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The Angry Spotlight: Trait Anger and Selective Visual Attention to Rewards

BRETT Q. FORD[1]*, MAYA TAMIR[2,3], STEPHANIE A. GAGNON[4,5], HOLLY A. TAYLOR[5] and TAD T. BRUNYÉ[4,5]

[1]*University of Denver, Denver, CO, USA*
[2]*The Hebrew University, Jerusalem, Israel*
[3]*Boston College, Boston, MA, USA*
[4]*U.S. Army NSRDEC, Natick, MA, USA*
[5]*Tufts University, Medford, MA, USA*

Abstract: This investigation examined links between trait anger and selective attention to threats and rewards. Existing research has focused mainly on trait anxiety and is equally consistent with several competing theoretical accounts of trait emotion and visual attention. Both valence-based and motivation-based accounts predict that trait anxiety would be associated with biased attention toward threats. In contrast, a valence-based account predicts that trait anger would be associated with biased attention toward threats, whereas a motivation-based account predicts that it would be associated with biased attention toward rewards. To test these predictions, we measured trait anxiety, trait anger and selective attention to threats and rewards. Consistent with a motivation-based account, we found that trait anger was associated with selective attention toward rewarding but not threatening information, whereas trait anxiety was associated with selective attention toward threatening but not rewarding information. Copyright © 2012 John Wiley & Sons, Ltd.

Key words: anger; anxiety; selective attention; motivation; emotion

People differ from one another in their emotional dispositions, and such differences are linked to the way people view the world around them. One of the most established findings, in this respect, is a link between individual differences in trait anxiety and threat detection (see Williams, Watts, MacLeod, & Mathews, 1997). People who are higher (vs lower) in trait anxiety tend to be faster to attend to threats in the environment. This processing tendency, in turn, may contribute to the maintenance of anxiety (Wells & Matthews, 1996). In this paper, we argue for the importance of moving beyond trait anxiety in the study of selective visual attention by studying the link between selective attention and trait anger. In addition to understanding patterns of visual attention that may be unique to trait anger, we propose that by studying trait anger, it may be possible to test two prominent theoretical accounts that may explain the links between emotional dispositions, in general, and selective visual attention.

Models of emotion and selective visual attention

Why might emotional dispositions be linked to biases in selective visual attention? At least two main accounts have been proposed, one based on valence and another based on motivation. Based on two-dimensional frameworks of affect (e.g. Lang, Bradley, & Cuthbert, 2008; Tellegen, 1985), emotions can be located along the dimensions of valence (i.e. positive vs negative) and engagement (i.e. high vs low). According to a valence-based account, emotions that reflect increased engagement with the environment (i.e. high, but not low, in arousal) should bias visual attention by prioritising the processing of information that is consistent with the valence of the emotional state (e.g. Mogg & Bradley, 1998). For example, experiencing a high arousal negative emotion should bias visual attention toward negative information. On the other hand, experiencing a high arousal positive emotion should bias visual attention toward positive information.

According to a motivation-based account, emotions that reflect an active motivational system should bias visual attention by prioritising the processing of motivationally relevant information (e.g. Van der Heijden, 1992). Specifically, two separate motivation systems have been proposed: the avoidance motivation system that manages withdrawal and avoidance behaviours (e.g. Davidson, 1998) and the approach motivation system that manages appetitive and approach behaviours (e.g. Cacioppo & Berntson, 1994). For example, experiencing an emotion that reflects high avoidance motivation should bias visual attention toward threats. On the other hand, experiencing an emotion that reflects high approach motivation should bias visual attention toward rewards.

Most of the existing literature concerning links between trait emotions and selective attention biases has focused on trait anxiety. Trait anxiety has been consistently linked with a selective attention bias to threats, compared with non-threats (e.g. MacLeod, 1999; Mathews & MacLeod, 1985; Mogg, Mathews, Bird, & Macgregor-Morris, 1990). A recent meta-analysis confirmed that a threat-related bias among anxious individuals is a robust phenomenon that holds constant under a variety of methodologies, experimental conditions and different types of anxious populations (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007).

*Correspondence to: Brett Q. Ford, Department of Psychology, University of Denver, Frontier Hall, 2155 S. Race St, Denver, CO 80208, USA.
E-mail: Brett.Q.Ford@du.edu

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This pattern, however, is consistent with the predictions of both the valence and the motivation accounts. According to the valence-based account, anxiety should increase attention to threatening information because it is associated with increased engagement and is negatively valenced. Similarly, according to the motivation-based account, anxiety should increase attention to threatening information because it is associated with an active avoidance system. In order to contrast the two models, it is necessary to examine a case where the two theoretical accounts might offer different predictions. Such a case is provided by trait anger.

