Psychology of Violence

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Fear Processing Deficit in Violent Offenders: Intact Attentional Guidance but Impaired Explicit Categorization

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Objective: Impaired recognition of fearful expressions has been documented across a wide range of antisocial populations but it remains unresolved whether this deficit reflects impaired attention to fearful expressions or is restricted to categorization. Here, we used visual search to investigate the relationship between impaired visual attention and emotion recognition in a group of violent offenders and healthy controls. ***Method:*** Task 1 measured attentional guidance by physical and affective saliency. Participants indicated the gender of a face identity singleton in an array of neutral distractor faces with a different identity. Singletons were paired with additional physical (color) or affective (happy, angry, fearful expression) task-irrelevant features. Task 2 used similar search displays but required participants to categorize the emotional expression of a happy, angry, or fearful target face in an array of neutral distractors. ***Results:*** In Task 1, both groups' visual search was aided by both physical and affective features, providing no evidence for impaired incidental processing of affective or physical saliency in violent offenders. In Task 2, violent offenders showed impaired explicit categorization performance, particularly for fearful expressions. Visual search performance was not correlated with self-reported psychopathy. ***Conclusion:*** Impaired processing of affective stimuli in antisociality results from later processing stages related to explicit recognition and categorization. These deficits are not restricted to individuals with elevated psychopathic traits but are linked to antisociality more generally. These findings represent a first step in localizing the fear processing deficit along the processing hierarchy in violent offenders, demonstrating intact attentional guidance but impaired categorization.

Keywords: interpersonal violence, violent offenders, antisocial personality disorder, emotion recognition, visual search

Stable patterns of aggressive behavior represent a substantial characteristic of severe psychopathologies which emerge early in the development (oppositional defiant and conduct disorder, CD) and can manifest in antisocial personality disorder (ASPD) as well as psychopathy in adulthood. An impairment in amygdala-mediated functions resulting in an attenuated reactivity to affective cues is hypothesized to lie at the root of aggressive psychopathology (Blair, 1995, 2001). Despite a wealth of studies that demonstrated perturbed affect recognition in antisocial and psychopathic populations, little is known about the cognitive processes that underlie the widely reported deficits. In the present study we determined how different processing stages contribute to recognition deficits in a group of violent offenders.

According to the prominent violence inhibition mechanism (VIM) model (Blair, 1995, 2001), distress cues (sad or fearful faces) observed in interaction partners elicit empathic reactions and thus have the potential to inhibit antisocial or aggressive behaviors that cause these expressions. This inhibitory mechanism is assumed to be impaired in habitually aggressive individuals, possibly due to deficits in the very recognition of distress cues. This notion is corroborated by a large number of studies which documented facial affect recognition deficits across various aggressive and antisocial populations throughout the developmental course (Dawel, O'Kearney, McKone, & Palermo, 2012; Marsh & Blair, 2008). Although the VIM model was originally developed to account for affective functioning deficits in psychopathic individuals, evidence suggests that impaired recognition of fear and

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impaired empathy are not restricted to psychopathy, but may apply to antisocial individuals in general (Chaplin, Rice, & Harris, 1995; Marsh & Blair, 2008; Schönenberg, Mayer, Christian, Louis, & Jusyte, 2016). However, a particular facet of psychopathy from the affective domain, namely callous-unemotional traits, has been shown to be associated with a more stable and severe symptomatology (Frick, Cornell, Barry, Bodin, & Dane, 2003) and to be particularly predictive of fear recognition deficits in antisocial populations (Dadds, El Masry, Wimalaweera, & Guastella, 2008; Hodsoll, Lavie, & Viding, 2014; Jusyte, Mayer, Künzel, Hautzinger, & Schönenberg, 2015; Marsh et al., 2008; Sylvers, Brennan, & Lilienfeld, 2011; Viding et al., 2012; but see Dawel et al., 2012; Hoppenbrouwers, Bulten, & Brazil, 2016; Wilson, Juodis, & Porter, 2011). There is an ongoing debate not only with regard to the affected subgroups, but also the specificity of the reported deficits: While most evidence suggests specific impairment in the recognition of fearful facial expressions (Blair et al., 2004; Dadds et al., 2008; Hastings, Tangney, & Stuewig, 2008; Marsh & Blair, 2008; Montagne et al., 2005; Schönenberg, Louis, Mayer, & Jusyte, 2013; Schönenberg et al., 2016; White et al., 2016), deficient processing of other facial affect categories has been reported as well (Best, Williams, & Coccaro, 2002; Dawel et al., 2012; Hastings et al., 2008; Hoaken, Allaby, & Earle, 2007; Kosson, Suchy, Mayer, & Libby, 2002; Leist & Dadds, 2009; Sato, Uono, Matsuura, & Toichi, 2009; Schönenberg et al., 2014; Schönenberg et al., 2013; Schwenck et al., 2014).

Correct recognition of facial affect relies on a number of preceding perceptual and cognitive processes which means that deficits in categorization performance can arise at each of these processing stages. Aside from low-level physical stimulus features such as color, contrast, or motion, affective information can also confer visual saliency and thus receive preferential processing (Bishop, 2007; Öhman, 2009; Tamietto & De Gelder, 2010; Vuilleumier, 2005). For example, affective stimuli capture attention (Eastwood, Smilek, & Merikle, 2003; Hodsoll, Viding, & Lavie, 2011; Öhman, Lundqvist, & Esteves, 2001; Vuilleumier & Schwartz, 2001) and enhance visual processing (Lucas & Vuilleumier, 2008; Phelps, Ling, & Carrasco, 2006) even when they are irrelevant to the task at hand. Impaired early perceptual selection and attentional guidance may thus represent candidate mechanisms underlying the deficient facial affect recognition in antisocial populations.

