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Psychiatry Research 200 (2012) 761–766

Contents lists available at SciVerse ScienceDirect

Psychiatry Research

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

Psychopaths lack the automatic avoidance of social threat: Relation to instrumental aggression

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ARTICLE INFO

Article history:
Received 27 September 2011
Received in revised form
12 June 2012
Accepted 15 June 2012

Keywords:
Approach
Avoidance
Aggression
Psychopathy
Empathy
Facial emotions
Social threat

ABSTRACT

Psychopathy (PP) is associated with marked abnormalities in social emotional behaviour, such as high instrumental aggression (IA). A crucial but largely ignored question is whether *automatic* social approach-avoidance tendencies may underlie this condition. We tested whether offenders with PP show lack of automatic avoidance tendencies, usually activated when (healthy) individuals are confronted with social threat stimuli (angry faces). We applied a computerized approach-avoidance task (AAT), where participants pushed or pulled pictures of emotional faces using a joystick, upon which the faces decreased or increased in size, respectively. Furthermore, participants completed an emotion recognition task which was used to control for differences in recognition of facial emotions. In contrast to healthy controls (HC), PP patients showed total absence of avoidance tendencies towards angry faces. Interestingly, those responses were related to levels of instrumental aggression and the (in)ability to experience personal distress (PD). These findings suggest that social performance in psychopaths is disturbed on a basic level of automatic action tendencies. The lack of implicit threat avoidance tendencies may underlie their aggressive behaviour.

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1. Introduction

Psychopathy (PP) forms a significant emotional and economic burden for society. Although it is characterized by severe abnormalities in social emotional behaviour (e.g., antisocial behaviour, aggression, lack of guilt and remorse), the exact mechanisms underlying this psychopathological pattern of behaviour remain poorly understood. Psychopaths typically show increased (instrumental) aggressive behaviour in social situations (Glenn and Raine, 2009). Instrumental aggression (IA) is viewed as premeditated, calculated and goal-directed. Although this behavioural pattern may result from alterations in very basic social approach and avoidance tendencies, no studies have directly tested this premise.

Social emotional behaviour can be roughly divided into social approach and social avoidance (Davidson et al., 1990; Lang et al., 1990; Gray, 1994). These action tendencies involve a basic response to stimulus valence, are mediated by primary motivational systems of the brain and are underlying every complex emotional responding (Lang et al., 1997). While appetitive stimuli elicit approach tendencies, non-appetitive stimuli activate avoidance tendencies (Chen and Bargh, 1999). Rolls (2000) emphasized the importance of facial expressions as input for these systems conveying social information. Indeed, on social approach-avoidance tasks (AATs), healthy people show a general tendency to move away from angry expressions, and to approach happy faces (Lang et al., 1997; Chen and Bargh, 1999; Marsh et al., 2005; Roelofs et al., 2009a; Volman et al., 2011). However, several forms of psychopathology have been associated with disturbed social approach-avoidance behaviour. Social phobics, for example, show a dramatic increase in avoidance tendencies to angry face stimuli (Heuer et al., 2007; Roelofs et al., 2009b; Roelofs et al., 2010). Psychopathy, on the other hand, is associated with low levels of fear (Lykken, 1957) in combination with abnormal social behaviour (Blair et al., 2005). Lykken even describes lack of fear as an etiological factor of psychopathy (Low fear Hypothesis, Lykken, 1957). Blair, in his violence inhibition model, suggests that the absence of fear to distress cues of others contributes to the emergence of violence (Blair et al., 2005). Empirically, patients with psychopathy, for example, show reduced autonomic reactions to distress stimuli (House and Milligan, 1976; Blair, 1999),

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0165-1781/$ - see front matter © 2012 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.psychres.2012.06.026

disturbed recognition of facial emotions such as fear and sadness (Blair et al., 2004; Hastings et al., 2008) and abnormal risk taking and moral behaviour (Blair, 1995; Bechara et al., 2000; Blair and Cipolotti, 2000). On a neural level, they show reduced activity in limbic and frontal brain structures (Birbaumer et al., 2005), which are critical for adequate regulation of social approach and avoidance behaviour (Birbaumer et al., 2005; Roelofs et al., 2009a; Volman et al., 2011). In the context of these insights, instrumental aggression in psychopathy may be explained by limited and biased response repertoires such as lack of automatic avoidance or even automatic aggressive approach behaviour to threat stimuli (e.g., Dodge and Crick, 1990; Crick and Dodge, 1996; Orobio de Castro et al., 2005). However, most research on behavioural responses in psychopathy were based on questionnaires or were directed at non-automatic controlled behaviour, whereas human behaviour is largely driven by implicit and automatic action tendencies as shown by work from Bargh and Chartrand (1999).