The case of trait anger

Like anxiety, anger is an emotion high in arousal yet negatively valenced. Unlike anxiety, however, anger reflects an active approach motivational system (Carver & Harmon-Jones, 2009). Therefore, in the case of trait anger, the two theoretical accounts offer different predictions. First, according to the valence-based account, anger should bias attention to negative information (e.g. threats) because these stimuli are high in arousal and negative in valence. Second, according to the motivation-based account, anger should bias attention to stimuli that should be approached (e.g. rewards) because it reflects an active approach system. Examining biases toward threats and rewards in trait anger, therefore, could effectively contrast the valence and the motivation accounts.

There has been limited research to date on selective visual attention and trait anger. The research that does exist has shown that people who are higher (vs lower) in trait anger preferentially attend to hostile stimuli (e.g. angry faces or words such as 'rape' or 'attack'; Smith & Waterman, 2003; Smith & Waterman, 2004; Van Honk, Tuiten, de Haan, van den Hout, & Stam, 2001; Van Honk, Tuiten, van den Hout, et al., 2001). Although hostile stimuli are unequivocally negative, they can be ambiguous from a motivational perspective. For example, someone may be motivated to approach a hostile person to engage in a confrontation, but someone may also be motivated to avoid a hostile person to escape a confrontation. As such, attentional biases towards hostile stimuli in people higher in trait anger may be consistent with either a valence-based or a motivation-based account. To contrast these two accounts, it is necessary to examine attention to stimuli that are unambiguous from a motivational perspective, such as rewards—which engender approach motivation—and threats—which engender avoidance motivation. More specifically, it is necessary to examine trait anger in the context of stimuli that represent the critical dimensions in each account (i.e. negative and threatening information, positive and rewarding information). This was the approach taken in the current investigation.

There is already some indication that anger may be linked to increased attention to reward. Some of our prior work has shown that, in accordance with a motivation-based account, state anger is associated with selective attention to rewarding information, compared with threatening or neutral information (Ford et al., 2010). In that study, participants were randomly assigned to either an anger, neutral, fear or excitement emotion induction condition. We then examined selective attention to images depicting rewards, threats or high arousal control images using an eye tracker. We found that participants who were led to feel angry showed selective attention to rewarding (but not threatening) images when they were paired with either control or threatening images.

Thus, there is evidence that induced state anger biases attention toward rewarding images. In the current study, we sought to examine whether trait anger is associated with selective attention to rewards or threats, independent of state anger. Although state and trait anger are often positively linked, states and traits do not necessarily give rise to the same patterns of selective attention. For instance, Mathews and MacLeod (1985) found that interference in the emotional Stroop was correlated with state anxiety but not with trait anxiety. On the other hand, Mogg, Mathews, and Weinman (1989) found that interference in the emotional Stroop was correlated with trait anxiety but not with state anxiety. Such findings demonstrate that state affect and trait affect may have independent effects on attention and that such effects are not always consistent. Indeed, there are multiple ways in which state and trait affect may uniquely influence visual attention: it is possible that trait emotions reflect stable motivational concerns that constantly guide attention to motivationally relevant information. It may also be that attentional biases give rise to unique motivational and emotional experiences over time. To understand the association between affect and attention, therefore, it is important to examine attentional biases as a function of states as well as traits. In particular, to understand whether and how people differ from each other in their selective attention biases more generally, it is important to study possible links between emotional traits and selective attention.

In this investigation, we were primarily interested in trait anger and the extent to which it is linked with particular patterns of selective visual attention. Specifically, we assessed selective visual attention to threats and rewards as a function of trait anger by using eye tracking. Although eye tracking has been used in prior research to examine attentional biases in anxiety (e.g. Mogg, Garner, & Bradley, 2007), depression (e.g. Kellough, Beevers, Ellis, & Wells, 2008) and even positive mood (e.g. Wadlinger & Isaacowitz, 2006), it is a novel paradigm to examine selective attention biases in anger (see Ford et al., 2010).

To establish the validity of our findings, we measured both trait anger and trait aggression because the two have been consistently linked (Berkowitz, 1983, 1990). For the purpose of comparison, we also assessed individual differences in trait anxiety. Finally, to ensure our findings are specific to stable emotional dispositions, we assessed and controlled for state anger and anxiety. Because some research has found interactions between state and trait anger when predicting attention biases to hostile information (Cohen, Eckhardt, & Schagat, 1998; Eckhardt & Cohen, 1997), we also tested for such interactions in our data. Consistent with a motivation-based approach, we expected participants higher (vs lower) in trait anxiety to show increased attention to threats and participants higher (vs lower) in trait anger to show increased attention to rewards. We expected

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these effects to be independent of state emotions. We further expected trait anger and trait aggression to show similar associations with visual attention.

