



# Spatial Attention to Emotional Images and Psychopathic Personality Traits

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## Abstract

Psychopathy has often been thought to be associated with a deficit in processing of the affective content of stimuli. This hypothesis was tested by examining if stimuli that depicted a threat to the viewer, or stimuli that depicted distressing scenes, would produce an automatic shift in spatial attention, and whether this effect would be modified by individual differences in trait psychopathy as conceptualised by the triarchic model of psychopathy. Using a large mixed gender community sample ( $N=286$ ) it was found that spatial attention was averted *away* from threat stimuli for both short (200 ms) and long (500 ms) periods from cue to target, while the distress cues did not produce any spatial attention shifts. The trait of Meanness was found to be associated with a reduction in the effect of threat stimuli, while the trait of Disinhibition was found to be associated with an increase in this threat effect. However, the dot-probe task showed poor reliability. We conclude that the callous unemotional aspects of psychopathy, as captured by the Meanness scale, are underpinned by a lack of response to affective information, whereas impulsive/irresponsible traits of psychopathy, as captured by the Disinhibition scale, are underpinned by an exaggerated response to such affective information.

**Keywords** Dot probe task · psychopathy · triarchic model · TriPM · spatial attention · Meanness · Disinhibition

Psychopathy is a personality disorder characterised by a cold-hearted and self-centred interpersonal style alongside irresponsible and antisocial behaviors (Hare, 1999). The condition is associated with a variety of criminal behaviors of which violence to others is prominent (Reidy et al., 2015). Problems in the processing of emotions have long been thought to be at the heart of the disorder (Blair et al., 2005; Cleckley, 1941; Lykken, 1957; Nentjes et al., 2022) - though see Baskin-Sommers & Brazil (2022). In the present study, we examined if stimuli that contain strong affect, such as the depiction of threats or distressing scenes, have the same attention-grabbing properties for people who score

highly in the personality traits of psychopathy as they do for people low in such traits.

The human visual system has limited capacity to process the whole of the image projected onto the retina and so prioritises what information is processed via the allocation of attention to parts of the image (Snowden et al., 2012). It would seem sensible that this allocation of attention was based on the current needs of the person and that certain types of information, such as the sudden onset of a new object (Schreij et al., 2008) or loud noise (Spence & Driver, 1997), would receive appropriate attention in order to be processed. It has therefore been suggested that certain classes of image, such as those that carry a strong affective component, might also attract and hold visual attention (Vuilleumier & Huang, 2009).

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## The Dot-Probe Task

The dot-probe task (Macleod et al., 1986) was invented to examine the covert (i.e., without any eye movement) movement of visual attention and builds upon the idea that targets are processed more quickly/accurately when they occur

at the location of visual attention rather than some other location (Posner, 1980). Typically, two cues are presented either side of a fixation mark and some time later they are removed and replaced by a target stimulus that occurs at one of the locations (see Fig. 1). If the cues differ in affective content (e.g., one affective cue and one neutral cue) it is thought that spatial attention will be more attracted to the location of the affective cue and therefore targets that appear at this location will be processed more efficiently than those that occur at the other location. While a variety of stimuli, such as words and images of facial expressions, have been used as the cue stimuli (see Okon-Singer et al. (2013) for a review), the present review and study are confined to the use of pictorial images depicting scenes that have an emotional content as these stimuli are more likely to be processed via early visual processes, tap evolutionary-distant mechanism, and produce greater effects than these other stimuli (Thom et al., 2014).

Mogg et al. (2000) examined the role of “threat” by presenting high threat (images of mutilated bodies, murder victims) and mild threat (e.g., images of a soldier holding a gun) as cues alongside neutral images (e.g., person playing the piano). They found that people were indeed faster when the targets appeared at the location of the high threat images, though no bias was found using the mild threat images. A similar result has also been reported for images of fear-relevant animals such as spiders and snakes (Lipp & Derakshan, 2005). Hence, this early research seems to support the simple notion that such threatening images have greater attention-grabbing properties than their low affect controls.

However, in a second study Mogg et al. (2000) found a different set of results. They found that increasing threat and increasing levels of anxiousness did produce a greater attention to the threat. However, for people who were not anxious and when using mild threats, RTs were faster at the opposite location to the threat cue – a type of threat avoidance. Later results of meta-analyses appear to support this finding. Bar-Haim et al. (2007) meta-analysed 19 studies that used the dot-probe task with “moderate” cue to target time intervals (see below) in non-anxious participants and found a small ( $d = -0.06$ ) but non-significant effect of bias away from the threat stimuli. Anxious people showed a bias ( $d = 0.31$ ) towards the threat. Frewen et al. (2008) provide more specific data on studies that have used pictures as the threat cues ( $k = 6$ ). They too report that these images produce attention away from the threat location for low anxious individual but towards the threat for high anxious individuals (though also see Zvielli et al., 2014).

More recent studies have also questioned the idea that threat stimuli have any reliable effect on spatial attention. Kappenman et al. (2014) used a large ( $N = 96$ ) sample of

participants but failed to find any bias towards or away from the threatening images. They also note that the dot-probe task showed poor reliability on a split-half (odd vs. even) test – a finding echoing previous reports (Schmukle, 2005; Staugaard, 2009) using other stimuli on the dot probe task. Indeed, the lack of reliability of this task has been used an exemplar of the need to report the reliability of behavioral tasks (Parsons et al., 2019).

