1-28-2015

Neural basis of positive, negative, and controversial moral processing in incarcerated adult males with psychopathic traits

Samantha Fede

Samantha Fede
Candidate

Psychology
Department

This thesis is approved, and it is acceptable in quality and form for publication:

Approved by the Thesis Committee:

Kent Kiehl, Chairperson

Vince Calhoun

Vince Clark

Neural basis of positive, negative, and controversial moral processing in incarcerated adult males with psychopathic traits

by

Samantha J. Fede

B.S., Psychology, Virginia Polytechnic Institute and State University, 2011

THESIS

Submitted in Partial Fulfilment of the Requirements for the Degree of

Master of Science

Psychology

The University of New Mexico,

Albuquerque, New Mexico

December, 2014

ACKNOWLEDGMENTS

Data used in this thesis were provided by my advisor, Dr. Kent Kiehl, and his data collection team. Additionally, Prashanth Nyalakanti and Vikram Rao contributed to the data analysis described within.

Portions of this data were presented at the annual meeting of the Society for the Scientific Study of Psychopathy (June, 2013). Portions of this thesis are also under review for peer-reviewed publication (October, 2014). I would like to acknowledge my co-authors on those projects for their contributions to this work: Jana Schaich Borg, Prashanth Nyalakanti, Lora Cope, Carla Harenski, Walter Sinnott-Armstrong, Mike Koenigs, Vince Calhoun, and Kent Kiehl.

Research described here was supported by the National Institute of Mental Health and National Institute on Drug Abuse under Award Numbers R01MH070539, R01DA026964-03, and R01DA026505-01A1 to Kent A. Kiehl. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Neural basis of positive, negative, and controversial moral processing in incarcerated adult males with psychopathic traits

by

Samantha J. Fede

B.S., Psychology, Virginia Polytechnic Institute and State University, 2011

M.S., Psychology, University of New Mexico, 2014

Abstract

Background:

Psychopathy is a disorder characterized by antisocial and affective traits and moral violations. It has developed over time from a general sense of moral insanity to a scientifically investigated personality disorder. Prior studies of psychopathy have found abnormal brain activity during moral processing in the amygdala, posterior cingulate, and basal ganglia; however, these studies only examined negatively valenced moral stimuli. Here we aim to replicate prior moral decision-making research in a forensic population and the differences between moral verdict and moral deliberation by psychopathy. We also aim to replicate prior psychopathy research on negative moral judgment and to extend this work by investigating positive and controversial moral stimuli and to investigate whether psychopaths can determine right from wrong.

Methods:

Incarcerated adult males (*N* = 245) completed a functional magnetic resonance imaging protocol on the Mind Research Network's mobile imaging system. Psychopathy was assessed using the Hare Psychopathy Checklist-Revised (PCL-R). Participants were shown words describing three types of moral stimuli: negative (e.g., stealing), positive (e.g., giving to charity), and controversial (e.g., abortion). Participants rated each stimulus as "wrong" or "not wrong". Results were modeled time-locked to stimulus presentation and separately to participant response.

Results:

PCL-R Total scores were correlated with "not wrong" responses to negative moral stimuli. PCL-R Total scores were also inversely related to hemodynamic activity in the middle temporal gyrus, basal ganglia, anterior cingulate, and temporal pole and positively related to greater activity in the anterior insula in the contrast of *negative* > *positive*. In the *controversial* > *noncontroversial* comparison, psychopathy was inversely associated with activity in the temporal parietal junction and dorsolateral prefrontal cortex. Stimulus-locked and response-locked models had few differences.

Conclusions:

Results support the paralimbic dysfunction hypothesis of psychopathy while demonstrating behavioral impairments and distinct patterns of positively and negatively valenced moral processing in psychopaths. It also indicates that deficits related to psychopathy in moral processing are more pronounced in response to controversial moral stimuli. Differences in deficiencies by psychopathy between moral verdict and moral deliberation are unclear.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

Chapter 1

Introduction

1.1 What is Psychopathy?

Psychopathy is a clinical condition characterized by deficient emotional reactivity and antisocial traits (R.D. Hare, 2003). Psychopaths regularly commit moral violations and are responsible for a disproportionate amount of violent and repetitive crime; psychopaths also constitute around 25% of incarcerated populations (Alterman, Cacciola, & Rutherford, 1993; R.D. Hare, 2003). These callous and antisocial behaviors contribute to a high financial burden of psychopathy, estimated to be 30-50% of the $3.2 trillion dollar societal cost of crime in the United States (Anderson, 1999; Kiehl, 2014; Kiehl & Hoffman, 2011).

