EFFECT OF SUCCESSFUL PSYCHOPATHY ON REWARD-BASED DECISION-MAKING

An Undergraduate Research Scholars Thesis

by

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ABSTRACT

Effect of Successful Psychopathy on Reward-Based Decision-Making. (May 2015)

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Previous research suggests that psychopathy may be correlated with decision-making impairments in reward processing. Explanations for such a relationship may be a result of enhanced reward sensitivity, or reduced sensitivity to losses. Striatal dopamine is critical for reward-based decision-making and may be a mechanism for differential sensitivity to gains versus losses in individuals high in psychopathy. This research addressed whether psychopathy is indeed associated with deficits in decision-making due to hypersensitivity to reward, or if, instead, such deficits result from hyposensitivity to losses, and whether dopamine influences this sensitivity. Participants completed the Iowa Gambling Task (IGT) and dopamine levels were measured indirectly using spontaneous eyeblink rate. Here we show that striatal dopamine moderates the effects psychopathy on decision-making. Individuals who had higher levels of dopamine, and also reported more antisocial behavior, chose more advantageous decks.

Likewise, more manipulative individuals chose more advantageous decks than less manipulative individuals. However, more manipulative individuals with higher striatal dopamine levels chose less advantageous decks on the IGT. Striatal dopamine appears to function as a buffer among individuals who engage in antisocial behavior more often, resulting in better decision-making,

but was associated with detrimental IGT performance among highly manipulative individuals. Our results highlight the importance of analysis at the facet level and examining physiological factors to better understand the mechanisms underlying decision-making of psychopathic individuals.

DEDICATION

I dedicate my thesis work to my family and friends. This could not have been done without the love of my grandma, grandpa, mom, boyfriend, and best friend. A very special thank you to my incredible grandparents, Judee and Ken Wolvin, and mother, Melissa Wolvin, who have always had faith in me and have supported me every step of the way. Thank you for caring for and loving me unconditionally, and for the countless sacrifices you have made for my success. I am forever in debt for all that you have done for me. I also would like to express extreme appreciation to my boyfriend, Dean Dunbar, who has never left my side and always supported me in my hopes and dreams. Thank you for driving over four hours every weekend just to see me, even if I was very busy, because I could not arrange time to make the trip myself. I will never forget how you happily make sacrifices to keep our relationship strong. It is admirable how you drove last minute in the night to fix my laptop when I had troubles. I do not know anyone else but you who would be crazy enough to stay with me at the library on nights when they had to leave by five the next morning to make it to class or work simply so we could spend time together. Also, it is absolutely necessary to thank Meagan Volquardsen, my best friend who has been there for me since middle school. Thank you for never hesitating to grab a cup of coffee to catch up these past few years. I have an incredible support system and each and every one of you hold a very special place in my heart.

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NOMENCLATURE

ASPD	Antisocial Personality Disorder
DSM	Diagnostic and Statistical Manual
EBR	Eyeblink Rate
EOG	Electrooculogram
fMRI	Functional Magnetic Resonance Imaging
IGT	Iowa Gabling Task
vmPFC	Ventromedial Prefrontal Cortex
OFC	Orbitofrontal Cortex
PCL-R	Psychopathy Checklist Revised
SRP-III	Self Report Psychopathy III

CHAPTER I

INTRODUCTION

Individuals must make decisions that can have consequences every day. For instance, deciding whether to study for a test or go out and socialize can have significant long-term consequences on not only on one's grade but also on one's future career. Consequently, understanding factors that affect decision-making quality and preferences can have important short-term and long-term effects. One factor that has been linked with differences in decision-making is psychopathy.

Psychopathy is a complex personality disorder that is characterized by impaired affective and reward-based processing. A large body of research suggests individuals who score high on psychopathic personality measurements have neurocognitive deficits in decision-making, which results in an affinity for less-than-optimal immediate rewards rather than the advantageous future outcomes (Boulanger, Habib, & Lancon, 2008; Carre, Hyde, Neumann, Viding, & Hariri, 2013; Finger, Mitchell, Jones, & Blair, 2008; Mitchell, Colledge, Leonard, & Blair, 2002; Seara-Cardoso & Viding, 2014; van Honk et al., 2002). The literature presents are two plausible competing explanations: enhanced reward sensitivity, or reduced sensitivity to losses, and little research has been done comparing these in a non-criminal population, and understanding psychopathic influences at the dimensional level. Whether there is a unique decision-making pattern present in noncriminal populations, which distinguished them from psychopathic criminals, is still questioned. Furthermore, it is necessary to incorporate physiological markers to examine whether they reveal etiological explanation for poor decision-making increasing the likelihood of being caught in criminal acts. Establishing distinct influences could be useful in

