenmaa, Hietanen, Calvo, & Hyona, 2011) found that, compared to satiated participants, hungry participants showed a stronger attentional bias to food-related words. Attention is not only deployed toward events that are rewarding during goal pursuit. In a study by Maner et al. (2007), activating a mating goal caused an attentional bias toward pictures of potential romantic rivals in jealous individuals.

Several studies have examined the automaticity of these effects in more detail (see Moors & De Houwer, 2006, for a discussion of automaticity features). Vogt and colleagues (Vogt et al., 2010; Vogt, De Houwer, & Moors, 2011) found that having the goal of reacting to specified stimuli (e.g., the words "ship" and "field") in order to win points led to shifts of attention to these stimuli when they were briefly presented as noninformative cues in a goal-unrelated cueing task. This indicates that goals cause the rapid orienting of attention to goal-relevant events even when an intention to attend to these stimuli is not present. Other studies have suggested that attention to goal-relevant events is efficient. For instance, goal-relevant events attract attention when participants are engaged in an effortful task in which goal-relevant stimuli appeared as distractors (Rothermund, 2003). Finally, attention is deployed to goal-relevant events when the events are subliminally presented (Ansorge, Kiss, & Eimer, 2009) or when the goal itself is only unconsciously active (Moskowitz, 2002). In sum, this research has shown that attentional biases are not limited to a fixed class of events that gained motivational relevance during evolution such as threatening events.

## Present Research

Given that both threatening stimuli and stimuli relevant to current and temporary goals automatically demand attention, the question that arises is: Which attentional bias prevails when both types of events are present? Is attention biased toward information relevant to temporary goals when emotionally salient stimuli are present? In most real-life situations, individuals encounter goal-relevant information in the presence of other salient information, and in particular emotionally salient information. It is unclear whether the attentional bias to information relevant to temporary goals is pervasive and "strong" and whether goal-relevant information can compete with threatening events.

Presenting stimuli relevant to temporary goals in competition with threatening information can also reveal whether the preferential processing of threatening information is forceful and unconditional. Many accounts (e.g., Bradley, 2009; Kenrick et al., 2010; LoBue et al., 2010; Öhman & Mineka, 2001; Öhman et al., 2001; Pratto & John, 1991) have posited that threatening events will be prioritized at any time because they reflect a demand of higher importance (i.e., survival). Therefore, a threat bias should also emerge when participants are pursuing goals that are unrelated to threat and when threatening stimuli are presented together with stimuli relevant to these goals. Recently, however, some studies have suggested that threatening events bias attention only when they are at the same time relevant to the current goals of the individual (e.g., Hahn & Gronlund, 2007; Stein et al., 2009; Van Dillen et al., 2011). The latter findings indicate a much stronger role for temporary goals in the automatic attentional deployment than previously assumed. However, these studies left open whether only the combination of threat and relevance to the individual's current goals attracts attention or whether goal relevance alone is sufficient to bias attention when threats are present.

To investigate this issue, we combined an attention task with a second task that implemented a temporary goal. More specifically, we investigated how attention is deployed to stimuli relevant to this goal when they are presented simultaneously with neutral or threatening stimuli in the attention task. Because the goal could only be pursued in the goal task and not in the attention task, goal-relevant stimuli were task relevant in the goal task but not in the attention task. Prior research has shown that goal-relevant stimuli nevertheless demand attention in the attention task (see Vogt et al., 2010; Vogt, De Houwer, & Crombez, 2011; Vogt, De Houwer, & Moors, 2011).

The goal task was simple. In each trial of this task, a single stimulus appeared briefly in the middle of the screen. Participants were instructed to respond by pressing the spacebar when one particular stimulus was presented. Correct reactions to this stimulus were rewarded with points. Participants were given the goal of striving for the maximum number of points that could be obtained during the whole task. Consequently, the stimulus (requiring a response) can be considered as relevant for a temporary goal.

We employed a dot probe paradigm (MacLeod, Mathews, & Tata, 1986) to examine the deployment of spatial attention. In this task, two stimuli are simultaneously presented at two different spatial locations on the screen, immediately followed by a probe. If individuals selectively attend to a stimulus, responses are faster to probes at the location previously occupied by this stimulus than to probes presented at the other location. The goal-relevant stimulus as well as neutral and threatening stimuli were used as cues in this task. Threatening events consisted of threatening pictures (Experiments 1 and 2) or of a signal of imminent and genuine threat (i.e., colored patches that predicted the presentation of an aversive noise; Experiment 3). Trials of the dot probe task alternated with trials of the goal task. This procedure allowed us to measure the attentional processing of the goal-relevant stimulus while participants were simultaneously pursuing the goal. However, because goal and dot probe tasks were clearly separated, attending to the goal-relevant stimulus in the dot probe task was neither necessary nor instrumental for achieving the goal. Therefore, participants were not encouraged to build an intention to attend to goal-relevant stimuli in the dot probe task. This argument supports the conclusion that attentional bias effects, as measured in this paradigm, are due to unintentional processes (Moors & De Houwer, 2006). Cues were presented for 350 ms (Experiments 1 and 2) or for 250 ms (Experiment 3) in the dot probe task in order to investigate the deployment of attention at an early stage of processing (cf. Bar-Haim et al., 2007).

To investigate our hypotheses, we used trials comparing the goal-relevant stimulus to neutral stimuli, and trials comparing the goal-relevant stimulus to threatening stimuli. We also implemented trials comparing neutral stimuli to threatening events. In Experiment 1, we also manipulated the valence of the goal-relevant stimuli (i.e., whether they were threatening or neutral pictures) in order to compare the effects of a goal-relevant threatening picture to the effects of a goal-relevant neutral picture.

## Experiment 1

### Method

**Participants.** A sample of 20 students (seven women; $M_{age}$ = 19 years, $SD$ = 1.62) at Ghent University received course credit for participating in the experiment. All participants had normal or corrected-to-normal vision and were naive as to the purpose of the experiment. Eleven participants had a threatening picture as goal-relevant picture, and nine participants had a neutral picture as goal-relevant picture.

**Apparatus and materials.** The experiment was programmed using Inquisit 2.0 software (Millisecond Software) that was implemented on a Dell Dimension 5000 computer with an 85 Hz, 17-in. CRT monitor. All stimuli were presented against a black background.

