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No reliable effects of emotional facial expression, adult attachment orientation, or anxiety on the allocation of visual attention in the spatial cueing paradigm

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ABSTRACT

The primary goal of the current study was to examine the allocation of attention to emotional facial stimuli as a function of adult attachment orientation. Using a modified version of the spatial cueing paradigm we examined these effects in three experiments. In each experiment predictable cue validity effects were observed and these effects were always modulated by the expression of the facial cue. Furthermore, the magnitude of these cue validity effects was also influenced by individual differences in both adult attachment orientation and anxiety. The direction of these effects, however, was not consistent across experiments and did not replicate previous findings. We conclude that this paradigm may not usefully elucidate the processes underlying the allocation of attention to emotional stimuli.

1. Introduction

The attachment behavioural system is an innate control system that predisposes humans to attach to others, such as to caregivers in childhood and family, and peers and romantic partners in adulthood (Bowlby, 1980; Hazan & Shaver, 1987). Attachment-related representations of cognition, behaviour and affect regulation in relationships – or dispositional attachment orientations – develop as a result of stable and consistent attachment experiences in early life. They can be conceptualised along the orthogonal dimensions of *anxiety* (regarding abandonment) and *avoidance* (of intimacy) yielding four categories of attachment orientation (Bartholomew & Horowitz, 1991; Brennan, Clark, & Shaver, 1998). Adults with different dispositional attachment orientations differ on a behavioural level in a number of ways, including their tendency to seek intimacy vs. independence and their ability and willingness to depend on others in times of distress (see Mikulincer & Shaver, 2007 for an overview). Individuals who are low on both attachment anxiety and avoidance (securely attached individuals) seek closeness and interdependence in close relationships, see the self as worthy of the care and the attention of others and find it easy to trust and rely on others when experiencing distress. Individuals who are high in attachment anxiety are also highly motivated to achieve intimacy in relationships and are able to rely on other in times of need, but are mistrustful of others and their continuing availability to them. By contrast individuals who are high in attachment avoidance are characterised by compulsive self-reliance in times of distress and a denial of the importance of intimacy because they see others as unreliable. Individuals who are high in attachment anxiety (preoccupied), avoidance (dismissing-avoidant), or both (fearful-avoidant) are referred to as insecure in attachment orientation.

In addition to the behavioural differences described above, each attachment dimension is thought to bias the processing of emotional stimuli in different ways. While attachment anxiety is associated with a tendency for hypervigilance towards emotional stimuli, attachment avoidance is associated with cognitive avoidance of these stimuli. In terms of the four attachment styles, the valence of emotional stimuli has also been found to influence early processing responses. Preoccupied individuals are biased toward the processing of emotional information irrespective of valence. There is evidence that they show hypervigilance to emotional cues compared to secure individuals (e.g., facial expressions: Maier et al., 2005; Niedenthal, Brauer, Robin, & Innes-Ker, 2002; Shaver & Hazan, 1993). Fearful-avoidant individuals, by contrast, are thought to defend themselves against positive and negative attachment-related emotions (Bartholomew & Horowitz, 1991), and reflect this goal when processing emotional stimuli. For example, they are quicker to judge the offset of emotional expressions than secure individuals (Niedenthal et al., 2002). Secure individuals show neither bias and exhibit balanced and moderate responses to emotional information and events (Shaver & Hazan, 1993).

The behaviour of dismissing-avoidant individuals in response to emotionally-laden information is currently disputed. Historically, it was thought that dismissing-avoidant individuals, like fearful avoidant individuals and in contrast to secure and preoccupied individuals, had an automatic bias to orient processing resources away from emotionally arousing attachment-relevant information (e.g., Bowlby, 1980; Fraley & Shaver, 1997). Recent studies, however,

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suggest that the avoidance manifested by dismissing-avoidants may reflect a secondary, controlled strategy as opposed to the originally assumed single process. Niedenthal et al. (2002) digitized sequences of faces showing happiness, sadness and anger morphed to neutral expressions. Participants identified the frame at which the emotion disappeared. The results suggest that, like preoccupied individuals, dismissing-avoidant participants perceived the offset of the emotion later than did secure and fearful-avoidant individuals. In other words, dismissing-avoidant participants showed a perceptual bias toward the processing of facial emotion, a finding not compatible with the single process theory. Niedenthal et al. suggest that the previously reported bias to orient away from emotional stimuli might in fact reflect a secondary, controlled strategy. This perspective predicts that two processes are employed when dismissing-avoidants are presented with emotional material (see also Maier et al., 2005).

Attentional engagement/disengagement tasks can potentially determine whether dismissing-avoidant and preoccupied individuals show an early attentional bias towards emotional stimuli and then differ in their secondary processing strategy as suggested by the two process theory. This theory suggests that after an initial bias to orient attention toward emotional stimuli in both attachment styles, dismissing-avoidant individuals would efficiently orient attention away from these stimuli, while preoccupied individuals would find it difficult to disengage attention from them.

The classical engagement/disengagement task involves a cue appearing in one of two locations on a computer screen (e.g., Posner, 1980). The cue is followed by a target that appears either in the cued ('valid') location or in the alternative ('invalid') location. Speeding of reaction times on valid trials reflects attentional engagement with the cued location, while slowing on invalid trials reflects costs arising from disengaging attention from the cued location. Individuals with high levels of trait anxiety, for example, have difficulties disengaging from threat-related cues in such tasks (e.g., Fox, Russo, & Dutton, 2002; Yiend & Mathews, 2001).

In our experiments, images of emotional expressions act as cues to target location. Participants should be faster to attend to the location of facial stimuli depicting emotion vs. neutral facial expressions as they serve social coordination functions (Buck, 1999). For example, anger and sadness signal social unavailability caused by aggression and self-preoccupation, respectively, while happiness signals availability. Valid trials allow a comparison of attentional engagement (assessed through reaction time) to emotional expressions across the attachment style groups.

The single process theory predicts that preoccupied individuals should be the fastest on valid trials with emotional faces, followed by secure and fearful-avoidant and dismissing-avoidant individuals, respectively. The two process theory, however, predicts that both dismissing-avoidant and preoccupied individuals will show an early processing bias towards these stimuli, which would lead to both styles responding significantly faster on these trials than secure and fearful-avoidant individuals (Maier et al., 2005; Niedenthal et al., 2002). Reaction times on valid trials measure performance at the initial stage of processing and thus speak to the single process theory and the first stage of the two process theory.

Reaction times on invalid trials reflect ease of disengagement from different facial expressions and measure performance at the second stage of processing. Disengagement is hypothesized to be fastest for trials cued by neutral faces across attachment styles. The two process theory predicts that preoccupied participants should be slower on invalid trials with emotional expressions than secure, fearful-avoidant and dismissing-avoidant individuals, due to their difficulty in disengaging attention from emotional cues.