identifying risks and protective factors that result in successful versus unsuccessful psychopathy. Further examination of these similarities and differences could reveal clues to reducing future violence and recidivism, enhancing intervention efficacy or rehabilitation techniques (Hare & Hart, 1993; Hemphill, Wong, & Hare, 1998; Salekin, Rogers, & Sewell, 1996; Stone, 2007).

When one thinks of a psychopath, characteristics such as grandiosity, remorselessness, impulsivity, delinquency, and lack of empathy may come to mind, but explicit diagnoses of psychopathy or sociopathy are not in the Diagnostic and Statistical Manual (DSM). However, antisocial personality disorder (ASPD) resembles psychopathy most closely so it is important to distinguish the two as they may incorrectly be used interchangeably which can lead to serious consequences. When ASPD is equated with psychopathy, stigmatizing effects can occur and disproportionately affect legal and clinical decisions (Edens, Petrila, & Buffington-Vollum, 2001). ASPD relies heavily on behavioral aspects but an individual with ASPD must also exhibit interpersonal and affective dysfunction to be considered psychopathic. Only 1/3 of those diagnosed with ASPD meet criteria for psychopathy (Hart & Hare, 1996). Psychopathy has been debated, redefined, operationalized, and empirically tested with measurements such as Psychopathic Personality Inventory, Self Report Psychopathy Scale III (SRP-III), and the most popular, the Hare Psychopathy Checklist- Revised (PCL-R). Other conceptualizations of psychopathy such as the Triarchic Model, which measures boldness, meanness, and disinhibition, have been gaining support (Patrick, Fowles, & Krueger, 2009). However, for the sake of this study, we use the Self Report Psychopathy Scale- III, which is an analogue of the PCL-R used to assess psychopathy for non-criminal, research samples (Hare, 2003; Levenson, Kiehl, & Fitzpatrick, 1995; Williams, & Paulhus, 2004). Blunted interpersonal and affective

characteristics distinguish a psychopath from the common criminal and, thus, could be present in an undergraduate population.

Although many individuals with personality disorders are capable of rehabilitation, research shows that individuals who score high on psychopathy measures are less capable of rehabilitation and are at risk for future violence and recidivism (Hare & Hart, 1993; Hemphill, Wong, & Hare, 1998; Salekin, Rogers, & Sewell, 1996; Stone, 2007). Given this relationship, it is reasonable to suggest that some individuals who exhibit psychopathic traits may experience deficits in decision-making processes, which may underlie their criminal tendencies. On the other hand, some psychopathic individuals are not criminals and may display unique psychoneurological factors that are different in comparison to criminal psychopaths'. In support of this idea, previous research suggests that there are associations of psychopathic traits with enhanced reward or reduced loss sensitivity explain the decision-making outcomes (Carre et al., 2013; Finger et al., 2008; Seara-Cardoso & Viding, 2014).

In order to understand decision-making of non-criminal psychopaths, we use The Iowa Gambling Task (IGT) that is an experience-independent and real world decision-making task that allows us to collect important behavioral data that is not based on antisocial or criminal history, and assess participants' learning from gains and losses. As striatal dopamine is critical for reward-based decision-making, and may be a mechanism for differential sensitivity to gains versus losses in individuals high in psychopathy, the goal of the current study was to elucidate the relationship between psychopathy and decision-making and the possible role of striatal dopamine in moderating this relationship.

In one study, individuals with frontal brain damage, damage to the reward and emotional centers, failed to respond autonomically to social stimuli and had difficulty learning from mistakes (Damasio, Tranel, & Damasio, 1990). These individuals continuously chose immediate rewards that result in future losses. Brain damage to this area seemed to impair ability to recognize the later consequences of their actions. Thus, emotions in response to gains and losses may guide decision-making behavior in ways that are not always advantageous, especially in tasks that entail reward and punishment processing. Additionally, these individuals had emotional impairments that resembled that of psychopaths, such as lack of empathy and irresponsibility. The ability to process and make rational social decisions may be impaired from abnormalities originating in the brain functioning of psychopaths. Because their results seemed to illustrate irrational decision-making, it is plausible that the vmPFC, and more specifically striatal dopamine, moderates emotional reactions differently among psychopathic undergraduates. The current study examines dopamine levels in the ventral striatum indirectly guided by the suggestion that physiological components accompanying emotions relating to feedback to gains and losses may additionally influence decision-making (Bechara, 2003; Damasio, Tranel, & Damasio, 1990).

