Processing of emotional faces in sexual offenders with and without child victims: an eye-tracking study with pupillometry

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Abstract

Socio-affective dysfunction is a risk-factor for sexual offense recidivism. However, it remains unknown whether men who have sexually offended with and without child victims show differences in eye scan paths and autonomic responsivity while viewing facial expressions of emotion. We examined differences in accuracy of emotion recognition, eye movements, and pupil dilation responses between sex offenders with child victims, sex offenders without child victims, and a group of non-offenders living in the community. Sex offenders without child victims looked for longer at the eyes than sex offenders with child victims and non-offenders. Men without child victims also scored higher for psychopathy linked disinhibition, and these traits were associated with looking longer at the eyes of afraid faces. We found no evidence for group differences in accuracy, visual attention to the mouth, or pupil dilation responses. Our findings have implications for understanding the nature of socio-affective dysfunction in sexual offenders.

Key words: victim age; empathy; emotion recognition; eye movements; pupil size

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Facial expressions of emotion serve a critical role in everyday social interaction. While the upturned lips of a smile communicate approachability and trust, the presence of widened eye whites can communicate that one is afraid, alerting others to potential danger in the environment. In this way, emotional facial expressions allow the expresser to communicate information about their emotions and intentions to an observer, and they can evoke responses in the perceiver (Keltner, Ekman, Gonzaga, & Beer, 2003). There is accumulating evidence that antisocial populations show impaired processing of others' facial expressions of emotion (Marsh & Blair, 2008). The breakdown of the ability to recognize others' emotional expressions is hypothesized to reflect a reduced ability to interpret others' social cues, and to understand when a potential victim is distressed (Blair, 2003). In their multicomponent model of empathy in sexual offenders, Marshall and colleagues suggest that sexual offenders may be impaired at discriminating the emotions of others (Marshall, Hudson, Jones, & Fernandez, 1995), and that these problems may contribute to a lack of empathy. Few studies have provided a direct test of these hypotheses by examining emotion recognition in sexual offenders, and none have explored differences between distinct subgroups of sexual offenders (Chapman, Gillespie, & Mitchell, 2018).

It is postulated that facial expressions of emotion serve a communicatory function, imparting specific information to an observer (Blair, 2003). Blair (2003) focusses on the communicatory functions of fearful, happy, and sad expressions, and it is argued that these expressions act as reinforcers, influencing the probability that a particular behaviour will be performed again in the future. It is suggested that fearful and sad expressions are aversive unconditioned stimuli that provide information to an observer that a stimulus or behaviour is aversive and should be avoided or discouraged. For example, the perceiver of a fearful expression may feel fear through a process of affective resonance with the other's emotion or as a direct response to the perceived threat in the environment. The feeling of fear may in turn lead one to avoid the threatening stimulus or refrain from behaving in ways that elicit fear in others. Alternatively, happy expressions are appetitive unconditioned stimuli that convey information that a stimulus or behaviour is positive and should be

approached or repeated (Blair, 2003, 2005). When considered in the context of violent or sexual offending, it is hypothesized that a failure to recognize another's fear or sadness may lead to difficulty withholding harmful actions in response to another's distress, and the individual may fail to learn that the behavior should be avoided in the future (Blair, 2003).

A small number of studies have examined processing of emotional facial expressions in sexual offenders (see Chapman et al., 2018 for a review). In one early study, sexual offenders with child victims were found to be impaired at recognizing anger, disgust, surprise, and fearful expressions compared with non-violent offenders and non-offenders (Gery, Miljkovitch, Berthoz, & Soussignan, 2009). Similar impairments have also been found in a mixed sample of sexual offenders consisting of men with child or adult victims, but differences based on victim age were not explored (Gillespie, Rotshtein, Satherley, Beech, & Mitchell, 2015). Victim age represents an important point of distinction among sexual offenders that is often considered for the purposes of assessment and treatment (Seto, 2017). The choice to offend against a child victim may be driven by a number of factors, including the focus of sexual attraction (Seto, 2017), problems in socio-affective functioning and the establishment of age appropriate romantic relationships (Mitchell & Beech, 2011), and the presence of psychopathological features associated with motivations to offend (Hoyer, Kunst, & Schmidt, 2001; McElroy et al., 1999; Raymond, Coleman, Ohlerking, Christenson, & Miner, 1999). Thus, although it may be expected that sexual offenders with and without child victims would show problems in the recognition of emotional expressions, the nature of these problems and the associated cognitive and affective processes underlying these problems may differ.

The allocation of visual attention to emotionally salient aspects of the face represents a candidate mechanism for understanding emotion recognition impairments (Wells, Gillespie, & Rotshtein, 2016). The eye region and the surrounding area represents the most diagnostic facial feature when judging emotional expressions. The importance of the eyes has been demonstrated using a partial masking method (bubbles) to show that, independent of the type of expression, information from the eyes is required for making accurate judgements of emotional content (Smith, Cottrell, Gosselin, & Schyns, 2005). This was true for both computer models and human observers. However, information from the eyes may be more useful for recognizing expressions showing fear, anger and

sadness, while information from the mouth appears to be most important for expressions showing happiness, surprise and disgust (Smith et al., 2005). Eye tracking studies have also shown that dwell times tend to be greater on the eyes than the mouth (Eisenbarth & Alpers, 2011; Wells et al., 2016), and that dwell time on the eyes appears to be longest for fearful expressions, and shortest for happy expressions (Wells et al., 2016). The importance of scanning the eyes for fear recognition has been demonstrated by several neuropsychological studies (Adolphs et al., 2005; Morris, deBonis, & Dolan, 2002; Whalen et al., 2001). For example, Adolphs et al. (2005) found that SM, a patient who showed impaired fear recognition, also made fewer spontaneous saccades toward the eye region relative to healthy controls. However, SM's fear recognition recovered when she was instructed to look at the eye region.

