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Emotion regulation in psychopathy

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ABSTRACT

Emotion processing is known to be impaired in psychopathy, but less is known about the cognitive mechanisms that drive this. Our study examined experiencing and suppression of emotion processing in psychopathy. Participants, violent offenders with varying levels of psychopathy, viewed positive and negative images under conditions of passive viewing, experiencing and suppressing. Higher scoring psychopathics were more cardiovascularly responsive when processing negative information than positive, possibly reflecting an anomalously rewarding aspect of processing normally unpleasant material. When required to experience emotional response, by 'getting into the feeling' of the emotion conveyed by a negative image, higher factor 1 psychopathic individuals showed reduced responsiveness, suggesting that they were less able to do this. These data, together with the absence of corresponding differences in subjective self-report might be used to inform clinical strategies for normalising emotion processing in psychopathic offenders to improve treatment outcome, and reduce risk amongst this client group.

1. Introduction

In the first part of the 19th century Pinel described psychopathy as a *manie sans délire*, a disorder of affect and impulse that otherwise seemed to spare intellectual functioning (Pinel, 1801, 1806). Later Cleckley's (1941) psychopath was identifiable by his 'general poverty in major affective reactions'. More recently, Hare's (1991, 2003) 2 factor model of psychopathy distinguished callous, unemotional traits (factor 1) from antisocial acts and unstable/deviant lifestyle (factor 2). Factor 2 psychopathy is characterised by affective disturbances believed to originate in aversive psychosocial learning (Blair and Mitchell, 2009). Disturbances include poor behavioural controls and impulsivity. Factor 2 is also associated with anxiety (Blackburn, 2007). In contrast, factor 1 psychopathy is characterised by callous unemotional traits thought to be rooted in temperament (Blair and Mitchell, 2009) and highly heritable (Viding et al., 2005). These traits include shallow affect and a lack of empathy, guilt or remorse. Factor 1 is exemplified by conning, manipulative behaviour combined with superficial charm aimed at maximising personal gain or excitement. The Psychopathy Check List-Revised (PCL-R; Hare, 1991, 2003) is the measurement standard for psychopathy in research and clinical settings. The PCL-R yields a total score, as well as subscores reflecting factor 1 and factor 2. While factor scores are correlated, they are also dissociable (Verona et al., 2004). Cognitive affective deficits have been shown, as predicted, to be most strongly related to factor 1 psychopathy. It is therefore important to consider them separately when examining emotion processing ability in psychopathy (Blair et al., 2004; Verona et al., 2004). Estimates suggest that 20–30% of prison populations can be categorized as 'psychopathic' (Harpur and Hare, 1994), while an additional unknown number of individuals meet similar affective criteria, without coming to the attention of criminal justice systems (Hare et al., 1999).

Emotion processing in psychopathy is an important area of study because the associated deficits are functionally linked to violent offending and can be a target for treatment. Importantly, factor 1 characteristics are thought to be more treatment resistant than those of factor 2 (Poythress et al., 2007). One of the most consistent findings from a wide range of studies of incarcerated psychopathic individuals is that they fail to process, experience or appreciate the emotional significance of stimuli in the way that individuals with lower psychopathy do (Blair et al., 2005; Book et al., 2007; Burns et al., 2011a; Christianson et al., 1996; Day and Wong, 1996; Kiehl et al., 1999; Louth et al., 1998; Patrick et al., 1993, 1994; Williamson et al., 1991; Hastings et al., 2008; Munro et al., 2007). Emotion processing in psychopathy has been studied in a variety of different ways, including the recognition of emotional categories (see Kirsch and Becker, 2007; Willmott et al., 2009 for reviews), the subjective experience of emotion (Kirsch and Becker, 2007) and psychophysiological responses to emotional material (Arnett, 1997; Kirsch and Becker, 2007; Lorber, 2004). In the present

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investigation we concentrated on the latter two, measuring both the strength of subjective experience of, and cardiovascular responsivity to, emotional images.

The psychophysiological response to differences in emotional valence (and arousal) has been well documented in the healthy population. Negative or unpleasant stimuli prompt heart rate deceleration, increased electromyographic (EMG) activity (such as frowning), increased skin conductance (SC) and potentiation of affective startle (see Kirsch and Becker, 2007 for a review). Conversely positive emotional material is generally associated with the reverse pattern (with the exception of SC). In contrast reduced or deficient autonomic responsivity to emotional material is usually reported in psychopathic individuals (Arnett, 1997; Kirsch and Becker, 2007; Lorber, 2004). In particular there are widely documented deficits in fear conditioning suggesting that psychopathic individuals are unable to learn a fear response in the way that others do (Hare et al., 1978) and reduced or absent autonomic differentiation between fearful and neutral stimuli across a variety of measures (e.g. Patrick et al., 1994; Levenston et al., 2000). In a detailed review of autonomic responsivity in psychopathy, Arnett (1997) notes that studies involving SC show a fairly consistent pattern of reduced electrodermal activity when psychopathic individuals process punishment or fearful stimuli, although response to positive material has been less well studied. In contrast the findings for cardiovascular (heart rate) response are less clear, with some showing acceleration in response to aversive stimuli (e.g. Hare and Craigen, 1974; Hare et al., 1978), while others suggest few psychopathy related differences (e.g. Patrick et al., 1993; Lorber, 2004).