The major aim of the present investigation was to objectively assess automatic social approach and avoidance behaviour in patients with psychopathy. A direct, objective way to measure social approach and avoidance behaviour is by using reaction-time tasks in which participants either push emotional faces away or pull the faces towards them, upon which the faces decrease or increase in size, respectively (the zooming social approach-avoidance task (AAT: Heuer et al., 2007). Generally, individuals are faster when the movement is congruent to their automatic tendency to approach happy faces and to avoid angry faces, as compared to affect-incongruent conditions in which individuals have to override these automatic action tendencies and have to select a rule-driven response (push happy away and pull angry faces towards them: Chen and Bargh 1999; Rotteveel and Phaf, 2004; Roelofs et al., 2009a; Roelofs et al., 2009b). We applied the AAT with angry, happy and neutral face stimuli in male violent offenders diagnosed with PP and matched healthy controls (HC) to test whether problems in social emotional responding associated with PP are manifested at a basic level of automatic action tendencies. So far, psychopathy research has been mainly focussed on perceptual processing of fearful faces. In the present study we are not interested in fear recognition but in the magnitude of actual fear behaviour in response direct social threat, such as communicated by angry faces. Unlike fearful faces, angry faces directly communicate social challenge to the observer (Adams et al., 2005; Heuer et al., 2007), thereby eliciting fear related (avoidance) behaviour in healthy individuals (Marsh et al., 2005). With this set-up, we tested the following hypotheses: (1) PP, as compared to HC, show diminished avoidance of social threat cues (angry faces). (2) The altered threat avoidance tendencies in PP are related to instrumental aggression. Finally, because altered threat avoidance in PP may be influenced by (A) the ability to recognize facial emotions or by (B) the amount of personal distress (PD) resulting from observing another's negative experiences in social interaction (anxiety in a tense emotional situation, Davis, 1996; Beven et al., 2004)—we additionally tested for a possible modulatory role of these two factors. Furthermore, to be able to distinguish alterations in motivational processes from alterations in general stimulus-response compatibility effects, we applied the gaze variant of the zooming AAT (Roelofs et al., 2010) where faces are presented not only with direct gaze but also with averted gaze. In contrast to angry faces with direct gaze, angry faces with averted gaze do not directly communicate threat to the observer and serve as a preferred control stimulus in that they express the same valence but lack the direct motivational component (Roelofs et al., 2010). We expected that alterations in approach-avoidance tendencies to angry faces in PP would be specific for faces with direct gaze and not for those with averted gaze.

Table 1
Group Characteristics of individuals with psychopathy (PP) and healthy control subjects (HC, mean values and standard errors).

	PP ($N=17$)	HC ($N=15$)	Statistic	p-value (2-tailed)
Age	36.53 (1.71)	36.40 (2.53)	$t(30)=0.043$	0.97
IQ (NLV)	97.00 (2.62)	103.80 (2.20)	$t(30)=-1.96$	0.06
IRI total	56.76 (3.60)	58.67 (2.10)	$t(30)=-0.441$	0.66
IRI PD	9.94 (0.99)	8.60 (0.89)	$t(30)=0.997$	0.33
IRI F	13.18 (1.71)	13.60 (0.81)	$t(30)=-0.241$	0.83
IRI PT	17.82 (1.12)	19.13 (1.00)	$t(30)=-0.862$	0.40
IRI EC	15.82 (1.28)	17.33 (0.85)	$t(30)=-0.958$	0.35
PCL-R total	30.47 (1.03)	-	-	-
PCL-R Factor1	12.35 (0.61)	-	-	-
PCL-R Factor2	14.12 (0.50)	-	-	-
RPQ_IA	7 (5.4)			
RPQ_RA	9 (5.5)			

PD=personal distress, F= fantasy, PT=perspective taking, EC=empathic concern, PCL-R=psychopathy checklist.