## Threat vs. Distress

A further complication to the interpretation of many previous studies of the dot-probe task may be the nature of the images used. Many experiments have used a variety of stimuli such as mutilated bodies, animals attacking, or guns pointing at the viewer. While many of these can be seen as “threats” (including a mixture of both phylogenetic and ontological threats - Shapouri & Martin, 2022) others, such as mutilated bodies, may induce feelings of disgust, distress, or revulsion (which we will refer to as “distress”). In experiments that have looked at interference effects (rather than shifts of spatial attention) of such images, it has been shown that these two types of images have different effects (Caretie et al., 2011; Krusemark & Li, 2011; Schimmack, 2005; Van Hooff et al., 2013). Snowden and Gray (submitted) examined a range of negatively-valenced images using an interference paradigm across a range of spatial and temporal configurations and showed that distress images consistently produced interference effects, whereas stimuli that depicted threats only produced (small) interference effects when the target and interfering image were spatially separated.

So far there have been few studies that have considered and compared different forms of negative affective images in the dot-probe task. Carlson et al. (2009) used a range of phylogenetic (evolutionary relevant) and other (evolutionary irrelevant) threat stimuli and found similar results for the two types. Both induced attention towards the threat – though the effects were very small ( $< 6$  ms). This study is also atypical in that the cues were presented very briefly (33 ms) before being masked (producing a cue to target interval of 133 ms). Zvielli et al. (2014) tested a range of stimuli that could all be regarded as “threats” (dogs, snakes, angry faces, weapons, violence) and found small effects ( $< 10$  ms and  $d < 0.3$ ) of attention towards these threats in a sample of high-anxious participants. However, they also note that within the sample there were some individuals that showed consistent attention towards all threats (34%), some that showed consistent attention away from the threats (21%), while others were not consistent in their attentional bias. So far there has been not direct test of threat vs. distress

using the dot-probe task and so the present study used both a “threat” condition and a “distress” condition.

### Cue Duration Effects on DPT.

The time course of the spatial attention has been well studied for simple stimuli that attract attention exogenously (i.e. the automatic shift of attention even under conditions where the cue offers no information about the likely location of the target). Studies such as Nakayama and Mackeben (1989) show that the effects of exogenous attention peak at around 100 ms from cue to target and dissipate over the next few hundred milliseconds. Hence, its effects are transient.

Studies using the dot-probe task typically use a cue to target interval of 500 ms. While direct comparisons with the simple cues used by Nakayama and Mackeben (1989) are difficult, as it presumably takes more time to encode the affective component of the image, the use of such long cue to target intervals might “miss” the transient effects of spatial attention or might allow for attention that was originally allocated to the affective image to have shifted away from this location. Few studies have systematically examined the effects of cue to target duration. As mentioned above, Carlson et al., (2009) used a brief and mask such that there was a 133 ms cue to target interval and showed that this brief interval still produced attention to the threatening images. Cooper and Langton (2006) used happy and angry (vs. neutral) faces as their affective cues and tested at both 100 and 500 ms cue to target intervals. At 100 ms they found attention towards the angry face, but this effect reversed when the interval was 500 ms (the happy faces showed just the opposite effect!). Hence, this study shows the possible importance of the cue to target interval in determining the location of spatial attention and that 500 ms (which has been used in most studies of the dot-probe effect) may not be ideal to isolate the early automatic movements of attention. In the present study we included a much shorter cue to target interval (200 ms) as well as the more standard 500 ms interval.

### Psychopathy and Emotional Deficits

A large variety of techniques have been used to demonstrate that the processing of emotional stimuli is compromised in those with psychopathic traits. However, the exact nature of this problem is not agreed upon, with some suggesting that the problem is specific to threat stimuli (Esteller et al., 2016), others to negatively-valenced stimuli (Burley et al., 2019; Patrick et al., 1993), and others to a more general deficit across emotional stimuli (Snowden et al., 2022).

For instance, Snowden et al. (2022) used the interference task to show that people with high psychopathic traits had less interference from both negative and positive images compared to those low in such traits. However, not all traits of psychopathy produced this effect. The Triarchic model of psychopathy (Patrick & Drislane, 2015) proposes that psychopathy is underpinned by three phenotypes – Boldness, Meanness, and Disinhibition. Boldness captures a fearless disposition with a tolerance to stressors and danger along with social dominance. Meanness captures a cold-hearted disposition including callousness, an inability to form close relationships, and a willingness to exploit others. Disinhibition captures impulsiveness and poor emotional regulation. Snowden et al. (2022) found that the traits of Meanness were most associated with this reduction in interference from both negative and positive images.

### Dot-Probe Task and Psychopathy

Despite its widespread usage in many clinical populations, there have been only a few studies of emotional processing in psychopathy using the dot-probe task. Kimonis et al. (2006) looked at the effects of both threat stimuli and distress stimuli (defined in their paper as a “child crying” rather than mutilated bodies) as well as positive images in a sample of children (mean age 9.3 years) who were screened for psychopathic traits. They calculated a “facilitation index” for the dot probe task which was the difference between a target appearing at the location of the affective picture (versus a neutral foil cue) versus one that occurred after a neutral image (versus another neutral foil cue)<sup>1</sup>. The cue to target interval was 500 ms. They found a robust facilitation for all three affective cues (>40 ms). Their measure of psychopathy was not related to the vigilance effect for the threat cues or the positive cues. However, there was the expected reduction in the effect as a function of psychopathy for the distress cues, which was confined to those children who also showed high levels of aggression.