Indeed, there is evidence that early visual processing of affective stimuli is impaired in antisocial and psychopathic individuals (Jusyte et al., 2015; Sylvers et al., 2011; Viding et al., 2012). For instance, amygdala responses to fearful expressions are attenuated in children (Jones, Laurens, Herba, Barker, & Viding, 2009; Marsh et al., 2008; Viding et al., 2012; White et al., 2012) and adults (Blair, 2008; Coccaro, McCloskey, Fitzgerald, & Phan, 2007; DeLisi, Umphress, & Vaughn, 2009; Moul, Killcross, & Dadds, 2012) with elevated psychopathic traits. Attenuated amygdala reactivity to fearful faces has also been found under masked viewing conditions, particularly in individuals with high callous-unemotional traits, which indicates a disruption in early processing stages (Viding et al., 2012). This is supported by behavioral studies which have linked delayed access to awareness for fearful expressions to affective psychopathic traits in community samples (Oliver, Mao, & Mitchell, 2015), antisocial pediatric (Sylvers et al., 2011), as well as adult (Jusyte et al., 2015) populations. Thus, the fear recognition deficit may be related to impairments at early visual processing stages, possibly reflecting altered processing of bottom-up visual saliency. However, a mere bottom-up account is in conflict with other work showing that fear recognition in psychopathic and antisocial populations can be reduced by explicit (Dadds et al., 2008) and implicit (Schönenberg et al., 2014) instructions to attend to salient features of facial expressions. These results suggest that fear recognition deficits are related to impairments at later processing stages involving top-down components of emotional attention which also rely on amygdala-mediated neural circuitry (Adolphs et al., 2005; Han, Alders, Greening, Neufeld, & Mitchell, 2012; Moul et al., 2012; Troiani, Price, & Schultz, 2014; White et al., 2012).

Here, we tested directly whether visual attention for affective information is impaired in violent offenders and whether this impairment is linked to deficient recognition of affective information. We designed two visual search tasks that enabled us to test for impairments at early and later stages of the processing hierarchy. Visual search represents a powerful method to probe both bottom-up guidance of visual attention and higher-level processing involving explicit categorization and recognition. Only two studies to date have used this approach to investigate whether and how visual attention is compromised in antisocial populations with psychopathic traits. One previous study used visual search in psychopathic violent offenders (Hoppenbrouwers, Van der Stigchel, Slotboom, Dalmaijer, & Theeuwes, 2015). This study investigated how physical saliency (color) and top-down cues aided visual search. The authors found no evidence for a link between psychopathy and processing of physical saliency but some support for disruptions in top-down processing as a function of affective psychopathy traits. As this study investigated attentional guidance by physical saliency only, it remains unknown how attentional guidance would be influenced by affective stimuli, which are thought to have pivotal relevance for the etiology of antisocial behavior. Only one previous study investigated visual attention in a search task involving affective stimuli in a pediatric CD population with varying severity of psychopathic traits (Hodsoll et al., 2014). The authors reported less attentional capture by angry, happy, and fearful emotional distractors in the CD group with high callous-unemotional traits, but intact facilitation of visual search when emotion was a target feature. Because affective expressions were task-irrelevant in this study, it is unclear whether such impaired bottom-up processing of affective stimuli may be related to actual recognition performance.

In the present study we systematically delineated impairments in visual processing along consecutive processing stages in order to understand their contributions to emotion recognition deficits in a group of violent offenders. We used two variants of visual search in a sample of violent offenders and control participants. In Task 1, we probed attentional guidance by task-irrelevant salient visual information (low-level physical and affective) by asking the participants to indicate the gender of a face identity singleton in an array of neutral distractor faces with a different identity. In some trials, the singleton was paired with additional physical (color) or affective (emotional expression) cues. In normal observers, such task-irrelevant salient information (physical and affective) has been shown to improve visual search (Lucas & Vuilleumier, 2008) and we were interested whether the processing of task-irrelevant salient information is impaired in violent offenders. Our design allowed us to test whether any such impairment would reflect a more general deficit in stimulus saliency processing (both physical and affective) or whether it would be specific to affective information and to fear in particular. In Task 2, we used similar search displays but participants now categorized the emotional expression of an affective singleton (happy, angry, fearful) in an array of neutral faces. Thus, the emotional expression was directly relevant for guiding attention and for selecting the response. We examined whether violent offenders would exhibit specific impairments in categorizing fearful expressions, or whether deficient performance would extend to other emotions. Finally, given the strong link between affective facets of psychopathy and emotion recognition deficits, we measured the relationship between deficits in the processing of affective information and callous-unemotional traits. Specifically, we hypothesized that

1. In Task 1, there would be no differences in the incidental processing of low-level features between groups, but pronounced deficits in the incidental processing of fear in violent offenders, as reflected in increased response times for fearful relative to non-fearful expressions.

2. Fear processing impairments in the violent offenders should also be evident at higher-level processing stages related to categorization related to categorization (Task 2), as reflected in increased response times for fearful relative to nonfearful expressions.

3. We expected to find associations between higher callous-unemotional traits and increased response latencies for fearful faces in violent offenders in both tasks.