**Pictures.** Pictures were taken from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999). We used two sets of four pictures. Participants were randomly assigned to one of the two sets. Each set consisted of two neutral and two threatening pictures. We used two sets in order to have a larger variety of pictures. The numbers of the IAPS pictures were: 1120, 6350 (threatening, set 1), 7009, 7090 (neutral, set 1), 1300, 6560 (threatening, set 2), 5510, and 7006 (neutral, set 2). One picture always served as the goal-relevant picture and the other three pictures served as comparison pictures. Which picture served as the goal-relevant picture was counterbalanced between subjects. The comparison pictures were also shown in the goal task. They required no reaction in this task but were presented here to ensure that all pictures were presented equally often during the experiment.

Threatening pictures were selected in the following manner. First, each set contained one picture corresponding to evolutionary threat (attacking snake, barking pit bull) and one picture revealing a human attack scene (see Koster, Crombez, Verschuere, Vanvolsem, & De Houwer, 2007). Second, all threatening pictures had to be rated as highly negative ($M$ = 2.85, $SD$ = 1.60) and highly arousing ($M$ = 6.93, $SD$ = 1.92) according to the normative IAPS ratings. Moreover, all pictures belonged to the 16% most fear-evoking IAPS pictures using the ratings provided by Mikels et al. (2005).

We selected neutral pictures based on the normative valence and arousal IAPS ratings. These pictures displayed a mug, a bowl, mushrooms, or a book. Valence ratings had to be near the midpoint of the valence scale ($M$ = 5.03, $SD$ = 1.22) and arousal ratings under the midpoint of the arousal scale ($M$ = 2.67, $SD$ = 1.96).

In addition to the two sets of pictures, we used three colored patches (green, gray, and blue) as filler stimuli in the goal task only. Finally, we selected four additional neutral pictures from the IAPS for the practice phase.

**Dot probe and goal task.** Each trial in the *dot probe task* started with the presentation of a black fixation cross (5 mm high) in a white square in the middle of the screen, along with two white rectangles (4.6 cm high × 6.1 cm wide) above and below the fixation cross (see Figure 1). The middle of each of these peripheral rectangles was 4.6 cm from the fixation cross. Cues and probes were presented within the rectangles. After 500 ms, two cue pictures appeared for 350 ms. Immediately after cue offset, a probe consisting of a black square (0.5 × 0.5 cm) appeared. Responses required locating the probe by pressing one of two keys (“4” or “5” on the number pad) with index or middle finger of the right hand. Distribution of keys to probe locations was counterbalanced between participants. A trial ended after a response was registered or 1500 ms had elapsed since the onset of the probe.

A trial in the *goal task* started with the appearance of a picture in the middle of the screen for 250 ms, after which it was replaced by a red question mark (8 mm high). The trial ended with a response (only required for the goal-relevant picture) or when 2000 ms had elapsed since the onset of the question mark. Responses required pressing the spacebar with the left hand. Correct reactions to the goal-relevant picture were followed by a feedback screen indicating that the reaction was correct. Incorrect reactions (i.e., no reaction) to the goal-relevant picture and incorrect reactions to the other pictures (i.e., pressing of the spacebar) were followed by error feedback that was presented for 200 ms.

**Procedure: Practice phase.** Participants were seated approximately 60 cm from a computer screen. Instructions were presented on the screen. For the dot probe task, participants were asked to maintain attention at the fixation cross and to respond as quickly and as accurately as possible to the probe location. For the goal task, instructions informed participants that after responding to the probe, a single picture would be presented in the middle of the screen. If this picture was the goal-relevant picture, they should press the spacebar with the left hand when the question mark appeared. Instructions for the goal task emphasized that speed was not important in this task. In the practice and test phases, different pictures were used. The practice phase included 15 trials.

**Procedure: Test phase.** Before the test phase, participants were shown the goal-relevant picture and were told that this picture would be used in the test phase. Instructions informed participants that they would win 10 points for correctly indicating the presence of the goal-relevant picture during the goal task. Moreover, they were instructed to strive for the maximum score of 380 points. In fact, there were only 30 trials with the goal-relevant picture so the maximum score was actually 300 points. However, to keep motivation high until the end of the experiment, we chose to implement a goal that still appeared to require effort even near the end of the experiment.

During the test phase, each of the four types of dot probe trials was presented 40 times, resulting in 160 trials of the dot probe task. When the goal-relevant picture was *threatening*, the dot probe trials were: goal versus threat, goal versus neutral, threat versus neutral, and *neutral versus neutral*. When the goal-relevant picture was *neutral*, the dot probe trials were: goal versus threat, goal versus neutral, threat versus neutral, and *threat versus threat*. We implemented the fourth trial type (neutral vs. neutral trials or threat vs. threat, depending on condition) in order to present the same kind of trials in both conditions. For instance, because the goal-relevant picture was threatening in one condition, this condition had two trial types with a threatening versus a neutral picture

