Psychopathy and developmental instability

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Abstract

Psychopaths are manipulative, impulsive, and callous individuals with long histories of antisocial behavior. Two models have guided the study of psychopathy. One suggests that psychopathy is a psychopathology, i.e., the outcome of defective or perturbed development. A second suggests that psychopathy is a life-history strategy of social defection and aggression that was reproductively viable in the environment of evolutionary adaptedness (EEA). These two models make different predictions with regard to the presence of signs of perturbations or instability in the development of psychopaths. In Study 1, we obtained data on prenatal, perinatal, and neonatal signs of developmental perturbations from the clinical files of 643 nonpsychopathic and 157 psychopathic male offenders. In Study 2, we measured fluctuating asymmetry (FA, a concurrent sign of past developmental perturbations) in 15 psychopathic male offenders, 25 nonpsychopathic male offenders, and 31 male nonoffenders. Psychopathic offenders scored lower than nonpsychopathic offenders on obstetrical problems and FA; both psychopathic and nonpsychopathic offenders scored higher than nonoffenders on FA. The five offenders from Study 2 meeting the most stringent criteria for psychopathy were similar to nonoffenders with regard to FA and had the lowest asymmetry scores among offenders. These results provide no support for psychopathological models of psychopathy and partial support for life-history strategy models. © 2001 Elsevier Science Inc. All rights reserved.

Keywords: Psychopathy; Developmental instability; Fluctuating asymmetry; Obstetrical problems; Adaptation

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1. Introduction

Psychopaths are deceitful, selfish, manipulative, irresponsible, impulsive, and aggressive individuals who have no concern for the welfare of others and who experience little remorse or guilt as a result of their injurious and antisocial behavior (Gacono, 2000; Hare, 1991). Psychopaths are mostly male and are quite rare (estimated as less than 1% in the general population). Approximately 11% of the forensic psychiatric population and 23% of the correctional population are psychopaths (Hare, 1991). The following abbreviated case history shows many features of psychopathy as currently defined in the clinical literature. Some details have been modified to protect anonymity:

> Since kindergarten, Frank was a problem. He bullied smaller pupils, disobeyed school rules, and was often truant. He quit school during the 11th grade, then traveled the continent using money he borrowed from friends (but never repaid). He also had many short-term jobs, fraudulently collected welfare, and dealt drugs. He had many heterosexual relationships, fathering at least one child by the time he was 16. He was first incarcerated at 15 for stealing a car, and by 18, he had a criminal record that included violent offenses, theft and possession of stolen goods, and drug trafficking. When he was 19, Frank was arrested for the brutal rape of an acquaintance. The victim barely survived severe internal injuries, but Frank always maintained that the sex was mutually consenting. He was found not guilty by reason of insanity. After many years in a maximum security institution, Frank was transferred to a less secure hospital. While there, he persuaded a nurse that he was innocent and misunderstood. Believing Frank was in love with her, she helped him escape by unlocking the door and hiding him in the trunk of her car. Frank stayed the weekend with her, then left while she was out buying groceries; she never heard from him again. After being apprehended, Frank was returned to the maximum security facility but, within a few years, he was again transferred to a less secure hospital. During his stay there, he sexually assaulted three fellow female patients and a staff member. While on a pass, he viciously raped a young woman in the local community. Again, he was returned to maximum security. Since then he has written a two-volume autobiography featuring a portrait of himself on the cover. He reads all of our published research from which he tries to use out-of-context quotations to convince the Review Board to release him again. Recently, a nurse on his unit lost her job after Frank convinced her to smuggle testosterone tablets to him.

Offenders scoring high on measures of psychopathy have extensive and versatile criminal histories (Hare, Forth, & Strachan, 1992; Hare & Jutai, 1983; Hare & McPherson, 1984a; Hare, McPherson, & Forth, 1988) and are more likely than low-scoring offenders to commit crimes upon release or discharge (Harris, Rice, & Cormier, 1991a; Serin, 1991, 1996; Serin, Peters, & Barbaree, 1990). As well, the crimes committed by psychopaths are different from those committed by nonpsychopaths: They are more often goal-oriented, more often involve weapons and violence, more often involve nonkin and stranger victims, and more often involve male victims (Cornell et al., 1996; Hare & McPherson, 1984a; Serin, 1991; Williamson, Hare, & Wong, 1987; reviewed in Patrick & Zempolich, 1998).

Most of the research on psychopathy has been conducted in prisons or secured hospitals. The few studies of psychopathic men recruited from the general community also show that they engage in more antisocial and criminal activities than nonpsychopathic men (Belmore &

Quinsey, 1994; Seto, Khattar, Lalumière, & Quinsey, 1997; Widom, 1977; Widom & Newman, 1985). Also, scores on measures of psychopathy are consistently and positively associated with self-reported use of sexual coercion and aggression (Kosson, Kelly, & White, 1997; Lalumière & Quinsey, 1996). In fact, it has been difficult for researchers to recruit male community volunteers who score high on measures of psychopathy and who have not engaged in criminal behavior. Results from studies of nonadjudicated boys and men also suggest a very early onset of psychopathic tendencies (Frick, O'Brien, Wootton, & McBurnett, 1994; Lynam, 1996, 1997, 1998; Skilling, Quinsey, & Craig, in press). The seriousness, diversity, pervasiveness, and continuity of the antisocial and criminal behavior of psychopaths has intrigued many and has led to much research aimed at better understanding the origin and development of this phenomenon.

Psychopathic men recruited from prisons, psychiatric hospitals, or the community differ from nonpsychopathic men in several ways. In the laboratory, they show little tolerance of delay, more perseverance when punished, less control over dominant (highly probable) responses, and are generally less affected by the consequences of their actions (Howard, Payamal, & Neo, 1997; Howland, Kosson, Patterson, & Newman, 1993; Lykken, 1957; Newman & Kosson, 1986; Newman, Kosson, & Patterson, 1992; Newman, Patterson, & Kosson, 1987). Psychopaths are less physiologically reactive when exposed to cues of distress or to aversive or unexpected stimuli like loud sounds, and less reactive when anticipating some aversive stimuli (Hare, 1978; Ogloff & Wong, 1990; Patrick, 1994; Schmauk, 1970). Psychopaths appear to process emotionally charged information very differently: In contrast to nonpsychopaths, psychopaths do not show different behavioral and electrocortical reactions to emotional and to neutral verbal information (Williamson, Harpur, & Hare, 1991). Also, psychopaths show less cerebral lateralization than nonpsychopaths and differ on contemporaneous measures of cerebral activity when processing verbal information (Day & Wong, 1996; Hare & McPherson, 1984b; Intrator et al., 1997; Kiehl, Hare, Liddle, & McDonald, 1999; Raine, O'Brien, Smiley, Scerbo, & Chan, 1990). Results of neuropsychological and neuroimaging tests, however, have shown no evidence of lesions or other brain damage (Hare, 1984; Hart, Forth, & Hare, 1990).