To date, one study has used the spatial cueing paradigm to measure the allocation of attention to emotional facial expressions as a function of adult attachment orientation, with somewhat surprising results. Dewitte and De Houwer (2008) presented photographic images of emotional facial expressions (angry, happy, and neutral) as cues with a cue-target stimulus onset asynchrony (SOA) of 550 ms. They reported an overall cue validity effect (i.e., quicker responses in valid compared with invalid trials) and then used scores on an adult attachment measure (Experiences in Close Relationships – Revised; Fraley, Waller, & Brennan, 2000) to predict the magnitude of the cue validity effect for each of the face cues. They found that high levels of both attachment anxiety and attachment avoidance (fearful-avoidant attachment orientation) were associated with a reduced cue validity effect for angry and happy faces, suggesting that insecure attachment orientation was associated with *reduced* attention for both negative and positive emotional stimuli. This supports neither the single, nor the dual process theory.

There is currently no evidence, however, showing how the allocation of attention might proceed at different SOAs. As Dewitte and De Houwer (2008) note, the observed reduction in the allocation of attention at the 550 ms SOA may have been preceded, or indeed be followed, by a different pattern of attentional allocation. The main goal of the present study was therefore to measure the allocation of attention to emotional facial expressions (Experiment 1) as a function of adult attachment orientation and examine the time course of this effect (Experiments 2 and 3). Since attachment anxiety is correlated with trait anxiety (Mickelson, Kessler, & Shaver, 1997), and there is a considerable body of evidence suggestion that trait anxiety is associated with a threat-specific attentional bias (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijendoorn, 2007, for a meta-analysis) we also measure anxiety with a subsidiary goal of comparing anxiety-related effects with attachment-related effects. We also recorded state anxiety as this too has been implicated in contributing to bias in attentional allocation (Bar-Haim et al., 2007).

2. Experiment 1

As our starting point we closely replicated the method of Experiment 1 from Fox et al. (2002) who were interested in measuring the allocation of attention to emotional facial expressions as a function of self-reported anxiety. Note that we used photographic rather than schematic images of emotional facial expressions (angry, happy, sad, and neutral) and, critically, measured participants' attachment orientation, as well as trait and state anxiety.

2.1. Method

2.1.1. Participants

The Experiences in Close Relationships (ECR) adult attachment questionnaire (Brennan et al., 1998) was completed by 369 students at the University of Bristol. Of this, 26% were classified as secure, 32% preoccupied, 30% fearful, and 11% dismissive. The criterion for this classification is described in Brennan et al. (1998). At the same time participants also completed the trait component of the State Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), the Beck Depression Inventory (BDI; Beck, Erbaugh, Ward, Mock, & Mendelsohn, 1961) and a short form of the Marlowe–Crowne Social Desirability Scale (Strahan & Gerbasi, 1972). A measure of social desirability was included as there is evidence that this affects self-report measures of anxiety (Eysenck, 1997; Fox, 1993). We then invited individuals to take part in the current experiment until we had tested 120 individuals with approximately equal numbers of males and females in each of the four attachment orientations (dismissing-avoidant – 29, 14 female; fearful-avoidant, 31, 16 female; Preoccupied, 30, 15 female; Secure 30, 16 female). This sub-sample had a mean age of 20.5 years (range 18–53). Table 1 shows the relation-

Table 1
Pearson correlation coefficients (r) for the scores on all questionnaire measures in Experiment 1.

	ECR anxiety	STAI trait	STAI state	BDI	SDS
ECR avoidance	−.07	.13	−.16	.15	−.21*
ECR anxiety		.56**	.43**	.50**	−.15
STAI trait			.57**	.71**	−.31
STAI state				.44	−.20
BDI					−.21

* $p < .05$.
** $p < .01$.

ships between responses on all completed questionnaire measures. Participants received cash (£6) or course credit in return for their participation.

2.1.2. Materials and apparatus

Face stimuli were 32 pictures from the Ekman and Friesen (1976) set of emotional facial expressions. The photographs comprised eight individuals (four female) each posing one of four expressions (angry, happy, sad, and neutral). The pictures were greyscaled, cropped tightly to the outline of the face so that all extraneous features (including the hair) were removed, and resized to measure approximately 3.5 cm by 2.5 cm. The target stimulus was either a white circle or a white square, both with a diameter of 0.3 cm. Stimuli were presented on a black background inside two white rectangular frames measuring 6.8 cm by 4.5 cm, the midpoint of each frame being 4.2 cm from fixation. Stimulus presentation was controlled by E-Prime running on a Dell Optiplex desktop PC and the experiment was displayed on a 15 in. CRT monitor set to 85 Hz. Responses were collected on an E-Prime buttonbox.

2.1.3. Procedure

On arrival at the laboratory participants were asked to complete the state component of the STAI. Following this they were given both verbal and written instructions for the spatial cueing task. The beginning of each trial was signalled by the appearance of a fixation cross in the centre of the screen. This was followed 1000 ms later by the appearance of a picture of a face cue (angry, happy, sad, or neutral) inside one of the two rectangular frames for 250 ms. Following an interstimulus interval of 50 ms, a target stimulus (square or circle) was presented, on valid trials, 1 cm below the location of the cue face or, on invalid trials, in the opposite location until response. Participants pressed the top button on the response box to identify the target as a square and the bottom button to indicate the target as a circle. Individuals were free to place their hands at either key with the restriction that both hands were to be used throughout. Participants completed 12 practice trials and 256 experimental trials. Valid trials accounted for 192 (75%) of all trials with invalid trials making up the remaining 64. Each facial expression was presented 48 times in valid trials and 16 times in invalid trials. Each target appeared equally often in each condition of the experiment and on each side of the screen, and trials appeared in a new random order for each participant. Participants were instructed to maintain central fixation throughout each trial and were informed of the predictive nature of the cue. Participants were encouraged to be as quick and accurate as possible in their responses.

2.2. Results

Trials with errors (4.2%) were removed as were the data from two participants who made more errors than three SDs above the sample mean (one participant made errors in 29% of trials and another in 41% of trials) and were not analysed further. Analysis was conducted on the interparticipant means of median response times using repeated measures analysis of variance (ANOVA). If the higher-order interactions were significant the magnitude of the cue validity effect was calculated by subtracting response times made during valid trials from response times made during invalid trials (Koster, Crombez, Verschuere, Vanvolsem, & De Houwer, 2007). In order to examine individual differences in the allocation of attention to emotional facial expressions, individual difference measures (attachment anxiety and attachment avoidance; trait anxiety and state anxiety) were included as covariates with separate analyses for the attachment and anxiety data. These were mean-centred (Delaney & Maxwell, 1981) with their cross products serving as the interaction term (c.f., Cohen, 1978). Unless otherwise stated, for pairwise comparisons we used two-tailed tests with the alpha level set to .05 throughout. Across all experiments, Greenhouse-Geisser corrections are reported where assumptions of sphericity were violated. A measure of effect size is given by partial eta-squared (η_p^2). In agreement with guidelines set by Cohen (1988), η_p^2 of .01, .10, and .25, corresponds to small, medium, and large effects, respectively. Although all main effects and interactions are reported here, interactions were only further explored when they contained the variable of cue validity (i.e., the effect involved in the allocation of attention).

