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Self-reported trauma, cortisol levels, and aggression in psychopathic and non-psychopathic prison inmates

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Abstract

The relationship between self-reported traumatic childhood experiences, cortisol levels, aggression, and psychopathy was investigated in prison inmates ($n = 47$) and healthy controls ($n = 27$). Besides questionnaires, a brief salivary diurnal profile was measured. Results show that criminals (both psychopaths and non-psychopaths) demonstrate more traumatic childhood experiences than the control group. Within the group of criminals, psychopaths showed the lowest diurnal cortisol concentrations, whereas the non-psychopaths demonstrated highest daily average cortisol (DAC) scores. High levels of aggression were related to traumatic childhood experiences in non-psychopaths and control participants, but not in psychopaths. Although psychopathic offenders demonstrated low levels of cortisol, high levels of childhood traumatic experiences and high levels of aggression, cortisol was not a mediating factor between childhood traumatic experiences and aggression. Implications of the finding that psychopathic offenders displayed lower and non-psychopaths showed higher daily cortisol levels are discussed.

Keywords: Cortisol; Psychopathy; Self-reported trauma; Aggression

1. Introduction

Psychopathy is a clinical construct traditionally defined by a constellation of interpersonal, behavioural, and affective characteristics that are associated with a socially deviant lifestyle (Hare, 2003). These characteristics include irresponsibility, manipulation of others, impulsivity, sensation seeking (i.e., behavioural components), and a general poverty in major affective reactions, such as a lack of remorse, shame and empathy (Hare, 2003). Psychopathic personality has typically been operationalized using the psychopathy checklist-revised (PCL-R; Hare, 2003). Studies utilizing the PCL-R have focused on the original 2-factor model (Blair, 2005). The first factor comprises interpersonal and affective characteristics of psychopathy, which includes symptoms as shallow affect, lack of remorse or guilt and glibness/superficial charm (Cooke, 2001; Hare, 2003). The second impulsive, antisocial and unstable lifestyle factor comprises the social deviance characteristics such as, impulsivity, early behavioural problems, and parasitic lifestyle (Cooke, 2001; Hare, 2003). Another instrument measuring these psychopathic characteristics is the psychopathic personality inventory (PPI; Lilienfeld and Andrews, 1996) which determines psychopathic traits via self-report. This measurement is heavily grounded in the work of Cleckley (1941) and other early theorists, focusing on personality traits, attitudes, and dispositions, but unlike the PCL-R, does not assess explicitly antisocial behaviour (Patrick et al., 2006). Work by Benning et al. (2003), revealed that the subscales of the PPI come together around two factors. The first factor is termed the fearless dominance factor (Benning et al., 2005) and comprises the subscales social potency, fearlessness, and stress immunity. This factor is associated with a lack of social and physical anxiety. The second factor is termed impulsive antisociality, and is marked by the subscales carefree nonplanfullness, impulsive nonconformity, Machiavellian egocentricity, and blame externalization (Benning et al., 2005), and this factor is associated with a lack of impulse control, ruthlessness, and insouciant flaunting of social norms. These two PPI factors exhibit markedly different correlates. Indeed, Benning et al. (2003) found that the two factors (i.e., PPI-1 and PPI-2) were differentially associated with other concepts. For instance, PPI-1 was correlated with academic performance, socioeconomic status, and verbal intelligence, while PPI-2 was negatively associated with these variables. In

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line with this notion, research has demonstrated that psychopathic offenders who show low fearlessness (e.g., higher PPI-1 scores), display lower autonomic reactivity (Popma et al., 2006). Additionally, the PPI-1 factor has been negatively linked to levels of anxiety and depression (Benning et al., 2003; Uzieblo et al., 2007), indicating a relationship with low emotional reactivity (Herpertz et al., 2001). Since the stress hormone cortisol is related to anxiety responses (e.g., Buss et al., 2004; Kirschbaum and Hellhammer, 1989, 1994), one would expect lower levels of the stress hormone cortisol in those individuals being less fearful (e.g., high PPI-1 factor). However, studies regarding the relationship between cortisol levels and psychopathy are sparse. Moreover, there are only indirect studies showing that cortisol is related to psychopathic traits. For instance, in a study of Oosterlaan et al. (2005) low cortisol levels were associated with conduct disorder (CD). Research has demonstrated that CD problems are linked to the development of psychopathy (Christian et al., 1997), and refers to a pattern of antisocial behaviour in childhood or adolescence (McBurnett et al., 2000). In line with this, another study (Shoal et al., 2003) demonstrated that low levels of cortisol appeared predictive of clinically important personality factors. More specifically, the study demonstrated that in 314 boys aged 10–12, the personality factor of self-control accounted for a high percentage of the relation between cortisol and aggressive behaviour at age 15–17. Especially, impulsiveness, carelessness, and aggressive behaviour were associated with lower cortisol levels (e.g., McBurnett et al., 2000; Ramirez, 2003; Shoal et al., 2003). The study of Shoal et al. (2003) actually extends studies of McBurnett et al. (2000) by demonstrating that low cortisol is in fact predictive of aggressive behaviour 5 years later. Furthermore, CD has been linked to lower cortisol levels (Oosterlaan et al., 2005; Vanyukov et al., 1993).

However, results regarding the relationship between cortisol levels and aggression are mixed. Earlier studies suggested increased tryptophan and testosterone concentrations along with decreased cortisol concentrations in violent offenders compared to healthy controls (Virkkunen, 1985; Dabbs et al., 1991; Bergman and Brismar, 1994; Tiihonen et al., 2001). Moreover, Van Bokhoven et al. (2005) found higher cortisol levels in boys with CD than in those without CD. In addition, boys with an aggressive form of CD had higher cortisol levels than those who showed a covert form of CD. Accordingly, a study from Soderstrom et al. (2004) demonstrated that violent offenders demonstrated elevated cortisol levels compared to healthy controls. Although the mixed results, most recent studies all demonstrated that CD problems are negatively related to cortisol levels (e.g., Loney et al., 2006).