2. Methods

2.1. Participants

We recruited 17 male violent offenders between 18 and 55 years of age (mean age=36.53 yr, S.D.=7.03) diagnosed with a psychopathy score of ≥ 26 (Schönberg et al., 2008) according to the Psychopathy Check List-Revised (PCL-R; Hare, 1991) from the in-patient population of a forensic psychiatric institute in The Netherlands[1] based on available information about clinical status and prior history. PCL-R consensus scores were obtained by trained clinicians following the official procedure of using interviews and patient file information to reach a consensus score. We assessed IQ levels using the Dutch version of the National Adult Reading Test. Fifteen healthy male controls matched for age and IQ, without criminal records or a history of psychiatric disorders, were recruited by advertisement (for group characteristics, see Table 1). Participants in both groups were checked for drug use and for medical/neurological history.[2] There were no differences between the groups on IQ, age or any of the scores of the Interpersonal Reactivity Index (see Table 1 for characteristics).

2.2. Tasks

2.2.1. Approach-avoidance task

Stimuli were black–white photographs (sized 8.4×13.5 cm) of facial expression (eight actors: four men, four women) selected from Ekman and Friesen (1976) and from Karolinska Institute databases (Lundqvist et al., 1998). For each actor angry, happy and neutral facial expressions were used. Eye regions (Roelofs et al., 2010) were modified resulting in a direct gaze expression (original) and two versions with averted gaze (looking left and right, respectively), resulting in 48 stimuli (8 actors*3 emotions*2 gaze directions).

In six blocks (push happy–pull neutral; pull happy–push neutral; push neutral–pull angry; pull neutral–push angry; pull happy–push angry; push happy–pull angry) we presented 384 experimental trials in a semi-random order with the restriction that no more than three of the same stimulus response combination were presented successively. Each block was preceded by 16 practice trials (in total 96 practice trials). Order of the blocks was counterbalanced and participants were given the possibility to take a short break after each block.

Pictures were presented on a computer screen with a resolution of 1024×768 pixels. A joystick of the type Logitech Attack 300 was placed between the participant and the computer screen. Participants were positioned in such a way that by moving the joystick they either moved their arm towards or away from their body. Each trial was self-paced: participants had to press the fire button while the joystick was in the resting (upward) position and the screen was blank to have a picture appear in the

[1] The Pompestichting is a "TBS-clinic" located in Nijmegen. TBS is a disposal to be treated on behalf of the state for people who committed serious criminal offences in connection with having a mental disorder. TBS is not a punishment, but an entrustment act for mentally disordered offenders (diminished responsibility).

[2] Exclusion criteria: Alcohol use more than 3 units/day, cannabis use or other illicit drugs in the week preceding the experimental measure and use of alcohol within 24 h of the measurement. Psychotropic medication other than oxazepam during the 5 days before measurement. Use of oxazepam within 12 h before measurement. Smoking within 3 h before measurement. History of trauma capitis, visual and auditive disorders, neurological disorders, first degree relative with any relevant neurological disorders.

Table 2
Mean number of correct responses (standard errors) for full blown happy, angry and neutral expression for individuals with psychopathy (PP) and healthy control subjects (HC).

Facial expression	PP ($N=17$)	HC ($N=15$)
Angry	5.06 (0.26)	5.13 (0.22)
Happy	5.71 (0.14)	5.40 (0.24)
Neutral	4.59 (0.35)	3.53 (0.46)

middle of the screen. Participants responded by pushing or pulling the joystick which resulted in the picture shrinking or respectively growing in size (initial size and minimal and maximal size of the stimuli in visual degrees were: 9.5°*13°; 3.5°*4.5°; and 15.5°*20°) and disappeared from the screen when the maximum 30° joystick flex was reached. This zooming version (Rinck and Becker, 2007) showed to be particular resistant to possible cognitive re-interpretation of arm movements (i.e., pushing/pulling unambiguously mean avoidance/approach, respectively).

A practice phase, in which pictures did not disappear after an erroneous response (allowing participants to practice until the response was correct), preceded the experimental phase in which no feedback was provided. Participants were instructed to respond as fast and as accurate as possible. As a measure of approach and avoidance tendencies the reaction time to initiate the joystick movement was used.