Edalati et al. (2016) tested 33 male prisoners using a dot-probe task (cue to target interval of 500 ms) with cues of emotional faces (angry, happy, sad, fearful, versus neutral). The dot probe effect was calculated in the conventional manner ( $RT_{\text{neutral}} - RT_{\text{emotion}}$ ). The results were complex. Overall, the results suggest that attention was diverted away from the emotional faces. The only significant effect with respect to psychopathy was a positive relationship of the attention index to happy faces and the “affective” component of psychopathy. The authors interpret this as “a positive

<sup>1</sup> This is not the standard measure for the dot-probe task as most studies calculate the difference between the target appearing at the location of the affective image and it appearing at the neutral location.

association between psychopathy and attention towards happy... faces". However, as the overall effect was away from the happy faces it might be better interpreted as a reduction in the avoidance of the happy face.

Perhaps the most rigorous study to date is that of Kimonis et al. (2020) and is similar in many ways to the present study. Psychopathic traits relating to the triarchic model were measured in 117 men who completed a dot-probe task that had distressing (scenes of mutilation, assault, and starvation) and threat (pointed weapons, attacking animals). Two indices were calculated for each image type. For trials with a cue to target interval of 100 ms a "facilitation index" was calculated in the same manner as above (Kimonis et al., 2006). At 500 ms a "disengagement index" was calculated which reversed the scoring procedure for the facilitation index. It is important to note that this is the "reverse" of the vigilance score and now positive scores are indicative of slower RTs at the location of the emotional cue. The paper does not report the size or direction of these effects, however, our analysis of the archived data shows that the only significant effect was a positive disengagement index (20.6 ms) for the distressing stimuli which suggests that overall participants were slower at the location of the distressing images at 500 ms. There were no significant correlations between any of these indices and psychopathy. However, in a series of regression analyses they were able to detect a significant ( $p = .04$ ) interaction between Meanness and Disinhibition for the disengagement index for the threat stimuli. This interaction was interpreted as the Meanness scale being negatively related to the disengagement index (which can be rephrased as showing less slowing by the threat images) but only in those participants who also had high Disinhibition scores.

## Present Study

Given the complex and contradictory nature of previous findings on the relationship of psychopathy to shifts in spatial attention due to negatively-valenced images, the present study aimed to examine this further in a larger sample. The task contained images of both threats and distress so that separate effects could be calculated for each of these types of images. Given the differences found in previous research due to changes in cue to target interval (Cooper & Langton, 2006) the study also used two cue to target intervals: 200 ms which we hypothesised would isolate early automatic components of attention and 500 ms which is the "standard" interval. Our hypotheses were:

- 1) that attention would be drawn to the emotional images so RTs would be smaller for targets appearing at the

location of the affective image(s). We recognise, however, that many previous studies have found the opposite result (see above).

- 2) With respect to the differences between threat cues and distress cues, we predicted that the distress cues would produce a greater attentional bias than the threat cues as they have been shown to produce greater effects on emotional interference tasks (Van Hooff et al., 2013).
- 3) With respect to the differences between cue to target intervals (200 vs. 500 ms) we did not make any specific hypotheses but included this independent variable as a possible modifier of any attention biases.
- 4) The traits of psychopathy related to Boldness have been previously shown to be related to the processing of fear/threat stimuli (Esteller et al., 2016) – though see Verona et al., 2013). We therefore predicted that individuals high on these traits would reduce the bias effects for threat cues.
- 5) The traits of traits of psychopathy related to Meanness have been previously shown to be related to the processing of negative stimuli (Gray et al., 2022; Snowden et al., 2022). We therefore predicted that individuals high on these traits would reduce the bias effects for the negative cues. Given that Meanness is associated with a lack of empathy we also hypothesised that the moderation of biases due to Meanness would be more apparent in the distress condition than the threat condition.
- 6) The traits of psychopathy related to Disinhibition have been previously shown to be related to an increase the processing of some emotional images (e.g., Vanman et al., 2003). We therefore speculated that individuals high on these traits would have increased bias effects for the negative cues.

## Methods

### Participants

The study was powered to detect a small to medium effect size ( $r = .25$ ) with an alpha of 0.05, a power of 0.80, for a one-tailed test. Using software for estimating power of a Pearson's correlation the required sample size was determined to be 95. However, as we were concerned that the effects might differ for the two cue to target intervals (200 vs. 500 ms) which were manipulated between participants, we wanted at least this many in each of the cue to target interval conditions. In total 307 participants commenced the study (female = 266; male = 36; undisclosed orientation = 5) aged 18–40 years (18–20 = 268, 21–30 = 36, 31–40 = 3) all from the participant pool of the School of Psychology, Cardiff University and completed the study as part of their

**Table 1** Valence and arousal rating from the IAPS manual for the images used

	Valence Mean (SD)	Arousal Mean (SD)
Threat	2.88 (0.70)	6.60 (0.51)
Neutral Foil	6.40 (1.71)	4.52 (0.72)
Distress	1.71 (0.56)	6.72 (0.74)
Neutral Foil	6.05 (1.06)	4.04 (0.95)

required course credits. Two hundred and sixty-five (86.3%) participants self-reported their ethnicity as white, with 29 (9.1%) reporting as Asian, six (2.0%) as Black and eight (2.6%) reporting as mixed or undisclosed.