METHOD

Participants

A total of 96 male Tufts University undergraduate students ($M_{age} = 19.4$ years, $SD_{age} = 1.5$) participated for monetary compensation.

Materials

Selective attention task

To assess patterns of visual attention to rewards and threats, we adopted a paradigm used in prior research (Ford et al., 2010). The task involves viewing pairs of images selected from the International Affective Picture System (Lang et al., 2008). A total of 54 images (600 × 450 pixels) were chosen to represent one of three categories: rewarding (e.g. erotic couples, hang gliding), threatening (e.g. people bearing weapons, mutilated bodies) and control (e.g. jet planes). Based on the published norms, the images from each of the three categories were equally arousing (Ms = 6.38) but differed in valence (Ms = 7.40, 2.64 and 4.86 in the rewarding, threatening and control categories, respectively), $F(2, 53) = 381.9$, $p < .01$, $\eta^2 = .94$. Three independent samples t-tests confirmed differences between all image categories (all p–values $<.01$). The three image categories were equated in perceived visual complexity (see Brunyé, Mahoney, Augustyn, & Taylor, 2009; Ford et al., 2010), luminosity, contrast and RGB colour channel frequencies (all p-values $>.47$).

With these images, we created four sets of 27 image pairs consisting of all nine pairwise combinations of rewarding, threatening and control images. Each set contained all 27 images; in the first two sets, the images were paired at random by selecting images from the three image categories (rewarding, threatening and control). The third and fourth sets were created by rotating the images from the first two paired sets from the right to the left position and vice-versa. Each image pair depicted two horizontally aligned images against a black background with a 25-pixel vertical gap between the two images.

To promote equal viewing of each image regardless of its affective nature, we created test questions that would appear after each image pair (e.g. *Did you see a tree?*), referring to inanimate and mundane objects. Half of the questions were correctly answered as 'Yes' and half as 'No', and of the Yes questions, the referenced object appeared in either the left or right image of the preceding pair (balanced across trials).

Trait anger

The Trait Anger Scale (TAS) measures individual differences in the frequency and intensity of anger experiences over time (Spielberger, Jacobs, Russell, & Crane, 1983). The scale includes 10 items (e.g. *I have a fiery temper*). Participants rate each item in relation to how they 'generally feel' on a scale from 1 (= *almost never*) to 4 (= *almost always*). The TAS was scored by calculating a single composite score that summed responses across the 10 items. See Table 1 for all scale descriptive statistics.

Trait aggression

The Trait Aggression Scale (TAQ) measures individual differences in verbal and physical aggression over time (Buss & Perry, 1992). The scale includes 29 items (e.g. *I get into fights a little more than the average person*). Participants rate each item by indicating the extent to which a statement is 'characteristic' of them on a scale from 1 (= *extremely uncharacteristic of me*) to 5 (= *extremely characteristic of me*). The TAQ was scored by reverse-scoring two positive scale items and calculating a single composite score that summed responses across all 29 items.

Trait anxiety

The Beck Anxiety Inventory (BAI) measures individual differences in symptomatic experiences of anxiety over time (Beck, Epstein, Brown, & Steer, 1988). The scale includes 21 items (e.g. *Hands trembling*; *Heart pounding or racing*). Participants rate each item indicating how much they have 'been bothered by each symptom during the past week,

Table 1. Descriptive statistics and simple correlations between trait and state emotions and selective attention biases toward rewarding versus control images (positive values indicate reward bias), threatening versus control images (positive values indicate threat bias) and rewarding versus threatening images (positive values indicate reward bias, whereas negative values indicate threat bias)

	Zero-order correlations				Descriptive statistics			Selective attention biases		
	Trait aggression	Trait anxiety	State anger	State anxiety	*M*	*SD*	α	Reward vs control	Threat vs control	Reward vs threat
Trait emotions										
Trait anger	0.73***	0.23*	0.11	0.17	17.9	4.8	.81	0.26*	−0.03	0.20*
Trait aggression	–	0.42***	0.10	0.15	59.9	16.1	.88	0.32**	−0.11	0.08
Trait anxiety		–	0.02	0.31**	6.8	5.3	.81	0.17	0.29**	−0.13
State emotions										
State anger				0.40***	8.8	3.4	.80	−0.02	0.10	−0.01
State anxiety				–	7.9	3.1	.82	−0.03	−0.08	−0.07