As well as problems in accurately recognizing others' emotional expressions, sex offenders may also show problems in feeling what another is feeling, more commonly referred to as affective resonance (Bird & Viding, 2014). Several studies have highlighted that impairments in feeling what another is feeling may be associated with interpersonal violence, as the perpetrator is unable to 'feel' the distress caused to the victim (Blair, 2013; Lozier, Cardinale, VanMeter, & Marsh, 2014). Affective resonance is typically assessed by measuring one's neural or physiological responses to stimuli portraying others' affective states, including images of afraid faces (Gillespie et al., 2019; Lozier et al., 2014; White et al., 2012), or images showing another in painful situations (Decety, Skelly, & Kiehl, 2013; Jauniaux, Khatibi, Rainville, & Jackson, 2019). The physiological changes that typically accompany emotional responses are mediated by the relative actions of the two branches of the autonomic nervous system (ANS): the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). An increase in SNS activity is associated with increases in heart rate and greater expenditure of energy, whereas increases in PNS activity are associated with reductions in heart rate and increased conservation of resources. Activity of the SNS may be examined using several measures, including the pre-ejection period of the heart (Beauchaine, 2001), skin conductance responses (Critchley, Elliott, Mathias, & Dolan, 2000), or pupil dilation responses (Liu, Rodenkirch, Moskowitz, Schriver, & Wang, 2017).

The smooth muscles involved in the pupil response are controlled by the two opposing branches of the ANS: the dilator muscle is influenced by activity of the SNS, while the sphincter muscle is influenced by activity of the PNS. When presented with an affective stimulus, neurons of the locus coeruleus (LC) respond to the salience and biological significance of the stimulus and give rise to noradrenergic release into the neocortex, while parallel activation of the SNS causes direct activation of the pupil dilator muscle (Joshi, Li, Kalwani, & Gold, 2016; Murphy, O'Connell, O'Sullivan, Robertson, & Balsters, 2014; Sara, 2009). Thus, smaller pupil dilation responses to an affective stimulus are indicative of hypoactivity of the LC-noradrenaline system. If lower sympathetic arousal to others' affective states is associated with sexual violence, then sexual offenders should show smaller pupil dilation responses to others' emotional expressions than non-offenders.

The processing of emotional faces is also associated with symptoms of various disorders associated with socio-affective dysfunction, including psychopathy and social anxiety. Sexual offenders without child victims tend to show higher levels of psychopathy compared to sexual offenders with child victims (Brown, Dargis, Mattern, Tsonis, & Newman, 2015; Olver & Wong, 2006; Porter et al., 2000), and show a more generalist, disinhibited pattern of antisocial behavior (Mitchell & Beech, 2011). The triarchic model conceptualizes psychopathy along three core dimensions, namely Boldness, Meanness, and Disinhibition (Patrick, Fowles, & Krueger, 2009). While Boldness refers to venturesomeness, fearlessness, and interpersonal dominance, Meanness indexes the callous and uncaring features at the core of the psychopathy construct (Patrick et al., 2009). Finally, Disinhibition refers to impulse control problems, emotional reactivity, and poor behavioral restraint (Patrick et al., 2009). Taken together, a meta-analysis has shown that psychopathic traits are associated with impaired recognition of others' emotional expressions (Dawel, O'Kearney, McKone, & Palermo, 2012). Eye tracking techniques have also been used to show that Boldness psychopathic traits are associated with reduced attention to the eyes (Dargis, Wolf, & Koenigs, 2018; Gillespie, Rotshtein, Beech, & Mitchell, 2017), while Meanness is associated with hypoactivity of the pupil dilation response to others' emotional expressions (Gillespie et al., 2019). Thus, psychopathic traits may, in part, help to explain sexual offenders' difficulties in recognizing and responding to others' emotional expressions.

In contrast to psychopathic traits, social anxiety tends to be associated with hypervigilance to affective cues, particularly those signaling social threat (e.g., afraid or angry faces) (Garner, Mogg, & Bradley, 2006). A relatively high incidence of social anxiety or social phobia has been reported among child sexual offenders (Hoyer et al., 2001; McElroy et al., 1999; Raymond et al., 1999), with some suggesting that social phobia may be a contributory factor to sexual offending against children (Mitchell & Beech, 2011). The relationship of social anxiety with eye scan paths is complex and may vary across the presentation of an affective stimulus. An enhanced tendency to reflexively shift attention towards the eyes of emotional faces has been observed in people with high social anxiety (Boll, Bartholomaeus, Peter, Lupke, & Gamer, 2016), and this is thought to reflect hypervigilance toward cues signaling disapproval or social evaluation. However, the converse pattern has also been reported, where people with social anxiety made fewer and shorter fixations to the eye region of emotional faces (Horley, Williams, Gonsalvez, & Gordon, 2003; Horley, Williams, Gonsalvez, & Gordon, 2004; Moukheiber et al., 2010). A pattern of hypervigilance-avoidance may explain this pattern, whereby social anxiety is associated with a more pronounced orienting response to affective cues that is followed by subsequent avoidance (Garner et al., 2006; Wieser, Pauli, Weyers, Alpers, & Mühlberger, 2009). Relationships with pupil dilation are similarly complex, with reports of blunted pupil dilation to emotional faces in children with social anxiety disorder (Keil et al., 2018), as well as more typical (Kadosh et al., 2018), or increased pupil dilation dependent on the emotional content of the expression.

Although a small number of studies have examined accuracy of emotional expression recognition in sexual offenders, no studies have examined accuracy of emotion recognition, visual exploration, and autonomic responsivity, between men with and without child victims. In this study, we aimed to examine how accuracy, visual attention toward the eyes and the mouth, and pupil dilation responses to emotional expressions varied between groups of sexual offenders with and without child victims, and community controls. Our analyses focused on the emotional faces that have been described as reinforcers by Blair (2003), that is, the expressions of fear, happy, and sad.

