

BRIEF REPORT

Priming a natural or human-made environment directs attention to context-congruent threatening stimuli

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Research suggests that attention is attracted to evolutionary threats (e.g., snakes) due to an evolved “fear-module” that automatically detects biological threats to survival. However, recent evidence indicates that non-evolutionary threats (e.g., guns) capture and hold attention as well, suggesting a more general “threat-relevance” mechanism that directs attentional resources toward any potential danger in the environment. The current research measured how selective attentional resources were influenced both by the type of threat (e.g., snake vs. gun) and by the context in which the threat was encountered. Participants were primed with either natural or human-made environments to assess how these contexts influence attention to evolutionary and non-evolutionary threats, as measured by a spatial-cueing task. The results indicate that whether biological or non-biological threats receive greater attentional processing is determined by the context in which they are encountered.

Keywords: Evolutionary psychology; Attention; Threat.

Processing potentially threatening objects in the environment is a critical cognitive operation. Research has revealed the efficiency with which this operation is conducted, as potential dangers quickly engage attentional resources (e.g., Öhman & Mineka, 2001). For example, snakes and spiders (e.g., Öhman, Flykt, & Esteves, 2001), angry faces (e.g., Öhman, Lundqvist, & Esteves, 2001), and sources of possible pathogen infection are swiftly detected and processed (e.g., Ackerman

et al., 2009; Fox, Russo, & Dutton, 2002). This preferential devotion of selective attention to such objects has been attributed to an evolved “fear module” that efficiently detects common dangers in human ancestral environments, resulting in a “biological preparedness” to attend to such threats (e.g., Öhman & Mineka, 2001; Seligman, 1971).

However, additional research suggests that the range of objects that have attentional privilege is broader than biologically threatening stimuli. For

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example, just as snakes and spiders are noticed quickly, so too are contemporary threats that evoke fear, such as guns and knives (Blanchette, 2006; Brosch & Sharma, 2005; Carlson, Fee, & Reinke, 2009; Fox, Griggs, & Mouchlianitis, 2007). Results such as these have been taken as support for a more domain-general mechanism that is capable of directing attention to both evolutionary and human-made threats (Blanchette, 2006). Beyond this, recent evidence suggests that attentional resources are rapidly directed toward *any* situationally relevant stimuli and not only dangerous or negative stimuli, underscoring that attentional resources are part of a broad and flexible *relevance-detection* mechanism (e.g., Brosch, Sander, Pourtois, & Scherer, 2008; Schimmack, 2005; Vogt, Lozo, Koster, & De Houwer, 2011).

Consistent with this relevance-detection perspective, many theories stipulate that emotional reactions to stimuli serve to guide attention and behaviour in appropriate ways (e.g., Brosch, Sander, & Sharma, 2007; Clore, Gasper, & Garvin, 2001), therefore any object that induces an affective reaction should hold sway over attentional resources. For example, beverage-related constructs are highly accessible for thirsty participants (Aarts, Dijksterhuis, & De Vries, 2001) and words relevant to high-value and attainable goals engage attention (Vogt, De Houwer, & Crombez, 2011). Relatedly, in a shooter-bias paradigm (e.g., Correll, Park, Judd, & Wittenbrink, 2002) the perception of angry faces facilitates discrimination between weapons and non-weapons (Baumann & DeSteno, 2010). Such findings indicate that situational factors such as the perceiver's goals (e.g., finding a drink), motives (e.g., goal pursuit) and the environmental context (e.g., angry expressions) guide attentional resources by fixing attention on currently relevant stimuli (e.g., Yantis, 1996).

The current research

With this in mind, the present experiment tested situational factors that might influence the comparative relevance of evolutionary or modern

threats. More specifically, the relevance-detection framework (e.g., Brosch et al., 2008; Fox et al., 2007; Vogt et al., 2011) and multiple theories of emotion (e.g., Clore et al., 2001; Keltner et al., 2006) predict that situational factors should determine the particular stimuli that demand attention. Thus, contexts that render evolutionarily based threats more important should produce an attentional bias for evolutionarily relevant stimuli (e.g., snakes, spiders) compared to human-made threats (e.g., guns, knives). Contrariwise, contexts that render human-made threats most relevant should produce the opposite effect: an attentional bias for human-made threats relative to evolutionary threats.

