Automatic Processing of Emotional Images and Psychopathic Personality Traits.

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Abstract

Psychopathy is associated with a deficit in affective processes and might be reflected in the inability to extract the emotional content of a stimulus. Across two experiments, we measured the interference effect from emotional images that were irrelevant to the processing of simultaneous target stimuli and examined if this interference was moderated by psychometrically defined traits of psychopathy. In Experiment 1 we showed this emotional distraction effect was reduced as a function of psychopathic traits related to cold-heartedness and occurred for both positively- and negatively-valenced images. Experiment 2 attempted to test the automaticity of the effects by presenting the emotional stimuli briefly so that the emotion was difficult to report. Again, high visibility images produced strong effects that were moderated by the cold-heatedness/meanness traits of psychopathy, but the low-visibility images did not evoke the emotional distractor effect. Our results strongly support the notion that psychopathic traits related to cold-heartedness/meanness are associated with an inability to automatically process the emotional content of images.

Keywords: Affect, psychopathy, PPI-R, triarchic model, TriPM, emotional distraction, subliminal perception, backward masking.

Automatic Processing of Emotional Images and Psychopathic Personality Traits.

Psychopathic individuals are often characterised by their lack of empathy, poor remorse, and callousness (Cleckley, 1976; Hare, 2001). It has often been suggested (e.g., van Dongen, 2020) that at the core of the condition lies an inability to sense or feel emotions in the same manner that normal individuals do. However, there is developing evidence that the phenomenology of the disorder is heterogeneous and there may be different forms of psychopathy with possible differential aetiologies (e.g., Yildirim & Derksen, 2015). This opens the question as to whether the different manifestations or dimensions of psychopathy have similar deficits in the processing of emotions.

Emotional Processing in Psychopathy.

There have been many studies of the processing of emotional stimuli in psychopathic individuals, and many paradigms have been used to test theories. For instance, many studies have examined the ability to detect or recognise facial expressions of emotion (for meta-analysis see Brook, Brieman, & Kosson, 2013; Dawel, O'Kearney, McKone, & Palermo, 2012; Wilson, Juodis, & Porter, 2011). In such experiments the person is required to name the emotion on the face (Blair, Colledge, Murray, & Mitchell, 2001) or to detect which face had the emotional expression (Snowden, Craig, & Gray, 2013), thus the emotional content of the image is the focus of attention in this task. The results of such experiments have been very mixed with evidence presented for deficits processing negative emotions only (Blair et al., 2004), both positive and negative emotions (Hastings, Tangney, & Stuewig, 2008), no deficits at all (Glass & Newman, 2006), or even enhanced processing of some emotions (Habel, Kuhn, Salloum, Devos, & Schneider, 2002). More recent evidence

suggests that most of these deficits could be accounted for my general mental ability rather than a specific deficit in the perception of emotions (Olderbak, Mokros, Nitschke, Habermeyer, & Wilhelm, 2018).

While the reasons for such a wide range of results are unclear, one possibility may lie in the amount of resources required by each task. Newman and colleagues (Newman, 1998) have suggested that some results that appear to support the notion of a deficit in the processing of emotions in psychopathy may be better thought of as problems in attention. The response modulation hypothesis (RMH) suggests that psychopaths have a problem disengaging attention from an on-going focus of attention (Newman, 1998; Newman, Curtin, Bertsch, & Baskin-Sommers, 2010). Hence, under conditions where the emotional stimulus is already the focus of attention psychopathic individual will not show any differences in performance in comparison to healthy controls. When the emotional image is not the main focus of the task (i.e., it is task irrelevant), however, psychopaths will have deficits in processing this stimulus (irrespective of any emotional content). Hence, this might appear as a lack of emotional processing under these conditions.

The “emotional distraction task” tests for the effects of emotional images which are irrelevant to the actual task being performed to examine if the emotional content of the image is processed even under the conditions where it can, and should, be ignored. For example, Erthal et al. (2005) required participants to compare the orientation of two lines presented either side of an image. The image could be emotionally ladened (images of mutilated bodies) or neutral but was always irrelevant to the task. They found that participants were slower to complete the visual task when the distractor was emotionally ladened than when it was neutral. The finding that emotional stimuli cause slowing of a concurrent task has been demonstrated many times using a variety

of different stimuli and tasks within the emotional distraction paradigm, and extended to both positive and negative valences (Codispoti, De Cesarei, Biondi, & Ferrari, 2016; Kagerer et al., 2014; Schimmack & Derryberry, 2005) - for a review see Carretié (2014). Such results are explained by the idea that stimuli compete for processing resources and that some stimuli, those that cause high arousal or have strong motivational salience, are given a lot of processing resources (Bradley, Keil, & Lang, 2012) which is reflected in competing stimuli being processed less efficiently. As no attention should be paid to these distracting images it has been suggested that this effect shows that the processing of emotional material is prioritised and takes place in a mandatory fashion (Vuilleumier, Armony, Driver, & Dolan, 2001).

The emotional distraction paradigm seems, therefore, ideal to test theories of deficient emotional processing in psychopathy. To our knowledge, this is the first study of the effects of psychopathy on the traditional emotional distraction task. At first glance, the study of Mitchell, Richell, Leonard, and Blair (2006) appears to be such a study. However, their paradigm did not present the target and distractor images together (spatially separated) but separated them temporally so that the visual target occurred 200 ms after the onset of the distractor image and was then followed immediately by this same distractor image – indeed, they do not term this an "emotional distraction task" but an "emotional interruption task". It is unknown if this variation of the paradigm engages the same processing mechanisms as the more conventional spatial separation between target and distractor of the emotional distraction task, but there is evidence that there may be quite distinct mechanisms operating in each task (Most & Wang, 2011). Crucially, however, they instructed the participants to pay attention to the "distractor images" as they would be asked about them. Hence, this variation means that these distractor stimuli are no longer

"irrelevant", and participants would be attempting to encode the content, presumably including the emotional content. They found that for people with low psychopathy scores affective distractor images slowed processing of the visual target compared to a neutral image. This occurred for both positive and negative-valenced images. However, for individuals with high psychopathy scores this effect was absent also for both positively and negatively-valenced images. While this study is certainly supportive of some emotional processing deficit in psychopathy it cannot be used to illustrate deficits in automatic (non-attended) images in psychopathy.

