Psychopathic Traits and Endocrine Function as Predictors of Costly and Non-Costly Reactive Aggression

by

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Abstract

I investigated factors of psychopathy (fearless dominance, self-centered impulsivity) and hormones (testosterone, cortisol, estradiol) in predicting costly and non-costly reactive aggression. I hypothesized that whereas self-centred impulsivity (SCI) would promote costly aggression, fearless dominance (FD) would promote non-costly aggression. Costly aggression was measured using the Point Subtraction Aggression Paradigm and non-costly aggression was measured using one-shot dictator games. In women (n = 97; M age = 19.86 years), greater SCI and lower baseline estradiol predicted greater costly aggression; also, greater FD predicted greater non-costly aggression, particularly among women with lower SCI. In men (n = 104; M age = 20.15 years), psychopathy and endocrine function did not predict costly aggression; however, greater FD and greater increases in testosterone were associated with greater non-costly aggression. Thus, there are sex-specific links between psychopathic personality traits, hormones, and aggressive behaviour, and psychopathic traits and endocrine function predict aggressive behaviour independently of each other.

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Antisocial behaviour and aggression are hallmarks of the personality disorder of psychopathy (reviewed in Leistico, Salekin, DeCoster, & Rogers, 2008; Porter & Woodworth, 2006; Reidy, Shelley-Tremblay, & Lilienfeld, 2011), but there is uncertainty as to which psychopathic traits promote aggressive behaviour and whether such associations differ depending on the type of aggression studied. Research has also revealed sex-specific links between hormones and both psychopathy and aggression. To further inform the interplay among these factors, in the present study I tested psychopathic traits (fearless dominance, self-centered impulsivity) and hormones (testosterone, cortisol, estradiol) as predictors of behavioural reactive aggression (costly and non-costly) in men and women.

Psychopathy and Aggression

Psychopathy is a personality disorder characterized by severe interpersonal, emotional, and behavioural dysfunction (Cleckley, 1941/1988; Hare, 1991). Psychopaths have been defined as "intraspecies predators who use charm, manipulation, intimidation, and violence to control others and satisfy their own selfish needs... violating social norms and expectations without the slightest sense of guilt or regret" (Hare, 1996, p. 26). Although only 1% of the population meet the clinical criteria for psychopathy (with higher prevalence in men than in women; Coid, Yang, Ullrich, Roberts, & Hare, 2009), the constellation of personality traits that characterize psychopathy vary along a continuum in the general population. Accordingly, numerous clinical and self-report measures have been developed to assess these traits in both clinical and non-clinical

populations (for a review of clinical and self-report assessment instruments, see Hare & Neumann, 2006; Lilienfeld & Fowler, 2006).

For most of the measures of psychopathic personality traits, factor analysis indicates psychopathy comprises distinct factors. Although there is debate as to the number of factors that delineate these traits (see Cooke, Michie, & Hart, 2006; Hare & Neumann, 2006), a two-factor structure is most common: Factor I traits[1] generally include fearlessness, glibness/superficial charm, lack of remorse/guilt and anxiety, and shallow affect, whereas Factor II traits generally include impulsivity, irresponsibility, early behaviour problems, and criminal versatility. Factor I traits are associated with greater behavioural (e.g., Hall, Benning, & Patrick, 2004) and attentional control (e.g., Baskin-Sommers, Zeier, & Newman, 2009) and higher executive cognitive functioning (e.g., Sellbom & Verona, 2007), whereas Factor II traits are associated with lower behavioural (e.g., cautiousness, planning ahead; Verona, Patrick, & Joiner, 2001), anger (e.g., Hall et al., 2004) and attentional control (Baskin-Sommers et al., 2009), and lower executive cognitive functioning (Sellbom & Verona, 2007). At face value, Factor I and Factor II traits have different relationships to cost-benefit analysis and self-control, two cognitive mechanisms suggested to operate in parallel to regulate aggressive behaviour

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[1] Factor I traits is used throughout the paper as an umbrella term for: Factor I traits as assessed by the Psychopathy Checklist Inventory (Hare, 1980) and its revised versions (PCL-R; Hare, 1991; Hare, 2003); the Self-Report Psychopathy Scale (Hare, 1985) and its revised versions (SRP-II, Hare, Harpur, & Hemphill, 1989; SRP-III, Paulhus, Hemphill, & Hare, in press) primary psychopathy as assessed by Levenson's Self-Report Psychopathy Scale (LSRP; Levenson, Kiehl, & Fitzpatrick, 1995); or fearless dominance as assessed by the Psychopathic Personality Inventory (Lilienfeld & Andrews, 1996) and its revised version (PPI-R; Lilienfeld & Widows, 2005). Factor II traits is also used throughout the paper as an umbrella term for: Factor II of the PCL, PCL-R and SRP-I,II,III; secondary psychopathy as assessed by the LSRP; and impulsive antisociality as assessed by the PPI (or self-centred impulsivity, as labelled in the PPI-R).

(Archer, Fernandez-Fuertes, & Thanzami, 2010); thus, the two factors may differ in their relationship with aggressive behaviour.

Like psychopathy, aggression is not unidimensional and encompasses a wide variety of behaviours that can be assorted into two main sub-types: proactive/instrumental aggression and reactive/hostile aggression (Anderson & Bushman, 2002). Proactive/instrumental aggression is often premeditated, planned, and committed in hopes of obtaining some goal (e.g., money, status). It is characterized by little or no affect and low physiological arousal (reviewed in Cima & Raine, 2009). Proactive/instrumental aggression seems consistent with the traits that make up Factor I (high execute function, low affect and arousal, good behavioural control). Conversely, reactive/hostile aggression occurs in response to provocation, is often characterized by anger, thoughtlessness, impulsivity, information processing problems and neurocognitive deficits, high stress reactivity, and is committed with the goal of harming someone (Anderson & Bushman, 2002; Cima & Raine, 2009), and would thus seem consistent with the traits of Factor II.

Research has found that Factor I traits typically share stronger, positive, and more consistent associations with proactive/instrumental aggression than do Factor II traits (using self-report, criminal review, and laboratory aggression paradigms, in both incarcerated and non-incarcerated samples, reviewed in Reidy et al., 2011). In contrast, the evidence for a relationship between Factor II traits and reactive/hostile aggression is mixed. Some studies found a stronger association between Factor II (vs. Factor I) traits and reactive/hostile aggression measured using self-report and criminal history measures (e.g., Cima & Raine, 2009; Flight & Forth, 2007; Vitacco, Neumann, Caldwell, Leistico,

& Van Rybroek, 2006). Other studies using laboratory aggression paradigms report stronger associations between Factor I (vs. Factor II) traits and reactive/hostile aggression (e.g., Reidy, Zeichner, Miller, & Martinez, 2007), or that individuals higher in Factor I traits are more reactive aggressive than those lower in Factor I traits (e.g., Lotze, Veit, Anders, & Birbaumer, 2007). Thus, findings concerning the links between the two factors of psychopathy and reactive aggression are inconsistent.

The cost of the aggression is a situational factor that may help elucidate the relationship between psychopathy trait factors and reactive aggression. Woodworth and Porter (2002, 2006) suggested that psychopaths may be selectively impulsive such that reactive aggression is inhibited when the stakes are high. When the stakes are low, however, psychopaths may choose not to inhibit reactive aggression such that aggressive behaviour may actually be promoted. This selective impulsivity – perhaps better labelled as self-control or cost-benefit analysis – may be more consistent with high Factor I than high Factor II traits (Porter & Woodworth, 2006). For example, Fowles and Dindo (2006) suggested that Factor I is associated with the type of risk-taking for which the consequences of the act are considered before acting, rather than with impulsive risk-taking for which consequences are not considered. In a review of the literature, Poythress and Hall (2011) reported that Factor I traits were most strongly related to functional and adaptive forms of impulsivity (compared to dysfunctional and maladaptive forms), which suggests an ability to properly weigh the consequences of one's actions and consider alternative behavioural choices. Conversely, Factor II traits were associated with more dysfunctional and maladaptive forms of impulsivity, suggesting an inability to weigh consequences or consider behavioural alternatives. Therefore, the cost of reactive

aggression may be an important situational factor to which individuals high in Factor I traits are particularly sensitive.

Nevertheless, studies of the associations between psychopathic personality traits and reactive aggression using laboratory aggression paradigms typically have involved low-stakes aggression in which participants can aggress without incurring financial or other overt costs (e.g., Jones & Paulhus, 2010; Lotze et al., 2007; Miller & Lynam, 2003; Reidy et al., 2007; Reidy, Zeichner, & Seibert, 2011; Reidy, Zeichner, & Martinez, 2008; Veit et al., 2010). Such low-stake paradigms may exaggerate relationships between reactive aggression and both factors of psychopathy given that some traits are associated with improved cost-benefit analysis and may only protect against high-stakes forms of reactive aggression. Additionally, many laboratory studies reported results for total psychopathy scores only (e.g., Jones & Paulhus, 2010; Miller & Lynam, 2003; Nouvion, Cherek, Lane, Tcheremissine, & Lieving, 2007), leaving the relationships between aggression and specific factors of psychopathy unknown. How psychopathic personality factors differentially promote, or possibly inhibit, reactive aggression may better be determined by exploring each factor as a separate (but simultaneous) predictor, and using a variety of aggression measures for which the cost of aggression varies.

In the current study, I thus investigated associations between both psychopathic personality factors and two forms of reactive aggression: costly and non-costly. Because Factor I traits are associated with enhanced cost-benefit analysis (based on a link between Factor I and higher executive cognitive function, attentional control, and "selective impulsivity", Baskin-Sommers et al., 2009; Porter & Woodworth, 2006; Sellbom & Verona, 2007) and Factor II traits are associated with decreased self-control (e.g.,

Sellbom & Verona, 2007), two cognitive mechanisms suggested to operate in parallel to regulate aggressive behaviour (Archer et al., 2010), I hypothesized differential associations between the factors and the forms of reactive aggression. Specifically, I hypothesized that Factor I would be a stronger predictor of non-costly reactive aggression than Factor II. In contrast, I predicted that Factor II would be a stronger predictor of costly reactive aggression than Factor I. Further, I predicted that Factor I and II traits would interact (e.g., Walsh & Kosson, 2008) such that Factor II traits may have stronger associations with costly reactive aggression when Factor I traits are low, and Factor I traits may have stronger association with non-costly aggression when Factor II traits are low. Thus, I tested for interactions between Factor I and Factor II traits in predicting each form of reactive aggression.

Endocrine Function and Aggression

A second aim of the study was to test psychopathic personality traits and endocrine function as simultaneous predictors of reactive aggression given evidence that they may not be independently related to aggression. For example, van Honk and Schutter (2006) proposed that the emotional processing deficits in psychopathy may result from an endocrine profile of low cortisol, a hormone involved in the stress response (Stratakis & Chrousos, 1995), and high testosterone, a sex hormone associated with dominance (Mazur & Booth, 1998). Additionally, this hormonal profile is thought to increase the risk for both proactive/instrumental and reactive/hostile aggression (Terburg, Morgan, & van Honk, 2009; van Honk, Harmon-Jones, Morgan, & Schutter, 2010). It was thus important to determine if psychopathic personality traits and endocrine function

(particularly the interaction between testosterone and cortisol) have independent roles in predicting aggressive behaviour.

I also tested hypotheses derived from the broader literature addressing the association between endocrine functioning (as reflected in baseline testosterone, cortisol, and estradiol, and changes in these hormones over time) and aggression. Most previous research on this issue has examined only testosterone, and its relationship with aggressive behaviour has been inconsistent, possibly because of the use of self-report measures of aggression in many studies rather than behavioural measures, with the former type of measure tending to produce smaller associations with endocrine measures than the latter (reviewed in Archer, Graham-Kevan, & Davies, 2005). In studies in which behavioural measures of aggression have been used, however, there is generally a positive association between baseline testosterone and aggression (reviewed in Archer et al., 2005).

Similar to van Honk and Schutter's (2006) proposal that low cortisol and high testosterone may lead to the emotional deficits in psychopathy, others have also suggested the relationship between testosterone and aggression is moderated by baseline cortisol concentrations, such that baseline testosterone and aggression are only positively correlated when baseline cortisol concentrations are low (Dabbs, Jurkovic, & Frady, 1991; Popma et al., 2007; Mehta & Josephs, 2010; also reviewed in Carré & Mehta, 2011; Liening & Josephs, 2010; Terburg et al., 2009; van Honk et al., 2010). In addition, there is some evidence of a negative relationship between baseline cortisol and aggressive and antisocial behaviour (reviewed in Alink et al., 2008). Thus, I tested the hypotheses that baseline testosterone would be positively associated with aggression, baseline cortisol would be negatively related to aggression, and that baseline testosterone and

cortisol would interact to predict aggression such that only among those with low cortisol would greater testosterone concentrations be associated with greater aggression.