The mechanism linking aggression and low cortisol is still unclear. One might expect certain lifestyle correlates of antisocial families (e.g., maternal use of tobacco, abuse, or deprivation; Wakschlag et al., 1997; McGee and Williams, 1999) to be associated with dysregulation of children's HPA axis. Among many factors that contribute to individual differences in antisocial behaviour, stress-regulating mechanisms appear important (Vanyukov et al., 1993; Kerr et al., 1997; Mezzacappa et al., 1997; McBurnett et al., 2000). Animal models have shown that prenatal and early developmental stress can cause long-lasting or even permanent alteration of the hypothalamic-pituitary-adrenal (HPA) axis (Levine, 1994; Weinstock, 2005) by affecting steroid receptors residing in the hippocampus and frontal cortex (Meany et al., 1958). For example, in a study of Bosch et al. (2007), it was demonstrated that exposure to prenatal stress in rats, resulted in long-lasting behavioural and neuroendocrine alterations in the female offspring, which are manifested during the lactation period. Furthermore, the study implicates that alterations in the HPA axis reactivity are involved. The HPA axis is sensitive to physical and psychological stressors. Activity of the HPA axis can be measured using its end products, glucocorticoids. The primary glucocorticoid in humans is cortisol, which can be reliably measured via saliva sampling (Kirschbaum and Hellhammer, 1989,1994). Typically, activity of the HPA axis follows a circadian rhythm. In the morning, a rapid and acute increase in cortisol (i.e., the primary glucocorticoid secreted by the adrenal cortex) levels can generally be observed, with a peak occurring at about 30 min after awakening (Pruessner et al., 1997; Wüst et al., 2000). During the remainder of the day cortisol levels continually decrease. Lower levels of this stress hormone cortisol may occur when exposed to extreme stress and as a consequent a post-traumatic stress disorder (PTSD; APA, 1994) develops. Indeed, patients with PTSD have been found to have normal or reduced function of the HPA axis resulting in lower cortisol levels (Yehuda, 2002; McNally, 2003). In line with this notion, some studies reported significant associations between traumatic youth experiences and low salivary cortisol levels (e.g., Bugental et al., 2003). For instance, in a study of Weissbecker et al. (2006), patients with a history of trauma had markedly low levels of cortisol at the time of awakening. However, this study also reports elevated evening cortisol levels in emotionally abused women. These findings are partly consistent with studies in which cortisol is elevated in relation to stress through the day in abused women (e.g., Heim et al., 2003). Research regarding cortisol levels in Holocaust survivors with PTSD, has demonstrated that these subjects demonstrate lower mean 24-h urinary cortisol excretion than both Holocaust survivors without PTSD and controls not exposed to the Holocaust (e.g., Yehuda et al., 1995). In contrast, other studies demonstrated that traumatic experiences during youth were related to high salivary cortisol levels (e.g., Nicolson, 2004), leading to extreme sensitivity to stressors (Resnick et al., 1995). For instance, one study demonstrated elevations of 24-h urine cortisol excretion among victims of childhood sexual abuse (Lemieux and Coe, 1995).

In sum than, although there is evidence that cortisol levels in aggressive offenders are reduced (Virkkunen, 1985; Dabbs et al., 1991; Bergman and Brismar, 1994; Tiihonen et al., 2001), the direct relationship between cortisol and psychopathy has never been investigated. Since psychopathic traits can lead to severe forms of aggression (Frick and Morris, 2004; Poulin and Boivin, 2000; Kimonos et al., 2006), one would expect high levels of aggression to be related to lower cortisol levels in psychopathic offenders. Moreover, earlier research has demonstrated HPA axis dysregulations following exposure to

traumatic childhood experiences (e.g., Resnick et al., 1995; Bugental et al., 2003). Therefore, the current study investigated the idea that a history of traumatic childhood experiences may influence the HPA-axis functioning resulting in lower cortisol levels. Such reduced cortisol levels, in turn, would be related to higher levels of aggression (McBurnett et al., 2000; Oosterlaan et al., 2005). Given that higher levels of aggression may be related to higher levels of psychopathy (Poulin and Boivin, 2000; Kimonos et al., 2006), the central question in this study is whether cortisol levels mediate the relation between childhood traumatic experiences and aggression within those offenders who demonstrate high psychopathic characteristics.

2. Methods

2.1. Participants

A healthy control group ($n = 27$) and a group of prison inmates ($n = 47$) participated in this study. Since HPA axis functioning is influenced by menstrual cycle (e.g., Symonds et al., 2004), only men were included in this study. Controls were Maastricht University undergraduates who were recruited by means of flyers in which information regarding the study was given. After they had signed up for participation, they were contacted by the researchers for an appointment. Prison inmates were recruited by means of an information letter, by which they could sign in for participation. In the information letter it was emphasized that participation was voluntary. Before providing delinquents with an information letter regarding this study, some exclusion criteria were taken into account. Exclusion criteria for both delinquents as well as controls, were as follows: suffering from psychiatric disorders (as rated by a psychologist or psychiatrist); use of any kind of medication (indicated by the psychiatrist); a history of traumatic brain injury (personal file records); current drug and/or alcohol dependence. In the delinquent sample these criteria were considered by the psychologist, psychiatrist and file records. In the healthy control sample, these criteria were enquired using a standardized procedure. More specifically, participants were asked whether they had experienced any psychiatric illness during their life. Since none of the control participants reported experiencing psychiatric illness, all of these participants were included. Participants were all Caucasian, native Dutch speakers, had the Dutch nationality, and all gave written informed consent. As prison inmates were older than controls (means being 30.4 ± 9.72 and 24.9 ± 8.56 for prisoners and controls, respectively; $t(72) = 2.47$; $p < .01$), age differences were controlled for in all subsequent analyses.

Of the 47 prison inmates, 7 (15%) were convicted for murder or manslaughter, while 4 (9%) had committed a sexual offence. Three (6%) were convicted for bodily harm, 6 (13%) for arson, 8 (17%) for theft, and 19 (40%) for other crimes (i.e., fraud or robbery). Mean duration of imprisonment varied for all offenders. However, since all delinquents were already convicted and imprisoned for the crime committed at the time of this study, their mean length of time since incarceration always exceeded 3 months. Furthermore, of the 47 delinquents, 17 (36%) were first-time offenders, while the majority (30; 64%) were recidivists.

2.2. Instruments

2.2.1. Psychopathy

The psychopathic personality inventory (Lilienfeld and Andrews, 1996) was administered to all participants to determine whether they had low or high psychopathic traits. This 187-item instrument is a self-report measurement intended to measure psychopathic features. It was originally designed to measure the core personality features of psychopathy among non-criminal populations, but it turned out to be a good screening instrument among criminal populations as well (Jelicic et al., 2004). For each item, respondents rate themselves on a 4-point scale (1 = false, 2 = somewhat false, 3 = somewhat true, 4 = true). A total score can be obtained by summing across items. The PPI has eight subscales and three validity scales, of which scores can be calculated separately.