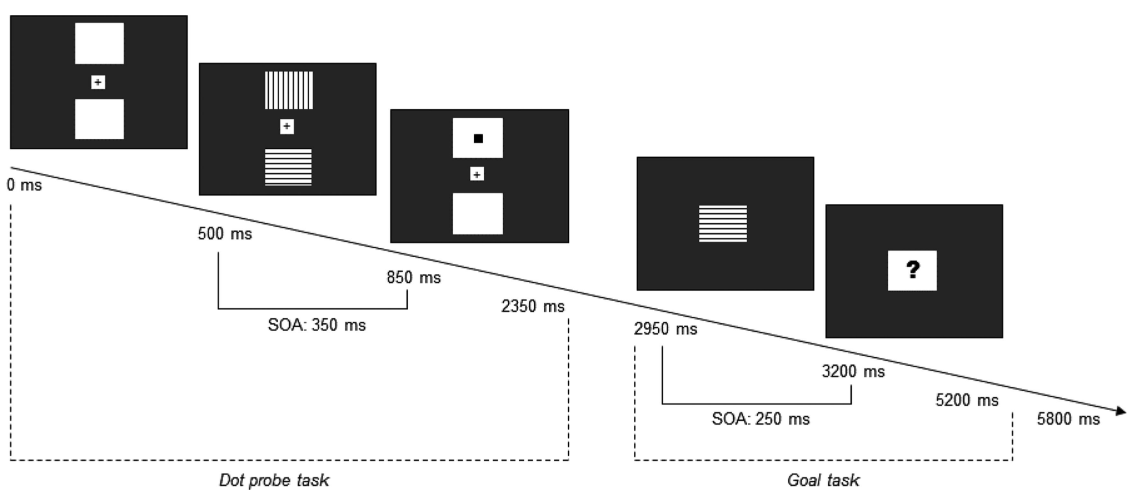


*Figure 1.* Schematic overview of a trial of the combined dot probe and goal tasks in the experiments. The first three boxes depict the dot probe task in which the presentation of two cues was followed by a probe (black square) that had to be localized. The last two boxes display the goal task in which the presentation of a single stimulus was followed by the appearance of a question mark. Participants had to react to the question mark by pressing the spacebar when the single stimulus presented was the goal-relevant stimulus. The cues for the dot probe task and the stimuli in the goal task consisted of threatening and neutral pictures in Experiments 1 and 2 and of colored patches in Experiment 3. In Experiment 3, cues for the dot probe task were presented for 250 ms. SOA = 250 ms.

(goal vs. neutral, threat vs. neutral) and one trial type with two threatening pictures (goal vs. threat). In contrast, the other condition (neutral goal-relevant picture) also had two trial types with a threatening versus a neutral picture (goal vs. threat, threat vs. neutral), but one trial type with two neutral pictures (goal vs. neutral). Therefore, we implemented neutral versus neutral trials in the condition with a threatening goal-relevant picture and threat versus threat trials in the condition with a neutral goal-relevant picture. Each picture category was presented on half of the trials in the upper cue location and on the other half in the lower cue location. For each picture category, the probe was presented on the location of pictures of that category on half of the trials.

There were 160 trials in the goal task. Each of the four pictures was presented in 30 trials. Therefore, there were 60 trials with threatening pictures and 60 trials with neutral pictures. In the remaining 40 trials, a filler picture was presented. Hence, goal and comparison pictures were presented equally often in the experiment [former expression unclear].

Trials of goal and dot probe tasks alternated. The intertrial interval was 600 ms. The order of the different trials of both tasks was determined randomly for each participant. The order of the dot probe task trials and the goal task trials was determined independently. Subsequently, the cue pictures that were presented in a dot probe trial were not predictive of the picture that would appear in the consecutive trial of the goal task.

## Results

Performance on the goal task was accurate (0.53% errors). Trials with errors in the dot probe task were removed from the data (2.78%). Reaction times (RTs) faster than 150 ms and slower than 1000 ms were considered outliers and discarded from the analyses (1.91%; cf. Koster et al., 2004).[1] To test the effect of goal-relevant and threatening pictures when presented with different types of comparison stimuli, we performed separate analyses of variance (ANOVAs) with congruence (congruent, incongruent) as within factor and with valence of the goal-relevant picture (neutral, threatening) as between factor. For trials with a goal-relevant picture, congruent trials are trials in which the probe replaced the goal-relevant picture, whereas incongruent trials are trials in which the probe replaced the comparison picture. For trials with a goal-irrelevant threatening picture and a goal-irrelevant neutral picture, congruent trials are trials in which the probe replaced the threatening picture, whereas incongruent trials are trials in which the probe replaced the neutral picture. Mean latencies and standard deviations of dot probe task responses can be found in Table 1.

We also calculated attentional bias indices for each trial type (see Table 1). For instance, an attentional bias index for goal-relevant pictures in trials comparing goal-relevant pictures to goal-irrelevant threatening pictures was calculated by subtracting mean RTs of trials congruent with the goal-relevant picture from the mean RTs of trials incongruent with the goal-relevant picture (i.e., the probe appeared on the former location of the threatening picture). A positive attentional bias index indicates selective attention for a specific type of information, in this case for goal-relevant pictures, whereas 0 indicates no attentional preferences. A negative attentional bias index indicates attentional avoidance. To test whether an index differed significantly from 0, we performed one-sample $t$ tests. Cohen's $d$ was calculated to determine whether the expected differences had a small (.20), medium (.50), or large (.80) effect size (Cohen, 1992).[2]

Table 1
*Mean Reaction Times and Standard Deviations as a Function of Trial Type and Congruence in Experiment 1*

| | Congruent[a] | | Incongruent[b] | | ABI[c] | |
|---|---|---|---|---|---|---|
| Trial type | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Threatening goal-relevant picture | | | | | | |
| Goal vs. neutral | 457 | 105 | 512 | 78 | 55 | 39 |
| Goal vs. threat | 468 | 89 | 514 | 80 | 46 | 30 |
| Threat vs. neutral | 490 | 73 | 495 | 94 | 5 | 55 |
| Neutral vs. neutral | 473 | 89 | 469 | 89 | −4 | 29 |
| Neutral goal-relevant picture | | | | | | |
| Goal vs. neutral | 476 | 56 | 530 | 78 | 54 | 37 |
| Goal vs. threat | 488 | 56 | 526 | 73 | 38 | 51 |
| Threat vs. neutral | 510 | 51 | 513 | 76 | 3 | 55 |
| Threat vs. threat | 506 | 59 | 506 | 54 | 0 | 38 |

*Note.* Reaction times in milliseconds. ABI = attentional bias index.
[a] Refers to trials in which the probe replaced the picture category first mentioned under trial type. [b] Refers to trials in which the probe replaced the picture category mentioned second under trial type. [c] Each ABI was calculated by subtracting reaction times on congruent trials from reaction times on incongruent trials.

The first ANOVA was performed on trials examining attention to goal-relevant pictures when presented simultaneously with neutral pictures. This analysis revealed a significant main effect of goal congruence, $F(1, 18) = 41.55$, $p < .001$. The interaction between goal congruence and valence of the goal picture was not significant, $F < 1$. The attentional bias index for goal-relevant pictures differed significantly from 0 ($M = 55$ ms, $SD = 37$), $t(19) = 6.66$, $p < .001$, $d = 1.49$. We also tested each condition (neutral goal-relevant picture, threatening goal-relevant picture) separately to determine whether the attentional bias index for goal-relevant pictures differed significantly from 0. This was the case in both conditions, goal-relevant neutral picture ($M = 54$ ms, $SD = 37$), $t(8) = 4.47$, $p < .003$, $d = 1.46$, goal-relevant threatening picture ($M = 55$ ms, $SD = 39$), $t(10) = 4.70$, $p < .002$, $d = 1.41$.