We predicted that independent of victim selection, sexual offenders would show impaired recognition of emotional faces, reduced attention toward the eyes, and hypoactivity of the pupil

dilation response. We also asked participants to self-report levels of psychopathy linked Boldness, Meanness, and Disinhibition, and social anxiety. We predicted that Boldness and Meanness would be associated with worse accuracy, shorter dwell times on the eyes and smaller pupil dilation responses. Conversely, we predicted that while Disinhibition would be associated with worse accuracy, there would be a positive correlation with dwell time on the eyes and pupil dilations responses, consistent with accounts of hypervigilance and emotional reactivity (Patrick et al., 2009). We predicted that social anxiety scores would be associated with avoidance of the eye region when assessed across the duration of the stimulus presentation.

Method

Participants

We recruited a sample of 22 adult men from a Category B prison in the UK with convictions for sexual offenses. The sample of sexual offenders without child victims consisted of 11 men aged 22 to 60 years who had been convicted of at least one contact sexual offense against an adult over the age of 16 years in the absence of a history of sexual offenses against children. The sample of sexual offenders with child victims consisted of 11 men aged 28 to 72 years who met inclusion criteria of having been convicted of at least one contact sexual offense against a person under the age of 16 years (the legal age for sexual consent in the UK). Four of these men also had convictions for sexual offenses against an adult. For comparison, a group of 25 adult men aged 18 to 69 years without a self-reported history of sexual offending was recruited from the local community. All participants signed their fully informed consent. Most participants (n = 45, 95.7%) were white Caucasian, and all had normal or corrected-to-normal vision. The study was approved by the University of Birmingham Committee for Ethical Review (Science, Technology, Engineering, and Mathematics), and Her Majesty's Prison and Probation Service (formerly the National Offender Management Service) for England and Wales.

Measures

We used the Triarchic Psychopathy Measure (TriPM; Patrick et al., 2009) to measure the trait dimensions Boldness, Meanness and Disinhibition. The TriPM consists of 58 items scored on a 4-point Likert scale (3 = *true*, 2 = *somewhat true*, 1 = *somewhat false*, 0 = *false*). Good internal

consistency of the TriPM dimensions has been reported in a sample of 141 predominantly White, male inmates (Stanley, Wygant, & Sellbom, 2013).

We used the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987) to measure fear/anxiety and avoidance dimensions of social anxiety in offenders. The subscales are summed to create a total score, with higher scores reflecting greater levels of social anxiety. The LSAS total score showed good internal consistency in a sample of patients awaiting treatment for social anxiety (Heimberg et al., 1999).

Social desirability was assessed in offender participants using the Marlowe-Crowne Form C (MC-C; Reynolds, 1982), with forensic norms for this measure reported by Andrews and Meyer (2003).

One participant in the prison sample failed to complete the TriPM, while two participants failed to complete the LSAS and one failed to compete the MC-C. Participants in the comparison group were only asked to complete the TriPM and it was completed by all but two of the participants.

Stimuli

We used a subset of the morphed facial stimuli developed by Gillespie and colleagues for use with offender samples (Gillespie, Mitchell, Satherley, Beech, & Rotshtein, 2015; Gillespie et al., 2017; Gillespie et al., 2019; Gillespie, Rotshtein, Satherley, et al., 2015). Facial expression stimuli from five male (model numbers 20, 27, 30, 31, 36) and five female (models numbers 1, 5, 7, 9, 10) Caucasian models were selected from the NimStim Face Stimulus Set (Tottenham et al., 2009; https://danlab7.wixsite.com/nimstim). For each of the ten models, we selected expressions showing neutral, angry, disgust, fear, happy, sad, and surprise expressions. Open or closed mouth expressions were selected for each model/emotion based on validity data (Tottenham et al., 2009). We used images showing each expression morphed with neutral to show 55% and 90% expressive intensity (for details of the morphing procedure, see Gillespie, Rotshtein, Satherley, et al., 2015). Neutral stimuli were displayed at 100% neutral (i.e., neutral stimuli did not vary in intensity). Stimuli had a resolution of 504 x 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. There were no differences in contrast,

$F(5, 108) = .153$, $p = .979$, or luminance, $F(5, 108) = .214$, $p = .956$, between the different emotional expressions.

Eye tracking and pupillometry

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 and pupil diameter of the right eye were recorded. Gaze location and pupil size were sampled at 1000 Hz. We used a Dell Precision laptop computer to manage the recording of eye movements and pupil diameter. Stimuli were displayed on a 19-in. LG colour monitor, using SR-Research Experiment Builder software, running on a laptop computer with a separate mouse and keyboard.

Procedure

Offender participants were tested in a private room inside the prison, and community participants were tested in a dedicated eye-tracking laboratory at the university. Participants were seated approximately 68 cm from the display monitor and a chin rest of adjustable height was used to minimize head movements. Images were presented at a visual angle of 21.2°. Following standard EyeLink calibration and validation procedures, each consisting of a series of nine fixation points, facial expression stimuli were presented in a randomized order over four blocks. Each trial began after the experimenter had 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 1,000 ms, followed by an image of an emotional expression that was displayed for 2,000 ms. After the display period had ended, participants were asked to categorize the facial expression stimuli as quickly and accurately as possible. Participants used the numeric keys 0 to 6 to classify each expression, with labels displayed in a vertical list on the screen (e.g., "1. ANGER").

Analytic strategy

Analyses were focussed on fear, happy, and sad expressions, as these expressions are thought to represent unconditioned reinforcers that modulate the probability that a particular behaviour will be performed again in the future (Blair, 2003).