Table 2 displays interparticipant means of median response times (ms) as well as standard deviations (SDs) for each of the within-subjects conditions across the whole sample. Inspection of these data suggests a validity effect (i.e., faster responses in valid compared with invalid trials) as well as a modulation of this effect by cue emotion with a larger cue validity effect for angry and neutral face cues compared with happy and sad face cues. These data were subjected to a 2 (cue-validity) $\times$ 4 (cue-emotion) repeated measures ANOVA. There was a main effect of cue validity, $F(1, 117) = 256.4$, $p < .001$, $\eta_p^2 = .69$, reflecting faster responding of approximately 40 ms in valid compared with invalid trials. There was also a main effect of cue emotion, $F(3, 351) = 5.4$, $p < .01$, $\eta_p^2 = .04$, reflecting faster responding in trials containing happy and sad face cues compared with trials containing angry and neutral face cues. These effects were qualified by a significant two-way interaction between cue validity and cue emotion, $F(2.5, 291.1) = 11.3$, $p < .001$, $\eta_p^2 = .09$. Further analysis broken down by cue validity revealed that there was no main effect of cue emotion on valid trials, $F(3, 351) = 1.5$, $p = .21$, $\eta_p^2 = .01$. There was, however, a main effect of emotion on invalid trials, $F(2.6, 309.9) = 9.7$, $p < .001$, $\eta_p^2 = .08$, reflecting emotion modulated attentional disengagement from the cue stimuli. Pairwise comparisons of the cue validity effects revealed that the cue validity effects following angry face cues were larger than those following both happy, $t(117) = 4.1$, $p < .001$, and sad, $t(117) = 3.9$, $p < .001$, face cues. Similarly, validity effects following neutral face cues were larger than those following happy, $t(117) = 2.5$, $p = .015$, and sad, $t(117) = 2.5$, $p = .015$, face cues. In contrast, the cue validity

Table 2
Mean correct response times (ms), standard deviations (SD), and cue validity effects (CVE) following the presentation of the four emotional face cues as a function of cue validity (valid or invalid) in Experiment 1.

SOA	Cue emotion	Cue validity	*M*	SD	CVE
300 ms	Angry	Valid	426	58	48
		Invalid	474	67	
	Happy	Valid	429	55	31
		Invalid	460	65	
	Sad	Valid	429	58	31
		Invalid	460	71	
	Neutral	Valid	427	58	49
		Invalid	476	65	

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scores did not differ for the angry and neutral, or for the happy and sad, emotional cues, $t < .5$.

2.2.1. Attachment orientation

In order to investigate the effects of adult attachment orientation on the allocation of attention to emotional cues we entered, as covariates, participants' scores (mean-centred) on both the attachment anxiety and attachment avoidance components of the ECR, as well as their interaction term, to the repeated measures ANOVA reported with the full data set. This revealed only an interaction between cue validity, cue emotion, and attachment anxiety, $F(2.5, 287.3) = 3.25$, $p = .03$, $\eta_p^2 = .03$. To clarify the nature of this interaction and following the approach of Dewitte and De Houwer (2008), individual regression slopes were calculated for each of the four cue validity effects, using attachment anxiety as a predictor. Of these, only the regression slope for the happy cue validity effect approached significance (standardised beta = −.18, $r^2 = .03$, $p = .057$; all other $ps < .2$) suggesting a negative relationship between attachment anxiety and the cue validity effect following happy face cues.

In order to test our specific predictions concerning attachment-related effects on the processes of engagement with, and disengagement from, emotional facial expressions, we ran separate ANOVAs for the valid and invalid trials as a function of emotional expression with attachment orientation as covariates as above. This did not reveal any significant effects (all $ps < .09$).

2.2.2. Anxiety

In order to investigate the effects of anxiety on the allocation of attention to emotional cues, we entered, as covariates, participants' scores (mean-centred) on both the state and trait components of the STAI as well as their interaction term to the repeated measures ANOVA reported above.[1] Neither trait nor state anxiety alone influenced response times (all $ps > .14$). The interaction term, in contrast, modulated the main effect of emotion, $F(3, 115) = 3.0$, $p = .03$, $\eta_p^2 = .03$, and the critical interaction between cue validity and emotion, $F(2.6, 268.9) = 3.8$, $p = .015$, $\eta_p^2 = .04$. To help clarify this interaction, four individual stepwise multiple regressions were conducted (one for each of the four emotional facial expressions) with state and trait anxiety (mean-centred) entered as predictors in a first step, and the interaction term entered in a second. This approach yielded only one significant effect: for the cue validity effect following happy face cues. While step one of the model (state and trait anxiety) was not significant[2] (standardised betas: trait anxiety = −.035, state anxiety = .087, $R^2 = .005$, $ps > .4$), the amount of variance explained by the model significantly increased from step1 to step 2 (i.e., with the addition of the interaction term), standardised beta for the interaction term = −.301, $\Delta R^2 = .074$, $p = .004$. The final regression equation (step 2) featuring state and trait anxiety, as well as the interaction term was also significant, $R^2 = .079$, $F(3, 105) = 3.01$, $p = .033$ (see Egloff and Hock (2001) for a similar analysis strategy).

To illustrate the interaction between state anxiety, trait anxiety and the happy cue validity effect, we plotted the regression of state anxiety on happy cue validity at three levels of trait anxiety: the mean and ±1SD of the mean (Cohen, Cohen, West, & Aiken, 2003). As shown in Fig. 1, high trait anxiety is associated with a decreasing cue validity effect at increasing levels of state anxiety. In contrast low trait anxiety is associated with an increasing cue validity effect at increasing levels of state anxiety. Analysis of the simple slopes, however, indicated that only the regression slope for the low anxiety data was significant, standardised beta = .065, $t(104) = 2.03$, $p = .045$ (other $ps > .15$).

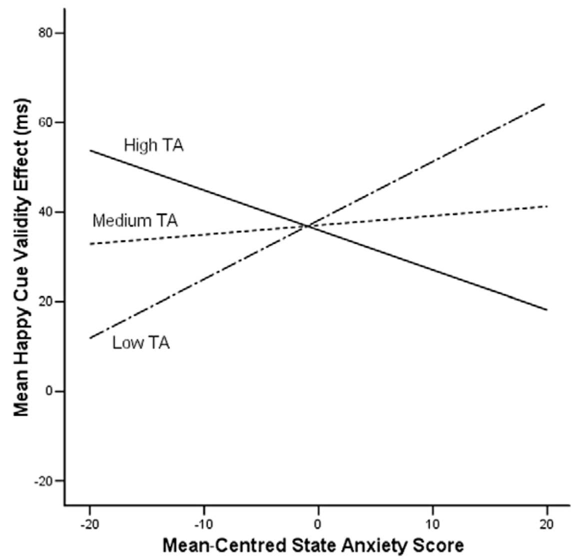

Fig. 1. Cue validity effect (ms) in Experiment 1 following happy face cues as a function of state anxiety for three levels of trait anxiety (medium (mean), high (+1SD), and low (−1SD)).