2.2.2. Morphed facial emotion recognition task

To control for possible difference in emotion recognition between the groups, a facial emotion recognition task was used. This task consists of six basic emotional expressions (fear, anger, sadness, happiness, disgust, surprise) each shown in 10 different intensities (10%, 20%, etc.) and neutral faces. Six models from the Ekman and Friesen (1976) picture database were chosen (SW, PE, MF, MO, JJ, WF). This leads to a total of 366 stimuli. The task requires two responses, one indicating the time needed to identify the expression (viewing time), and one indicating the emotion identified. No feedback was given during the task. Each trial began with the presentation of a facial expression (9*11.5 cm) for a maximum of 3000 ms. Participants were instructed to press the space bar as soon as they knew what expression was shown. If the space bar was pressed, or the maximum stimulus duration had been reached, a response screen was shown on which the subject saw all 7 expressions and a corresponding number which had to be pressed in order to indicate which emotion was seen. There was no response-time limit for the second response. Here we only report accuracy for full blown expressions (e.g., 100% intensity) of neutral, angry and happy faces (the majority of results of this task will be published elsewhere) as the pictures used in the AAT were also of 100% intensity. One-way ANOVAs revealed that groups did not differ in accuracy on neutral, happy and angry full blown expressions (angry: $F(1/30)=0.046$, $p=0.831$; happy: $F(1/30)=1.306$, $p=0.262$; neutral: $F(1/30)=8.868$, $p=0.074$; see Table 2).

2.2.3. The Interpersonal Reactivity Index

The Interpersonal Reactivity Index (IRI; Davis, 1996) was created to measure four factors related to empathy (fantasy, perspective taking, empathic concern, personal distress). The personal distress (PD) scale measures the kind of feelings (anxiety, etc.) that result from observing another's negative experiences ('experienced empathy'). Since the PD scale has been related to aggression (Davis, 1996; Beven et al., 2004) and has been shown to be crucial for prosocial behaviour (Decety and Lamm, 2006) we will focus on the PD scale (see Table 1 for mean scores in each group). PD or self oriented aversive emotional reactions, such as anxiety, worry and discomfort to someone else's emotional state, can lead to self-oriented egoistic reactions. In order to reduce these feelings an egoistic reaction would be to withdraw from the distress which leads to decreased likelihood of prosocial behaviour (Tice et al., 2001).

2.2.4. Reactive-proactive questionnaire

The reactive-proactive aggression questionnaire (RPQ; Raine et al., 2006) is a self-report questionnaire designed to measure two forms of aggression: instrumental aggression and reactive aggression. Each item describes an aspect of aggressive behaviour. Participants have to indicate (0, 1, 2) how often they have acted a certain way. One sum score for reactive (RA) and one for instrumental aggression (IA) are obtained. In this study, scores of patients ($N=13$, mean score $IA=7$ (S.D.=5.4), mean score $RA=9$ (S.D.=5.5)) but not of controls are available (see Table 1).

2.3. Procedure

Participants received written information about the experiment and signed an informed consent before being screened for psychiatric exclusion criteria[3] by trained psychologists using the SCID-II and MINI. Next, participants completed the IRI and the RPQ. All questionnaires were filled in before participants returned for a second test session in which they performed the morphed facial emotions recognition task, the two versions of the AAT (direct and indirect version), a reversal learning task (reported elsewhere) and received a financial reimbursement. The local medical ethical committee 'Commissie Mensgebonden Onderzoek' region Arnhem-Nijmegen approved all procedures.

2.4. Analyses

AAT: Reaction time (RT) outliers were filtered using a <150 ms (controls 0.3%, PP 0.6%) and >1500 ms (controls 1.6%, PP 2.8%) cut-off. RTs were log-transformed as no normal distribution was found. The mean of the remaining RTs (94%) for the correct responses were calculated per cell [defined by: Group, Emotion, Movement and Gaze].

To test whether PP show altered avoidance of social threat cues presented with direct gaze, we conducted a Repeated Measures Analyses of Variance (rm ANOVA) for the RTs for angry faces with Group (PP versus controls) as between-subject factor: and Gaze (direct versus averted) and Movement (pull versus push) as within-subject-factors. To check whether there are no such findings for happy and neutral faces, similar analyses were repeated for happy and neutral faces.

Subsequently, AAT effect-scores were calculated for angry faces per cell [cell defined by Group and Gaze] by subtracting the individual log-transformed mean RTs for pull movements form the individual log-transformed mean RTs for push movements. Negative AAT effect-scores indicate stronger avoidance and positive effect-scores reflect stronger approach tendencies (e.g., Heuer et al., 2007). We tested whether AAT effect-scores for angry faces reflected significant avoidance tendencies (i.e., were significantly different from zero) by conducting separate one-sample t-tests (one-tailed) for the AAT effect-scores.