For accuracy data, we used proportion of correct responses for each emotion. For eye movement data, we created two separate a-priori areas of interest (AOIs) that included the eyes (300 × 100 pixels) and the mouth (240 × 125 pixels). Analyses tested differences in the total dwell time on the eyes and the mouth over the course of each trial in msec. Finally, to test for differences in pupil dilation responses, we calculated within participant percent change difference scores for each emotion (see Attard-Johnson, Ó Ciardha, & Bindemann, 2018). In doing so, we were able to control for individual differences in pupil size, lighting conditions in the room, and other factors that vary between participants e.g., heat, tiredness (Holmqvist et al., 2017). First, we calculated the average pupil diameter across all individual fixations for each trial. We then used these values to calculate the mean pupil diameter for each participant, across all trials. The percentage difference in pupil diameter for each emotion compared with the overall mean was calculated using the following formula:

$$\Delta P_c = \left(\frac{\bar{x}_c - \bar{x}_e}{\bar{x}_e}\right) * 100$$

where $\bar{x}_{ic}$denotes the mean change for a specific emotion category, $\bar{x}_e$ denotes the mean response to all conditions, and ΔP_c denotes the overall change in pupil diameter for a specific emotion category (c) compared with the overall mean. According to the equation, no change in pupil size is indicated by zero, whereas positive or negative values indicate larger (dilation) or smaller (constriction) pupil dimeters in response to each emotion category. Percentage change has been shown to be optimal for estimating change in pupil diameter as a function of test conditions (Attard-Johnson et al., 2018). Second, to ensure that observed changes in pupil diameter reflected changes in the emotional content of the stimuli, we subtracted the percentage change in pupil diameter for neutral expressions from the percentage change in pupil diameter for each emotion category.

Statistical analysis. Because the sample sizes were small and data were not normally distributed, we examined differences in accuracy, dwell time on the eyes and the mouth, and pupil dilation responses between the three groups using separate Kruskal-Wallis *H* tests for each emotion (fear, happy, sad). Data were collapsed across the gender of the face and intensity of the expression to maximise test power and sensitivity. Age was not significantly correlated with any of the outcome variables (accuracy, dwell time on eyes or mouth, or pupil dilation responses for fear, happy or sad

expressions) and so was not controlled for in the analyses. Significant *H* tests (assessed using Chi square statistics) on group for each emotion category were followed up using Dunn-Bonferroni corrected post-hoc tests to examine differences between each of the three groups (men without child victims, men with child victims, men form the community), reported as standard deviation (z) differences. Effect sizes for all *H* tests are reported as epsilon squared (ε^2). Based on the interpretation of the effect size R^2, the following interpretation of ε^2 has been offered: small = .01, medium = .06, large = .14 (Salkind, 2006). We used a series of Kendall's τ-b correlations to examine the relationships of TriPM Boldness, Meanness and Disinhibition, and total LSAS, with accuracy, dwell time on the eyes and mouth, and pupil dilation responses for each emotion category (fear, happy sad). Kruskal-Wallis and associated post-hoc tests and Kendall's τ-b correlations were performed using SPSS version 25. Effect sizes ε^2 were calculated using jamovi version 1.1 (The jamovi project, 2019), running in the R environment (R Core Team, 2018).

All group analyses were also repeated using Bayesian ANOVAs (van den Bergh et al., 2020; van Doorn et al., 2020), which outperform frequentist statistics when parameters are not normally distributed (van de Schoot et al., 2014). Based on commonly recommended cut-offs (Keysers, Gazzola, & Wagenmakers, 2020), where the Bayes factor BF_{10} equals greater than 3, there is moderate evidence that the observed data are more likely to occur under the alternative model than the null model; where the Bayes factor BF_{10} equals less than 1/3, there is moderate evidence that the observed data are more likely to occur under the null model than the alternative model; where the Bayes factors BF_{10} falls between 1/3 and 3, the data do not provide much evidence to distinguish the alternative model from the null. Thus, a major advantage of the Bayes factor is that it can discriminate between "absence of evidence" and "evidence of absence" (i.e., data that support the null hypothesis over the alternative hypothesis) (van de Schoot et al., 2014). Post-hoc tests were conducted with the posterior odds corrected for multiple testing by fixing to 0.5 the prior probability that the null hypothesis holds across all conditions (Westfall, Johnson, & Utts, 1997). Individual comparisons were based on the default *t*-test with a Cauchy ($r = 1/\sqrt{2}$) prior. Bayesian analyses were performed using jamovi version 1.1 (The jamovi project, 2019), using the BayesFactor package (JASP Team, 2018;

Morey & Rouder, 2018; Rouder, Morey, Speckman, & Province, 2012), running in the R environment (R Core Team, 2018).

Results

Figure 1 shows the distributions of TriPM Boldness, Meanness, and Disinhibition, LSAS total score, and Marlowe-Crowne Form C, for each group. Table 1 shows that participants significantly differed in Age and TriPM Disinhibition scores. Participants without child victims were younger than participants with child victims. Participants without child victims scored higher for Disinhibition than community controls. No other group differences were significant.