2.3. Discussion

Experiment 1 demonstrated a highly reliable cue validity effect for each emotional facial expression cue. This suggests that, as expected, the sudden onset of each cue stimulus attracted attention (Posner & Cohen, 1984). Further, invalid trials featuring angry and neutral face cues were associated with slower response times compared with responses made following happy and sad invalid cues. No differences in response time were observed on valid trials. If responses on invalid trials can be taken to reflect participants' ability to disengage their attention from the invalid cue (Fox et al., 2002), these data suggest angry and neutral face cues held attention at their location for longer than happy and sad faces. One interpretation of these data is that participants are demonstrating a specific bias to threat-related stimuli. The angry face is an unambiguous signal of threat but the neutral face (with eyes directed at the viewer) is ambiguously threatening. There is other evidence from the dot-probe task that attention can be allocated to neutral faces in an almost identical manner as it is to angry faces, but distinct from attention allocation to happy faces (Cooper & Langton, 2006). If it is the case that under certain circumstances the processing of neutral faces is indistinct from the processing of angry face, this has important implications for research which assumes neutral emotional expressions are in some sense a control with which to compare the effects of emotional expressions.

2.3.1. Attachment orientation

In this experiment we found that attachment anxiety, but not attachment avoidance, modulated the cue validity effect from happy trials, but not from trials featuring the other facial expressions (angry, sad, and neutral). The single process theory predicts that preoccupied individuals should be the fastest on valid trials with emotional faces, followed by secure and fearful- and dismissing-avoidant individuals, respectively. The two process theory, however, predicts that both dismissing-avoidant and preoccupied individuals will show an early processing bias towards these stimuli, which would lead to both styles responding significantly faster on these trials than secure and fearful-avoidant individuals (Maier

[1] Nine participants failed to complete either the trait or state component of the STAI and so are not included in this analysis.

[2] We also considered the relationship between each of the emotional cue validity effects and both state and trait anxiety separately (i.e., least conservative test). None of these relationships were significant ($p < .25$).

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et al., 2005; Niedenthal et al., 2002). There was no evidence to support either of these positions.

Our data also run contrary to those of Dewitte and De Houwer (2008). They found that high levels of attachment anxiety and attachment avoidance should be associated with a reduced attentional bias toward emotional facial expressions. We found that attachment anxiety only was associated with an increased attentional bias towards happy faces.

2.3.2. Anxiety

In common with Fox et al. (2002) and Fox, Russo, Bowles, and Dutton (2001) we find evidence that the relationship between cue validity and cue emotion is modulated by participants' anxiety level. In contrast with both Fox et al. studies, which found that high trait anxiety modulated the cue validity effect associated with negative schematic face targets, the data from the current experiment suggest it is an interaction between trait and state anxiety that modulates the cue validity effect, but for happy face targets, not for negative face targets. At a low value of trait anxiety, the magnitude of the state anxiety score predicted the size of the cue validity effect following happy face targets: higher state anxiety scores were associated with larger cue validity effects. No such relationship was seen with high trait anxiety individuals or with the other emotional cues (angry, sad, and neutral). Thus the anxiety-related data in Experiment 1 suggest that it is only the attentional bias to happy face cues that is modulated by anxiety and only for low anxious individuals. This is a surprising result.

In summary, results from Experiment 1 show clear cue validity effects that are weakly, but significantly modulated by cue emotion. In turn, these effects are modulated by individual differences in both anxiety and adult attachment orientation. The specific directions of these effects do not replicate existing work.

3. Experiment 2

Given that previous evidence of adult attachment effects on attention to emotional faces had only been tested in one study at a SOA of 550 ms (Dewitte & De Houwer, 2008), and given that our findings from Experiment 1 are not consistent with those data, we decided to try to replicate our findings at 300 ms, and extend them to look at two longer SOAs (550 ms and 1050 ms). Sad faces were no longer used as cues because (a) they did not interact with any of the individual difference measures in Experiment 1, and (b) to equate the emotional face types with those seen in Dewitte and De Houwer (2008).[3]

3.1. Method

3.1.1. Participants

Forty-seven[4] undergraduate students (43 female) from the University of Bristol (mean age 20, range 18–27) took part for cash (£6) or course credit. Table 3 shows the relationships between responses on all completed questionnaire measures.

Table 3
Pearson correlation coefficients (r) for the scores on all questionnaire measures in Experiment 2.

	ECR anxiety	ECR-R avoidance	ECR-R anxiety	STAI trait	STAI state	BDI	SDS
ECR avoidance	.27	.73**	.38**	.39**	.20	.26	.04
ECR anxiety		.17	.68**	.61**	.28	.34*	−.23
ECR-R avoidance			.41**	.29	.26	.23	−.20
ECR-R anxiety				.49**	.30*	.22	−.21
STAI trait					.49**	.50**	−.13
STAI state						.34*	.01
BDI							.03

* $p < .05$.
** $p < .01$.

3.1.2. Materials and apparatus

These were identical to Experiment 1 except the ECR-R was also administered and sad facial expressions were no longer included as cue stimuli in the spatial cueing task. The ECR-R is a 36-item self-report attachment measure developed by Fraley et al. (2000). Like the ECR, the ECR-R yields scores on two dimensions, Attachment Avoidance (or Discomfort with Closeness and Discomfort with Depending on Others) and Attachment Anxiety (or Fear of Rejection and Abandonment).

3.1.3. Procedure

This was identical to Experiment 1 except for the following details: three SOAs (300 ms, 550 ms, and 1050 ms) and only three emotional face cues (angry, happy, and neutral) were used. In the current experiment the 12 practice trials were followed by 576 experimental trials; 48 valid and 16 invalid trials in each experimental condition. Participants were able to take a short break after each block of 72 trials. In keeping with the method of Dewitte and De Houwer, the ECR-R was completed following the attention task.

3.2. Results

Trials with errors (4.8%) were removed as were the data from one participant who made more errors than 3SDs above the mean (errors on 25% of trials) and another who had an overall mean response time more than 3SDs slower than the rest of the sample. These data were not analysed further. The analysis strategy followed that from Experiment 1.

Table 4
Mean correct response times (ms), standard deviations (SD), and cue validity effects (CVE) following the presentation of the three emotional face cues as a function of SOA (300 ms, 550 ms, 1050 ms) and cue validity (valid or invalid) in Experiment 2.

SOA	Cue emotion	Cue validity	*M*	SD	CVE
300 ms	Angry	Valid	435	50	33
		Invalid	468	56	
	Happy	Valid	433	55	43
		Invalid	476	68	
	Neutral	Valid	439	52	41
		Invalid	480	67	
550 ms	Angry	Valid	437	54	38
		Invalid	475	53	
	Happy	Valid	428	57	45
		Invalid	473	65	
	Neutral	Valid	435	47	41
		Invalid	476	58	
1050 ms	Angry	Valid	440	49	32
		Invalid	472	52	
	Happy	Valid	435	56	46
		Invalid	481	65	
	Neutral	Valid	439	51	35
		Invalid	474	51	

[3] Our failure to replicate the attachment-related findings of Dewitte and De Houwer (2008) in Experiment 1 may be due, in part, to our use of a different measure of adult attachment than that used by Dewitte and De Houwer. In order to rule out this possibility Experiment 2 included two measures of adult attachment orientation: the ECR questionnaire used in Experiment 1 and the Experiences in Close Relationships – Revised (ECR-R; Fraley, Waller, & Brennan, 2000) used by Dewitte and De Houwer. The conclusions from our studies, however, are unchanged by using the ECR-R data and here we report only the data obtained using the ECR.