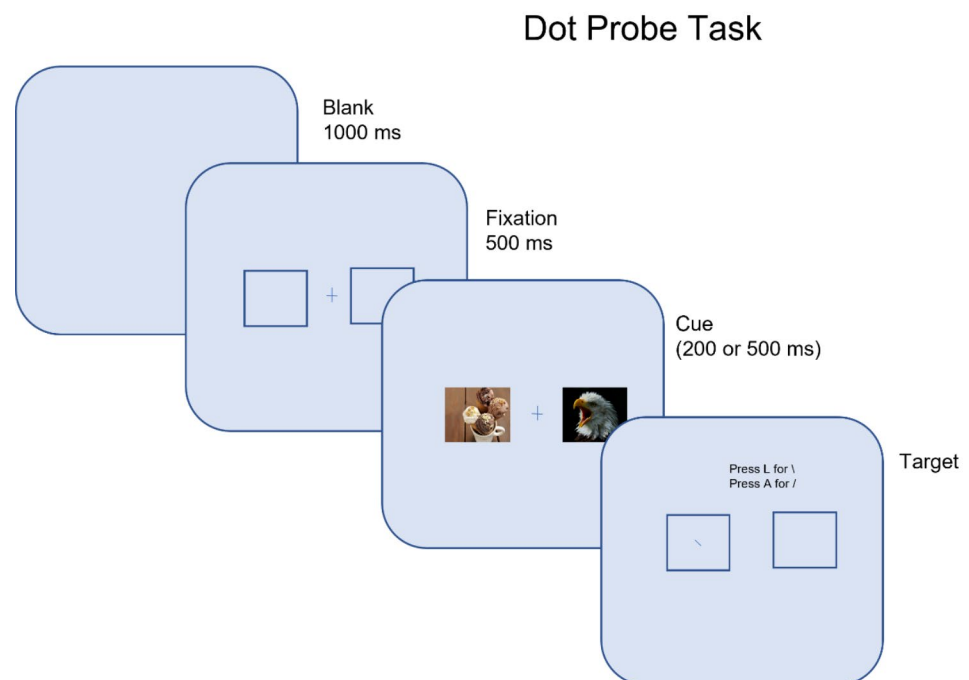
### The Dot Probe Task

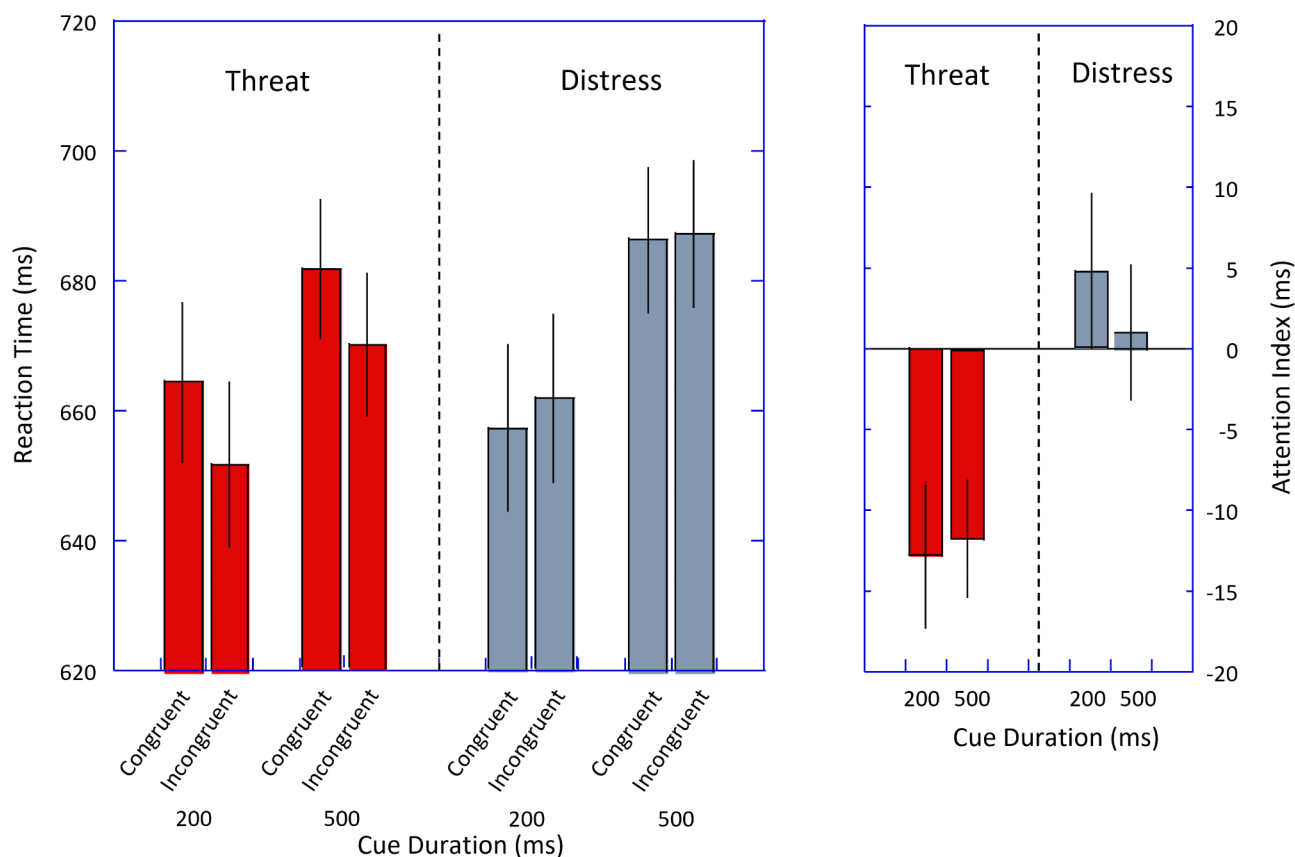
Stimuli for the main experiment were carefully selected. Images were chosen from the Affective Picture System (IAPS; Lang et al., 1997). For the threat cues we chose eight images that depicted a direct threat to the viewer and these included attacking animals (dog, snake, shark, bear), guns aimed at the viewer, and a man attacking with a knife. For the distress cues we chose images that would cause people to be upset and these included images of mutilated or injured bodies, people being attacked, and an image of a person holding a gun to their head. For each of the threat images we chose a neutral stimulus that matched the threat image in terms of image composition. For instance, for the snarling dog (threat) we chose an image of a dog that was passive (neutral), and for the shark (threat) an image of a porpoise playing (neutral). Most of these images were from the IAPS but one image was sourced on-line as we could not

find a suitable foil from the IAPS images. The same process was repeated for the distress images. In this instance, two images had to be sourced on-line. Ratings of valence and arousal for the images (taken from the IAPS manual) are shown in Table 1.