The striking differences between psychopaths and other men are illustrated and underlined by the finding that psychopathy represents a discrete entity. Harris, Rice, and Quinsey (1994), Skilling, Harris, Rice, and Quinsey (2000), and Skilling et al. (in press) reported, using Meehl's taxometric methods, that a score on a measure of psychopathy represents a probability of the person assessed belonging to the psychopathy class rather than a degree of psychopathy. This empirical finding has been obtained with samples of adult male psychiatric patients, adult male prisoners, and grade school boys. The essential logic of taxometric analyses is that, when a construct is underlain by a distinct natural class, valid indicators of the construct do not covary (or show low covariance) when members of the class and its complement are considered separately. The same indicators covary much more when members of the natural class and its complement are mixed together (Harris, Skilling, & Rice, in press). The discrete nature of psychopathy suggests that its development may be quite unique. There are two general theoretical views about the development of psychopathy.

1.1. Psychopathy as psychopathology

Psychopathy has traditionally been seen as an extreme mental disorder and a disease. More recently, it has been described as a serious personality disorder, a brain-based pathology, or a virulent strain of conduct disorder (e.g., Hart & Hare, 1989, 1996; Lapierre, Braun, & Hodgins, 1995; Lynam, 1996; Schulsinger, 1972). Psychopathy is seen as destructive to self and others, as illustrated in these statements: "... given the morbidity of psychopathy and its negative impact on society, it is difficult to imagine that any mental disorder, save perhaps schizophrenia, could be considered a greater public health concern" (Hart & Hare, 1996, p. 131); "In the psychopathic child ... we have an opportunity to observe the development of the disorder before it has had an opportunity to destroy its host" (Lynam, 1997, p. 434).

According to this view, the development of psychopaths has been disturbed, so that they are unable to experience such moral sentiments as empathy or remorse, cannot fully appreciate the consequences of their actions, and therefore cannot behave in prosocial ways. Although the causal developmental disturbances have not been identified, there are many candidates: deleterious genes, obstetrical problems, or injuries leading to neurological problems, inadequate or abusive childhood environments, failure to bond with a primary caretaker in infancy, and so on (Lykken, 1995).

Thus, the most common interpretation of the observed differences between psychopaths and nonpsychopaths is that psychopaths are behaviorally, emotionally, physiologically, and cognitively impaired. For example, Patrick (1994, p. 327) concluded that "[t]he absence of normal startle potentiation in psychopaths during exposure to aversive pictures or warning cues signifies a *deficit* in capacity for defensive response modulation, which is the essence of fear" (italics added). The psychopathology interpretation has not yet led to successful etiological models of psychopathy, but has nonetheless led to interventions designed to promote prosocial emotions, cognitions, and behavior. Thus, therapy programs have attempted to increase empathy, responsibility, understanding and caring for others, and so on. However, these treatments have not produced the desired effects on criminal recidivism. In one study, an increase in the violent recidivism of psychopaths was associated with therapy designed to improve their emotional and social functioning, probably because psychopaths learned new ways to appear empathic and to better manipulate others (Harris, Rice, & Cormier, 1994; Rice, Harris, & Cormier, 1992; see also Seto & Barbaree, 1999).

1.2. Psychopathy as "special design"

An alternative interpretation is that psychopaths are different by design, rather than as a result of impairment. Based on considerations of evolutionary biology, a characteristic would qualify as a deficit or an impairment only when it represents a failure of a mechanism to perform its evolved function. According to recent Darwinian models of psychopathy, the behavioral, emotional, cognitive, and neuropsychological characteristics of psychopaths are not deficits or impairments; instead, they are a set of organized, functional, and specialized phenotypic features that formed a viable reproductive social strategy in human evolutionary history.

Harpending and Sobus (1987) used the concepts and results of game theory research to demonstrate that a cheater (or nonreciprocator) could achieve Darwinian success under certain conditions: cheaters are successful when they are difficult to detect, highly mobile, verbally skilled, and especially skilled at persuading females to mate. Harpending and Sobus pondered the possibility that psychopathy (they used the term ''sociopathy'') could be the result of a condition-dependent or an obligate strategy, or perhaps a combination of both. Mealey (1995, p. 536) extended and documented these ideas and suggested that psychopathy — what she called primary sociopathy — might be an evolutionarily stable strategy maintained by frequency-dependent selection. By this account, psychopaths are genetically different from other antisocial individuals and from everyone else, their genotype strongly predisposing them to a lifetime of antisociality: ''Without love to 'commit' them to cooperation, anxiety to prevent 'defection,' or guilt to inspire repentance, they will remain free to continually play for the short-term benefit in the Prisoner's Dilemma.''

Lalumière and Seto (1998) argued, based on the work of Harpending and Sobus (1987), Mealey (1995), and also Axelrod (1984) and Frank (1988), that a ''cheater'' or ''defector'' model of psychopathy would require the following conditions in the environment of evolutionary adaptedness (EEA): (1) most members of human social groups were strongly inclined to cooperate, (2) it was possible to move from one group to another, and (3) detecting defectors entailed costs. A fairly evenly mixed group of cooperators and defectors would have resulted in many fruitless interactions between defectors, and would have resulted in greater vigilance for defection by cooperators. Lack of mobility would have resulted in high cost for gaining a reputation as a defector and eventual ostracism or even death. And cost-free detection would have excluded defectors from all interactions (and again their eventual elimination). Quinsey, Harris, Rice, and Cormier (1998, p. 230) noted that psychopaths also use aggression and violence as part of their strategy of social defection and suggested that ''psychopathy can be considered to be a life-history strategy consisting of short-term mating tactics, an aggressive and risky (''warrior-hawk'') approach to achieving social dominance, and frequent use of nonreciprocating and duplicitous (cheating) tactics in social exchange.''[1]

These ideas suggest that the defining features of psychopaths (manipulative, charming, glib, deceptive, parasitic, irresponsible, selfish, callous, promiscuous, impulsive, antisocial, aggressive), and the laboratory findings (not tolerating delay of gratification, perseveration despite punishment, superficial processing of emotional material, lesser reactivity to cues of other's distress and fear) are not pathological outcomes of impaired development, but rather features of a Darwinian adaptation designed to thrive in an interpersonal environment dominated by social cooperators.

The defining features and characteristics of psychopaths do show evidence of design with regard to the particular life-history and social strategies hypothesized by evolutionary psychologists. It is difficult to imagine how the combination of these characteristics could

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[1] Psychopaths may sometimes use cooperative tactics. Widom (1976, p. 333) had institutionalized psychopaths and nonpsychopaths play a game of Prisoner's Dilemma and found that ''[p]sychopaths can and will cooperate with one another over a period of time if the stakes are high enough and if feedback on their performance is immediate.''

result from pathology. It is not immediately obvious, however, how to devise clear-cut empirical tests to distinguish between psychopathological and special design views of psychopathy. In this article, we use the concept of developmental instability to examine whether adult psychopathy is the result of a pathological or a nonpathological development.

1.3. Developmental instability

Developmental instability "refers to the imprecise expression of a given developmental design because of untoward environmental or genetic perturbations that disrupt developmental processes" (Gangestad & Yeo, 1994, p. 572). Thus, measures of developmental instability tell a historical tale of poor or disrupted design, random errors and accidents, or deleterious environments. Measures of developmental instability allow the assessment of some crucial properties of adaptation and pathology, in particular, developmental precision (or lack thereof). A psychopathological view of psychopathy suggests that psychopaths should show signs of developmental perturbations, while a special design view of psychopathy suggests that they should not.

