Boldness psychopathic traits predict reduced gaze toward fearful eyes in men with a history of violence

Gillespie, Steven; Rotshtein, Pia; Beech, Anthony; Mitchell, Ian

DOI:
10.1016/j.biopsycho.2017.07.003

Biological Psychology 128 (2017) 29–38

Contents lists available at ScienceDirect

Biological Psychology

journal homepage: www.elsevier.com/locate/biopsycho

Boldness psychopathic traits predict reduced gaze toward fearful eyes in men with a history of violence

Steven M. Gillespie*, Pia Rotshtein, Anthony R. Beech, Ian J. Mitchell

School of Psychology, University of Birmingham, Birmingham, B15 2TT, UK

ARTICLE INFO

Keywords:
Triarchic
Psychopathy
Eye scan paths
Emotion
Expression
Fear
Boldness
Eye gaze

ABSTRACT

Research with developmental and adult samples has shown a relationship of psychopathic traits with reduced eye gaze. However, these relationships remained to be investigated among forensic samples. Here we examined the eye movements of male violent offenders during an emotion recognition task. Violent offenders performed similar to non-offending controls, and their eye movements varied with the emotion and intensity of the facial expression. In the violent offender group Boldness psychopathic traits, but not Meanness or Disinhibition, were associated with reduced dwell time and fixation counts, and slower first fixation latencies, on the eyes compared with the mouth. These results are the first to show a relationship of psychopathic traits with reduced attention to the eyes in a forensic sample, and suggest that Boldness is associated with difficulties in orienting attention toward emotionally salient aspects of the face.

1. Introduction

Facial expressions of emotion represent a crucial component of human social interaction, allowing the observer to infer another's emotional state (Frith, 2009; Keltner, 2003), and adjust their behaviour accordingly (Blair, 2003). Children and adults affected by disorders of social and affective functioning, including psychopathy, often show difficulties in recognizing others' emotional expressions (Dawel, O'Kearney, McKone, & Palermo, 2012; Marsh & Blair, 2008). When categorizing expressions, attention is typically directed toward critical facial features, most notably the eyes and the mouth (Eisenbarth & Alpers, 2011; Wells, Gillespie, & Rotshtein, 2016). A failure to attend to these regions may lead to difficulties in judging the expressed emotion. Although psychopathic traits in children and non-offenders are associated with atypical eye scan paths for emotional faces (Dadds, El Masry, Wimalaweera, & Guastella, 2008; Gillespie, Rotshtein, Wells, Beech, & Mitchell, 2015), these relationships are yet to be tested in a forensic sample.

Psychopathy is best understood as a collection of personality traits that vary along a continuum in the general population (Coid, Yang, Ullrich, Roberts, & Hare, 2009). These traits include elevated levels of antisocial behaviour, a callous disregard for others, and a deceitful and manipulative interpersonal style (Hare, 2003), and are often prominent in clinical and forensic samples (Skeem, Polaschek, Patrick, & Lilienfeld, 2011). A triarchic conceptual framework describes psychopathy along three core dimensions that have been reliably identified and distinguished in clinical and non-clinical samples, namely Boldness, Meanness, and Disinhibition (Patrick, Fowles, & Krueger, 2009). Boldness refers to psychologically adaptive traits emphasised by Cleckley (1941), and includes venturesomeness, fearlessness, and interpersonal dominance (Patrick et al., 2009). Boldness explains a key difference between psychopathy and antisocial personality disorder [ASPD] (Wall, Wygant, & Sellbom, 2015), and contributes over and above Meanness and Disinhibition to the prediction of clinical psychopathy (Venables, Hall, & Patrick, 2014). Meanness entails a callous disregard for others, empathy problems, and a tendency toward exploiting others (Drislane & Patrick, 2016). The Disinhibition dimension refers to impulse control problems, emotional reactivity, poor behavioural restraint, and irresponsibility (Patrick et al., 2009).

Several prominent accounts of psychopathy emphasise the presence of emotion recognition impairments in relation to the fearless and unempathic features (e.g., Boldness, Meanness) of the disorder (Blair, 2005, 2008; Moul, Killcross, & Dadds, 2012). These difficulties have been observed among adult male psychopaths, and in relation to the broader psychopathy phenotype in both adults and children (Blair et al., 2004; Dolan & Fullam, 2006; Dadds et al., 2008; Hastings, Tangney, & Stuewig, 2008; Kosson, Suchy, Mayer, & Libby, 2002; Prado, Treeby, & Crowe, 2015). Although it is theorized by Blair (2005, 2008) that impairments in recognizing others distress cues (fear and sadness) are of particular importance in psychopathy, a recent meta-analysis suggests that these difficulties are pervasive across fear, sad, happy, and surprise emotional expressions (Dawel et al., 2012).

* Corresponding author at: Psychological Sciences, Institute of Psychology, Health and Society, University of Liverpool, L69 3GB, UK.
E-mail address: steven.gillespie@liv.ac.uk (S.M. Gillespie).

http://dx.doi.org/10.1016/j.biopsycho.2017.07.003
Received 18 August 2016; Received in revised form 28 June 2017; Accepted 8 July 2017
Available online 17 July 2017
0301-0511/

Neurobiologically inspired models of psychopathy propose that the disorder is characterized by functional impairments in areas related to emotion processing, including the amygdala (Blair, 2008), and the extended limbic system (Kiehl, 2006). Support for these models comes from studies that have shown a reduced amygdala response to fearful expressions in both adults and children/adolescents with increasing psychopathic traits (Decety, Skelly, Yoder, & Kiehl, 2014; Jones, Laurens, Herba, Barker, & Viding, 2009; Lozier, Cardinale, VanMeter, & Marsh, 2014).

The successful decoding of different emotional expressions depends on visual attention toward emotionally salient aspects of the face, most notably the eyes and the mouth (Eisenbarth & Alpers, 2011; Smith, Cottrell, Gosselin, & Schyns, 2005; Wells et al., 2016). The precise pattern of eye movements is thought to be dependent upon the emotion expressed, and attention is often guided toward the most diagnostic facial features for a given emotion (e.g., the widened eye whites of fearful expressions) (Schurgin et al., 2014; Smith et al., 2005; Wells et al., 2016). While attention to these regions is likely to be modified by conscious control, even briefly presented faces trigger very early, potentially reflexive eye movements toward diagnostic regions of the face (Gamer & Büchel, 2009; Scheller, Büchel, & Gamer, 2012). Again, reflexive eye movements in these studies were more commonly toward the eyes than away from the eyes, and varied with the type of expression. Psychopathy related impairments in emotion recognition may therefore reflect reduced attention to the eye region of emotional faces.

In support of this hypothesis, children with elevated callous-unemotional (CU) traits, referring to the affective dimension of psychopathy, show impaired fear recognition and a reduced number and length of fixations on the eye region (Dadds et al., 2008). When instructed to fixate the eye region, these children showed normalized levels of performance (Dadds et al., 2008). A similar pattern of performance has also been observed in a patient with bilateral amygdala dysfunction (Adolphs et al., 2005), and is taken as support for amygdala based models of psychopathy. More recent evidence from non-offending adult males has shown that the interpersonal and affective features of psychopathy are associated with reduced attention to the eyes, and that the number of fixations on the eye region is positively correlated with fear accuracy (Gillespie, Rotshtein, Wells et al., 2015). Another study with non-offenders has shown that equivalent measures of Boldness, but not Meanness, are associated with reduced face exploration during a face perception task (Boll & Gamer, 2016).

In the present study we examined eye scan paths for emotional faces among adult male violent offenders, and assessed the relationship of distinct psychopathic traits with attention to the eyes. For comparison we also recruited a community control group of non-offending adult males. Because psychopathy consists of a number of positively related dimensions, suppressor effects in statistical analyses may obscure understanding of the unique correlates of distinct psychopathic traits. Thus, we aimed to model these dimensional traits simultaneously in a way that can account for their covariance (Hicks & Patrick, 2006; Lozier et al., 2014). We also measured levels of negative affect, including anxiety and depression, as differences in emotional face processing and attentional allocation have been observed in these disorders (Buckner, Maner, & Schmidt, 2010; Easter et al., 2005; Kohler, Hoffman, Eastman, Healey, & Moberg, 2011). One earlier study suggests that psychopathy primarily affects the perception of moderate intensity expressions (Hastings et al., 2008). Therefore in the current experiment we manipulated the intensity of the emotional expression by morphing each prototypical expression (100%) with the neutral expression of the same person. Thus, participants classified expressions at 90% and 55% intensities (see Gillespie, Rotshtein, Wells et al., 2015; Gillespie, Rotshtein, Satherley, Beech, & Mitchell, 2015; Gillespie, Mitchell, Satherley, Beech, & Rotshtein, 2015; Wells et al., 2016).