***$p < .001$; **$p < .01$; *$p < .05$.

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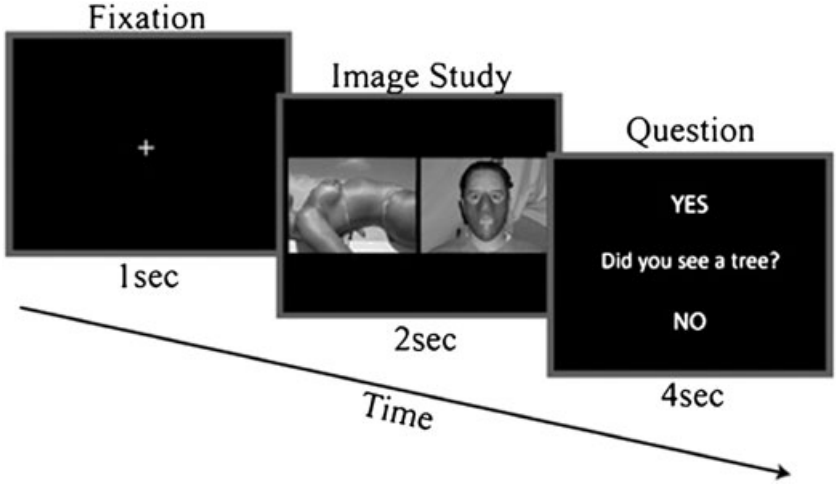

Figure 1. Sample trial using images not from International Affective Picture System (due to copyright restrictions), involving the pairing of a rewarding (left) and threatening (right) image, and a question correctly answered NO. Note that images were always presented in colour.

including today on a scale from "Not at all" to "Severely: I could barely stand it."' The BAI was scored by calculating a single composite score that summed responses across the 21 items.

State anger and anxiety

The state Positive and Negative Affect Schedule—Expanded Form (PANAS-X) measures the current experience of affect (Watson & Clark, 1994). The scale includes adjectives (e.g. *Happy* and *Sad*) that participants rate indicating to what extent they 'feel this way RIGHT NOW' on a scale from 1 (= *very slightly* or *not at all*) to 5 (= *extremely*). We used standard scoring procedures in assessing state anger by averaging across six items (*angry*, *hostile*, *irritable*, *scornful*, *disgusted* and *loathing*) and state anxiety by averaging across six items (*afraid*, *nervous*, *scared*, *frightened*, *jittery* and *shaky*).

Procedure

Participants visited the laboratory twice, with each visit separated by at least 4 days. During the first visit, participants completed the three trait measures: TAS, TAQ and BAI. During the second visit, participants completed the state PANAS-X and then completed an eye tracker calibration. We used iView X™ Hi-Speed eye tracking device (SensoMotoric Instruments, Berlin, Germany) to perform monocular tracking of the right eye at 1250-Hz sampling rate (<0.01° tracking resolution and 0.25°–0.50° gaze position accuracy). Calibration involved fixating on a series of nine points presented along screen diagonals on a 19″ LCD monitor (at 1280 × 1024 resolution) and repeating this process until the average error between all points fell below 0.5°. All participants had an approximate viewing distance of 80 cm.

Immediately following calibration, participants began the selective attention task. During this phase, participants were instructed to study each image pair presented on the screen and accurately answer each following question by directing their eyes towards YES or NO text written above and below the question (respectively). Each participant viewed 27 image pairs selected from one of the four image sets (balanced across participants). Each image pair was presented for 2 seconds at the centre of the monitor. Immediately following each image pair, a corresponding question was presented, and the participant had 4 seconds to read the question and fixate their gaze on an answer. Each participant viewed 27 unique test questions, one for each image pair. Overall, each of the 27 image–question trials took 7 seconds, with a 1-second central fixation cross between successive trials (see Figure 1). Once the participant finished the last of the 27 image–question trials, they were debriefed and thanked for their participation.

RESULTS

Scoring and analysis

Eye movement data were analysed by assessing the number of fixations in each of two regions of interest corresponding to the two images in each pair on a trial-by-trial basis. Minimum fixation duration was 80 milliseconds (i.e. Inhoff & Radach, 1998), and average overall fixation duration was 285.4 ms, corresponding to roughly seven fixations per trial. Fixation data were collapsed across left and right balanced image positions (across image sets), resulting in three control image pairs (Rewarding–Rewarding, Threatening–Threatening andControl–Control) and three critical image pairs of interest (Rewarding–Control, Threatening–Control and Rewarding–Threatening). Difference scores were calculated for each of these five image pairs to assess the relative number of fixations falling on each image type within a pair. These difference scores allowed for an assessment of patterns of relative overt visual attention for each image type. [1]

[1]There were no differences between the four counterbalanced sets of image pairs on the number of fixations (all p values >.09). There were also no differences between the sets of image pairs with regard to emotional traits (all p values >.50) or states (all p values > .10).