Further, hormone concentrations are not static, but instead fluctuate in response to contextual cues of future competitive and aggressive encounters (reviewed in Archer, 2006; Mazur & Booth, 1998; Oliveira, 2009; Wingfield, Hegner, Dufty, & Ball, 1990) and these fluctuations may serve to influence subsequent behaviours aimed at regulating status (Mazur, 1985). For example, increases in testosterone that are dependent on the outcome of competitive social interactions increase subsequent competitive and aggressive behaviour (e.g., Carré & McCormick, 2008; Carré, Putnam, & McCormick, 2009; Geniole, Carré, & McCormick, 2011; Mehta & Josephs, 2006; also reviewed in Carré, McCormick, & Hariri, 2011). Some studies have found state dependent changes in hormone concentrations were more predictive of aggressive behaviour than were trait or baseline concentrations (e.g., Carré, Gilchrist, Morrissey, & McCormick, 2010; Geniole et al., 2011). Evidence also suggests that increases in cortisol, rather than lower levels of baseline concentrations, may be more important for predicting aggression in men (e.g., Geniole et al., 2011). Further, women administered hydrocortisone were more aggressive than a placebo group (Böhnke et al., 2010). Thus, in the present study I also tested the hypotheses that an increase in testosterone and/or cortisol would be associated positively with aggression.

In addition to examining testosterone and cortisol, estradiol was also investigated given that estradiol may be a more relevant hormone for aggression in women than testosterone and cortisol. For example, a recent report found that lower baseline estradiol concentrations were associated with greater self-reported aggression, whereas there was

no relationship between baseline testosterone and self-reported aggression (Stanton & Schultheiss, 2007). Researchers have also reported negative associations between baseline estradiol and athletic competition (Cashdan, 2003). Thus, I tested the hypothesis of a negative association between baseline estradiol and aggression. Although I also included changes in estradiol as a predictor (along with changes in testosterone and cortisol), I had no hypotheses regarding this variable given that little research to date has investigated such changes as a predictor of aggression.

The Present Study

In the present study I investigated the relationship between psychopathic personality traits, endocrine function, and reactive aggression under conditions in which the aggression was costly or non-costly to the participant. To measure psychopathic personality traits, I used the PPI-R (Lilienfeld & Widows, 2005), which contains two orthogonal factors, labelled Fearless Dominance (Factor I) and Self-Centred Impulsivity (Factor II). I used the Point Subtraction Aggression Paradigm (PSAP) as a measure of costly aggression and two different one-shot dictator games (originally used in Forsythe, Horowitz, Savin, & Sefton, 1994; Kahneman, Knetsch, & Thaler, 1986) as measures of non-costly aggression. I also tested the various hypotheses outlined above separately for men and women because psychopathic personality traits, much like testosterone concentrations and aggression, are sexually dimorphic (higher in men; reviewed in Dolan & Völlm, 2009). Further, evidence suggests that psychopathy may be a qualitatively different phenomenon in women than in men (e.g., Anestis, Caron, & Carbonell, 2011; also reviewed in Dolan & Völlm, 2009). In addition, many studies of hormone-behaviour

interactions have found the relationships to be sex-specific (e.g., Böhnke et al., 2010; Carré et al., 2009; Poustka et al., 2010).

Methods

Participants

Undergraduate students (107 men, 101 women, M_{age} = 20.0 years, $S.D_{age}$ = 2.5 years, age range: 18 – 37 years; 79.3% White, 5.3% Asian, 3.4% Black, 11.5% other) were recruited from the Brock University undergraduate research pool. Procedures were approved by Brock University's research ethics board (see Appendix A).

Measures

Psychopathic personality traits.

The Psychopathic Personality Inventory – Revised (PPI-R) is a self-report questionnaire comprising 154 items focusing on psychopathic personality traits (Lilienfeld & Widows, 2005), rather than antisocial or criminal behaviour, and is designed to be used in both clinical and non-clinical samples. The questionnaire consists of eight content scales subsumed under three factors: Fearless dominance (45 items; e.g., "I feel sure of myself when I am around other people", "I like (or would like) to play sports with a lot of physical contact", "I can remain calm in situations that would make other people panic"), Self-centered impulsivity (70 items; e.g., "How much I like someone really depends on how much that person does for me", "I have never cared about society's 'values of right and wrong'", "I get blamed for many things that aren't my fault", "I like to act first and think later"), and Coldheartedness (16 items; e.g., "When someone gets hurt by something I say or do, that's their problem") (Lilienfeld & Widows, 2005). I made no specific hypotheses of associations between Coldheartedness

and aggression because there is debate as to whether it compromises the factor structure of the PPI-R (e.g., Anestis et al., 2011) and as to whether it properly measures callousness/cruelty (e.g., Benning, Patrick, Hicks, Blonigen, & Krueger, 2003). Nevertheless, I included it as a control variable in my models to ensure that any associations between fearless dominance and aggressive behaviour and between self-centred impulsivity and aggressive behaviour were independent of this factor. Items on the PPI-R are rated on 4-point Likert-type scales, ranging from 1 (true) to 4 (false). Scores for fearless dominance, self-centered impulsivity, and coldheartedness were computed by summing the ratings for the respective factor items; αs = .91, .90, and .82, respectively. Higher scores indicate greater fearless dominance, greater self-centred impulsivity, and greater coldheartedness, respectively. According to a recent meta-analysis (Marcus, Fulton, & Edens, 2012), fearless dominance shares significant positive associations with Factor I scores as assessed by the revised Psychopathy Checklist Inventory (Hare, 2003) and Self-Report Psychopathy Scale (Hare, Harpur, & Hemphill, 1989), and with primary psychopathy as assessed by the Levenson's Self-Report Psychopathy Scale (Levenson, Kiehl, & Fitzpatrick, 1995) (*r*s = .21, .53, .17, respectively). Conversely, self-centred impulsivity shares strong positive associations with Factor II scores and with secondary psychopathy as assessed by these scales (*r*s = .41, .67, .65, respectively). The PPI-R also includes an inconsistent responding scale, which is used to identify inconsistent responders for whom the scores are likely invalid. Seven participants (three men, four women; 3.3% of sample) were removed from the present study because of inconsistent responses on the PPI-R reducing the sample to 104 men and 97 women.

Costly reactive aggression.

The Point Subtraction Aggression Paradigm (PSAP) is a well validated measure of reactive aggression (Cherek, Moeller, Schnapp, & Dougherty, 1997; Cherek, Lane, Dougherty, Moeller, & White, 2000). The PSAP is a computer game in which a participant is paired with a fictitious player of the same sex and is informed that the goal of the game is to earn points that are exchangeable for money at the end of the task (see Appendix B for the verbal script). In the version of the PSAP used here, there were three response options available: Participants could earn a point by pressing button #1 100 consecutive times, steal a point from the other player by pressing button #2 10 consecutive times, and/or protect their points by pressing button #3 10 consecutive times. After a one minute practice round, participants completed two ten minute sessions. Throughout each session, the participant's point total was displayed in black font in the middle of the computer screen. Whereas in previous research our lab has utilized a version of the PSAP that limited the speed with which participants could press buttons by constraining the minimum inter-press interval to 170 ms, (Carré & McCormick, 2008; Carré et al., 2009; Carré et al., 2010; Geniole et al., 2011), in the current study I decreased the minimum inter-press interval to 50 ms, given that I was interested in individual differences in self-control (i.e., impulsivity) processes in relation to aggression. Further, I used only two rounds rather than three rounds of the PSAP to keep the test session within an hour based on my findings that button presses across rounds are highly correlated (Geniole et al., 2011).

During the game, participants have points stolen from them by the fictitious player (i.e., they are provoked), which is indicated to the participant by the point counter

increasing in size, flashing several times in red font, and decreasing by a point. They may respond by stealing the opponent's points but they are told that points stolen from the opponent are not added to their own total. Thus, because participants do not gain financially by stealing points, it can be inferred that participants are stealing points to 'punish' their partner. Therefore, stealing points on the PSAP fits the definition of aggressive behaviour, which is any behaviour "directed toward the goal of harming or injuring another living being who is motivated to avoid such treatment" (Baron & Richardson, 1994, p. 7). According to Baron and Richardson (1994), the harm need not be physical but must be considered aversive by the target. Further, our lab has shown that stealing points comes at the expense of gaining points (e.g., Carré & McCormick, 2008; Carré et al., 2009; Carré et al., 2010), which is why I describe PSAP aggression as costly aggression; for example, in the present sample, the number of times participants stole a point from the opponent was negatively correlated with their total points earned (r = -.57, $p < 0.001$)[2]. Stealing is considered reactive aggression because it occurs in response to provocation (Geniole et al., 2011), and, indeed, preliminary analyses of the data from this study showed that aggression increased after the first provocation for both men and women (M pre-provocation steals = 12.12 for women, 19.82 for men; M post-provocation steals = 27.30 for women, 36.01 for men; ts > 5.10, ps < 0.001, Cohen's ds > .52).

The measure of aggression used in my analyses was calculated by first averaging (separately) earn, steal, and protect presses across the two PSAP rounds. The number of

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[2] Controlling for the total number of button presses (the sum of earn, steal and protect presses), as an index of the individual differences in the speed in which participants can press buttons. Previously, our lab has limited the speed with which participants could press buttons. Here, I did not, thus, individuals who were faster at pressing the buttons earned, stole, and protected more. It was thus important to control statistically for this potential confound.

steal presses was then regressed on the number of earn and protect presses, and the residuals from this analysis were then used as an index of costly aggression. This residual score was thus independent of participants' earn and protect presses. In the following analyses, this residual is referred to as 'PSAP aggression'.

Post-PSAP questionnaire.

After the PSAP task, participants were asked to write any thoughts or impressions they had about their opponent, and to include any general comments about the PSAP. These questions were included to assess participant suspicion about the reality of their opponent. Seventeen participants (4 women, 13 men; 9% of the sample) expressed suspicion, which is comparable to suspicion rates in previous studies (Carré, Gilchrist, Morrissey, & McCormick, 2010; Geniole, Carré, & McCormick, 2011). Results, however, did not differ when these participants were excluded, thus they were included in all subsequent analyses.

Non-costly aggression.

After the PSAP, participants were randomly assigned to one of two conditions that were similar to reward allocation and dictator paradigms used in the literature (reviewed in Rabin, 1998). In one of the conditions (similar to reward allocation paradigms), participants were told they had earned more points than their opponent during the PSAP, which meant they would decide how much of an honorarium the other player would receive (up to 5 dollars). Because the amount of the honorarium did not affect participants' own monetary gain, responses ranging from 0-4 dollars were classified as aggressive and responses of 5 dollars were defined as non-aggressive.

Aggression in this condition is considered non-costly because doing so did not affect the participant's monetary gain.

Because I was concerned that this condition may have a low base-rate of aggression, half of participants were randomly assigned to an alternative non-costly aggression condition after the PSAP in which they were told they had earned more points than their opponent during the PSAP, which provided them with an additional 5 dollars to split with their opponent (similar to dictator game; Forsythe, Horowitz, Savin, & Sefton, 1994; Kahneman, Knetsch, & Thaler, 1986). In this condition, aggression was defined as not sharing (0 dollars), and sharing any amount (1 to 5 dollars) was considered non-aggressive. Because participants had more incentive to aggress in this condition (i.e., they kept money not given to their opponent) than in the "decide the honorarium" condition, I expected a greater frequency of aggressive responses in this condition compared to the "decide the honorarium" condition.

For both non-costly aggression conditions, participants were reminded that their identity would be completely confidential, and then the researcher left the room so the participant could provide a response in private. Participants recorded their decision on a small slip of paper with dollar amounts ranging from $0 - $5 (Appendix C).

Endocrine measures.

Participants provided two saliva samples for endocrine analyses: one after completing the PPI-R, but before the first round of the PSAP, and another 8 minutes (± 2 minutes) after completing the PSAP but preceding the non-costly aggression task. Samples were collected in polystyrene culture tubes, centrifuged for 15 min to remove particles, and the supernatant was stored at −20 ◦C. Salivary testosterone (pg/mL),

cortisol (ng/mL), and estradiol (pg/mL) concentrations were obtained using commercial enzyme immunoassay kits (DRG International, Inc.). Assays were conducted on three separate days, one for each hormone measure. In brief, samples were thawed and duplicate 100 μL of saliva were assayed according to the instructions of the kits. Optical densities were determined using a Biotek Synergy plate reader at 450 nm. The mean intra-assay and inter-assay coefficient of variation were less than 5% and 10%, respectively. The stability of testosterone and cortisol concentrations over time has been reported to be $r \geq 0.65$ from samples obtained over a two week period (Liening, Stanton, Saini, & Schultheiss, 2010). In addition to determining baseline and post-PSAP hormone levels, to evaluate whether changes in hormones were associated with aggression I also created difference scores for each hormone by subtracting baseline hormone concentrations from post-PSAP hormone concentrations.

Procedure

Test sessions were approximately 60 minutes in length and occurred between the hours of 12:00 p.m. to 6:00 p.m. Participants first completed a consent form (Appendix D), demographic questionnaire (Appendix E), the PPI-R questionnaire, and provided a saliva sample. The participants then completed both rounds of the PSAP, the post-PSAP questionnaire, and provided a second saliva sample. After the second saliva sample, the researcher informed participants that based on their total point score during the PSAP they earned five dollars (participants were told at the beginning of the study that they could win up to 10 dollars). The participant then decided the money allocated to the fictitious player in the non-costly aggression conditions. After deciding the amount,

participants were fully debriefed (Appendix F) and paid $10, regardless of their PSAP performance or the amount of money given to the fictitious player.