In contrast, self-report ratings of the emotional content of stimuli have frequently failed to show corresponding differences, with psychopathic individuals showing similar valence and arousal ratings as do comparator groups. For example, Patrick et al. (1993) and Carmen Pastor et al. (2003) found no significant group differences for subjective ratings of picture content. Both high and low psychopathic individuals reported that they found emotional pictures more arousing and more interesting than neutral ones. A similar dissociation between psychophysiological response and self-report ratings was reported by Verona et al. (2004) when examining evocative sounds taken from a standardized set (positive for example baby's laugh; negative, for example baby's cry; neutral, for example toothbrush). Factor 1 was associated with attenuated SC for both valences of emotional sound, and factor 2 was related to heart rate differences, but neither factor was related to affective ratings, which were in line with normative data for these stimuli. Together these findings point to dissociations between physiological response and self-report related to affective stimuli in psychopathy.

Although experimental investigation of emotion regulation is a topic of considerable current interest (see Koole, 2009) its investigation in psychopathy has rarely been reported. Two studies are of some relevance however. Steinberg and Schwartz (1976) examined the extent to which psychopathic individuals could modify SC by using instructions alone and then using biofeedback training. Controls but not psychopathic individuals could implement instructions (requiring affective imagery) alone, whereas after biofeedback training both groups could influence their SC responsivity. In contrast no heart rate differences were found until after biofeedback training, when psychopathic individuals were unable to maintain the heart rate effects of the instructional manipulation. The authors concluded that while psychopathic individuals were able to regulate some physiological responses, other autonomic differences were less susceptible to control. A second study of direct relevance is that of Lobbestael et al. (2009) who examined the effect of anger induction in antisocial personality disorder (ASPD) and psychopathy. They found no group differences in self-reported levels of anger following mood induction, although heart rate and blood pressure were reduced for those with ASPD. In addition, post hoc analyses showed that those 6 participants who scored highly on factor 1 psychopathy were less physiologically responsive (blood pressure *decreased*) to the anger induction.

More recent emotion regulation paradigms (cf. Ochsner et al., 2004; Gross, 2002; Dalgleish and Yiend, 2006; Yiend et al., 2008; Mathews et al., 2004) have not yet been used to investigate emotion processing in psychopathy. In particular enhancement and suppression of emotional experience when viewing affective images has not, to our knowledge, been examined in psychopathy. In an fMRI study Ochsner et al. (2004) instructed participants to view affective pictures (negative and neutral) under three conditions (look, experience and suppress) and to rate the level of their emotional experience (0 = weak to 7 = strong). Results indicated that self-report ratings were significantly higher for experience and significantly lower for suppress compared to base-line look when viewing negative images. In addition, experiencing increased activation of the left amygdala whilst suppression decreased amygdala activation bilaterally. Deficits in amygdala activation are implicated in emotion processing deficits in psychopathy (Blair et al., 2005). We used an adaptation of the Ochsner design to examine emotion regulation in psychopathy. We used an instructed encoding task to manipulate the cognitive processing of emotional pictures in a sample of violent offenders categorised according to their level of psychopathy. If clinicians are to improve therapy outcome amongst psychopathic offenders, then evidence based knowledge about how these individuals process and regulate their emotional responses is vital. Our translational study (compare Yiend et al., 2011) aimed to address this clinical need by investigating the basic mechanisms involved in regulating emotion processing.

2. Method

2.1. Participants

95 male prisoners at the Dangerous and Severe Personality Disorder (DSPD) Unit, 'D Wing' at HMP Whitemoor were approached over a fourteen-month recruitment period between June 2009 and July 2010. Heart rate was chosen as the sole physiological measure due to the pragmatic considerations of security restrictions around equipment and prisoner acceptability and consent rates. The political and clinical context of these specialist units is described in detail in Burns et al. (2011a), together with characteristics of the UK DSPD population and how these compare to similar previous samples in the literature. Of these 70 (74%) consented to take part in the study. Seven participants subsequently refused to take part due to paranoid concerns about the heart rate monitoring equipment. For the same reasons, one participant agreed to complete only the self-report ratings. One participant was transferred from the prison before testing commenced. Consequently complete datasets were available for 61 participants, with 62 sets of data available in the case of self-report ratings.

2.2. Materials

2.2.1. Individual difference measures

Level of psychopathy was measured using the PCL-R (Hare, 1991, 2003), administered by trained and experienced clinical and forensic psychologists who conduct inter-rater reliability checks as part of their routine duties. It consists of a semi-structured interview used in conjunction with a collateral file search to give a score on a scale of 0–40 (sum of 0–2 for each of 20 traits) with higher scores indicating greater levels of psychopathy. In clinical settings a score of 30 is used as a diagnostic cut off. The Eysenck Personality Questionnaire (EPQ, Eysenck, 1975) was also administered. This is a widely used 100 item self-report questionnaire examining extroversion/introversion and neuroticism/stability and including a lie scale.