Maes and Brazil (2015) also provide evidence for psychopathy related effects on an emotional distraction task, though again on a rather non-standard version of the task. They had participants classify stimuli presented at the point of fixation (and therefore, presumably, attentional focus) while a distractor image of either low or high arousal was presented more peripherally. As expected, they found the high-arousal stimuli produced a distraction effect and that this distraction effect was modified by psychopathy in a rather complex manner such that those with higher traits of fearlessness were less distracted if they had low levels of impulsive-antisocial traits, but more distracted if they had high levels of impulsive-antisocial traits.

The nature of the psychopathic dysfunction.

While there may be a consensus that psychopathy is associated with a dysfunction in processing of emotional material, the specificity of the deficit is widely debated. As mentioned above, studies of the identification of facial expressions have produced just about every result possible. Other studies, however, seem to show a more specific deficit. The fear potentiated startle effect refers to the finding that the startle reflex is greater when the person is made afraid or is viewing fear-inducing images. A repeated finding is that the fear potentiated startle is reduced in psychopathy

(Patrick, Bradley, & Lang, 1993). This finding occurs only for negatively-valences stimuli and is most related to the interpersonal-affective aspects of psychopathy. More recent evidence suggests that this deficit is specific to threat-related images and to the "fearless" traits of psychopathy (Esteller, Poy, & Molto, 2016).

The emotional deficit in psychopathy has been linked at a neurophysiological level to dysfunction in the amygdala (Blair, 2003). It is clear that the amygdala has a strong role in the perception of threat or fear (Davis, 1992) and therefore the findings of a reduced response to threat (e.g., Esteller et al., 2016; Patrick et al., 1993) seems consistent with this idea. However, the amygdala does far more than just process threats and has strong links to the processing of "motivationally salient" stimuli (Cunningham & Brosch, 2012). Hence, if psychopathy is underpinned by deficits in amygdala function, we might expect to see deficits to both negative and positive images if they are salient enough. The present experiments, therefore, included both negative and positive images to provide a simple test of whether deficits, if found, are confined to negative images only or to both positive and negative images.

Subtypes of Psychopathy.

It has long been recognised that the global construct of psychopathy is underpinned by subcomponents. For example, the Psychopathy Checklist-Revised (PCL-R; Hare, 2003) is thought to be underpinned by a 2-factor structure with the first factor (Factor 1) representing a cold interpersonal style and poor affective processing, with the second factor (Factor 2) representing poor behavioural controls and antisocial tendencies.

While the PCL-R is regarded by many as the gold-standard measure of psychopathy in forensic settings, it is not easy to administer in community samples.

Hence, other measures and models of psychopathy have been developed for use in these community samples. Further, psychopathy has been shown to be a dimensional scale rather than a taxon (Guay, Ruscio, Knight & Hare, 2007; Walters et al., 2007) and can therefore be studied in non-forensic samples in the form of psychopathic personality traits. Studies in forensic samples are difficult due to a lack of accessibility and willingness to participate, common nuisance variables such as the presence of substance misuse and head injuries. Hence, studies in non-forensic samples can supplement studies in forensic samples but are unlikely to contain many (if any) individuals that would meet criteria for being regarded as "psychopathic" (e.g., a PCL-R score of 30 or greater).

The Psychopathic-Personality Inventory-Revised (PPI-R; Lilienfeld & Widows, 2005) was devised as a self-report questionnaire of psychopathic personality traits and was designed to be used in a community setting. Most recent models of psychopathy acknowledge that there are at least two factors underpinning the overall concept, and that these two (or more) factors can often have quite different relationships to criterion measurements. Hence, it is important to not only look at the overall concept of psychopathy but at these distinct facets (Patrick, Edens, Poythress, Lilienfeld, & Benning, 2006). Factor analysis of the PPI-R has traditionally revealed two subscales (Benning, Patrick, Hicks, Blonigen, & Krueger, 2003). The Fearless Dominance scale attempts to quantify aspects of psychopathy such as boldness, assertiveness, persuasiveness, a lack of stress, and social potency, while the Self-centred Impulsivity scale attempts to quantify tendencies related to social deviancy such as impulsivity, alienation, aggressiveness, and rule-breaking. However, another aspect of psychopathy, the Cold-heartedness scale, does not load onto with the Fearless Dominance of the Self-centred Impulsivity scale, and many researchers have

therefore regarded this as a third factor of psychopathy measured by the PPI-R (Berg, Hecht, Latzman, & Lilienfeld, 2015).

The scales of the PPI-R do not show strong correlations (see for example, (Hughes, Stout, & Dolan, 2013) and are thought to measure quite different aspects of psychopathy. It is therefore of interest to see which of the subscales might be related to emotional deficits. As mentioned, the Fearless Dominance scale includes such features as social potency, fearlessness, and a lack of stress. Clearly, a lack of a fear response might be expected to lead to a smaller distraction effect for images that portray a threat of some sort. We therefore made the prediction that this scale would be negatively related to the magnitude of the distraction effect when we used negatively-valenced distractor stimuli. The Self-Centred Impulsivity scale covers aspects of psychopathy such as a lack of planning, rash actions, and blame externalization. These concepts have strong relations to concepts such as borderline personality and do not appear to be strongly linked to a lack of emotional processing. Indeed, it might be argued that such individuals show an exaggerated reaction to certain emotional events. However, we also note that this scale (and not Fearless Dominance) is negatively related to measures of emotional empathy (Patrick et al., 2006). Nevertheless, we hypothesised that this scale would not be related to the magnitude of the emotional distraction effect to either positive of negative distractors. Finally, the Cold-heartedness scale is characterised by a paucity of social emotions (Berg et al., 2015). As such we would expect individuals that score high on the Cold-heartedness scale to be less effected by the emotional distractors and this formed our main hypothesis.