The first subscale is Machiavellian egocentricity. It consists of 30 items and assesses narcissistic and ruthless attitudes in interpersonal functioning. The second subscale of the PPI is the 24-item social potency scale. It measures the perceived ability to influence and manipulate others. Cold-heartedness is the PPI's third subscale and consists of 21 items measuring a propensity toward callousness, guiltlessness and unsentimentality. The fourth subscale is called carefree nonplanfullness, consisting of 20 items assessing an attitude of indifference in planning actions. The fifth subscale is fearlessness and consists of 19 items. It measures the level of absence of anticipatory anxiety concerning harm and a willingness to participate in risky activities. Alienation or blame externalization is subscale six and consists of 18 items measuring the tendency to blame others for one's problems and to rationalize one's misbehaviour. The seventh subscale of the PPI is called impulsive nonconformity and consists of 17 items. It measures a reckless lack of concern regarding social norms. Finally, the 11-item counting subscale stress immunity is the eighth subscale. It assesses the absence of marked reactions to anxiety-provoking events. Furthermore, the PPI consists of three validity scales: the deviant responding (DR) scale which measures malingering, the unlikely virtues (UV) scale measuring socially desirable impression management, and the variable response inconsistency (VRIN) scale, which measures inconsistencies in answers, such as careless responding (Lilienfeld and Andrews, 1996; Edens et al., 2001). Factor analysis of Benning et al. (2003) reveals that scores on the PPI are underpinned by two largely orthogonal factors. The first factor is called the fearless dominance factor and is associated with a lack of social and physical anxiety, and surgency in social interactions. The second factor is termed impulsive antisociality, which is associated with a lack of impulse control, ruthlessness, and an insouciant flaunting of social norms. Since research has demonstrated that childhood trauma history was unrelated to the interpersonal and affective factors (PCL-R-1; Poythress et al., 2006), this suggests that such trauma may not be relevant to all components of psychopathy. Besides the PPI subscale scores, this study therefore also describes PPI factor 1 and 2 scores.

Several studies have examined the psychometric properties of the PPI. For the PPI total score, internal consistency ranges from .90 to .93. For the PPI subscales internal consistency ranges from .70 to .89 (Lilienfeld and Andrews, 1996). The test–retest reliability of the PPI is high (.95) and test–retest reliability of the subscales ranges from .82 to .94 (Lilienfeld and Andrews, 1996). Scores on the PPI also correlate significantly with scores on Hare's psychopathy checklist revised ($r = .54$), the most commonly used instrument to determine psychopathy (Hare, 2003). Also, the PPI showed a positive correlation with the PCL-R factor 1; the core personality traits of personality (Poythress et al., 1998). Internal consistency in the current sample was excellent (Cronbach's alpha = .91) for the PPI total-score. For the subscales, Cronbach alpha's were good, ranging from .74 to .87. Internal consistency of the PPI factor 1 and 2 scores was very good (.91 and .88, respectively).

2.2.2. Traumatic experiences

Traumatic experiences were measured using the childhood trauma questionnaire (CTQ; Bernstein et al., 1994). This questionnaire consists of 25 items divided into five subscales regarding experiences during childhood. Some of the items are fairly specific (e.g., "*When I grew up, I got hit or beaten so badly that it was noticed by someone like a teacher, neighbor, or doctor*"), but it also includes broadly formulated items (e.g., "*When I grew up, someone molested me*"). Both categories of items are scored on frequency scales that range from "never true" to "very often true". According to the authors, the CTQ is a valid "screening instrument" to assess childhood trauma (Cronbach's alpha ranging from .84 to .95; Bernstein et al., 1994; Paivio and Cramer, 2004). Internal consistency of the CTQ within the healthy controls was good (Cronbach's alpha = .77), for the offender groups internal consistency was excellent (Cronbach'alpha = .93). Internal consistencies of CTQ subscales were adequately, ranging from .65 to .86.

2.2.3. Aggression

Buss and Perry (1992) developed a self-report questionnaire consisting of 29 items designed to measure several forms of aggression. More specifically, this aggression questionnaire (AVL) addresses: (a) physical aggression (e.g., "*When I get teased a lot, it might happen that I will hit someone*"), (b) verbal aggression (e.g., "*When people annoy me, I sometimes tell them what I think*"), (c) anger (e.g., "*I sometimes feel like a barrel ready to explode*"), (d) hostility (e.g.,

"*When someone acts really nice, I ask myself what he/she wants from me*"). Items are answered on a 5-point scale (anchors: 1 = totally disagree; 5 = totally agree). After recoding items with reversed scoring formats, a total score (Cronbach's alpha = .90) was obtained by summing across items. The total score varies from 29 to 145 (Meesters et al., 1996). It has been shown that this questionnaire is a reliable instrument of which the reliability coefficient (Cronbach's alpha) for the total and subscale scores ranged from .50 to .84 (Meesters et al., 1996). Internal consistency of the AVL within the healthy controls was good (Cronbach's alpha = .77), for the offender groups internal consistency was very good (Cronbach's alpha = .89).

2.3. Procedure

Daily patterns of cortisol can be obtained by measuring several cortisol samples during the day (e.g., Wolf et al., 2005). Saliva samples were taken four times a day to assess cortisol levels using Salivettes (Sarstedt®, Nümbrecht, Germany). The first sample was taken at 8.00 a.m. followed by additional samples at 11.00 a.m., 2.00 p.m., and 4.00 p.m. These time points were mainly geared to the regime of the prison inmates. After providing informed consent, control participants were provided with cortisol sampling devices and detailed instructions on how and when to collect all data. Instructions were that they had to chew four times on an absorbent cotton on 1 day. Regarding the time points of cortisol collection, instructions were the same as the prisoners (i.e., 8.00 a.m.; 11.00 a.m.; 2.00 p.m.; 4.00 p.m.). They were explained to chew for at least 45 s on every absorbent cotton, after which they had to store the sampling in the refrigerator until the next day when bringing it back to the university. Additionally, instructions included that they should not drink caffeine, smoke cigarettes or eat within an hour prior to the measures. More specifically, participants were asked to carefully follow the instructions in order for the researcher to reliable assesses levels of the stress hormone cortisol.