To test these predictions, participants engaged in a backward-masked spatial-cueing procedure, where both attention allocation and attentional disengagement were measured by reaction-time (RT) to locate a probe that appeared on a computer monitor shortly after the presentation of a threatening stimulus. These stimuli were either evolutionarily based (e.g., snakes, spiders) or contemporary, non-evolutionary objects (e.g., guns, knives). Each threatening stimulus was preceded by a context prime, which was either a picture of a natural environment (e.g., forest, wooded path) or a modern urban context (e.g., city sidewalk, city street). If the situational relevance of a stimulus determines attentional effects (e.g., Brosch et al., 2008; Vogt et al., 2011), then attention should be most engaged by threatening stimuli when the prime context and threatening stimuli are congruent (e.g., nature prime and evolutionarily based threat).

METHOD

Participants

Sixty-two university students participated in the experiment in exchange for course credit.

Procedure

Participants arrived at the lab in groups of one to five although they always completed the

experiment at individual computer workstations. Participants were informed via the computer that they were participating in an experiment about attention and that they would complete a task in which they would first see various pictures presented rapidly on the computer screen, after which they would see an asterisk (*) on the screen and indicate its location (left or right) using the control keys (Ctrl) on the keyboard.

On each trial, a fixation point appeared at the centre of the screen for 1,000 ms. Then, one of 12 context primes (six images each of natural and human-made contexts, respectively) was shown randomly in the centre of the screen.¹ The natural context contained images of outdoor wooded scenes and hiking trails. The human-made contexts depicted city streets and other urban environments. Each context image was displayed in colour, sized to 350 × 350 pixels, and presented for 2,000 ms. Immediately following the prime, one of 12 target stimuli (6 evolutionary threats, 3 snakes, 3 spiders; 6 non-evolutionary threats, 3 guns, 3 knives) was presented randomly on the left or right side of the screen for 33 ms. The threatening stimulus images were sized to 350 × 350 pixels and taken from the International Affective Picture System database (Lang, Bradley, & Cuthbert, 1999).² Directly after the presentation of the target stimulus, a backward-mask replaced the target stimulus. The mask was one of 12 random patterns of Gaussian noise sized to 350 × 350 pixels and remained on screen for 100 ms. Lastly, an asterisk (probe) sized to 25 × 25 pixels appeared either on the same side or on the opposite side of the screen as the prime and target and remained on screen until participants responded. The location of the probe created two unique trial types: valid (same location) and invalid (opposite location).

The pairing of prime and threatening target stimulus was randomised, with the constraint that

each prime image preceded the presentation of both evolutionary and non-evolutionary threats during valid and invalid trials an equal number of times. This produced the four following prime–stimulus pairs: (1) natural prime–evolutionary threat; (2) natural prime–non-evolutionary threat; (3) human-made prime–evolutionary threat; and (4) human-made prime–non-evolutionary threat. For each of these four prime–stimulus pairs, participants completed 36 valid and 36 invalid trials for a total of 288 trials.

Importantly, the use of valid and invalid trials presents theoretically important constraints on data analysis and interpretation. In brief, some past research has construed valid trials as a measure of attentional engagement (i.e., faster responses to the probe indicate that the participants were attending to the previously displayed images) and invalid trials as a measure of attentional disengagement (i.e., slower responses indicate participants were removing their attention from the location of the previously displayed target stimulus to the probe, e.g., Fox et al., 2007). However, this interpretation has been challenged by evidence suggesting that threatening stimuli influence reaction times through multiple co-acting processes, including motor response slowing and attention cueing effects (e.g., Mogg, Holmes, Garner, & Bradley, 2008). According to Mogg and colleagues, disentangling attentional engagement and disengagement effects is challenging because of motor response slowing (i.e., threatening stimuli can delay RTs by slowing motor reactions even if attention is not affixed to the threatening stimuli). This phenomenon can result in engagement effects being underestimated and disengagement effects being overstated. To control for these co-acting influences on response times, Mogg and colleagues recommend calculating cue validity indices by subtracting RTs on valid trials from invalid RTs

¹We conducted a pre-test of the context images to ensure they were not differentially threatening. To do so, 20 participants were asked to rate “how threatening is the scene depicted in this image” for each context on a 1–7 scale (high numbers indicating greater threat ratings). The results found that nature contexts ($M = 1.85$, $SD = 1.31$) and human-made contexts ($M = 2.20$, $SD = 1.32$) did not differ, $t(19) = 1.20$, $p = .25$.

²IAPS images: evolutionary: 1050, 1080, 1090, 1200, 1220, 1240; non-evolutionary: 6260, 6300, 6350, 6550, 6610, 6800.

$(RT_{\text{invalid}} - RT_{\text{valid}})$ to create a general measure of attentional deployment.