2.2.2. Picture stimuli

12 positive and 12 negative stimuli were selected from the International Affective Picture System (IAPS; Lang et al., 1999) on the basis of their normative valence and arousal ratings. Negative pictures included guns, scenes of attack and fire, while positive images (which were matched for arousal, see below) included sporting and

relationship pictures. Almost all pictures involved people.[2] For each valence (negative and positive) pictures were divided into 3 matched sets of 4 pictures each. Sets did not differ significantly on normative arousal ratings (positive $M = 6.28$, negative $M = 6.27$), $t(22) = .08$, $p > .05$ but differed significantly on valence (positive $M = 7.29$, negative $M = 2.50$), $t(22) = 27.92$, $p < .01$. Sets were assigned to the emotion regulation task condition (Look, Experience, and Suppress: see below) in counterbalanced order across participants, according to a Latin square design.

2.2.3. Apparatus

Heart rate was measured by finger pulse amplitude (FPA) and recorded with a photoplesythmograph connected to a pulse oximeter and placed by a clip on the second finger of the non-dominant hand. FPA was sampled at 1000 Hz using a Cambridge Electronic Designs Micro 1401 data acquisition unit with Spike 2 version 4 software. Stimuli were presented using Psychology Software Tools' E-prime version 1.1 which also recorded self-report response ratings indicating strength of emotion experienced.

2.3. Procedure

Assessment took place in a designated room on a quiet part of the prison wing. Heart rate recording was commenced at the beginning of the session prior to the task starting and continued throughout the task. On screen task instructions indicated participants would see a series of pictures, with each one preceded by one of the following words: 'Look', 'Experience' or, 'Suppress'. Initial instructions explained that 'Look' meant participants should 'view the picture naturally'; 'Experience' meant they should 'get into the feeling of the picture by imagining themselves involved in the scene shown'; 'Suppress' meant they should 'view the picture with the detached perspective of a photographer' (cf. Yiend et al., 2008). On individual trials this instruction appeared for 2 s followed by the picture presented full screen in colour for 10 s. Participants then rated the picture on a Likert scale according to 'the strength of feeling experienced while viewing the picture' (1 = weak to 7 = strong). Each trial ended with a 4 s rest period. Participants were given three practice trials (look, experience, and suppress) to allow familiarisation with the task. The entire task took approximately 30 min to complete. In line with site practice (where prisoner earnings are capped at a very low level) participants were not paid for participation.

In a separate task delivered after the main emotion regulation paradigm we obtained participant ratings of the *affective content* (as opposed to 'strength of feeling') of the stimuli used. Pictures used in the present task were presented full screen on computer and participants were asked to rate valence and arousal (i.e. valence: 1, unpleasant – 7, pleasant, and arousal: 1, calming – 7, energetic). The rating task was self-paced.

3. Results

3.1. Participant characteristics and design of analyses

Two type of analysis were used to investigate the relationship between psychopathy and emotion regulation. First we used a median split group comparison, based on the clinical threshold of 30 (high psychopathic group = PCL-R $\geq$ 30, lower psychopathic group = PCL-R < 30). We compared these groups using repeated measures ANOVAs with within subjects factors of Picture Type (positive and negative) and Instruction (Look, Experience, Suppress) and between subjects factor Group (high psychopathic, lower psychopathic). Second, in line with previous practice (e.g. Yiend et al., 2008; Mathews et al., 2004), we calculated indices of experiencing and suppressing of emotion and used regression analyses to examine their relationship with individual difference measures, in particular psychopathy.

Table 1 therefore presents the characteristics of the whole sample and each group separately. The two groups differed significantly in factor 1, factor 2 and total psychopathy score (by design), and also on EPQ-neuroticism, with non-significant trends indicating possible differences on EPQ-extraversion and the number of previous convictions. The latter three variables were therefore used as covariates in all analyses reported below.

[2] A full list of IAPS picture stimuli used can be obtained from the corresponding author upon request.

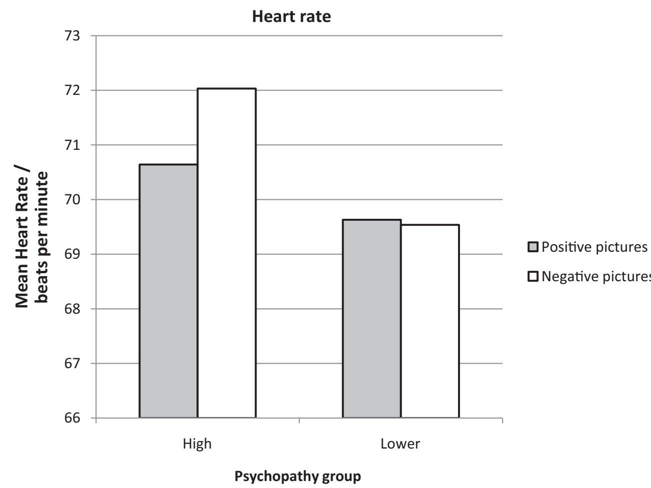

Fig. 1. Psychopathy-related group differences in cardiovascular response.