Samples had to be returned the day after they had collected the saliva samples. Upon return, participants were asked whether they had followed the instructions. All participants self-reportedly stated to have followed the instruction with the utmost care. After having collected all four samples, participants received a financial compensation (€ 10). Note that inmates' saliva sampling was closely monitored by the researchers. Samples were stored at −40 °C until all samples were collected, at which time they were centrifuged and assayed using radioimmunoassay (RIA; University of Liège, Belgium).[1]

2.4. Statistical analyses

Demographic variables (age, education) were analyzed using independent samples *t*-tests. Scores on the PPI, CTQ, and AVL were analyzed using a one-way analysis of variance with age as covariate (ANCOVA), and with group (healthy controls vs. non-psychopathic offenders vs. psychopathic offenders) as between-subject factor. Since the total CTQ scores were skewed to the right, we normalized these scores using log transformation. Total PPI and AVL scores demonstrated a normal distribution. Traumatic experiences subscale scores were analyzed using a multiple analysis of variance controlling for age (MANCOVA). Cortisol levels were log transformed in order to normalize the distribution. In order to examine the influence of psychopathic characteristics on diurnal cortisol concentrations, we performed a repeated analysis of variance controlling for age (ANCOVA) with cortisol samples (8 a.m. vs. 11 a.m. vs. 2 p.m. vs. 4 p.m.) as within subject factor and group (healthy controls vs. non-psychopathic offenders vs. psychopathic offenders) as between-subject factor.

Regarding the mean cortisol levels, univariate ANOVAs were used all controlling for age, to test group differences in the cortisol area under the curve (AUC; see Pruessner et al., 1997,2003), with AUC as dependent variable and group (healthy controls vs. non-psychopathic offenders vs. psychopathic offenders) as independent variable. Following Sephton et al. (2000) and Weissbecker et al. (2006), we quantified the diurnal cortisol slope (β) by estimating how each participant fit the normal descending profile. To this end, a series of multiple regressions with cortisol values regressed upon the time of collection (i.e., cortisol sample) individually for each participant. Larger β values represent flatter slopes and, thus, slower declines in cortisol. Steeper slopes (smaller β 's), on the other hand, indicate that cortisol decreases more rapidly. Finally, we computed daily average cortisol (DAC; Gunnar et al., 2001; Nicolson, 2004) by first standardizing cortisol measures over all participants at each sampling time and then averaging these *Z*-scores for each participant. Significant interactions were further inspected using Bonferroni-corrected post-hoc comparison tests. In all cases where differences reached significance, effect sizes (Cohen's *d*) are reported.

In order to investigate whether certain variables were interrelated, a Pearson correlation analysis was conducted. To investigate whether the obtained correlations were different amongst the three groups, we completed a linear regression with aggression scores as dependent variable, group as independent variable, and trauma × group as interaction factor. To examine whether cortisol mediates the relation between childhood traumatic experiences and aggression within those offenders who demonstrate high psychopathic characteristics, we conducted a linear regression analysis.

By analyzing the relationship from traumatic childhood experiences to cortisol, and from cortisol to aggression in all three groups (psychopathic offenders, non-psychopathic offenders and healthy controls) β's and standard errors were calculated. In determining whether lower levels of daily cortisol secretion was a mediating variable between high levels of traumatic childhood experiences and high levels of aggression within psychopathic offenders, the β's and standard errors form the regression analysis were used to perform a Sobel test.

2.5. Ethics

The Ethical Committee of the Faculty of Psychology, Maastricht University approved this study. Participants were recruited by means of an information letter, by which they could sign in for participation. After they had signed up for participation, they were contacted by the researchers for an appointment. In the information letter it was emphasized that participation was voluntary and that they were free to discontinue their participation at any given time. Before starting the study, all participants gave written informed consent.

3. Results

3.1. Psychopathy

According to the PPI median (405), the prison inmates were divided into the group of psychopathic ($n = 24$) and non-psychopathic ($n = 23$) offenders. Both psychopathic and non-psychopathic offenders showed higher PPI-2 than PPI-1 scores. For the psychopathic offenders mean PPI-1 and PPI-2 scores were 162.17 (18.72) and 219.38 (23.64), respectively. For the non-psychopathic offenders mean PPI-1 and PPI-2 scores were 126.43 (18.40) and 180.43 (22.06), respectively. As expected, mean PPI-1 scores of the psychopathic offenders were significantly higher than the mean PPI-1 scores of the non-psychopathic offenders ($t(45) = 6.60$; $p < .001$). Accordingly, mean PPI-2 scores of the psychopathic offenders were also significantly higher than the mean PPI-2 scores of the non-psychopathic offenders ($t(45) = 5.83$; $p < .001$). Analysis indicated that the relationship between PPI-1 and PPI-2 was strong and significant ($r = .42$; $p < .001$).

3.2. Childhood trauma

Since traumatic childhood scores (i.e., CTQ) were skewed to the right, total CTQ scores as well as CTQ subscale scores were normalized using log transformation. A one-way ANCOVA

[1] See acknowledgement.

Table 1
Original mean (S.D.'s) CTQ (childhood trauma questionnaire) and AVL (aggressive questionnaire) scores of controls ($n = 27$), non-psychopathic ($n = 24$), and psychopathic ($n = 23$) criminals

	Controls	Non-psychopaths	Psychopaths
Childhood trauma*	34.04 (5.99)	59.91 (24.55)	51.63 (17.29)
Aggression*	71.74 (12.39)	85.52 (17.56)	100.75 (18.56)

* $p < .001$, two-tailed.

Table 2
Log transformed mean CTQ (chilhood trauma questionnaire) subscale scores and there differences as measured by a MANCOVA of controls ($n = 27$), non-psychopathic ($n = 24$), and psychopathic ($n = 23$) criminals

	Controls	Non-psychopaths	Psychopaths	*F*-values
Emotional abuse	1.97 (.27)	2.36 (.52)	2.37 (.47)	6.07**
Sexual abuse	1.63 (.06)	2.08 (.55)	1.90 (.42)	5.26*
Physical abuse	1.69 (.23)	2.27 (.64)	2.20 (.56)	8.67**
Emotional neglect	2.21 (.33)	2.73 (.35)	2.55 (.43)	9.06**
Physical neglect	1.80 (.22)	2.27 (.44)	2.00 (.31)	7.79**

* $p < .05$ two-tailed.
** $p < .001$ two-tailed.