To examine the effect of different psychopathic traits on the processing of emotions we designed an emotional distraction task. The visual task was to compare the orientation of two lines presented either side of an image (see Figure 1). The image

was irrelevant to the task and participants were told this and to ignore this image. We first (Experiment 1) tested the general hypothesis that the expected emotional distraction effect would be obtained, and that this would be reduced in individuals with high traits of psychopathy, with the traits relating to cold-heartedness being particularly related to this reduction.

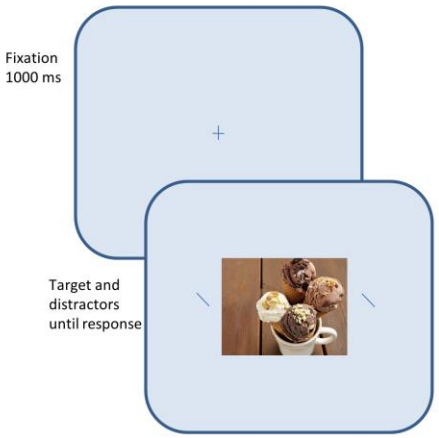

Figure 1. Depiction of stimuli for the emotional distraction task. The participant classified whether the two target lines to the left and right of the distractor image have the same orientation (as depicted here) or have different orientations (always at 90° to each other).

Experiment 1.

We modelled our initial experiment on the task described by Erthal et al. (2005). Participants had to state whether two lines, one presented on either side of a distractor image, had the same orientation or difference orientations. The target lines and distractor image were presented simultaneously and remained until a response was

made. It is important to note that the images were completely irrelevant to the completion of all aspects of the task and should be ignored. Participants were explicitly told this. Hence, any effect from these must be due to automatic (in the sense that it was not deliberate) attentional processes.

The distractor images could have neutral content or could have either emotional content related to negative or positive valence. We predicted that these emotional images would demand more automatic attention than the neutral images and therefore the processing of the target stimulus would be slowed (Erthal et al, 2005; Schimmack & Derryberry, 2005; Kagerer et al., 2014; Codispoti et al., 2016). We hypothesised that this slowing effect would be moderated by traits of psychopathy. As stated in the introduction, our main hypothesis is that it would be the traits that relate to a lack of emotionality that would underpin this effect.

Methods.

Participants

The study was powered to detect a small to medium effect size ($r = 0.25$) 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 98.

In total, 112 participants (53 males and 59 females) with a mean age of 20.2 years (SD = 2.2) were recruited to the study. All female subjects and 39 male subjects participated in the study in exchange for course credits. These subjects were recruited using the *** University Psychology Experimental Management System. A further 14 men participated in the study in exchange for payment (£10). These subjects were recruited through advertisement on social media. The experimental protocol was

approved by the School of Psychology Ethics Committee, and participants gave informed consent.

Materials

The Psychopathic Personality Inventory-Revised (PPI-R). The PPI-R (Lilienfeld & Fowler, 2006) is a personality test for traits related to psychopathy in adults. The questionnaire consisted of 154 items. Each item is answered on a four-point scale of *false, mostly false, mostly true,* or *true.* Higher scores on the scales indicate a greater number of psychopathic traits. These items are grouped into three factors; fearless dominance, self-centred impulsivity, and cold-heartedness. The PPI-R was found to be highly reliable using Cronbach's alpha (α = .92) in this sample.

The emotional distractor task.

The emotional distractor task was designed to examine how emotional processing affects a simple motor response task. The task was created using PsychoPy2. Participants were seated in front of a computer screen and required to engage in a simple motor response task. They were asked to perform left or right button presses. Each trial involved the presentation of a pictorial stimulus from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1997)) and two lines either side of this picture. The two lines were either of the same orientation or different (see Figure 1). The participant was required to press a green button with their left hand if the lines were of the same orientation, or a red button with their right hand if the lines were of a different orientation.

The pictorial stimuli were selected from the IAPS based on their valence and arousal scores. These scores were based on a 9-point rating scale in the IAPS manual. Higher scores on valence related to greater pleasantness, whereas higher scores on arousal related to greater arousal. Sixty images were selected; twenty were of neutral

valence and low arousal, twenty were of positive valence and high arousal, and twenty were of negative valence and high arousal. The mean valence score for neutral images was 4.94 (range 4.38 to 5.82) and the mean arousal score for the neutral images was 3.03 (1.72 to 3.95). The mean valence score for positive images was 7.11 (5.95 to 8.34) and the mean arousal score for positive images was 6.46 (5.12 to 7.35). The mean valence score for negative images was 2.37 (1.48 to 3.79) and the mean arousal score for negative images was 6.74 (5.49 to 7.34).

The images were all resized to a dimension of 4 by 4 cm and were presented at the point of fixation. The lines measured 4 by 0.5 cm and were presented 4 cm either side of fixation simultaneously with the image. On half the trials the orientation of the two lines was the same, and on the other half they were different. Participants first completed 20 practice trials (which used other images from the IAPs that were not used in the main block of trails) and then completed the main block of 120 trails (20 neutral, 20 negative, and 20 positive distractor images each presented twice) which were presented in a unique random order for each participant.