To further examine such explanations, studies have demonstrated psychopaths' impairments in response inhibition (Sellbom & Verona, 2007) aversive conditioning (Flor et al., 2002), passive avoidance learning (Blair et al., 2004; Newman & Schmitt, 1998), response reversal (Mitchell et al., 2002) and other impairments, such as reduced emotional and lexical expression and recognition, and have an insensitivity to fear (Blair et al., 2002; Patrick et al., 1994, Kosson, Suchy, Mayer, & Libby, 2002; Stevens, Charman, & Blair, 2001). Several studies identified

areas of the brain such as the amygdala (Blair, Morris, Frith, 1999; Blair, 2001, 2003; Flor et al., 2002; Patrick, 1994), the orbitofrontal cortex and nucleus accumbens (Blair et al., 1999; Blair, 2003; Bechara, Damasio, & Damasio, 2000; Damasio, 1994; Kiehl et al., 2001; Mahmut, Homewood, & Stevenson, 2008; Mitchell et al., 2002), and the cingulate cortex (Arias-Carrión, Stamelou, Murillo-Rodríguez, Menéndez-González, & Pöppel, 2010; Hayden & Platt, 2010; Knutson and Cooper, 2005; Lennington, 2011) which play major roles in reward-based decision-making (Comings & Blum, 2000). It is possible that dopaminergic dysregulation is associated with psychopathy as research shows that individuals with psychopathic traits experience enhanced dopaminergic release and an increased willingness to exert more effort for larger rewards (Arias-Carrión et al., 2010; Buckholtz et al., 2010;Comings & Blum, 2000; Treadway et al., 2012) or after continuous wins (Dong et al., 2014).

A review of functional magnetic resonance imaging (fMRI) studies conducted on both clinical and non-clinical community sample by Seara-Cardoso & Viding (2014) demonstrated that individuals scoring high on psychopathy, according to the PCL-R, showed deficits in reward processing, decision-making and cognitive control measures in both populations. Among community samples, higher levels of trait psychopathy were associated with enhanced ventral striatal activation on reward processing tasks. In a similar light, specific research on psychopathy and reward-based decision-making using the IGT has shown that psychopathy is related to increased selection of the disadvantageous options on the task, which yield a net loss (Boulanger, Habib, & Lancon, 2008; Mitchell et al., 2002; van Honk, Hermans, Putman, Montagne, & Schutter, 2002). Not all research has replicated these findings (Pujara, Motzkin, Newman, Kiehl, & Koenigs, 2013); some studies suggest other factors such as antisocial impulsivity (Miranda,

MacKillop, Meyerson, Justus, & Lovallo, 2009) low attention (Lösel & Schmucker, 2004) or anxiety (Schmitt, Brinkley, & Newman, 1999) may be driving the disordered decision-making. However, many discrepancies may be attributed to use of different psychopathy measurements, different samples such as criminal or non-criminal, and different rewards such as hypothetical versus real, to name a few. This conclusion highlights the importance in examining the different facets of psychopathy which lead to heightened reward sensitivity or reduced loss sensitivity, as each may influence decision-making uniquely.

Collectively, previous research suggests that psychopathy may be correlated with unique, and often detrimental, decision-making patterns. Therefore, the current study aims to test whether psychopathy is associated with deficits in decision-making due to hypersensitivity to reward, or if, instead, such deficits result from hyposensitivity to losses. To address the competing hypotheses, participants will complete the IGT, and the SRP-III will be utilized to measure levels of antisocial behavior, callous affect, interpersonal manipulation, and erratic lifestyle. Additionally, spontaneous eyeblink will be measured to examine whether dopamine modifies the observed behavioral effects. We predict that if successful psychopathy is associated with enhanced reward sensitivity, then psychopathic individuals will choose options with net gains on the IGT. If instead, psychopathy is associated with decreased loss sensitivity, psychopathic individuals should fail to learn to avoid choices that result in net losses on the IGT.