We predicted that the preference for information form the eye region would be absent among violent offenders, and that they would show an absence of stimulus driven effects on eye scan paths. Moreover, we predicted that distinct psychopathic traits related to a lack of empathy and fearlessness, namely Meanness and Boldness, would be associated with a pattern of impaired emotion recognition, and reduced attention to the eyes relative to the mouth. We tested these relationships across various parameters of attention to the eyes and the mouth: overall dwell time, fixation count, and first fixation time. The analyses focused on the average response across all emotions, and also specifically on the processing of fearful expressions, given findings that the eye region is of particular importance for recognizing fear (Smith et al., 2005; Whalen et al., 2004). Furthermore, at least one prominent theory of psychopathy proposes that psychopaths are characterized by particular deficits in recognizing others distress cues (Blair, 2005, 2008).

2. Method

2.1. Participants

Thirty male violent non-sex offenders, aged between 32 and 50 years ($M = 35.1$, $SD = 11.8$), were recruited from HMP Grendon, UK. All participants had normal or corrected to normal vision. The majority of participants were White Caucasian ($n = 19$, 63%). Index offences included, but were not limited to, murder ($n = 17$) or attempted murder ($n = 2$), and wounding with intent ($n = 3$). Case file histories showed that no participants had a pre-diagnosed mental health problem, although one participant was taking antidepressant medication. The number of any previous convictions ranged from 0 to 31 ($M = 9$, $SD = 10$), and the number of previous violent convictions ranged from 0 to 14 ($M = 2$, $SD = 3$). All participants signed their fully informed consent. Ethical approval for the study was granted by the University of Birmingham Committee for Ethical Review, and access was approved by the National Offender Management Service for England and Wales, and the HMP Grendon Research Advisory Group.

Eye movement data were also collected from an approximately age matched community control group of 25 adult males, aged 18–69 years ($M = 37.88$, $SD = 18.29$), to assess the typicality of the eye movements observed in the violent offender sample. The comparison group was recruited from the community using online advertisements and participants received a monetary payment for taking part. None of the control group participants reported a history of convictions for either violent or sexual offences.

2.2. Materials

2.2.1. Facial expression stimuli

We used a selection of the facial stimuli developed by Gillespie and colleagues (Gillespie, Rotshtein, Wells et al., 2015 Gillespie, Rotshtein, Satherley et al., 2015 Gillespie, Mitchell et al., 2015 Wells et al. 2016) consisting of male and female expressions displayed at varying degrees of intensity. These stimuli consisted of five male and five female Caucasian models, selected from the NimStim Face Stimulus Set (Tottenham et al., 2009; http://www.macbrain.org/resources.htm), showing each of seven different expressions: neutral, angry, disgust, fear, happy, sad, and surprise. Emotional and neutral images from the same model were morphed to create images of varying levels of emotional intensity (see Gillespie, Rotshtein, Wells et al., 2015; Gillespie, Rotshtein, Satherley et al., 2015; Gillespie, Mitchell et al., 2015) for details of the morphing procedure. Images used in the current study consisted of each emotion, for each model, displayed at moderate (55% expressive) and high (90% expressive) intensity. The neutral expression was also included for each model so that participants were not only viewing emotional faces. Stimuli had a resolution of 504 × 624 pixels. The positioning of each image on the canvas was manipulated such that the eyes and the mouth appeared in the same location across all stimuli.

2.2.2. Measures

The Triarchic Psychopathy Measure (Drislane, Patrick, & Arsal,

2014) was used for the assessment of psychopathic traits. The 58-item self-report measure yields scores on three subscales: Boldness, Meanness, and Disinhibition. Participants respond on a 4-point Likert scale (3 = *true*, 2 = *somewhat true*, 1 = *somewhat false*, 0 = *false*). Internal consistencies (Cronbach's α) for the Boldness, Meanness, and Disinhibition subscales in the violent offender sample were .69, .75, and .91, respectively. Participants in the control group were also asked to complete the TriPM for comparison, although two participants in this group failed to complete the measure. In order to provide a better description of the sample, participants in the violent offender group were also asked to complete the State Trait Anxiety Inventory [STAI] (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), which contains both State [STAI-S] and Trait [STAI-T] subscales, and the Beck Depression Inventory [BDI] (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). Internal consistencies for the STAI-S, STAI-T, and the BDI in the current sample were good: Cronbach's α = .94, .93, and .79.

2.3. Eye tracking

We used an EyeLink 1000 corneal-reflection based portable eye tracking system (SR Research Ltd.) to record participants' eye movements. Although viewing was binocular, only movements of the right eye were recorded. Gaze location was sampled at 1000 Hz. A Dell Precision laptop computer was used to manage the recording of eye movements. Stimuli were displayed on a 19" LG colour monitor, using SR-Research Experiment Builder software, running on a laptop computer with a separate mouse and keyboard.

2.4. Procedure

Testing took place either in a private room inside the prison, or in a dedicated eye tracking laboratory at the university. Participants were seated at a desk and a chin rest of adjustable height was provided to minimize head movements. Participants were positioned approximately 68 cm form the display monitor, and images were presented at a visual angle of 21.2°. Participants were asked to categorize the emotional expression stimuli as quickly and accurately as possible as either neutral or one of the six basic emotions while their eye movements were being recorded. Standard EyeLink calibration and validation procedures were performed, each using a series of nine fixation points, presented at random in one of nine locations on the screen. Facial expression stimuli were presented in a randomized order over four blocks of 35 trials using the EyeLink software. At the start of each trial the experimenter confirmed that the participant's eye gaze fell on a fixation point presented in the centre of the screen. A fixation cross was then presented for 1000 ms, followed by an image of an emotional expression that was displayed for 2000 ms, considered to be the time taken for an individual to judge facial affect in an *in vivo* social interaction (Hoaken et al., 2007). Following display of the target expression, participants were asked to categorize the facial expression as neutral, or as one of the six basic emotions: anger, disgust, fear, happy, sad, surprise. Expression labels were displayed in a vertical list alongside the relevant number key (e.g., 1. ANGER). Responses were made using the numeric keys 0–6.

2.5. Eye movement parameters

Two separate areas of interest (AOIs) were created *a-priori* that included the eyes (300 × 100 pixels) and the mouth (240 × 125 pixels). For each AOI we were interested in the following gaze parameters: overall dwell time, total fixation count, and first fixation time. For the analysis of first fixation times we only included first fixations that were initiated 100 ms after the presentation of each stimulus. While dwell time and fixation count provide an estimate of the participants' interest in the eyes and the mouth, first fixation time provides an index of early gaze shifts towards these regions.

2.6. Data analysis

As Age is suggested to affect the processing of emotional expressions, it is included as a covariate in all analyses. For comparison with the non-offender control group, we first examine the main effects of Group, and any interactions of Group with Emotion, Intensity, or AOI, for accuracy, dwell time, fixation count, and first fixation time. However, as the focus of this paper is on the eye movements of violent offenders, we present in the main text the results for the violent offenders only. For the results of analyses conducted on the comparison group please see supplementary materials. Effects on accuracy were computed using a mixed ANCOVA, with the factors Emotion (Anger, Disgust, Fear, Happy, Sad, Surprise) and Intensity (55%, 90%) as repeated factors. For the three eye tracking parameters, we computed separate mixed ANCOVAs for each eye tracking parameter (dwell time, fixation count, first fixation time) using Emotion, Intensity, and AOI (Eyes, Mouth) as repeated factors. Significant interactions were broken down using follow up ANCOVAs and Bonferroni adjusted *post hoc* tests.

To assess the relations of the TriPM subscales with accuracy and scanning pattern in violent offenders, we computed regression models across all faces and intensities, and specifically for fearful expressions, for each of the four dependent variables (accuracy, dwell time, fixation count, and first fixation time). For each regression model normalized scores of Boldness, Meanness, Disinhibition, and Age, were used as predictors of differential attention to the Eyes and the Mouth (Eyes − Mouth).

3. Results

Mean scores and standard deviations for all self-report measures completed by violent offenders are shown in Table 1, along with the inter-correlations between measures. For comparison, descriptive statistics for the TriPM subscales in the non-offender control group, and in non-offender (N = 496), and forensic psychiatric samples (N = 296), reported by van Dongen et al. (2017) are also included. In the violent offender sample, there was a significant positive correlation between the TriPM Meanness and Disinhibition subscales that survived correction for multiple comparisons. The correlations of Boldness with

Table 1
Descriptive statistics and inter-correlations for boldness, meanness, disinhibition, state and trait anxiety, and depression (N = 30), and control group (N = 23), community, and forensic psychiatric comparison scores for the TriPM.