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Table 2. Results from regression analyses

Model	Predictor	Selective attention bias								
		Reward (vs control)			Threat (vs control)			Reward (vs threat)		
		β	t	p	β	t	p	β	t	p
A	Trait anger	**.24**	**2.31**	**.023**	−.10	<1	.324	**.25**	**2.40**	**.019**
	Trait anxiety	.12	1.19	.239	**.32**	**3.12**	**.002**	**−.19**	**−1.83**	**.070**
B	Trait aggression	**.30**	**2.74**	**.007**	−.28	−2.61	.011	**.17**	**1.51**	**.134**
	Trait anxiety	.05	<1	.641	**.41**	**3.87**	**< .001**	**−.20**	**−1.82**	**.073**
C	Trait anger	**.27**	**2.68**	**.009**	−.02	<1	.850	**.21**	**2.01**	**.047**
	State anger	−.04	<1	.667	−.06	<1	.552	−.04	<1	.687
	Trait anger × state anger	.08	<1	.436	.11	1.03	.305	−.04	<1	.692
D	Trait aggression	**.34**	**3.37**	**.001**	−.08	<1	.423	**.09**	**<1**	**.418**
	State anger	−.05	<1	.608	−.07	<1	.534	−.02	<1	.835
	Trait aggression × state anger	.09	<1	.357	.09	<1	.379	.00	<1	.980
E	Trait anxiety	.20	1.85	.068	**.31**	**2.96**	**.004**	**−.13**	**−1.20**	**.230**
	State anxiety	−.08	<1	.482	−.07	<1	.538	.06	<1	.955
	Trait anxiety × state anxiety	−.01	<1	.964	.20	1.84	.068	−.10	<1	.355

Note: All predictors were centred on their mean; all predictors entered within one model were entered simultaneously.

Our main analyses proceeded in three phases. First, we assessed whether average number of fixations differed in each of the critical image pairs (Rewarding–Control, Threatening–Control and Rewarding–Threatening) and confirmed that the overall number of fixations was equated across the left and right images in each of the three control image pairs (Rewarding–Rewarding, Threatening–Threatening and Control–Control). Second, we conducted a series of repeated measures analyses of variance (ANOVAs) to explore the specificity of specific traits in predicting motivationally relevant attentional biases in the critical image pairs and conducted a series of regressions to verify the directionality of any significant effects. In these and all following analyses, attentional biases were assessed using difference scores between the relative numbers of fixations falling on each image type within a pair. Finally, regressions were used to assess any interactions between trait emotions and state emotions in influencing attentional biases. Effect sizes are provided using Cohen's d for t-tests and eta-squared (η^2) for ANOVAs.

Average patterns of fixation

As expected, there were overall attentional biases toward valenced images, compared with control images. There was an overall bias towards Reward ($M = 6.5$) in the Rewarding–Control pair, $t(95) = 5.29$, $p < .001$, $d = .66$; an overall bias towards Threat ($M = 7.4$) in the Threatening–Control pair, $t(95) = 6.45$, $p < .001$, $d = .54$; but no overall attentional bias ($M = -0.01$) in the Rewarding–Threatening pair, $t < 1$, indicating no global attentional bias towards rewards versus threats.

We also tested for biases in the control pairs (i.e. pairs that include two stimuli of the same category). As expected, no biases were found in such pairs. The difference scores between the left image minus the right image in mean number of fixations approached zero for the three control image pairs, Rewarding–Rewarding ($M = -0.48$), Threatening−Threatening ($M = -0.69$) and Control–Control ($M = -01.03$), ts < 1.

Relationships between trait anger, trait anxiety and attention

To examine within-subject variation in attentional biases as a function of trait emotions, we ran a repeated-measures analysis in which trial type (Rewarding–Control, Threatening–Control and Rewarding–Threatening) was a within-subject factor and centred trait anger and centred trait anxiety were covariates. This analysis included three main effects (trial type, trait anger and trait anxiety) and two interaction terms (trial type × trait anger and trial type × trait anxiety). This analysis yielded a marginal interaction between trait anger and trial type, $F(2, 186) = 3.03$, $p = .051$, $\eta^2 = .03$; and a significant interaction between trait anxiety and trial type, $F(2, 186) = 6.01$, $p = .003$, $\eta^2 = .06$.