Of particular importance to this study were trials comparing goal-relevant pictures to threatening pictures. The analyses revealed a significant main effect of goal congruence, $F(1, 18) = 21.37$, $p < .001$. The interaction between goal congruence and valence of the goal picture was not significant, $F < 1$. The attentional bias index for goal-relevant pictures differed significantly from 0 ($M = 43$ ms, $SD = 40$), $t(19) = 4.79$, $p < .001$, $d = 1.27$, revealing a strong attentional bias to goal-relevant pictures on these trials. We again tested each condition (neutral goal-relevant picture, threatening goal-relevant picture) separately to determine whether the attentional bias index for goal-relevant

[1] The same results were obtained for all three experiments reported in the main text when the medians of the reaction times were used.

[2] We reanalyzed the data of all three experiments reported in the main text using Bonferroni corrections to control for multiple comparisons. All significant results remained significant when significance levels were adjusted.

pictures differed significantly from 0. Despite the small number of participants, the effect was virtually significant in the condition with a goal-relevant neutral picture ($M$ = 38 ms, $SD$ = 51), $t(8)$ = 2.25, $p$ = .055, $d$ = 0.75, and significant in the condition with a threatening goal-relevant picture ($M$ = 46 ms, $SD$ = 30), $t(10)$ = 5.17, $p$ < .001, $d$ = 1.55.

To test whether the attentional bias to goal-relevant pictures differed depending on the valence of the comparison picture (neutral, threatening), we performed an ANOVA on the two trial types examining attention to goal-relevant pictures (goal vs. threat, goal vs. neutral), with goal congruence (congruent, incongruent) and valence of comparison picture (threatening, neutral) as within factors and valence of the goal picture (threatening, neutral) as the between factor. This analysis revealed a significant main effect of goal congruence only, $F(1, 18) = 42.66$, $p < .001$. None of the other main effects or interactions were significant, $F$s < 1.73, $p$s > .206.

The fourth ANOVA was performed on trials comparing goal-irrelevant threatening pictures to goal-irrelevant neutral pictures, with threat congruence (congruent, incongruent) as the within factor and valence of the goal picture (neutral, threatening) as the between factor. Neither the main effect of threat congruence nor the interaction between threat congruence and valence of goal picture were significant, $F$s < 1. Hence, we did not find an attentional bias to threatening pictures on goal-unrelated trials.

Finally, we checked whether there were any effects in the filler trials (trials comparing the two goal-irrelevant threatening pictures for the participants having a neutral picture as goal-relevant picture; trials comparing the two goal-irrelevant neutral pictures for the participants having a threatening picture as goal-relevant picture). As expected, none of the ANOVAs performed on these trials revealed a significant effect, $F$s < 1.[3]

## Discussion

The results of this experiment showed that attention was deployed to pictures relevant to a temporary goal when these pictures were compared to neutral and when they were compared to threatening pictures. Whether the goal-relevant picture itself was threatening or neutral did not have a significant influence. On goal-unrelated trials, we did not find an attentional bias to threat.

Two factors might have limited the chance of a threat bias to counteract a bias toward goal-relevant stimuli. First, unselected participants took part in this experiment. Previous evidence has suggested that attention to threat is most pronounced in anxiety-prone individuals (for an overview, see Bar-Haim et al., 2007). For instance, Koster et al. (2007; see also, e.g., Mogg, Holmes, Garner, & Bradley, 2008; Yiend & Mathews, 2001) found a robust attentional bias toward threatening pictures comparable to the pictures used in our study only in highly trait-anxious individuals. To maximize the chance that a threat bias would emerge in Experiment 2, we only invited participants high in trait anxiety. Second, in the first experiment, we only used two threatening pictures. We did this so we could present all stimuli equally often. Although there are reasons to believe that attention to threatening events does not habituate (e.g., Öhman & Mineka, 2001), it is difficult to exclude the possibility that threatening pictures had little effect on attention because they were presented many times. To address this issue, we used 12 threatening pictures in Experiment 2. Finally, because we did not find any significant influence of the valence of the goal-relevant picture (i.e., whether it was neutral or threatening), we decided to use only neutral pictures as goal-relevant pictures.

# Experiment 2

## Method

**Participants.** Participants were recruited using an online screening survey, which was filled out by subjects registered in the online experiment scheduling system at Ghent University ($N$ = 1,458). One of the questionnaires in the survey was the trait anxiety scale of the State and Trait Anxiety Inventory (STAI-Trait, Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983; see also the following section). Students whose T-Anxiety scale scores were among the 25% highest scores ($N$ = 365) were invited to participate. The mean T-Anxiety scale score for the total sample in the screening survey was 40.68 ($SD$ = 10.94). In the actual study, 39 students (5 men; $M_{age}$ = 19.56 years, $SD$ = 1.87) volunteered and were paid €5. All participants had normal or corrected-to-normal vision and were naive to the purpose of the experiment. The mean T-Anxiety scale score of the participants at the time of the experiment was 48.38 ($SD$ = 8.59).

**Stimuli, materials, and procedure.** The experiment was identical to Experiment 1 except for the following changes. In Experiment 2, we used 12 threatening and 12 neutral pictures from the IAPS. The numbers of the IAPS pictures were: 1050, 1120, 1201, 1300, 1930, 6230, 6260, 6313, 6350, 6540, 6550, and 6560 (threatening pictures); and 5510, 7002, 7006, 7009, 7090, 7140, 7150, 7175, 7211, 7224, 7234, and 7550 (neutral pictures).