3.2. Heart rate data

Pulse oximeter heart rate data was first down-sampled using a low pass differentiator filter to remove extraneous noise. Identification of individual HR events (beats) was based on semi-automated detection of peak amplitudes in the resulting differential data. User-adjustable interactive cursors provided instantaneous event interval displays, which were adjusted by eye to allow optimum event detection on a participant by participant basis. Individual recordings were further examined for spurious events (e.g. due to movement artefacts), which were manually removed. Spike 2 automatically generated an evenly sampled waveform from this final, clean datafile which was then used to calculate (in milliseconds) beats per minute and inter beat interval by participant by condition (each 10 s picture presentation).

3.3. Group comparison

A $2 \times 2 \times 3$ repeated measures ANOVA with Group (high psychopathic, lower psychopathic) $\times$ Picture (positive, negative) $\times$ Instruction (Look, Experience, Suppress) was performed, with EPQ neuroticism, EPQ Extraversion and Previous Convictions as covariates. There were no significant main effects, but a significant interaction of Group $\times$ Picture, $F(1, 54) = 5.77$, $p = 0.02$, partial $\eta^2 = 0.1$.[3] This interaction was interpreted by examining the simple main effects of Picture at each level of Group. This revealed that while the lower psychopathic group showed no difference in heart rate response to different types of pictures, the high psychopathic group showed a significant increase in heart rate when viewing negative compared to positive pictures ($t(28) = 2.6$, $p = 0.01$, $d = 0.49$; see Fig. 1). Analyses of the same design were conducted upon measures of the inter-beat interval. A similar pattern of results emerged in which only high psychopathic scorers had significantly shorter (853 vs. 875 ms) inter-beat intervals when viewing negative than positive pictures ($F(1, 54) = 5.83$, $p = 0.02$, partial $\eta^2 = 0.1$).

3.4. Regression analysis

In order to examine emotion regulation across the whole sample indices of experiencing and suppression were calculated in line with previous practice (e.g. Yiend et al., 2008; Mathews

[3] Partial η^2 effect size conventions vary but one suggestion is as follows: .04 small; .25 medium; .64 large (Ferguson, 2009).

Table 1
Participant characteristics (means with standard deviations in parentheses, unless otherwise stated).

	Whole sample ($n = 62$[c])	High psychopathic group ($n = 30$[c])	Lower psychopathic group ($n = 32$[c])	p[a]
Age	41 (11)	42 (12)	39 (10)	ns
Years spent in full time education	10.5 (.76)	10.3 (0.7)	10.6 (0.8)	ns
IQ score[b]	96 (13.9)	99 (13.6)	94 (14)	ns
PCL-R, total score	27.8 (5.7)	32.5 (1.9)	23.5 (4.5)	<.001
Factor 1	11.0 (3.3)	13.5 (1.6)	8.7 (2.7)	<.001
Factor 2	14.1 (3.0)	15.9 (1.4)	12.5 (3.2)	<.001
EPQ-R				
Neuroticism	13.2 (5.6)	11.4 (5.2)	15.0 (5.5)	.01
Psychoticism	9.3 (5.0)	9.0 (4.8)	9.6 (5.2)	ns
Extraversion	13.9 (5.9)	15.4 (5.5)	12.6 (6.0)	.06
Lie	8.1 (3.1)	8.1 (3.2)	8.1 (3.1)	ns
Clinical diagnoses				
Personality disorder (number with 1 or more diagnosis)				
Cluster A: Eccentric-odd	17	10	7	ns
Cluster B: Dramatic-erratic	22	12	10	
Cluster C: Anxious-fearful	16	6	10	
All clusters (mean number of diagnoses)	2.2	2.3	2.0	
DSM III Axis I Disorders (number of participants with one or more diagnosis):				
Anxiety/Depression/Bipolar	16	7	9	ns
Psychoses	5	3	2	
Criminal profile				
Previous convictions	13.4 (15.2)	16.7 (19.6)	10.3 (8.5)	.09
Tariff (years)	12 (6.7)	12.6 (6.8)	11.4 (6.7)	ns
Time served (years)	10.7 (7.4)	11.6 (7.1)	9.9 (7.7)	ns
Index offence at time of testing (number of participants)				
Homicide	32	20	12	ns
Other violent	13	5	8	
Sexual	15	5	10	
Other	2	0	2	
Risk of reoffending				
HCR20	27.1 (5.4)	28.0 (5.3)	26.2 (5.4)	ns
Static 99	6.4 (1.9)	6.5 (1.4)	6.2 (2.3)	ns