Procedure

Participants were presented with an information sheet upon arrival and asked to complete a consent and demographic form. Before starting, participants were presented with an A4 sheet of thumbnail sized images (the 60 images that were about to be used in the task) and asked to scan through them. Ethically, it was thought that participants should be warned about the graphic nature of some of the images. Once they had agreed that they were comfortable viewing arousing images, the task was explained to them. Participants were told that images would appear on the centre of the screen with a line either side. They were instructed to respond as quickly as possible to the lines by pressing the green or red button. They were told that they would complete

20 practice trials before the main experiment started (images used in the practice trials were not part of the main experiment). After each practice trial participants were shown their response time and whether they had pressed the correct button; this did not happen during the experimental trials. Participants were also asked to wear headphones to block out surrounding noises.

The participants then went to an adjoining room and completed the PPI-R without the experimenter. They were then debriefed, thanked and given course credit or payment for their time.

Data Analytic Plan

The reaction times for all trials were then trimmed by the removal of trials that were too fast (< 150 ms) or too slow (> 1500 ms). Mean reaction times for each condition were then calculated for trials with a correct response. Participants were excluded from data analysis because if their errors rates on the task was greater than 25%. Participants whose reaction times were deemed to be outliers (defined as > 3SD from the group mean) were removed from further analysis.

The data for the reaction times were positively skewed for most of the experiments, as is typical for reaction times, and so were transformed for statistical analysis via reciprocal transformation. The resulting distributions were inspected visually (Tabachnick & Fidell, 2007) and found to approximate a normal distribution. However, all figures and tables present the untransformed data for ease of interpretation.

For each experiment we first analysed the task without regard to possible individual differences. This was done via the analysis of variance as appropriate to the individual experiments. Mauchly's W was calculated for possible problems with sphericity and the degrees of freedom were corrected if needed. Main effects and

interactions were then followed up by t-tests where this was needed. Effect sizes with 95% confidence intervals were calculated for all significant effects.

Distributions from the self-report questionnaires were also inspected visually (Tabachnick & Fidell, 2007) and found to approximate a normal distribution. Internal reliability (Chronbach's alpha) was calculated for each scale. To investigate the effects of psychopathy on the emotional distractor task, we first calculated emotional distraction effects, by subtracting the reaction times for the neutral condition to that of the emotional condition. Hence, if the person was slower to the emotional condition than the neutral condition, this would produce a positive score with the magnitude of this score indicating the amount of slowing. We then calculated the zero-order correlations between the emotional distraction effects and the psychopathy scores and the psychopathy scores including the total score for psychopathy. We chose to use correlations rather than form groups as psychopathy is considered a dimensional construct rather than a taxon (Edens, Marcus, Liliienfield, & Polythress, 2006; Walters et al., 2007), and the self-report scales that we used were designed to produce a dimensional score rather than a grouping (Lilienfeld & Widows, 2005; Patrick, 2010), and that correlation produces a more powerful test of our hypotheses (MacCallum, Zhang, Preacher, & Rucker, 2002). We also examined the unique relationship of the psychopathy scales to the emotional distraction effects by regression (using z-scored scales (Aiken & West, 1991) and present the standardised beta weights.

Results

Two participants were excluded from the data analysis because their error rate was deemed to high (> 25%).

Main effects of task

Figure 2 shows the pattern of results. Participants responded quickly (and most accurately) to the task when the images were of neutral valence, and response latency increased when the images were of negative or of positive valence.

Data were analysed using a repeated measure ANOVA with the factor of valence (positive, neutral negative). A main effect of valence was found, $F(2, 218) = 47.93$, $p < .001$, $\eta_p^2 = .31$; 95% CI [.21, .39]. In comparison to the neutral condition, planned paired t-tests showed significant slowing for unpleasant images, $t(109)= 7.29$, $p < .001$, $d = 0.26$; 95% CI [0.18, 0.33], and for pleasant images, $t(109)= 8.97$, $p < .001$, $d = 0.31$; 95% CI [0.23, 0.39].

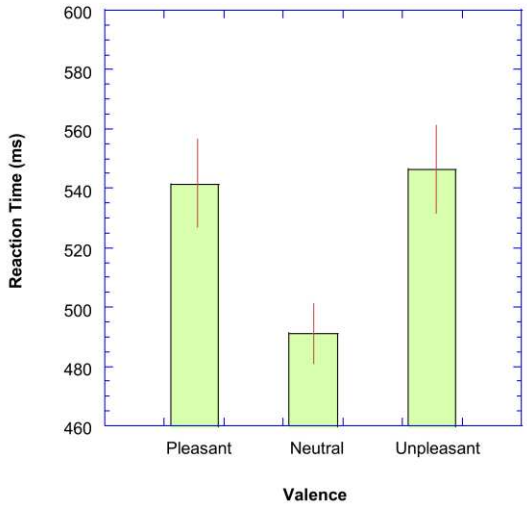

Figure 2. Reaction times (ms) are plotted as a function of the valence of the distractor image. Error bars represent ±1 standard error of the mean (SEM).

Psychopathy

A Pearson product-moment correlation was run to determine the relationship between PPI-R scores and the emotional distraction effect and a simple regression (using the z-scored scales of the PPI-R) was also performed in order to isolate the unique contribution of each of the subscales of the PPI-R. The results are summarised in Table 1.

Overall psychopathy traits were significantly negatively correlated with the emotional distraction effect for both negative and positive distractors. This indicates that the emotional content of the images had less of an effect in those people with higher psychopathic traits and is in line with our first hypothesis. Examination of the subscales of the PPI-R shows that significant effects were detected for the Cold-hearted scale for both valences with similar magnitude.