with age as covariate showed that there was a significant difference between the three groups (i.e., controls, psychopathic and non-psychopathic participants) regarding their traumatic childhood experiences $F(2, 70) = 13.48$; $p < .001$. Follow-up *t*-tests demonstrated that the non-psychopathic as well as psychopathic criminals reported significantly more traumatic childhood experiences than the control group $t(48) = 5.56$; $p < .001$ and ($t(49) = 5.74$; $p < .001$, respectively), whereas the non-psychopathic criminals did not differ from the psychopathic criminals, $t(45) = 1.03$; $p > .05$. Differences between non-psychopathic and psychopathic offenders versus the healthy controls were large ($d = 1.45$ and 1.36, respectively). Original mean scores per group can be seen in Table 1. Table 2 provides an overview of all log transformed subscale means of the CTQ for each group. A MANCOVA revealed a significant effect on all five CTQ subscale scores for group (see Table 2). Follow-up *t*-tests demonstrated that differences between controls and non-psychopathic offenders were significant for all CTQ subscale scores (all t's > 3.34, all p's $< .05$, all d's $> .94$) as were differences between controls and psychopathic offenders (all t's > 2.73, all p's $< .05$, all d's $> .74$). However, there were no differences for CTQ subscale scores (Bonferroni-corrected p's $> .05$) between non-psychopathic and psychopathic offenders, except for the physical neglect subscale, which reached significance ($t(45) = 2.36$; $p < .05$, $d = .71$). Note that original CTQ total mean scores of 59.9 and 51.6 of the non-psychopathic and psychopathic offenders, respectively, were somewhat elevated as compared to, for example, the data reported for a large sample of young adults ($N = 109$) by Merckelbach et al. (2002). Differences between the sample of Merckelbach et al. (2002) and our offenders were significant [$t(130) = 4.04$; $p < .001$] for the psychopathic group and [$t(131) = 4.57$; $p < .001$] for the non-psychopathic offenders. In terms effect sizes, these differences were large ($d = 1.12$ and 1.28, respectively). Differences between Merckelbach's sample (Merckelbach et al., 2002) and our controls were nonsignificant [$t(134) = 1.80$; $p > .05$].

3.3. Cortisol

With regard to normal diurnal pattern of cortisol, repeated measures ANCOVA showed the expected significant main effect of time, $F(3, 204) = 6.50$; $p < .001$ controlled for age. As Fig. 1 demonstrates, cortisol levels over the four different time measurements showed a similar pattern for all three groups (i.e., higher levels in the morning and a decline during the day). Although there was no interaction effect of group by time ($F(6, 204) = 1.00$; $p > .05$), the group effect was significant, $F(2, 68) = 3.16$; $p < .05$. This effect was brought about by the psychopathic group who had lower cortisol levels throughout

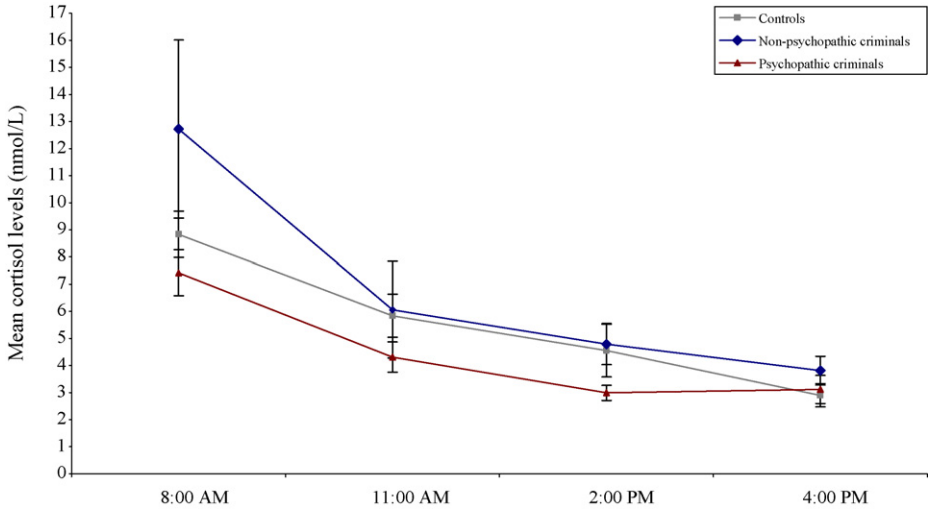

Fig. 1. Levels of cortisol at four times during the day for controls ($n = 27$), non-psychopathic criminals ($n = 23$), and psychopathic criminals ($n = 24$). Error bars represent standard error of mean.

the day than the non-psychopathic group ($t(42) = 2.46$; $p < .05$). More specifically, this differences was due to time 1 ($t(45) = 1.28$; $p < .05$, $d = .70$) and time 3 ($t(45) = 2.09$; $p < .05$, $d = .62$). Controls did not differ from the non-psychopathic and psychopathic group (see Fig. 1). Furthermore, an ANCOVA controlling for age showed a significant difference between groups in DAC scores [$F(3, 70) = 3.77$; $p < .05$]. Follow-up t-tests using Bonferonni correction, demonstrated that this differences was mainly due to non-psychopathic offenders showing higher DAC scores than healthy controls ($t(47) = 2.53$; $p < .05$, $d = .74$). While the differences between healthy controls and psychopathic offenders was nonsignificant ($t(48) = .29$; $p > .05$), and between non-psychopathic and psychopathic offenders reached borderline significance ($t(44) = 2.28$; $p = .08$, $d = .69$). However, no group difference were found with respect to the AUCg [$F(3, 70) = 1.59$; $p > .05$]. Likewise, analysis of the diurnal cortisol slopes (β's), showed no significant differences between the groups [$F(3, 70) = 1.04$; $p > .05$].

3.4. Aggression

As to the mean score on the aggression questionnaire (AVL; see Table 1), direct comparisons are difficult because normative scores for this Dutch version are yet to be reported in the literature. Note, however, that aggression scores of the offenders (both psychopathic as well as non-psychopathic) in this study were high as compared to, for example, the data reported for a large sample ($N = 244$) by Meesters et al. (1996). Differences between the sample of Meesters et al. (1996) and our psychopathic and non-psychopathic offenders was significant [$t(265) = 7.46$; $p < .001$; $t(266) = 4.70$; $p < .001$, respectively]. In terms of effect size, these differences were large for both the non-psychopathic offenders ($d = .91$) as well as for the psychopathic offenders (d = 1.80). In contrast, the control group scored within the normal range. Differences between the sample of Meesters et al. (1996) and our controls were nonsignificant [$t(269) = .23$; $p > .05$]. A one-way ANCOVA controlling for age demonstrated a significant between group difference $F(2, 70) = 19.13$; $p < .001$. Follow-up t-tests demonstrated that psychopathic criminals scored higher on aggression than non-psychopathic criminals, $t(45) = 2.87$; $p < .001$ ($d = .84$), as well as the controls $t(49) = 6.63$; $p < .001$. In terms of effect size, this difference was large: $d = 1.84$. Non-psychopathic criminals had higher aggression scores than did controls, $t(48) = 3.22$; $p < .001$ ($d = .91$; see Table 1 for mean AVL scores for each group).