[a] p values reflect significance of high and lower group comparisons using either independent t-tests or chi squared analyses, as appropriate.
[b] Normative scores measured using either the Wechsler Adult Intelligence Scale or the WASI.
[c] Numbers may vary on individual measures due to occasional missing data points.

et al., 2004). For this the ‘just look’ condition acted as a baseline which was subtracted from the ‘experience’ and ‘suppress’ conditions respectively (Experience Index = Experience – Look; Suppress Index = Suppress – Look). Thus a positive Experience Index reflected the extent of heart rate speeding produced by the instruction to ‘get into the feeling of the picture’, and a negative Suppress Index reflected heart rate slowing when attempting to view in a detached manner, relative to simply looking at the pictures. Indices were calculated by type of picture (positive and negative) for each dependent measure separately (heart rate and inter-beat interval).

Bivariate correlations between these psychophysiological indices and psychopathy scores were examined. This suggested a possible association between total psychopathy score and the heart rate Experience Index for negative pictures ($r = -.29$, $p = .023$) and between factor 1 psychopathy (i.e. the affective subscale) and the same index ($r = -.31$, $p = .015$). Psychopathy was significantly negatively correlated with number of years spent in full time education ($r = -.29$, $p = .023$), EPQ-neuroticism ($r = -.26$, $p = .035$) and positively associated with the measure of recidivism risk, the HCR20 ($r = .29$, $p = .04$). Index scores were significantly positively associated with number of years spent in full time education ($r = .30$, $p = .029$) and negatively associated with the HCR20 ($r = -.37$, $p = .017$). These variables were therefore entered as predictors alongside psychopathy in the regression analysis.

The distribution of the dependent variable (Experience Index, negative pictures) was approximately normal. As stated above, several predictors were correlated, therefore tolerances and variance inflation values were examined to assess potential multicollinearity problems. Low tolerances (∼0) and high variance inflation values (>2) indicated significant multicollinearity among the predictors and values were therefore z transformed prior to entry into the regression model, after which collinearity was acceptable (Cohen et al., 2003). Stepwise linear regression was chosen because we had no a priori reasons to expect that the confounding variables would be related to regulation of emotion. Results of the regression are presented in Table 2.

As shown in Table 2 psychopathy factor 1 score was the strongest predictor of heart rate Experience Index for negative pictures and the only one to meet entry criteria ($p < .05$) for the model. This produced a well fitting model in which factor 1 significantly predicted increased heart rate when experiencing negative pictures ($p = .001$), accounting for just over a quarter (26%) of its variance. As can be seen in Fig. 2, the model suggests that for every one point increase in factor 1 score, increased heart rate when experiencing negative pictures will be smaller by approximately half a beat per minute.

Table 2
Linear regression to determine predictors of heart rate speeding when experiencing negative pictures.

Predictor	Cumulative R^2	β	t	p
Psychopathy factor 1	.26*	–.51	–3.53	.001
Years in education		.25	1.80	.08
HCR20		.24	–1.57	.13
Psychopathy total		–.20	–.78	.44
Psychopathy factor 2		–.10	–.65	.52
EPQ neuroticism		.03	.19	.85

* $F(1, 35) = 12.42$, $p = 0.001$.

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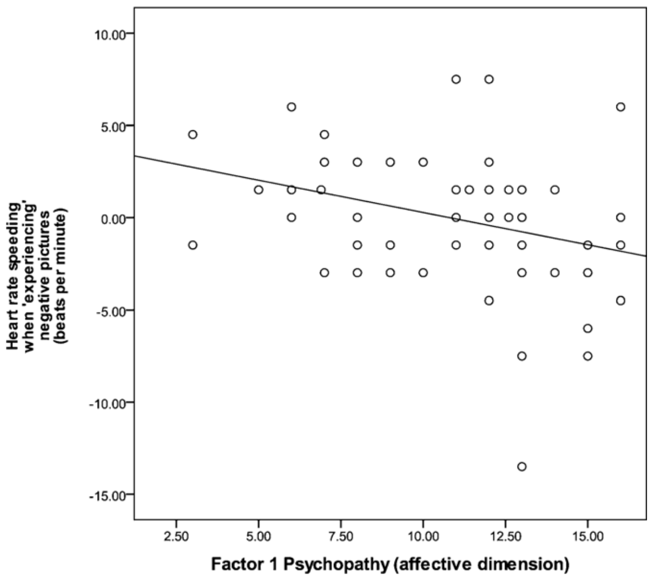

Fig. 2. The affective component of psychopathy is associated with reduced ability to experience negative emotion.

3.5. *Affective rating data*

Self-reported ratings assessed the strength of feeling experienced on a 7 point Likert scale while viewing each picture, with higher values indicating stronger feeling. Average ratings were calculated for each participant separately according to condition (Picture type × Instruction). Group comparisons and regression analysis controlled for confounding variables in the same manner as reported above.