[4] While this is a smaller sample than used in Experiment 1 it is comparable to the number of participants tested by Dewitte and De Houwer (2008; $n = 42$) and by Fox et al. (2002; $n = 34$).

Table 4 displays the interparticipant means of median reaction times (ms) and SDs from data collected in Experiment 2. Inspection of these data suggests both a validity effect (i.e., faster responses in valid compared with invalid trials) as well as a modulation of this effect by cue emotion. Unlike the data from Experiment 1, responses following happy cues are associated with slower response times than those following angry or neutral cues. The data were subjected to a 2 (cue-validity) × 3 (cue-emotion) × 3 (SOA) repeated measures ANOVA. There was a main effect of cue validity, $F(1, 44) = 144.7$, $p < .001$, $\eta_p^2 = .77$, reflecting faster responding of approximately 39 ms in valid compared with invalid trials. This effect was qualified by a marginally significant two-way interaction between cue validity and cue emotion, $F(2, 88) = 3.1$, $p = .051$, $\eta_p^2 = .065$. Further analysis of the emotion effect broken down by cue validity revealed that there was a main effect of cue emotion on valid trials, $F(1.7, 74.0) = 3.5$, $p = .042$, $\eta_p^2 = .074$, but not on invalid trials, ($p > .3$) suggesting emotion modulated engagement with the cue. Examination of the cue validity effects revealed validity effects following happy face cues (44 ms) were larger than those following angry face cues (35 ms), $t(44) = 2.4$, $p = .019$. In contrast, the cue validity effects did not differ for the angry and neutral, or for the happy and neutral, emotional cues, $p > .14$. With the exception of an interaction between SOA and cue emotion that approached significance, $F(4, 176) = 2.2$, $p = .07$, no other effects or interactions were significant, $p > .4$.

3.2.1. Attachment orientation

We again entered, as covariates, participants' mean-centred scores on the attachment anxiety and attachment avoidance subscales of the ECR into the repeated measures ANOVA reported with the full data set. There was a marginally significant interaction between cue emotion and attachment anxiety, $F(2, 82) = 2.87$, $p = .062$, $\eta_p^2 = .065$. Of more direct interest was a significant three-way interaction between cue validity, cue emotion, and attachment avoidance, $F(2, 82) = 4.77$, $p = .011$, $\eta_p^2 = .104$. In order to qualify this interaction we calculated regression slopes for each cue validity effect. Only the angry cue validity effect was predicted by attachment avoidance (standardised beta = −.29, $r^2 = .084$, $p = .053$; all other $p > .19$). As Fig. 2 shows, as attachment avoidance scores increase, the angry cue validity effect decreases.

3.2.2. Anxiety

Following the approach in Experiment 1 we entered, as covariates, participants' scores (mean-centred) on both the state and trait components of the STAI, as well as their interaction term, to the repeated measures ANOVA reported above. There was a marginal interaction between cue emotion and trait anxiety, $F(2, 82) = 2.9$, $p = .06$, $\eta_p^2 = .066$, which was qualified by a three-way interaction between cue emotion, SOA, and trait anxiety, $F(4, 164) = 4.04$, $p = .004$, $\eta_p^2 = .09$. There were interactions between cue validity and state anxiety, $F(1, 41) = 6.03$, $p = .018$, $\eta_p^2 = .128$, cue validity and the anxiety interaction term, $F(1, 41) = 6.81$, $p = .013$, $\eta_p^2 = .142$, and cue validity, cue emotion and trait anxiety, $F(2, 82) = 3.66$, $p = .03$, $\eta_p^2 = .082$. These interactions were qualified by a further critical interaction between cue validity, cue emotion, and the anxiety interaction term, $F(2, 82) = 3.35$, $p = .04$, $\eta_p^2 = .076$.

As in Experiment 1, to help clarify this interaction, we conducted three individual stepwise multiple regressions (one for each of the three emotional facial expressions) with state and trait anxiety (mean-centred) entered as predictors in a first step, and the interaction term entered in a second. This approach yielded only one significant effect: for the cue validity effect following angry face cues. While step one of the model (state and trait anxiety) was not significant (standardised betas: trait anxiety = −.312, state anxiety = .298, $R^2 = .096$, $ps > .07$), the amount of variance explained by the model significantly increased from step1 to step 2 (i.e., with the addition of the interaction term), standardised beta for the interaction term = .472, $\Delta R^2 = .216$, $p = .001$. The final regression equation (step 2) featuring state and trait anxiety, as well as the interaction term was also significant, $R^2 = .312$, $F(3, 41) = 6.21$, $p = .001$.

Again following the approach in Experiment 1, to illustrate the interaction between state anxiety, trait anxiety and the angry cue validity effect, we plotted the regression of state anxiety on angry cue validity at three levels of trait anxiety: the mean and ±1SD of the mean (Cohen et al., 2003). As Fig. 3 shows, both mean and high trait anxiety are associated with an increasing cue validity effect at increasing levels of state anxiety. In contrast, low trait anxiety is associated with a decreasing cue validity effect at increasing levels of state anxiety. Analysis of the simple slopes indicate that only the regression slopes for the medium and high trait anxiety data are

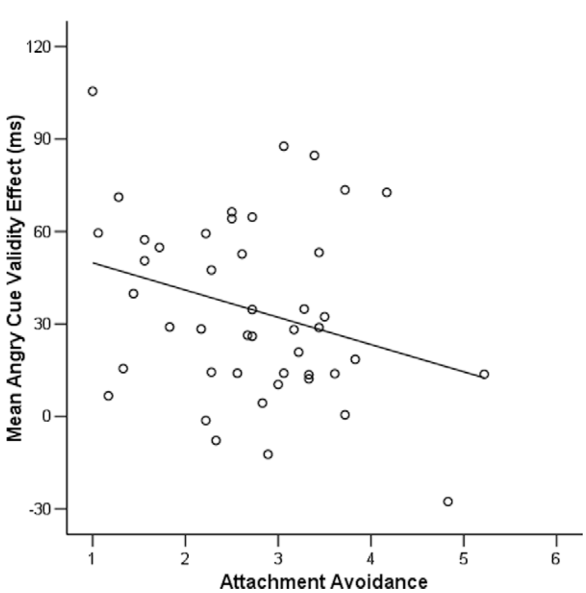

Fig. 2. Cue validity effect (ms) in Experiment 2 following angry cues as a function of attachment avoidance.