CHAPTER II

METHODS

Participants

Ninety-two undergraduate students (45 females, 47 males; M_{age} = 18.71, SD_{age} = 0.90) at a large southwestern university participated in the study for partial fulfillment of their Introduction to Psychology course requirement.

Self Report Psychopathy Scale –III

We utilized the Self-Report Psychopathy Scale -version three (SRP-III) to examine trait psychopathy (Paulhus, Neumann, & Hare, 2012). The SRP-3 is the self-report analogue of the Psychopathy Checklist – Revised (Hare, 2003) that contains 64-items and four subscales. Each of the four subscales (callous affect, antisocial behavior, erratic lifestyle, and interpersonal manipulation) is comprised of 16 items. Participants were instructed to rate the degree to which they agreed with each statement using a 5-point Likert scale that ranged from strongly disagree (1) to strongly agree (5). Each of the subscales has been shown to be a reliable construct and have higher internal consistency with Cronbach's alphas ranging from .74 - .82. The normed means for college students (Paulhus, Neumann, & Hare, 2012) and means of our sample in each experiment are listed in Table 1.

Spontaneous Eyeblink Rate (Dopamine Marker)

Spontaneous eyeblink rate (EBR) was recording using an electrooculogram (EOG). We modeled the EBR recording procedure after the method described in Fairclough & Venables (2006). We

measured vertical eyeblink activity by attaching Ag/AgCl electrodes above and below the left eye, with a ground electrode placed on the center of the forehead. All EOG signals were filtered at 0.01 - 10 Hz and amplified by a Biopac EOG100C differential corneal–retinal potential amplifier. Eyeblinks were defined as an increase in amplitude greater than 100 μV and less than 400ms in duration. Eyeblink frequency was counted manually from the graph.

After the electrodes were securely placed and participants were seated in a comfortable position, participants were instructed to look in the direction of a black "X", which was marked on a wall one meter from where the participant was seated at eye level. Participants were also asked to try to avoid moving or turning their head throughout the recording. Eyeblinks were recorded for six minutes under resting conditions. Each participant's EBR was determined by computing the average number of blinks across the six-minute time interval. In our sample, participants' EBRs ranged from 13 - 35.20 blinks/minute (M = 16.77, SD = 8.06).

Iowa Gambling Task

The decision-making instructions and task design were the same as those used in the original IGT version (Bechara, Damasio, Damasio, & Anderson, 1994). The IGT is a history-independent task that is comprised of four decks that offer gains and losses of varying values and magnitudes. Deck A offered high value reward, high frequency losses (five loss equivalent to 250 points) with a total loss of 250 points over every 10 trials. Deck B offered high value, low frequency losses (one loss trial valued at 1250 points) with a loss of 25 points over every 10 trials. Deck C provided frequent losses of low value, but yielded more gains than losses overall (total gain of 250 points over every 10 trials). Deck D also provided infrequent losses of high value, but offered more gains as compared to losses over every 10 trials. Thus, Deck A and B were the

disadvantageous decks because they result in overall net losses, while Deck C and D represent the advantageous decks because they yielded overall net gains. Table 2 shows the payoff structure for each of the four decks across every 10 trials. We computed IGT performance by calculating the difference in proportion of advantageous deck selections from disadvantageous deck selections [(C+D)-(A+B)] across all trials during the task.

Procedure

The questionnaire and decision-making task were displayed on PC computers using Psychtoolbox for Matlab (version 2.5). Participants first completed the SRP-III questionnaire and then performed the IGT decision-making task. Task instructions specified that the purpose of the task was to gauge how people use information to make decisions. Participants were asked to repeatedly choose from one of four decks of cards, and that they could either gain or lose points on each draw. In the beginning of the task, participants started with 2000 points. They were instructed that the goal of the task was to earn at least 2500 points by the end of the experiment. No information regarding the number of trials was provided. The task included 100 trials. After completing the IGT, participants had their eyeblink rate recorded, and were then debriefed about the nature of the task.

CHAPTER III

RESULTS

We first examined correlations between the IGT net score [(C+D)-(A+B)], EBR, and each of the SRP-III subscales. Results showed that the SRP-III antisocial behavior factor was significantly positively correlated with IGT performance, $r = .25$, $p = .02$, indicating that individuals who reported more antisocial behavior selected more advantageous decks on the IGT. No other significant correlations were observed between EBR and any of the SRP-III factors or IGT performance, EBR, and the SRP-III factors, $p > .10$.