Furthermore, to investigate whether possible difference in effect score on angry direct gaze pictures were related to PCL-R total scores, PCL-R factor 1, PCL-R factor 2 scores we performed correlations.

To test whether eventual group differences in AAT effects-scores would be related to group differences in face recognition or IQ, these factors were added as covariates to the above mentioned rm ANOVA in separate analyses.

Finally, we investigated whether instrumental aggression and empathy scores contributed unique variance to the AAT effect-scores for angry faces in the PP group, using linear regression analysis with AAT effect-scores for angry (direct gaze) faces as dependent variable. We will include both IRI_PD scores and RPQ_IA scores together as predictors for the analyses of PP data. For HC, we entered only IRI-PD scores were as predictors as we did not have RPQ_IA scores for the healthy controls.

Our hypothesis regarding empathy is specifically related to the personal distress scale. However, the empathic concern scale has been linked to psychopathic traits (Seara-Cardoso et al., 2012). To ensure the validity of our measures we will on a side note report correlations between the empathic concern scale, the PCL-R scores and movement parameters for all three emotions in the direct gaze condition.

For all analyses alpha was set at 0.05. Effect-sizes of significant results are reported with the Cohen's d.

3. Behavioural results

3.1. AAT

Mean RTs and error rates are presented in Table 3. PPs and HC did not differ with respect to error rates (overall $t(30)=-0.137$, $p=0.892$), and in relation to Emotion (all $p>0.534$) or Movement (all $p>0.950$). Groups did also not differ with respect to overall RT ($F(1,30)=1.563$, $p=0.221$). There was no main effect of Correctness on RT ($F(1/30)=1.766$, $p=0.194$) nor an interaction effects of Correctness*Group with respect to RT ($F(1/3)=0.406$, $p=0.529$).

An rm ANOVA for the RTs to angry faces resulted in a significant Group*Gaze*Movement interaction ($F(1/30)=4.951$, $p=0.034$, $\eta^2=0.023$, Cohen's $d=0.3049$). There were no other significant main or interaction effects (all $p>0.111$). To explore the three-way interaction, we conducted separate analyses for the averted and direct gaze stimuli. As expected, there were no significant AAT effect-scores elicited by the averted gaze stimuli

[3] Psychiatric exclusion criteria: Depressive Disorder, Bipolar Disorder, Schizophrenia, Schizoaffective Disorder, Schizophreniform Disorder, Delusional and (*footnote continued*) other Psychotic Disorders, Schizoid or Schizotypical PD, Current Alcohol and Substance intoxication, first degree relatives with DSM IV axis I schizophrenia or schizophreniform disorder.

Table 3
Mean reaction times for pull and push conditions, for control participants (HC) and psychopathic individuals (PP), for each emotion.

		Direct gaze		Averted gaze	
		PP ($N=17$)	HC ($N=15$)	PP ($N=17$)	HC ($N=15$)
Angry	Pull	695 (21)	701 (22)	691 (20)	682 (21)
	Push	706 (23)	669 (23)	700 (23)	677 (25)
Happy	Pull	633 (21)	630 (23)	625 (22)	618 (23)
	Push	651 (20)	644 (22)	658 (21)	647 (23)
Neutral	Pull	688 (21)	686 (23)	696 (20)	723 (22)
	Push	698 (20)	706 (21)	706 (22)	722 (23)

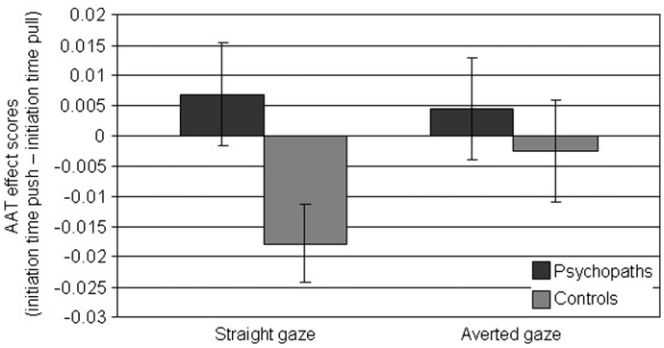

Fig. 1. AAT effect-scores on angry facial expressions. Log transformed AAT effect-scores (standard errors) for individuals with psychopathy (PP, dark grey) and control participants (HC, light grey) on angry facial expressions for pull (approach) and push (avoid) conditions.