Method

Participants

Violent offenders were recruited from cooperating German correctional facilities (Justizvollzugsanstalten Heimsheim, Rottenburg, Hohenasperg) through advertisement via pamphlets and blackboards within the facilities. The advertisement specified that we sought inmates aged 18–65 years with a primary conviction for violent crimes (not drug-related or domestic violence) and sufficient knowledge of the German language. Interested individuals were contacted by the facility's psychological service to schedule the assessments. All assessments were carried out in designated rooms of the facility by trained psychologists from our research group unrelated to the correctional facility in any way. All assessors were bound to confidentiality regarding any information about the mental health status disclosed during assessments or the behavioral test results. Exclusion criteria were: primary conviction for drug-related crime, domestic violence, psychotic spectrum, or bipolar disorders (as assessed by clinical interview). All interested 52 violent offenders were eligible for participation and included in the study. All participating violent offenders were convicted of violent crimes such as assault, first-degree murder, robbery, kidnapping, or threat. Controls were recruited through advertisements in newspapers and university's mailing list (inclusion criteria: 18–65 years, no self-reported convictions, no ASPD, no history of bipolar or psychosis-spectrum disorder). Six participants were excluded in the control group due to fulfillment of exclusion criteria, resulting in a final sample of $N = 46$. Individual participant data were coded via pseudonyms and were at no point accessible to the correctional facility's staff members. The study was approved by the local ethics committee and was conducted in accordance with the Declaration of Helsinki. Healthy control participants were compensated with 8 €/hr, following the convention at the university. Upon the recommendation of the ministry of justice and the facility, the reimbursement for participants from the violent offender group was 6 €/hr.

Clinical and Control Measures

The 29-item Buss-Perry Aggression Questionnaire (Buss & Perry, 1992) was used to assess self-reported aggression. The questionnaire contains 29 items and can be divided into four subscales measuring verbal and physical aggression as well as anger and hostility. The items contain statements which are rated on a 5-point Likert scale ranging from 0 (*not at all characteristic of me*) to 4 (*extremely characteristic of me*). The questionnaire has been validated for both violent offenders as well as for community samples, showing satisfactory psychometric properties (von Collani & Werner, 2005; Williams, Boyd, Cascardi, & Poythress, 1996).

The Self-Reported Psychopathy Scale (Paulhus, Neumann, & Hare, 2012) assessed four factors (interpersonal manipulation, callous affect, erratic lifestyle, and antisocial behavior) of self-reported psychopathy with 64 items, to which the participants respond on a 5-point Likert scale (1 = *disagree strongly* to 5 = *agree strongly*). This questionnaire has been shown to have sound psychometric properties in both violent offenders and community samples (Gordts, Uzieblo, Neumann, Van den Bussche, & Rossi, 2017; Mahmut, Menictas, Stevenson, & Homewood, 2011; Neal & Sellbom, 2012)

To control for cognitive abilities related to IQ, the 18-item short version of the Wiener Matrizen Test (WMT; Formann & Piswanger, 1979; Formann, Waldherr, & Piswanger, 2011) was used. The WMT is a nonverbal test derived from Raven's Progressive Matrices Test that assesses deductive reasoning and problem solving. The participants match different patterns of matrices to an analogous missing matrix piece by selecting the corresponding part out of eight options. The WMT reportedly exhibits satisfactory psychometric properties with Cronbachs's $\alpha = .81$.

Current and life-time psychopathology was assessed with the Mini International Neuropsychiatric Interview (MINI; Ackenheil, Stotz, Dietz-Bauer, & Vossen, 1999; Lecrubier et al., 1997) which was administered by trained postgraduate psychologists with extensive experience in conducting clinical interviews. The MINI is developed to assess the *DSM–IV* and *ICD-10* criteria for all Axis I disorders as well as for antisocial personality disorder and has excellent interrater reliability for all Axis I diagnosis ($\kappa > .79$; Ackenheil et al., 1999; Lecrubier et al., 1997).

Experimental Tasks

In both tasks, the main dependent variable was response latency, for which median response times (RTs) for correct responses were calculated for every participant and every condition. Furthermore, mean accuracy rates for every participant and condition were computed in order to rule out potential speed–accuracy trade-offs between groups or conditions.

Task 1. Thirty-two photographs (16 female identities) depicting neutral, angry, happy, or fearful expressions were selected from the FACES Database (Ebner, Riediger, & Lindenberger, 2010). Colored stimuli were cropped using a rectangular mask to eliminate irrelevant picture parts and fully desaturated. Following the procedure in the work of Lucas and Vuilleumier (2008), for the color condition, the faces with a neutral expression were tinted red by changing the color balance (adding 24 pixel values to the red channel and subtracting 12 pixel values from the green and blue channels, respectively) to enhance physical saliency (Figure 1A). A stimulus set comprising an additional eight (four female) faces with neutral and affective expression identities were created for practice trials.

Each trial began with a fixation cross (1,900 ms) which was followed by a visual search display until response. The search array comprised eight faces: seven neutral identical distractors and a target singleton with a different identity. The participants were instructed to identify the gender of the singleton via a button press (labeled keyboard buttons) as quickly and accurately as possible. The target face differed from the distractors by being a different identity with a neutral facial expression (neutral condition), by being a different identity and having an emotional facial expression (angry, happy, and fearful condition), or by being a different identity and tinted in red (shaded) (color condition; Figure 1A).

Task 1 consisted of 160 trials in which each combination of five target conditions (color, neutral, happy, angry, fear), two target genders, and 16 target identities per gender occurred once. Trial order was randomized. The target could appear in any of the eight positions within the search array (Figure 1A) with the constraint that each target position occurred twice per target condition. Similarly, the specific distractor identities were randomized, with the constraints that for every condition the distractors had the same gender as the target in half of the trials and the other gender in the other half of the trials and that a given distractor identity occurred only once per condition. The gender of the distractors was therefore not predictive of the target gender. There was one obligatory break after 80 trials. A brief training block of 20 trials in which the participants received performance feedback (red/green coloration of the cross following response) preceded the proper experiment. In the proper experiment, no feedback was provided.