In each version of the experiment, one of the neutral pictures served as goal-relevant picture. Three of the neutral pictures could serve as goal-relevant picture (IAPS picture numbers 7009, 7140, and 7150). We counterbalanced among participants which of these three pictures served as the goal-relevant picture. The threatening pictures were rated as highly negative ($M$ = 2.68, $SD$ = 1.64) and highly arousing ($M$ = 6.93, $SD$ = 1.98) according to the normative

[3] This experiment was semireplicated in a sample of 16 highly (HTA) and low trait- anxious (LTA) individuals (seven HTA [six women], $M_{age}$ = 18 years, $SD$ = 1, T-Anxiety scale score: $M$ = 55, $SD$ = 8; nine LTA [8 women], $M_{age}$ = 23 years, $SD$ = 9, T-Anxiety scale score: $M$ = 28, $SD$ = 3). The same results were found. First, on trials comparing goal-relevant pictures to neutral pictures, we found a significant main effect of goal congruence only, $F(1, 12) = 4.82$, $p < .05$. The attentional bias index for goal-relevant pictures ($M$ = 44 ms; $SD$ = 58) differed significantly from 0, $t(15) = 3.01$, $p < .01$, $d = 0.88$. Most crucially, on trials presenting goal-relevant pictures in competition with threatening pictures, a significant main effect of goal congruence was found, $F(1, 12) = 8.51$, $p < .02$. The attentional bias index for goal-relevant pictures ($M$ = 49 ms; $SD$ = 51) differed significantly from 0, $t(15) = 3.81$, $p < .01$, $d = 0.96$. All other interactions, including those with trait anxiety (high, low) were not significant, $F$s < 1. Finally, analyses on trials comparing (goal-irrelevant) threatening pictures to (goal-irrelevant) neutral pictures revealed no significant effects, $F$s < 3.17, $p$s > .09. However, in this study, we presented in both conditions (neutral goal-relevant picture, threatening goal-relevant picture) trials comparing (goal-irrelevant) neutral pictures as fourth trial type. Hence, in this study, the presentation frequency of neutral and threatening pictures was not balanced between conditions.

IAPS ratings. On the ratings provided by Mikels et al. (2005), they belonged to the 25% most fear-evoking IAPS pictures. The pictures displayed a spider, attacking animals (snakes, dog, shark), human attack scenes, and aimed guns. The neutral pictures were selected in the same way as in Experiment 1 ($M_{valence} = 4.89$, $SD = 1.31$; $M_{arousal} = 2.98$, $SD = 1.99$). The majority of these pictures displayed different kinds of objects such as a lamp or a mug.

During the test phase, each type of probe trial (goal vs. threat, goal vs. neutral, threat vs. neutral) was presented 40 times, resulting in 120 trials of the dot probe task. In the 120 trials of the goal task, there were 30 trials per trial type (goal-relevant picture, threatening pictures, neutral pictures, filler pictures). We did not add threat versus threat trial types in this experiment in order to prevent habituation to the emotional value of the threatening pictures. It was randomly determined which picture of the threatening and neutral picture category was presented in a trial of dot probe task or goal task, but all pictures were presented equally often. To measure their trait anxiety score at the time of the experiment, participants filled in the T-Anxiety scale (Spielberger et al., 1983) after finishing the tasks. This questionnaire consisted of 20 short items (e.g., "I feel safe") that have to be rated on a 4-point scale (1 = *not at all* to 4 = *very often*).

## Results

Participants made few errors on the goal task (0.45% of all trials). We removed trials with errors in the dot probe trials from the data (2.82%). RTs faster than 150 ms and slower than 1000 ms were considered outliers and removed them from the data (1.43%). We performed three separate ANOVAs for the different trial types with congruence (congruent, incongruent) as the within factor. Again, for trials with a goal-relevant picture cue, congruence was coded as congruence to the goal-relevant picture. For trials comparing goal-irrelevant threatening pictures to goal-irrelevant neutral pictures, congruence was coded as congruence to the threatening pictures. Attentional bias indices were calculated as they had been in Experiment 1. These indices as well as means and standard deviations of dot probe task responses are found in Table 2.

The first ANOVA was carried out on trials comparing goal-relevant pictures to neutral pictures. We found a significant main effect of goal congruence, $F(1, 38) = 52.72$, $p < .001$, $d = 1.19$, revealing an attentional bias to goal-relevant pictures ($M = 42$ ms; $SD = 36$).

Of note, the second ANOVA was carried out on trials presenting goal-relevant pictures simultaneously with threatening pictures. The analysis revealed a significant main effect of goal congruence, $F(1, 38) = 50.03$, $p < .001$, $d = 1.14$, indicating an attentional bias to goal-relevant pictures in comparison to threatening pictures ($M = 41$ ms; $SD = 36$).

To test whether the attentional bias to goal-relevant pictures differed depending on the comparison picture (neutral, threatening), we performed an ANOVA on the two trial types examining attention to goal-relevant pictures (goal vs. threat, goal vs. neutral) with goal congruence (congruent, incongruent) and valence of comparison picture (threatening, neutral) as within factors. This analysis revealed a significant main effect of goal congruence only, $F(1, 38) = 64.33$, $p < .001$. Neither the main effect of valence of the comparison picture nor the interaction between goal congruence and valence of the comparison picture were significant, $Fs < 2.34$, $ps > .134$.

Finally, an ANOVA was performed on trials comparing goal-irrelevant threatening pictures to goal-irrelevant neutral pictures with threat congruence (congruent, incongruent) as the within factor. The main effect of threat congruence was not significant, $F < 1.98$, $p > .167$. Hence, we did not find an attentional bias to threat on goal-unrelated trials.

Table 2
*Mean Reaction Times and Standard Deviations as a Function of Trial Type and Congruence in Experiment 2*

| | Congruent[a] | | Incongruent[b] | | ABI[c] | |
|---|---|---|---|---|---|---|
| Trial type | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Goal vs. neutral | 471 | 75 | 513 | 75 | 42 | 36 |
| Goal vs. threat | 476 | 71 | 517 | 77 | 41 | 36 |
| Threat vs. neutral | 516 | 72 | 509 | 72 | −7 | 30 |

*Note.* Reaction times in milliseconds. ABI = attentional bias index.
[a] Refers to trials in which the probe replaced the picture category first mentioned under trial type. [b] Refers to trials in which the probe replaced the picture category mentioned second under trial type. [c] Each ABI was calculated by subtracting reaction times on congruent trials from reaction times on incongruent trials.

## Discussion

The results of this experiment replicated the findings of Experiment 1: Attention was deployed to pictures relevant to the induced temporary goal when these pictures were compared to neutral, and also when they were compared to threatening pictures. This was the case although participants were highly trait-anxious individuals and although we used a wider range of threatening pictures. On trials unrelated to the temporary goal, we did not find an attentional bias to threat.