Statistical Analyses

Six participants (two men, four women; 2.9% of sample) did not fully complete the PPI-R questionnaire, and two participants (both women; 1% of sample) did not complete the PSAP due to technical difficulties. Further, some participants had missing values for the hormone measures because they had provided insufficient saliva amounts (testosterone, four women, one man, 2.6% of sample; cortisol, two women, one man, 1.5% of sample, and; estradiol, three women, 1.5% of sample). Missing values were found to be 'missing completely at random' (Little's MCAR test: $\chi^2(370) = 43.30, p = 1.00$) and were thus imputed using the expected maximization (EM) algorithm in SPSS. Thus, all available data from all participants (except the seven excluded for inconsistent responding on the PPI-R; see above) were employed in all analyses.

Distributions for the primary study measures (see Table 1) were screened for outliers and normality. I also screened for multivariate outliers, outliers in the regression model solutions, and influential cases. The coldheartedness scores and hormone levels were not normally distributed. Nevertheless, results did not differ when using log10 transformations of these measures; untransformed data were used in subsequent analyses. In preliminary analyses, *t*-tests, mixed factor analyses of variance, and chi-square tests were used to assess sex differences in psychopathy, hormones (baseline, post-PSAP, or changes), and aggression.

In the primary analyses, hierarchical linear regression was used to determine if the PPI-R scores and hormone measures predicted PSAP aggression. In the first step of the

regression model, PSAP aggression was regressed onto the three PPI-R factors and the baseline hormone measures[3]; in the second step, the hypothesized interactions between fearless dominance and self-centered impulsivity, and between baseline testosterone and cortisol were added to the model; in the third step, changes in hormone concentrations were added. To avoid multicollinearity involving the interaction effects, the PPI-R scores and hormone values were centered before being entered into the regression model, and interaction terms were created using these centred values (Cohen, Cohen, West, & Aiken, 2003).

Binary logistic regression was used to determine if the PPI-R scores, hormone measures, or PSAP aggression predicted non-costly aggression. In the first step of the model, a dichotomous aggression score (0-non-aggressive, 1-aggressive) was regressed onto the PSAP aggression score, the three PPI-R factors, and the three baseline hormone measures; in the second step of the model, the hypothesized interactions between fearless dominance and self-centred impulsivity, and between baseline testosterone and baseline cortisol were added; in the third step, changes in hormones were added to the model. Note that the non-costly aggression condition type did not interact with any of the PPI-R variables or hormone measures, but non-costly aggression condition type was a significant predictor of aggression. Thus, I kept condition type as a predictor in the binary logistic regression model to control for variation in overall aggression levels between conditions.

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[3] Adding total button presses as a predictor in the statistical model does not change the results.

Results

Preliminary analyses

Means and standard deviations for the primary study measures are shown in Table 1. Correlations among these measures are shown in Table 2. Women scored lower than men in fearless dominance, self-centred impulsivity, and coldheartedness, and were less aggressive in the PSAP (*t*s (199) > 2.52, *p*s < 0.02, see Table 1). They did not differ, however, in the proportions that were aggressive in the "share a sum of money" aggression ($\chi^2(1) = 1.504$, $p = 0.22$) or "decide the honorarium" aggression conditions ($\chi^2(1) = .114$, $p = 0.74$), or when these conditions were combined ($\chi^2(1) = 1.34$, $p = 0.24$). For men, 45% and 26% were aggressive in the "share a sum of money" and "decide the honorarium" aggression conditions, respectively; for women, corresponding values were 33% and 25%. In addition, 2 (men, women) by 2 (baseline, post-PSAP hormone concentrations) mixed-model analyses of variance on testosterone revealed a main effect of sex ($F(1,199) = 195.83$, $p < 0.001$), with men having higher concentrations of testosterone than women. The same analysis on cortisol concentrations revealed an interaction between sex and time ($F(1,199) = 5.10$, $p = 0.03$); men and women did not differ on baseline cortisol ($t(199) = 0.09$, $p = 0.93$) but men had marginally lower post-PSAP cortisol concentrations than did women ($t(199) = 1.77$, $p = 0.08$). There was no main effect of sex, time, or an interaction with estradiol concentrations (*F*s > 0.86, *p*s > 0.35). Whereas the PPI-R factors were significantly, but modestly, associated in women, they were not associated in men (see Table 2).

Table 1

Descriptive statistics for psychopathy, aggression, and hormone measures, by sex.

	Men	Women
	Means (*SD*)	Means (*SD*)
Fearless Dominance	120.84 (16.63)*	110.19 (19.64)
Self-Centred Impulsivity	148.83 (21.02)*	136.91 (18.97)
Coldheartedness	33.08 (6.94)*	29.23 (6.46)
PSAP aggression	50.04 (307.20)*	-53.65 (271.80)
% Aggressive in the NC conditions	37%	29%
Baseline Hormones		
Testosterone	107.35 (49.62)*	38.64 (23.93)
Cortisol	3.81 (1.64)	3.83 (1.22)
Estradiol	3.57 (1.34)	3.83 (2.09)
Post-PSAP Hormones		
Testosterone	112.73 (47.60)*	38.93 (22.30)
Cortisol	3.17 (1.19)	3.47 (1.19)
Estradiol	3.77 (1.94)	3.85 (2.34)
Change in Concentrations		
Testosterone	5.38 (35.07)	0.29 (13.37)
Cortisol	-0.64 (0.92)*	-0.36 (0.84)
Estradiol	0.19 (1.67)	0.01 (1.46)

Note. N = 104 (men) and 97 (women). PSAP = Point subtraction aggression paradigm. NC = non-costly aggression conditions. * = ts (199) > 2.26, ps < 0.03.

Table 2

Correlations among psychopathy, hormones, and aggression measures, by sex.

				Aggression		Baseline			Change		
Variables	FD	SCI	CH	PSAP	NC	T	C	E	T	C	E
Fearless Dominance	-	.08	.07	.03	**.21**	.04	.16	-.11	-.05	-.02	-.06
Self-Centred Impulsivity	**.23**	-	.09	.08	.08	.11	.00	-.05	-.04	-.08	-.16
Coldheartedness	**.27**	**.31**	-	.04	.08	-.12	.04	.01	.06	.06	-.01
PSAP Aggression	-.04	**.26**	.08	-	-.02	-.04	-.02	-.04	.15	.14	-.09
NC Aggression	**.27**	**.27**	.15	.00	-	-.05	-.14	-.01	.18	.14	-.14
Baseline Testosterone	.04	.19	.13	.01	.17	-	**.35**	.17	**-.41**	**-.42**	-.18
Baseline Cortisol	.15	.10	-.04	.09	.04	**.22**	-	**.25**	**.25**	-.11	-.06
Baseline Estradiol	.14	**.27**	-.02	-.13	.07	**.26**	.19	-	-.12	-.16	-.19
Change in Testosterone	-.09	**-.20**	.14	-.11	-.12	**-.40**	-.06	**-.30**	-	**.32**	**.22**
Change in Cortisol	-.03	-.14	.14	-.16	**-.20**	**-.36**	**-.38**	-.04	**.33**	-	.19
Change in Estradiol	.03	-.05	.14	.00	-.15	-.18	-.12	-.17	**.32**	**.37**	-

Note. $N = 104$ (men) and 97 (women). Results for men are shown in the upper right triangle, above the dashes; results for women are shown in the lower left triangle, below the dashes. Correlations (Pearson product-moment and point biserials coefficients) in bold are significant, $p < 0.05$. FD = Fearless Dominance. SCI = Self-Centred Impulsivity. CH = Coldheartedness. PSAP = Point subtraction aggression paradigm. NC = non-costly aggression conditions (coded as 0 = non-aggressive, 1 = aggressive). T = Testosterone. C = Cortisol. E = Estradiol.

Do psychopathic personality traits or hormones predict costly aggression?

In men, none of the steps in the hierarchical regression model accounted for significant variability in PSAP aggression (Fs ≤ 1.95, ps ≥ 0.13). Furthermore, as shown in Table 3, within each step, none of the predictors were significant. In women, the first step of the hierarchical regression model was significant and accounted for 13% of the variance in PSAP aggression ($F(6,90) = 2.28$, $p = 0.04$). Women with higher (vs. lower) self-centred impulsivity and lower (vs. higher) baseline concentrations of estradiol were more aggressive in the PSAP. The second and third steps were not significant ($F_{changes} \leq 0.89$, $p \geq 0.45$).

Table 3

Results from hierarchical linear regression model predicting costly aggression in the Point Subtraction Aggression Paradigm, by sex.

	Step 1			Step 2			Step 3		
Sex / Predictors	β	*t*	*p*	β	*t*	*p*	β	*t*	*p*
Results for men									
Fearless Dominance	0.03	0.25	0.80	0.04	0.39	0.70	0.01	0.08	0.94
SCI	0.07	0.71	0.48	0.05	0.45	0.65	0.05	0.44	0.67
Coldheartedness	0.02	0.23	0.82	0.02	0.23	0.82	0.01	0.08	0.94
Baseline									
Testosterone	-0.03	-0.31	0.76	-0.01	-0.04	0.97	0.06	0.49	0.63
Cortisol	-0.01	-0.08	0.94	0.01	0.12	0.90	0.18	1.12	0.27
Estradiol	-0.03	-0.24	0.81	-0.02	-0.20	0.84	-0.05	-0.50	0.62
Testosterone x Cortisol				-0.10	-0.81	0.42	-0.05	-0.46	0.65
FD x SCI				0.03	0.30	0.77	0.05	0.46	0.64
Change in									
Testosterone							0.13	1.14	0.26
Cortisol							0.25	1.58	0.12
Estradiol							-0.15	-1.38	0.17
Results for women									
Fearless Dominance	-0.11	-1.01	0.31	-0.10	-0.94	0.35	-0.13	-1.18	0.24
SCI	0.33	3.05	<0.01	0.33	2.86	<0.01	0.30	2.59	0.01
Coldheartedness	0.01	0.13	0.89	0.00	0.04	0.97	0.07	0.57	0.57
Baseline									
Testosterone	-0.03	-0.25	0.80	-0.04	-0.36	0.72	-0.12	-0.99	0.33
Cortisol	0.12	1.18	0.24	0.13	1.23	0.22	0.11	1.00	0.32
Estradiol	-0.22	-2.05	0.04	-0.23	-2.10	0.04	-0.22	-1.97	0.05
Testosterone x Cortisol				0.07	0.69	0.49	0.02	0.16	0.87
FD x SCI				0.02	0.19	0.85	0.04	0.33	0.74
Change in									
Testosterone							-0.16	-1.27	0.21
Cortisol							-0.11	-0.85	0.40
Estradiol							0.05	0.47	0.64

Note. N = 104 (men) and 97 (women). FD = Fearless Dominance. SCI = Self-Centred Impulsivity.

Do psychopathic personality traits or hormones predict non-costly aggression?

In men, the first ($\chi^2(8) = 15.78$, $p = 0.05$, *Nagelkerke* $R^2 = .19$) and third steps of the binary logistic regression model ($\chi^2_{change}(3) = 9.36$, $p = 0.03$, *Total Nagelkerke* $R^2 = .31$) were significant, but the second step was not ($\chi^2_{change}(8) = 1.60$, $p = 0.45$) . As shown in Table 4, results from the third step showed that men who were asked to split a sum of

Table 4

Results from binary logistic regression predicting non-costly aggression by sex.