Following their precedent, we employed the same analytic strategy in the current work by creating cue validity indices for each context prime type and for each threat type, resulting in the following validity indices: (1) natural prime–evolutionary threat $RT_{\text{invalid}} - \text{natural prime–evolutionary threat } RT_{\text{valid}}$; (2) natural prime–non-evolutionary threat $RT_{\text{invalid}} - \text{natural prime–non-evolutionary threat } RT_{\text{valid}}$; (3) human-made prime–evolutionary threat $RT_{\text{invalid}} - \text{human-made prime–evolutionary threat } RT_{\text{valid}}$; (4) human-made prime–non-evolutionary threat $RT_{\text{invalid}} - \text{human-made prime–non-evolutionary threat } RT_{\text{valid}}$. Within the context of this analytic procedure, positive RT values indicate a greater attentional bias toward a given stimulus type following the different context primes (e.g., Mogg et al., 2008). Thus, we predicted greater attentional deployment in the form of longer RTs on trials where context and target stimuli matched (e.g., we expected to observe larger RT values on natural prime–evolutionary threat trials compared to natural prime–non-evolutionary threat trials).

RESULTS

Prior to calculating cue validity scores and conducting analyses, RTs on error trials were removed as were those more than 2.5 standard deviations from each participant's mean RT (<5% of the all

trials). The remaining RTs were then transformed as described above and submitted to a 2 (Prime Type: nature, urban) \times 2 (Threat Type: evolutionary, non-evolutionary) repeated-measures analysis of variance (ANOVA).³ This revealed no main effects of Prime Type, $F(1, 61) = 1.48, p = .23$, or Threat Type, $F(1, 61) < 1, p = .94$, but did reveal a significant interaction, $F(1, 61) = 9.22, p < .01$ (see Figure 1).

To interpret this interaction, we compared RTs within each type of prime context (natural vs. human-made). Following nature primes, paired sample *t*-tests found that participants showed greater attentional deployment for evolutionary threats ($M = 10.9, SD = 31$) than non-evolutionary threats ($M = -0.23, SD = 35$), $t(61) = 2.16, p = .038, d = 0.62$. However, following urban primes, attentional deployment was more notable for non-evolutionary ($M = 15.97, SD = 42$) than evolutionary threats ($M = 5.22, SD = 43$), $t(61) = -2.01, p = .049, d = -0.51$.

To summarise, the extent to which attention was deployed in response to threatening stimuli was contingent not on the type of threat but on the match between the threat (evolutionary or human-made) and the context in which participants encountered the threat. Specifically, context-congruent threats (e.g., a gun shown after a cityscape) were attended to more than context-incongruent threats (e.g., a gun shown after a nature scene). Overall, these results follow predictions derived from relevance-detection models of attention (e.g., Brosch et al., 2008; Vogt et al., 2011).

³The analytic strategy reported in the main text was recommended by an anonymous reviewer. Given that numerous other researchers have explored separate effects on valid and invalid trials, we also conducted analyses with this factor included in the model. The associated 2 (Prime Type: nature, urban) \times 2 (Threat Type: evolutionary, non-evolutionary) \times 2 (Trial Type: valid, invalid) repeated-measures ANOVA revealed a three-way interaction, $F(1, 61) = 6.05, p = .02$. We next conducted separate 2 (Context Prime) \times 2 (Threat Type) ANOVAs for RTs on valid and invalid trials. For valid trials, the 2 \times 2 ANOVA revealed no significant effects of Prime Type, $F(1, 61) = 1.92, p = .17$, or Threat Type, $F(1, 61) < 1, p = .47$, and no interaction between these two factors, $F(1, 61) < 1, p = .64$. However, for invalid trials, the 2 \times 2 ANOVA produced a significant interaction, $F(1, 61) = 12.33, p < .01$. Follow-up paired-sample *t*-tests found that participants in the natural prime were slower to disengage from evolutionary threats ($M = 411, SD = 79$) than from non-evolutionary threats ($M = 402, SD = 68$), $t(61) = 2.43, p < .05$. However, following urban primes, participants were slower to disengage from non-evolutionary ($M = 415, SD = 79$) than evolutionary threats ($M = 404, SD = 66$), $t(61) = -2.01, p < .05$. Granting caution in interpreting these results (e.g., Mogg et al., 2008) these findings suggest that the effects of stimuli relevance were limited to attentional disengagement, which is consistent with other work (e.g., Ackerman et al., 2009; Fox et al., 2007; Maner et al., 2003).