Variable	Bold	Mean	Disin.	STAI-S	STAI-T	BDI	Age
TriPM Boldness	–						
TriPM Meanness	.04	–					
TriPM Disinhibition	.03	.64***	–				
STAI-S	−.19	.26	.09	–			
STAI-T	−.28	.60**	.47**	.63***	–		
BDI	−.31	.29	.37*	.50**	.59**	–	
Age	−.03	.13	.01	.10	.12	.04	–
Range	15–43	0–50	6–54	20–57	20–59	2–24	32–50
Mean	30.4	14.2	29.2	28.4	39.8	11.0	35.1
SD	7.1	12.0	14.4	8.5	10.6	6.2	11.8
Comparison scores							
Control group Mean	28.9	13.4	17.7				
Control group SD	9.0	9.8	10.5				
Community Mean[a]	31.1	12.3	11.5				
Community SD[a]	8.14	7.8	7.8				
Forensic Mean[b]	30.6	16.1	26.7				
Forensic SD[b]	9.2	9.6	12.0				

* < .05, ** < .01, *** < .002 (Bonferroni adjusted alpha level). *Note*: TriPM = Triarchic Psychopathy Measure; STAI-S = State Trait Anxiety Inventory − State; STAI-T = State Trait Anxiety Inventory − Trait; BDI = Beck Depression Inventory.

[a] Scores reported by van Dongen et al. (2017) for a community sample (N = 496).

[b] Scores reported by van Dongen et al. (2017) for a forensic psychiatric sample (N = 296).

Table 2
Accuracy as a function of emotion expressed and expression intensity for violent offenders (N = 30) and a community control group (N = 25).

Emotion	Intensity	Violent *M* (SD)	Control *M* (SD)
Angry	55%	.86 (.12)	.79 (.16)
	90%	.89 (.13)	.86 (.13)
Disgust	55%	.77 (.17)	.78 (.21)
	90%	.88 (.15)	.87 (.18)
Fear	55%	.70 (.19)	.61 (.24)
	90%	.60 (.18)	.54 (.25)
Happy	55%	.86 (.16)	.87 (.11)
	90%	.97 (.07)	.98 (.04)
Sad	55%	.77 (.18)	.75 (.14)
	90%	.89 (.14)	.85 (.11)
Surprise	55%	.81 (.18)	.84 (.15)
	90%	*.89 (.12)*	*.82 (.19)*

Meanness and Disinhibition were not significant. TriPM Meanness and Disinhibition were both positively correlated with STAI-T, and Disinhibition was positively correlated with BDI, though none survived Bonferroni correction.

3.1. Accuracy

Accuracy for recognition of different emotional expressions as a function of the intensity of the expression is shown in Table 2. A mixed ANCOVA showed that there was a significant three way interaction of Group with Emotion and Intensity $F(5, 260) = 2.69$, $p = .021$, $p\eta^2 = .049$. Although both groups showed a similar pattern of emotion recognition, when broken down by Group, the interaction effect was greater for community controls compared with violent offenders. Below we present the results for violent offenders only. Results for the control group are show in the supplementary materials.

The confusion matrix in Fig. 1 illustrates the pattern of responding among male violent offenders for each emotional expression as a function of Intensity. Overall, neutral expressions were classified with a relatively high degree of accuracy ($M = 81.5\%$, $SD = 19.8$). We found significant main effects of Emotion $F(5, 140) = 19.37$, $p < .001$, $p\eta^2 = .409$, and Intensity $F(5, 140) = 24.77$, $p < .001$, $p\eta^2 = .469$, and a significant two-way interaction $F(5, 140) = 2.80$, $p = .019$, $p\eta^2 = .091$. This two-way interaction was also affected by Age $F(5, 140) = 11.34$, $p < .001$, $p\eta^2 = .288$. Based on the data in Table 3, the interaction of Emotion and Intensity emerged as expressions of anger, disgust, happy, sad and surprise were recognized better at higher intensities, but the pattern was reversed for fear. To test these observations formally we analysed each emotion separately. While expressions of Disgust $F(1, 28) = 20.91$, $p < .001$, $p\eta^2 = .428$, Happy $F(1, 28) = 14.42$, $p = .001$, $p\eta^2 = .340$, Sad $F(1, 28) = 33.87$, $p < .001$, $p\eta^2 = .547$, and Surprise $F(1, 28) = 9.50$, $p = .005$, $p\eta^2 = .253$ were recognized better at high intensity, the converse was true for Fear $F(1, 28) = 11.70$, $p = .002$, $p\eta^2 = .295$. Angry expressions were recognized equally well at 55% and 90% intensities $F(1, 28) = .657$, $p = .424$, $p\eta^2 = .023$. It is also worth noting that Bonferroni adjusted comparisons showed that Fear was recognized least accurately compared with all other emotions (all $p < .001$), while Happy was recognized with the most accuracy compared with Disgust, Fear, Sad and Surprise (all $p < .018$). Anger was also recognized with more accuracy than Sad ($p = .041$).

3.2. Effects of emotion, intensity, and AOI

Table 3 shows means and standard deviations for dwell time, fixation count, and first fixation times as a function of Group, Emotion, Intensity, and AOI.

3.2.1. Dwell time

For dwell time, the two-, three-, and four-way interactions of Group with Emotion, Intensity, and AOI were non-significant (all $F < 2.14$, $p > .058$), suggesting that dwell times patterns were broadly similar in both groups. When focussing on the effects for violent offenders only, there was a significant three-way interaction of Emotion, Intensity, and AOI $F(5, 140) = 2.49$, $p = .034$, $p\eta^2 = .082$. When broken down by Intensity, the interaction of Emotion and AOI was significant for expressions at both 55% $F(5, 140) = 22.62$, $p < .001$, $p\eta^2 = .447$, and 90% intensity $F(5, 140) = 8.07$, $p < .001$, $p\eta^2 = .224$, but the interaction effect was larger for 55% compared to 90% intensity.

For 55% expressions, the effect of Emotion was significant for both the Eyes $F(5, 140) = 17.13$, $p < .001$, $p\eta^2 = .380$, and the Mouth $F(5, 140) = 17.35$, $p < .001$, $p\eta^2 = .383$. Bonferroni adjusted comparisons for 55% expressions showed that dwell time on the Eyes was greatest for Fear compared with all other expressions (all $p < .012$), and for Surprise compared with Anger, Disgust, Happy, and Sad (all $p < .01$). Conversely, dwell time on the Mouth was greatest for Happy and Disgust compared with all other expressions (all $p < .012$).

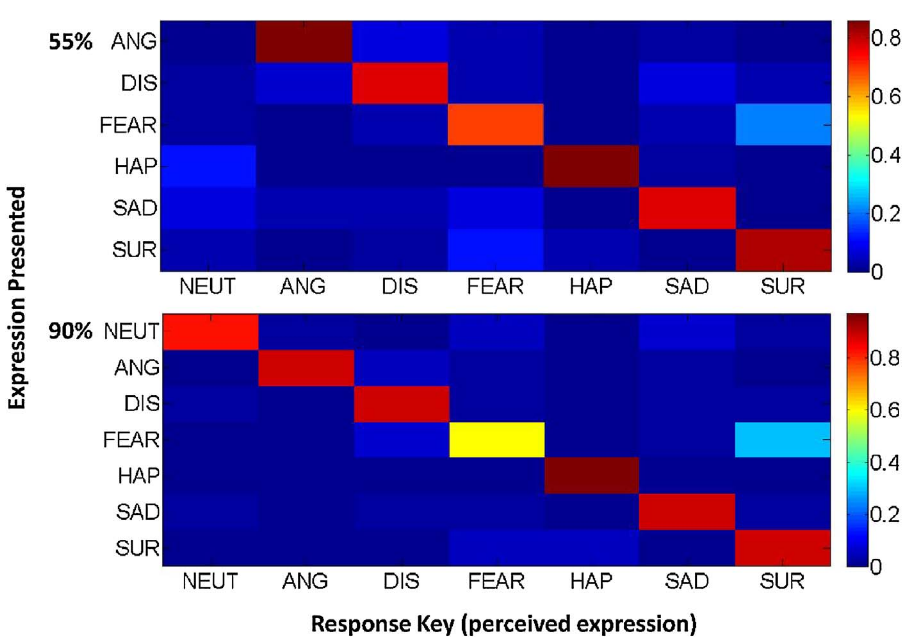

Fig. 1. Confusion matrices showing correct responses and error types as a function of the expression presented and expression intensity for violent offenders.