Predictors	Step 1			Step 2			Step 3		
	Wald	*p*	*expB*	*Wald*	*p*	*expB*	*Wald*	*p*	*expB*
Results for men									
Condition	6.07	0.01	0.30	5.58	0.02	0.31	5.98	0.01	0.28
PSAP Aggression	0.03	0.87	1.00	0.04	0.85	1.00	0.56	0.45	1.00
Fearless Dominance	7.42	<0.01	1.04	7.96	<0.01	1.05	8.22	<0.01	1.05
SCI	0.50	0.48	1.01	0.07	0.79	1.00	0.00	0.96	1.00
Coldheartedness	0.01	0.94	1.00	0.05	0.82	1.01	0.09	0.76	1.01
Baseline									
Testosterone	0.01	0.94	1.00	0.01	0.94	1.00	0.31	0.58	1.00
Cortisol	4.03	0.05	0.71	3.42	0.06	0.73	2.38	0.12	0.68
Estradiol	0.40	0.53	1.11	0.45	0.50	1.12	0.10	0.76	1.06
Testosterone x Cortisol				0.15	0.70	1.00	0.00	0.96	1.00
FD x SCI				1.31	0.25	1.00	1.90	0.17	1.00
Changes in									
Testosterone							5.53	0.02	1.02
Cortisol							0.01	0.91	1.05
Estradiol							2.56	0.11	0.71
Results for women									
Condition	1.96	0.16	0.49	2.39	0.12	0.43	1.96	0.16	0.46
PSAP Aggression	0.43	0.51	1.00	0.73	0.39	1.00	0.75	0.39	1.00
Fearless Dominance	4.42	0.04	1.03	8.99	<0.01	1.07	7.77	<0.01	1.07
SCI	4.31	0.04	1.04	5.59	0.02	1.05	4.84	0.03	1.05
Coldheartedness	0.01	0.92	1.00	0.04	0.85	0.99	0.00	1.00	1.00
Baseline									
Testosterone	1.93	0.17	1.02	0.81	0.37	1.01	0.61	0.44	1.01
Cortisol	0.00	1.00	1.00	0.48	0.49	0.85	1.03	0.31	0.75
Estradiol	0.48	0.49	0.92	0.77	0.38	0.89	0.26	0.61	0.92
Testosterone x Cortisol				0.40	0.53	1.01	0.09	0.76	1.00
FD x SCI				7.13	<0.01	0.99	5.32	0.02	0.99
Changes in									
Testosterone							0.15	0.70	1.01
Cortisol							1.07	0.30	0.66
Estradiol							0.37	0.54	0.87

Note. N = 104 (men) and 97 (women). FD = Fearless Dominance. SCI = Self-Centred Impulsivity. Condition: 0 = share a sum of money, 1 = decide the honorarium.

money were more aggressive than those who decided the honorarium (main effect of condition type); men high in fearless dominance were more aggressive than were men low in fearless dominance (see Figure 1), and men who experienced a greater increase in

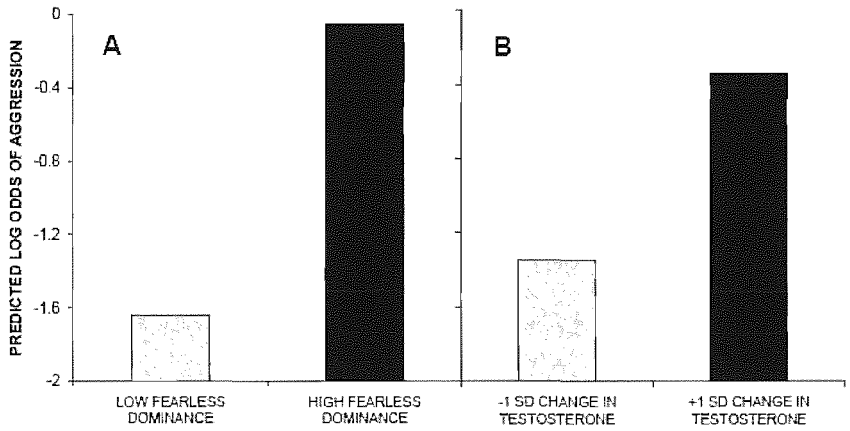

Figure 1. Main effects of fearless dominance and changes in testosterone in predicting non-costly aggression in men. Panel A depicts the predicted log odds of aggression when fearless dominance is 1 standard deviation below and above the mean holding all other variables constant. Panel B depicts the predicted log odds of aggression when testosterone changes are 1 standard deviation below and above the mean holding all of the other variables constant.

testosterone were more aggressive than those who experienced a lesser increase (see Figure 1).

In women, the first step of the binary logistic regression model was significant ($\chi^2(8) = 16.35, p = 0.04$, *Nagelkerke* $R^2 = .22$). At this step, greater fearless dominance and greater self-centred impulsivity both predicted greater likelihood of aggression. The second step of the model accounted for significantly more variability in aggression ($\chi^2_{change}(2) = 10.25, p = 0.01$, *Nagelkerke* $R^2 = .34$). At this step, the interaction between fearless dominance and self-centered impulsivity was significant. As shown in Figure 2, higher fearless dominance was associated with a greater likelihood of aggression, especially among women with low self-centred impulsivity; similarly, higher self-centered impulsivity was associated with a greater likelihood of aggression, especially

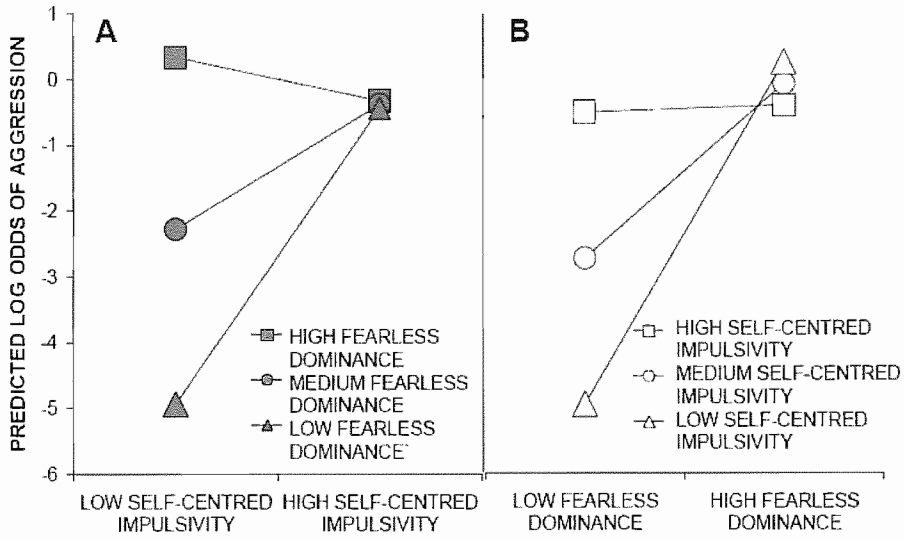

Figure 2. Interaction between fearless dominance and self-centered impulsivity in predicting non-costly aggression in women. Panel A depicts fearless dominance as the moderator. Panel B depicts self-centred impulsivity as the moderator. High and low values represent scores 1 standard deviation above and below the mean (medium value), respectively.

among women with low fearless dominance. The third step of the model was not significant (χ^2_{change} (3) = 1.99, p = 0.58).

Discussion

There have been mixed findings regarding the relationship between psychopathic personality traits and reactive aggression, and regarding the extent to which the two factors of psychopathy differentially promote or inhibit such behaviour (reviewed in Reidy et al., 2011). Woodworth and Porter (2002, 2006) proposed that the cost of reactive aggression may be an important factor such that reactive aggression may be inhibited when it is costly but will be promoted when it is non-costly. Further, the ability to selectively inhibit aggression may be related differentially to each factor of psychopathy. I thus examined associations between the factors of psychopathy (fearless dominance and self-centred impulsivity) and reactive aggression under conditions in which the behaviour

was either costly or non-costly. I also examined the role of hormones in predicting costly and non-costly aggressive behaviour to test emerging hypotheses of the physiological correlates of psychopathy and aggression. My findings and their theoretical implications are outlined in the next sections.

Psychopathic personality traits and costly aggression

Under conditions in which reactive aggression is costly, I hypothesized that high self-centred impulsivity would share stronger, positive, associations with aggression, and that fearless dominance would share weaker (or perhaps negative) associations with aggression. These predictions were made on the basis of the different relationships each factor has with cost-benefit analysis and self-control, two cognitive mechanisms thought to operate in parallel to regulate aggression (Archer et al., 2010). Whereas fearless dominance may involve improved cost-benefit analysis and self-control, self-centred impulsivity may involve impaired cost-benefit analysis and self-control (Porter & Woodworth, 2006; Sellbom & Verona, 2007). My hypothesis received partial support: In the Point Subtraction Aggression Paradigm (PSAP), higher self-centred impulsivity predicted greater costly aggression in women, but there was no relationship between PSAP aggression and either psychopathic personality factor in men.

My finding that women higher in self-centred impulsivity were more aggressive on the PSAP is consistent with previous research linking impulsivity in delayed discounting tasks and costly aggressive behaviour on the PSAP (Cherek et al., 1997) and in the Ultimatum Game (Crockett, Clark, Lieberman, Tabibnia, & Robbins, 2010). That psychopathic personality traits better predicted PSAP aggression in women than in men is surprising given that other studies found stronger associations between psychopathy and

aggression in men than in women (e.g., Miller & Lynam, 2003). One possibility for the lack of an association between self-centred impulsivity and PSAP aggression in men (and the weak association in women) is that reactive aggression in the PSAP is too normative a response and too readily justifiable in the context of the provocation in the game; very few participants do not increase aggressive responding when provoked in the PSAP (Carré et al., 2010; Geniole et al., 2011). Additionally, other researchers reported that the increase in aggression in reaction to provocation in the PSAP among healthy individuals paralleled that of patients with intermittent explosive disorder (New et al., 2009), individuals who usually display disproportionately high levels of aggression relative to a provocation (American Psychiatric Association, 2000). Thus, aggression in the PSAP test used here may not have a range sufficient enough to detect relationships with psychopathic personality traits.

Consistent with this possibility, in a modified version of the PSAP in which participants were not provoked (aggression was less justifiable) and were able to keep the points they stole (aggression was beneficial rather than costly), individuals who displayed high levels of aggression had higher psychopathic personality traits than those who displayed lower levels of aggression (Nouvion et al., 2007). Similarly, in the Money Withdrawal Aggression Paradigm, a measure of aggression modelled after the PSAP in which participants can aggress without incurring financial costs, psychopathy in men was associated positively with reactive aggression (Miller & Lynam, 2003). Although these studies did not investigate the role of separate factors of psychopathy, their evidence that psychopathic personality traits were positively associated with aggression when non-costly is consistent with my hypotheses. When aggression is costly, however, Factor I

traits may not be associated with reactive aggression, as was the case in the current study, or may even protect against reactive aggression. For example, Osumi and Ohira (2010) presented individuals low and high in Factor I traits with low offers (<30%) in an Ultimatum Game (in which rejection of offers are costly to personal earnings) and found that individuals higher in Factor I traits were less likely to reject such offers.

In sum, my findings highlight the complexity of relationships between psychopathic personality traits and costly reactive aggression. In women, higher self-centred impulsivity, but not fearless dominance, predicted greater aggression whereas in men, none of the factors of psychopathy were relevant predictors of aggression. These results may additionally suggest that self-centred impulsivity is a more relevant predictor of aggression in women than in men.

Psychopathic personality traits and non-costly aggression

After the PSAP, non-costly reactive aggression was measured in one of two conditions: Participants either decided the honorarium of, or split an additional sum of money with, their fictitious PSAP opponent. Men were more aggressive (did not allocate funds) when asked to share a sum of money than when asked to decide the honorarium, which is not surprising considering that not aggressing in the "share" condition is costly to the participant, whereas there is no cost to the participant for either aggressing or not aggressing in the "decide the honorarium" condition. The same trend was observed for women, but the difference was not significant. Nevertheless, for both men and women, non-costly aggression condition type did not interact with other predictors of aggression, thus the non-costly aggression conditions are combined for discussion.

My hypothesis that fearless dominance would be a better predictor of non-costly aggression than self-centred impulsivity was supported, although results differed somewhat for men and women. In men, higher fearless dominance was associated with a greater likelihood of non-costly aggression and there was no association between self-centred impulsivity and non-costly aggression. These findings are consistent with several studies that used measures of reactive aggression that did not involve a cost. For example, Reidy and colleagues (2007) reported that in male undergraduates Factor I was a better predictor of reactive aggression compared to Factor II traits. Lotze and colleagues (2007), using a similar aggression paradigm in a community sample, found that men higher in Factor I traits were more reactive aggressive than were men lower in Factor I traits. One study, however, reported a negative association between Factor I traits and reactive aggression in male psychiatric patients (Veit et al., 2010). Thus, except in the study of psychiatric patients, findings from studies using laboratory aggression paradigms support the positive association between Factor I traits and non-costly reactive aggression.

For women in the present study, both self-centred impulsivity and fearless dominance predicted a greater likelihood of non-costly aggression, and their association with aggression was strongest when scores on one of the two factors were low. This study is the first to report an interaction between the factors of psychopathy in predicting a behavioural measure of aggression. Additionally, this study is the first to report an association between psychopathy and a behavioural measure of aggression in a sample of women; other studies have used mixed-sex samples and did not report the findings separately for each sex (e.g., Jones & Paulhus, 2010; Nouvion et al., 2007), or found no significant associations between psychopathy and aggression (Miller & Lynam, 2003). In

Miller and Lynam's (2003) study, however, the authors only reported associations between global psychopathy and reactive aggression; they did not report associations specific to each factor. That I found an association between reactive aggression and self-centred impulsivity but Miller and Lynam (2003) reported no association between total psychopathy and reactive aggression may suggest that in women the factors of psychopathy are more relevant for predicting laboratory aggression than is the global psychopathy score.

In sum, my finding that fearless dominance in women interacted with self-centred impulsivity but in men was a linear predictor of reactive aggression highlights the sex-specificity of the relationships between psychopathic personality traits and reactive aggression. I also found that whereas the factors of psychopathy were not correlated in men, they were correlated positively in women. These findings suggest that the construct of psychopathy may be qualitatively different in men and women, consistent with other studies (e.g., Anestis et al., 2011; also reviewed in Dolan & Völlm, 2009)

Endocrine status and costly aggression

In women, lower baseline estradiol predicted greater costly aggression in the PSAP but there was no relationship between any of the hormone measures (baseline or changes) and costly aggression in men. My finding that lower baseline estradiol predicted greater costly aggression in women is consistent with other studies that have reported negative associations between baseline estradiol and athletic competition (Cashdan, 2003), and between baseline estradiol and self-reported aggression (Stanton & Schultheiss, 2007). Further, that baseline estradiol was a unique predictor of PSAP aggression over and above the influence of baseline testosterone and baseline cortisol

suggests that estradiol may be more important for the prediction of aggression in women than these other hormones. Nevertheless, few studies have included all three of these hormones as simultaneous predictors of aggression. My data may suggest that previously reported associations between baseline cortisol and aggression (Böhnke et al., 2010) and between baseline testosterone and aggression (reviewed in Archer et al., 2005) in women may have been mediated by baseline estradiol. In future studies, examining all three hormones simultaneously will be required to inform this issue.