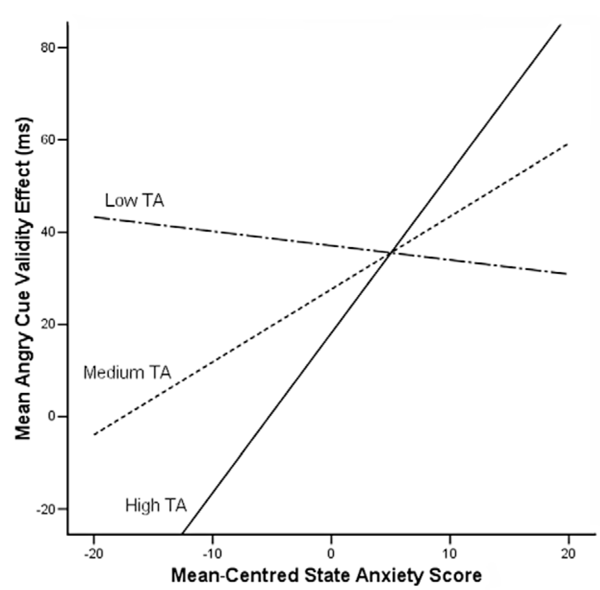

Fig. 3. Cue validity effect (ms) in Experiment 2 following angry face cues as a function of state anxiety for three levels of trait anxiety (medium (mean), high (+1SD), and low (−1SD)).

significant, standardised beta = .061, $t(40) = 2.57$, $p = .01$, and standardised beta = .87, $t(40) = 3.98$, $p < .001$, for the medium and high trait data, respectively (other $p > .6$).

3.3. Discussion

Consistent with the data reported in Experiment 1, the results from Experiment 2 revealed a clear cue validity effect of a very similar magnitude (~40 ms). This, in turn, was again modulated by cue emotion. In contrast with Experiment 1, however, effects of cue emotion were present on valid, rather than invalid, trials suggesting the attentional component of engagement, rather than disengagement was affected. The magnitude of the cue validity effect, furthermore, was greater following happy cues than it was following angry cues. These findings do not support the notion of an overall threat-related processing bias as suggested by the data in Experiment 1. They suggest, on the contrary, that angry faces influenced the allocation of attention to a lesser extent than did happy faces. Neither the cue validity effect, not its interaction with cue emotion, were modulated by SOA.

3.3.1. Attachment orientation

The attachment-related effects from Experiment 2 differ from those found in Experiment 1 in two ways: (1) they are specific to the angry trials rather than happy cue trials; (2) the relationship between the cue validity effect and attachment is a function of attachment avoidance rather than attachment anxiety. Thus, we have not replicated the key attachment-related effects from Experiment 1. Despite this, the attachment-related findings from Experiment 2 do resemble those seen by Dewitte and De Houwer (2008) in a very similar study. Experiment 2 finds a negative relationship between attachment avoidance and the angry cue validity effect where as attachment avoidance scores increase, the angry cue validity effect decreases. Dewitte and De Houwer reported a similar negative relationship except it was seen only when both attachment avoidance and attachment anxiety were high.

3.3.2. Anxiety

In Experiment 2 the effects of emotion on the allocation of visual attention were modulated by individual differences in anxiety. The interaction between state and trait anxiety was again shown to modulate allocation of attention to the emotional cues. The current effects, though, differ from those seen in Experiment 1 since they relate to the cue validity effect from angry trials rather than from happy trials. In Experiment 2, high trait anxiety was associated with a positive relationship between state anxiety and the magnitude of the cue validity effect following angry cues (i.e., at high levels of trait anxiety, high state anxiety was associated with a relatively large cue validity effect for angry faces). While not being consistent with the anxiety-related data in Experiment 1, these findings are somewhat consistent with Fox et al. (Experiment 2, 2001) who reported high state anxious individuals took longer to disengage from an angry face cue (i.e., longer responses on invalid trials) than did those with low state anxiety. The interaction between trait and state anxiety, however, was not assessed in the Fox et al. study.

In summary, results from Experiment 2 again show clear cue validity effects. The magnitude of these effects is not influenced by the SOA between cue and target. As in Experiment 1 the magnitude of the cue validity effect is modulated by the emotional expression of the cue but unlike Experiment 1 the effects following happy cues are larger than those following angry cues. We again find that individual differences in both attachment orientation and anxiety are related to the magnitude of cue validity effects. However, we do not replicate our own findings from Experiment 1.

4. Experiment 3

One procedural factor which could account for the failure to directly replicate previous attachment-related effects (Dewitte & De Houwer, 2008) is our use of emotional cues that are informative of target location (i.e., the cues provide valid information about the location of the target on three-quarters of trials) rather than non-informative cues (i.e., the cue is equally likely to be invalid as valid). This was to comply with previous research using this paradigm to examine individual differences in anxiety (e.g., Fox, Russo, Bowles, & Dutton, 2001). Given that the relationship between cue and target is itself known to influence the allocation of visual attention (Müller & Findlay, 1988) and non-informative cues were employed by Dewitte and De Houwer, we used non-informative cues in Experiment 3.

4.1. Participants

Forty-four undergraduate students (34 female) from the University of Bristol (mean age 21, range 18–31) took part for cash (£6) or course credit. Table 5 shows the relationships between responses on all completed questionnaire measures.

4.2. Materials and apparatus

These were identical to Experiment 2.

4.3. Procedure

This was identical to Experiment 2 except the number of valid and invalid cue trials was now equal, rendering the cue uninformative. In the current experiment the 12 practice trials were followed by 288 experimental trials; 16 valid and 16 invalid trials in each experimental condition. Participants were able to take a short break after each block of 72 trials.

4.4. Results

Trials with errors (3.6%) were removed and not analysed further. Analysis continued on the parameters set out in Experiment 1. Table 6 displays interparticipant means of median response times (ms) and SDs for each of the within-subjects conditions across the whole sample. Inspection of these data suggests a cue validity effect at both the 300 ms and 550 ms SOAs, which has subsided at the 1050 ms SOA. The magnitude of the cue validity effect again appears to be dependent on the cue emotion. The data were subjected to a 2 (cue-validity) × 3 (cue-emotion) × 3 (SOA) repeated measures ANOVA. There was a main effect of cue validity, $F(1, 43) = 14.5$, $p < .001$, $\eta_p^2 = .25$, reflecting faster responding in valid compared with invalid trials. This was qualified by a significant interaction between cue validity and SOA, $F(2, 86) = 7.5$, $p < .01$,

Table 5
Pearson correlation coefficients (r) for the scores on all questionnaire measures in Experiment 3.

	ECR anxiety	ECR-R avoidance	ECR-R anxiety	STAI trait	STAI state	BDI	SDS
ECR avoidance	.11	.63**	.22	.28	−.01	.31*	.17
ECR anxiety		.12	.75**	.61**	.13	.39**	.28
ECR-R avoidance			.15	.16	−.09	.12	.08
ECR-R anxiety				.46**	.21	.31*	.30*
STAI trait					.24	.58**	.56**
STAI state						.17	.22
BDI							.43**

* $p < .05$.
** $p < .01$.

Table 6
Mean correct response times (ms), standard deviations (SD), and cue validity effects (CVE) following the presentation of three emotional face cues as a function of SOA (300 ms, 550 ms, 1050 ms) and cue validity (valid or invalid) in Experiment 3.