The images were then all resized to fit the placeholders and converted to black and white to avoid any differences in colour-cues. For the threat trials, we constructed eight cues consisting of the threat cue on one side and its foil on the other. The two images mean luminance and contrast were adjusted so that they were approximately equal. Another eight cues were constructed so that we had 16 cues with the threat cue on the left for eight and on the right for eight. Sixteen distress cues were constructed in the same manner.

The dot-probe task is illustrated in Fig. 1. On each trial participants first saw a blank screen for 1000 ms followed by a fixation cross and blank “holder squares”. On a typical 50 cm screen these holders would be 80 mm by 80 mm and centred 70 mm from the fixation cross. However, as the device used by each participant will vary so will these measurements whilst retaining their ratios. After 500 ms the holders were filled with two cue stimuli, and then after either 200 or 500 ms the target (10 by 1 mm) appeared at the centre of one of the holding squares along with a reminder of the correct response to make. These remained until the participant responded. The participant had to respond to the orientation of the target (clockwise or anticlockwise) via one of two buttons on the keyboard. A task where the decision to be made (clockwise vs. anticlockwise) was not related to the location of the cues was chosen to make sure

**Fig. 1** Illustration of a typical trial in the study.



**Fig. 2** Left panel : Reaction time is plotted as a function of cue duration and trial type (congruent refers to the target appearing at the location of the emotional cue, and incongruent when it appears at the location of the neutral cue). Data for the threat cues is on the left, and for

distress cues on the right. Error bars represent  $\pm 1$  SEM. Right panel: The Attention Index ( $RT_{\text{neutral}} - RT_{\text{emotion}}$ ) is plotted as a function of cue duration and threat type. Error bars represent  $\pm 1$  SEM.

the task was not contaminated by possible response priming or Simon effects (Simon, 1969).

In the main experiment each of the cues was presented with each of the four possible targets (left vs. right location, tilted clockwise or anticlockwise) for a total of 128 trials. These trials were presented in a new random order for each participant. In addition, the participant performed 16 practice trials before the main experiment that used two neutral cues that were not included in the main block.

### Triarchic Psychopathy Measure (TriPM, Patrick, 2010)

As psychopathy can be thought to be a dimension rather than a taxon (see Guay et al., 2007; Walters et al., 2007) it can be studied in non-forensic samples in the form of psychopathic personality traits. The TriPM is a self-report measure with three subscales: Boldness, Meanness, and Disinhibition. It consists of 58 questions, with 19 measuring Boldness, 19 measuring Meanness, and 20 measuring Disinhibition. Each question is answered via a 4-point Likert scale (scored from

0 to 3, higher scores indicating higher psychopathic traits). Missing responses in the self-completed TriPM questionnaires were filled by pro-rating the average score for the relevant subscale (though these were  $< 1\%$  of the scores).

### Procedure

The experimental protocol was approved by the School of Psychology Ethics Committee, and participants gave informed consent. Participants were recruited through the school's participant panel which advertised the study and warned that the stimuli to be used contained distressing images. Participants were asked to use a desktop or laptop computer and to access the study via the URL given to them. The participants were also asked to complete the study in a quiet and private environment due to the nature of images presented. Approximately half the participants were assigned to the 200 ms cue duration and half to the 500 ms cue duration. All aspects of the study were programmed using PsychoPy3 and run online via the Pavlovia.org website (Peirce et al., 2022).

Participants were presented with an information sheet with a further warning of the distressing nature of some of the images. To continue they had to agree to look at a page of “thumbnail” images of the stimuli to be used which was then presented to them so that they could decide if they wanted to take part in the main study. They then were asked to give their consent via a button press. They were then presented with a small number of demographic questions.

The dot-probe task followed and started with a set of instructions on the nature of the task and how to respond to the targets. They then completed 16 practice trials. A further reminder of the task instructions was given and they the participant completed the main block of trials. This took around 5 min. The TriPM questions were then presented one at a time and the participant gave their responses via keypresses (1–4) as to their answer. The option to not answer could be signalled by pressing the spacebar. The TriPM typically took around 5 min. The participant was then thanked and debriefed via a debrief form and given course credit for their participation.

## Data Analytic Plan

For the dot-probe task, trials on which the person made an incorrect response were noted, removed, and analysed separately. The reaction times (RTs) for all trials were then trimmed by the removal of trials that were too fast (<250 ms) or too slow (>1500 ms). Mean RTs for each condition were calculated for trials with a correct response. Participants were excluded from data analysis if their errors rate on the task was greater than 20% ( $n=13$ ). Participants whose RTs were deemed to be outliers (defined as >3SD from the group mean) were removed from further analysis ( $n=8$ ) leaving a total of  $N=286$  for data analysis.

The data for the RTs were slightly positively skewed, however levels of skew were small (<1) in all conditions and so parametric analysis was justified. Distributions from the self-report questionnaires were also inspected and found to approximate a normal distribution with all levels of skew <1.