($F(1/30)=0.356$, $p=0.555$, $\eta^2=0.0$, Cohen's $d=0.0$) but there was a significant Movement* Group interaction for the angry faces presented with direct gaze ($F(1/30)=5.073$, $p=0.032$, $\eta^2=0.125$, Cohen's $d=0.756$). Whereas HC showed the expected significant AAT effect-scores (push versus pull) for the angry faces with direct gaze ($t(14)=2.754$, $p=0.016$), PP did not show this effect ($t(16)=-0.798$, $p=0.436$, see Fig. 1).

For HC, the AAT effect-score for angry direct gaze faces differed significantly from zero ($t(14)=-2.754$, $p=0.016$), while this was not true for angry averted gaze pictures ($t(14)=-0.307$, $p=0.764$) in the same group. For the PP group, none of the angry face AAT effect-scores differed significantly from zero (straight: $t(16)=0.798$, $p=0.436$, averted $t(16)=0.540$, $p=0.596$). Together these findings show that whereas HC do show the expected avoidance tendencies towards angry faces, PP lack these avoidance tendencies towards social threat cues and even show a (non-significant) tendency to approach them.

Similar group analyses for neutral and happy faces did not reveal significant results (all $p>0.2$).

Next we checked whether group differences in threat avoidance tendencies remained when accounting for individual differences in recognition accuracy (for full blown angry facial expressions), by adding the individual accuracy rates (see Table 2) as a continuous variable (covariate, Judd and McClelland, 1998) into the above mentioned critical Group* Movement rm ANOVA for angry faces with direct gaze. There were no significant main or interaction effects for recognition accuracy (all $p>0.168$). Similarly, the effects were also not explained by IQ (all $p>0.260$).

3.2. Relation instrumental aggression and personal distress

A multiple regression analysis was conducted to determine if instrumental aggression (RPQ_IA) and personal distress (IRI_PD) contributed unique variance to the prediction of AAT effect-scores

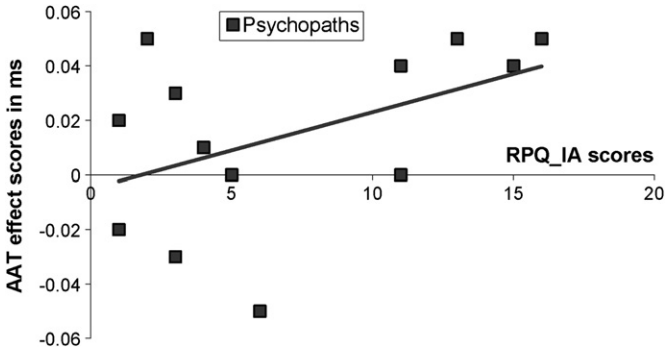

Fig. 2. Correlation between AAT effect-scores and instrumental aggression scores. Correlation between AAT effect-scores (pull minus push, milliseconds, log-transformed) and the instrumental aggression subscale of the RPQ for psychopathic individuals.

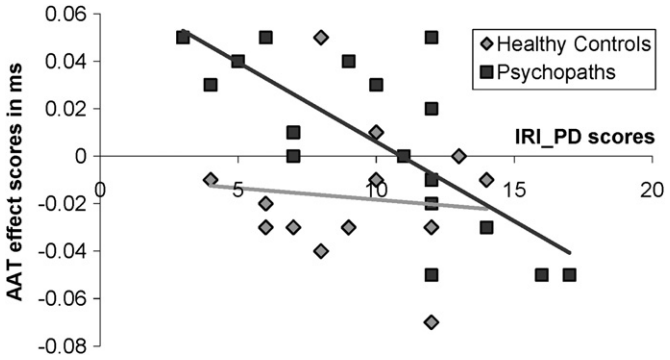

Fig. 3. Correlation between AAT effect-scores and empathy. Correlation between AAT effect-scores (pull minus push, milliseconds, log-transformed) and the personal distress subscale of the IRI for psychopathic individuals (PP, dark grey) and control participants (HC, light grey).

for angry (direct gaze) faces within the group of PP. A significant model emerged ($F(2/10)=9.8$, $p=0.004$, adjusted $R^2=0.595$). Effects were significant for both RPQ_IA (beta=0.349, $p_{\text{one-sided}}=0.045$) and IRI_PD (beta=−0.680, $p_{\text{one-sided}}=0.002$).