One set of developmental perturbations are obstetrical problems, including difficulties during pregnancy, labor, delivery, and postdelivery (e.g., bleeding, hypertension, toxemia, use of forceps) and atypical outcomes of pregnancy (e.g., prematurity, low birth weight, signs of neurological problems). These problems have been associated with low intelligence, mental retardation, epilepsy, autism, early-onset schizophrenia, hyperactivity, anxiety disorders, behavior disorders, and other developmental problems (Allen, Lewinson, & Seeley, 1998; Bolton et al., 1997; Broman, 1989; Firestone & Prabhu, 1983; Hunt & Cooper, 1989; Verdoux et al., 1997). Some obstetrical problems (e.g., toxemia) may be causes, as well as signs of developmental perturbations. In Study 1, we investigated the relationship between psychopathy and a history of obstetrical problems among a large group of male offenders.

2. Study 1

2.1. Method

2.1.1. Subjects

The sample consisted of 800 male offenders assessed or treated in a maximum-security psychiatric hospital between 1970 and 1983. All subjects were part of one or more previous studies on recidivism and treatment outcome: An evaluation of a maximum-security therapeutic community (Rice et al., 1992), a comparison of the outcomes of insanity acquittees vs. convicted offenders (Rice, Harris, Lang, & Bell, 1990) and follow-up studies of sex and nonsex offenders (Quinsey, Lalumière, Rice, & Harris, 1995; Rice & Harris, 1995, 1997; Rice, Harris, & Quinsey, 1990; Rice, Quinsey, & Harris, 1991). The characteristics of the sample have been described in detail in the earlier reports. Briefly, virtually all had committed a violent offense ranging from simple assault to multiple homicide. Selected subject characteristics are shown in Table 1.

Table 1
Characteristics of the 800 offenders in Study 1

	Mean (S.D.) or percent
Age at index offense (years)	27.9 (10.7)
Highest grade achieved	8.6 (2.6)
Lived with both natural parents until age 16	40%
Unemployed at index offense	50%
Longest period of employment (months)	49.8 (104)
Number of prior admissions to correctional institutions	1.2 (2.1)
Number of prior psychiatric admissions	1.3 (2.3)
Parental criminal history	7%
Parental psychiatric history	14%
Parental history of alcohol abuse	36%
Subject had an alcohol problem at the time of the index offense	45%
Ever married or equivalent	55%
Ever committed a violent offense	98%
Ever committed a sexually motivated violent offense (rape or child molestation)	38%
Meets DSM-III criteria for schizophrenia	22%
Hare's PCL-R	16.0 (9.1)
Verbal IQ	99 (15)

2.1.2. Measures and procedure

A large number of variables were coded for the studies from which the present sample was derived. Details about the coding and determination of interrater reliabilities can be found in the original reports (Harris, Rice, & Quinsey, 1993; Quinsey et al., 1995; Rice et al., 1992; Rice, Harris, Lang, et al., 1990; Rice, Harris, & Quinsey, 1990). Briefly, interrater correlations on continuous variables exceeded .80 and κ on categorical variables exceeded .70. The coding of background variables relied on very comprehensive clinical and medical records. These records have formed the basis of many previous research studies (e.g., Harris et al., 1991a, 1991b; Lalumière, Harris, Quinsey, & Rice, 1998; Lalumière, Harris, & Rice, 1999) and contained reports from subjects' families, schools, and previous hospitalizations. For the purpose of the present report, the most important variables are those that reflected reports (usually from family members) about obstetrical problems.

The 20-item Psychopathy Checklist-Revised (PCL-R; Hare, 1991) was scored entirely based on the clinical records. Earlier research on the same population indicated that this scoring method yielded very high reliability, identical factor structure, and predictive validity at least as good as the more commonly used interview plus file method (Harris, Rice, & Quinsey, 1994). The PCL-R is currently the best instrument to assess psychopathy among inmates and forensic patients. It contains 20 items: glibness/superficial charm, grandiose sense of self-worth, need for stimulation/proneness to boredom, pathological lying, conning/manipulative, lack of remorse or guilt, shallow affect, callous/lack of empathy, parasitic lifestyle, poor behavioral controls, promiscuous sexual behavior, early behavior problems, lack of realistic long-term goals, impulsivity, irresponsibility, failure to accept responsibility for own actions, many short-term marital relationships, juvenile delinquency, revocation of

conditional release, and criminal versatility. Each PCL-R item is scored as 0 (*not present*), 1, or 2 (*definitely present*). PCL-R total scores vary from 0 to 40. Previous research has shown that a score of 25 is the best cut-off to identify psychopaths using the file scoring method (Harris, Rice, & Quinsey, 1994).

The indicators of obstetrical problems are shown along with the prevalence of each in Table 2. These indicators were combined into a single scale by giving the subject a point for each indicator coded as present for him. The prevalences were low, so that few offenders received more than a single point and most (69%) received none. There were some variables we tried to code (e.g., maternal high fever during pregnancy, malnutrition during pregnancy, exposure to toxic substances during pregnancy or infancy) that were never noted in the files and, thus, could not be used in this study.

2.2. Results and discussion

The average PCL-R score for the whole sample was 16.0 (S.D. = 9.1; range from 0 to 40) and the average score for the obstetrical problems scale was 0.28 (S.D. = 0.59; range from 0 to 4). Fig. 1 shows the mean values on the obstetrical problems scale for nonpsychopaths (PCL-R of 0 to 24, $n = 643$) and for psychopaths (PCL-R of 25 to 40, $n = 157$). There is almost no overlap between the two groups' 95% confidence intervals. The Pearson correlation between the obstetrical problems scale and PCL-R score was $r(798) = -.104$, $P < .005$; Spearman $\rho = -.104$, $P < .005$ (all P values are two-tailed). Because schizophrenia has been linked to obstetrical problems (e.g., Verdoux et al., 1997) and because 22% of the subjects were diagnosed with schizophrenia, it was important to ensure that this statistically significant inverse correlation was not solely the result of developmental problems associated with schizophrenia. We recomputed the correlation with all schizophrenic offenders removed [$r(624) = -.140$, $P < .001$; Spearman $\rho = -.136$, $P < .001$].