Internal reliability (Chronbach’s alpha) was calculated for each of the psychopathy scales. The reliability of the dot-probe task(s) was calculated via a split-half technique. Trials were divided into “odd vs even” and the attention index (see below) was calculated for each set of trials. The correlation coefficient was calculated and then corrected according to the Spearman-Brown prophecy to give the reliability coefficient.

To investigate the effects of psychopathy on the dot-probe task we calculated an “attention index” by subtracting the RTs for targets that appeared at the location at the

emotional cue (threat or distress) from those that appeared at the location of the neutral cue. Hence, if the person was faster for target at the emotion cue location than the neutral cue location this would lead to a positive attention index. The influence of psychopathy on this attention index was then assessed via multiple regression (we also report zero-order correlations). We chose to use continuous measures of psychopathy rather than form groups as psychopathy is considered a dimensional construct rather than a taxon (Edens et al., 2006; Walters et al., 2007) and the self-report scales used were designed to produce a dimensional score rather than a grouping (Patrick, 2010). Correlation/regression also produces a more powerful test of our hypotheses than forming groups (MacCallum et al., 2002).

## Results

### Main Effects of Task

The data were initially examined via 4-way ANOVA with within-subject factors of congruence and image type, and between subject factors of cue duration and gender (people who did not describe themselves as either male or female were excluded). This analysis showed no interaction effects due to gender and so subsequent analyses dropped gender as an independent variable.

The main results are illustrated in Fig. 2a. Data were analysed using a mixed measures ANOVA with the factors of congruency (congruent, incongruent), cue duration (200, 500ms) and image type (threat, distress). There were main effects of congruency,  $F(1, 283)=5.75$ ,  $p=.017$ ,  $\eta_p^2=0.02$ , and of image type,  $F(1, 283)=5.75$ ,  $p<.017$ ,  $\eta_p^2=0.02$ , but no main effect of cue duration,  $F(1, 283)=1.96$ ,  $p=.16$ ,  $\eta_p^2=0.007$ . However, these main effects were subject to a significant interaction between image type and cue duration,  $F(1, 283)=5.29$ ,  $p=.02$ ,  $\eta_p^2=0.02$ , and image type and congruence,  $F(1, 283)=10.98$ ,  $p=.001$ ,  $\eta_p^2=0.04$ . The interaction between congruence and cue duration was not significant ( $F<1$ ), nor was the three-way interaction between congruence, cue duration and image type ( $F<1$ ).

The two-way interaction between image and cue duration was examined. Data from the congruent and incongruent conditions were combined. Paired t-tests showed that there was no difference in RTs between the distress (659.3 ms) and threat (658.0 ms) images at 200 ms,  $\Delta 1.4$  ms:  $t(121)=0.45$ ,  $p=.65$ , whereas RTs were longer for the distress (686.9 ms) than the threat (675.6 ms) images at 500 ms,  $\Delta 11.3$  ms:  $t(121)=3.79$ ,  $p<.001$ ,  $d=0.29$ .

The crucial two-way interaction between image type and congruence was examined. RTs from the congruent condition were subtracted from the incongruent condition to form

**Table 2** Descriptive statistics and correlation coefficients for the TriPM scores

	Mean	SD	Reliability	1	2	3
Boldness	24.4	7.5	0.79	-	0.25	0.09
Meanness	11.2	7.2	0.85	-	-	0.73
Disinhibition	15.8	7.6	0.83	-	-	-

an “attention index” where positive scores would indicate faster RTs when the probe appeared at the location of the emotional image. These are displayed in Fig. 2b. Due to the lack of an interaction between congruence and cue duration, the data were combined across cue durations. One-sample *t*-tests showed that the attention index did not differ from zero for the distress images, 2.6 ms:  $t(284)=0.83$ ,  $p=.41$ ,  $d=0.05$ , whereas the attention index was significantly below zero for the threat images, -12.1 ms:  $t(284)=4.35$ ,  $p<.001$ ,  $d=0.26$ .

Errors were similar across all conditions of cue type, cue congruence and cue duration (range 4.4 to 6.0%). However, a two-way ANOVA with factors of cue congruence and cue type showed a significant interaction,  $F(1, 285)=5.87$ ,  $p=.02$ ,  $\eta_p^2=0.02$ . This was examined via follow-up non-parametric tests that showed that for the distress condition errors were smaller for the congruent trials than incongruent trials (4.9 vs. 5.9%; Wilcoxon signed rank  $p=.005$ ) whereas there was no difference for the threat condition (5.3 vs. 5.2%; Wilcoxon signed rank  $p=.90$ ). As such, these results do not suggest any form of speed-accuracy trade-off as performance is worse for the incongruent condition for the distress condition, but better (though not significantly so) for the threat condition. Both results are in line with the data from the RTs.

## Reliability

To examine the reliability of the attention index for the dot probe task the data were analysed via a split-half (based on odd and even trials) reliability tests and corrected for loss of trials via the Spearman-Brown prophecy formula. The reliability index was poor for both image types (distress = 0.09; threat = -0.01). Supplementary tests examining reliability at different cue durations all showed poor reliability for the dot probe task.

## Summary

The data show different effects for the distressing and the threat images. The distress images appear to slow overall processing in comparison to the threat images (at 500 ms cue duration) but did not produce shifts in spatial attention for either image duration. The threat images, however, did

**Table 3** Regression coefficients ( $\beta$ ) and zero-order correlations (Pearson's  $r$ ) between the scales of psychopathy and the threat and distress indices

	Threat Index		Distress Index	
	$\beta$	$r$	$\beta$	$r$
Boldness	-0.09	-0.03	0.02	-0.01
Meanness	0.29**	0.13*	-0.16	-0.08
Disinhibition	-0.19*	0.01	0.10	-0.02

\*  $p<.05$ , \*\*  $p<.01$

produce an effect but this was for attention to be moved away from the threatening. However, it should be noted that this dot probe task had very low internal reliability under all conditions tested.