Table 3
Dwell times, fixation counts, and first fixation times, on the eyes and the mouth as a function of emotion expressed and expression intensity for violent offenders (N = 30) and a community control group (N = 25).

Emotion	Intensity	AOI	Dwell time (ms)		Fixation count		First fixation time (ms)	
			Violent M (SD)	Control	Violent	Control	Violent	Control
Anger	55%	Eyes	629.69 (342.03)	667.03 (245.99)	2.64 (1.46)	2.61 (1.10)	713.44 (343.79)	667.32 (288.48)
		Mouth	526.54 (232.69)	505.52 (233.23)	1.83 (.67)	1.74 (.68)	543.27 (267.74)	641.74 (289.39)
	90%	Eyes	667.95 (369.39)	644.33 (309.75)	2.83 (1.70)	2.49 (1.36)	651.49 (292.61)	689.48 (290.32)
		Mouth	457.83 (232.31)	459.72 (218.07)	1.77 (0.83)	1.64 (.62)	540.47 (293.81)	628.83 (283.94)
Disgust	55%	Eyes	564.31 (324.96)	588.37 (303.77)	2.42 (1.47)	2.31 (1.29)	717.67 (352.58)	693.05 (270.83)
		Mouth	672.84 (293.92)	615.93 (262.44)	2.19 (.87)	1.95 (.72)	535.35 (279.11)	576.70 (294.09)
	90%	Eyes	650.04 (335.64)	674.76 (244.68)	2.72 (1.49)	2.65 (1.11)	649.26 (332.97)	578.40 (236.16)
		Mouth	535.72 (242.13)	470.15 (217.56)	1.98 (.80)	1.74 (.58)	534.46 (283.21)	630.88 (259.48)
Fear	55%	Eyes	753.37 (380.63)	696.03 (297.57)	3.23 (1.67)	2.77 (1.30)	606.35 (302.31)	600.80 (294.22)
		Mouth	516.70 (308.70)	478.24 (240.63)	1.88 (.98)	1.72 (.74)	580.18 (329.32)	663.49 (325.21)
	90%	Eyes	763.65 (382.03)	694.79 (305.48)	3.40 (1.81)	2.87 (1.41	599.89 (314.07)	588.02 (278.69)
		Mouth	449.24 (263.34)	468.83 (243.52)	1.81 (.93)	1.71 (.76)	639.42 (309.65)	641.14 (308.91)
Happy	55%	Eyes	564.96 (322.30)	560.12 (253.26)	2.35 (1.47)	2.28 (1.13)	788.65 (418.10)	681.47 (317.77)
		Mouth	653.83 (285.86)	599.02 (253.48)	1.86 (.86)	1.97 (.70)	519.15 (287.69)	616.65 (281.52)
	90%	Eyes	561.13 (325.18)	550.17 (261.54)	2.46 (1.49)	2.12 (1.09)	642.13 (291.44)	617.75 (271.38)
		Mouth	473.82 (227.27)	484.52 (234.96)	1.91 (.78)	1.75 (.64)	557.60 (319.90)	678.31 (351.18)
Sad	55%	Eyes	598.14 (353.35)	650.57 (260.43)	2.46 (1.49)	2.49 (1.14)	659.27 (318.30)	631.17 (297.78)
		Mouth	526.31 (264.30)	464.49 (249.94)	1.91 (.78)	1.72 (.83)	669.85 (333.00)	716.38 (336.36)
	90%	Eyes	651.10 (370.72)	661.42 (242.74)	2.70 (1.60)	2.55 (1.01)	575.53 (293.23)	590.96 (253.55)
		Mouth	440.32 (239.49)	451.46 (223.37)	1.71 (.79)	1.67 (.71)	644.15 (297.83)	678.36 (284.55)
Surprise	55%	Eyes	673.22 (366.85)	705.81 (253.13)	2.90 (1.66)	2.78 (1.14)	662.53 (354.01)	590.16 (242.57)
		Mouth	536.16 (321.59)	444.27 (228.78)	1.90 (.89)	1.54 (.70)	606.07 (319.11)	707.21 (300.35)
	90%	Eyes	687.62 (373.39)	695.93 (284.29)	3.00 (1.81)	2.79 (1.22)	558.69 (259.06)	563.84 (271.71)
		Mouth	441.80 (278.86)	420.48 (245.68)	1.70 (.90)	1.53 (.64)	638.61 (355.58)	704.07 (312.12)

For 90% expressions, the effect of Emotion was significant for both the Eyes $F(5, 140) = 9.63$, $p < .001$, $p\eta^2 = .256$, and the Mouth $F(5, 140) = 4.28$, $p = .001$, $p\eta^2 = .133$. For 90% expressions dwell time on the Eyes was greatest for Fear compared with all other expressions excluding Anger (all $p < .038$), as well as for Anger ($p = .045$) and Surprise ($p = .004$) compared with Happy. Conversely, dwell time on the mouth was greatest for Disgust compared with Anger, Fear, and Sad faces (all $p < .035$).

In summary, as a group violent offenders dwelled relatively longer on the eyes of fearful faces, and the mouth of disgusted faces, compared with other emotions. However, the strength of these biases varied with the expression intensity. This is a similar pattern to that previously reported for non-offenders (Gillespie, Rotshtein, Wells et al., 2015; Wells et al., 2016).

3.2.2. Fixation count

For fixation count, the two-, three- and four-way interactions of Group with Emotion, Intensity, and AOI were all non-significant (all $F < 2.59$, $p > .073$), suggesting a similar pattern for fixation counts in both violent offenders, and non-offenders. When focussing on the effects for violent offenders only, the two-way interactions of Intensity with AOI $F(1, 28) = 24.95$, $p < .001$, $p\eta^2 = .471$, and Emotion with AOI $F(5, 140) = 21.27$, $p < .001$, $p\eta^2 = .432$, were both significant.

When broken down by AOI we found opposing patterns at 55% and 90% intensity, with the Eyes fixated more often at higher intensities $F(1, 28) = 13.55$, $p = .001$, $p\eta^2 = .326$, and the Mouth fixated more often at lower intensities $F(1, 28) = 20.93$, $p < .001$, $p\eta^2 = .428$. The effect of Emotion was significant for both the Eyes $F(5, 140) = 20.52$, $p < .001$, $p\eta^2 = .423$, and the Mouth $F(5, 140) = 5.71$, $p < .001$, $p\eta^2 = .169$. Bonferroni adjusted comparisons showed that the Eyes were fixated more often for Fear compared with all other expressions (all $p < .002$), for Surprise compared with Happy and Sad (all $p < .006$), and for Anger compared with Happy ($p = .003$). Conversely, the Mouth was fixated more often for Disgust compared with Angry, Sad, and Surprise (all $p < .041$).

Mirroring the dwell time results, offenders made more fixations on fearful eyes and disgusted mouths relative to other expressions

3.2.3. First fixation time

For first fixation time, the two-, three- and four-way interactions of Group with Emotion, Intensity, and AOI were all non-significant (all $F < 2.37$, $p > .131$), suggesting that first fixation times followed a similar overall pattern in both offenders and non-offenders. When focussing on the violent offender sample, there were significant two-way interactions of Intensity with AOI $F(1, 28) = 27.38$, $p < .001$, $p\eta^2 = .494$, and Emotion with AOI $F(5, 140) = 17.90$, $p < .001$, $p\eta^2 = .390$.

When broken down by AOI, we showed that first fixation times on the Eyes were faster for higher than lower intensity expressions $F(1, 28) = 40.93$, $p < .001$, $p\eta^2 = .59$, while first fixation times for the Mouth were similar at 55% and 90% intensities $F(1, 28) = 2.16$, $p = .153$, $p\eta^2 = .072$. The effect of Emotion was significant for both the Eyes $F(5, 140) = 9.83$, $p < .001$, $p\eta^2 = .260$, and the Mouth $F(5, 140) = 10.95$, $p < .001$, $p\eta^2 = .281$. Bonferroni adjusted comparisons showed that the Eyes were fixated faster for Fear compared with Anger, Disgust and Happy expressions (all $p < .01$). Surprise Eyes were also fixated faster than Anger Eyes ($p = .028$), and both Sad Eyes ($p = .007$) and Surprise Eyes ($p = .008$) were fixated faster than Happy Eyes. Conversely, the Mouth was fixated slowest for Sad compared with Anger, Disgust, Fear, and Happy ($p < .05$). The Mouth was also fixated faster for Happy than Fear and Surprise ($p < .030$), for Anger than Surprise ($p = .047$), and for Disgust than Fear ($p < .020$).