The latter result corresponds with studies that have shown that the attentional bias to threatening pictures is eliminated when cognitive resources are absorbed (Pessoa et al., 2002; Van Dillen & Koole, 2009). Van Dillen and Koole (2009), for instance, found that attentional interference by angry faces was erased when working memory was loaded by letting participants remember complex information during the interference task. Keeping goal-relevant information active in the present study probably required considerably cognitive resources (Smith & Jonides, 1999). It is unlikely, however, that our results are due merely to the load imposed by the goal task, because the task eliminated only the attentional bias to threatening pictures while actually installing an attentional bias to goal-relevant pictures. The findings also correspond to findings suggesting that individuals high in dispositional attentional control do not show an attentional bias to threat (Derryberry & Reed, 2002; Peers & Lawrence, 2009; see also Bishop, 2009). The temporary goal of our task might have a similar effect as high dispositional attentional control because it appears to control the attentional deployment and, by this, prevents attentional capture by threatening but goal-irrelevant information.

Moreover, the so-called threatening pictures in Experiments 1 and 2 were merely proxies for actual threat, whereas the stimuli related to the temporary goal were stimuli that were actually rewarded.[4] Hence, the fact that attention was directed to goal-relevant stimuli rather than to threatening pictures might not be due to a difference between temporary goals and motives but to the degree to which the stimuli are related to that goal or motive (i.e., displaying actual goal-relevant stimuli or proxies of relevant stimuli). To exclude this alternative explanation of the results, we ran a third experiment in which the threatening stimuli posed an actual threat to the participants. More specifically, we used stimuli signaling a *real* and *imminent* threat (i.e., an aversive noise). Previous work has demonstrated that these stimuli evoke a strong and robust attentional bias even in normal individuals (e.g., Koster et al., 2004; Van Damme, Crombez, & Notebaert, 2008). Moreover, in this experiment, participants could not win points in the goal task.

To test this idea, one stimulus (conditioned stimulus, CS+) was fear-conditioned during the goal task using an aversive white noise (unconditioned stimulus, UCS). In the dot probe task, we presented trials comparing the CS+ to a neutral stimulus (CS−) and trials presenting the CS+ together with a goal-relevant stimulus. The CS− did not require a reaction in the goal task and was never followed by an aversive noise. The goal-relevant stimulus required a reaction in the goal task. We also used trials comparing the goal-relevant stimulus to the CS− in the dot probe task. We presented the cue stimuli only for 250 ms in the dot probe task in order to measure even earlier attentional processes.

## Experiment 3

### Method

**Participants.** A sample of 27 students (22 women; $M_{\text{age}} = 20.31$ years, $SD = 4.41$) at Ghent University received €5 for participating in the experiment. All participants had normal or corrected-to-normal vision and were naive as to the purpose of the experiment.

**Apparatus, materials, and stimuli.** The experiment remained the same, except for the following changes. Three colored patches (pink, yellow, and orange) were used as the goal-relevant stimulus, the threatening stimulus (CS+), and the neutral stimulus (CS−). These stimuli were matched for luminance using ImageJ software (U.S. National Institutes of Health). The function of the patches was counterbalanced between subjects. Additionally, 18 filler stimuli were used in the goal task. We used filler stimuli to present the relevant stimuli (CS+, CS−, and goal stimulus) less often, to prevent habituation to the CS+. These filler stimuli consisted of seven colored patches and 11 neutral pictures from the IAPS. The colors were three shades of green, two shades of brown, and two shades of gray. The IAPS numbers were: 7002, 7006, 7009, 7090, 7140, 7150, 7175, 7211, 7224, 7234, and 7550.

In the dot probe task, cue stimuli were presented for 250 ms. In the goal task, 50% of the trials presenting the CS+ were followed by a 460-ms white-noise burst delivered through a headphone at an intensity of 95 dBA (cf. Koster et al., 2004; Van Damme et al., 2008). The onset of the UCS was simultaneous with the onset of the question mark.

**Procedure.** At first, participants practiced only the dot probe task, in two practice phases of 12 trials and 144 trials, respectively. No significant results were found in the second practice phase, $F$s $< 2.49$, $p$s $> .127$. Thereafter, participants were introduced to the goal task. At first, they were informed that one colored patch would sometimes be followed by an unpleasant noise, and that this noise would never be presented after another stimulus. This information was followed by 6 practice trials. Participants were instructed to find out which color could be followed by the UCS. After this phase, they were informed that after another colored patch, they were required to press the spacebar. These instructions were followed by another 15 practice trials. The CS+, the CS−, and the goal-relevant stimulus were all presented five times during these two phases and three times the CS+ was followed by the UCS. In the remaining six trials, filler stimuli were presented. Then, participants exercised the combined procedure of the dot probe and goal tasks in 24 practice trials. These were 12 trials of the goal task and 12 trials of the dot probe task. In the dot probe task, each trial type (CS+ vs. CS−, CS+ vs. goal-relevant stimulus, goal-relevant stimulus vs. CS−) was presented four times. In the goal task, each stimulus (CS+, CS−, goal-relevant stimulus) was presented two times. The remaining six trials were filler trials.

During this phase, the CS+ was on one occasion followed by the UCS. In the test phase, each of the three trial types was presented 48 times, resulting in 144 trials of the dot probe task. Each of the three stimulus categories was presented in half of the trials in the upper cue location and in the other half in the lower cue location. For each stimulus category, the probe was presented in the location of a stimulus of that category in half of the trials.

There were 144 trials in the goal task. The CS+, CS−, and goal-relevant stimulus were each presented on 24 trials. The CS+ was followed by the UCS on 12 trials. The remaining 72 trials were filler trials. The intertrial interval between the two tasks was 700 ms.

After the experiment, participants had to indicate how threatening (1 = *not at all* to 7 = *very much*), unpleasant (1 = *not at all* to 7 = *very much*), and controllable (1 = *not at all* to 7 = *very much*) the noise was. They also indicated in how much they expected the presentation of a noise after the appearance of CS+, CS−, and goal color patch (1 = *never* to 7 = *always*), and how afraid they were during the presentation of CS+, CS−, and goal color patch (1 = *not at all* to 7 = *very much*).