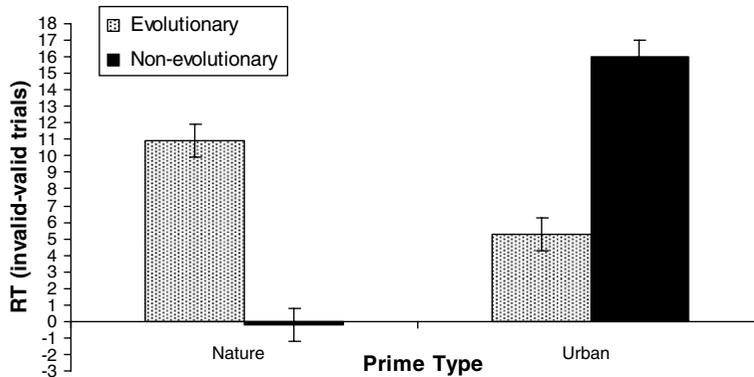


Figure 1. Reaction times by prime type (error bars represent standard error of the mean).

DISCUSSION

Contending with potential threats in the environment requires the functional deployment of selective attention. Indeed, a large literature documents the dramatic attentional effects of threatening stimuli, such as snakes and spiders (e.g., Öhman et al., 2001). Influential theories have proposed that these attentional effects are the result of certain stimuli presenting evolutionarily recurrent survival threats, resulting in a biological “preparedness” to process such dangers (Öhman & Mineka, 2001; Seligman, 1971). However, other research indicates that non-evolutionary threats (e.g., Blanchette, 2006; Fox et al., 2007) and goal-relevant *positive* stimuli have equivalent effects on attention (Brosch et al., 2008; Schimmack, 2005; Vogt et al., 2011). These latter findings suggest the existence of a more domain-general “relevance-detection” system that directs attentional resources toward any situationally compelling stimuli. Consistent with this domain-generalised attention system, even non-threatening stimuli that are congruent with perceivers’ current goals and motives direct and hold attention (e.g., Yantis, 1996).

The current research was designed to explore how attention deployment to evolutionary or non-evolutionary threats is sensitive to contextual manipulations. To do so, we had participants engage in a spatial-cueing procedure. On a trial-by-trial basis we primed participants with pictures

designed to evoke natural or human-made contexts. Drawing predictions from relevance-detection perspectives, we expected context-congruent threats to have more notable effects than context-incongruent threats, regardless of the evolutionary origin of the stimuli.

The current findings are generally consistent with the relevance-detection perspective (e.g., Brosch et al., 2008; Vogt et al., 2011) and suggest that whether evolutionary (e.g., snakes, spiders) or human-made (e.g., guns, knives) threats have more potent effects on attentional resources is determined by their situational relevance. Thus, one’s current environment partly dictates what potential threats are most important to attend to and process, suggesting a “situational preparedness”.

That said, the current work was not designed to argue against the existence of a biological preparedness to process evolutionarily relevant dangers. In fact, preparedness theories allow for the acquisition of learned fears (Öhman & Mineka, 2001). Consistent with this notion, developmental work suggests that evolutionarily based threats demand attention in young children and infants, yet modern threats only do so after children learn the dangers associated with such items (LoBue, Rakison, & DeLoache, 2010). For example, children who have experienced painful injections devote attention to syringes but not to modern threats with which they have little or no experience (e.g., knives); yet no experience is

necessary for children to attend to snakes and spiders (LoBue, 2010). However, the current results indicate that in adult populations, this preparedness can be overwhelmed by factors that make modern threats highly important. Situational demands appear to determine what types of threats hold attention.

Importantly, the present experiment is not without limitations. For example, the current experiment tested only negative stimuli. This was done to keep the number of trials practical and to prevent participant fatigue, but it would be profitable for future research to include neutral stimuli as a baseline measure of attention, or perhaps to use positive stimuli to test for more general effects of stimulus relevance. Future work could also be designed to rule out alternative explanations for our findings. To elaborate, the current results could be due to a more basic priming effect, such that priming particular environments makes related stimuli accessible, but not necessarily more relevant or meaningful, than unrelated stimuli. Such a mechanism could lead to similar attentional biases as presently observed (e.g., Chun, 2000). Granting these limitations, the current experiment nevertheless provides insight into the operation of selective attention to evolutionary and non-evolutionary threats by documenting context sensitivity.

To conclude, this work marks a transition away from comparing the attentional potency of evolutionary and modern threats (e.g., Blanchette, 2006; Carlson et al., 2009; Fox et al., 2007) by investigating the situations in which one class of stimuli or the other is most critical to process. The results indicate that context-congruency, more so than the evolutionary or modern nature of a threat, guides attentional processing. In sum, these results underscore the situational sensitivity and context specificity of selective attention and indicate further evidence for a relevance-detection attentional mechanism in adult humans.

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