Table 2
The obstetrical problems items and their prevalence among the 800 offenders in Study 1

|	Prevalence (%)
Mother older than 35 at subject's birth	7
Toxemia	1
Abnormal fetal posture (e.g., breech birth)	3
Asphyxia, anoxia	1
Caesarian section	2
Fetal distress during labor and delivery	1
Use of forceps/instruments during delivery	7
Perinatal infection	1
Prolonged labor and delivery	4
Rh problems	1
Umbilical, placental problems	1
Colic	1
Neurological impairment in infancy	3
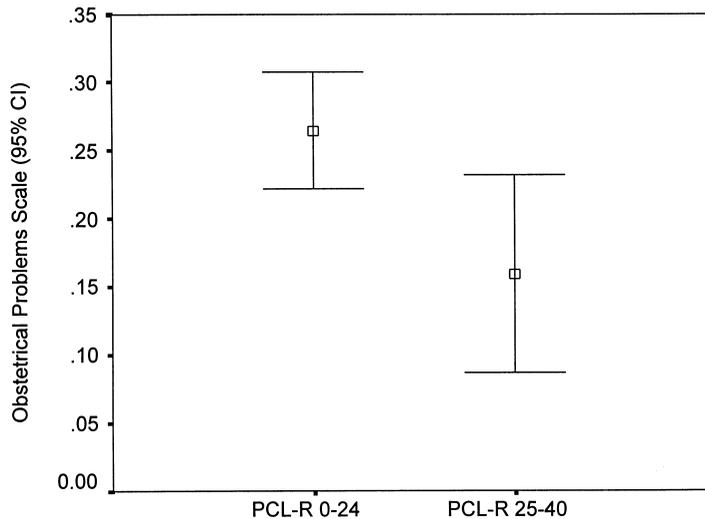
Fig. 1. Obstetrical problems scale mean values for nonpsychopaths ($n = 643$) and psychopaths ($n = 157$).

As discussed above, our earlier work indicated that psychopaths comprised a qualitatively distinct subgroup of offenders and examination of the distributions of PCL-R scores indicated that offenders who obtained scores below 10 were very unlikely ($P < .10$) to be members of the discrete psychopath class, while those who scored above 25 were very likely ($P > .90$) to be members (Harris, Rice, & Quinsey, 1994). Consequently, we compared these two extreme groups on the obstetrical problems scale: low scorers [$n = 292$, mean $= 0.34$ (S.D. $= 0.63$)] vs. high scorers [$n = 140$, mean $= 0.21$ (S.D. $= 0.52$)], $t(430) = 2.09$, $P < .05$. When we selected a more conservative ($P > .95$) definition of psychopathy (PCL-R score of at least 30), the mean on the obstetrical problems scale was even lower, 0.15 (S.D. $= 0.41$), as suggested by the correlational analysis.

Unlike several serious mental disorders that are positively related to obstetrical problems, psychopathy was inversely related to these problems in a sample of male offenders. In a similar vein, Schulsinger (1972) reported that psychopaths (using a different operational definition) did not differ from matched controls (with no mental disorder) on a composite measure of obstetrical complications. These findings are consistent with the idea that psychopathy is not the result of the kinds of developmental perturbations implicated in the etiology of many serious mental disorders.

3. Study 2

Study 1 revealed that psychopathic offenders had a lower prevalence of obstetrical problems than nonpsychopathic offenders. Because our measure of obstetrical problems was based on clinical files, we did not have access to comparable data from nonoffenders. In Study 2, we measured another sign of developmental perturbations among three groups of

men — psychopathic offenders, nonpsychopathic offenders, and nonoffenders — that did not rely on informant report.

Fluctuating asymmetry (FA) is a measure of random fluctuations between the left and right side of bilateral morphological traits designed to develop symmetrically. It is very likely the best measure of developmental instability (Møller & Swaddle, 1997; Thornhill & Møller, 1997). Low FA is associated with high phenotypic quality in several species, including humans (Malyon & Healy, 1994; Manning, Kourkouakis, & Brodie, 1997; Manning & Pickup, 1998; Møller, 1990).

In several species, low FA individuals grow faster and have higher fecundity and survival rates (Møller, 1997). In humans, low FA men use more direct intrasexual competitive tactics and report more sexual partners, an earlier age at first intercourse, and more offspring than high FA men (Simpson, Gangestad, Christensen, & Leck, 1999; Thornhill & Gangestad, 1994; Waynforth, 1998). In contrast, high FA is related to schizophrenia (Mellor, 1992), developmental delay, mental retardation (Naugler & Ludman, 1996), birth prematurity (Livshits & Kobyliansky, 1991), and left-handedness (Yeo, Gangestad, & Daniel, 1993).

Shackelford and Larsen (1997) studied the relationship between an indirect measure of psychopathic tendencies (Psychoticism on the Eysenck Personality Questionnaire) and facial asymmetry among college men. They reported a positive relationship in one sample and a negative relationship in another. The present study investigated the relationship between body FA and psychopathy in a group of offenders and compared offenders' FA scores to those obtained from adult male nonoffenders.

3.1. Methods

3.1.1. Subjects

Offenders were 38 men who had been charged with violent crimes (murder, sexual assault, assault, armed robbery), plus 2 who were civilly committed because of concerns about their potential for violence. They were all patients at a maximum-security psychiatric hospital at the time of data collection (February 1997 to August 1997). Their mean age was 37.8 years (range 19–62). Review of their clinical files showed that 80% had not completed high school, 85% were single, 94% had no, unskilled, or semiskilled occupations at the time of their arrest, 60% had a diagnosis of personality disorder, 58% a diagnosis of psychosis (schizophrenia or bipolar disorder), and 30% a diagnosis of substance abuse (patients could have more than one diagnosis). Nonoffender controls were 31 men with a mean age of 38.8 years (range 14–65). Based on self-report, 6.5% had not completed high school and 29.0% were single. They were recruited among the staff of the hospital.

3.1.2. Measures and procedure

FA was assessed with a digital caliper (Mitutoyo No. 500-138) measuring to the nearest 0.01 mm. Two trained researchers measured each participant. The left and right side of 10 bilateral traits (length of ears, third, fourth, and fifth digits, and width of ears, hands, wrists, elbows, feet, and ankles) were measured separately. The interrater correlations varied from .459 (right ear width) to .940 (left fourth finger length), with a mean correlation of .851 and a

median of .914. The PCL-R scores were obtained from the offenders' clinical files, as described in Study 1. The PCL-R, which is designed for use with offender samples only, was not obtained for nonoffenders. All participants gave informed consent and offenders were paid CDN\$5 for their participation.

3.1.3. Manipulation of FA data

The scores from both raters were averaged first. Signed and unsigned composite FA scores were then calculated for each participant, taking into account body size differences:

$$\text{signed FA} = \frac{\sum_{1}^{10}(L-R)/0.5(L+R)}{10}$$

$$\text{unsigned FA} = \frac{\sum_{1}^{10}|L-R|/0.5(L+R)}{10}.$$

To avoid extreme scores due to injuries or large measurement error, an arbitrary maximum score of ± 0.10 for signed scores and 0.10 for unsigned scores was used for each trait (used for 6.1% of all values). Thus, the theoretical range of FA composite scores was -0.10 to $+0.10$ for signed scores and 0.00 to 0.10 for unsigned scores. The estimated reliability of the unsigned FA scores based on all 10 features was .65 (Spearman–Brown formula,[2] Anastasi, 1988). This value is similar to values obtained by other investigators using similar measurement procedures (e.g., Furlow, Gangestad, & Armijo-Prewitt, 1998; Waynforth, 1998).