Table 1. *Zero-order correlations (Pearsons' r) and regression coefficients (β) between the scales of psychopathy (PPI-R) and the emotional distraction effect (EDE) caused by the negative and the positive images.*

	EDE_{neg}		EDE_{pos}	
	r	*β*	*r*	*β*
Total	-.18*		-.20*	
FD	-.08	.02	-.14	-.06
SCI	-.10	.00	-.08	.03
Cold	-.23**	-.24*	-.23**	-.21*

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

FD = Fearless Dominance scale; SCI = Self-centred Impulsivity scale; Cold = Cold-heartedness scale.

Discussion

The emotional distraction task showed the expected effect of participants being slower to classify the orientation of the lines when the distractor contained emotional material and is consistent with many previous reports using this paradigm (Codispoti et al., 2016; Erthal et al., 2005; Kagerer et al., 2014; Schimmack & Derryberry, 2005). The paradigm therefore appears reliable and therefore a good one with which to explore emotional processes in psychopathy.

In line with our predictions, there was a negative (small effect size) relationship between psychopathy and the magnitude of the emotional distraction. Crucially, this occurred for both negatively- and positively-valenced distractors with similar effect sizes. Finally, the negative relationship appears to be most driven by the Cold-heartedness aspects of psychopathy.

Experiment 2

Low-visibility (subliminal) stimuli and emotional processes.

To test the automaticity of emotional processing many researchers have chosen to reduce the visibility of the stimulus, normally via brief presentation and backward masking, to the point that the person is not able to report on either its emotional content or even its presence – these are often referred as “subliminal” stimuli. The exact definition of subliminal has been a cause for debate in the literature (Wiens,

2006) and different studies have used different definitions. It is not the purpose of this paper to enter this debate and for the purposes of this review (and of Experiment 2) we will simply use the term "low-visibility" to refer to a stimulus that is presented very briefly and is masked so that its content is difficult to discern without making any specific definition of how "difficult" is defined. We will also limit the discussion to experiments that have used this method of brief presentation and masking to reduce visibility rather than other methods such as binocular suppression or the use of participants with brain lesions that lead to a lack of visual awareness.

Despite a lack of subjective awareness on behalf of the observer, such low-visibility stimuli are claimed to activate regions of the brain thought to be involved in emotion processing, such as the amygdala (Morris, Ohman, & Dolan, 1999). As well as causing changes in brain activity and psychophysiology, there is a long history of low-visibility presentation of primes causing changes in perception and behaviour (Van den Bussche, Van den Noortgate, & Reynvoet, 2009; Zajonc, 2001). For example, Prochnow et al. (2013) showed that the brief presentation of a face with an emotional expression causes a subsequent neutral face to take on the attributes of the emotional face as participants now rate the neutral face as more happy, angry, etc. dependent on the expression of the low-visibility prime.

To our knowledge, there has been no attempt to examine the effects of low-visibility distractors on the emotional distractor task, and so our experiment provides the first test of whether low-visibility emotional content can cause an emotional distraction effect. However, the issue has been explored for the "dot-probe task". Hedger, Gray, Garner, and Adams (2016) meta-analysed 44 studies (using a range of cues such as words, pictures, and faces) and found a significant effect ($d = 0.28$) even under masked conditions. However, they note that the effect appears related to the

visibility of the cues and that the notion of shifts of attention due to truly “subliminal” stimuli has only weak support.

Low-visibility stimuli have been used to test the nature of emotional deficits in other psychological conditions. For example, Nuske, Vivanti, Hudry, and Dissanayake (2014) show that subliminal stimuli that cause an emotional modulation of the pupil response in healthy young controls do not do so for young children with autism, while at supraliminal levels both groups showed pupil reactions to emotional stimuli. Hence, the use of low visibility stimuli was able to detect emotional deficits in autism that were not apparent at high levels of visibility.

In Experiment 2 we tested the effects of both high and low visibility distractors on the emotional distraction task and the effects of psychopathy on any such distraction effect. For high visibility stimuli we expected the usual distraction effect with this being reduced for individuals with high traits of psychopathy related to cold-heartedness. For the low-visibility stimuli we entertained two hypotheses. First, if there is no emotional distraction effect under low-visibility conditions then there is no effect for individual differences in emotional processing to influence – hence, we expect no effect of psychopathy. Second, if the extraction of emotional information is automatic we would expect an emotional distraction effect under low visibility conditions and this effect would be reduced by psychopathy in the same manner as for high-visibility distractors.

To test these hypotheses only images of mutilation and erotica were chosen as the negative and positive images due to previous research showing strong effects of these types of image (Codispoti et al., 2016).

Triarchic Model of Psychopathy

For this experiment we decided to use the triarchic model of psychopathy. The Triarchic Psychopathy Measure (TriPM; Patrick, 2010) is a self-report questionnaire that aims to capture these personality constructs and was designed for use in community samples.

The triarchic model of psychopathy hypothesises that there are three distinct phenotypic constructs underpinning the global construct of psychopathy (Patrick, Fowles, & Krueger, 2009). “Boldness” captures a fearless disposition with a tolerance to stressors and danger along with social dominance – this dimension has a strong theoretical relationship to the Fearless Dominance scale of the PPI-R with supporting empirical evidence (Sellbom & Phillips, 2013; Sica et al., 2015; Stanley, Wygant, & Sellbom, 2013). “Meanness” captures a cold-hearted disposition including callousness, an inability to form close relationships, and a willingness to exploit others. This scale is strongly associated with the Cold-heartedness scale of the PPI-R (Sellbom & Phillips, 2013; Sica et al., 2015; Stanley et al., 2013). “Disinhibition” captures impulsiveness and poor emotional regulation and is similar to the Self-centred Impulsivity scale of the PPI-R (Sellbom & Phillips, 2013; Sica et al., 2015; Stanley et al., 2013).

Methods.

The task was similar to that described for Experiment 1, hence this section only gives the important differences for Experiment 2.