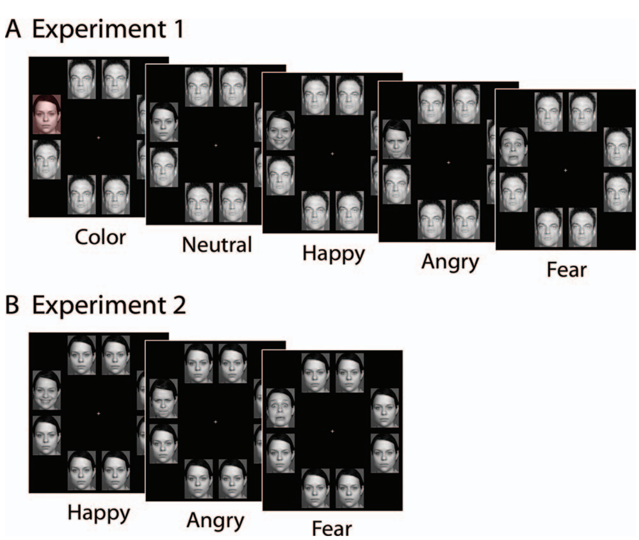

Figure 1. Example search displays. (A) In Task 1, participants categorized the gender of an identity target singleton. In the color condition, the target was additionally tinted in red (shaded). In the three emotion conditions, the target additionally showed an emotional expression. (B) In Task 2, participants categorized the facial expression of an emotion target singleton. See the online article for the color version of this figure.

Task 2. Task 2 was similar to Task 1 except that participants now searched for a target defined by an emotional expression rather than being a different identify. The same cropped and gray-scaled images of 32 model identities with neutral, angry, happy, and fearful expressions were used in Task 2. The target (happy, angry, or fearful) was presented within an array of seven neutral distractors with the same identity (see Figure 1B). Participants were instructed to search for the singleton defined as the non-neutral face and to indicate the emotional expression (angry, happy, fearful) via a button press (labeled keyboard buttons) as quickly and accurately as possible. Response mapping to emotional categories was randomized across participants. Each trial began with a presentation of a fixation cross (1,900 ms) which was replaced by a search array displayed until response. There were 12 practice trials and 96 experimental trials, with one repetition per emotion condition with each of the 32 identities. In every condition, each of the eight target positions occurred four times. Trial order was randomized.

Procedure

Prior to the assessment, all participants were notified about the purposes of the study and signed a written informed consent. Subsequently, the participants completed self-report questionnaire measures and the WMT. Following diagnostic assessments, participants were introduced to Task 1. After completion of Task 1, participants were administered the clinical interview and subsequently introduced to Task 2. The task order was fixed (Task 2 always followed Task 1) in order to avoid carry-over effects from the explicit categorization in Task 2 to the incidental processing in Task 1. All assessments were carried out in unitary settings in laboratory rooms for the controls. Data of the violent offenders was gathered in designated rooms within the facility; none of the security or psychological service staff members were present in the room during testing. The experiment was run on a 14.1-inch HP Notebook computer at a viewing distance of about 40 cm. Stimulus presentation and data collection were controlled by MATLAB (The MathWorks, Natick, MA) using the Psychtoolbox functions (http://psychtoolbox.org/).

Results and Discussion

Participants

Demographic and clinical sample descriptions are presented in Table 1. The violent offender participants tended to be older but did not differ from controls with regard to years of education and the performance on the WMT (see Table 1). Compared to controls, violent offenders reported higher physical and verbal aggression and anger but there were no differences between groups in the hostility subscale. Furthermore, violent offenders scored higher on the overall SRP score as well as the antisocial behavior subscale.

Table 1
Demographic Diagnostic Sample Description

Variable	VO (N = 52)	CTL (N = 46)	Statistics	Cohen's d	Cronbach's α
SRP					
Age	38.17 (10.04)	33.15 (10.53)	$t(96) = 2.42^{*}$	.08	—
WMT sum score	7.35 (3.90)	8.76 (3.77)	$t(96) = 1.83$	.04	.79
Education (years)	9.63 (1.29)	9.85 (.63)	$t(96) = 1.02$	.12	—
Interpersonal manipulation	41.98 (5.72)	44.20 (5.46)	$t(96) = 1.96$	.41	.71
Callous affect	45.15 (6.12)	44.35 (4.76)	$t(96) = .72$	.12	.75
Erratic lifestyle	47.96 (7.20)	45.50 (6.02)	$t(96) = 1.82$	.37	.80
Antisocial behavior	42.39 (9.50)	34.61 (6.38)	$t(96) = 4.69^{***}$	.95	.85
Total score	177.48 (23.12)	168.65 (16.46)	$t(96) = 2.15^{*}$	.44	.91
BPAQ					
Physical aggression	22.52 (7.97)	18.80 (6.28)	$t(96) = 2.54^{*}$	.52	.83
Verbal aggression	15.94 (3.80)	14.57 (2.86)	$t(96) = 2.00^{*}$	.40	.68
Anger	16.70 (5.64)	13.87 (3.98)	$t(96) = 2.83^{**}$	.57	.77
Hostility	23.13 (6.57)	21.26 (5.46)	$t(96) = 1.53$	.31	.75
Total score	78.29 (19.87)	68.50 (14.32)	$t(96) = 2.77^{**}$	.56	.88

Note. The data represented in the table refer to mean sum scores and standard deviations for each measure (in parentheses). VO = violent offenders; CTL = healthy controls; WMT = Wiener Matrizen Test; SRP = Self-Reported Psychopathy Scale; BPAQ = Buss-Perry Aggression Questionnaire.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Four violent offenders and one control were excluded from further data analysis due to very low response accuracy indicative of inattention (proportion correct < 50%). The data from two violent offenders were lost due to a hardware malfunction. The final sample consisted of 46 violent offenders and 45 controls. Thirty violent offenders fulfilled the criteria for a full diagnosis of ASPD according to the MINI. Seven violent offenders fulfilled the criteria for substance or alcohol abuse, and four reported symptoms of an anxiety disorder. None of the controls fulfilled criteria for ASPD; four participants reported alcohol or substance abuse; two participants reported lifetime depression or anxiety symptoms. None of the controls reported having been in treatment for psychiatric illnesses.