3.6. *Group comparison*

A 2 × 2 × 3 repeated measures ANOVA with Group (high psychopathic, lower psychopathic) × Picture (positive, negative) × Instruction (Look, Experience, Suppress) was performed, with EPQ neuroticism, EPQ Extraversion and Previous Convictions as covariates. There were no significant main effects or interactions.

3.7. *Regression analyses*

Indices of experiencing (Experience Index = Experience − Look) and suppressing (Suppress Index = Suppress − Look) were calculated for rating data. Bivariate correlations between these rating indices and psychopathy scores were examined, but there were no significant associations (all $ps > .2$). There were three other significant correlations between indices and our other sample characteristics. The Experience Index for negative picture ratings was significantly negatively correlated with age ($r = -.31$, $p = .01$) and time served in prison ($r = -.25$, $p = .05$), while the Experience Index for positive picture ratings was significantly negatively correlated with EPQ Lie score ($r = -.26$, $p = .05$).

3.8. *Participant ratings of valence and arousal*

Although our main interest in subjective self-report concerned the *strength of feeling experienced* across emotion regulation conditions, we nevertheless also obtained participant ratings of the *affective content* of the stimuli used (i.e. ratings of valence, 1, unpleasant – 7, pleasant, and arousal, 1, calming – 7, energetic). As expected, and as reported previously in this population, stimulus content was judged by our participants in the same manner as suggested by normative rating data. Specifically, participants' ($n = 59$) ratings of pictures did not differ significantly on arousal (positive $M = 5.51$, SD = .82 negative $M = 5.81$, SD = .96), $t(60) = 1.32$, $p > .05$ but differed significantly on valence (positive $M = 5.80$ SD = 1.02, negative $M = 1.39$ SD = .61), $t(60) = 20.72$, $p < .01$. This was in line with the intended differences reported above under stimulus selection (see Section 2.2).

4. Conclusions

The present study examined psychophysiological (heart rate) and subjective self-report responses to positive and negative images in psychopathy. The current investigation is the first to our knowledge to examine emotion regulation in psychopathy using an instructed encoding technique with both measures of subjective experience and psychophysiology. Our design had the added strength of contrasting responses to differently valenced stimuli (positive as well as negative) matched for arousal, as called for by other researchers in this field (Arnett, 1997). Overall our data reflect three main phenomena of interest. First, there was clear evidence of psychopathy related psychophysiological differences, *in the absence of* corresponding differences in subjective self-reported experience. Second, clinical levels of psychopathy involved faster heart rate during negative than positive picture processing. Third, the affective component of psychopathy (factor 1) was associated with specific deficits in the ability to experience negative emotion.

First the data suggest a dissociation between cardiovascular response and subjective experiencing of unpleasant stimuli in psychopathy. The strength of feeling reported during picture viewing was not influenced by the emotion regulation procedure, nor showed any differences related to variation in psychopathy scores, either in group comparison or dimensional analyses. While a similar dissociation has been widely reported elsewhere (Carmen Pastor et al., 2003; Levenston et al., 2000; Patrick et al., 1993; Williamson et al., 1991; Verona et al., 2004), this has been in relation to ratings of the hedonic tone of the emotional information itself (e.g. valence and arousal ratings of picture content). In contrast the current data reflected participants' strength of feeling during the task, in line with previous methods of investigating emotion regulation. That there were no such differences points to one of several possibilities. First, participants may simply have been non-compliant, making no attempt to alter their emotional experience in line with instructions. However this is unlikely, given that cardiovascular response *was* affected. Second, it is possible that participants were 'faking bad' (i.e. reporting no subjective emotional effects despite experiencing them). This potential confound is ever present (in one direction or another) when investigating this population. Most interesting however, is the possibility that participants' genuine attempts to regulate emotion simply failed to elicit downstream subjective effects, despite their influencing underlying physiological mechanisms. Instrumental violence is known to be associated with self-reported lack of emotional experience during an actual offense (Cornell et al., 1996; Williamson et al., 1987) and the current investigation may be a useful laboratory analogue for investigating this further.

Our second main finding indicated faster cardiovascular responses at higher levels of psychopathy. Specifically, those with psychopathy scores above the standard diagnostic threshold exhibited raised heart rate when viewing negative compared to positive pictures, whereas those with lower psychopathy did not. This result may at first seem at odds with the wider literature in which reduced or deficient autonomic responsivity to emotional material is reported in psychopathic individuals (Arnett, 1997; Kirsch and Becker, 2007; Lorber, 2004). However, this is to deny the complexity of the field, and in particular the specific findings for

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cardiovascular measures. In his review of autonomic responsivity in psychopathic individuals, Arnett (1997) notes that while the findings involving heart rate measures are less robust than other psychophysiological indices, the two best designed studies show heart rate speeding and acceleration in response to aversive stimuli (e.g. Hare and Craigen, 1974; Hare, 1978b). The current data are in line with this, but are the first to demonstrate a pattern of increased responsivity to negative material using an affective picture processing paradigm (cf. Patrick et al., 1993, 1994).