Psychopathy is operationalized by the Hare Psychopathy Checklist (Robert D. Hare, 1980) and the subsequent Hare Psychopathy Checklist-Revised (PCL-R; 1991; 2003; See Table 1 for a list of items). The PCL-R has been established as a reliable and valid measure of psychopathy across populations, including incarcerated groups, probationary samples, forensic and psychiatric patients and substance abusers (R.

Table 1. **20 Items of the Psychopathy Checklist-Revised (R.D. Hare, 2003).**
Factor 1: Interpersonal/Affective; Factor 2: Lifestyle/Antisocial."-" items do not load on any factor.

	Item	2 Factor Model
1	Glibness/Superficial Charm	1
2	Grandiose Sense of Self Worth	1
3	Need for Stimulation	2
4	Pathological Lying	1
5	Conning/Manipulative	1
6	Lack of Remorse or Guilt	1
7	Shallow Affect	1
8	Callous/Lack of Empathy	1
9	Parasitic Lifestyle	2
10	Poor Behavioral Controls	2
11	Promiscuous Sexual Behavior	-
12	Early Behavioral Problems	2
13	Lack of Realistic Goals	2
14	Impulsivity	2
15	Irresponsibility	2
16	Failure to Accept Responsibility	1
17	Many Marital Relationships	-
18	Juvenile Delinquency	2
19	Revocation of Release	2
20	Criminal Versatility	2

D. Hare, 1996; R.D. Hare, 2003; Robert D. Hare, 1980; McDermott et al., 2000; Wintrup, Coles, Hart, & Webster, 1994). It can be used as a continuous measure of psychopathic traits (on a scale of 40 points) or dimensionally, with 30 or above being considered high psychopathy and 20 or below low psychopathy based on recommended cut offs from (R.D. Hare, 2003).Scores can also be broken down into the two factor model: the interpersonal/affective and lifestyle/antisocial factors (R.D. Hare, 2003).

Factor 2 of psychopathy (Lifestyle/Antisocial) is related to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) axis II disorder Antisocial Personality Disorder (ASPD; APA, 1994), but it is important to note that although ASPD was intended to incorporate vital features of psychopathy, the two do not capture the same population. ASPD criteria is met by 80-90% of inmates in maximum security prisons, compared to 15-25% for psychopathy (Hart & Hare, 1989). This difference is from the reliance of ASPD on antisocial behaviors while it largely ignores the affective/interpersonal characteristics essential to psychopathy.

There are several prominent theories of psychopathy have arisen. Lykken proposed a low-fear hypothesis (Lykken, 1995), Damasio the somatic marker theory (Damasio, Tranel, & Damasio, 1991; Schmitt, Brinkley, & Newman, 1999), and Newman the response modulation perspective(Newman, 1998). Several studies have also shown reduced fear conditioning (Robert D Hare, 1982), and reduced startle response to negative stimuli (Patrick, Bradley, & Lang, 1993) in psychopaths. Additionally, psychopaths have been found to have a reduced error-monitoring response (Dikman & Allen, 2000) and increased number of false alarms in a response inhibition task (Kiehl,

Liddle, & Hopfinger, 2000) associated with abnormal anterior cingulate response. These all indicate abnormal cognitive processes.

From a neurobiological perspective, the paralimbic dysfunction hypothesis of psychopathy has been formed from studies of neuroimaging, patient and brain lesion studies, and behavioral work (Kiehl, 2006). This implicates a network of brain regions in psychopathy, including the anterior superior temporal gyrus (ATC), anterior cingulate cortex (ACC), posterior cingulate cortex (PCC), orbital frontal cortex (OFC), insula, and parahippocampal regions. Additionally, some connected limbic areas, including the amygdala, are thought to be involved. Recent studies of psychopathy have begun to confirm this, having found associations with reduced grey matter volume in the insula, the vmPFC, the fusiform gyrus, the PCC, the nucleus accumbens, amygdala and the ACC(Boccardi et al., 2011; de Oliveira-Souza et al., 2008; E. Ermer, Cope, Nyalakanti, Calhoun, & Kiehl, 2012; Ly et al., 2012; Tiihonen et al., 2008; Yang, Raine, Narr, Colletti, & Toga, 2009). Additionally, psychopathy is related to reduced activation in brain regions including the amygdala, vmPFC, insula, ACC and PCC (Birbaumer et al., 2005; Glenn, Raine, & Schug, 2009; Harenski, Harenski, Shane, & Kiehl, 2010; Kiehl, 2006; Veit et al., 2002). However, some studies have found increased activation in those regions during viewing of positive and negative emotional pictures (Muller et al., 2003; Schneider et al., 2000).