Participants

A sample of 130 participants (63 male, 67 female) consisting of undergraduate students responded to an online study advert in return for course credit (n = 122) or cash payment (n = 8). The average age of participants was 20.1 (SD = 1.95).

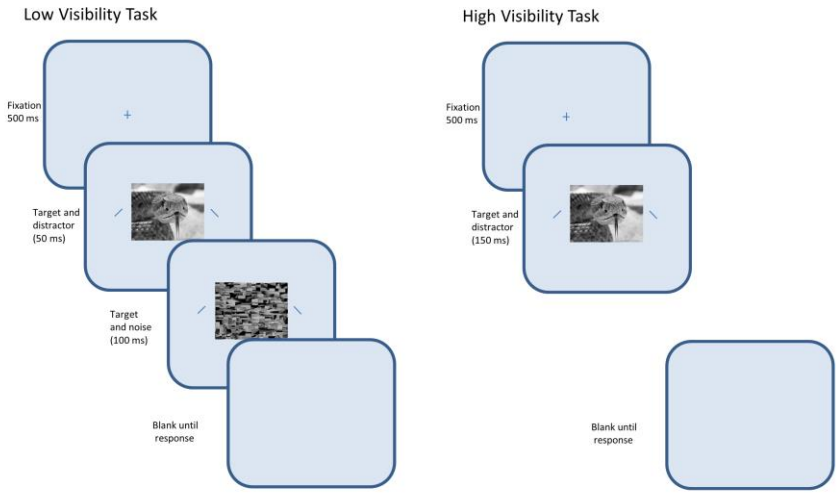

Figure 3. Illustration of low and high visibility trails in Experiment 2.

Emotional Distraction Paradigm

The pictures used were drawn from the International Affective Image System (Lang et al., 1997). They consisted of 20 pleasant (erotic) images (arousal = 6.6; valence = 6.4), 20 unpleasant (mutilated bodies) images (arousal = 6.7; valence = 1.7) and 30 neutral images (arousal = 3.6; valence = 5.3), though 10 of these were only used during the practice trials. A "masking" stimulus was also used in the experiment. This consisted of a collage of samples (80 samples) from distraction images to match (approximately) the luminance of these images. The pictures were presented in a

rectangle box with blue edges (15x11cm) between two diagonal blue lines, on a 50x30cm white computer screen. The computer programme used for this experiment was Direct RT.

The two conditions are illustrated in Figure 3. In the high visibility condition of the task, all the pictures were presented for 150 ms without masking them, whilst in the low visibility condition the pictures were presented for 50 ms and masked for 100 ms. There then followed a black screen until the participant responded.

Triarchic Psychopathy Measure (TriPM, Patrick, 2010)

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 – 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 experiment was conducted in sound attenuated laboratory. Participants read an Information sheet that outlined the experiment and warned that it contained images of an erotic nature and of body mutations and that they should not participate if these would cause them distress. No person declined to take part at this stage. They then gave written consent to participate.

The participant then completed the emotional distraction task under the low visibility condition, and then under the high visibility condition. This order was

chosen in order eliminate any effects that might have occurred due to having had a good sight of the images in the high visibility condition.

Each trial started with a fixation cross in the middle of the box which was presented for 500 ms. This was followed by the distracting image and two lines presented on each side of the image. In the high visibility condition, the distraction image and target lines were present for 150 ms before being removed. In the low visibility condition, the distraction image was presented for only 50 ms and was then replaced by the masking image for 100 ms, and then all stimuli were removed (see Figure 3).

The first 20 trials were regarded as practice and only used neutral distractors that were not then used in the main task. The main tasks consisted of 120 trials with the 60 distractors being presented twice, one with the target lines in the "same" orientation and the other with them in the "different" orientation. Trials were presented in a randomised order for each participant.

The participants then completed the TriPM as a measure of psychopathy. After finishing the study, participants were given the opportunity to watch a short mood restoring comedic clip, ask questions, and were given a debrief sheet.

To understand if the low visibility condition was producing the desired effect, we ran 13 participants (2 men, 11 women) on a pilot task that presented the images to be used in the main experiment but asked the participant to merely name which category of emotion was presented (erotic, mutilation, or neutral). Performance on this task was 38.9% correct, which shows that the task was very difficult but differed from chance (33.3%; $p = .002$). Hence, the emotional content was very difficult to discern but was not strictly "subliminal". Under the high visibility conditions all participants were 100% correct.

Results

Data reduction

Data from six participants were lost due to computer error. The data from 16 participants were excluded from analysis because their error rate was deemed to high (> 25%) in either the low or high visibility conditions.

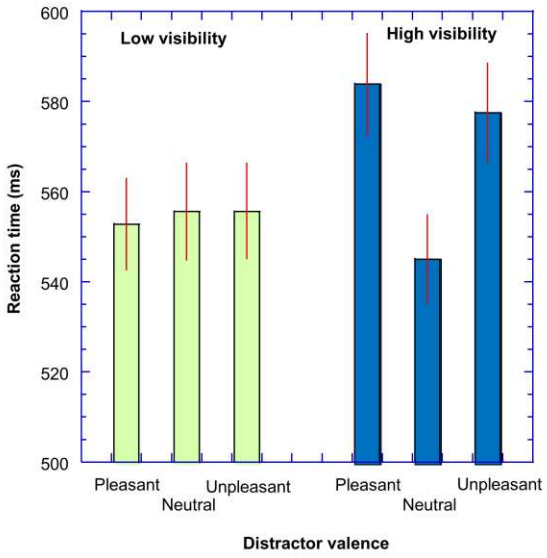

Figure 4. Reaction times (ms) are plotted as a function of the valence of the distractor image. Error bars represent ±1 standard error of the mean (SEM).