There was also a significant two-way interaction of Emotion and Intensity $F(5, 140) = 2.43$, $p = .038$, $p\eta^2 = .080$. When broken down by Intensity the effect of Emotion was significant for expressions at lower $F(5, 140) = 3.04$, $p = .012$, $p\eta^2 = .098$, but not at higher intensities $F(5, 140) = .54$, $p = .748$, $p\eta^2 = .019$. Bonferroni adjusted comparisons for 55% expressions showed that the critical facial features were fixated faster for Fear than for Sad expressions ($p = .001$).

In summary, the data suggest that fearful eyes, and to lesser degree

Table 4
Results of regression models predicting dwell times, fixation counts, and first fixation times on the eyes relative to the mouth, across all emotions and for fearful expressions among violent offenders (N = 30).

	Overall model			Parameter estimates						
	F	*p*	ΔR^2	*β*	*SE*	*t*	*p* value	Zero-order	Partial	Part
Dwell time										
Averaged across emotions	2.776	.049	.197							
Age				−224.291	93.915	−2.388	**.025**	−.404	−.431	−.397
Boldness				−193.354	94.01	−2.057	**.050**	−.339	−.380	−.342
Meanness				154.674	128.036	1.208	.238	.138	.235	.201
Disinhibition				−75.351	127.657	−.590	.560	−.069	−.117	−.098
Fear	2.932	.041	.210							
Age				−249.204	104.159	2.393	**.025**	−.395	−.432	−.395
Boldness				−226.411	104.264	−2.172	**.040**	−.354	−.398	−.358
Meanness				195.774	142.001	1.379	.180	.119	.266	3227
Disinhibition				−132.982	141.581	−.939	.357	.015	−.185	−.155
Fixation count										
Averaged across emotions	2.936	.041	.21							
Age				−.139	.055	−2.524	**.018**	−.425	−.451	−.416
Boldness				−.133	.063	−2.108	**.045**	−.349	−.388	−.348
Meanness				.075	.071	1.057	.300	.108	.207	.174
Disinhibition				−.038	−.069	−.546	.590	.057	−.108	−.090
Fear	3.082	.034	.223							
Age				−.024	.009	−2.518	**.019**	−.415	−.450	−.412
Boldness				−.148	.067	−2.208	**.037**	−.360	−.404	−.361
Meanness				.095	.075	1.268	.217	.107	.246	.207
Disinhibition				−.062	.074	−.846	.406	.021	−.167	−.138
First fixation time										
Averaged across emotions	3.647	.018	.267							
Age				254.597	85.172	2.989	**.006**	.471	.513	.475
Boldness				172.430	85.259	2.022	.054	.320	.375	.321
Meanness				−176.671	116.117	−1.521	.141	−.115	−.291	−.242
Disinhibition				134.331	115.773	1.160	.257	.003	.226	.184
Fear	4.177	.010	.305							
Age				270.619	87.153	3.105	**.005**	.471	.528	.481
Boldness				192.666	87.242	2.208	**.037**	.339	.404	.342
Meanness				−209.176	118.817	−1.760	.091	−.106	−.332	−.273
Disinhibition				181.263	118.466	1.530	.139	.047	.293	.237

Note: p values highlighted in bold are significant p < .05

surprised eyes, are associated with greater attentional capture as assessed using the timing of the first fixation. Smiles also appeared to capture attention. These effects were larger for the more prototypical (90% intensity) expressions.

3.3. Effects of psychopathic traits on accuracy and eye scan paths

We next assessed whether accuracy of expression recognition across intensities among violent offenders can be predicted by the three subscales of the TriPM (Meanness, Boldness, and Disinhibition) after we controlled for Age, using linear regression. The analysis suggested that psychopathic traits did not affect accuracy $F(4, 25) = .632$, $p = .644$, $\Delta R^2 = -.50$. Psychopathic traits also failed to predict accuracy of responses to fearful expressions $F = .39$, $p = .812$, $\Delta R^2 = -.09$.

We then assessed whether the scanning pattern for emotional faces (irrespective of Emotion or Intensity), and specifically for Fear, can be predicted by the TriPm subscales after controlling for Age. The analysis focused on the preference for the Eyes compared with the Mouth (Eyes–Mouth). The results of linear regression models predicting eye scan paths are summarized in Table 4 and Fig. 2. For illustrative purposes in Fig. 2D we also present average heat maps for high (n = 10) and low (n = 10) Boldness participants.

The analyses revealed that scanning patterns (assessed by dwell time, fixation count, and first fixation time) for emotional faces in general, and for fearful expressions in particular, can be reliably predicted by distinct psychopathic traits and Age (see Table 4). A closer inspection of the parameter estimates for the regressors (proxy to the strength of relationship) suggested that Boldness and Age were negatively associated with the preference for the Eyes when measured in dwell time and fixation count, both when collapsed across expressions, and when modelled separately for fearful expressions (Fig. 2A, B). These results are indicative of relatively reduced attention to the eyes (compared with the mouth) with advancing years and Boldness scores. Similarly Boldness predicted slower first fixation times (Fig. 2C), suggesting that advancing years and Boldness scores were associated with a relatively longer time taken to first fixate the eyes compared with the mouth. Age was also positively associated with first fixation times across all expressions, although the effect of Boldness missed significance. The effects of Meanness and Disinhibition were non-significant for each parameter, across all emotions, and for fearful expressions only.

To formally verify that Meanness and Disinhibition did not contribute to the eye scanning pattern, we computed backward linear regression. The results of these analyses were similar to those reported here. Statistical detail for linear regression models predicting dwell time, fixation count, and first fixation time on the eyes relative to the mouth for the remaining emotions (Anger, Disgust, Happy, Sad, Surprise) are available in Supplementary Materials. These analyses show a similar pattern of results to those observed for fearful faces, suggesting that Boldness and Age effects may be generic across different expressions.

4. Discussion

In the present study we examined the eye movements of adult male violent offenders compared with non-offenders, and the extent to which

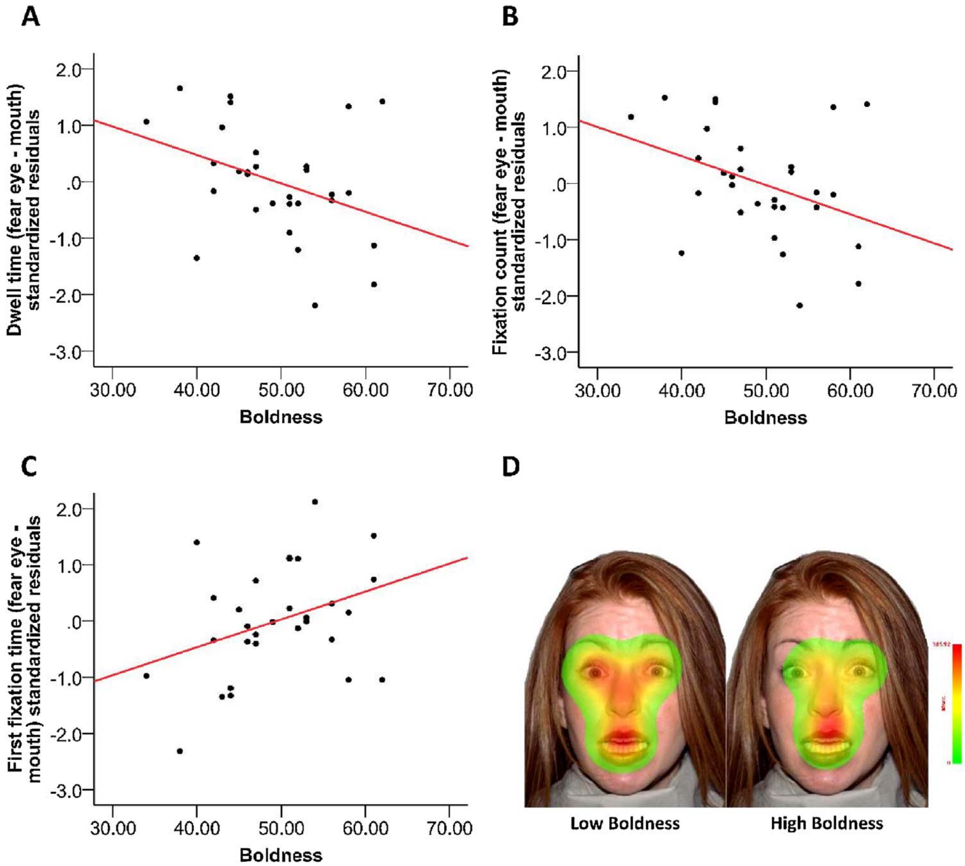

Fig. 2. Scatter plots for violent offenders with fitted regression lines showing the relationship of Boldness with attention to the eyes relative to the mouth of fearful faces for (A) dwell time, (B) fixation count, and (C) first fixation time, and (D) heat maps of fixation durations for the lowest (n = 10) and the highest (n = 10) scoring Boldness participants for a female fearful expression.

distinct psychopathic traits predicted violent offenders' preference for information from the eye region compared with the mouth. Violent offenders' eye movements did not differ from those of non-offenders, and were found to vary with the emotion and intensity of the expression. Furthermore, Boldness, but not Meanness or Disinhibition, was associated with reduced attention to the eyes across various eye tracking parameters among violent offenders.