Task 1

Accuracy rates. Overall accuracy was high (controls: 97.2% correct, violent offenders: 96.5% correct). Because accuracy rates were not normally distributed, statistical analyses (analyses of variance, ANOVAs) were carried out following a rationalized arcsine transformation. A mixed ANOVA with the within-subjects factor condition (color, neutral, happy, angry, fearful) and the between-subjects factor group (controls, violent offenders) only yielded a trend toward a significant main effect of condition, $F(4, 356) = 2.36$, $p = .053$, $\eta_p^2 = .03$, reflecting somewhat higher accuracy in the color condition (M = 97.8% correct) than in the neutral, happy, angry, and fearful conditions (Ms = 96.5%–96.8% correct). There was no significant effect of group, $F(1, 89) = 0.52$, $p = .473$, $\eta_p^2 < .01$, and no significant interaction, $F(4, 356) = 0.32$, $p = .868$, $\eta_p^2 < .01$. Thus, response accuracy in both groups benefited from the greater physical saliency of the target in the color condition.

Response times. As evident from Figure 2A and 2B, although violent offenders exhibited overall longer RTs than did controls, the pattern across conditions was similar for both groups. Indeed,

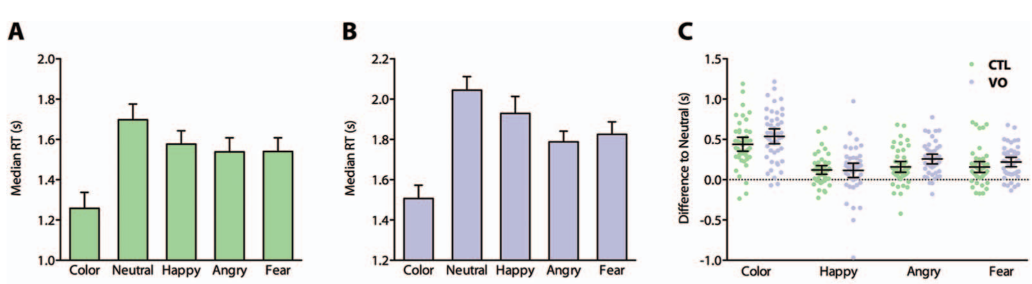

Figure 2. Results from Task 1. Average median reaction times (RTs) (A) for controls (CTL) and (B) for violent offenders (VO) and the five different target conditions. Error bars represent standard errors of the mean. (C) Effect of physical and emotional saliency. For every participant, median RTs for the color target condition (physical saliency) and for the three emotional target conditions (happy, angry, fear) were subtracted from the neutral target condition. Difference scores are shown for every participant (circles) and as the average (horizontal bars, together with 95% confidence intervals represented by the vertical error bars), separately for CTL and VO and every condition. See the online article for the color version of this figure.

for median RTs the mixed ANOVA revealed a significant main effect of group, $F(1, 89) = 10.27$, $p = .002$, $\eta_p^2 = .10$, reflecting overall faster RTs for controls ($M = 1.52$ s) than for violent offenders ($M = 1.82$ s), but no significant interaction between condition and group, $F(4, 356) = 1.79$, $p = .130$, $\eta_p^2 = .02$. The main effect of condition was significant, $F(4, 356) = 90.78$, $p < .001$, $\eta_p^2 = .51$, reflecting faster RTs in the color condition ($M = 1.38$ s) than in all other conditions (Ms = 1.66–1.87 s, Holm-Sidak's multiple comparisons test, all ps $< .001$, all ds > 1.07), and significant RT differences between all other conditions (Holm-Sidak's multiple comparisons test, all ps $< .05$, all ds > 0.29), except for the comparison between angry and fear ($d = 0.11$).

To directly assess differences in the effects of physical and affective saliency between groups, we ran another analysis for which RTs for the color condition (physical saliency) or for the three emotion conditions (affective saliency) were subtracted from the neutral condition. As can be seen from Figures 2A and 2B, both physical and affective saliency were associated with faster RTs in both groups: color condition, $t(90) = 15.35$, $p < .001$, $d = 1.61$; affective conditions, all ts(90) > 4.58, all ps $< .001$, all ds > 0.48. However, the effect of physical saliency did not differ between groups, $F(1, 89) = 1.22$, $p = .122$, $\eta_p^2 = .03$, meaning that RTs for both violent offenders and controls benefited to a similar extent from the target face being colored. Furthermore, there was no evidence that violent offenders were less sensitive to the target's affective saliency than controls: the effect of happy targets did not differ between groups ($F < 1$), and the effect of angry targets was even significantly larger for violent offenders than for controls, although the size of this effect was small, $F(1, 89) = 4.74$, $p = .032$, $\eta_p^2 = .05$. Most importantly, responses were faster to fearful as compared to neutral targets in both violent offenders, $t(45) = 7.56$, $p < .001$, $d = 1.11$, and controls, $t(44) = 4.69$, $p < .001$, $d = 0.70$, and this fear advantage did not differ between groups, $F(1, 89) = 1.94$, $p = .167$, $\eta_p^2 = .02$ (Figure 2C). These additional RT analyses demonstrate that the incidental processing of both physical and affective saliency, including fear, was intact in violent offenders.