### Results

**Manipulation checks and goal task.** Participants described the noise as threatening ($M = 4.37$, $SD = 1.57$), unpleasant ($M = 5.63$, $SD = 1.33$), and uncontrollable ($M = 2.04$, $SD = 1.43$). They reported expecting the presentation of the noise after the appearance of a CS+ color patch ($M_{\text{CS+}} = 5.04$, $SD = 1.32$) but not after a CS− or a goal color patch ($M_{\text{CS−/goal}} = 1.54$, $SD = 0.83$), $t(26) = 10.71$, $p < .001$; they also reported that they were afraid during the presentation of the CS+ color patch ($M_{\text{CS+}} = 4.41$, $SD = 1.78$), but not during the presentation of the CS− or a goal color patch ($M_{\text{CS−/goal}} = 1.30$, $SD = 0.56$), $t(26) = 9.38$, $p <$

[4] We are grateful to an anonymous reviewer for pointing out this possibility.

.001. This indicates that conditioning was successful.[5] On the goal task, participants made errors on 0.77% of the trials.

**Dot probe task.** Trials with errors in the dot probe task were removed from the data (2.37%). RTs faster than 150 ms and slower than 1000 ms were considered outliers and removed from the data (1.08%). We performed three separate ANOVAs for the different trial types with congruence (congruent, incongruent) as the within factor. For trials with the goal-relevant stimulus as cue, congruence was coded as congruence to the goal-relevant stimulus. For trials comparing the CS+ to CS−, congruence was coded as congruence to the CS+ (threat congruence). Means and standard deviations of dot probe task responses can be found in Table 3.

We first analyzed the trials presenting the goal-relevant stimulus, together with the CS−. The analysis revealed a significant main effect of goal congruence, $F(1, 26) = 34.68$, $p < .001$, $d = 1.14$, demonstrating an attentional bias to goal-relevant stimuli ($M = 47$ ms, $SD = 41$).

The second ANOVA was performed on trials comparing the goal-relevant stimulus with the CS+. We found a significant main effect of goal congruence, $F(1, 26) = 19.56$, $p < .001$, $d = 0.83$, revealing an attentional bias to goal-relevant stimuli when compared to the CS+ ($M = 37$ ms, $SD = 44$).

We also performed an ANOVA on the two trial types examining attention to the goal-relevant stimulus (goal vs. CS+, goal vs. CS−) with goal congruence (congruent, incongruent) and comparison stimulus (CS+, CS−) as within factors. This analysis revealed a significant main effect of goal congruence only, $F(1, 26) = 35.40$, $p < .001$. The interaction between goal congruence and comparison stimulus and the main effect of comparison stimulus was not significant, $F$s $< 1.2$. This demonstrates that the attentional bias to the goal-relevant stimulus did not differ between the comparison stimuli.

We then analyzed the trials comparing the CS+ to the CS−, with threat congruence (CS+ congruent, CS+ incongruent) as the within factor. The analyses showed a significant main effect of threat congruence, $F(1, 26) = 8.25$, $p < .010$, $d = 0.55$. Hence, there was an attentional bias to the CS+ when this stimulus was presented simultaneously with the CS− ($M = 18$ ms, $SD = 33$). Finally, we performed an ANOVA on the two trial types examining attention to the CS+ (CS + vs. goal-relevant stimulus, CS+ vs. CS−) with threat congruence (CS+ congruent, CS+ incongruent) and comparison stimulus (goal-relevant stimulus, CS−) as within factors. As expected, this ANOVA showed a significant interaction between threat congruence and comparison stimulus, $F(1, 26) = 36.80$, $p < .001$. The main effects of threat congruence and comparison stimulus were not significant, $F$s $< 2.75$, $p$s $>$ .108. Summing up, this experiment demonstrated that attention is deployed to a signal of imminent threat when this stimulus is presented with a neutral event. However, when the threatening stimulus is presented simultaneously with a goal-relevant event, attention is deployed to the goal-relevant event.

Table 3
*Mean Reaction Times and Standard Deviations as a Function of Trial Type and Congruence in Experiment 3*

| | Congruent[a] | | Incongruent[b] | | ABI[c] | |
|---|---|---|---|---|---|---|
| Trial type | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Goal vs. CS− | 382 | 75 | 429 | 67 | 47 | 41 |
| Goal vs. CS+ | 388 | 76 | 425 | 66 | 37 | 44 |
| CS+ vs. CS− | 396 | 68 | 414 | 71 | 18 | 33 |

*Note.* Reaction times in milliseconds. ABI = attentional bias index; CS+ = conditioned stimulus; CS− = neutral stimulus.
[a] Refers to trials in which the probe replaced the stimulus category first mentioned under trial type. [b] Refers to trials in which the probe replaced the stimulus category mentioned second under trial type. [c] Each ABI was calculated by subtracting reaction times on congruent trials from reaction times on incongruent trials.

## General Discussion

The aim of the present study was to examine whether attention would be oriented to stimuli relevant to a temporary goal when goal-relevant and threatening events were presented simultaneously. The results of Experiment 1 revealed that goal-relevant events evoke an attentional bias in the presence of neutral and threatening information. Moreover, the valence of the comparison picture (threatening or neutral) or the valence of the goal-relevant picture (threatening or neutral) did not influence the magnitude of the attentional bias to goal-relevant pictures. Experiment 2 replicated and extended these findings by showing that attention was oriented to goal-relevant stimuli rather than to threatening stimuli in a sample of highly trait-anxious individuals and with a variety of threatening pictures. Finally, Experiment 3 demonstrated that attention prioritizes goal-relevant events in the presence of stimuli signaling imminent threat (i.e., a color patch signaling the presentation of an aversive noise).

These results extend the growing evidence demonstrating that attention is biased toward events relevant to the temporary and current goals of an individual (e.g., Folk et al., 1992; Moskowitz, 2002). The existing findings showed, for example, that attention is rapidly and unintentionally allocated to goal-relevant events (Folk et al., 1992; Vogt et al., 2010; Vogt, De Houwer, & Moors, 2011), even when participants are currently engaged in a different task (Rothermund, 2003) or when the goal is only unconsciously active (Moskowitz, 2002). The present findings revealed that the attentional bias to goal-relevant events is also pervasive and robust. We examined whether attention is still biased toward information relevant to a temporary goal when this information is presented in competition with other stimuli that are known to demand attention, namely, threatening events. Predominant accounts of attention to threat (Bradley, 2009; Kenrick et al., 2010; LoBue et al., 2010; Öhman et al., 2001; Öhman & Mineka, 2001) would predict that threatening information always receives priority because rapidly reacting to this information could guarantee survival. Hence, these accounts predict that attention would not be allocated to goal-relevant stimuli when these stimuli compete with threatening events. Contrary to this prediction, our results showed that attention prioritizes stimuli relevant to a temporary goal, even in the presence of threat. These results indicate that the current and temporary goals of an individual are essential in the automatic deployment of attention.