Across all parameters, offenders and non-offenders showed similar patterns of eye gaze, with generally increased attention to fearful eyes, and to happy and disgusted mouths. These effects are consistent with those found in non-offending participants tested using the same stimuli (Gillespie, Rotshtein, Wells et al., 2015; Wells et al., 2016), and similar effects have also been shown by Scheller et al. (2012), and Eisenbarth and Alpers (2011). Our findings support the notion that eyes are more salient for recognizing fear compared with other emotions (Adolphs et al., 2005; Elsherif, Sahan, & Rotshtein, 2017; Smith et al., 2005), and that widened eye whites represent the critical diagnostic facial feature for fear (Whalen et al., 2004). On the other hand, the mouth appears to be most salient for happy and disgust expressions, perhaps due to the rather unique shape of a smile, or the furrowing of the nose and the mouth for disgust (Elsherif et al., 2017; Schurgin et al., 2014).

These stimulus driven effects appear to be greater with increasing task difficulty, including when expressions are presented at shorter durations, or when expression intensity is reduced (Schurgin et al., 2014). Increasing task difficulty in this study was achieved by morphing emotional expressions with neutral to create expressions that were 55% expressive. Results showed that the interaction of emotion and AOI on violent offenders' dwell times was greatest when task difficulty was increased, that is, when judging expressions at 55% intensity. Violent offenders also fixated the eyes of higher intensity expressions more often, and more quickly, and fixated the critical facial features more quickly for fear than sad at 55% intensity. It is argued that these patterns may reflect increased attention toward the most diagnostic facial features for each emotion as task difficulty increases (Schurgin et al., 2014; Wells et al., 2016).

When examining the effects of distinct psychopathic traits in violent offenders, we found that increasing Boldness scores and advancing Age were associated with shorter overall dwell times, and a fewer number of fixations, on the eyes compared with the mouth. However, there were no effects of Meanness or Disinhibition. These results were found for dwell times and fixation counts averaged across all expressions, as well as separately for fearful expressions. Similar results were also found for first fixation times, with increasing Boldness scores associated with slower first fixations on the eyes compared with the mouth of fearful expressions. These results are consistent with those previously reported in samples of non-offending adult males (Gillespie, Rotshtein, Wells et al., 2015), and adolescent boys (Dadds et al., 2008). In both of these studies it was found that psychopathic tendencies indexing the callous features of the disorder were associated with reduced eye gaze.

Findings from a recent study with non-offenders also showed that Fearless Dominance, an equivalent measure of Boldness, was associated with reduced scanning behaviour for emotional faces (Boll & Gamer, 2016). Furthermore, and perhaps surprisingly, these authors found that Self-Centred Impulsivity, equivalent to Disinhibition, was associated with fewer reflexive gaze shifts toward the eyes. These findings are in contrast to results from adult and developmental samples that found relationships of the fearless and unempathic features of psychopathy with eye gaze (Dadds et al., 2008; Gillespie, Rotshtein, Wells et al., 2015), and also with those reported here for violent offenders. However, there are important methodological differences between these two studies. In the current study participants were asked to judge the emotional expression following a 2000 ms presentation of a facial stimulus. Early eye fixations recorded here therefore share features with voluntary attentional control, and may not reflect an impairment in reflexive orienting *per se*. In contrast, Boll and Gamer (2016) measured reflexive gaze shifts when faces were shifted unpredictably above or below a fixation point during presentations lasting 150 ms or 2000 ms. Furthermore, Boll and Gamer used the Psychopathic Personality Inventory (Lilienfeld & Widows, 2005) to assess Fearless Dominance and Self-Centred Impulsivity. Although these scales measure similar constructs to the TriPM Boldness and Disinhibition scales, future research should seek to further examine the effects of distinct psychopathic traits on reflexive, as well as more controlled attentional processes, and use differing measures of psychopathic traits.

The modest inter-correlations between the TriPM subscales reported in this study may seem surprising. Although others have reported significant correlations of Boldness and Meanness (van Dongen et al., 2017), these subscales have previously been shown to be unrelated in prison inmates (Wall et al., 2015), or modestly related in a large mixed gender sample (Drislane et al., 2014). Drislane et al. suggest that although Boldness and Meanness may share a fearless temperament, other factors are also likely to contribute to dispositional Meanness (also see Patrick, Drislane, & Strickland, 2012). Weak negative correlations between Boldness and Disinhibition may also be expected, given that Boldness taps adaptive traits including immunity to stress and a fearless temperament, while Disinhibition taps impulse control problems and impaired regulation of affect (Drislane et al., 2014; Patrick et al., 2012). Others have debated that Boldness, or Fearless Dominance features, may be peripheral to psychopathy. However, findings from a recent meta-analysis (N = 10,693) underline the importance of these more adaptive traits to the conceptualisation and measurement of psychopathic personality (Lilienfeld et al., 2016).

The finding that reduced eye gaze in violent offenders is specifically related to Boldness, but not Meanness or Disinhibition, may reflect a specific relationship of Boldness with impaired processing of emotional stimuli, and reduced physiological fear reactivity (Benning, Patrick, & Iacono, 2005; Dindo & Fowles, 2011; Esteller, Poy, & Moltó, 2016). In support of this argument, participants scoring high on a trait measure of psychopathy that indexes Boldness features, including social potency, stress immunity, and fearlessness (see Benning et al., 2003), also show abnormal neural activations in the amygdala and prefrontal cortex during the processing of emotional facial expressions (Gordon, Baird, & End, 2004).

An alternative theory draws support from a recent study which showed that Boldness, but not Meanness or Disinhibition, is associated with a smaller N170 response to low (LSF), but not high (HSF), spatial frequency filtered emotional expressions (Almeida et al., 2014). LSF information is detected by magnocellular cells of the tectopulvinar pathway (superior colliculi–pulvinar), and is thought to allow for the rapid interpretation of emotional expressions by the amygdala (Tamietto & De Gelder, 2010; Vuilleumier, Armony, Driver, & Dolan, 2003). The results reported by Almedia et al. therefore suggest that Boldness may be associated with reduced amygdala processing during the analysis of LSF emotional expressions. Somewhat intriguingly, detection of fearful eyes is thought to rely predominantly on this magnocellular route (Vuilleumier et al., 2003), and dysfunction at an early stage in this pathway might account for reduced orienting toward the eyes, as well as hypoactivity of the amygdala in response to fearful expressions. These possibilities are worthy of future investigation.

With regard to accuracy, like earlier findings, expressions of higher intensity were typically recognized with more accuracy (Gillespie, Rotshtein, Wells et al., 2015; Schurgin et al., 2014; Wells et al., 2016), and fear was recognized with least accuracy compared with other expressions (Guo, 2012; Wells et al., 2016). However, accuracy was unrelated to psychopathic traits, and did not differ for violent offenders compared with controls. While some studies have found correlations of psychopathic traits with accuracy (Gillespie, Mitchell et al., 2015; Prado et al., 2015), these relationships are not consistently reported. Also, although difficulties in emotion recognition have previously been reported for violent offenders (Gillespie, Rotshtein, Satherley et al., 2015; Robinson et al., 2012; Schönenberg et al., 2014), the mean values reported here are similar to those reported by Gillespie, Rotshtein, Satherley et al. (2015) for sexual and violent offenders tested using the same stimuli (but fear appears to be less impaired here than previously observed). The comparison group reported here also show particular difficulty identifying fear compared with other non-offender samples (see Gillespie, Rotshtein, Wells et al., 2015; Gillespie, Rotshtein, Satherley et al., 2015; Wells et al., 2016). However, it is important to note that the current task was made more challenging by limiting the presentation of emotional faces to 2000 ms, meaning that comparisons with earlier studies should be made with some caution.