How might we interpret this result? As Arnett argues, increased heart rate does not necessarily imply a more fearful response, but it does indicate a *stronger* cardiovascular output which requires explanation, especially in the light of contrasting electrodermal data in which psychopathic individuals show *attenuated* responses to emotional information (e.g. Lorber, 2004; Dvorak-Bertsch and Rubinstein, 2009; Patrick et al., 1993). The best account to date remains that of Hare (1978a), although this is not without critics (Siddle and Trasler, 1981; Fowles and Missel, 1994). Hare suggests a gating hypothesis in which heart rate is used to tag and subsequently filter out negative cues, while electrodermal attenuation reflects the extent to which this gating has been successfully achieved. However, an alternative explanation of our finding suggests itself. In our sample the more callous and unemotional the participant, the more responsive was his cardiovascular system when processing negative compared to positive information. In the wider literature heart rate acceleration is the usual response to processing *pleasant* visual stimuli (e.g. Lang et al., 1999). This raises the possibility that the response of high factor 1 psychopathic individual to negative images may reflect a rewarding emotional response to material that would normally be experienced negatively (Kirsch and Becker, 2007). Thus psychopathic individuals may process the emotions that victims are most likely to express as rewarding and this may contribute to explaining their crimes (compare Marshall et al., 1995).

Our third and arguably most interesting finding was that dimensional analyses revealed a specific relationship between factor 1 (affective component) psychopathy scores and the experiencing of emotional responses to negative pictures. More callous/unemotional individuals exhibited smaller increases in heart rate when trying to 'get into the feeling of' negative pictures. This result suggests that the experiencing of negative emotion is more impaired at higher levels of factor 1 psychopathy. High factor 1 psychopathic individuals fail to experience the physiological signals that those lower on factor 1 experience when fully engaging in negative emotional processing. Again, it is possible that high factor 1 psychopathic individuals merely *appeared* unable to increase physiological response to negative material, but in fact were simply less compliant with instructions to do so. However, the absence of a similar pattern in affective rating data renders this an unlikely explanation. If high factor 1 psychopathic individuals were less compliant in regulating their emotions as instructed, one would expect this to be at least, if not more, apparent when directly asked to report how they were feeling under different regulation conditions. That rating data showed no differences in factor 1 psychopathy level mitigates against this explanation. Failure to experience emotional response to negative material will inevitably lead to a relatively reduced appreciation and understanding of that negativity, which in turn could form the basis for the absence of empathy that characterises factor 1 psychopathy. Despite lack of empathy being core to the construct of psychopathy (especially factor 1) very little research has directly examined the relationship (Kirsch and Becker, 2007). Objective measures of empathy are required and the ability to 'get into the feeling' of emotional information using paradigms such as that reported here could provide one possible starting point.

The present study had a number of strengths, but also limitations. Although none of the effects reported here were attributable to any confounding characteristics that were measured, unmeasured confounders cannot be ruled out. Practical constraints meant that it was only possible to use a 2 dimensional model of psychopathy (factor 1; factor 2). However more complex models of the construct are increasingly being favoured (e.g. Cooke et al., 2006, 2007) and it remains under debate which of these models provides the best fit. Similar practical constraints meant that only one physiological measure (heart rate) was taken. Future studies on emotion regulation in psychopathy should consider using other measures of autonomic responsivity in addition to heart rate. In particular Polyvagal Theory, which refers to the parasympathetic regulation of cardiac activity, may be a useful framework for understanding emotional regulation in psychopathy in the future (cf. Beauchaine et al., 2007). It has been used as a framework to investigate emotion regulation problems in conduct disordered children (Beauchaine et al., 2007; Hastings et al., 2008) and has been shown to predict spontaneous regulation of negative emotional expression in healthy adults (Pu et al., 2009). This would require measuring respiratory sinus arrhythmia (the natural variation in heart rate occurring during the breathing cycle) in psychopathy during emotion regulation tasks of the sort used here and would be one useful way to validate and extend the present work.

A further limitation of our data was the absence of a truly low psychopathic comparator group. Due to the population from which our sample was taken (incarcerated male offenders from the UK DSPD service) the entire sample scored in the upper ranges of the PCL-R. It is therefore possible that the effects reported here apply only to those upper ranges of the psychopathy distribution. In addition, our design did not include a neutral picture viewing condition, meaning that conclusions must necessarily be limited to differences in valence alone. This does not therefore permit conclusions about general emotional responsivity in psychopathy, which may have been either attenuated or enhanced.