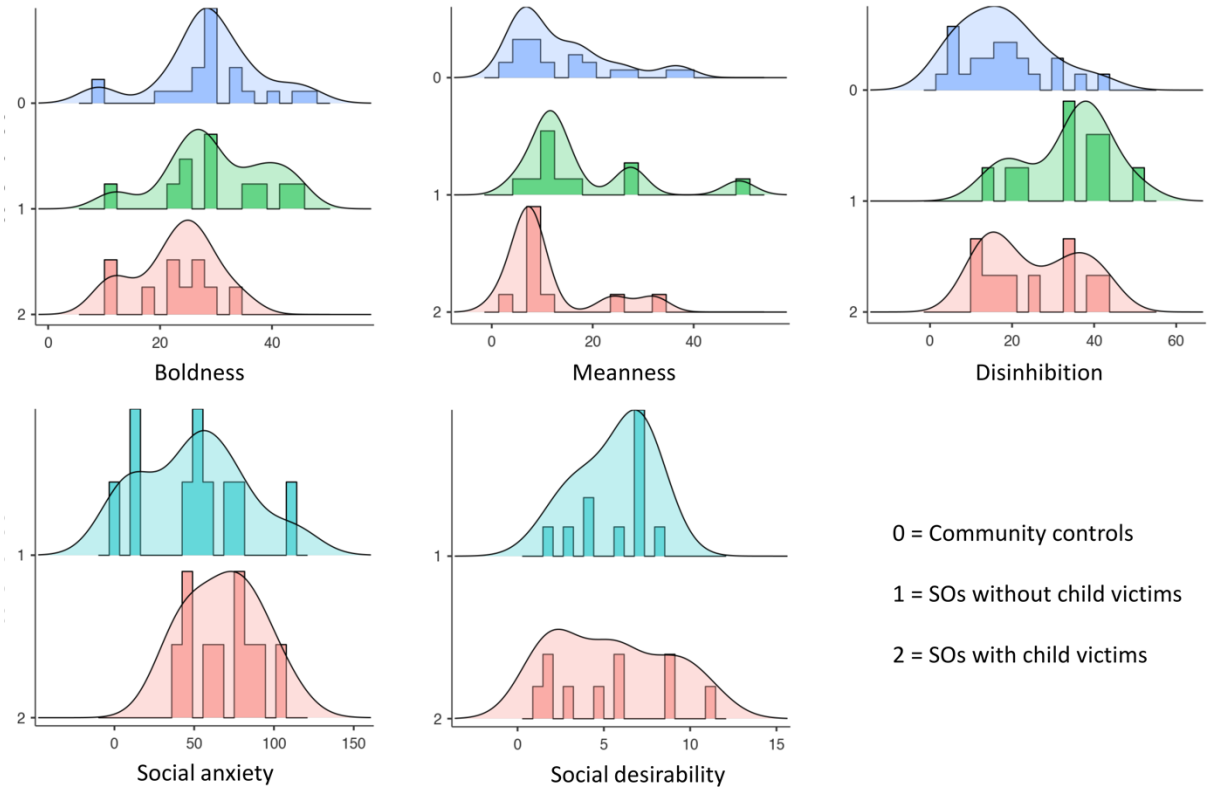

Figure 1. Distributions of TriPM Boldness, Meanness, and Disinhibition, social anxiety, and social desirability as a function of group.

Accuracy

Accuracy of fear, happy, and sad emotional facial expression recognition is shown in Table 2. There were no statistically significant differences in accuracy of expression recognition between the three groups, and the Bayes factors indicated that the data were insensitive at distinguishing the alterative model from the null, therefore suggesting an absence of evidence rather than evidence of

absence, for afraid faces, $\chi^2(2) = 3.414$, $p = .181$, $\varepsilon^2 = .07$, $BF_{10} = 0.40$ (error % = 0.02); happy faces, $\chi^2(2) = 1.349$, $p = .509$, $\varepsilon^2 = .03$, $BF_{10} = 0.63$ (error % = 0.03); and sad faces $\chi^2(2) = 2.001$, $p = .368$, $\varepsilon^2 = .04$, $BF_{10} = 0.35$ (error % = 0.03).

Dwell time on the eyes

Dwell times on the eyes of fear, happy, and sad faces are shown in Figure 2. There was a significant difference in attention to the eyes of afraid faces between the three groups, $\chi^2(2) = 7.086$, $p = 0.029$, $\varepsilon^2 = .15$, $BF_{10} = 1.89$ (error % = .001). Dunn-Bonferroni post-hoc tests revealed that men without child victims attended to the eyes of afraid faces more than men with child victims ($z = 2.612$, $p = .027$). Non-offenders were similar to men with child victims ($z = 1.126$, $p = .781$), and men without child victims ($z = -1.953$, $p = .153$). The Bayes factor indicated that the data were insensitive at distinguishing the alternative model from the null.

There was also a significant difference in attention to the eyes of happy faces between the three groups, $\chi^2(2) = 6.219$, $p = .045$, $\varepsilon^2 = .14$, $BF_{10} = 2.48$ (error % = 0.01). Dunn-Bonferroni post-hoc tests revealed that men without child victims attended to the eyes of happy faces more than men