The findings reported here are based on a restricted sample of severe violent offenders that was relatively modest in size, and our results should therefore be replicated in a larger sample. Further, emotion recognition and eye movement patterns may differ between different types of offender, for example sexual offenders with child and adult victims, or may vary with other disorders know to affect the processing of emotional faces, including anxiety disorder (Short, Sonuga-Barke, Adams, & Fairchild, 2016), and borderline personality disorder (Domes, Schulze, & Herpertz, 2009). Understanding these differences would provide a more detailed understanding of affective processing in clinical samples. We used static images of emotional expressions, and the extent to which psychopathy related differences in eye gaze would be observed during a natural social interaction is also of interest. Further, although psychopathy refers to a dimensional construct (Edens, Marcus, Lilienfeld, & Poythress, 2006), recent findings suggest that the relationship of psychopathy with social-cognitive abilities may change at a point close to the cut-off score on the Psychopathy Checklist − Revised [PCL-R] (Hare, 2003) (Abu-Akel, Heinke, Gillespie, Mitchell, & Bo, 2015). As such, it would also be of interest to examine differences in eye scan paths for offenders with extreme scores on the PCL-R, relative to non-psychopaths.

5. Conclusion

For the first time, the present study explored the eye scanning behaviour of violent offenders during a facial emotion recognition task. Across different parameters the scanning behaviour was found to vary with emotion and intensity, suggesting that eye scan paths were sensitive to stimulus driven effects. We also showed that Boldness, but not Meanness or Disinhibition, was associated with a reduced tendency to dwell on and revisit the eye region. Similarly, Boldness was also associated with longer first fixations latencies for the eyes compared with the mouth, raising the possibility that these traits are associated with impaired automatic attention to the eyes. Our results extend the finding of psychopathy related differences in eye scan paths from developmental samples to incarcerated adult violent offenders, and highlight the utility of the triarchic conceptualization of psychopathy (Patrick et al., 2009), in particular Boldness traits, for understanding emotion processing impairments in forensic samples. Our findings also lend support to models of psychopathy that emphasise the differential effects of distinct psychopathic features on emotion processing (Fowles & Dindo, 2009).

Acknowledgements

This work was funded by a grant from the Economic and Social Research Council (ESRC) [ES/L002337/1]. The funder had no role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; and in the decision to submit the article for publication. The authors would like to thank the staff and men of HMP Grendon for allowing the research to take place.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.biopsycho.2017.07.003.

References

Abu-Akel, A., Heinke, D., Gillespie, S. M., Mitchell, I. J., & Bo, S. (2015). Metacognitive impairments in schizophrenia are arrested at extreme levels of psychopathy: The cut-off effect. *Journal of Abnormal Psychology*, *124*, 1102–1109.

Adolphs, R., Gosselin, F., Buchanan, T. W., Tranel, D., Schyns, P., & Damasio, A. R. (2005). A mechanism for impaired fear recognition after amygdala damage. *Nature*, *433*, 68–72.

Almeida, P. R., Ferreira-Santos, F., Vieira, J. B., Moreira, P. S., Barbosa, F., & Marques-Teixeira, J. (2014). Dissociable effects of psychopathic traits on cortical and subcortical visual pathways during facial emotion processing: An ERP study on the N170. *Psychophysiology*, *51*, 645–657.

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, *4*, 561–571.

Benning, S. D., Patrick, C. J., Hicks, B. M., Blonigen, D. M., & Krueger, R. F. (2003). Factor structure of the Psychopathic Personality Inventory: Validity and implications for clinical assessment. *Psychological Assessment*, *15*, 340–350.

Benning, S. D., Patrick, C. J., & Iacono, W. G. (2005). Psychopathy, startle blink modulation, and electrodermal reactivity in twin men. *Psychophysiology*, *42*, 753–762.

Blair, R. J. R., Mitchell, D. G. V., Peschardt, K. S., Colledge, E., Leonard, R. A., Shine, J. H., ... Perrett, D. I. (2004). Reduced sensitivity to others' fearful expressions in psychopathic individuals. *Personality & Individual Differences*, *37*, 1111–1122.

Blair, R. J. R. (2003). Facial expressions, their communicatory functions and neuro-cognitive substrates. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *358*, 561–572.

Blair, R. J. R. (2005). Applying a cognitive neuroscience perspective to the disorder of psychopathy. *Development and Psychopathology*, *17*, 865–891.

Blair, R. J. R. (2008). The amygdala and ventromedial prefrontal cortex: Functional contributions and dysfunction in psychopathy. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*, 2557–2565.

Boll, S., & Gamer, M. (2016). Psychopathic traits affect the visual exploration of facial expressions. *Biological Psychology*, *117*, 194–201.

Buckner, J. D., Maner, J. K., & Schmidt, N. B. (2010). Difficulty disengaging attention from social threat in social anxiety. *Cognitive Therapy and Research*, *34*, 99–105.

Cleckley, H. (1941). *The mask of sanity: An attempt to reinterpret the so-called psychopathic personality*. St. Louis, MO: Mosby.

Coid, J., Yang, M., Ullrich, S., Roberts, A., & Hare, R. D. (2009). Prevalence and correlates of psychopathic traits in the household population of Great Britain. *International Journal of Law and Psychiatry*, *32*, 65–73.

Dadds, M. R., El Masry, Y., Wimalaweera, S., & Guastella, A. J. (2008). Reduced eye gaze explains fear blindness in childhood psychopathic traits. *Journal of the American Academy of Child & Adolescent Psychiatry*, *47*, 455–463.

Dawel, A., O'Kearney, R., McKone, E., & Palermo, R. (2012). Not just fear and sadness: Meta-analytic evidence of pervasive emotion recognition deficits for facial and vocal expressions in psychopathy. *Neuroscience & Biobehavioral Reviews*, *36*, 2288–2304.

Decety, J., Skelly, L., Yoder, K. J., & Kiehl, K. A. (2014). Neural processing of dynamic emotional facial expressions in psychopaths. *Social Neuroscience*, *9*, 36–49.

Dindo, L., & Fowles, D. (2011). Dual temperamental risk factors for psychopathic personality: Evidence from self-report and skin conductance. *Journal of Personality and Social Psychology*, *100*, 557–566.

Dolan, M., & Fullam, R. (2006). Face affect recognition deficits in personality-disordered offenders: Association with psychopathy. *Psychological Medicine*, *36*, 1563–1570.

Domes, G., Schulze, L., & Herpertz, S. C. (2009). Emotion recognition in borderline personality disorder—A review of the literature. *Journal of Personality Disorders*, *23*, 6–19.

Drislane, L. E., & Patrick, C. J. (2016). Integrating alternative conceptions of psychopathic personality: A latent variable model of triarchic psychopathy constructs. *Journal of Personality Disorders*. http://dx.doi.org/10.1521/pedi_2016_30_240 [Ahead of print].

Drislane, L. E., Patrick, C. J., & Arsal, G. (2014). Clarifying the content coverage of differing psychopathy inventories through reference to the Triarchic Psychopathy Measure. *Psychological Assessment*, *26*, 350–362.

Easter, J., McClure, E. B., Monk, C. S., Dhanani, M., Hodgdon, H., Leibenluft, E., ... Ernst, M. (2005). Emotion recognition deficits in pediatric anxiety disorders: Implications for amygdala research. *Journal of Child & Adolescent Psychopharmacology*, *15*, 563–570.

Edens, J. F., Marcus, D. K., Lilienfeld, S. O., & Poythress, N. G., Jr. (2006). Psychopathic, not psychopath: Taxometric evidence for the dimensional structure of psychopathy. *Journal of Abnormal Psychology*, *115*, 131–144.

Eisenbarth, H., & Alpers, G. W. (2011). Happy mouth and sad eyes: Scanning emotional facial expressions. *Emotion*, *11*, 860–865.

Elsherif, M. M., Sahan, M. I., & Rotshtein, P. (2017). The perceptual saliency of fearful eyes and smiles: A signal detection study. *PLoS One*, *12*(6), e0179149.

Esteller, À., Poy, R., & Moltó, J. (2016). Deficient aversive-potentiated startle and the Triarchic model of psychopathy: The role of boldness. *Biological Psychology*, *117*, 131–140.

Fowles, D. C., & Dindo, L. (2009). Temperament and psychopathy: A dual-pathway model. *Current Directions in Psychological Science*, *18*, 179–183.

Frith, C. (2009). Role of facial expressions in social interactions. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *364*, 3453–3458.