3.5. Childhood trauma and psychopathy

To explore whether the different variables were related in a meaningful way, a set of Pearson product–moment correlations were performed. Table 3 demonstrates the most important relationships. This analysis showed that regarding the traumatic childhood experiences (i.e., CTQ total and subscale scores) correlational analysis with psychopathy (i.e., PPI total score) was nonsignificant (all r's $< .21$; all p's $> .05$). However, within the non-psychopathic offenders traumatic childhood experiences was related to PPI-2 factor scores ($r = .45$; $p < .05$). As can be seen in Table 3, some of the PPI subscale scores were significantly related to certain CTQ subscale scores within the offenders.

3.6. Childhood trauma and cortisol

Regarding the association between traumatic childhood experiences and daily cortisol secretion (i.e., DAC, AUCg, and β's) parameters, all were nonsignificant (all r's $< .24$; all p's $> .05$). However, within the psychopathic offenders only, there was a significant relationship between DAC and physical abuse ($r = .46$; $p < .05$), AUCg and emotional neglect ($r = -.53$; $p < .001$), and ß and physical neglect ($r = .40$; $p < .05$).

Table 3
Correlational analysis between psychopathy (PPI subscale scores) and traumatic childhood experiences (CTQ- total and -subscale scores) in non-psychopathic ($n = 24$), and psychopathic ($n = 23$) criminals

	PPI-1	PPI-2	PPI-cold-heartedness	PPI-impulsive nonplan	PPI-external blame	PPI-stress immunity
Non-psychopathic offenders ($n = 24$)						
CTQ total	−.08	.45*	−.33	.41*	.52*	−.40*
Emotional abuse	−.15	.41*	−.22	.53*	.43*	−.18
Sexual abuse	.09	.44*	−.22	.53*	.43*	−.18
Physical abuse	.05	.37*	−.37*	.50*	.39*	−.31
Emotional neglect	−.21	.14	−.14	−.03	.36*	−.37*
Physical neglect	−.17	.60*	−.28	.44*	.54*	−.50*
Psychopathic offenders ($n = 23$)						
CTQtotal	−.02	.20	−.16	.36*	.17	−.26
Emotional abuse	−.06	.08	−.05	.11	.32	−.14
Sexual abuse	−.35*	−.03	−.07	.07	.21	−.40*
Physical abuse	.12	.20	−.05	.28	.03	−.19
Physical neglect	−.07	.45*	−.20	.45*	.21	−.30

Note that only those subscales demonstrating significant correlations are indicated in this table.
* $p < .05$ two-tailed.

Table 4
β's and standard errors of regression analysis within the different groups $N = 74$

	Controls ($n = 27$)	Non-psychopaths ($n = 23$)	Psychopaths ($n = 24$)
a	β's = −.13; S.E. = .61	β's = −53.95; S.E. = 147.43	β's = .22; S.E. = .25
b	β's = −7.44; S.E. = 23.49	β's = 6.01; S.E. = 26.99	β's = −1.31; S.E. = 9.26
c	β's = −.08; S.E. = .33	β's = .04; S.E. = .16	β's = .25; S.E. = .33
d	β's = −3.21; S.E. = 4.0	β's = −.01; S.E. = .01	β's = 6.00; S.E. = 11.35
e	β's = −.09; S.E. = .10	β's = −.01; S.E. = .06	β's = .05; S.E. = .31
f	β's = 4.30; S.E. = 7.54	β's = −4.20; S.E. = 10.15	β's = −.27; S.E. = 8.79

a = relation traumatic childhood with diurnal cortisol secretion (DAC); b = relation traumatic childhood with diurnal cortisol secretion (AUCg); c = relation traumatic childhood with steepness of slope (β); d = relation diurnal cortisol secretion (DAC) with aggression; e = relation diurnal cortisol secretion (AUCg) with aggression; f = relation steepness of slope (β) with aggression.

3.7. Psychopathy and cortisol

Within the non-psychopathic offenders, there was no relationship with daily cortisol secretion (all r's $< .28$; all p's $> .05$). However, within the psychopathic offenders there was a significant relationship between PPI total scores and DAC ($r = .57$; $p < .001$), with PPI-1 and DAC ($r = .46$; $p < .05$), and with PPI-1 and AUCg ($r = .46$; $p < .05$).

3.8. Agggression and cortisol

Correlations between AVL scores and daily cortisol secretion (i.e., DAC, AUCg, and β's) parameters, were all nonsignificant (all r's $< -.23$; all p's $> .05$).

3.9. Psychopathy and aggression

Psychopathy was significantly related with aggression ($r = .47$; $p < .001$), especially the PPI-2 factor score ($r = .72$; $p < .01$). Further analysis of the PPI subscales demonstrated that aggression was related to the Machiavellian egocentricity subscale ($r = .54$; $p < .01$), fearlessness subscale ($r = .47$; $p < .01$), impulsive nonplanfullness ($r = .57$; $p < .01$), external blame attribution ($r = .56$; $p < .01$), and negatively with stress immunity ($r = -.36$; $p < .01$).

3.10. Childhood trauma and aggression

Another important correlation was the one between traumatic childhood experiences and aggression for the total sample ($r = .49$; $p < .001$). It was investigated whether this was true for all groups. Further analysis demonstrated that this association was due to the non-psychopathic criminals ($r = .61$; $p < .001$) and control participants ($r = .53$; $p < .001$). Within the psychopathic offenders, the relationship between aggression and trauma was nonsignificant ($r = .03$; $p > .05$). To investigate whether this correlation was significantly lower than both the one reported within the non-psychopathic delinquents, and the healthy controls, linear regression was performed, with aggression as dependent variable, group (healthy controls versus offenders) and trauma as the independent variable and trauma × group as interaction factor. Results of the linear regression showed that there were no significant differences between the correlations regarding the healthy controls versus the psychopathic offenders [$t(48) = 1.85$; $p > .05$], while the correlation for the psychopathic offenders was significantly lower than those of the non-psychopathic offenders [$t(45) = 2.17$; $p < .05$]. In comparing the correlations of the non-psychopathic offenders with the healthy controls, difference did not reach significance [$t(49) = 0.40$; $p > .05$]. Aggression was positively related to all CTQ subscales (all r's $> .29$; all p's $< .05$).