We examined whether the signed composite scores across all participants met the statistical requirements for FA (normal distribution around a mean of zero). The mean of the signed composite scores across all participants was -0.00551 (95% confidence interval ± 0.00336). The minimum and maximum scores were -0.031 and $+0.032$. The skewness was .485 ($z = 1.70$) and the kurtosis was $-.233$ ($z = -0.41$). Thus, the signed composite scores were normally distributed but were significantly shifted to the left of the distribution, suggesting the presence of directional asymmetry (DA) favoring the right side.

Of the 10 features, 4 showed statistically significant right-biased DA (wrist, foot, and ear width, and fourth finger length) and one showed statistically significant left-biased DA (elbow width). A signed composite FA score based on the five features that did not show DA (ankle and hand width, ear length, third and fifth finger length) was calculated for each participant. The mean was -0.00378 (± 0.0093) and did not significantly deviate from zero; the distribution was normal. The analyses reported below were performed on the unsigned FA composite scores based on the five features that did not show DA (FA_5). The estimated reliability of the unsigned FA_5 composite was .63 (Spearman–Brown formula).

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[2] $r_{tt} = (2 \times r_{hh})/(1 + r_{hh})$, where r_{tt} is the reliability of the final score (based on two raters) and r_{hh} is the correlation between the two raters.

3.2. Results and discussion

Fig. 2 shows mean FA_5 scores as a function of group membership. An analysis of variance revealed a significant group difference [$F(2,68) = 6.19$, $P < .005$]. The use of age as a covariate did not affect the result [$F(2,67) = 6.14$, $P < .005$]. Examination of the 95% confidence intervals reveals that the nonoffenders had lower FA than nonpsychopathic offenders, with psychopathic offenders scoring in the middle. The correlation between FA_5 and PCL-R scores among the offenders was negative and nonsignificant [$r(38) = -.132$, $P = .416$, when corrected for age: $r(37) = -.136$]. Five offenders had PCL-R scores that met the most stringent criterion for the identification of psychopathy (≥ 30). Their mean FA_5 was 0.0318 (the mean FA_5 value for nonoffenders was 0.0300).

Psychopathic offenders were much less likely to have received a diagnosis of psychosis (13%) than nonpsychopathic offenders (84%). Psychopaths without a diagnosis of psychosis ($n = 12$) had a nonsignificantly lower mean FA_5 (0.035) than nonpsychopaths without a diagnosis of psychosis [0.041, $n = 4$, $t(15) = -1.08$, $P = .299$].

In summary, nonoffender controls showed lower FA than both groups of offenders. The two offender groups differed, with psychopaths scoring lower. The small number of psychopathic offenders meeting the most stringent criterion for the identification of psychopathy showed the lowest asymmetry values among offenders.

3.2.1. Supplementary analyses

Waynforth (1998) reported that low FA men from rural Belize had more offspring and were more attractive than high FA men. Waynforth (1999) also found that more attractive men spend more time in mating effort and less time in nepotistic effort than less attractive men. Among offenders recruited for Study 2, the relationship between PCL-R scores and self-
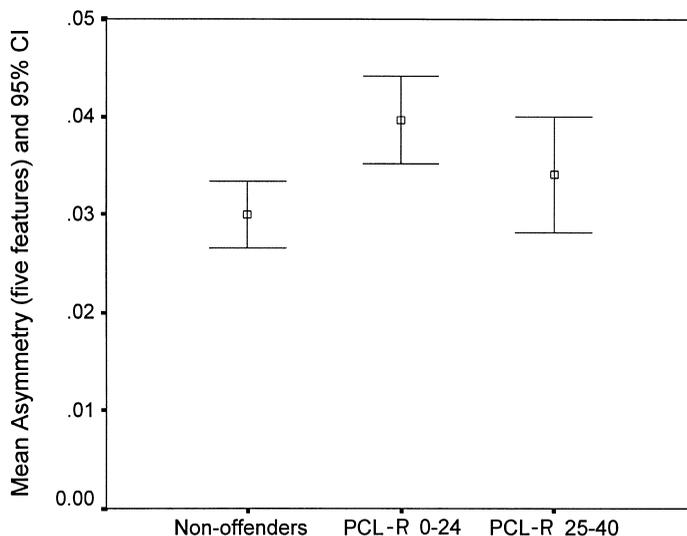

Fig. 2. FA mean values for nonoffenders ($n = 31$), nonpsychopaths ($n = 25$), and psychopaths ($n = 15$).

reported number of children was $r(35) = .434$, $P < .01$ (corrected for age). The relationship between PCL-R scores and physical attractiveness, averaged over two independent raters, was $r(36) = .332$, $P < .01$. The two PCL-R items reflecting mating effort, "Many Short-Term Marital Relationships" and "Promiscuous Sexual Behavior," correlated $-.384$ ($P < .05$) and $-.242$ ($P = .162$), respectively, with FA (corrected for age).

Left-handedness is associated with a large number of health problems and neurological pathologies (reviewed in Coren, 1993; Yeo & Gangestad, 1998). Hare and Forth (1985) reported that offenders scoring high on the PCL were no different in handedness than control samples. We had handedness data (observed handwriting preference) on 66 subjects from Study 2: 13% of nonoffenders, 22% of nonpsychopaths (PCL-R 0–24), and 8% of psychopaths (PCL-R 25–40) were left-handed. Altogether, these results are more consistent with a special design view of psychopathy.

4. General discussion

A psychopathological view of psychopathy predicts, all else being equal, that psychopathic offenders would show greater evidence of developmental instability than nonpsychopathic offenders and nonoffenders. A special design view predicts that psychopathic offenders would show less evidence of developmental instability than other offenders and would not differ from nonoffenders. The comparison of psychopathic and nonpsychopathic offenders on measures of obstetrical problems and FA reveal that psychopathic offenders showed less evidence of developmental instability than nonpsychopathic offenders. However, psychopathic offenders scored higher than nonoffenders on FA — except for those offenders who met the most stringent criterion for psychopathy. Unfortunately, there were only five participants with PCL-R scores of 30 and above. These high-scoring offenders are the most interesting psychopaths to compare to nonoffender controls to test the differential predictions of the psychopathology and special design models. In summary, the special design view received more support than the psychopathological view, but was not completely supported.

Low FA is associated with two of the main features of psychopathy: high mating effort and aggression. The PCL-R items most directly relevant to mating effort were associated with lower FA among offenders. With regard to aggression, Furlow et al. (1998) reported that low FA was associated, among college men, with a higher number of fights and a greater chance of fight escalation toward physical violence. Manning and Wood (1998) reported that low FA boys tended to be more physically aggressive and more responsive to provocation or threats than high FA boys. The relationship between low FA, mating effort, and aggressiveness has also been observed in other species (e.g., Thornhill, 1992). The negative relationship between FA and certain aspects of aggression strongly suggest, as evolutionary psychologists have long argued (e.g., Daly & Wilson, 1988; Furlow, Armijo-Prewitt, Gangestad, & Thornhill, 1997), that not all violence and aggression is pathological. Elsewhere, we have suggested that there are at least two developmental pathways to persistent antisociality and criminal violence. The first involves early neurodevelopmental disruptions and the second psychopathy. Using structural equation modeling, we found that the latent factors "neurodevelop-

mental insults" and "psychopathy" were not related to each other and were each independently related to lifetime violence (Harris, Rice, & Lalumière, in press).