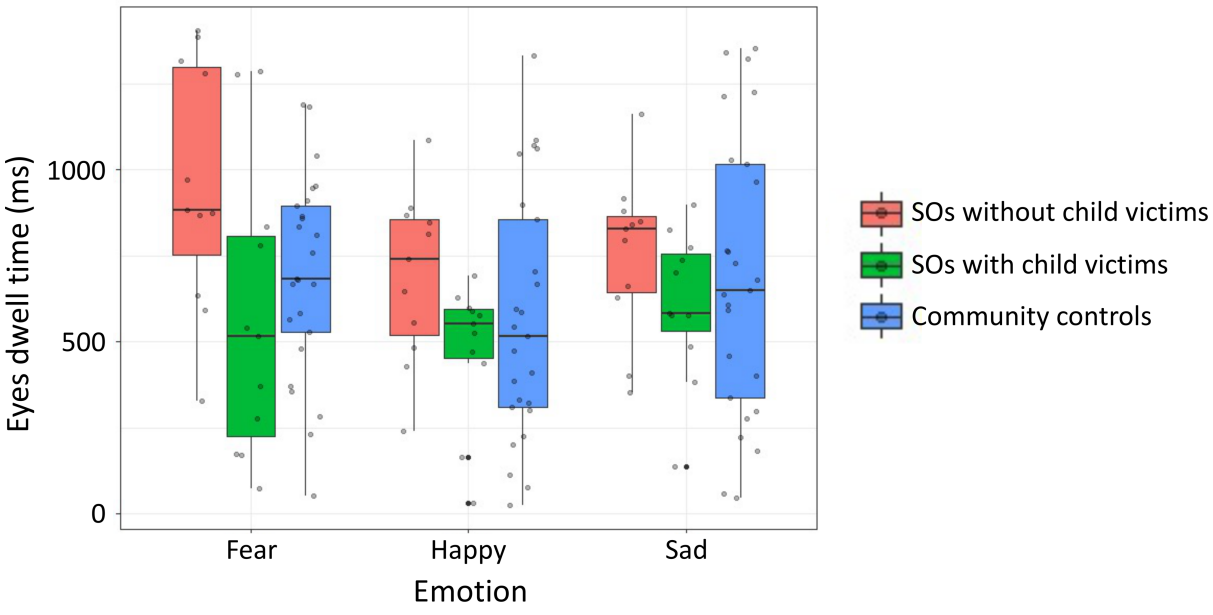

Figure 2. Dwell time on the eyes of fear, happy, and sad facial expressions of emotion in sex offenders without child victims, sex offenders with child victims, and community controls.

Table 1

Descriptive statistics and results of Kruskal-Wallis H-tests and Dunn-Bonferroni corrected post-hoc tests for Age, Boldness, Meanness, and Disinhibition subscales of the Triarchic Psychopathy Measure, and the Liebowitz Social Anxiety Scale

	Sex offenders without child victims		Sex offenders with child victims		Community				
Measure	*M* (*SD*)	Median	*M* (*SD*)	Median	*M* (*SD*)	Median	χ^2	*p*	ε^2
Age	36.2 (11.1)	32[a]	52.7 (11.0)	54[b]	37.9 (18.3)	31[a,b]	6.79	.034*	.15
TriPM Boldness	30.0 (9.4)	29	22.8 (7.2)	24	28.9 (9.0)	28	5.03	.081	.12
TriPM Meanness	17.5 (12.6)	12	11.1 (9.3)	7	13.4 (9.8)	9	3.32	.191	.08
TriPM Disinhibition	33.6 (10.7)	35[a]	25.1 (11.6)	22[a,b]	17.7 (10.5)	17[b]	11.45	.003*	.27
LSAS	49.7 (34.0)	50	68.1 (22.9)	72			1.29	.256	.07
Marlowe-Crowne Form C[†]	5.64 (2.01)	7	5.40 (3.44)	5.50			.21	.64	.01

Note. TriPM = Triarchic Psychopathy Measure; LSAS = Liebowitz Social Anxiety Scale. Values that share a superscript letter are not significantly different.

* $p < .05$

[†] Forensic norms for the Marlowe-Crowne Form C have been reported as $M = 7.61$, $SD = 3.32$ (Andrews & Meyer, 2003)

with child victims (z = 2.488, p = .039). Non-offenders were similar to men with child victims (z = 1.328, p = .552), and men without child victims (z = -1.953, p = .326). The Bayes factors indicated that the data were insensitive at distinguishing the alterative model from the null.

Table 2

Recognition accuracy (proportion correct) for fear, happy, and sad facial expressions of emotion

	Sex offenders without child victims		Sex offenders with child victims		Community	
Emotion	*M* (*SD*)	Median	*M* (*SD*)	Median	*M* (*SD*)	Median
Fear	.44 (.25)	.46	.55 (.25)	.57	.58 (.23)	.62
Happy	.92 (.08)	.91	.87 (.15)	.91	.94 (.06)	.95
Sad	.85 (.11)	.87	.81 (.10)	.82	.79 (.11)	.78

There was a significant difference in attention to the eyes of sad faces between the three groups, $\chi^2(2) = 7.135$, p = .028, ε^2 = .16, BF_{10} = 4.59 (error % < 0.001). Men without child victims attended to the eyes of sad faces more than men with child victims (z = 2.643, p =.025). Non-offenders were similar to men with child victims (z = 1.248, p = .637), and men without child victims (z = -1.868, p = .185). The Bayes factor also indicated moderate evidence in favour of the alternative hypothesis, suggesting that the data were approximately 4.59 times more likely to occur under the alternative model than the null model. The adjusted posterior odds showed that men without child victims attended to the eyes of sad faces more than men with child victims (odds of 2.01), and non-offenders (odds of 3.18), but that men with child victims and non-offenders were similar (odds of 0.39).

Dwell time on the mouth

Dwell times on the mouth of fear, happy, and sad facial expressions of emotion are shown in Figure 3. There were no statistically significant differences in attention to the mouth between the three groups, and the Bayes factors indicated that the data were insensitive at distinguishing the alterative model from the null, for afraid faces, $\chi^2(2) = 2.338$, p = .311, ε^2 = .05, BF_{10} = 0.55 (error % = 0.01); happy faces, $\chi^2(2) = 4.884$, p = .087, ε^2 = .11, BF_{10} = 1.10 (error % = 0.02); and sad faces $\chi^2(2)$ = 2.926, p = .232, ε^2 = .06, BF_{10} = 0.73 (error % = 0.02).