Main effects of task

Figure 4 shows the pattern of results. Data from the RTs were analysed using repeated measures ANOVA with factors of valence (positive, neutral, negative) and visibility (low, high). Mauchly's test indicated that the assumption of sphericity was

not violated. There was a significant main effect of valence, $F(2, 214) = 12.38$, $p < .001$, $\eta_p^2 = .10$; 95% CI[.04, .18], but the main effect of distractor visibility was not significant, $F(1, 107) = 2.22$ $p = .14$, $\eta_p^2 = .02$. The interaction between valence and visibility was significant, $F(2, 214) = 17.80$, $p < .001$, $\eta_p^2 = .14$; 95% CI[.06, .22].

To examine this interaction and our hypotheses, we performed a series of t-tests comparing the condition(s) with the emotional stimulus to the appropriate neutral stimulus. For the high visibility images, the positive distractors produced a significant slowing, $t(107)= 6.47$, $p < .001$, $d = 0.62$; 95% CI [0.42, 0.83], as did the negative distractors, $t(107)= 4.60$, $p < .001$, $d = 0.44$; 95% CI [0.24, 0.64]. However, there were no effects for the emotional stimuli at low visibility; positive; $t(107)= -0.73$, $p = .48$, $d = -0.03$; 95% CI [-0.10, 0.04], negative; $t(107)= -0.11$, $p = .91$, $d = -0.003$; 95% CI [-0.07, 0.06].

Table 2. *Data from Experiment 2.*

	High visibility				*Low visibility*			
	EDE_{neg}		EDE_{pos}		EDE_{neg}		EDE_{pos}	
	r	*β*	*r*	*β*	*r*	*β*	*r*	*β*
Total	-.15		-.17*		.01		.02	
Bold	-.00	.14	-.20*	-.14	.01	-.06	-.02	-.09
Mean	-.28**	-.36**	-.20*	-.17	.10	.18	.12	.19
Dis	-.05	.06	.03	.10	-.09	-.10	-.06	-.12

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

Psychopathy

The results are summarised in Table 2. The results for the high visibility conditions were similar to Experiment 1 in showing a weak negative correlation between the emotion distractor effect and total psychopathy score for the positive images and a trend for such a result for the negative images ($p = .06$). This appears driven by the negative association between both emotion distractor effect and the Meanness scale of the TriPM, though we note on this occasion the Boldness scale was significantly negatively correlated with the emotion distractor effect for the positive images. The results for the low visibility condition did not provide any significant results.

Discussion

Two findings emerged from this experiment. First, in line with Experiment 1, the emotionally-valenced stimuli produced an interference effect (in comparison to the neutral stimuli) when they were highly visible, and this interference effect was reduced as a function of psychopathy traits related to meanness/cold-heartedness. These findings will be discussed in the General Discussion.

Second, we did not find any evidence that stimuli that were of low-visibility, due to brief presentation and masking, produced any emotion related interference. To our knowledge, this is the first reported experiment that has examined whether low-visibility images could produce the emotional distraction effect. We stress that the present study was well-powered and should have been able to detect small effect sizes (Cohen's $d = 0.30$). Further, inspection of Figure 4 shows that the RTs for the emotional distractors were actually smaller than for the neutral control. Hence, it does not appear that a lack of power is responsible for that lack of a significant effect.

There is a large literature using other paradigms that claims to demonstrate that the emotional content of a low-visibility image can interfere/alter responses to other stimuli. For example, Hermans (2003) used pictures as primes and found that these low-visibility images were able to influence the responses to a word or picture that was presented subsequently. However, the results were rather different to that found with high-visibility primes in that the negative primes speeded the response to positive targets, and positive primes speeded responses to the negative targets. However, other studies of priming, such as that of Andrews, Lipp, Mallan, and Koenig (2011) using face primes and the affective evaluation of target words, have failed to find any evidence of low-visibility priming. Hence, at this stage the case for low-visibility images being able to influence performance on other behavioural tasks is not proven (see also Hedger et al., 2016) and clearly there appear to be cases where this is not occurring. Our results show that under the present conditions where the emotional images are not task-relevant and are presented under low-visibility conditions their emotional content did not interfere with the processing of the targets, whereas the same stimuli when of high-visibility were able to produce this interference.

General Discussion

Our finding of an emotional distraction effect on a simultaneous task merely replicates several previous reports (e.g., Codispoti et al., 2016; Erthal et al., 2005; Kagerer et al., 2014; Schimmack & Derryberry, 2005) and attests to the robustness of this effect though it should be noted that the effect sizes would only be classed as small to moderate by standard nomenclature (Cohen, 1988). We also note that emotional distraction was caused by both positive and negative images in the present

experiments. Hence, we believe that this task appears sufficiently robust to be used as an assay of individual differences in the processing of emotional stimuli.

Psychopathy and Emotional Interference

The present experiments showed a consistent pattern of results whereby people with higher traits related to cold-heartedness or meanness showed a reduced emotional distraction and hence supports theories that suggest that psychopathy is related to a deficit in processing the emotional world.