It is important to note that all offenders recruited for Studies 1 and 2 were patients at a maximum-security hospital and many had serious psychiatric diagnoses. It would be worthwhile to conduct the same study among samples that contain a larger number of individuals without major mental disorders, such as offenders recruited from correctional institutions and men recruited from the community. The psychopathic patients of psychiatric institutions may not be "typical" psychopaths.

We believe the results reported here warrant future studies investigating measures of developmental instability among large samples of psychopaths, nonpsychopaths, and other groups of men with serious mental disorders. Signs of developmental instability worth investigating include obstetrical and early neurological problems, FA, minor physical anomalies, physical attractiveness, deviation from moderate right-handedness, and deviation from average performance in neuropsychological tests of brain laterality (see Thornhill & Møller, 1997; Yeo & Gangestad, 1998). These studies will provide a very strong test of the two main models of psychopathy. We also believe this conceptual approach would be useful to the study of human psychopathology more generally.

Studies of developmental instability do not tell us whether the life histories of psychopaths reflect condition-dependent or obligate development. This question can be better addressed with behavioral and molecular genetics studies, as well as with longitudinal studies of psychopathic and nonpsychopathic children. It is worth noting that personality and behavioral features akin to psychopathy have been observed among young children and adolescents (e.g., Forth, Hart, & Hare, 1990; Frick et al., 1994; Lynam, 1997; Skilling et al., in press), and that laboratory studies of children and adolescents scoring high on measures of psychopathy have produced results similar to those reported in adult studies (e.g., Blair, 1999). If psychopathy is a result of condition-dependent development, the environmental triggers are likely to operate very early.

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References

Allen, N. B., Lewinsohn, P. N., & Seeley, J. R. (1998). Prenatal and perinatal influences on risk for psychopathology in childhood and adolescence. *Development and Psychopathology, 10*, 513–529.

Anastasi, A. (1988). *Psychological testing* (6th ed.). New York: Macmillan.

Axelrod, R. (1984). *The evolution of cooperation*. New York: Basic Books.

Belmore, M. F., & Quinsey, V. L. (1994). Correlates of psychopathy in an noninstitutional sample. *Journal of Interpersonal Violence, 9*, 339–349.

Blair, R. J. R. (1999). Responsiveness to distress cues in the child with psychopathic tendencies. *Personality and Individual Differences, 27*, 135–1456.

Bolton, P. F., Murphy, M., MacDonald, H., Whitlock, B., Pickles, A., & Rutter, M. (1997). Obstetric complications in autism: consequences or causes of the condition? *Journal of the American Academy of Child and Adolescent Psychiatry*, *36*, 272–281.

Broman, S. H. (1989). Infant physical status and later cognitive development. In: M. H. Bornstein, & N. A. Krasnegor (Eds.), *Stability and continuity in mental development* (pp. 45–62). Hillsdale, NJ: Lawrence Erlbaum.

Coren, S. (1993). *The left-hander syndrome*. New York: Vintage.

Cornell, D. G., Warren, J., Hawk, G., Stafford, E., Oram, G., & Pine, D. (1996). Psychopathy in instrumental and reactive violent offenders. *Journal of Consulting and Clinical Psychology*, *64*, 783–790.

Daly, M., & Wilson, M. (1988). *Homicide*. New York: Aldine.

Day, R., & Wong, S. (1996). Anomalous perceptual asymmetries for negative emotional stimuli in the psychopath. *Journal of Abnormal Psychology*, *105*, 648–652.

Firestone, P., & Prabhu, A. N. (1983). Minor physical anomalies and obstetrical complications: their relationship to hyperactive, psychoneurotic, and normal children and their families. *Journal of Abnormal Child Psychology*, *11*, 207–216.

Forth, A. E., Hart, S. D., & Hare, R. D. (1990). Assessment of psychopathy in male young offenders. *Psychological Assessment*, *2*, 342–344.

Frank, R. H. (1988). *Passions within reason: the strategic role of the emotions*. New York: Norton.

Frick, P. J., O'Brien, B. S., Wootton, J. M., & McBurnett, K. (1994). Psychopathy and conduct problem in children. *Journal of Abnormal Psychology*, *103*, 700–707.

Furlow, B., Gangestad, S. W., & Armijo-Prewitt, T. (1998). Developmental stability and human violence. *Proceedings of the Royal Society of London, Series B: Biological Sciences*, *265*, 1–6.

Furlow, F. B., Armijo-Prewitt, T., Gangestad, S. W., & Thornhill, R. (1997). Fluctuating asymmetry and psychometric intelligence. *Proceedings of the Royal Society of London, Series B: Biological Sciences*, *264*, 823–829.

Gacono, C. (2000). *The clinical and forensic assessment of psychopathy: a practitioner's guide*. Mahwah, NJ: Lawrence Erlbaum.

Gangestad, S. W., & Yeo, R. A. (1994). Parental handedness and relative hand skill: a test of the developmental instability hypothesis. *Neuropsychology*, *8*, 572–578.

Hare, R. D. (1978). Psychopathy and electrodermal responses to nonsignal stimulation. *Biological Psychology*, *6*, 237–246.

Hare, R. D. (1984). Performance of psychopaths on cognitive tasks related to frontal lobe function. *Journal of Abnormal Psychology*, *93*, 133–140.

Hare, R. D. (1991). *The Revised Psychopathy Checklist*. Toronto: Multi-Health Systems.

Hare, R. D., & Forth, A. E. (1985). Psychopathy and lateral preference. *Journal of Abnormal Psychology*, *94*, 541–546.

Hare, R. D., Forth, A. E., & Strachan, K. E. (1992). Psychopathy and crime across the life-span. In: R. Peters, R. J. McMahon, & V. L. Quinsey (Eds.), *Aggression and violence throughout the life span* (pp. 285–300). Newbury Park, CA: Sage.

Hare, R. D., & Jutai, J. W. (1983). Criminal history of the male psychopath: some preliminary data. In: K. T. Van Dusen, & S. A. Mednick (Eds.), *Prospective studies of crime and delinquency* (pp. 225–236). Boston: Kluwer-Nijhoff.

Hare, R. D., & McPherson, L. M. (1984a). Violent and aggressive behavior by criminal psychopaths. *International Journal of Law and Psychiatry*, *7*, 35–50.

Hare, R. D., & McPherson, L. M. (1984b). Psychopathy and perceptual asymmetry during verbal dichotic listening. *Journal of Abnormal Psychology*, *93*, 141–149.

Hare, R. D., McPherson, L. M., & Forth, A. E. (1988). Male psychopaths and their criminal careers. *Journal of Consulting and Clinical Psychology*, *56*, 710–714.

Harpending, H. C., & Sobus, J. (1987). Sociopathy as an adaptation. *Ethology and Sociobiology*, *8*, 63S–72S.

Harris, G. T., Rice, M. E., & Cormier, C. A. (1991a). Psychopathy and violent recidivism. *Law and Human Behavior*, *15*, 625–632.

Harris, G. T., Rice, M. E., & Cormier, C. A. (1991b). Length of detention in matched groups of insanity acquittees and convicted offenders. *International Journal of Law and Psychiatry*, *14*, 223–236.