SOA	Cue emotion	Cue validity	*M*	SD	CVE
300 ms	Angry	Valid	451	56	9
		Invalid	460	57	
	Happy	Valid	452	69	28
		Invalid	480	68	
	Neutral	Valid	450	62	13
		Invalid	463	61	
550 ms	Angry	Valid	449	56	12
		Invalid	461	51	
	Happy	Valid	452	66	21
		Invalid	473	82	
	Neutral	Valid	449	59	14
		Invalid	463	63	
1050 ms	Angry	Valid	463	67	−8
		Invalid	455	54	
	Happy	Valid	462	76	7
		Invalid	469	68	
	Neutral	Valid	466	76	−6
		Invalid	460	71	

$\eta_p^2 = .15$. Post-hoc analysis revealed significant cue validity effects at the 300 ms (cue validity effect = 17 ms) and 550 ms (cue validity effect = 15 ms) SOAs, $t(43) = 3.4$, $p = .002$ and $t(43) = 4.4$, $p < .001$, respectively, but no significant cue validity effect at the 1050 ms (cue validity effect = 2 ms) SOA.

There was also a marginally significant main effect of cue emotion, $F(2, 86) = 2.9$, $p = .061$, $\eta_p^2 = .06$ which was qualified by a significant two-way interaction between cue validity and cue emotion, $F(1.7, 71.8) = 5.1$, $p = .012$, $\eta_p^2 = .11$. Further analysis revealed there was no main effect of cue emotion on valid trials, $p = .9$. There was, however, a main effect of emotion on invalid trials, $F(2, 86) = 7.26$, $p = .001$, $\eta_p^2 = .14$. Examination of the cue validity effects revealed that validity effects following happy face cues (18 ms) were larger than those following both angry (5 ms), $t(43) = 2.5$, $p = .015$, and neutral (7 ms), $t(43) = 2.5$, $p = .016$, face cues. In contrast, the cue validity scores did not differ between the angry and neutral emotional cues, $t < .7$.

4.5. Attachment orientation

We again followed the analysis approach set out in Experiments 1 and 2. Attachment anxiety and avoidance scores (mean-centred) from the ECR were entered, along with their interaction term, as covariates into the repeated measures ANOVA reported above. ECR scores did not interact with any of the other factors (i.e., cue validity, cue emotion, SOA), $p > .14$, including the critical interaction found by Dewitte and De Houwer (2008) between cue validity, cue emotion, and the attachment interaction term ($p > .7$).

4.6. Anxiety

Following the approach taken in the previous experiments we entered into the repeated measures ANOVA, as covariates, participants' mean-centred state and trait anxiety scores, as well as the state-trait anxiety interaction term. This revealed a significant interaction between cue emotion, SOA, and the interaction term, $F(4, 160) = 3.8$, $p = .006$, $\eta_p^2 = .09$. The only interaction featuring anxiety and the critical variable of cue validity to approach significance was a four-way interaction between cue validity, cue emotion, SOA, and state anxiety, $F(4, 160) = 2.23$, $p = .068$, $\eta_p^2 = .05$. Given that a similar interaction has been found previously (Fox et al., 2002) we clarified the interaction by conducting individual repeated measures ANOVA on the cue validity effects at each SOA. This revealed that the cue validity effect was modulated by state anxiety at the 300 ms SOA, $F(2, 84) = 3.23$, $p = .045$, $\eta_p^2 = .07$, but not at the 550 ms or 1050 ms SOAs ($p > .13$). In order to further clarify the interaction between cue validity effect and state anxiety we used regression analyses to examine the relationship between state anxiety and each of the three cue validity effects (i.e., angry, happy, and neutral). The only regression slope approaching significance was that featuring the happy cue validity effect (standardised beta = −.28, $r^2 = .08$, $p = .068$; other $p > .4$) suggesting that as state anxiety increases, the cue validity effect associated with happy cues decreases (see Fig. 4).

4.7. Discussion

Consistent with the data reported in Experiments 1 and 2, the results from Experiment 3 revealed a clear cue validity effect, albeit an effect of smaller magnitude, and one that is modulated by SOA. The reduction in the size of the cue validity effect and its modulation by SOA are predictable consequences of switching from informative (Experiments 2 and 3) to non-informative cues (Müller & Findlay, 1988). As in the previous two experiments the cue validity effect was modulated by cue emotion. Further inspection, however, reveals that the specifics of the interaction between the cue validity and cue emotion have not been reliably demonstrated across experiments. Unlike Experiment 1, but in line with Experiment 2, the cue validity effect in Experiment 3 was larger for happy face cues compared with angry face cues. Unlike Experiment 2, but in line with Experiment 1, the observed differences in the cue validity effect were driven by differences in response times from invalid trials rather than valid trials. Thus, none of the basic attentional effects involving emotion have been replicated across these experiments.

4.8. Attachment orientation

Adult attachment orientation did not modulate the relationship between cue validity and cue emotion. This finding does not match any other attachment-related findings from Experiments 1 and 2. Experiment 1 found a positive relationship between attachment anxiety and the happy face cue validity effect, whereas Experiment

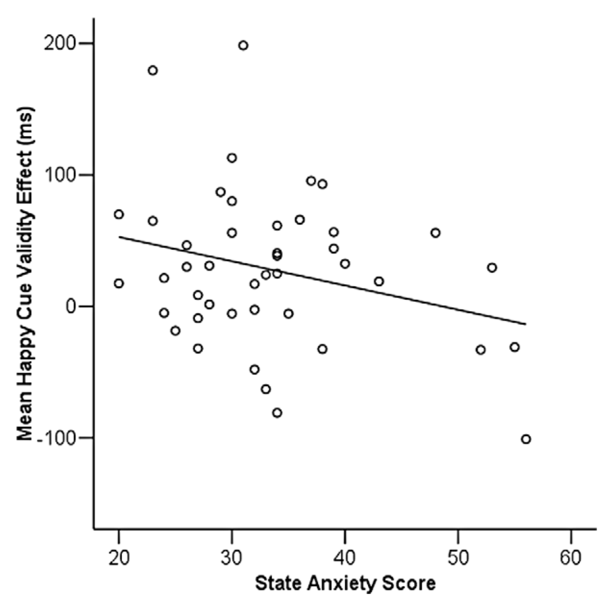

Fig. 4. Cue validity effect in Experiment 3 following happy cues as a function of state anxiety at a SOA of 300 ms.

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2 found a negative relationship between attachment avoidance and the angry face cue validity effect. Thus, attachment-related effects have not been replicated in these experiments.

4.9. Anxiety

Effects of emotion on the allocation of visual attention were also modulated by individual differences in anxiety, although in the current experiment the effect was only marginal. A negative relationship was observed between state anxiety and the happy cue validity effect suggesting higher state anxiety levels are associated with a smaller happy cue validity effect. This effect is reminiscent of the effect seen in Experiment 1 which also found a negative relationship between state anxiety and the happy cue validity effect, but then only in those with high trait anxiety. Such a relationship, however, was not observed in Experiment 2. Thus, not one anxiety-related effect was replicated in these experiments.