In addition, to reduce noise and to increase statistical power for assessing a potential fear-specific impairment in violent offenders, we compared median RTs for fear targets to median RTs averaged across neutral, angry, and happy targets (non-fear targets). This analysis also yielded no significant interaction between emotion (fear, non-fear) and group, $F(1, 89) = 0.86$, $p = .355$, $\eta_p^2 = .07$, demonstrating that incidental fear processing was intact in violent offenders. These results were in part consistent with Hypothesis 1: as expected, incidental processing of low-level features was intact in violent offenders. However, contrary to our prediction, there were no deficits in the incidental processing of fear.

Task 2

Having established that incidental processing of physical and emotional saliency was unimpaired in violent offenders, we next examined whether the processing of emotion, and of fear in particular, would be impaired in violent offenders when the explicit recognition of facial expression was required (Hypothesis 2).

Accuracy rates. As in Task 1, the overall accuracy was high (controls: 97.2% correct, violent offenders: 96.7% correct). A mixed ANOVA on the arcsine-transformed accuracy rates with the within-subjects factor condition (happy, angry, fearful) and the between-subjects factor group (controls, violent offenders) yielded a significant main effect of condition, $F(2, 178) = 20.11$, $p < .001$, $\eta_p^2 = .18$, with significantly higher accuracy in the happy condition ($M = 99.0\%$ correct) compared to the angry condition ($M = 95.9\%$ correct, Holm-Sidak's multiple comparisons test, $p < .001$, $d = 0.60$) and to the fear condition ($M = 95.9\%$ correct, Holm-Sidak's multiple comparisons test, $p < .001$, $d = 0.60$). There was no significant main effect of group, $F(1, 89) = 0.04$, $p = .840$, $\eta_p^2 <. 01$, and no significant interaction, $F(2, 178) = 2.14$, $p = .120$, $\eta_p^2 = .02$.

Response times. As can be seen from Figures 3A and 3B, RTs were overall longer for violent offenders than for controls, $F(1, 89) = 12.64$, $p = .001$, $\eta_p^2 = .12$. RTs also differed between conditions, $F(2, 178) = 151.76$, $p < .001$, $\eta_p^2 = .63$, with the

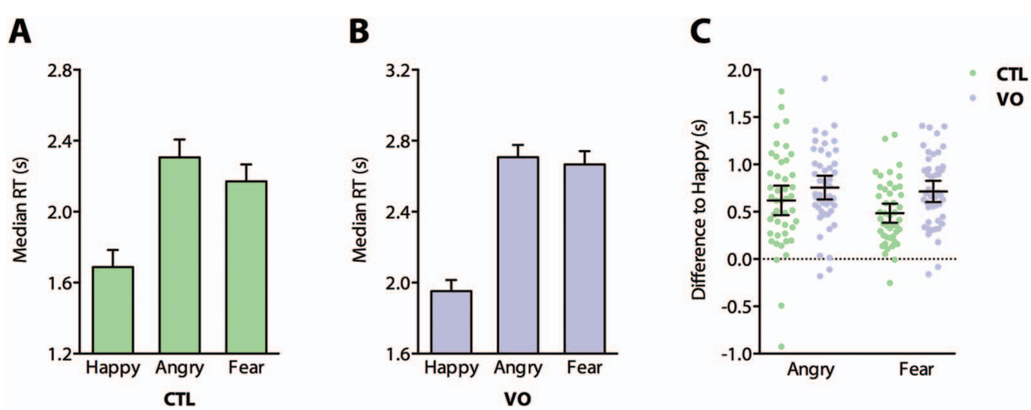

Figure 3. Results from Task 2. Average median reaction times (RTs) (A) for control (CTL) participants and (B) for violent offender (VO) participants and the three different target conditions. Error bars represent standard errors of the mean. (C) Effect of angry and fearful targets relative to happy targets. For every participant, median RTs for the angry target condition and for the fear condition were subtracted from the happy target condition. Difference scores are shown for every participant (circles) and as the average (horizontal bars, together with 95% confidence intervals represented by the vertical error bars), separately for CTL and VO. See the online article for the color version of this figure.

fastest overall RTs in the happy condition (M = 1.82 s) and slowest in the angry condition (M = 2.51 s). Most importantly, there was a significant interaction between participant group and condition, $F(2, 178) = 3.63$, $p = .028$, $\eta_p^2 = .04$.

We followed up on this interaction effect and computed separate analyses for control participants and violent offenders, comparing RTs with the Holm-Sidak's multiple comparison test. While control participants categorized fear targets faster than angry targets ($p < .05$, $d = 0.34$), no such relative fear advantage was evident for violent offenders (*ns*, $d = 0.11$). However, the results from a mixed ANOVA showed that the size of this fear advantage did not differ significantly between groups, $F(1, 89) = 1.33$, $p = .252$, $\eta_p^2 = .02$. Thus, these data provide no clear evidence that the advantage for fear targets, relative to angry targets, was significantly smaller in violent offenders than in controls. Similarly, another mixed ANOVA showed that the advantage for happy relative to angry targets did not differ significantly between groups, $F(1, 89) = 1.88$, $p = .174$, $\eta_p^2 = .02$ (see Figure 3C). Importantly, however, the advantage for happy versus fearful targets was significantly larger for violent offenders than for controls, $F(1, 89) = 9.41$, $p = .003$, $\eta_p^2 = .10$, meaning that compared to happy expressions, fearful targets slowed responding in violent offenders more than in controls (see Figure 3C). This pattern of results demonstrates that compared to healthy controls, violent offenders did not show the relative fear advantage, but that these group differences depended on the specific emotion contrast. While groups did not differ in the fear effect when calculated relative to angry targets, violent offenders showed a significantly smaller fear advantage than controls when the fear effect was calculated relative to happy targets.