Harris, G. T., Rice, M. E., & Cormier, C. A. (1994). Psychopaths: is a "therapeutic community" therapeutic? *Therapeutic Communities*, *15*, 283–300.

Harris, G. T., Rice, M. E., & Lalumière, M. L. (in press). Criminal violence: the roles of psychopathy, neurodevelopmental insults and antisocial parenting. *Criminal Justice and Behavior*.

Harris, G. T., Rice, M. E., & Quinsey, V. L. (1993). Violent recidivism of mentally disordered offenders: the development of a statistical prediction instrument. *Criminal Justice and Behavior*, *20*, 315–335.

Harris, G. T., Rice, M. E., & Quinsey, V. L. (1994). Psychopathy as a taxon: evidence that psychopaths are a discrete class. *Journal of Consulting and Clinical Psychology*, *62*, 387–397.

Harris, G. T., Skilling, T. A., & Rice, M. E. (in press). The construct of psychopathy. In: M. Tonry & N. Morris (Eds.), *Crime and justice: an annual review of research*. Chicago: University of Chicago Press.

Hart, S. D., Forth, A. E., & Hare, R. D. (1990). Performance of criminal psychopaths on selected neuropsychological tests. *Journal of Abnormal Psychology*, *99*, 374–379.

Hart, S. D., & Hare, R. D. (1989). Discriminant validity of the Psychopathy Checklist in a forensic psychiatric population. *Psychological Assessment*, *1*, 211–218.

Hart, S. D., & Hare, R. D. (1996). Psychopathy and antisocial personality disorder. *Current Opinion in Psychiatry*, *9*, 129–132.

Howard, R., Payamal, L. T., & Neo, L. H. (1997). Response modulation deficits in psychopaths: a failure to confirm and a reconsideration of the Patterson–Newman model. *Personality and Individual Differences*, *22*, 707–717.

Howland, E. W., Kosson, D. S., Patterson, D. S., & Newman, J. P. (1993). Altering a dominant response: performance of psychopaths and low-socialization college students on a cued reaction time task. *Journal of Abnormal Psychology*, *102*, 379–387.

Hunt, J. V., & Cooper, B. A. B. (1989). Differentiating the risk for high-risk preterm infants. In: M. H. Bornstein, & N. A. Krasnegor (Eds.), *Stability and continuity in mental development* (pp. 105–122). Hillsdale, NJ: Lawrence Erlbaum.

Intrator, J., Hare, R. D., Stritzke, P., Brichtswein, K., Dorfman, D., Harpur, T., Bernstein, D., Handelsman, L., Schaefer, C., Keilp, J., Rosen, J., & Machac, J. (1997). A brain imaging (single photon emission computerized tomography) study of semantic and affective processing in psychopaths. *Biological Psychiatry*, *42*, 96–103.

Kiehl, K. A., Hare, R. D., Liddle, P. F., & McDonald, J. J. (1999). Reduced P300 responses in criminal psychopaths during a visual oddball task. *Biological Psychiatry*, *45*, 1498–1507.

Kosson, D. S., Kelly, J. C., & White, J. W. (1997). Psychopathy-related traits predict self-reported sexual aggression among college men. *Journal of Interpersonal Violence*, *12*, 241–254.

Lalumière, M. L., Harris, G. T., Quinsey, V. L., & Rice, M. E. (1998). Sexual deviance and number of older brothers among sexual offenders. *Sexual Abuse*, *10*, 5–15.

Lalumière, M. L., Harris, G. T., & Rice, M. E. (1999). Birth order and fluctuating asymmetry: a first look. *Proceedings of the Royal Society of London, Series B: Biological Sciences*, *266*, 2351–2354.

Lalumière, M. L., & Quinsey, V. L. (1996). Sexual deviance, antisociality, mating effort and the use of sexually coercive behaviors. *Personality and Individual Differences*, *21*, 33–48.

Lalumière, M. L., & Seto, M. C. (1998). What's wrong with psychopaths? *Psychiatry Rounds*, *2*, 6.

Lapierre, D., Braun, C. M. J., & Hodgins, S. (1995). Ventral frontal deficits in psychopathy: neuropsychological test findings. *Neuropsychologia*, *33*, 139–151.

Livshits, G., & Kobyliansky, E. (1991). Fluctuating asymmetry as a possible measure of developmental homeostasis in humans: a review. *Human Biology*, *63*, 441–466.

Lykken, D. T. (1957). A study of anxiety in the sociopathic personality. *Journal of Abnormal and Social Psychology*, *55*, 6–10.

Lykken, D. T. (1995). *The antisocial personalities* Mahwah, NJ: Lawrence Erlbaum.

Lynam, D. R. (1996). Early identification of chronic offenders: who is the fledging psychopath? *Psychological Bulletin*, *120*, 209–234.

Lynam, D. R. (1997). Pursuing the psychopath: capturing the fledgling psychopaths in a nomological net. *Journal of Abnormal Psychology*, *106*, 425–438.

Lynam, D. R. (1998). Early identification of the fledgling psychopath: locating the psychopathic child in the current nomenclature. *Journal of Abnormal Psychology*, *107*, 566–575.

Malyon, C., & Healy, S. (1994). Fluctuating asymmetry in antlers of fallow deer, *Dama dama*, indicates dominance. *Animal Behaviour*, *48*, 248–250.

Manning, J. T., Koukourakis, K., & Brodie, D. A. (1997). Fluctuating asymmetry, metabolic rate and sexual selection in human males. *Evolution and Human Behavior*, *18*, 15–21.

Manning, J. T., & Pickup, L. J. (1998). Symmetry and performance in middle distance runners. *International Journal of Sports and Medicine*, *19*, 205–209.

Manning, J. T., & Wood, D. (1998). Fluctuating asymmetry and aggression in boys. *Human Nature*, *9*, 53–65.

Mealey, L. (1995). The sociobiology of psychopathy: an integrated evolutionary model. *Behavioral and Brain Sciences*, *18*, 523–599.

Mellor, C. S. (1992). Dermatoglyphic evidence of fluctuating asymmetry in schizophrenia. *British Journal of Psychiatry*, *160*, 467–472.

Møller, A. P. (1990). Fluctuating asymmetry in male sexual ornaments may reliably reveal male quality. *Animal Behaviour*, *40*, 1185–1187.

Møller, A. P. (1997). Developmental stability and fitness: a review. *American Naturalist*, *5*, 917–932.

Møller, A. P., & Swaddle, J. P. (1997). *Asymmetry, developmental stability and evolution*. Oxford: Oxford University Press.

Naugler, C. T., & Ludman, M. D. (1996). Fluctuating asymmetry and disorders of developmental origins. *American Journal of Medical Genetics*, *66*, 15–20.

Newman, J. P., & Kosson, D. S. (1986). Passive avoidance learning in psychopathic and nonpsychopathic offenders. *Journal of Abnormal Psychology*, *95*, 252–256.

Newman, J. P., Kosson, D. S., & Patterson, C. M. (1992). Delay of gratification in psychopathic and nonpsychopathic offenders. *Journal of Abnormal Psychology*, *101*, 630–636.