Similar analyses with only IRI_PD scores for the HC revealed no significant model ($F(1/13)=0.290$, $p=0.599$). Fig. 2 illustrates that PP scoring high on instrumental aggression show diminished avoidance of angry direct gaze pictures. Fig. 3 shows that PP scoring low on personal distress shows diminished avoidance of angry direct gaze pictures, while those PP scoring high show similar avoidance as HC.[4]

4. Discussion

Aim of the present study was to directly and objectively assess mechanisms of social approach and avoidance behaviour in psychopathy. Three major findings emerged from this study. First, PP showed diminished avoidance of angry faces. Second, impaired avoidance of social threat was related to specific aspects of psychopathy that are instrumental aggression and levels of personal distress measured by the IRI. The less avoidance tendencies

[4] Additional correlation analyses were performed on the empathic concern scale which has been linked to psychopathy before. Results (not corrected for multiple comparison) show that the empathic concern scale is related to the PCL-R factor 2 ($r=-0.564$, $p=0.018$, PCL-R factor 1: $p=0.289$, PCL-R total: $p=0.142$) but not to the AAT effect score ($p=0.267$). Furthermore, the IRI-PD and RPQ_IA scales were not correlated ($p=0.738$). Results also show that the effect score, which is the difference between the pull and push, do not correlate with the PCL-R total, factor 1 or factor 2 score (all $p>0.459$).

individuals with psychopathy have towards angry faces the higher the levels of instrumental aggression. Finally, this effect was related to the ability to experience feelings of discomfort (e.g., anxiety) when observing another's negative experiences. These findings and their implications will be discussed below.

The present study is the first to show that violent offenders diagnosed with PP show a lack of social threat avoidance tendencies. Normally, an angry facial expression functions as a threat signal conveying aggression by the expresser (Blair, 2003), and usually elicit personal distress, i.e. fear in the observer. In terms of models suggesting low fear reactivity in psychopathy (Lykken, 1957; Blair et al., 2005) one would expect that threat signals elicit lower fear responses in psychopathy. One theory, which suggests that certain emotional displays of others, do not inhibit aggressive behaviour is the violence inhibition model (Blair et al., 2005). Although, the theory describes reactivity to fearful and sad expressions of others, the basic idea can be extended to reactivity towards angry expression. A threat cue should elicit distress, i.e. fear in the observer, which would in turn lead to avoidance of the expresser and thereby minimize the chance for an aggressive interaction (Roelofs et al., 2009a). It might thus not only be a reduced reactivity to others' fearful expression that leads to heightened aggression, but also absence of fear in response to threat in the psychopathic individual itself which results in reduced inhibition of aggression. The absence of fear reactivity is a central deficit in PP leading to decreased socialization and increased antisocial behaviour due to diminished aversive arousal by punishment. Indeed, PPs threat-avoidance rates were negatively correlated to instrumental aggression rates, suggesting that those psychopaths who show the lowest avoidance tendencies have the highest instrumental aggression scores. Based on these findings, we propose the lack of automatic threat avoidance tendencies in PP may be at heart of the aggression symptoms in PP. This interpretation fits with the social information-processing model, which predicts that the presence of abnormal response repertoires in highly instrumental aggressive individuals may be related to altered information processing (Dodge and Crick, 1990; Crick and Dodge, 1996). The present results are a first indication that altered information processing may be manifested in altered motivational processing, i.e. action tendencies that are automatically activated by emotional stimuli rather than perceptual aspects per se. This extension also fits the behavioural account of instrumental aggression proposing that it is characterized by personal goal directedness. Not being inhibited by personal distress, such as fear or sadness, to the threat signals of others would facilitate the violation of social norms by the aggressor, while at the same time making it easier for the aggressor to accomplishing personal goals. Thus, although instrumental aggression is by definition calculated and goal-directed suggestive of counting on conscious mechanisms, the present study shows that basic automatic processes play part as well.