To examine whether striatal dopamine moderated the effect of psychopathy on IGT performance and assess whether any psychopathy dimensions predicted performance better than other facets, we performed a three-step hierarchical regression for IGT net score. Because previous research has shown that there are gender differences both in the degree of trait psychopathy exhibited (see Cale & Lilienfeld, 2002 for a review) and in performance on the IGT (e.g., Evans & Hampson, 2015; Reavis & Overman, 2001; van den Bos, Homberg, & de Visser, 2013) we controlled for gender in the first step of the model, $F(1, 88) = 3.42$, $p = .07$. Males tended to choose more advantageous decks than females on the task, $\beta = .19$, $p = .07$. In the second step of the model, EBR and each of the four SRP-III factors (callous affect, antisocial behavior, erratic lifestyle, and interpersonal manipulation) were entered into the model. Although the model for this second step, was not significant, $\Delta R^2 = .08$, $F(6, 83) = 1.86$, $p = .10$, SRP-III antisocial behavior was a significant predictor of IGT net score, $\beta = .30$, $p = .02$. No other SRP-III factors or EBR independently predicted IGT performance. In the last step of the model, the interaction terms

between EBR and each of the four SRP-III factors were examined. Results showed that the overall model was significant, $\Delta R^2 = .11$, $F(10, 79) = 2.28$, $p = .02$. The EBR by antisocial behavior interaction significantly predicted performance on the IGT, $\beta = 1.12$, $p = .03$. Individuals with higher levels of striatal dopamine, who also reported more antisocial behavior, chose more advantageous decks. Striatal dopamine appears to function as a buffer among individuals who engage in antisocial behavior more often that leads to enhanced performance on the IGT. However, antisocial behavior ($p = .29$) and EBR ($p = .94$) did not independently predict IGT performance. Additionally, the results revealed a significant interaction between EBR and interpersonal manipulation, $\beta = -1.89$, $p = .03$. Interpersonal manipulation did independently predicted IGT net score, $\beta = .78$, $p = .05$. Thus individuals who reported being more manipulative, chose advantageous decks C and D more than less manipulative individuals. In contrast, more manipulative individuals with higher striatal dopamine levels chose less advantageous decks on the IGT, resulting in poorer decision-making outcome. Striatal dopamine therefore was associated with detrimental IGT performance among highly manipulative individuals.

CHAPTER IV

CONCLUSIONS

Our results demonstrated that striatal dopamine moderated the relationship between SRP-III psychopathic manipulation and antisocial behavior and IGT performance. For example, individuals who reported being more manipulative and had more striatal dopamine, preferred IGT decks with immediate gain, despite that over time, such decks lead to higher net losses. Overall, more manipulative individuals who have more striatal dopamine were less loss averse and thus, selected more disadvantageous decks on the IGT. However, individuals who exhibited more antisocial behavior and striatal dopamine were more loss averse and selected advantageous decks with less losses, but gains that are smaller in magnitude, which lead to overall net gains. The current study shows that striatal dopamine moderates the manipulation and antisocial behavior dimensions of psychopathy such that more dopamine is detrimental to decision-making for individuals high on manipulation but beneficial for those who tended to engage in more antisocial behavior. For the manipulation dimension of psychopathy, the results are consistent with the reduced loss sensitivity explanation, but for the antisocial behavior dimension, the results show the opposite effect. This suggests that looking at dimensions of psychopathy may lead to a more accurate analysis and may account for the discrepancy in the previous study results. As many life choice options are complex, conflicting, arbitrary, or unfamiliar, it is important to further examine what causes individuals to persistently select advantageous and disadvantageous choices.

More specific examination of the IGT and other decision-making tasks are necessary in the future. It would be beneficial to examine learning over time through repeated measures tasks, as well as compare analyses of the individual deck selection through regression or ANOVA. In addition, it is important to examine the effects of delay discounting, BIS/BAS, and other correlated measures such as substance abuse, attention, and anxiety. Factors such as age and gender may additionally add to the weight of the analysis, and should be examined as well. One factor limiting our results currently is that the EBR dataset was not normally distributed.