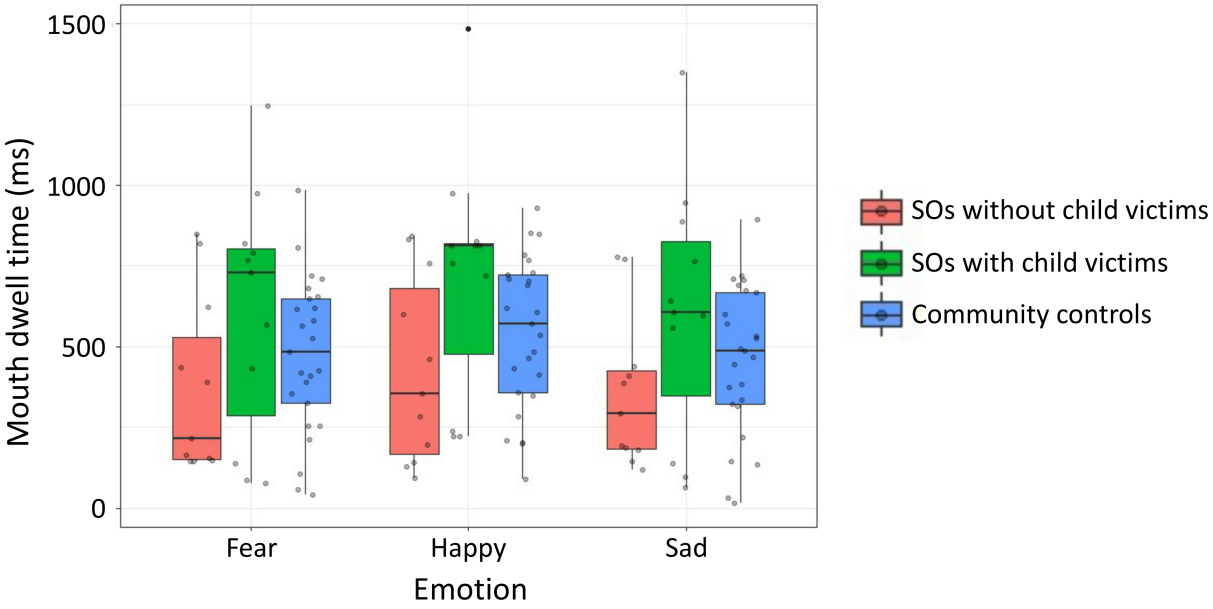

Figure 3. Dwell time on the mouth of fear, happy, and sad facial expressions of emotion in sex offenders without child victims, sex offenders with child victims, and community controls.

Pupil dilation response

Pupil dilation responses to fear, happy, and sad facial expressions of emotion are shown in Table 3. There were no statistically significant differences in pupil dilation responses between the three groups, and the Bayes factors indicated evidence in favour of the null hypothesis, for afraid faces, $\chi^2(2) = 0.038$, $p = .981$, $\varepsilon^2 < .001$, $BF_{10} = 0.18$ (error % = 0.03); happy faces $\chi^2(2) = 1.261$, $p = .532$, $\varepsilon^2 = .03$, $BF_{10} = 0.24$ (error % = 0.04); and sad faces $\chi^2(2) = 1.506$, $p = .471$, $\varepsilon^2 = .03$, $BF_{10} = 0.19$ (error % = 0.03).

Table 3

Pupil dilation responses (relative to neutral) to fear, happy, and sad facial expressions of emotion

	Sex offenders without child victims		Sex offenders with child victims		Community	
Emotion	*M* (*SD*)	Median	*M* (*SD*)	Median	*M* (*SD*)	Median
Fear	1.91 (4.56)	1.22	1.52 (3.50)	1.97	1.96 (5.09)	.56
Happy	.74 (3.90)	.96	2.06 (3.95)	1.21	.75 (3.71)	.08
Sad	1.62 (4.12)	2.95	2.11 (3.50)	.98	1.36 (4.18)	.70

Effects of psychopathic traits and social anxiety

Significant correlations are shown in Figure 4. Higher TriPM Boldness was associated with worse recognition of sad faces (Kendall's τ-b = -.336, $p = .025$), but not fearful (Kendall's τ-b = -.054,

p = .738), or happy (Kendall's τ-b = -.056, p = .736) faces. Higher total LSAS was associated with worse recognition of fearful faces (Kendall's τ-b = -.330, p = .044), but not happy (Kendall's τ-b = -.187, p = .265), or sad (Kendall's τ-b = -.032, p = .845) faces. Higher TriPM Disinhibition was associated with greater attention toward the eyes of fearful faces (Kendall's τ-b = .336, p = .036), but not happy (Kendall's τ-b = .277, p = .084), or sad (Kendall's τ-b = .287, p = .074) faces. There were no other correlations of TriPM Boldness, Meanness or Disinhibition, or total LSAS, with accuracy, visual attention to the eyes or mouth, or pupil dilation responses, to fearful, happy, or sad expressions (all p > .05).

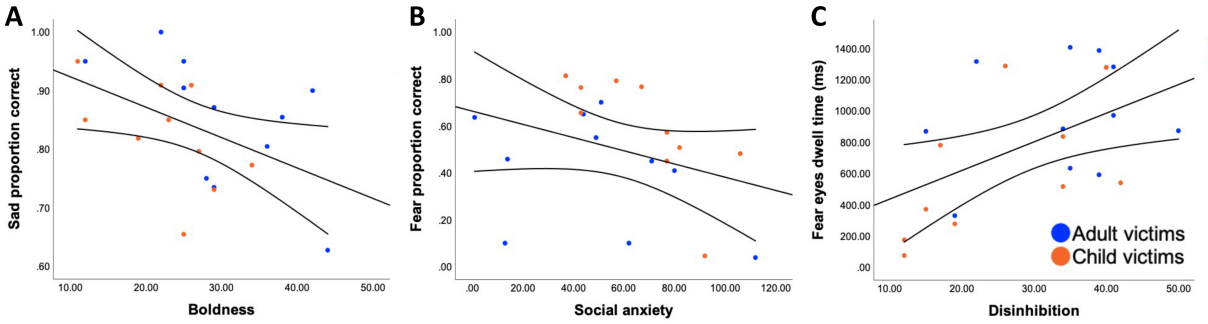

Figure 4. Scatter plots showing relationships of (A) Boldness with recognition of sad expressions, (B) Social anxiety with recognition of fear expressions, and (C) Disinhibition with dwell time on afraid eyes.