In men, I found no significant associations between the hormone measures (baseline or changes) and costly reactive aggression. Generally, baseline testosterone shares weak associations with self-reported ($r = .08$) and behavioural measures of aggression ($r = .13$; reviewed in Archer et al., 2005). Indeed, our lab has not yet found such an association using the PSAP (e.g., Carré & McCormick, 2008; Carré et al., 2009; Carré et al., 2010; Geniole et al., 2011) although a couple of studies have reported positive associations using the ultimatum game (e.g., in men, Burnham, 2007; in men and women, Mehta & Beer, 2010). Some research suggests that baseline testosterone shares a non-linear relationship with aggression (and dominance) such that there is only a significant positive association in individuals with low baseline cortisol (e.g., Dabbs, Jurkovic, & Frady, 1991; Mehta & Josephs, 2010; Popma et al., 2007 but see Scerbo & Kolko, 1994). I also tested this possibility but found no evidence of such an interaction. Similarly, in a previous report using a sample of men, this interaction was not a significant predictor of costly PSAP aggression (Geniole et al., 2011). Perhaps this interaction is more relevant in the prediction of self-report or criminal history measures

of aggression (as used in Dabbs, Jurkovic, & Frady, 1991; Popma et al., 2007) than in the prediction of laboratory measures of aggression.

Contrary to previous reports (e.g., Carré & McCormick, 2008; Carré et al., 2009, 2010; Geniole et al., 2011; Pope, Kouri, & Hudson, 2000), I also found no evidence of an association between changes in testosterone or in cortisol and costly aggression in the PSAP. Findings of an association between changes in testosterone and aggression, however, were typically moderated by situational and trait variables. For example, testosterone changes were only associated with aggression in losers of a rigged number tracing task, but not winners (Carré et al., 2009). Further, among the winners, changes in testosterone were only associated with aggression in those who had high trait dominance but not in those with low trait dominance. In another study, changes in testosterone only predicted PSAP aggression in individuals who were socially included prior to the PSAP whereas there was no association among individuals who were socially excluded (Geniole et al., 2011). I cannot identify, however, a situational factor that may have reduced the relationship between testosterone and PSAP aggression in the present study.

In summary, estradiol was an important predictor of costly reactive aggression in women whereas none of the hormone measures (baseline or changes) predicted costly reactive aggression in men. Although researchers have reported relationships between baseline estradiol and self-reported aggression (e.g., Stanton & Schultheiss, 2007), this study is the first to report such an association using a laboratory measure of aggression.

Endocrine status and non-costly reactive aggression

In men, although there was no relationship between baseline testosterone and reactive aggression, increases in testosterone predicted a greater likelihood of non-costly

reactive aggression. This finding is consistent with previous studies conducted in our lab and elsewhere in which testosterone dynamics were more important for predicting subsequent behaviour than were baseline concentrations (Carré & McCormick, 2008; Carré et al., 2009; Geniole et al., 2011; Mehta & Josephs, 2006). Zak and colleagues (2009), on the other hand, used a similar paradigm to one of my non-costly conditions (men were asked to split a sum of money with another participant) and found that men did not differ in aggression after administration of testosterone. Nevertheless, their participants were not provoked prior to deciding the split as were my participants. Provocation may be an important factor in testosterone-aggression relationships: Our lab has only found associations between changes in testosterone and aggression in versions of the PSAP in which the participant was provoked (Carré et al., 2010). Thus, testosterone fluctuations may only facilitate subsequent aggressive/competitive behaviour if they occur in response to a provocation.

In women, changes in testosterone were not associated with non-costly aggression. Increases in testosterone may be less relevant in promoting aggression, in general, in women compared to in men. For example, women administered testosterone were not significantly different from controls in their rejection rate of unfair offers in an ultimatum game (Zethraeus et al., 2009), and in another study women administered testosterone were actually more generous when proposing offers in the ultimatum game compared to women given a placebo (Eisenegger, Naef, Snozzi, Heinrichs, & Fehr, 2010). Additionally, in a previous version of the PSAP, our lab found that changes in testosterone preceding the PSAP were not associated with aggression in women, but were positively associated with aggression in men (Carré et al., 2009). Thus, changes in

testosterone may not be as important in predicting aggression in women as it is in men. Furthermore, some evidence suggests that increases in testosterone may actually decrease aggression in women (Eisenegger et al., 2010).

In men, I also found that lower baseline cortisol concentrations were marginally associated with a greater likelihood of non-costly reactive aggression although this effect was no longer significant when changes in testosterone, cortisol, and estradiol were added to the regression model. Although the effect of baseline cortisol was marginal, recent studies have also reported associations between baseline cortisol and aggression and, further, that these associations differed for men and women (e.g., Böhnke et al., 2010; Poustka et al., 2010). In Poustka and colleagues' study (2010), there was a negative association between baseline cortisol and self-reported reactive aggression in adolescent boys, but not girls. In contrast, Böhnke and colleagues (2010) reported a negative association between baseline cortisol and reactive aggression in the Taylor Aggression Paradigm in women but not in men. Given these discrepancies, more research will be required to determine the sex-specificity of the relationship between baseline cortisol and aggression.

In sum, changes in testosterone (and to some degree, baseline cortisol) predicted non-costly aggression in men, whereas there was no association between hormone concentrations (baseline or changes) and non-costly aggression in women. These findings highlight the importance of considering differences between sexes in hormone-aggression analyses, consistent with findings reported in other studies (e.g., Böhnke et al., 2010; Carré et al., 2009; Poustka et al., 2010). Furthermore, my results suggest that the relationship between endocrine function and reactive aggression may depend on the costs

associated with the aggression. In women, baseline estradiol predicted costly aggression, but was not related to non-costly aggression. Given the dearth of studies that have examined the relationship between estradiol and reactive aggression, however, it is difficult to determine if this relationship truly differs as a function of the cost of aggression. Future studies are thus required before the differential effects of baseline estradiol on costly and non-costly aggressive behaviour in women can be confirmed. In men, although I found that changes in testosterone only predicted non-costly aggression, most studies linking changes in or baseline levels of testosterone and reactive aggression in men have used laboratory paradigms in which aggression was costly to the participant, such as the PSAP (e.g., Carré & McCormick, 2008; Carré et al., 2009; Carré et al., 2010; Geniole et al., 2011; Pope, Kouri, & Hudson, 2000) or the ultimatum game (e.g., Burnham, 2007; Mehta & Beer, 2010). Thus, more studies utilizing non-costly aggression paradigms are required before the robustness of the relationship between testosterone dynamics and non-costly aggression can be confirmed. My findings, nevertheless, highlight the importance of simultaneously examining all three hormones (cortisol, testosterone, and estradiol), and changes in each over time, to identify the unique effects of each hormone independent of the others.

Theoretical Implications

Few theoretical models explicitly address the link between psychopathic personality traits and reactive aggression. Additionally, none consider the possibility of sex differences in psychopathy and the joint role of traits and hormones. There are models linking hormone concentrations to psychopathy and aggression (e.g., van Honk & Schutter, 2006), but my results suggest that endocrine status and psychopathic personality

traits function independently and differently within the sexes to promote aggression. In Blair's (2010) integrated emotions systems model, psychopaths are believed to be more prone to reactive aggression than are non-psychopaths because they are more susceptible to frustration (frustration is an antecedent of reactive aggression; Dollard, Doob, Miller, Mowrer, & Sears, 1939). Frustration occurs when an expected goal is not obtained or is blocked. Psychopaths are believed to be more susceptible to frustration compared to non-psychopaths because of their inability to alter behaviour in response to contingency changes (i.e., when previously rewarded behaviour is now punished). Harenski and Keihl (2010) added that psychopaths may be more prone to reactive aggression because they experience more frustration to an event than do non-psychopaths, and/or because they are less able than non-psychopaths to regulate their frustration in response to an event. Thus, susceptibility to frustration, a heightened frustration response, and an impaired ability to regulate frustration may all be important mechanisms in the relationship between psychopathy and reactive aggression.

Nevertheless, these mechanisms do not readily explain the association between Factor I traits (or fearless dominance) and reactive aggression and contrast the results reported here. Specifically, my results suggest that individuals high in fearless dominance may be more sensitive to contingency changes because they were not more aggressive than others when it was costly, but were more aggressive than others when it was non-costly. Furthermore, fearless dominance is characterized by stress immunity (Lilienfeld & Widows, 2005), less negative emotionality (Benning et al., 2003), and less anger (Edens & McDermott, 2010), which should render individuals high in fearless dominance less prone to frustration. Frustration may be more relevant for individuals high in Factor II

traits (or self-centred impulsivity). Further, my findings suggest that the cost of aggression should be considered as a potential moderator of the relationship between psychopathic personality factors and reactive aggression, and should be added to explanatory models. For example, my results are consistent with the hypothesis of Woodworth and Porter (2002, 2006) that psychopaths, particularly those high in Factor 1 traits (fearless dominance), may inhibit reactive aggression when the stakes are high.

A better fit between my data and "frustration" models linking psychopathy and reactive aggression may have been obtained using a clinical or prison population of psychopaths who have higher scores on measures of psychopathic personality traits: Although studies suggest that psychopathy is not taxonomic and is instead dimensional (e.g., Edens, Marcus, Lilienfeld, & Poythress, 2006), Reidy and colleagues (2011) have pointed out that the relationship between psychopathy and reactive aggression seems to differ between incarcerated and non-incarcerated populations. Specifically, Lotze and colleagues (2007) found, using a non-incarcerated sample, that individuals high in Factor I traits were more reactive aggression than those low in Factor I traits, whereas Veit and colleagues (2010) found, using the same laboratory measure of aggression, that Factor I traits were negatively associated with reactive aggression. The relationship between psychopathic personality traits and the cortical and peripheral responses to provocation differed between the incarcerated and non-incarcerated groups as well (Lotze et al., 2007; Veit et al., 2010). Divergent findings have also been found in the ultimatum game in which psychopathic traits were associated with more (in prison samples, Koenigs, Kruepke, & Newman, 2010) or fewer (in community samples, Osumi & Ohira, 2010) rejections of unfair offers. Thus, it is possible that the results of the current study may

have provided better support for the aforementioned "frustration" models had I assessed the relationship between psychopathy and reactive aggression in a prison instead of a university sample.

Nevertheless, my results do show that psychopathic personality traits are of relevance for predicting aggression in a convenience sample of university students. Further, using such a sample, I have shown that fearless dominance predicts antisocial behaviour (Geniole, Keyes, Mondloch, & McCormick, 2012). Men high in fearless dominance (one standard deviation above the mean) were 22 times more likely to cheat in a lottery for a cash prize than were men average in fearless dominance. Thus, the present results may better fit models of psychopathy designed to address the variance in psychopathic personality traits in both the community and in institutionalized and clinical samples.

One such model proposes two types of psychopathy: "successful" and "unsuccessful". Successful psychopaths are defined as individuals who have the core personality features of psychopathy, yet avoid incarceration and have proficient information processing and executive functioning abilities relative to unsuccessful psychopaths, who are more likely to be incarcerated (reviewed in Gao & Raine, 2010; Hall & Benning, 2006). Further, several researchers have suggested that some psychopathic personality traits (e.g., fearlessness, superficial charm, manipulation) may even be advantageous in business, law, and politics (Babiak, 1995; Lykken, 1995; Lykken, 2006). Indeed, there is a higher prevalence of psychopathy in business executives and managers relative to the general population (Babiak, Neumann, & Hare, 2010). Hall and Benning (2006) suggested that successful, high-functioning psychopaths

likely have high Factor I traits and low Factor II traits. In contrast to successful psychopaths, higher Factor II traits and lower Factor I traits may characterize the unsuccessful psychopath. Relative to successful psychopaths, unsuccessful psychopaths are thought to be less sensitive to environmental cues of detection or danger (Gao & Raine, 2010). Thus, individuals high in unsuccessful psychopathic personality traits may be more prone to reckless forms of aggression thereby increasing their chance of detection or incarceration, whereas individuals high in successful psychopathic personality traits may only aggress when it is strategic to do so and thereby decrease their chance of detection or incarceration.

The factor of fearless dominance, as measured by the PPI and its revised version, seems to capture the qualities of the successful psychopathic personality traits (Hall & Benning, 2006). Conversely, the factor of self-centred impulsivity seems to capture the unsuccessful psychopathic personality traits. For example, there is evidence that fearless dominance is associated positively, and self-centred impulsivity is associated negatively, with executive cognitive functioning (Sellbom & Verona, 2007), well-being, achievement, and education level (Benning et al., 2003). Thus, my finding that fearless dominance in men and women was associated with greater aggression when non-costly is consistent with the concept of successful psychopathy. Nevertheless, the relationship between self-centred impulsivity and costly reactive aggression was found only in women, and in a separate study I found a relationship between fearless dominance and cheating only in men.