Our results support both hypotheses, that different facets of psychopathy (i.e. antisocial behavior) lead to heightened reward sensitivity while other facets (i.e. interpersonal manipulation) lead to reduced loss sensitivity. These results highlight the importance of considering how psychopathy is defined in order to determine how it is related to reward preferences for future studies. In order to account for the discrepancy in findings on psychopathy and decision-making, it is important to incorporate several measures that examine different facets of trait psychopathy. It appears that manipulative psychopaths in the non-criminal population showed similar deficits in decision-making as to incarcerated psychopaths. Since striatal dopamine may enhance reward sensitivity, manipulative individuals may not learn from punishment because they are blinded by the possibility to gain rewards in the first attempt.

Mahmut, Homewood, & Stevenson (2008) found no association between IQ and psychopathy; therefore, the explanation that successful psychopaths are smarter than unsuccessful psychopaths was ruled out. Instead, they suggest that non-criminal psychopaths may be of a higher socioeconomic status and have better parental supervision while growing up than criminal

psychopaths. Additionally, successful psychopaths may possess more personality features of psychopathy, with reduced antisocial and behavioral features. The DSM's ASPD seems to encompass mostly disinhibition and meanness, in terms of the triarchic model of psychopathy. It should be examined whether the component of boldness that is defined by dominance, low anxiousness, and venturesomeness contributes to the differences in decision-making among college samples since it appears these characteristics may be encouraged. Although moderate levels of boldness characteristics may be praised, people displaying more extreme levels may be unpleasant and detrimental to others around them.

Because of this seemingly irrational decision-making of criminal psychopaths, and superior decision-making of successful psychopaths high on antisocial behavior and striatal dopamine, reward sensitivity and emotional reactions are unique and may cause some psychopathic individuals to break the law, or get caught breaking the law, and not others. Dopamine helped successful antisocial individuals in processing complex scenarios to favor advantageous outcomes. The current study concluded that dopamine levels in the ventral striatum enhanced learning on the IGT for antisocial individuals. Dopamine may make manipulative individuals more likely to make poor decisions and associated with negative consequences. Future studies should examine both successful and unsuccessful psychopathy dimensionally to test this.

REFERENCES

Arias-Carrión, O., Stamelou, M., Murillo-Rodríguez, E., Menéndez-González, M., & Pöppel, E. (2010). Dopaminergic reward system: a short integrative review. *International Archives of Medicine, 3*, 24.

Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition, 50*, 7-15.

Bechara, A., Damasio, H., & Damasio, A. R. (2000). Emotion, decision making and the orbitofrontal cortex. *Cerebral Cortex, 10*, 295-307.

Bechara, A. (2003) Risky business: Emotion, decision-making and addiction. *Journal of Gambling Studies*, 19, 23–51.

Blair, R. J. R., Mitchell, D. G. V., Peschardt, K. S., Colledge, E., Leonard, R. A., Shine, J. H., Murray, L., K., & Perrett, D. I. (2004). Reduced sensitivity to others' fearful expressions in psychopathic individuals. *Personality and Individual Differences, 37*, 1111-1122.

Blair, R. J. R. (2003). Neurobiological basis of psychopathy. *The British Journal of Psychiatry, 182*, 5-7.

Blair, R. J. R., Mitchell, D. G., Richell, R. A., Kelly, S., Leonard, A., Newman, C., & Scott, S. K. (2002). Turning a deaf ear to fear: impaired recognition of vocal affect in psychopathic individuals. *Journal of abnormal psychology,111*, 682.

Blair, R. J. R., Morris, J. S., Frith, C. D., Perrett, D. I., Dolan R. J. (1999). Dissociable neural responses to facial expressions of sadness and anger. *Brain, 122*, 883-893.

Comings, D. E., & Blum, K. (2000). Reward deficiency syndrome: genetic aspects of behavioral disorders. *Progress in brain research, 126*, 325-341.

Boulanger, C., Habib, M., & Lancon, C. (2008). Impaired making-decision and empathy disorder in psychopathy. *European Psychiatry, 23*, S92.

Buckholtz, J. W., Treadway, M. T., Cowan, R. L., Woodward, N. D., Benning, S. D., Li, R., & Zald, D. H. (2010). Mesolimbic dopamine reward system hypersensitivity in individuals with psychopathic traits. *Nature Neuroscience, 13,* 419-421.

Cale, E. M., & Lilienfeld, S. O. (2002). Sex differences in psychopathy and antisocial personality disorder: A review and integration. *Clinical Psychology Review*, *22*, 1179-1207.