Newman, J. P., Patterson, C. M., & Kosson, D. S. (1987). Response perseveration in psychopaths. *Journal of Abnormal Psychology*, *96*, 145–148.

Ogloff, J. R. P., & Wong, S. (1990). Electrodermal and cardiovascular evidence of coping response in psychopaths. *Criminal Justice and Behavior*, *17*, 231–245.

Patrick, C. J. (1994). Emotion and psychopathy: startling new insights. *Psychophysiology*, *31*, 319–330.

Patrick, C. J., & Zempolich, K. A. (1998). Emotion and aggression in the psychopathic personality. *Aggression and Violent Behavior*, *3*, 303–338.

Quinsey, V. L., Harris, G. T., Rice, M. E., & Cormier, C. A. (1998). *Violent offenders: appraising and managing risk*. Washington, DC: American Psychological Association.

Quinsey, V. L., Lalumière, M. L., Rice, M. E., & Harris, G. T. (1995). Predicting sexual offenses. In: J. C. Campbell (Ed.), *Assessing dangerousness: violence by sexual offenders, batterers and child abusers* (pp. 114–137). Thousand Oaks, CA: Sage.

Raine, A., O'Brien, M., Smiley, N., Scerbo, A., & Chan, C. (1990). Reduced lateralization in verbal dichotic listening in adolescent psychopaths. *Journal of Abnormal Psychology*, *99*, 272–277.

Rice, M. E., & Harris, G. T. (1995). Violent recidivism: assessing predictive validity. *Journal of Consulting and Clinical Psychology*, *63*, 737–748.

Rice, M. E., & Harris, G. T. (1997). Cross-validation and extension of the violence risk appraisal guide for child molesters and rapists. *Law and Human Behavior*, *21*, 231–241.

Rice, M. E., Harris, G. T., & Cormier, C. (1992). An evaluation of a maximum security therapeutic community for psychopaths and other mentally disordered offenders. *Law and Human Behavior*, *16*, 399–412.

Rice, M. E., Harris, G. T., Lang, C., & Bell, V. (1990). Recidivism among male insanity acquittees. *Journal of Psychiatry and Law*, *18*, 379–403.

Rice, M. E., Harris, G. T., & Quinsey, V. L. (1990). A follow-up of rapists assessed in a maximum security psychiatric facility. *Journal of Interpersonal Violence*, *5*, 435–448.

Rice, M. E., Quinsey, V. L., & Harris, G. T. (1991). Sexual recidivism among child molesters released from a maximum security psychiatric institution. *Journal of Consulting and Clinical Psychology*, *59*, 381–386.

Schmauk, F. J. (1970). Punishment, arousal and avoidance learning in sociopaths. *Journal of Abnormal Psychology*, *76*, 325–335.

Schulsinger, F. (1972). Psychopathy: heredity and environment. *International Journal of Mental Health*, *1*, 190–206.

Serin, R. C. (1991). Psychopathy and violence in criminals. *Journal of Interpersonal Violence*, *6*, 423–431.

Serin, R. C. (1996). Violent recidivism in criminal psychopaths. *Law and Human Behavior*, *20*, 207–217.

Serin, R. C., Peters, DeV. R., & Barbaree, H. E. (1990). Predictors of psychopathy and release outcome in a criminal population. *Psychological Assessment*, *2*, 419–422.

Seto, M. C., & Barbaree, H. E. (1999). Psychopathy, treatment behavior and sex offender recidivism. *Journal of Interpersonal Violence*, *14*, 1235–1248.

Seto, M. C., Khattar, N. A., Lalumière, M. L., & Quinsey, V. L. (1997). Deception and sexual strategy in psychopathy. *Personality and Individual Differences*, *22*, 301–307.

Shackelford, T. K., & Larsen, R. J. (1997). Facial asymmetry as an indicator of psychological, emotional and physiological distress. *Journal of Personality and Social Psychology*, *72*, 456–466.

Simpson, J. A., Gangestad, S. W., Christensen, P. N., & Leck, K. (1999). Fluctuating asymmetry, sociosexuality and intrasexual competitive tactics. *Journal of Personality and Social Psychology*, *76*, 159–172.

Skilling, T. A., Harris, G. T., Rice, M. E., & Quinsey, V. L. (2000). *The assessment of persistently antisocial offenders* (submitted for publication).

Skilling, T. A., Quinsey, V. L., & Craig, W. M. (in press). Evidence of a taxon underlying serious antisocial behavior in boys. *Criminal Justice and Behavior*.

Thornhill, R. (1992). Fluctuating asymmetry, interspecific aggression and male mating tactics in two species of Japanese scorpionflies. *Behavioral Ecology and Sociobiology*, *30*, 357–363.

Thornhill, R., & Gangestad, S. W. (1994). Human fluctuating asymmetry and sexual behavior. *Psychological Science*, *5*, 297–302.

Thornhill, R., & Møller, A. P. (1997). Developmental stability, disease and medicine. *Biological Review*, *72*, 497–548.

Verdoux, H., Geddes, J. R., Takei, N., Lawrie, S. M., Bovet, P., Eagles, J. M., Heun, R., McCready, R. G., McNeil, T. F., O'Callaghan, E., Stöber, G., Willinger, M. U., Wright, P., & Murray, R. M. (1997). Obstetric complications and age at onset in schizophrenia: an international collaborative meta-analysis of individual patient data. *American Journal of Psychiatry*, *154*, 1220–1227.

Waynforth, D. (1998). Fluctuating asymmetry and human male life-history traits in rural Belize. *Proceedings of the Royal Society of London, Series B: Biological Sciences*, *265*, 1497–1501.

Waynforth, D. (1999). Differences in time use for mating and nepotistic effort as a function of male attractiveness in rural Belize. *Evolution and Human Behavior*, *20*, 19–28.

Widom, C. S. (1976). Interpersonal conflict and cooperation in psychopaths. *Journal of Abnormal Psychology*, *85*, 330–334.

Widom, C. S. (1977). A methodology for studying non-institutionalized psychopaths. *Journal of Consulting and Clinical Psychology*, *45*, 674–683.

Widom, C. S., & Newman, J. P. (1985). Characteristics of non-institutionalized psychopaths. In: D. P. Farrington, & J. Gunn (Eds.), *Aggression and dangerousness* (pp. 57–80). New York: Wiley.

Williamson, S., Hare, R. D., & Wong, S. (1987). Violence: criminal psychopaths and their victims. *Canadian Journal of Behavioural Sciences*, *19*, 454–462.

Williamson, S., Harpur, T. J., & Hare, R. D. (1991). Abnormal processing of affective words by psychopaths. *Journal of Psychophysiological Research*, *28*, 260–273.

Yeo, R. A., & Gangestad, S. W. (1998). Developmental instability and phenotypic variation in neural organization. In: N. Raz (Ed.), *Development, exceptionality, and pathology of the brain as models in cognitive neuroscience* (pp. 1–51). Amsterdam: Elsevier.

Yeo, R. A., Gangestad, S. W., & Daniel, W. F. (1993). Hand preference and developmental instability. *Psychobiology*, *21*, 161–168.