The group differences in threat-avoidance tendencies could not be explained by diminished recognition of angry expressions or by group differences in IQ. They were specific for angry faces (and not for neutral or happy) and emerged only for those angry face stimuli where the anger was directly communicated to the participant (direct gaze), indicating that our findings are due to specific expresser driven motivational changes and not to changes in stimulus–response-compatibility effects per see. Previous investigations already indicated that angry faces with averted gaze do not elicit approach-avoidance tendencies (Roelofs et al., 2010). We believe that the averted gaze faces are useful control stimuli, because the expressed valence is kept constant and only the motivational aspects are manipulated.

Our findings suggest that alterations in social motivational behaviour in PP are manifested on a basic level of automatic action tendencies. Those approach-avoidance action tendencies are immediately activated upon exposure to social threat stimuli and are likely mediated by direct connections between the amygdala and brainstem structures as the periaquaductal gray (e.g., Applegate et al., 1983). The fact that the behavioural alterations may be present in such basic levels of emotion processes may help to explain the persistence of PP and may have implication for its treatment. Therapeutic interventions are usually aimed at changing explicit and controlled behaviour (Wong and Hare, 2005). Our findings indicate that interventions focussing on changing automatic action tendencies may be fruitful as well. Such techniques, whereby participants are trained to approach or avoid (f.e. by pulling or pushing a joystick), have been proven to be successful in the domain of addiction (Wiers et al., 2010) and stereotyping behaviour (Kawakami et al., 2000, 2007). Apart from such applications, our findings raise the questions whether successful (aggression) treatment in PP results in altered action tendencies and whether such changes in automatic action tendencies are predictive of criminal recidivism.

Finally it is interesting to relate our current results to findings from recent neuroimaging research, showing that control of social approach-avoidance tendencies depends on amygdala-frontal circuits that have also been implied in PP (Birbaumer et al., 2005; Roelofs et al., 2009a; Volman et al., 2011). Interestingly, endogenous testosterone levels modulate activity in these circuits during performance of the AAT in healthy males (Volman et al., 2011), raising the question whether alterations in basal or reactive testosterone levels associated with PP and with aggression (Stalenheim et al., 1998; Nelson and Trainor, 2007) may be related to alterations in AAT performance.

Some limitations of the present study should be taken into account when interpreting the findings. No difference in IRI scores were found between the two groups and IRI EC scale did not correlate with PCL-R factor 1 scores. This could be due to a limited sample size. Furthermore, even though the Dutch version of the IRI has been validated (De Corte et al., 2007), it did not cover the concept empathy extensively, thereby possible weaknesses are not fully explored yet. We used a relatively small, but homogeneous (in terms of comorbidity, medication use, therapeutic context, etc) group of violent offenders with psychopathy. One should be careful with generalizing the results to the broad concept of psychopathy, as we have shown that it is related to specific aspects of psychopathy. Future investigations should consider relating this finding to more dimensional approaches of psychopathy (e.g., the Triarchic Conceptualization of Psychopathy; Patrick et al. (2009)). Aggression scores were not available for the control group and were only available for 13 of the 17 PPs. Aggression was measured using self-report questionnaires. Due to the small sample size the correlation between reaction AAT effect and aggression should be interpreted as preliminary until replicated. Future investigations should aim at using more objective measures in larger samples. Furthermore, an important question from a clinical point of view is how this behaviour relates to recidivism which can only be studied with longitudinal studies. Finally, the response modulation hypothesis (Newman, 1998) suggests that individuals with PP have a specific impairment in using peripheral information to control behaviour. Although not tested here, it would be of interest to test how these behavioural effects are affected by peripheral information.

In conclusion, the present study is the first to show impairments in avoidance of social threat cues in relation to specific aspects of psychopathy using a direct, objective measure. Violent offenders diagnosed with psychopathy showed significantly diminished avoidance of angry faces, which was in turn related to levels of instrumental aggression. The finding shows that alterations in motivational behaviour in PP are manifested on a

basic level of automatic action tendencies, which may in turn explain the persistence of PP and calls for interventions directed at training automatic actions tendencies.

Acknowledgements

The authors greatly acknowledge Frank Leonhard and Mike Rinck as authors of the AAT software.

Karin Roelofs is supported by the Netherlands Organization of Scientific Research (NWO), VIDI Grant no. 452-07-008.

Ellen de Bruijn is supported by the Netherlands Organisation for Scientific Research (NWO), VENI Grant no. 451-07-022.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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