Carre, J. M., Hyde, L. W., Neumann, C. S., Viding, E., & Hariri, A. R. (2013). The neural signatures of distinct psychopathic traits. *Social Neuroscience, 8,* 122-135.

Damasio, A. R., Tranel, D., Damasio, H. (1990) Individuals with sociopathic behavior caused by frontal damage fail to respond autonomically to social stimuli. Behavioural Brain Research, 41, 81- 94.

Damasio, A.R. (1994) Descartes' Error: Emotion, Reason, and the Human Brain, Putnam.

Dong, G., Lix, X., Zhou, H., & Du, X. (2014). Decision-making after continuous wins or losses in a randomized guessing task: Implication for how the prior selection results affect subsequent decision-making. *Behavioral and Brain Functions,* 10.

Edens, J. F. Petrila, J. Buffington-Vollum, J. K. (2001). Psychopathy and the death penalty: Can the Psychopathy Checklist-Revised identify offenders who represent a continuing threat to society? *The Journal of Psychiatry and Law,* 29, 433–481.

Evans, K. L., & Hampson, E. (2015). Sex differences on prefrontally-dependent cognitive tasks. *Brain and Cognition, 93,* 42-53.

Fairclough, S. H., & Venables, L. (2006). Prediction of subjective states from psychophysiology: A multivariate approach. *Biological Psychology, 71*, 100-110.

Finger, E. C., Mitchell, D. G., Jones, M., & Blair, R. J. R. (2008). Dissociable roles of medial orbitofrontal cortex in human operant extinction learning. *Neuroimage, 43,* 748-755.

Flor, H., Birbaumer, N., Hermann, C., Ziegler, S., & Patrick, C.J. (2002). Aversive Pavlovian Conditioning in Psychopaths: Peripheral and central correlates. *Psychophysiology, 39,* 505-518l.

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

Hare, R. D., & Hart, S. D. (1993). Psychopathy, mental disorder, and crime. *Mental disorder and crime.* (pp. 104-115). Thousand Oaks, CA,US: Sage Publications, Inc.

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

Hayden, B. Y., & Platt, M. L. (2010). Neurons in Anterior Cingulate Cortex Multiplex Information about Reward and Action. *The Journal of Neuroscience, 30*, 3339–3346.

Hemphill, J. F., Hare, R. D., & Wong, S. (1998). Psychopathy and recidivism: A review. *Legal and Criminological Psychology, 3*, 139-170.

Kiehl, K. A., Smith, A. M., Hare, R. D., Mendrek, A., Forster, B. B., Brink, J., & Liddle, P. F. (2001). Limbic abnormalities in affective processing by criminal psychopaths as revealed by functional magnetic resonance imaging. *Biological psychiatry, 50*, 677-684.

Knutson, B., & Cooper, J. C. (2005). Functional magnetic resonance imaging of reward prediction. *Current opinion in neurology, 18*, 411-417.

Kosson, D. S., Suchy, Y., Mayer, A. R., & Libby, J. (2002). Facial affect recognition in criminal psychopaths. *Emotion, 2*, 398.

Lennington, J. B., Pope, S., Goodheart, A. E., Drozdowicz, L., Daniels, S. B., Salamone, J. D., & Conover, J. C. (2011). Midbrain dopamine neurons associated with reward processing innervate the neurogenic subventricular zone. *The Journal of Neuroscience, 31*, 13078-13087.

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

Lösel, F., & Schmucker, M. (2004). Psychopathy, risk taking, and attention: a differentiated test of the somatic marker hypothesis. *Journal of Abnormal Psychology, 113*, 522-529.

Mahmut, M. K., Homewood, J., & Stevenson, R. J. (2008). The characteristics of non-criminals with high psychopathy traits: Are they similar to criminal psychopaths? *Journal of Research in Personality, 42*, 679-692.

Miranda Jr, R., MacKillop, J., Meyerson, L. A., Justus, A., & Lovallo, W. R. (2009). Influence of antisocial and psychopathic traits on decision-making biases in alcoholics. *Alcoholism: Clinical and Experimental Research, 33*, 817-825.

Mitchell, D. G., Colledge, E., Leonard, A., & Blair, R. J. R. (2002). Risky decisions and response reversal: is there evidence of orbitofrontal cortex dysfunction in psychopathic individuals? *Neuropsychologia, 40*, 2013-2022.