Perhaps individuals high in unsuccessful psychopathic personality traits display reactive aggression regardless of the costs involved whereas those high in successful

psychopathic personality traits display reactive aggression only when it is non-costly. That individuals high in fearless dominance were more aggressive than those low in fearless dominance only when it was non-costly suggests that this factor may reflect successful psychopathic personality traits. Nevertheless, I did not find a negative association between fearless dominance and costly aggression (the inhibition of high-stakes aggression, Porter & Woodworth, 2006), which would be expected if individuals high in this factor were truly sensitive to the costs and benefits associated with reactive aggression. Although there is some evidence that Factor I traits, generally, may protect against reactive aggression (reviewed in Reidy et al., 2011), the exact situations in which this occurs has yet to be determined.

Limitations

Although I report a novel association between baseline estradiol and costly reactive aggression in women using a laboratory measure of aggression, I did not control for variation in menstrual cycle and for the use of oral contraceptives; thus, this relationship may have been obscured. Furthermore, although changes in testosterone predicted non-costly aggression, I have no way of determining whether these changes actually caused an increase in aggression. That is, the temporal order of my testosterone and aggression measures does not preclude the possibility of a third variable influencing both changes in testosterone and an increased likelihood of aggression. Administration studies using experimental designs are required to test the causal relationship between testosterone and aggression (Eisenegger, Haushofer, & Fehr, 2011).

Another limitation is my reliance on a single measure of psychopathy. I chose to employ the PPI in the present work given that, unlike other popular self-report measures

of psychopathy (e.g., Self-Report Psychopathy Scale and the revised editions, Hare, 1985; Hare et al., 1989; Paulhus et al., in press) the scale items on the PPI are not confounded by explicit references to aggression (Lilienfeld & Widows, 2005), the outcome of interest in the present work. Nonetheless, as pointed out by Cale and Lilienfeld (2006), mono-operation bias (see Shadish, Cook, & Campbell, 2002) may be particularly problematic in research on psychopathy given that the numerous measures of the construct are not all highly correlated (e.g., Gaughan, Miller, Pryor, & Lynam, 2009; Marcus et al., 2012; Seibert, Miller, Few, Zeichner, & Lynam, 2011). It would be beneficial to include multiple measures of psychopathy and examine their shared or divergent associations with measures of aggression (e.g., Seibert et al., 2011). Other researchers have combined the conceptually analogous factors of different measures of psychopathy to create a composite of Factor I and Factor II scores (e.g., Reidy et al., 2011; Reidy, Zeichner, & Foster, 2009), which may also eliminate the problems associated with mono-operation bias and provide meaningful results.

Further, although many studies have reported a two or three factor solution using the PPI or its revised version (e.g., Anestis et al., 2011; Benning et al., 2003; Lilienfeld & Widows, 2005), researchers have nonetheless examined associations specific to each content scale within each of the factors (e.g., Curry, Chesters, & Viding, 2011; Seibert et al., 2011). This approach may also be of value in elucidating the relationship between psychopathy and reactive aggression. Additionally, although a two factor model of psychopathy is the most widely researched and was used in the current study, recent evidence suggests that self-report measures of psychopathy, when combined, load onto four distinct factors (Gaughan et al., 2009; Seibert et al., 2011). These factors showed

differential relationships with reactive aggression as measured by the Response Choice Aggression Paradigm (Seibert et al., 2011). Thus, it may be beneficial to examine associations between costly and non-costly reactive aggression using a four factor framework.

Finally, my data provides compelling evidence that the association between psychopathic personality traits and reactive aggression depends on the cost or consequences of aggressing, consistent with Woodworth and Porters' proposal (2002; 2006). Nevertheless, it will be of benefit to assess these differential associations using an experimental design in which the cost of aggression varies but all other variables remain constant. Such an experiment will be crucial in identifying cost as a moderator in psychopathy-aggression relationships.

Conclusion

The present study is the first to consider cost of aggression as a situational factor in the relationship between psychopathic personality traits and behavioural measures of aggression, and to examine simultaneously endocrine function for multiple hormones. Reactive aggression is typically defined as an affect-driven, impulsive response to provocation (Anderson & Bushman, 2002). This definition may only apply to some individuals however. For others, the appropriate definition may be found in the saying "revenge is a dish best served cold". Our finding that high fearless dominance was associated with reactive aggression only when non-costly suggests that this psychopathic personality factor may best discern for whom the definitions of reactive aggression are appropriate.

References

Alink, L. R. A., van IJzendoorn, M. H., Bakermans-Kranenburg, M. J., Mesman, J., Juffer, F., & Koot, H. M. (2008). Cortisol and externalizing behavior in children and adolescents: Mixed meta-analytic evidence for the inverse relation of basal cortisol and cortisol reactivity with externalizing behavior. *Developmental Psychobiology, 50*(5), 427-450.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed. text revision). Washington, D.C.: Author.

Anderson, C. A., & Bushman, B. J. (2002). Human aggression. *Annual Review of Psychology, 53*(1), 27-51.

Anestis, J., Caron, K., & Carbonell, J. (2011). Examining the impact of gender on the factor structure of the psychopathic personality inventory - revised. *Assessment, 18*(3), 340-349.

Archer, J. (2006). Testosterone and human aggression: An evaluation of the challenge hypothesis. *Neuroscience Biobehavioral Reviews, 30*(3), 319-345.

Archer, J., Fernandez-Fuertes, A. A., & Thanzami, V. L. (2010). Does cost-benefit analysis or self-control predict involvement in two forms of aggression? *Aggressive Behavior, 36*(5), 292-304.

Archer, J., Graham-Kevan, N., & Davies, M. (2005). Testosterone and aggression: A reanalysis of Book, Starzyk, and Quinsey's (2001) study. *Aggression and Violent Behavior, 10*(2), 241-261.

Babiak, P. (1995). When psychopaths go to work: A case study of an industrial psychopath. *Applied Psychology, 44*(2), 171-188.

Babiak, P., Neumann, C. S., & Hare, R. D. (2010). Corporate psychopathy: Talking the walk. *Behavioral Sciences & the Law, 28*(2), 174-193.

Baron, R. A., & Richardson, D. R. (1994). *Human aggression* (2nd ed.). New York: Plenum Press.

Baskin-Sommers, A. R., Zeier, J. D., & Newman, J. P. (2009). Self-reported attentional control differentiates the major factors of psychopathy. *Personality and Individual Differences, 47*(6), 626-630.

Benning, S. D., Patrick, C. J., Hicks, B. M., Blonigen, D. M., & Krueger, R. F. (2003). Factor structure of the psychopathic personality inventory: Validity and implications for clinical assessment. *Psychological Assessment, 15*(3), 340-350.

Blair, R. J. R. (2010). Psychopathy, frustration, and reactive aggression: The role of ventromedial prefrontal cortex. *British Journal of Psychology, 101*(3), 383.

Böhnke, R., Bertsch, K., Kruk, M. R., Richter, S., & Naumann, E. (2010). Exogenous cortisol enhances aggressive behavior in females, but not in males. *Psychoneuroendocrinology, 35*(7), 1034-1044.

Burnham, T. C. (2007). High-testosterone men reject low ultimatum game offers. *Proceedings of the Royal Society B: Biological Sciences, 274*(1623), 2327-2330.

Cale, E. M., & Lilienfeld, S. O. (2006). Psychopathy factors and risk for aggressive behavior: A test of the "threatened egotism" hypothesis. *Law and Human Behavior, 30*(1), 51-74.

Carré, J. M., Gilchrist, J. D., Morrissey, M. D., & McCormick, C. M. (2010). Motivational and situational factors and the relationship between testosterone

dynamics and human aggression during competition. *Biological Psychology, 84*(2), 346-353.

Carré, J. M., & McCormick, C. M. (2008). Aggressive behavior and change in salivary testosterone concentrations predict willingness to engage in a competitive task. *Hormones and Behavior, 54*(3), 403-409.

Carré, J. M., McCormick, C. M., & Hariri, A. R. (2011). The social neuroendocrinology of human aggression. *Psychoneuroendocrinology, 36*(7), 935-944.

Carré, J. M. & Mehta, P. H. (2011). Importance of considering testosterone-cortisol interactions in predicting human aggression and dominance. *Aggressive Behaviour, 37*, 489-491.

Carré, J. M., Putnam, S. K., & McCormick, C. M. (2009). Testosterone responses to competition predict future aggressive behaviour at a cost to reward in men. *Psychoneuroendocrinology, 34*(4), 561-570.

Cashdan, E. (2003). Hormones and competitive aggression in women. *Aggressive Behavior, 29*(2), 107-115.

Cherek, D. R., Lane, S. D., Dougherty, D. M., Moeller, F. G., & White, S. (2000). Laboratory and questionnaire measures of aggression among female parolees with violent or nonviolent histories. *Aggressive Behavior, 26*(4), 291-307.

Cherek, D. R., Moeller, F. G., Schnapp, W., & Dougherty, D. M. (1997). Studies of violent and nonviolent male parolees: I. Laboratory and psychometric measurements of aggression. *Biological Psychiatry, 41*(5), 514-522.

Cherek, D. R., Moeller, F. G., Dougherty, D. M., & Rhoades, H. (1997). Studies of violent and nonviolent male parolees: II. Laboratory and psychometric measurements of impulsivity. *Biological Psychiatry, 41*(5), 523-529.

Cima, M., & Raine, A. (2009). Distinct characteristics of psychopathy relate to different subtypes of aggression. *Personality and Individual Differences, 47*(8), 835.

Cleckley, H. M. (1941/1988). *The mask of sanity* (5th ed.). Retrieved September 1st, 2010, from http://www.cassiopaea.org/cass/sanity_1.PdF

Cohen, J., Cohen, P., West, S.G., & Aiken, L.S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences*. Mahwah, New Jersey: Lawrence Erlbaum Associates, Inc.

Coid, J., Yang, M., Ullrich, S., Roberts, A., & Hare, R. D. (2009). Prevalence and correlates of psychopathic traits in the household population of Great Britain. *International Journal of Law and Psychiatry, 32*(2), 65-73.

Cooke, D. J., Michie, C., & Hart, S. D. (2006). Facets of clinical psychopathy: Toward clearer measurement. In J. C. Patrick (Ed.), *Handbook of psychopathy* (pp. 91-106). New York: The Guilford Press.

Crockett, M. J., Clark, L., Lieberman, M. D., Tabibnia, G., & Robbins, T. W. (2010). Impulsive choice and altruistic punishment are correlated and increase in tandem with serotonin depletion. *Emotion, 10*(6), 855-862.

Curry, O., Chesters, M. J., & Viding, E. (2011). The psychopath's dilemma: The effects of psychopathic personality traits in one-shot games. *Personality and Individual Differences, 50*(6), 804-809.

Dabbs, J., Jurkovic, G., & Frady, R. (1991). Salivary testosterone and cortisol among late adolescent male offenders. *Journal of Abnormal Child Psychology, 19*(4), 469-478.

Dolan, M., & Völlm, B. (2009). Antisocial personality disorder and psychopathy in women: A literature review on the reliability and validity of assessment instruments. *International Journal of Law and Psychiatry, 32*(1), 2-9.

Dollard, J., Doob, L., Miller, N., Mowrer, O., & Sears, R. (1939). *Frustration and aggression.* New Haven, CT: Yale University Press.

Edens, J. F., Marcus, D. K., Lilienfeld, S. O., & Poythress, N. G. (2006). Psychopathic, not psychopath: Taxometric evidence for the dimensional structure of psychopathy. *Journal of Abnormal Psychology, 115*(1), 131-144.

Edens, J. F., & McDermott, B. E. (2010). Examining the construct validity of the psychopathic personality Inventory–Revised: Preferential correlates of fearless dominance and self-centered impulsivity. *Psychological Assessment, 22*(1), 32-42.

Eisenegger, C., Naef, M., Snozzi, R., Heinrichs, M., & Fehr, E. (2010). Prejudice and truth about the effect of testosterone on human bargaining behaviour. *Nature, 463*(7279), 356-359.

Eisenegger, C., Haushofer, J., & Fehr, E. (2011). The role of testosterone in social interaction. *Trends in Neurosciences, 15*(6), 263-271.

Flight, J. I., & Forth, A. E. (2007). Instrumentally violent youths. *Criminal Justice and Behavior, 34*(6), 739-751.

Forsythe, R., Horowitz, J. L., Savin, N. E., & Sefton, M. (1994). Fairness in simple bargaining experiments. *Games and Economic Behavior, 6*(3), 347-369.

Fowles, D. C., & Dindo, L. (2006). A dual-deficit model of psychopathy. In C. J. Patrick (Ed.), *Handbook of psychopathy* (pp. 14-34). New York: The Guilford Press.

Gao, Y., & Raine, A. (2010). Successful and unsuccessful psychopaths: A neurobiological model. *Behavioral Sciences & the Law, 28*(2), 194-210.

Gaughan, E. T., Miller, J. D., Pryor, L. R., & Lynam, D. R. (2009). Comparing two alternative measures of general personality in the assessment of psychopathy: A test of the NEO PI-R and the MPQ. *Journal of Personality, 77*(4), 965-996.