Gamer, M., & Büchel, C. (2009). Amygdala activation predicts gaze toward fearful eyes. *The Journal of Neuroscience*, *29*, 9123–9126.

Gillespie, S. M., Mitchell, I. J., Satherley, R. M., Beech, A. R., & Rotshtein, P. (2015). Relations of distinct psychopathic personality traits with anxiety and fear: Findings from offenders and non-offenders. *PLoS One*, *10*(11), e0143120.

Gillespie, S. M., Rotshtein, P., Satherley, R. M., Beech, A. R., & Mitchell, I. J. (2015). Emotional expression recognition and attribution bias among sexual and violent offenders: A signal detection analysis. *Frontiers in Psychology*, *6*, 595. http://dx.doi.org/10.3389/fpsyg.2015.00595.

Gillespie, S. M., Rotshtein, P., Wells, L. J., Beech, A. R., & Mitchell, I. J. (2015). Psychopathic traits are associated with reduced attention to the eyes of emotional faces among adult male non-offenders. *Frontiers in Human Neuroscience*, *9*, 552. http://dx.doi.org/10.3389/fnhum.2015.00552.

Gordon, H. L., Baird, A. A., & End, A. (2004). Functional differences among those high and low on a trait measure of psychopathy. *Biological Psychiatry*, *56*, 516–521.

Guo, K. (2012). Holistic gaze strategy to categorize facial expression of varying intensities. *PLoS One*, *7*(8), e42585.

Hare, R. D. (2003). *The hare psychopathy checklist-revised: Second edition*. Toronto, ON, Canada: Multi-Health Systems.

Hastings, M. E., Tangney, J. P., & Stuewig, J. (2008). Psychopathy and identification of facial expressions of emotion. *Personality and Individual Differences*, *44*, 1474–1483.

Hicks, B. M., & Patrick, C. J. (2006). Psychopathy and negative emotionality: Analyses of suppressor effects reveal distinct relations with emotional distress, fearfulness, and anger-hostility. *Journal of Abnormal Psychology*, *115*, 276–287.

Hoaken, P. N., Allaby, D. B., & Earle, J. (2007). Executive cognitive functioning and the recognition of facial expressions of emotion in incarcerated violent offenders, non--violent offenders, and controls. *Aggressive Behavior*, *33*, 412–421.

Jones, A., Laurens, K., Herba, C., Barker, G., & Viding, E. (2009). Amygdala hypoactivity to fearful faces in boys with conduct problems and callous-unemotional traits. *American Journal of Psychiatry*, *166*, 95–102.

Keltner, D. (2003). Expression and the course of life: Studies of emotion, personality, and psychopathology form a social-functional perspective. *Annals of the New York Academy of Sciences*, *1000*, 222–243.

Kiehl, K. A. (2006). A cognitive neuroscience perspective on psychopathy: Evidence for paralimbic system dysfunction. *Psychiatry Research*, *142*, 107–128.

Kohler, C. G., Hoffman, L. J., Eastman, L. B., Healey, K., & Moberg, P. J. (2011). Facial emotion perception in depression and bipolar disorder: A quantitative review. *Psychiatry Research*, *188*, 303–309.

Kosson, D. S., Suchy, Y., Mayer, A. R., & Libby, J. (2002). Facial affect recognition in criminal psychopaths. *Emotion*, *2*, 398–411.

Lilienfeld, S. O., & Widows, M. R. (2005). *Psychopathic personality inventory—Revised: Professional manual*. Lutz, FL: Psychological Assessment Resources.

Lilienfeld, S. O., Smith, S. F., Sauvigné, K. C., Patrick, C. J., Drislane, L. E., Latzman, R. D., & Krueger, R. F. (2016). Is boldness relevant to psychopathic personality? Meta-analytic relations with non-psychopathy checklist-based measures of psychopathy. *Psychological Assessment*, *28*, 1172–1185.

Lozier, L. M., Cardinale, E. M., VanMeter, J. W., & Marsh, A. A. (2014). Mediation of the relationship between callous-unemotional traits and proactive aggression by amygdala response to fear among children with conduct problems. *JAMA Psychiatry*, *71*, 627–636.

Marsh, A. A., & Blair, R. J. R. (2008). Deficits in facial affect recognition among antisocial populations: A meta-analysis. *Neuroscience and Biobehavioral Reviews*, *32*, 454–465.

Moul, C., Killcross, S., & Dadds, M. R. (2012). A model of differential amygdala activation in psychopathy. *Psychological Review*, *119*, 789–806.

Patrick, C. J., Fowles, D. C., & Krueger, R. F. (2009). Triarchic conceptualization of psychopathy: Developmental origins of disinhibition, boldness, and meanness. *Development and Psychopathology*, *21*, 913–938.

Patrick, C. J., Drislane, L. E., & Strickland, C. D. (2012). Conceptualizing psychopathy in triarchic terms: Implications for treatment. *International Journal of Forensic Mental Health*, *11*, 253–266.

Prado, C. E., Treeby, M. S., & Crowe, S. F. (2015). Examining relationships between facial emotion recognition, self-control, and psychopathic traits in a non-clinical sample. *Personality and Individual Differences*, *80*, 22–27.

Robinson, L., Spencer, M. D., Thomson, L. D., Sprengelmeyer, R., Owens, D. G., Stanfield, A. C., & Johnstone, E. C. (2012). Facial emotion recognition in Scottish prisoners. *International Journal of Law and Psychiatry*, *35*, 57–61.

Scheller, E., Büchel, C., & Gamer, M. (2012). Diagnostic features of emotional expressions are processed preferentially. *PLoS One*, *7*(7), e41792.

Schönenberg, M., Christian, S., Gaußer, A. K., Mayer, S. V., Hautzinger, M., & Jusyte, A. (2014). Addressing perceptual insensitivity to facial affect in violent offenders: First evidence for the efficacy of a novel implicit training approach. *Psychological Medicine*, *44*, 1043–1052.

Schurgin, M. W., Nelson, J., Iida, S., Ohira, H., Chiao, J. Y., & Franconeri, S. L. (2014). Eye movements during emotion recognition in faces. *Journal of Vision*, *14*, 1–16.

Short, R. M., Sonuga-Barke, E. J., Adams, W. J., & Fairchild, G. (2016). Does comorbid anxiety counteract emotion recognition deficits in conduct disorder? *Journal of Child Psychology and Psychiatry*, *57*, 917–926.

Skeem, J. L., Polaschek, D. L., Patrick, C. J., & Lilienfeld, S. O. (2011). Psychopathic personality bridging the gap between scientific evidence and public policy. *Psychological Science in the Public Interest*, *12*, 95–162.

Smith, M. L., Cottrell, G. W., Gosselin, F., & Schyns, P. G. (2005). Transmitting and decoding facial expressions. *Psychological Science*, *16*, 184–189.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the state-trait anxiety inventory*. Palo Alto, CA: Consulting Psychologists Press.

Tamietto, M., & De Gelder, B. (2010). Neural bases of the non-conscious perception of emotional signals. *Nature Reviews Neuroscience*, *11*, 697–709.

Tottenham, N., Tanaka, J. W., Leon, A. C., McCarry, T., Nurse, M., Hare, T. A., et al. (2009). The NimStim set of facial expressions: Judgements from untrained research participants. *Psychiatry Research*, *168*, 242–249.

van Dongen, J. D., Drislane, L. E., Nijman, H., Soe-Agnie, S. E., & van Marle, H. J. (2017). Further evidence for reliability and validity of the Triarchic Psychopathy Measure in a forensic sample and a community sample. *Journal of Psychopathology and Behavioral*

Assessment, *39*, 58–66.
Venables, N. C., Hall, J. R., & Patrick, C. J. (2014). Differentiating psychopathy from antisocial personality disorder: A triarchic model perspective. *Psychological Medicine*, *44*, 1005–1013.
Vuilleumier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2003). Distinct spatial frequency sensitivities for processing faces and emotional expressions. *Nature Neuroscience*, *6*, 624–631.
Wall, T. D., Wygant, D. B., & Sellbom, M. (2015). Boldness explains a key difference between psychopathy and antisocial personality disorder. *Psychiatry, Psychology and Law*, *22*, 94–105.
Wells, L. J., Gillespie, S. M., & Rotshtein, P. (2016). Identification of emotional facial expressions: Effects of expression, intensity, and sex on eye gaze. *PLoS One*, *11*(12), e0168307.
Whalen, P. J., Kagan, J., Cook, R. G., Davis, F. C., Kim, H., Polis, S., ... Johnstone, T. (2004). Human amygdala responsivity to masked fearful eye whites. *Science*, *306* [2061–2061.