Linear regressions were employed to further explore the link between trait anger, trait anxiety and each specific attention bias (see Table 2, Model A, for statistics). When centred trait anger and centred trait anxiety were entered as predictors of the number of fixations in the Rewarding–Control trials, trait anger was the only significant predictor, such that people higher in trait anger tended to fixate more on rewarding images versus control images. When entered as predictors of the number of fixations in the Threatening–Control trials, trait anxiety was the only significant predictor, such that people higher in anxiety tended to fixate more on threatening images versus control images. Finally, when entered as predictors of the number of fixations in the Rewarding–Threatening trials, trait anger was a significant predictor, such that people higher in trait anger tended to fixate more on rewarding images versus threatening images, whereas trait anxiety was a marginal predictor, such that people higher in trait anxiety tended to fixate on threatening images versus rewarding images. This pattern of results is consistent with our predictions. [2]

[2]The pattern of results is largely identical when examining number of fixations and when examining fixation duration. For the sake of clarity and to minimize repetition, we report here the patterns with number of fixations.

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Trait aggression and attention

To establish the validity of these findings, we repeated the aforementioned analyses using trait aggression instead of trait anger. We ran a repeated-measures analysis, in which trial type (Rewarding–Control, Threatening–Control and Rewarding–Threatening) was a within-subject factor and centred trait aggression and centred trait anxiety were covariates. This analysis included three main effects (trial type, trait aggression and trait anxiety) and two interaction terms (trial type × trait aggression and trial type × trait anxiety). This analysis yielded a significant interaction between trait aggression and trial type, $F(2, 186) = 6.67$, $p = .002$, $\eta^2 = .07$; and a significant interaction between trait anxiety and trial type, $F(2, 186) = 8.27$, $p < .001$, $\eta^2 = .08$.

Linear regressions were employed to further explore the link between trait aggression, trait anxiety and each specific attention bias (see Table 2, Model B, for statistics). When centred trait aggression and centred trait anxiety were entered as predictors of the number of fixations present during Rewarding–Control trials, only trait aggression remained a significant predictor, such that people higher in trait aggression tended to fixate more on rewarding versus control images. When entered as predictors of the number of fixations present during Threatening–Control trials, trait anxiety was a significant predictor, such that people higher in anxiety tended to fixate more on threatening versus control images, whereas trait aggression was a significant predictor in the opposite direction, such that people higher in aggression tended to fixate more on control versus threatening images. Finally, when entered as predictors of the number of fixations in the Rewarding–Threatening trials, neither trait aggression nor trait anxiety was a significant predictor. However, the direction of these effects is consistent with our predictions, such that people higher in trait aggression tended to fixate more on rewarding versus threatening images, whereas those higher in trait anxiety tended to fixate more on threatening versus rewarding images. Hence, the patterns that were obtained with trait anger were largely replicated with trait aggression.[3]

Trait and state emotions and attention

A series of linear regressions were conducted to test whether the relationships between trait emotions and selective attention biases hold when controlling for state emotions and to explore potential interactions between trait and state emotions.

Trait anger and state anger

When centred trait anger, centred state anger and their interaction were entered as predictors of the number of fixations present during Rewarding versus Control images, only trait anger remained a significant predictor. When entered as predictors of the number of fixations present during Rewarding–Threatening trials, only trait anger remained a significant predictor. Finally, when entered as predictors of the number of fixations present during Threatening–Control trials, none were significant predictors. Therefore, trait anger predicted selective attention to rewards but not threats, even when controlling for state anger. The interactions between trait and state anger were not significant (see Table 2, Model C, for statistics).

Trait aggression and state anger

When centred trait aggression, centred state anger and their interaction were entered as predictors of the number of fixations present during Rewarding–Control trials, only trait aggression remained a significant predictor. When entered as predictors of the number of fixations present during Rewarding–Threatening trials and when entered as predictors of the number of fixations present during Threatening–Control trials, none were significant predictors. Therefore, similar to trait anger, trait aggression tended to predict selective attention to rewards but not threats, even when controlling for state anger. The interactions between trait aggression and state anger were not significant (see Table 2, Model D, for statistics).

Trait anxiety and state anxiety

When centred trait anxiety, centred state anxiety and their interaction were entered as predictors of the number of fixations present during Threatening–Control trials, only trait anxiety remained a significant predictor. When entered as predictors of the number of fixations present during Rewarding–Threatening trials and when entered as predictors of the number of fixations present during Rewarding–Control trials, none were significant predictors. Therefore, trait anxiety tended to predict selective attention to threats but not rewards, even when controlling for state anxiety. The interactions between trait and state anxiety were not significant (see Table 2, Model E, for statistics).