Geniole, S. N., Keyes, A. E., Mondloch, C. J., & McCormick, C. M. (2012). *Psychopathic personality traits, cheating, and the facial width-to-height ratio.* Poster Presented at the 22nd Annual Meeting of the Canadian Society for Brain, Behaviour and Cognitive Science, Kingston, Ontario.

Geniole, S. N., Carré, J. M., & McCormick, C. M. (2011). State, not trait, neuroendocrine function predicts costly reactive aggression in men after social exclusion and inclusion. *Biological Psychology, 87*(1), 137-145.

Hall, J. R., & Benning, S. D. (2006). The "successful" psychopath: Adaptive and subclinical manifestations of psychopathy in the general population. In C. J. Patrick (Ed.), *Handbook of psychopathy* (pp. 459-480). New York: The Guilford Press.

Hall, J., Benning, S., & Patrick, C. (2004). Criterion-related validity of the three-factor model of psychopathy. *Assessment, 11*(1), 4-16.

Hare, R. D. (1985). A comparison of procedures for the assessment of psychopathy. *Journal of Consulting and Clinical Psychology, 53*(1), 7-16.

Hare, R. D. (1991). *The Hare psychopathy checklist-revised manual*. Toronto: Multi-Health Systems.

Hare, R. D. (1996). Psychopathy: A clinical construct whose time has come. *Criminal Justice and Behavior, 23*(1), 25-54.

Hare, R. D. (2003). *The hare psychopathy checklist-revised (PCL-R)* (2nd ed.). Toronto: Multi-Health Systems.

Hare, R. D., Harpur, T. J., & Hemphill, J. F. (1989). *Scoring pamphlet for the self-report psychopathy scale: SRP-II.* Unpublished manuscript.

Hare, R. D., & Neumann, C. S. (2006). The PCL-R assessment of psychopathy: Development, structural properties, and new directions. In C. J. Patrick (Ed.), *The handbook of psychopathy* (pp. 58-88). New York: The Guilford Press.

Hare, R. D. (1980). A research scale for the assessment of psychopathy in criminal populations. *Personality and Individual Differences, 1*(2), 111-119.

Harenski, C. L., & Kiehl, K. A. (2010). Reactive aggression in psychopathy and the role of frustration: Susceptibility, experience, and control. *British Journal of Psychology, 101*(3), 401-406.

Jones, D., & Paulhus, D. (2010). Different provocations trigger aggression in narcissists and psychopaths. *Social Psychological and Personality Science, 1*(1), 12-18.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1986). Fairness and the assumptions of economics. *The Journal of Business, 59*(4), 285-300.

Koenigs, M., Kruepke, M., & Newman, J. P. (2010). Economic decision-making in psychopathy: A comparison with ventromedial prefrontal lesion patients. *Neuropsychologia, 48*(7), 2198-2204.

Leistico, A. R., Salekin, R. T., DeCoster, J., & Rogers, R. (2008). A large-scale meta-analysis relating the hare measures of psychopathy to antisocial conduct. *Law and Human Behavior, 32*(1), 28-45.

Levenson, M. R., Kiehl, K. A., & Fitzpatrick, C. M. (1995). Assessing psychopathic attributes in a noninstitutionalized population. *Journal of Personality and Social Psychology, 68*(1), 151-158.

Liening, S. H., & Josephs, R. A. (2010). It is not just about testosterone: Physiological mediators and moderators of testosterone's behavioral effects. *Social and Personality Psychology Compass, 4*(11), 982-994.

Liening, S. H., Stanton, S. J., Saini, E. K., & Schultheiss, O. C. (2010). Salivary testosterone, cortisol, and progesterone: Two-week stability, interhormone correlations, and effects of time of day, menstrual cycle, and oral contraceptive use on steroid hormone levels. *Physiology & Behavior, 99*(1), 8-16.

Lilienfeld, S. O., & Fowler, K. A. (2006). The self-report assessment of psychopathy: Problems, pitfalls, and promises. In C. J. Patrick (Ed.), *The handbook of psychopathy* (pp. 107-132). New York: The Guilford Press.

Lilienfeld, S. O., & Widows, M. R. (2005). *Psychopathic personality inventory–revised: Professional manual.* Lutz, FL: Psychological Assessment Resources.

Lilienfeld, S. O., & Andrews, B. P. (1996). Development and preliminary validation of a self-report measure of psychopathic personality traits in noncriminal population. *Journal of Personality Assessment, 66*(3), 488-524.

Lotze, M., Veit, R., Anders, S., & Birbaumer, N. (2007). Evidence for a different role of the ventral and dorsal medial prefrontal cortex for social reactive aggression: An interactive fMRI study. *NeuroImage, 34*(1), 470-478.

Lykken, D. (1995). *The antisocial personalities*. Hillsdale, NJ: Erlbaum.

Lykken, D. T. (2006). Psychopathic personality: The scope of the problem. In C. J. Patrick (Ed.), *Handbook of psychopathy*. New York, NY: The Guilford Press.

Marcus, D. K., Fulton, J. J., & Edens, J. F. (2012). The two-factor model of psychopathic personality: Evidence from the psychopathic personality inventory. *Personality Disorders: Theory, Research, and Treatment, 3*(2), 140-154.

Mazur, A. (1985). A biosocial model of status in face-to-face primate groups. *Social Forces, 64*(2), 377-402.

Mazur, A., & Booth, A. (1998). Testosterone and dominance in men. *Behavioral and Brain Sciences, 21*(3), 353-363.

Mehta, P. H., & Josephs, R. A. (2006). Testosterone change after losing predicts the decision to compete again. *Hormones and Behavior, 50*(5), 684-692.

Mehta, P. H., & Beer, J. (2010). Neural mechanisms of the testosterone-aggression relation: The role of orbitofrontal cortex. *Journal of Cognitive Neuroscience, 22*(10), 2357-2368.

Mehta, P. H., & Josephs, R. A. (2010). Testosterone and cortisol jointly regulate dominance: Evidence for a dual-hormone hypothesis. *Hormones and Behavior, 58*(5), 898-906.

Miller, J. D., & Lynam, D. R. (2003). Psychopathy and the five-factor model of personality: A replication and extension. *Journal of Personality Assessment, 81*(2), 168-178.

New, A. S., Hazlett, E. A., Newmark, R. E., Zhang, J., Triebwasser, J., Meyerson, D., et al. (2009). Laboratory induced aggression: A positron emission tomography study of aggressive individuals with borderline personality disorder. *Biological Psychiatry, 66*(12), 1107-1114.

Nouvion, S. O., Cherek, D. R., Lane, S. D., Tcheremissine, O. V., & Lieving, L. M. (2007). Human proactive aggression: Association with personality disorders and psychopathy. *Aggressive Behavior, 33*(6), 552-562.

Oliveira, R. F. (2009). Social behavior in context: Hormonal modulation of behavioral plasticity and social competence. *Integrative and Comparative Biology, 49*(4), 423-440.

Osumi, T., & Ohira, H. (2010). The positive side of psychopathy: Emotional detachment in psychopathy and rational decision-making in the ultimatum game. *Personality and Individual Differences, 49*(5), 451-456.

Paulhus, D. L., Hemphill, J. F., & Hare, R. D. (in press). *Manual for the self-report psychopathy scale*. Toronto, Ontario, Canada: Multi-Health Systems.

Pope, H. G.,Jr, Kouri, E. M., & Hudson, J. I. (2000). Effects of supraphysiologic doses of testosterone on mood and aggression in normal men: A randomized controlled trial. *Archives of General Psychiatry, 57*(2), 133-140.

Popma, A., Vermeiren, R., Geluk, C. A. M. L., Rinne, T., van den Brink, W., Knol, D. L., et al. (2007). Cortisol moderates the relationship between testosterone and aggression in delinquent male adolescents. *Biological Psychiatry, 61*(3), 405-411.

Porter, S., & Woodworth, M. (2006). Psychopathy and aggression. In C. J. Patrick (Ed.), *The handbook of psychopathy* (pp. 481-494). New York: The Guilford Press.

Poustka, L., Maras, A., Hohm, E., Fellinger, J., Holtmann, M., Banaschewski, T., et al. (2010). Negative association between plasma cortisol levels and aggression in a high-risk community sample of adolescents. *Journal of Neural Transmission, 117*(5), 621-627.

Poythress, N. G., & Hall, J. R. (2011). Psychopathy and impulsivity reconsidered. *Aggression and Violent Behavior, 16*(2), 120-134.

Rabin, M. (1998). Psychology and economics. *Journal of Economic Literature, 36*(1), 11-46.

Reidy, D. E., Zeichner, A., Miller, J. D., & Martinez, M. A. (2007). Psychopathy and aggression: Examining the role of psychopathy factors in predicting laboratory aggression under hostile and instrumental conditions. *Journal of Research in Personality, 41*(6), 1244-1251.

Reidy, D. E., Zeichner, A., & Seibert, L. A. (2011). Unprovoked aggression: Effects of psychopathic traits and sadism. *Journal of Personality, 79*(1), 75-100.

Reidy, D. E., Shelley-Tremblay, J. F., & Lilienfeld, S. O. (2011). Psychopathy, reactive aggression, and precarious proclamations: A review of behavioral, cognitive, and biological research. *Aggression and Violent Behavior, 16*(6), 512-524.

Reidy, D. E., Zeichner, A., & Foster, J. D. (2009). Psychopathy, aggression, and emotion processing of violent imagery in women. *Journal of Research in Personality, 43*(5), 928-932.

Reidy, D. E., Zeichner, A., & Martinez, M. A. (2008). Effects of psychopathy traits on unprovoked aggression. *Aggressive Behavior, 34*(3), 319-328.

Scerbo, A. S., & Kolko, D. J. (1994). Salivary testosterone and cortisol in disruptive children: Relationship to aggressive, hyperactive, and internalizing behaviors. *Journal of the American Academy of Child Adolescent Psychiatry, 33*(8), 1174-1184.

Seibert, L. A., Miller, J. D., Few, L. R., Zeichner, A., & Lynam, D. R. (2011). An examination of the structure of self-report psychopathy measures and their relations with general traits and externalizing behaviors. *Personality Disorders, 2*(3), 193-208.

Sellbom, M., & Verona, E. (2007). Neuropsychological correlates of psychopathic traits in a non-incarcerated sample. *Journal of Research in Personality, 41*(2), 276-294.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference.* Boston: Houghton-Mifflin.

Stanton, S. J., & Schultheiss, O. C. (2007). Basal and dynamic relationships between implicit power motivation and estradiol in women. *Hormones and Behavior, 52*(5), 571-580.

Stratakis, C. A., & Chrousos, G. P. (1995). Neuroendocrinology and pathophysiology of the stress system. *Annals of the New York Academy of Sciences, 771*(1), 1-18.

Terburg, D., Morgan, B., & van Honk, J. (2009). The testosterone–cortisol ratio: A hormonal marker for proneness to social aggression. *International Journal of Law and Psychiatry, 32*(4), 216-223.

van Honk, J., & Schutter, D. J. L. G. (2006). Unmasking feigned sanity: A neurobiological model of emotion processing in primary psychopathy. *Cognitive Neuropsychiatry, 11*(3), 285-306.

van Honk, J., Harmon-Jones, E., Morgan, B. E., & Schutter, D. J. L. G. (2010). Socially explosive minds: The triple imbalance hypothesis of reactive aggression. *Journal of Personality, 78*(1), 67-94.

Veit, R., Lotze, M., Sewing, S., Missenhardt, H., Gaber, T., & Birbaumer, N. (2010). Aberrant social and cerebral responding in a competitive reaction time paradigm in criminal psychopaths. *NeuroImage, 49*(4), 3365-3372.

Verona, E., Patrick, C. J., & Joiner, T. E. (2001). Psychopathy, antisocial personality, and suicide risk. *Journal of Abnormal Psychology, 110*(3), 462-470.

Vitacco, M. J., Neumann, C. S., Caldwell, M. F., Leistico, A., & Van Rybroek, G. J. (2006). Testing factor models of the psychopathy checklist: Youth version and their association with instrumental aggression. *Journal of Personality Assessment, 87*(1), 74-83.

Walsh, Z., & Kosson, D. S. (2008). Psychopathy and violence: The importance of factor level interactions. *Psychological Assessment, 20*(2), 114-120.

Wingfield, J. C., Hegner, R. E., Dufty, A. M., & Ball, G. F. (1990). The" challenge hypothesis": Theoretical implications for patterns of testosterone secretion, mating systems, and breeding strategies. *American Naturalist, the, 136*(6), 829-846.

Woodworth, M. & Porter, S. (2002). In cold blood: Characteristics of criminal homicides as a function of psychopathy. *Journal of Abnormal Psychology, 111*(3), 436.

Zak, P. J., Kurzban, R., Ahmadi, S., Swerdloff, R. S., Park, J., Efremidze, L., et al. (2009). Testosterone administration decreases generosity in the ultimatum game. *PLoS ONE, 4*(12), e8330.

Zethraeus, N., Kocoska-Maras, L., Ellingsen, T., von Schoultz, B., Hirschberg, A. L., & Johannesson, M. (2009). A randomized trial of the effect of estrogen and testosterone on economic behavior. *Proceedings of the National Academy of Sciences, 106*(16), 6535-6538.