We now turn to a brief speculative discussion of the three themes of this special issue. The first theme is the 'Specificity of Emotional Attention Brain Mechanisms', in particular, how can emotional attention mechanisms be dissociated from systems involved in the control of non-emotional attention? We focus our discussion on the specification the concept of 'control'. Although our data cannot speak directly to the involvement of neural substrates, the question of attentional control of information processing is clearly central to paradigms such as ours that purport to investigate 'emotion regulation'. Controlling attention to different types of information is very obviously one way (but not the only way) that participants may use to implement instructions to 'experience' or 'suppress' their emotion. We have argued elsewhere (Yiend et al., 2008; Mathews et al., 2004) that an important next step is to investigate exactly how participants implement these instructions. Observed differences in participants' ability to 'control' their attention in the manner we ask may be due to different abilities to implement one particular strategy/mechanism, but it could also arise from differences in which strategies/mechanisms are actually used. One might start by evidencing the strategies and mechanisms that are spontaneously employed when instructions such as 'suppress' and 'experience' are given (an approach we have called 'explicit or volitional control', see Yiend et al., 2008). Subsequently, one might compare different experimental tasks, all designed to elicit attentional control in a tightly prescribed fashion, but which reflect different underlying mechanisms for doing so ('implicit control'; Yiend et al., 2008). In both approaches, biologically based measures such as psychophysiology and neuroimaging can provide objective and sensitive measurement of variations in the control of attention to stimuli differing in emotional tone.

The second theme is 'Emotional Attention in Psychopathology', in particular how can findings inform intervention strategies for relevant pathologies? We focus our discussion on the implication of our emotion regulation data for the treatment of psychopathy. It is well documented that addressing deficits in emotion processing is important for a good therapy outcome (Pos et al., 2003; Whelton, 2004; Greenberg and Pascual Leone, 2006). Indeed, some of the latest treatments for psychopathy in the UK specifically target emotional regulation (Burns et al., 2011b; Murphy and McVey, 2010). Our data suggest that effective treatment for psychopathy may need to focus on reducing the dissociation between subjective and physiological response that we report. One way to do this might be to raise individuals' awareness of their physiological responses to aversive information. Mindfulness approaches that use biofeedback exercises to enhance emotion regulation may be particularly effective. In addition, incorporating experimental measures alongside more traditional assessments of therapeutic outcome would be one potential translational application of the paradigm described here. Our data further suggest that although both patient and clinician may believe they are engaging with the emotions targeted by therapy, the higher the factor 1 score of the patient, the less likely this is to be true. Investigating emotion regulation ability in psychopathy may be essential not only for understanding its relationship to violent offending, but also for the appropriate allocation of scarce therapeutic resources.

The third theme of this special issue is the 'Methodology of Emotional Attention', in particular how the results from different research methodologies might be usefully combined to test models of emotional attention. We focus our discussion on the benefits and challenges of integrating different methodologies and consider applying this to two specific psychopathologies. Cross cutting research, whether across methods or disciplines, is lauded by policy makers and funders alike because of its potential to improve the validity and impact of the research output and generate high quality, innovative work. It is often hard to achieve though, due to inherent differences in researchers' theoretical priorities and assumptions or empirical constraints. As previous reviews have demonstrated (Yiend et al., in press; Yiend, 2010) the investigation of emotional attention is a classic case in point. Attention to emotion in the general population and attention to emotion in psychopathology have largely proceeded as independent fields of enquiry with separate methods and models. Integrated reviews, special interest groups and journal special issues, such as this, have an important role to play in promoting integration and encouraging cross fertilisation of ideas and methods, to promote translational and interdisciplinary research.

We will highlight two psychopathologies, psychopathy and psychosis, where there are obvious advances to be made in our knowledge of emotional attention by the cross fertilisation of methodologies. In psychopathy, although much is known about impaired emotion recognition (see Willmott et al., 2009), very little is known about the precise cognitive mechanisms underlying this, including attention to emotional information. Although the present study of emotion regulation in psychopathy almost certainly involves attentional effects, it only speaks to this indirectly (for the reasons discussed under question 1 above). Therefore there is much scope for more direct investigation of psychopathy-related differences in selective attentional processing using dedicated attentional paradigms, such as those reviewed elsewhere (Yiend et al., in press; Yiend, 2010). Psychosis is another example where the cross fertilisation of methods, and theories, about emotional attention could precipitate important advances (see Savulich et al., 2012, for more on this). This is because emotional selective attention in psychosis has rarely been examined using the precise paradigms together with behavioural and neuroscience methods available. Furthermore, although cognitive models of psychosis are influential, they do not currently recognise the component cognitive processes (such as attention) that might be differentially involved and that have proven so important in other clinical disorders.

In conclusion, the current investigation of emotion regulation in psychopathy revealed an amplified cardiovascular response when processing negative compared to positive emotional images in high psychopathic individuals. It is possible that this reflects an anomalously rewarding aspect of normally unpleasant material in the case of high psychopathic individuals. In addition when attempting to experience emotional response, by 'getting into the feeling' of the emotion conveyed by the image, higher factor 1 psychopathic individuals showed reduced responsiveness, suggesting that they were less able to do this. Overall this suggests that while psychopathic individuals may be more cardiovascularly responsive to negatively valenced material than positive, the subset who are higher on the factor 1 scale are less able to intentionally regulate this response. These results could be used to inform clinical strategies for targeting emotion regulation in psychopathic offenders. In this way our study may help to inform and improve treatment outcome, thereby reducing risk amongst this client group.

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