Finally, in order to assess a potential fear-specific impairment in violent offenders, we ran an additional analysis analogous to Task 1. In order to reduce noise and to increase statistical power, we compared median RTs for fear targets to median RTs averaged across angry and happy targets (non-fear targets). This analysis revealed a significant interaction, $F(1, 89) = 7.10$, $p = .009$, $\eta_p^2 = .07$, demonstrating that the slowing of RTs for fear targets was significantly larger in violent offenders (M = 0.34 s) than in controls (M = 0.17 s), thereby providing evidence for Hypothesis 2, that is, impaired fear processing in violent offenders.

Task 1 Versus Task 2

Finally, to examine the specificity of the fear impairment found in violent offenders in Task 2, we analyzed RTs from both experiments in mixed ANOVAs with the within-subjects factors experiment (1, 2), condition (happy, angry, fear), and the between-subjects factor participant group (controls, violent offenders). This ANOVA revealed a significant three-way interaction, $F(2, 178) = 5.44$, $p = .005$, $\eta_p^2 = .06$, demonstrating that the deficit in violent offenders was specific to the explicit emotion recognition task used in Task 2. This was supported by an additional analysis in which we directly compared the difference between fear and non-fear (averaged across happy, angry) targets between participant groups and experiments. These analyses also revealed a significant three-way-interactions, $F(1, 89) = 6.21$, $p = .015$, $\eta_p^2 = .07$. To exclude that potential differences in IQ were driving the observed effects, all main analyses were repeated with WMT as a covariate, yielding a qualitatively similar pattern of results. Consistent with Hypothesis 2, this demonstrates that the fear deficit in violent offenders was indeed specific to the explicit categorization of emotional faces.

Relationship to Psychopathic Traits

In order to investigate the relationship between psychopathic traits and task performance in violent offenders, we computed correlations between median RTs for every task and condition and the self-reported psychopathy measure. Contrary to Hypothesis 3, there were no significant correlations between self-reported psychopathy or any of its subscales and median RTs (see Table 2).

General Discussion

The present study is the first to systematically investigate both initial attentional guidance by physical and affective saliency as well as later explicit emotion categorization in an antisocial population using visual search paradigms. We asked whether the well-established emotion recognition deficits in antisocial and psychopathic individuals are related to impaired attentional guidance by affective or physical saliency at early visual processing stages or whether such impairments emerge only at later processing stages related to explicit emotion recognition. The results of the experimental series can be summarized as follows: (1) In

Table 2
Correlations Between Median Response Times (Tasks 1 and 2) and Self-Reported Psychopathy for the Violent Offenders

	Task 1					Task2		
Scale	Color	Neutral	Happy	Angry	Fearful	Happy	Angry	Fearful
SRP-IM	−.08	−.05	−.12	−.13	−.04	−.04	−.13	−.13
SRP-CA	−.21	−.13	−.18	−.21	−.23	−.16	−.19	.02
SRP-EL	−.26	−.23	−.18	−.21	−.25	.02	−.03	.06
SRP-AB	−.13	−.14	−.09	−.16	−.11	.07	.08	.20
SRP-Tot	−.22	−.18	−.18	−.22	−.18	−.02	−.06	−.14

Note. SRP = Self-Reported Psychopathy Scale; SRP-IPM = Interpersonal Manipulation subscale; SRP-CA = Callous Affect subscale; SRP-EL = Erratic Lifestyle subscale; SRP-AB = Antisocial Behavior subscale; SRP-Tot = SRP total score.

support for Hypothesis 1, attentional guidance by physical saliency was intact in violent offenders. However, contrary to our assumptions, there was no evidence for impairments of attentional guidance by affective saliency (and by fear in particular). (2) In accordance with Hypothesis 2, explicit emotion categorization was impaired in violent offenders. This impairment was specific to fearful expressions. (3) Contrary to Hypothesis 3, no relationship between any facets of psychopathy and task performance was evident in violent offenders. Thus, the fear recognition deficit in violent offenders does not seem to be related to impaired initial processing of saliency or to self-reported psychopathy. These findings represent a first step in delineating the mechanisms underlying the widely reported emotion recognition deficit in antisocial individuals.

Task 1 measured the influence of task-irrelevant affective and physical saliency on visual search. Task-irrelevant color and facial expressions facilitated visual search in both controls and violent offenders, demonstrating intact initial attentional guidance by both physically and affectively salient information. This is in accordance with two recent studies that examined the relationship between psychopathic traits and the processing of bottom-up (physical saliency of distractor cues) and top-down cues (attending to a target-relevant feature) in violent offenders (Hoppenbrouwers et al., 2015) and a community sample with varying degrees of psychopathy (Hoppenbrouwers, Van der Stigchel, Sergiou, & Theeuwes, 2016). Consistent with the present findings, these studies found no association between psychopathy and the initial processing of physical saliency, but only some evidence for affective psychopathy traits being linked to disruptions in top-down processing. Despite differences in study design (no healthy controls, assessing attentional capture vs. facilitation) and stimulus material (physical saliency only), our findings also support the conclusion that bottom-up processing of physical saliency is unimpaired in antisocial populations and is not related to psychopathic traits. Only one previous study examined bottom-up visual attention for affective information using an experimental design similar to the current study. In this study, children with CD searched for a neutral or an emotional target face in a display with neutral or emotional distractors (Hodsoll et al., 2014). In contrast to healthy controls, emotional distractor faces did not capture attention in the CD group with high callous-unemotional traits. In the present study, we found no evidence for impaired facilitation or the influence of psychopathy. One potential explanation for this discrepancy may be that we only manipulated affective saliency for target singletons and it is possible that facilitation for emotional targets and attentional capture by emotional distractors reflect different perceptual processes. It therefore remains to be established whether attentional capture by emotional faces is impaired in adult antisocial individuals and whether psychopathy is related to these impairments. Future research directly comparing attentional guidance and capture by affective information is needed to determine which aspects of bottom-up affective processing are impaired in antisocial individuals.