DISCUSSION

The current findings suggest that the associations between emotions and patterns of selective visual attention may be driven by motivational mechanisms, rather than valence per se. Specific trait emotions predicted motivationally relevant attention biases toward stimuli that call for increased engagement (i.e. that are high in arousal; Mogg & Bradley, 1998). Specifically, we found that people who tend to experience avoidance-oriented emotions, such as anxiety, attended more to avoidance-related stimuli (i.e. threats). On the other hand, people who tend to experience approach-oriented emotions, such as anger, attended more to approach-related stimuli in the environment (i.e. rewards) but showed no biases toward threatening information, even though that information is consistent with anger in valence.

[3]Trait anger and trait aggression were highly correlated in our sample ($r = .73$) and showed similar patterns of attentional bias. Although it was not the goal of the current investigation, we predicted that it is anger (an affective disposition) rather than aggression (a behavioural disposition) that is likely to drive attentional biases. Indeed, when both trait anger and trait aggression were entered as simultaneous predictors, trait anger remained a significant predictor of bias toward rewards, $\beta = .30$, $p = .044$, whereas trait aggression did not, $\beta = -.13$, $p = .37$.

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State and trait anger and selective attention

We have previously found that state anger biases attention toward rewards (Ford et al., 2010). However, the links between state emotion, trait emotion and attention are not always consistent (e.g. MacLeod & Rutherford, 1992; Rutherford, MacLeod, & Campbell, 2004). In this investigation, we found that trait anger is also linked to attention biases toward rewards. Furthermore, we were able to demonstrate that these links were independent of state anger.

Together with our previous findings, the current findings suggest that both state and trait anger are associated with attentional biases to rewards. How might state and trait anger operate in conjunction to affect selective attention? At least three potential models have been proposed to account for the joint operation of state and trait emotions in shaping affective information processing (Rusting, 1998). The first model suggests that state and trait emotions have separate and independent effects on cognitive biases. At present, this model appears to be consistent with the present findings, as trait anger was associated with attentional biases to threat, independent of state anger. However, because state anger was not manipulated in the current investigation and the levels of state anger were relatively low, other possible models should also be considered.

A second model that accounts for the interplay of state and trait emotions on information processing is a mediation model. According to this model, trait emotions predispose individuals to experience state emotions, which then lead to cognitive biases. Our findings do not appear to be consistent with this account. When both state and trait anger were entered as predictors of attention to rewards, it was trait anger (and not state anger) that remained a significant predictor.

A third model that accounts for the interplay of state and trait emotions on information processing is a moderation model. According to this model, state and trait emotions interact to predict cognitive biases. In other words, the link between state anger and cognitive biases may depend on the individual's level of trait anger and vice versa. Although our findings do not provide direct support for this account, they are not necessarily inconsistent with it. First, consistent with the present findings, the model allows for both trait and state anger to contribute to attention biases independently. Second, although we did not find a significant state $\times$ trait anger interaction, this null effect could be due to the fact that both the absolute level and the variance of state anger were relatively low in the present sample. To identify the mechanism by which both state and trait anger contribute to selective attention to rewards, future research could measure trait anger while experimentally manipulating state anger and examine whether they interact.

Theoretical implications

If motivation accounts for the effect between trait emotions and selective attention, as these results suggest, then arousal and valence are not sufficient to explain attentional biases. Therefore, to more fully understand attentional biases, it may be necessary to identify the motivational implications of the emotional trait or state under consideration. This opens the door to other possible influences on selective attention that go beyond the broad motivations of approach and avoidance. Rather, if the motivation of the emotional trait or state is driving selective attention biases, it is possible that other more specific motivational characteristics (e.g. influence vs adjustment, Morling, Kitayama, & Miyamoto, 2002; confrontation vs collaboration, Tamir & Ford, 2011) may contribute to these biases. Furthermore, approach and avoidance motivation (either measured or experimentally manipulated) could act to strengthen or weaken, respectively, the link between trait anger and biases to rewards. Such examinations could lend additional support for the motivation-based account. Exploring the interplay between motivation and selective attention biases may also help to understand the downstream processes that selective attention biases are thought to influence (e.g. information processing; Mathews & MacLeod, 2002).