## Effects of Psychopathy

The descriptive statistics for the TriPM scales are shown in Table 2. All scales showed good reliability and mean scores were in line with previous community samples.

To examine the influence of the TriPM scales on the spatial attention indices multiple regression analyses were run (using *Z*-scored scales – see Aiken & West 1991). The results are shown in Table 3. For the threat condition the attention index was positively associated with the Meanness scale and negatively associated with the Disinhibition scale. These results were unchanged when age and gender were also entered into the regression equation. We also conducted exploratory analyses where the data were split by gender. As might be expected from the fact that the majority of participants in the main analysis were female, the results for females alone were identical to those in Table 2. For the male participants alone the  $\beta$ s were: Boldness = -0.09, Meanness = 0.42, and Disinhibition = -0.32. Hence, this exploratory analysis did not suggest any gender differences in the pattern of results.

Given the pattern of results reported by Kimonis et al. (2020) we also examined interactions between the Disinhibition and Meanness psychopathy scales. However, addition of this interaction did not lead to a statistical improvement in the variance explained.

For the distress condition there were no significant effects of any of the psychopathy scales. Further, addition of the Disinhibition by Meanness interaction term did not significantly improve the model fit.



## Discussion

The results of this experiment appear in many ways to contradict those hypothesised by the simple idea that spatial attention should be drawn to a threatening or distressing image, and that the people high on psychopathy should show a reduced effect. Based on this we predicted that the spatial attention index would be positive (indicating attention towards the emotional image) and the magnitude of this index would reduce with the traits of psychopathy related to Meanness and Boldness (but possibly increase with those related to Disinhibition). The results show almost the mirror image. The spatial attention index for the threat stimuli was negative (indicating attention away from the emotional image) and this increased with increasing traits of Meanness and decreased with increasing traits of Disinhibition!

Our hypothesis was based on the idea that emotional processes would be decreased in people with high scores on the Meanness case of the TriPM (with greater emotional processing being predicted for high Disinhibition scores). As we thought that the spatial attention index would be positive, this predicted a *negative* relationship between the TriPM score and the spatial attention index. However, the spatial attention index to the threat stimuli was negative (i.e., the actual effect of threat was to *decrease* spatial attention to this location). So if Meanness does indeed serve to reduce the effect of emotional content (as hypothesised) then this should result in a positive relationship between the TriPM score and the spatial attention index. This was the result found, and hence we interpret this as evidence for reduced emotional processing in people with high Meanness scores. Likewise, if Disinhibition is related to greater processing or effects of emotional material we would now predict that this negative spatial attention index would become more negative as Disinhibition increased. Again, this was the pattern found and we interpret this as evidence for greater processing/effects of emotional material in those with high Disinhibition scores.

For the distress images we failed to find any significant effect of cueing, though the numerical trend in the data was towards a positive attention index. Given this lack of effect it is perhaps not surprising that there was no influence of the traits of psychopathy on this index. Hence, we do not conclude that the lack of the influence of psychopathy on processing of the distress images is evidence towards distress cues not being processed differently for those high and low in the traits of psychopathy. A test that is sensitive to the effect of distress is required before individual differences can be properly investigated.

The present data may appear at odds with those presented by Kimonis et al., (2020) but we suggest that this difference is superficial and related to the different presentation of the

data. Crucially, Kimonis et al. (2020) show that their “disengagement index” (for 500 ms cues) is negatively related to the Meanness scale, at least for those people also with high Disinhibition scores, whereas our data show a positive relationship to the attention index. It should be noted that the “disinhibition index” of Kimonis et al. is conceptually the opposite of our attention index. Hence, both results are in accord that people tend to be slower to targets at the location of the threat and that this effect is reduced with increasing levels of Meanness. The only difference appears to be that Kimonis et al. (2020) found this effect of Meanness when levels of Disinhibition were high while we found this was not specific to those with high Disinhibition scores.

Meanness is defined within the Triarchic model of psychopathy as relating to deficient empathy and a lack of close attachments to others. This cold-hearted style is seen as a central concept in some conceptualisations of psychopathy (McCord & McCord, 1964). The present results, and those from other paradigms that aim to look at the automatic processing of emotionally laden stimuli (Gray et al., 2022; Snowden et al., 2022) support the notion that these traits may arise due to an inability to encode or process information relating to negative valence. However, we note that some other studies (e.g., Esteller et al., 2016) point to the Boldness dimension being important. While the differences between these studies need further exploration, it seems feasible that different tasks may be reliant upon different psychological processes (with concomitant underpinning from different brain mechanisms). For instance, the fear startle paradigm used by Esteller et al. (2016) is thought to reflect the action of defence mechanisms when confronted with threats. While their data show increases in startle due to the presentation of images of either threat or mutilation, these increases were smaller for those with high scores on the Boldness scale for the threat images, but Boldness had no effect on the increased startle due to the images of mutilation.

A second finding of the present study was that the Disinhibition scale of the TriPM was negatively correlated to the attention effect for the threat stimuli. We interpret this as evidence that, in contrast to Meanness, Disinhibition is associated with greater sensitivity to the emotional content of the cues. The concept of Disinhibition within the TriPM refers to propensity towards impulse control problems with an impaired regulation of affect and urges. For instance, the Disinhibition scales appears to be strongly correlated to the concept of “urgency” (Weidacker et al., 2017) where people act rashly in the face of strong emotions. Hence, individuals with high Disinhibition scores appear unduly affected by emotional information.