5. General discussion

The current study was designed to investigate the allocation of attention to emotional facial expressions, primarily as a function of individual differences in adult attachment orientation, but also as a function of individual differences in self-reported anxiety. Large inconsistencies in our results across experiments, however, do not allow us to draw meaningful conclusions concerning these issues. Across three experiments we did find strong cue validity effects, supporting the notion that sudden-onset stimuli presented in peripheral vision influence the allocation of attention both when those stimuli are informative (Experiments 1 and 2) and non-informative (Experiment 3) of target location (Posner & Cohen, 1984). We also found that this effect dissipated at our longest SOA (1050 ms), but only with non-informative cues (Experiment 3) (Müller & Findlay, 1988). A weak–moderate (Cohen, 1988) modulation of the cue validity effect by cue emotion was obtained in each of the experiments, but was not consistent. This inconsistency is illustrated in Fig. 5 which presents cue validity effects for all emotional expressions in each experiment and at each SOA. Comparing only responses in the 300 ms SOA conditions,[5] it is clear that the relative size of the cue validity effect changes across experiments with angry and neutral cues delivering relatively large cue validity effects in Experiment 1, and happy cues delivering relatively large cue validity effects in Experiments 2 and 3.

Inconsistency is also very much a feature of the individual difference findings in the current study. Including the experiment published by Dewitte and De Houwer (2008) and those presented here we can compare four experiments looking at the relationship between attachment orientation and attentional biases when processing emotional stimuli. Each of these studies points to different conclusions (despite three of these experiments examining the allocation of attention at the same SOA of 550 ms). Given these inconsistencies we do not feel the current studies offer any evidence for or against the theoretical questions raised in the introduction. Additionally, the anxiety-related findings we report vary across experiments and do not replicate themselves or previous work (Fox et al., 2001, 2002; Koster, Leyman, De Raedt, & Crombez, 2006) despite the method being based closely on one of those studies (Fox et al., 2002).

An unavoidable question arises from the current set of experiments concerning the reliability of the Posner cueing paradigm when employing emotional stimuli as cues. While most studies

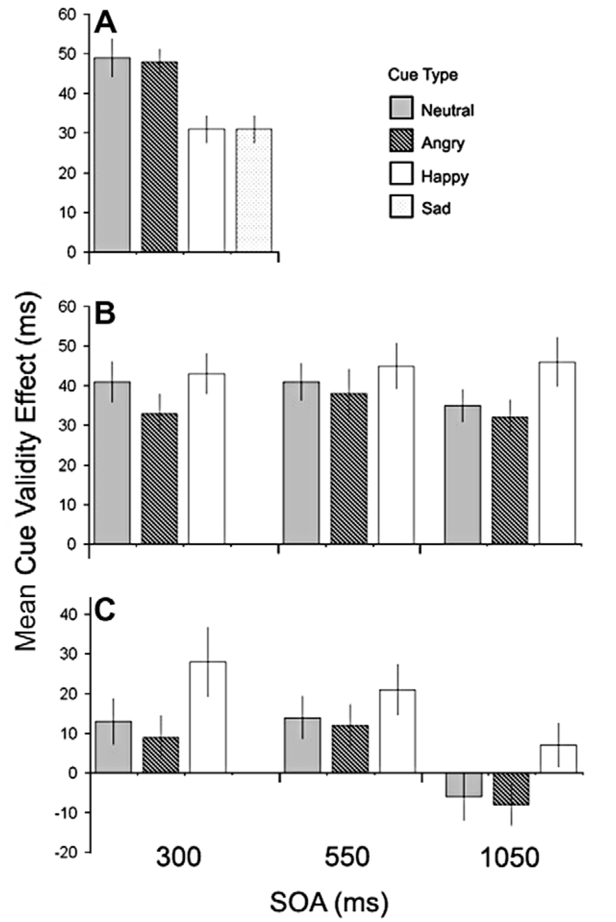

Fig. 5. Mean cue validity effects (with standard error bars) for each emotional expression at each SOA. Panels A–C denote Experiments 1–3, respectively.

agree that emotional facial expressions do modulate the allocation of attention in the Posner cueing paradigm, inconsistency appears to be a feature of these studies with some evidence that emotional faces (angry and happy) are associated with specific attentional biases (Koster, Verschuere, Burssens, Clusters, Crombez, 2007) and other evidence of no bias at all (Koster et al., 2006). Even when such factors as SOA, and the informative nature of the cues (factors known to influence the allocation of attention) are equated, inconsistencies are observed. For example, two studies by Fox and her colleagues (Fox et al., 2001, 2002) found that high anxious individuals take relatively long to disengage attention from emotional faces. The attentional bias in one study (Experiments 2 and 3; Fox et al., 2001) was specific to threat-related faces but in the other study (Experiment 1; Fox et al., 2002) was seen in both happy and threat-related faces.

Typically, when inconsistencies are found across experiments using this paradigm, differences in methodology are cited to explain these inconsistencies (e.g., Koster, Crombez, Verschuere, Vanvolsem, & De Houwer, 2007). Doubtless this is a very important consideration with the manipulation of some experimental parameters (e.g., SOA, cue–target relationship, stimulus intensity) resulting in predictable differences in the allocation of attention (see the current study and manipulation of the cue–target relationship in Experiment 2 vs. Experiment 3 for instance). There were a number of changes in methodology between Experiment 1 and Experiment 2 (e.g., an increase in the number of SOAs, removal of sad faces) but none that would be predicted a priori to result in the qualitative shift of bias favouring angry faces in Experiment 1 to happy faces in Experiment 2.

[5] We conducted a further 3 (cue validity effect: angry, happy, neutral) × 3 (Experiment 1, 2, and 3) mixed ANOVA on the bias scores at 300 ms. This revealed a highly significant interaction between cue validity effect and Experiment, consistent with the observations made from Fig. 5 ($F(4, 396) = 6.1$, $p < .001$, $\eta_p^2 = .06$).

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Along with the inconsistencies observed in the wider literature, the data from the current experiments therefore suggest that there may be a problem with the reliability of the spatial cueing task when used with emotional stimuli. Future research should directly examine the reliability of this paradigm. This is of particular importance given that a recent study demonstrated that the dot-probe task (a paradigm not too distantly related to the spatial cueing task) was unreliable as a measure of attentional bias to threat-related stimuli (pictures and words) in individuals with non-clinical levels of anxiety (Schmukle, 2005).

The data from the current study represent a challenge to researchers using the spatial cueing paradigm to investigate the allocation of attention to emotional stimuli. In each experiment we found interpretable, yet distinct effects of both emotion and individual differences in adult attachment orientation and anxiety. Any one of the experiments we describe here could have stood alone in a research report and been meaningfully interpreted within the context of the extant literature. It is only when the three studies are considered together that fundamental differences are observed. At the very least it suggests that while effects of emotion are always present in this paradigm, they are very sensitive to small procedural changes. This makes it very difficult to interpret the role emotion has in the allocation of visual attention and suggests that the modified spatial cueing paradigm may not usefully elucidate the psychological processes of interest.

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