Newman, J. P., & Schmitt, W. A. (1998). Passive avoidance in psychopathic offenders: A replication and extension. *Journal of Abnormal Psychology, 107*, 527-532.

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

Patrick, C. J., Fowles, D. C., & Krueger, R. F. (2009). Triarchic conceptualization of psychopathy: Developmental origins of disinhibition, boldness, and meanness. *Development and psychopathology, 21*, 913-938.

Paulhus, D.L., Neumann, C.S., & Hare, R.D. (2012). Manual for the *Self-Report Psychopathy scale*. Toronto: Multi-Health Systems.

Pujara, M., Motzkin, J. C., Newman, J. P., Kiehl, K. A., & Koenigs, M. (2013). Neural correlates of reward and loss sensitivity in psychopathy. *Social Cognitive and Affective Neuroscience, 9*, 794-801.

Reavis, R., & Overman, W. H. (2001). Adult sex differences on a decision-making task previously shown to depend on the orbital prefrontal cortex. *Behavioral Neuroscience, 115*, 196-206.

Salekin, R. T., Rogers, R., & Sewell, K. W. (1996). A review and meta-analysis of the psychopathy checklist and psychopathy Checklist—Revised: Predictive validity of dangerousness. *Clinical Psychology: Science and Practice, 3*, 203-215.

Schmitt, W. A., Brinkley, C. A., & Newman, J. P. (1999). Testing Damasio's somatic marker hypothesis with psychopathic individuals: risk takers or risk averse? *Journal of abnormal psychology*, *108*, 538.

Seara-Cardoso, A., & Viding, E. (2014). Functional neuroscience of psychopathic personality in adults. *Journal of Personality*. (not yet in print).

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

Stevens, D., Charman, T., & Blair, R. J. R. (2001). Recognition of emotion in facial expressions and vocal tones in children with psychopathic tendencies.*The Journal of genetic psychology*, *162*, 201-211.

Stone, M. H. (2007). Violent crimes and their relationship to personality disorders. *Personality and Mental Health, 1*, 138–153.

Treadway, M. T., Buckholtz, J. W., Cowan, R. L., Woodward, N. D., Li, R., Ansari, M. S., & Zald, D. H. (2012). Dopaminergic mechanisms of individual differences in human effort-based decision-making. *The Journal of Neuroscience*, *32*, 6170-6176.

van den Bos, R., Homberg, J., & de Visser, L. (2013). A critical review of sex differences in decision-making tasks: Focus on the Iowa Gambling Task. *Behavioural Brain Research*, *238*, 95-108.

van Honk, J., Hermans, E. J., Putman, P., Montagne, B., & Schutter, D. J. (2002). Defective somatic markers in sub-clinical psychopathy. *Neuroreport*, *13*, 1025-1027.

Williams, K. M., & Paulhus, D. L. (2004). Factor structure of the Self-Report Psychopathy scale (SRP-II) in non-forensic samples. *Personality and Individual Differences*, *37*, 765-778.

APPENDIX

Table 1

Comparison of normed means for the SRP-III subscales to the sample means in each experiment

	Callous Affect	Antisocial Behavior	Erratic Lifestyle	Interpersonal Manipulation	Overall
Normed Mean	2.31	1.56	2.56	2.38	2.20
Sample Mean - Exp 1	2.42	1.53	2.46	2.51	2.23
Sample Mean - Exp 2	2.41	1.57	2.51	2.55	2.26
Sample Mean - Exp 3	2.51	1.59	2.62	2.63	2.34

Note. The normed mean is based on college students' scores from the SRP-III manual (Paulhus et al., 2012).

Table 2

Reward Schedule for the IGT

	Deck A	Deck B	Deck C	Deck D
Draw from Deck				
1	100	100	50	50
2	100	100	50	50
3	100, **-150**	100	50, **-50**	50
4	100	100	50	50
5	100, **-300**	100	50, **-50**	50
6	100	100	50	50
7	100, **-200**	100	50, **-50**	50
8`	100	100	50	50
9	100, **-250**	100, **-1250**	50, **-50**	50
10	100, **-350**	100	50, **-50**	50, **-250**
Cumulative Payoff	**-250**	**-250**	**250**	**250**

Note. See Bechara et al. (1994) for the full table that lists payoffs for the first 40 cards drawn from each deck. In the present task the sequence was repeated for cards 41-80 and 81-100 so that a participant could potentially select the same deck on all 100 draws.