Understanding how selective attention biases operate for certain trait emotions is particularly important given the connection between attentional biases and psychological health. Indeed, selective attention biases are theorised to play an important role in the aetiology and continuation of affective disorders. For example, the attention paid to threats in the environment results in increased perception of danger and can further exacerbate anxiety symptoms (e.g. Wells & Matthews, 1996). Therefore, increased tonic attention to threats could be maladaptive because people are more likely to be constantly vigilant and feel threatened. Making a similar argument, one could suggest that increased tonic attention to rewards—as in the case of trait anger—is adaptive because people are more likely to be open to rewards and to think positively. However, trait anger is typically associated with undesirable outcomes (Miller, Smith, Turner, Guijarro, & Hallet, 1996; Smith, 1992). Perhaps to resolve this apparent inconsistency, it may be necessary to take into account not only which goals one pursues, but also how one pursues them. Although it is possible that individuals higher in trait anger may be more likely to pursue rewards (which could be beneficial), it is unclear how they prioritise and pursue these rewards. Speculatively, it may be that individuals high in trait anger or aggression are more likely to approach immediate rewards of lesser preference (i.e. Aarts et al., 2010; Manuck, Kaplan, & Lotrich, 2006) or may do so in a confrontational manner (rather than a collaborative manner). Indeed, anger plays a critical role in determining approach-related motor movements (e.g. Wilkowski & Meier, 2010), which could have important downstream implications for approach-related behaviours. In this sense, pursuing rewards may be associated with either adaptive or maladaptive outcomes, depending on the manner and context in which those rewards are pursued.

Limitations and future directions

There are several limitations to the current investigation. First, the cross-sectional design does not allow us to examine whether trait emotions lead to selective attention biases or vice versa. Previous studies involving experimental emotion

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inductions (e.g. Ford et al., 2010) lend support to a causal argument in which emotions contribute to attentional biases. However, other work has suggested that attentional biases themselves may contribute to emotional states (e.g. MacLeod & Hagan, 1992; Mathews & MacLeod, 2008; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). Specifically with regard to emotional traits, it is possible that trait emotions reflect stable motivational concerns that constantly guide attention to motivationally relevant information. However, one alternative may be that attentional biases give rise to unique motivational and emotional experiences over time. Overall, it seems likely that attention and emotions are closely linked in a complex feedback loop. Future examinations, however, examining trait emotions and selective attention biases across multiple time points and employing cross-lagged analyses may be able to help address this question more in depth.

Second, although the hypothesised pattern of results was consistently obtained when examining anger and attention to rewarding (vs control) information and anxiety and attention to threatening (vs control) information, the pattern of results was less consistent in the rewarding (vs threatening) trials. This could be due to a stronger competition for attentional resources when both images are valenced and because the source driving the attentional bias is unclear. Future examinations using different stimuli and methodological designs may help to clarify this pattern.

Third, to fully endorse a motivational account of selective attention biases, it would be necessary to examine various emotional states and traits (including anxiety, sadness and calmness) and patterns of attention to multiple types of stimuli (including both negative and positive, high and low in arousal, and reflecting both approach and avoidance). Indeed, although this investigation examined emotional traits of negative valence only, it would be useful to examine biases in positive emotional traits as well, such as trait excitement (i.e. positive valence and high approach motivation; see Tamir & Robinson, 2007), or to examine emotional traits that vary in the degree of motivational activation (e.g. anger, which is high in approach motivation, and sadness, which is low in approach motivation). It would also be important to examine various types of stimuli, such as positive and negative stimuli that engender approach motivation (e.g. rewards and revenge, respectively). Furthermore, it would be fascinating to extend this research into clinical populations such as those individuals who tend to experience chronic aggression (e.g. forms of antisocial personality disorder) or have chronically erratic emotional experiences (e.g. borderline personality disorder).

Finally, we included only young male participants for important methodological considerations. First, age is known to systematically influence selective attention (Isaacowitz & Fung, 2010). Second, pilot testing to select rewarding images that were as arousing as the threatening images indicated that many such images included erotic content that had a rewarding effect for males but not necessarily for females. To ensure that our stimulus set had the properties necessary for testing the prediction of our model and that the set led to similar responses across our sample, we chose to use young males only. However, to establish the generalisability of these findings, it would be important to replicate these effects in females and in other age groups (i.e. older adults).

In sum, the current investigation underscores the importance of examining trait anger to more fully understand the links between emotional dispositions and selective attention. By demonstrating that trait anger is associated with a bias toward rewards and not threats, we offer support for the motivational underpinnings of selective attention biases in trait emotions. These findings highlight the importance of taking into account various types of emotions when examining selective attention biases and particularly when attempting to tease apart multiple theoretical accounts.

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