3.11. Cortisol as mediating variable

To find support for the idea that cortisol levels mediates the relation between childhood traumatic experiences and aggression within those offenders who demonstrate high psychopathic characteristics, a linear regression analysis was performed. By analyzing the relationship from traumatic childhood experiences to diurnal cortisol secretion (i.e., DAC, AUCg, β's), and from diurnal cortisol secretion to aggression in all three groups (psychopathic offenders, non-psychopathic offenders and healthy controls) β's and standard errors were calculated (see Table 4). Within the psychopathic offenders, diurnal cortisol levels did not mediate between high levels of traumatic childhood experiences and high levels of aggression (Sobel test (DAC) = .045; $p > .05$; Sobel test (AUCg) = −.11; $p > .05$; Sobel test (β) = −.03; $p > .05$). In the non-psychopathic as well as the healthy controls, diurnal cortisol secretion was also not a significant mediating variable (all Sobel tests $> -.13$; all p's $> .05$).

4. Discussion

In line with earlier research (Dodge et al., 1990), our results show that prison inmates report higher levels of traumatic youth experiences than controls. More specifically, in all offenders, traumatic childhood experiences were positively related to impulsive nonplanfullness and external blame attribution on the PPI, while there was a negative association between traumatic childhood experiences and cold-heartedness, and stress immunity. As Table 3 demonstrates, certain CTQ subscales were related to certain PPI subscales.

Within the non-psychopathic offenders, those offenders who reported traumatic childhood experiences demonstrated high PPI impulsive antisociality (i.e., PPI-2 factor score), high impulsive nonplanfullness, high external blame attribution and

low stress immunity scores. In contrast to the non-psychopathic offenders with high sexual abuse scores, the psychopathic offenders who reported high sexual abuse demonstrated low stress immunity and low fearless dominance as measured with the PPI-1 factor score. Consequently, as to the relationship between psychopathy and traumatic childhood experiences, and in line with earlier research (e.g., Poythress et al., 2006), psychopathy was not directly related to traumatic childhood experiences. However, as was the case in the study of Poythress et al. (2006), the present study demonstrates that certain traumatic childhood experiences seem to be related to certain facets of psychopathy especially PPI-2 factor score (i.e., impulsive antisociality), impulsive nonplanfullness, external blame attribution, and low stress immunity.

Much of the research on psychopathy has treated psychopathy as a unitary construct. More recently, studies have suggested the existence of two distinct facets of psychopathy with unique external correlates (e.g., Patrick et al., 2006). In the current study, both factors were significantly interrelated. Our results indicate that the fearless dominance PPI-1 factor is negatively related to physical neglect, and positively to daily cortisol secretion, while the impulsive antisociality PPI-2 factor is associated with high levels of aggression, but not with childhood trauma experiences. This lack of a relationship between PPI-2 and childhood trauma experiences was mainly carried by the psychopathic offenders. In contrast, within the non-psychopathic offenders, impulsive antisociality (i.e., PPI-2) was significantly related to childhood trauma experiences, a finding which is in line with earlier research of Poythress et al. (2006), who reported that only the antisocial factor of the PCL-R was related to self-reported childhood trauma history. Moreover, in line with previous studies (McBurnett et al., 2000; Bugental et al., 2003; Ramirez, 2003) and in agreement with our expectations, psychopaths demonstrated high traumatic childhood experiences. However, this was also the case in the non-psychopathic offenders. It is often believed that malevolent behaviour (e.g., psychopathy) can have a psychological cause. For instance, Karpman (1941, 1955), attributed psychopathic features to unresolved conflicts (e.g., neuroses) arising from environmental factors, including parental rejection or harsh punishment. Lykken (1995) also noted the potential for environmental factors, including poor or ineffective parenting, to produce a person who appears psychopathic. Similarly, Porter (1996) postulated a specific subtype of psychopathy whose symptoms result from early abuse or abandonment. More recent research demonstrated that psychopathy might also be related to brain dysfunction (e.g., Williamson et al., 1991; Intrator et al., 1997; Raine et al., 1998, 2000, 2003, 2004; Birbaumer et al., 2005; Kiehl, 2006), which might indirectly support our findings of a lacking relationship between psychopathy and childhood trauma history. Nonetheless, psychological trauma could also act via various biopsychological routes, even brain dysfunction (e.g., Penza et al., 2001). It would be interesting to investigate whether in offenders a relationship between childhood trauma and psychopathic behaviour is mediated by brain dysfunction. Future research is needed to clarify this issue.

As expected and in agreement with research concerning the relationship between cortisol and aggression (e.g., McBurnett et al., 2000; Ramirez, 2003; Oosterlaan et al., 2005), psychopathic criminals showed lower diurnal patterns of cortisol than the non-psychopathic group during the day. This was not due to a systematic group by awakening time effect, since the diurnal pattern of cortisol was significantly lower at both T1 as well as at T3. However, daily cortisol secretion (i.e., DAC), was significantly higher in the non-psychopathic offender group. The overall cortisol results of the current study therefore seem to point to hyperarousal in non-psychopathic offenders instead of hypoarousal in psychopathic offenders. This finding is in line with the notion that non-psychopathic offenders are more reactive, emotional delinquents, while psychopathic offenders are more instrumental, cold-blooded delinquents (e.g., Porter et al., 2003; Woodworth and Porter, 2002). It would be an interesting question for future research to examine differences between reactive and proactive offenders regarding their hormonal secretion and how psychopathy is related to these different constructs. Interestingly, and in contrast to results of Benning et al. (2003), PPI-1 factor was related to daily average stress hormone cortisol, indicating a relationship between lack of fear (i.e., high PPI-1 factor) and high daily cortisol levels. This is in contrast to what we would expect (see for instance Popma et al., 2006), but may again stress the importance of distinguishing between instrumental, cold-blooded delinquents and reactive, emotional delinquents.

In keeping with earlier research (Pruessner et al., 1997; Wüst et al., 2000), cortisol levels showed a typical diurnal pattern for all three groups, with higher levels in the morning and declining levels later on. This pattern of decrease in diurnal variation regarding cortisol levels, is in contrast with research of Brewer-Smyth et al. (2004). However, the current study reported cortisol levels in males only, while Brewer-Smyth et al.'s study was conducted among female prison inmates.

In line with a study by Poulin and Bouvin (2000; see also Kimonos et al., 2006), levels of aggression were higher in psychopathic criminals than in non-psychopathic criminals and controls. Along the lines of research by Benning et al. (2003) and Patrick et al. (2006), PPI-2 (i.e., impulsive antisociality) was related to higher levels of aggression. Furthermore, within the offenders group external blame attribution and low stress immunity were related to high aggression scores. Only in the psychopathic offenders was aggression associated with cold-heartedness and Machiavellian egocentricity. These are both subscales measuring callousness, guiltlessness, unsentimentally, narcissistic, and ruthless attitudes in interpersonal functioning. Thus, these findings are reminiscent of a study by Raine et al. (1998), who found that aggression in psychopaths is more predatory and instrumental in nature.