Experimental demonstrations of this hypothesised exaggerated reaction to emotional information in those high in

the dimension of Disinhibition are scarce. Vanman et al. (2003) examined the startle response while participants viewed images of “threat” and quantified levels of psychopathy via the two-factor model of the PCL-R. When the two factors were regressed onto the increase in startle due to the threat images, Vanman et al. found that Factor 1 was associated with a decrease in this fear potentiated startle, but Factor 2 was associated with an increase in fear potentiated startle (though also see Vaidyanathan et al., 2011). As Factor 2 of the PCL-R and the Disinhibition scale of the TriPM are highly correlated (Yoon et al., 2022) this suggests that Disinhibition may also be related to a stronger defensive reaction to such threat stimuli. The present results, however, would appear to be the first study to suggest that this exaggerated processing of emotional content is also reflected in the allocation of spatial attention. Given the small effect size of this result, and the lack of any corroborative evidence for such a result, this finding needs replication and extension before it can be concluded that high Disinhibition is related to the greater processing of the emotional content of images.

## Gender

The present research used a sample of mainly female undergraduates. It therefore differs from that of Kimonis et al. (2020) that used only male undergraduates. Given that there may be some gender differences in the expression of psychopathy (Cale & Lilienfeld, 2002) (though also see Eisenbarth et al. (2021) for data rating to the TriPM) it is possible that gender differences may account for some of the differences between the present study and that of Kimonis et al. (2020). Due to the relatively small number of males in the present study, we were limited to an exploratory analysis of this issue. However, the pattern of results for the threat stimuli were the same in both genders, with some hint that the effects reported may even be stronger in the male sample. For the distress cues we did not obtain any significant results in relation to psychopathy, but in exploratory analyses there were indications of possible gender differences. We hope to continue this line of investigation in larger samples of male participants.

## Strengths, Limitations, and Future Directions

A major strength of the present study is the use of a large sample that is over twice the size of any previous study (e.g., Kimonis et al., 2020). The study also carefully matched the affective cue to its neutral foil in both of composition, luminance, and contrast. It is not always apparent if this was the case in previous studies of this issue.

There are also several limitations to the study. While the use of community samples allows investigation into larger numbers of participants, with lower concerns relating to possible effects of IQ (Olderbak et al., 2018) and drug-use, etc. it is possible that the expression of psychopathic traits may be qualitatively different in those with extremely high traits of psychopathy. The use of a community sample means that there would be few, if any, participants that would be classified as “psychopathic” by clinical methods (e.g. PCL-R: Hare 2003). Further, there is as yet no clear picture of just how scores, or combination of scores, on the TriPM can be easily related to the diagnosis of psychopathy as measured by these clinical methods.

The TriPM is also the topic of vigorous debate as to its factor structure (see, for example, Roy et al., 2021) and issues such as whether Boldness should be included in the nomological framework of psychopathy (see, for example, Sleep et al., 2019). It would therefore be of interest to examine how other conceptual models of psychopathy (such as those based on the PCL-R four facet model) are related to attention to emotional stimuli.

The present study, like many before, used images from the IAPS (Lang et al., 1997) as the affective cues as they are thought to induce stronger emotions than words or images of faces (Okon-Singer et al., 2013). However, such images are harder to match across such dimensions as luminance, composition, and contrast in comparison to others. Further, other stimuli, such as facial expression, may be processed via different neural circuits to other affective stimuli (Britton et al., 2006) or have differential effects on brain structures thought to be important to emotional processes (Hariri et al., 2002). In a similar vein, the present study was limited to only two categories of negative stimuli, threat and distress, due to previous findings that such categories might have quite different effects (e.g., Van Hooff et al., 2013). However, other categories of stimuli, in particular those that depict positive affect such as those related to sexual preference (Snowden et al., 2016) or nurture (Brosch et al., 2008), might also be used to examine the specificity of the emotional processing dysfunction related to psychopathy.

By far the greatest limitation, however, of the present study is the very poor reliability obtained for the dot-probe task. The low reliability problem does not appear to arise from the specific conditions of this study as other studies have reported on the low reliability of the dot-probe task (Rodebaugh et al., 2016; Schmukle, 2005; Staugaard, 2009) and there have been attempts to examine ways that the reliability might be improved (Carlson & Fang, 2020; Price et al., 2015). For instance, Yang et al. (2022) showed that both internal and test-retest reliability is far greater than the traditional split-half reliability when using a trial-level bias scores for a dot-probe task examining attention

to smoking cues. While there have recommendations that reliability should be routinely reported for such tasks (Parsons et al., 2019) the previous studies of psychopathy using the dot-probe task have not reported on the reliability. Such a lack of reliability clearly places limits on the ability of such tasks to examine individual differences (Parsons et al., 2019). Hence, we might speculate that the “true” relationship between the psychopathy and shifts in spatial attention may be far greater (Spearman, 1987). Improvements in the reliability of the task, however, are needed for the dot-probe task to become a valuable assay of emotional processing.

## Conclusion

The present study was able to demonstrate that shifts in spatial attention to threatening stimuli are altered by traits relating to psychopathy in a community sample. Specifically, the trait of Meanness appears to be associated with a reduction in shifts of attention away from threat, while the trait of Disinhibition appears to be associated with an increase in shifts of attention away from threat.

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## Declarations

**Competing Interests** All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

**Ethical Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Psychology Ethics Committee of \*\*\* University (EC.12.10.09.3209GA3).

**Consent** - Informed consent was obtained from all individual participants included in the study.

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