Appendix A. Brock University Research Ethics Board Clearance

Brock University
Research Ethics Board
Tel: 905-688-5550 ext. 3035
Email: reb@brocku.ca

Certificate of Ethics Clearance for Human Participant Research

DATE:	11/17/2010		
PRINCIPAL INVESTIGATOR:	MCCORMICK, Cheryl - Psychology		
FILE:	10-087 - MCCORMICK		
TYPE:	Masters Thesis/Project	STUDENT:	Shawn Geniole
		SUPERVISOR:	Cheryl McCormick

TITLE: Relationship between personality, salivary hormones and strategic decision-making

ETHICS CLEARANCE GRANTED

Type of Clearance: NEW Expiry Date: 11/30/2011

The Brock University Research Ethics Board has reviewed the above named research proposal and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement. Clearance granted from 11/17/2010 to 11/30/2011.

The Tri-Council Policy Statement requires that ongoing research be monitored by, at a minimum, an annual report. Should your project extend beyond the expiry date, you are required to submit a Renewal form before 11/30/2011. Continued clearance is contingent on timely submission of reports.

To comply with the Tri-Council Policy Statement, you must also submit a final report upon completion of your project. All report forms can be found on the Research Ethics web page.

In addition, throughout your research, you must report promptly to the REB:

a) Changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) All adverse and/or unanticipated experiences or events that may have real or potential unfavourable implications for participants;
c) New information that may adversely affect the safety of the participants or the conduct of the study;
d) Any changes in your source of funding or new funding to a previously unfunded project.

We wish you success with your research.

Approved: Michelle K. McG

Michelle McGinn, Chair
Research Ethics Board (REB)

Note: Brock University is accountable for the research carried out in its own jurisdiction or under its auspices and may refuse certain research even though the REB has found it ethically acceptable.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of research at that site.

Appendix B. Verbal Script

Script

Hello, are you here for the study called "earn points while playing game?" Great, my name is Shawn. I'll be one of the researchers running the experiment today. Please follow me down the hall- I'll get you set up in one of our testing rooms. I just wanted to let you know before we get started that I'm the only researcher here today and I will be running 2 participants at the same time, the other on the 5th floor. That being said, there may be times when you will have completing a questionnaire or task, and I will still be helping the other participant. If that happens just wait patiently and I will get to you as soon as I can.

[All of this will be read while walking the participant to the testing room].

Here are some forms and questionnaires I am going to need you to fill out. The first is a consent form which will describe the study in a bit more detail. The second is a demographic questionnaire and medical form and, finally, a personality questionnaire. For this questionnaire just try to answer the questions as truthfully as possible. Keep in mind that this information is completely confidential and your name will not be attached to any of the forms or the questionnaire.

While you are working on these, I will be on the fifth floor setting up the other participant in the study. I will be back in about 20 minutes to get the completed forms and will then get a saliva sample from you and provide you with instructions for the other part of the study.

20 minutes later...

Did you get a chance to complete all the forms? OK, great. Now I am going to get a 1-2 mL saliva sample from you. This saliva sample will allow us to determine the amount of active testosterone, cortisol, and estradiol you currently have in your system. Once we collect this from you, we will store it in a freezer until it is ready to be analysed. Imagine you are biting into a lemon if you have trouble generating saliva. Please fill the vial up to this black line. Here are a few napkins in case you make a mess – most people do the first time!

While you are working on the saliva sample I will get the other participant ready for the next part of the study. I'll be back in a couple of minutes.

3 minutes latter...

Ok, I'm just going to get the computer set up for the next task. OK we are all set up.

[turn computer to participant]

In the final part of the experiment, you will be playing a computer game against another guy/girl on the fifth floor where the goal of the game is to earn as many points as possible. The more points you earn, the more money you will make at the end of the task. During this game, there will be no way for your opponent to identify you, and no way for you to identify your opponent.

So, you have three response options available to you; 1, 2, and 3, which correspond to numbers 1, 2, and 3 on the keyboard **[point out the response options on the screen while explaining,**

this will facilitate understanding of the task]. Once you select an option, it will turn red, while the other two options will turn grey, indicating that they are temporarily unavailable. In terms of what the options do, hitting option 1 a hundred consecutive times will cause you point counter to enlarge with positive signs around, flash several times, causing your point counter to increase by one point, which is later exchangeable for money **[point out the point counter].** Once you hit this option 100 consecutive times, all response options will again be available to select. Throughout the task, it may occur that your point counter enlarges with negative signs around it, flashes several times, and decreases by one point indicating that the other participant has stolen a point from you. In addition to option 1, you can choose to select option 2 or option 3. Hitting option 2 ten consecutive times will steal a point from the person that you are playing. Either way, any points stolen from you are your opponent will not count as points earned. That is, if you steal a point from your opponent, he/she will lose a point, but you will not gain one. The same is true for your opponent. Finally, hitting option 3 ten consecutive times will protect your points for a variable amount of time. It could be anywhere from half a second to 45 seconds, it is completely random. OK, so now I will ask you a few questions about the task to make sure you understand everything. 1) what does option 1 do? 2) Option 2? 3) Do you get to keep the points you steal? 4) Does your opponent? 5) Option 3? OK Great, you obviously understand the task. I will now get you to do a 1 minute practice trial to get you familiar with the task. During the practice, you are not paired with anyone so any points you make will not count towards your point total. In other words, you will not make any money. However, following the practice I will get you to play 2 ten minute rounds during which time you will be paired with someone and all points earned will be converted to money at the end of the study. Do you have any questions? Are you ready for the practice? Great, I will be back in a couple of minutes to start up the game.

How did the practice session go? Do you have any questions? OK then. Everything is ready to go, and you will begin the first of two 10 minute rounds. The game will begin once the other participant is ready. It may take him/her a couple of minutes...

How did the first round go? Great. Ready for the second round. OK the computer again will connect when the other guy/girl is ready.

How was this round, did you make more points? Great, so we are all done. I am just going to get you to fill out this post-task questionnaire.

[hand participant post-task questionnaire]

[leave room]

OK, are you all done there? Perfect, now I am just going to get you to provide me with one more saliva sample.

[hand participant vial]

All done? Perfect.

Condition 1

So, based on your point total you won a total of five dollars! As it turns out though, you also had more points that your opponent, meaning you will be given the opportunity to decide their winnings! Remember that your identity is completely confidential and you can allocate however

much you want from 0 – 5 dollars! Please make your selection on this slip of paper and fold it in half when you are done.

Condition 2

So, based on your point total you won a total of five dollars! As it turns out though, you also had more points than your opponent, meaning you will be given another 5 dollars which you can split with your opponent however you please! Remember that your identity is completely confidential and you can allocate however much you want from your additional 5 dollars. Please make your selection on this slip of paper and fold it in half when you are done.

Appendix C. Non-costly Aggression Slips

"Share a sum of money condition"

Please indicate the amount of your additional winnings (5$) you wish to give to your opponent.

:_____:_____:_____:_____:_____:_____:

$0 $ 1 $ 2 $ 3 $ 4 $ 5

"Decide honorarium condition"

Please indicate the amount of money you would like your opponent to be paid.

:_____:_____:_____:_____:_____:_____:

$0 $ 1 $ 2 $ 3 $ 4 $ 5

Appendix D. Consent Form

Date: September 2010
Project Title: Relationship between personality, salivary hormones and strategic decision-making.

Principal Investigator
Cheryl McCormick, PhD
Professor
Psychology
Brock University
905-688-5550 ext 3700
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Shawn Geniole
MA Student
Psychology
Brock University
Shawn.geniole@brocku.ca
Principal Student Investigator

INVITATION

You are invited to participate in a study that involves both 1 hour research participation credit and the potential to be awarded an amount of money based on gameplay. The purpose of this study is to investigate the influence of personality and salivary hormones on decision-making processes.

WHAT'S INVOLVED

As a participant, you will be asked to provide the researcher with two saliva samples (1 – 2 mL) to later be assessed for testosterone, cortisol, and estradiol. This involves spitting into a vial. This is the least intrusive method for collecting hormonal data. When ready to analyze the saliva, it will be placed in wells and the hormones from the saliva will bind to the base of the wells. Next, the wells will be optically examined and this process will reveal the amount of testosterone, cortisol, or estradiol in your saliva.

At the beginning of the study, you will be asked to complete three brief questionnaires. Next, you will be paired with another participant and will have the opportunity to earn money on a computer task involving a strategic decision-making task based on your performance. After completing this task, you will complete a short questionnaire assessing your thoughts on the task. The study takes approximately 60 minutes to complete. Based on the nature of the task, certain individuals who significantly lack manual dexterity may be ineligible to participate in the study.

POTENTIAL BENEFITS AND RISKS

Possible benefits of participation include earning money based on strategic decision-making. Also, participation in this task may benefit the scientific community by adding to the developing knowledge on the relationship between personality, salivary hormones and strategic decision-making. Due to the nature of the computer task there is a slight risk that participation may lead to wrist strain.

CONFIDENTIALITY

Although your name will be associated with the raw data collected in the study, you will not be identified individually in any way in written reports of this research. Data collected during this study will be stored in a locked file cabinet in Dr. Cheryl

McCormick's laboratory). Data will be kept for 5 years after which time all data will be shredded and disposed. Saliva samples, once analyzed, will be disposed of according to the Research Ethics Board guidelines. Access to this data will be restricted to Shawn Geniole (Master's Thesis Student) and Dr. Cheryl McCormick (Professor).

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. Further, you may decide to withdraw from this study at any time and may do so without any penalty regarding research credits. However, if you wish to withdraw prior to the strategic game, you will receive no financial compensation. Additionally, if you withdraw during the strategic game, you will receive a pro-rated amount of money based on your performance prior to withdrawal. Any withdrawal will result in the termination of data collected.

PUBLICATION OF RESULTS

Results of this study may be published in professional journals and presented at conferences. Further, data may be shared with other researchers or labs, but will only be identifiable via identification numbers (no personal information will be linked to the data). Additionally, data may be reanalyzed following potential publication. Feedback about this study will be available from Shawn Geniole. If you wish to learn about the results of the study, you may contact him at sg06qo@brocku.ca.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact the Principal Investigator or the Faculty Supervisor using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (10-087). If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca. Thank you for your assistance in this project. Please keep a copy of this form for your records.

CONSENT FORM

I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

Name: _____

Signature: _____ Date: _____

Email (if you wish to be contacted for future studies or re-consent for reanalysis of data):
_____;_____;_____

This study is supported by a Social Sciences and Humanities Research Council (SSHRC) grant to Dr. Cheryl McCormick.

Appendix E. Demographic and Medical Questionnaire

Demographic/ Medical Questionnaire

1) Sex: Male or Female
2) How old are you? _____
3) What is your ethnic background? _____
4) Do you smoke cigarettes? Yes or No
   If yes, how may do you typically smoke per day? _____
   When did you last have a smoke? _____
5) How many alcoholic beverages do you consume per week? _____
6) Are you taking any prescription medications? Yes or No
   If yes, what? _____
   a. For WOMEN; are you using any form of birth control (e.g., patch, oral contraceptives)? Yes or No
      If yes, what?
      _____
   b. What date did your last period start? How many days did it last? (see calendar)?
      _____
7) Do you have any medical condition that may influence your hormone levels?
   Yes or No
   a. If yes, or **if you are not sure**, simply write down the name of your medical condition:
      _____
8) What program are you in at Brock/Niagara (e.g., math, psychology, undeclared)?
   _____
9) Did you consume any food 60 minutes prior to arriving? Yes or No
   If yes, what did you eat _____

Appendix F. Debriefing Letter

Dear Participant,

Thank you for participating in the experiment entitled "Relationship between personality, salivary hormones and strategic decision-making." Your participation is greatly appreciated.

You performed two tasks in this experiment: 1) a strategic decision-making game and; 2) a financial dictator task.

The first task that you performed was designed to assess the strategy used while playing the game with another person. In reality, you were not actually playing the game with anyone, but rather, you were playing against a computer program which was designed to take points away from your counter in a random fashion. We were primarily interested in examining the degree to which you stole points from your opponent, or protected your points, and how hormonal mechanisms may have mediated this relationship.

The second task, depending on which condition you were randomly assigned to, involved allocating a sum of money to the opponent, or allocating a sum of your winnings to the opponent. In reality, there was no opponent for this task either. This task was used to determine how you would allocate funds depending on whether it was free, or came at a cost to you, respectively. We also plan to examine how hormonal mechanisms may have functioned to influence your allocations.

We apologize for deceiving you; however, this deception was crucial in order to control the strategy of the "competitor" to allow us to evaluate your strategy and your hormone levels in a controlled manner. Results from this research will enable us to have a better understanding of the extent to which personality types and hormonal profiles contribute to the expression of aggressive behaviour. Thus, the purpose of the personality questionnaires was to examine how certain characteristics relate to strategy of gameplay. Additionally, the saliva samples will allow us to examine the extent to which hormones (testosterone, cortisol, and estradiol) mediate this relationship.

Thank-you once again for your participation in this study. If you have any questions and/or concerns, please feel free to contact me at cmccormick@brocku.ca

Sincerely,

Dr. Cheryl McCormick, Ph.D
Professor
Psychology
Brock University
cmccormick@brocku.ca