As discussed in the Introduction, there are no studies that are directly comparable to the present findings, though the studies by Mitchell et al. (2006) and Maes and Brazil (2015) both would appear to be similar in their conception and aims as the present experiments. Mitchell et al. (2006) also found that the interference caused by images that preceded (and followed) a target stimulus was greater for emotional images (of both positive and negative valence) than for an affectively neutral stimulus. However, the effect of both negatively and positively-valenced images was abolished in those with high psychopathy scores. Hence, these results are in accordance with the present results. Mitchell et al. (2006) only examined the total psychopathy score and so did not provide any information as to what aspects of psychopathy might underpin this abolition of the emotional interference. Maes and Brazil (2015) examined if peripherally presented images interfered with a target task at fixation in a community sample which completed the PPI (the forerunner to the PPI-R). They also found that emotional images (which they term “high arousal”) gave greater interference on a distraction task, but they did not differentiate between negative and positive valence. They did not examine any overall effect of psychopathy on this interference. They found that neither Fearless Dominance nor Impulsive

Antisociality (a scale which was updated to Self-centred Impulsivity for PPI-R) was related to the interference. Perhaps surprisingly, they did not examine whether the Cold-hearted scale was related to the emotional interference. They did, however, find an interaction between the traits of Fearless Dominance and Impulsive Antisociality, such that for participants with low Impulsive Antisociality the Fearless Dominance factor was associated with a reduced interference, while for those with high Impulsive Antisociality the Fearless Dominance factor was associated with an increased interference[1]. As such these results do not seem to fit well with those found in the present experiments. However, there are many differences in the tasks that might influence the results. Most notably, the distracting image commenced (250 – 600 ms) prior to the target, and the target was presented at the point of fixation. Clearly, further work is needed to examine if these changes alter the psychological processes underpinning the task and why these might highlight different aspects of psychopathy.

The present finding that psychopathy, or at least the traits related to coldheartedness/meanness, were related to blunted emotional processing for both negative and positive valenced images (see also Mitchell et al., 2006) adds to the debate as to the nature of the emotional deficit in psychopathy. It appears that some other tasks find only deficits when negative images are presented (e.g., Burley et al., 2019; Patrick et al., 1993). For example, in the affective modulation of the startle paradigm the startle response due to a loud noise is increased by negative images but decreased by positive images. (Patrick et al., 1993) found that the potentiation due to negative images did not occur for those with high psychopathy scores, but the reduction due to positive images was not affected by psychopathy. Later studies suggest that it may not be negative images *per se*, but that the dysfunction may be

[1] We also examined our data from Experiment 1 in this manner but did not find this interaction.

specific to threat/fear stimuli. Esteller et al. (2016). It may well be that the affective modulation of the startle taps very different psychological processes (for instance, a defensive reaction to possible threat) than the emotional distraction paradigm (an allocation of resources to process motivationally interesting stimuli). Several lines of evidence are suggestive. First, Esteller et al. (2016) found that the Boldness component of the triarchic model underpinned changes in threat-related potentiation of the startle response, whereas we find that it is the Meanness component of the triarchic model that underpins the reduction emotional distraction. Further, it has been found that the affective modulation of the startle is not habituated by many repetitions of the stimuli (Bradley, Lang, & Cuthbert, 1993), whereas the distraction from emotional images habituates if the same images are presented many times (Codispoti et al., 2016). Hence, psychopathy may be related to a range of dysfunctions (with the possibility that different traits of psychopathy may relate to different dysfunctions) and that different tasks may highlight different dysfunctions.

Emotional Distraction by Subliminal Images.

Though not the main focus of the present research, our findings also contribute to the debate about whether emotional processes are "automatic". Our findings, like others using this paradigm, show that the emotional content of an image is extracted to some extent even in a paradigm where the processing of the image is entirely irrelevant to the task. In this sense, there is some automatic processing of emotional content of the images under these conditions. More pertinent, however, is that this effect disappeared under conditions where the visibility of the distracting image was low. In this sense, there was no automatic processing of the emotional content of the image. We believe that this is the first experiment to examine the role of low visibility

images in the emotional distraction paradigm. While this result may appear "obvious" to the naïve reader, we stress that many other studies have shown that low visibility stimuli (and even "subliminal" ones) have been shown to influence performance on many other tasks (e.g. Carlson, Fee, & Reinke, 2009; Tamietto et al., 2009; Tsuchiya, Moradi, Felsen, Yamazaki, & Adolphs, 2009).

Limitations and Future Directions.

The most obvious limitation of the present studies is the use of a community sample where levels of psychopathy are likely to be low. Replication of the present findings is needed in samples that contain individuals with higher, including clinically significant, levels of psychopathy.

We have also only measured the effects of psychopathy across a small category of emotions. Given the clear differences have been found by others with respect to the interference caused by different categories of negative stimuli (e.g., Schimmack & Derryberry, 2005; Van Hooff, Devue, Vieweg, & Theeuwes, 2013) stimuli, it will be of interest to expand these studies to other categories of stimuli (e.g., disgust, sadness., etc.) and to the use of other emotion evoking stimuli (e.g., faces, sounds, etc.).

The samples used in the present experiments were of mixed gender and we did not analyse the data with respect to gender as such analyses would be underpowered and might produce misleading results. There appears to be consensus that men tend to show higher rates of psychopathy (e.g. Poy, Segarra, Esteller, López, & Moltó, 2014) but whether these traits manifest in different forms and have different external correlates between men and women remains a matter for debate (see Miller, Watts, & Jones (2011) and Efferson & Glenn, 2018). It seems also possible that there are gender differences in the processing of different emotional stimuli (Hall, 1978; Sass et al.,

2010) irrespective of psychopathy. Hence, studies are needed that use a range of different forms of emotional stimuli (e.g., disgust, threat, etc) and are sufficiently powered to examine possible gender differences with respect to the effects of psychopathy.

Finally, while the emotional distraction effect appears robust and replicable across laboratories, the effect sizes produced in our paradigms were only small to moderate. Refinement of the paradigm might be able to produce an even more robust effect and larger effect sizes with which to explore individual differences in emotional processing.

Declarations

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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

Data Availability - The data and materials for all experiments are available from the corresponding author.

Authors Contributions - RS designed each study, supervised the students, performed the statistical analysis, and wrote the first draft of the manuscript. AJ helped design study 2, collected the data, and helped with its statistical analysis. RL helped design study 1, collected the data, and helped with its statistical analysis. AM helped design study 1, wrote the programme to run the experiments, and collected pilot data. NG helped design all studies and co-wrote the manuscript. All authors commented on drafts of the manuscript.

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