Task 2 used similar search displays but required participants to directly categorize facial expressions. Results showed that relative to control participants, violent offenders were impaired in categorizing fearful target expressions (when taking happy facial expressions as baseline). This replicates previous evidence for a specific impairment in the recognition of fear in antisocial and psychopathic populations (Blair et al., 2004; Dadds et al., 2008; Hastings et al., 2008; Marsh & Blair, 2008; Montagne et al., 2005; Schönenberg et al., 2013, 2014, 2016; White et al., 2016). Taken together, the results from Tasks 1 and 2 show that the fear recognition deficit is not simply the result of an impaired initial processing of visual saliency. Search performance in both controls and violent offenders benefited from affective and physical saliency, demonstrating that recognition deficits cannot be traced back to an inability to perceive this information. This corroborates recent data from our lab, where we asked participants to judge emotional expressions of varying intensity regarding their affective content (neutral vs. emotional) or to explicitly categorize the expression. Processing of affective information was unimpaired under task demands that required simple valence judgments but deficient when the offender participants were asked to explicitly label the expressions (Jusyte & Schönenberg, 2016).

Although the fear-specific recognition deficit observed in the current study is in accordance with the VIM model, we failed to find support for a relationship between fear recognition impairments and self-reported psychopathy. There was no evidence for associations between self-reported psychopathic traits and affective attentional guidance (Task 1) or categorization performance (Task 2) that have been reported in several previous studies (Dadds et al., 2008; Hodsoll et al., 2014; Jusyte et al., 2015; Marsh et al., 2008; Sylvers et al., 2011; Viding et al., 2012). Our findings are, however, consistent with recent meta-analyses that failed to find specific associations between psychopathic traits and fear-recognition deficits (Dawel et al., 2012; Hoppenbrouwers, Bulten, et al., 2016). The current results are also consistent with two previous studies that did not find associations between impaired bottom-up visual attention and affective facets of psychopathy in an offending as well as a community sample (Hoppenbrouwers, Van der Stigchel, et al., 2016; Hoppenbrouwers et al., 2015). In summary, our findings support the notion that emotion recognition deficits are not restricted to psychopathy but are pervasive in antisocial individuals in general (Chaplin et al., 1995; Marsh & Blair, 2008; Schönenberg et al., 2016).

Limitations

The current study has several limitations worth noting. First, the study has been carried out on a male adult sample of violent offenders. Thus, it remains a subject of further investigations to determine whether the current findings can be extended to female and pediatric populations. Furthermore, the current study only included participants who committed violent acts toward nonintimate others. Previous research shows that domestic violent offenders may differ from generally violent individuals with regard to both personality traits (Swogger, Walsh, & Kosson, 2007) and the magnitude of antisocial behavior (Boyle, O'Leary, Rosenbaum, & Hassett-Walker, 2008). Thus, the present results may not be generalizable to intimate violence offenders and future studies are needed to examine whether similar deficits are present in this population. The assessment of self-reported psychopathy as opposed to categorical diagnoses using well-established procedures such as the psychopathy checklist (Hare & Vertommen, 1991) is another important limitation of the current study; the absence of a correlation between psychopathy and emotion recognition should therefore be interpreted with caution. Finally, on a theoretical note, it remains a matter of debate whether emotional stimuli represent a stimulus category with inherent bottom-up saliency (Awh, Belopolsky, & Theeuwes, 2012). Thus, the present findings cannot be directly related to visual search studies using nonaffective stimuli with physical, purely bottom-up saliency (Hoppenbrouwers, Van der Stigchel, et al., 2016; Hoppenbrouwers et al., 2015).

Research Implications

Our findings show that rather than being hard-wired in early visual and attentional systems, impaired processing of affective stimuli in antisocial individuals seems to result from later processing stages related to explicit recognition and categorization. Which mechanisms could give rise to these impairments? One possibility is that antisocial individuals have an imprecise mental representation of (specific) emotional expressions or of affective categories more generally and therefore confuse emotional labels in the categorization process. A more detailed understanding of such putative underlying mechanisms is relevant for etiology models of aggressive-spectrum disorders and has pivotal implications for therapeutic interventions. As mentioned above, one limitation of the present study is the assessment of psychopathy using self-reports; it thus remains to be established whether the observed deficit is associated with antisociality per se, violent behavior, or psychopathy. Furthermore, the present study focused on attentional guidance by emotional targets and did not assess other aspects of bottom-up processing such as attentional capture by emotional stimuli. Future studies are necessary to investigate these and other factors known to influence visual attention, such as intertrial priming (Hoppenbrouwers et al., 2015) or top-down attentional control, in order to fully understand the nature of impairments associated with deficits in the processing of affective information in antisocial and psychopathic individuals.

Clinical and Policy Implications

Recently, adjunct training procedures targeting the labeling (Schönenberg et al., 2014) or interpretation of facial affect (Penton-Voak et al., 2013) have been developed for aggressive groups. Importantly, these intervention strategies rely on entirely different assumptions regarding the targets of a social cognition training in aggressive populations. While one study attempted to shift biases in facial affect processing so the participants would perceive ambiguous facial expressions as less hostile (Penton-Voak et al., 2013), another computerized training targeted the fear-recognition deficit for facial expressions, providing promising results that similar procedures could benefit the overall ability to correctly categorize all basic emotion expressions (Schönenberg et al., 2014). In light of the current findings, therapeutic attempts that target discriminatory ability to achieve precise ascription of affective states appear to be a promising avenue for future research. However, future studies need to pinpoint the precise cognitive and perceptual mechanisms underlying this categorization deficit in order to understand which processing stages should be targeted, to develop more tailored procedures, and to determine which subgroups could benefit from such interventions.

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