Psychopathy was significantly related with aggression, especially the PPI-2 factor score. This finding supports the idea that behavioural features of the psychopath (impulsiveness, antisocial lifestyle) are really a proxy of antisocial/aggressive behaviour. In the non-psychopathic offenders, aggression was related to low social potency (i.e., perceived ability to influence

and manipulate others), high fearlessness (i.e., level of absence of anticipatory anxiety concerning harm and a willingness to participate in risky activities), and impulsive nonplanfullness (i.e., an attitude of indifference in planning actions), a finding that is in line with studies showing that aggression in non-psychopathic offenders is more impulsive and reactive (Raine et al., 1998). As stated before, it should be interestingly to examine whether the relationship between psychopathy and aggression is different for certain forms of aggression (e.g., proactive and reactive aggression). This matter is discussed in more details below.

Although all variables (i.e., elevated childhood trauma experiences, low diurnal pattern of cortisol, and high levels of aggression) were highly present in psychopathic offenders and in contrast to previous research (e.g., McBurnett et al., 2000; Bugental et al., 2003; McNally, 2003; Ramirez, 2003) the current data did not support the notion that cortisol may be represent a mediating factor between these concepts. However, in line with research of, for instance, Van Bokhoven et al. (2005) and Soderstrom et al. (2004), non-psychopathic offenders demonstrated higher daily cortisol secretion and more aggression (Benning et al., 2003; Patrick et al., 2006). In addition, since the results indicated a relationship between traumatic childhood experiences and aggression in these type of offenders, and in contrast to McBurnett et al. (2000), this supports the notion that traumatic childhood experiences may lead to an aggressive personality and this does not seem to be related to psychopathy.

Several methodological limitations should be mentioned here. First, since our healthy control group consisted of students who were significantly younger than the criminal group, the groups were not fully comparable with regard to their socio-economic status and education. However, we used the non-psychopathic offenders as matched controls for the psychopathic offenders. Furthermore, we decided to include a student sample to investigate cortisol levels in healthy controls. Future research could profit from also including non-student matched controls, thereby reducing the change that there will be an age-difference between the groups. Secondly, our sample was relatively small and consisted purely of men. Although inmates' cortisol sampling was controlled for time of day and done under supervision, the control group were not supervised which may have lead to unreliable saliva concentrations. In line with this, some studies have reported that a significant number of subjects did not obtain saliva samples reliably in an ambulatory setting (e.g., Broderick et al., 2004; Kudielka et al., 2003). However, all controls self-reportedly stated to have complied with the cortisol sampling procedures and their claims seem candid given their typical cortisol profiles. For future research, one should use electronic monitoring devices or other suitable methods as has been recommended by Broderick et al. (2004) and Kudielka et al. (2003). Thirdly, since we were mainly interested in average daily cortisol levels, this study did not measure the cortisol awakening response (CAR). Yet, the CAR has been recognized over recent years as a distinct phenomenon in the diurnal profile of cortisol output that is of considerable psychoneuroendocrinological significance (Wust et al., 2000; Clow et al., 2004). The first cortisol sampling was at 8.00 a.m.. Because we had no control over participants' awakening time, awakening may have occurred less than 1 h before 8.00 a.m. in some participants, which might have caused T1 to be somewhat inflated by the CAR. Moreover, to reliable assess CAR, three or four cortisol samples are needed within 1 h of awakening (Williams et al., 2005), preferably over multiple days (Kunz-Ebrecht et al., 2004). As the CAR is a significant part of HPA axis activity, future studies of the relationship between cortisol and aggression or psychopathy should therefore include CAR. Fourthly, although we asked participants to restrict their use of cigarettes and not to smoke 1 h before cortisol sampling, results might have been influenced by participants' smoking status. Indeed, Badrick et al. (2007) recently stated that smoking is significantly associated with increased salivary cortisol release throughout the day. However, this was predominantly present for the cortisol awakening response, which was not measured in the current study. Moreover, since all prisoners were smokers, one would have expected cortisol levels to be increased in the prisoners' sample. The finding that psychopathic offenders demonstrated lower cortisol levels than controls, argues against this explanation. More importantly, Badrick et al. (2007) concluded that smoking has a short-term effect on the neuroendocrine system. Since participants were asked not to smoke within 1 h before cortisol sampling, and the offenders were all smokers, the association between smoking and cortisol might be neglectable. Fifthly, research has recently demonstrated that aggression can often be divided into reactive and/or proactive aggression (Raine et al., 2006). For instance, impulsive offenders are assumed to use more reactive aggression, while the more predatory offenders are thought to demonstrate mainly instrumental, proactive aggression. In the current study we did not look into these different forms of aggression and their relationship with psychopathy. Future research regarding psychopathic offenders and aggression should take these different classifications into account. Sixth, cortisol values in the diurnal profile represent a basal measure of HPA axis regulation. This does not allow interference to HPA axis responses to stimulation. A recent study of Popma et al. (2006), demonstrated that delinquent adolescents with disruptive behaviour disorder, showed a pattern of low autonomic arousal (i.e., low cortisol and HR responsivity) during stress (i.e., public speaking task). However, reactive measures were not assessed in the current study, but might be of importance in future research. For instance, regarding the relationship of cortisol with lack of fear or increased aggression in psychopathic and non-psychopathic offenders, future research should include reactivity of the HPA axis.

Finally, one could question whether self-reported psychopathic traits, traumatic childhood experiences and aggression are sufficiently valid to rule out any relationship between these various measurements. Since one of the core characteristics of psychopathy consist of pathological lying and the manipulation of others (Hare et al., 1991), there is an intuitive basis for the assumption that psychopaths are better deceivers (Poythress et al., 2001). Given the characteristics of the psychopath (e.g.,

manipulation, superficial charm, deceiving; Hare et al., 1991) one might expect these participants to cheat on self-report measurements. However, the relationship between psychopathic personality and deceptive behaviour (e.g., malingering, dissimulation) as reported in the literature is controversial. For instance, some researchers have argued that there is a psychopathy-malingering link, indicating that psychopaths are successful malingerers (e.g., Gacono et al., 1995; Cima et al., 2007). In the study of Gacono et al. (1995), psychopathic offenders demonstrated higher malingering scores. However, other studies failed to support a psychopathy-malingering link (e.g., Poythress et al., 2001). In order to deal with this issue, a longitudinal design in which traumatized children are followed over several years to investigate whether they will develop lower cortisol levels and consequently become more aggressive and/or show more psychopathic behaviour, seems warranted. Clearly, this issue deserves further investigation.

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