[5] An anonymous reviewer suggested that the conditioning might have been even more powerful if the CS+ color patch and the aversive noise had been presented in parallel. CS+ = conditioned stimulus

Our results have important implications for theories about attention to threat. Foremost, they suggest that the attentional bias to threat is not fully automatic and unconditional as it is implied by prominent accounts (e.g., Bradley, 2009; LoBue et al., 2010; Mogg & Bradley, 1998; Öhman & Mineka, 2001; Öhman et al., 2001; Pratto & John, 1991). Öhman et al., for instance, suggested in their seminal study that attention to threat is driven by a passive attentional system (i.e., a hard-wired threat module) that scans the environment for potential dangers in a "preattentive, fast and automatic" manner (2001, p. 466). This implies that the presence of threatening information interrupts all ongoing activity and that attention to threat is not constrained by the currently pursued goals. In contrast, the present results demonstrate that attention to threat is not automatic in the sense of goal independent. For this reason, our findings add to existing evidence that has shown that attention to threat is not efficient or fast (e.g., Horstmann, Becker, Bergmann, & Burghaus, 2010; Notebaert et al., 2011; Pessoa et al., 2002; Yates et al., 2010).

The present evidence also implies that automatic attention to threat does not need to be caused by a hard-wired or threat-specific mechanism (e.g., a fear module that activates attentional resources when threat is encountered) but could or has to be caused by top-down factors such as the current goals of an individual. Supporting this assumption, Pessoa and Adolphs (2010) recently reviewed evidence showing that the (automatic) processing of emotional events depends heavily on cortical structures. Moreover, several studies found preferred attention to threatening information only when the emotional value of threatening stimuli was relevant to the task goal (Hahn & Gronlund, 2007; Pecchinenda, Pes, Ferlazzo, & Zoccolotti, 2008; Simons & Chabris, 1999; Stein et al., 2009; Van Dillen et al., 2011; see also Cunningham, Van Bavel, & Johnsen, 2008). Our results further underscore the importance of temporary goals, by demonstrating that it is not only the grouping of threat and relevance to a temporary goal that attracts attention but also that goal relevance on its own is sufficient, even in the context of real and imminent threats and even when highly trait-anxious individuals are tested. In a related vein, Wells and Matthews (1994; see also Vogt, Lozo, Koster, & De Houwer, 2011) suggested that attention to threat in anxiety is caused by the threat-related plans and goals of anxious individuals (e.g., to monitor the environment for potential threats). Most researchers have rejected this hypothesis because goal-directed attention was supposed to be limited to the strategic deployment of attention and therefore assumed to be nonautomatic per se (i.e., voluntary, effortful, slow, and conscious; e.g., Mathews & Mackintosh, 1998). In contrast, the existing evidence demonstrates that a dichotomy of attention into strategic and automatic processes is insufficient (cf. Moors & De Houwer, 2006; Vuilleumier & Huang, 2009). Instead, attention can hold features of both automatic and strategic processes. For instance, attending to goal-relevant events is strategic in the sense that it depends on the presence of a goal. In contrast, it appears to be automatic in the sense that it can emerge in a fast, unintentional, efficient, and unconscious manner (Ansorge et al., 2009; Folk et al., 1992; Moskowitz, 2002; Rothermund, 2003; Vogt et al., 2010; Vogt, De Houwer, & Moors, 2011). Consequently, (threat-related) goals could underlie attentional bias to threat.

## Study Limitations

The present research has limitations that should be addressed in future research. One pathway for future research could be to extend the present findings to even more variants of threatening information. For instance, future studies could use specific types of threatening stimuli such as phobic objects. Some studies suggest that, to find an effect of anxiety, the content of the presented threatening information needs to match the source of the anxiety (e.g., snake phobics display an attentional bias to snakes but not to more generally threatening information; see, e.g., Mathews & Sebastien, 1993; Van Strien, Franken, & Huijding, 2009). Future research could also vary the characteristics or the content of the implemented temporary goals. For instance, in Experiments 1 and 2, we induced approach-oriented goals (e.g., participants were instructed to *gain* a certain amount of points). The effects of temporary goals might be different for avoidance-oriented goals (e.g., avoiding *losing* a certain amount of points; see Higgins, 1997; Rothermund, Voss, & Wentura, 2008). Moreover, in Experiment 1 (see also footnote 2), we investigated the effects of stimuli that are relevant to the temporary goal and, at the same time, threatening. We did not find any additional influence of this manipulation. Future research could nevertheless further investigate this possibility, because our experiments might not have had enough power to reveal such probably subtle effects. Finally, we think that it is useful to study in more detail the automaticity of the present effects. The current data suggest that our effects were automatic in the sense of fast because we observed the effect with a cue presentation time of 350 ms (Experiments 1 and 2) or 250 ms (Experiment 3). These presentation times are short, given that prior studies using dot probe paradigms typically presented stimuli for 500 ms (see Bar-Haim et al., 2007). However, future research could investigate the attentional deployment when even shorter cues are presented. Furthermore, our data suggest that attention to goal-relevant events, as measured in the dot probe task, was unintentional because neither was attending to goal-relevant stimuli in the dot probe task instrumental for the goal task nor were goal-relevant or comparison stimuli predictive of the probe location. Future research could extend these findings to other features of automatic processes (cf. Moors & De Houwer, 2006), for instance, by investigating how attention is deployed when stimuli are presented subliminally.

## Conclusion

The present study showed that attention is oriented to events relevant to temporary goals when presented simultaneously with threatening events. Our results have important implications for understanding the manner in which temporary goals bias attention and the conditions under which attention is allocated to threatening stimuli. We hope our findings will encourage researchers to further examine the influence of goals on the automatic allocation of attention.

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