Discussion

We investigated differences in emotional face processing between men who had sexually offended with and without child victims and men living in the community without a self-reported history of offending. We examined processing of emotional facial expressions across three indices: accuracy, visual attention, and pupil dilation responses. Our findings showed that there were differences in visual attention toward the eyes of afraid, happy, and sad expressions, but not in accuracy, visual attention to the mouth, or pupil dilation responses.

When examining eye scan paths, the results of non-parametric tests showed that men with child victims spent less time looking at the eyes of afraid, happy, and sad expressions compared to men without child victims. These findings were partially supported by the results of Bayesian ANOVAs, which showed that the groups differed in attention to the eyes of sad faces but indicated an

absence of evidence for afraid and happy faces. Although the mechanisms that underpin these differences remain poorly understood, we found that sexual offenders without child victims had higher TriPM Disinhibition scores than men with child victims, and that these scores were associated with greater attention to the eyes of afraid faces, but not happy or sad. These findings have some support in the literature. For example, sex offenders without child victims scored higher for impulsive and antisocial features of psychopathy compared to sex offenders with child victims (Brown et al., 2015; Olver & Wong, 2006; Porter et al., 2000), and these features tend to be associated with anxiety and hypervigilance to threat related cues (Derefinko, 2015). Thus, longer dwell times on the eyes among sexual offenders without child victims may be a product of disinhibition and hypervigilance toward threatening cues in the environment.

In contrast to earlier findings for accuracy reviewed by Chapman et al. (2018), all groups performed similarly well when asked to judge the emotional content of a face. Although our community sample showed more pronounced problems in recognizing fear compared with other community samples when viewing the same stimuli (see Gillespie, Rotshtein, Satherley, et al., 2015; Gillespie, Rotshtein, Wells, Beech, & Mitchell, 2015; Wells et al., 2016), these samples varied in important ways. For example, Wells et al. (2016) included females and student participants, whereas in the current study we recruited community male participants from a variety of socioeconomic backgrounds. The current study also limited presentation times, which may have led to more errors. We also found limited evidence that accuracy was associated with psychopathic traits or social anxiety, with the only significant associations showing that participants with higher TriPM Boldness and social anxiety scores made more errors when categorizing sad and afraid faces, respectively.

Independent of victim age, sexual offenders tended to show pupil dilation responses that were similar in magnitude to those of the community comparison group. Pupil dilation responses were also unrelated to either psychopathic traits or social anxiety. When considered in the context of a recent framework of empathic functioning (Bird & Viding, 2014), our findings contribute to a more comprehensive understanding of empathy in sexual offenders. Bird and Viding (2014) emphasized the importance of considering both affective resonance and accuracy of emotion recognition to develop a more nuanced understanding of the empathic process. Our data suggest that sexual offenders show

relatively intact affective resonance (i.e., physiological responses), and that the affective state perceived is a close match for that being communicated (i.e., recognition accuracy). The importance of both processes can be illustrated in a scenario where one's perception of another's emotional state is inaccurate. In this situation, although an affective state may have been vicariously 'felt', the affective state generated in the empathizer will not be a good match for that felt by the other (Coll et al., 2017). The empathic process could not therefore be said to have unfolded in the usual way. Based on our data, we would suggest that sexual offenders can generate an autonomic response to another's affective sate (i.e., affective resonance), and that this response is generated based on an accurate representation of the expressed emotion. However, although these stages of the empathic process in sexual offenders – independent of victim selection – appear to be largely intact, a final component of the empathic process requires the empathizer to understand that the emotional state being felt does not belong to the self, but instead must be assigned to the other (Bird & Viding, 2014). This final part of the empathic process is not well understood. Based on our data, it is not possible to infer the extent to which participants are able to reliably assign the emotion being felt to the other (i.e., the expressor of the emotion shown in the image).

Our findings are subject to some limitations. First, our sample sizes were small, meaning there is a risk that effect sizes were inflated and that either type 1 or type 2 errors have occurred. Our results were supported by Bayesian ANOVAs which showed moderate evidence in favor of the alternative hypothesis for tests of visual attention to sad eyes, but indicated an absence of evidence rather than evidence for absence for the remaining tests. Our findings should therefore be replicated in larger samples to establish greater sensitivity. Second, our stimuli were limited to static images of adult faces, and future work should employ adult and child dynamic facial expressions, as well as emotional vocalizations and bodily poses. Third, psychopathic traits and social anxiety were measured using self-reports, and these methods are prone to response biases. Further, social anxiety was only assessed in offender participants and not in the community sample. In future work it would be helpful to supplement self-reports with clinician assessed Psychopathy Checklist – Revised (Hare, 2003) scores, and formal diagnoses of social anxiety disorder. Finally, we did not examine IQ or level of education, and although we can be relatively sure that few, if any, of our participants had a learning

disability – in the establishment where the research took place, residents with a learning disability are housed on a separate wing that we did not recruit from – future research should explore the effects of general intelligence on sexual offenders' emotion recognition abilities.

Conclusions

Our findings suggest that sexual offenders without child victims attend more to the eyes of emotional faces compared to men with child victims and men without a history of offending. These heightened dwell times may, to some extent, be driven by higher levels of psychopathy linked disinhibition. Our findings suggest that sexual offenders with and without child victims may be distinguishable in the pattern of attending to affective cues, but that these differences do not impact on the unfolding of the empathic process, with both accuracy of emotion recognition and affective resonance similar in degree to men living in the community. A final question that must be resolved is the extent to which sexual offenders are able to assign the emotion being felt to the other. In future research, it would be helpful to explore differences in socio-affective functioning between subgroups of child sexual offenders, including men who have committed online-only versus contact child sexual offenses, or those who have offended preferentially or exclusively against children versus those who have not. Our findings suggest that the ability to recognize and respond to others' emotional communications should not be prioritized as a treatment target when working with people who have sexually offended.

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