1.2 History of Psychopathy

Psychopathy was influenced by early physicians' conceptions of related conditions. Most notably, Phillipe Pinel coined the phrase "*manie sans delire*" or

"insanity without delirium" to describe someone who engaged in antisocial and immoral behaviors but without any more traditional symptoms of psychosis. Cesare Lombroso, an Italian criminologist, developed the idea of a "born criminal", first indicating that there may be physical differences to these individuals that may be reflected, in some senses, in the neurobiological study of psychopathy today. The term psychopathy itself was first used by Julius Koch, although not in the modern sense. Koch, a German psychiatrist, developed the concept of personality disorders, calling them "psychopathic inferiorities." Emil Kraepelin, when publishing the 1904 edition of his psychiatry textbook, included a full section on psychopathic personalities, referring exclusively to individuals with antisocial, manipulative, impulsive and aggressive traits close to the modern conception of the psychopath.

The modern study of psychopathy was pioneered by an American psychiatrist named Hervey Cleckley. Cleckley published *The Mask of Sanity* in 1941 based on experiences in psychiatric hospitals where he encountered and interacted with many individuals with these psychopathic traits. The current conception of a psychopath, both scientifically and in pop-culture, is largely based on the profiles Cleckley described. It continues to remain highly influential, and most notably, has strongly influenced the development of the Hare Psychopathy Checklist, the gold-standard of psychopathy measurement.

1.3 Review of Previous Literature on Psychopathy and Moral Decision Making

Despite the overwhelming impact of psychopathy on society and initial observations that immoral behaviors are common among psychopaths (Cleckley, 1976),

many studies have found that psychopaths do not differ from non-psychopaths on tasks where they differentiate between right and wrong (E. Aharoni, Sinnott-Armstrong, & Kiehl, 2012; Cima, Tonnaer, & Hauser, 2010; Glenn, Raine, & Schug, 2009; Harenski et al., 2010; O'Kane, Fawcett, & Blackburn, 1996; Simon, Holzberg, & Unger, 1951), although see (Blair, 1995; Koenigs, Kruepke, Zeier, & Newman, 2012; Liane Young, Koenigs, Kruepke, & Newman, 2012). However, even when making similar moral judgments, psychopaths show different patterns of brain engagement compared to non-psychopaths (Glenn, Raine, & Schug, 2009; Harenski et al., 2010). This includes reduced activation in the amygdala, posterior cingulate (PCC), and ventromedial prefrontal cortex (vmPFC) during moral processing.

These aforementioned brain regions play important roles in moral judgment. Blair suggests that the amygdala and the vmPFC work through stimulus-reinforcement learning to associate distress with moral transgressions to reduce antisocial behaviors (Blair, 2007). The PCC is engaged when individuals use theory of mind to generate intent stories, during self-reflection processes, and when integrating emotion into moral decision making (Fletcher et al., 1995; Greene, Sommerville, Nystrom, Darley, & Cohen, 2001; Johnson et al., 2006; Ochsner & Gross, 2005).

The psychopathy studies summarized above have only looked at moral judgment of negatively valenced stimuli; in fact, no studies to date have investigated the neural correlates of positive moral judgment in psychopathy. Research on social cooperation, however, has indicated that psychopathy is associated with reduced engagement of the orbitofrontal cortex (OFC), dorsolateral prefrontal cortex (dlPFC), and anterior cingulate cortex (ACC) (Rilling et al., 2007). Additionally, structural magnetic resonance imaging

analyses have indicated that psychopathy is associated with reduced grey matter in the insula, vmPFC, fusiform gyrus, PCC, amygdala, and ACC (Boccardi et al., 2011; de Oliveira-Souza et al., 2008; E. Ermer & Kiehl, 2010; Ly et al., 2012; Tiihonen et al., 2008; Yang et al., 2009). This paralimbic dysfunction is hypothesized to be the neurobiological underpinning of behavioral and personality traits associated with psychopathy (Kiehl, 2006); many of these regions are implicated in studies of positive moral judgment in healthy subjects.

In a comparison of moral verdicts in a healthy sample, hemodynamic activity was greater during judgments of moral wrongness in the insula, temporal poles, basal ganglia, temporoparietal junction (TPJ), and amygdala (Schaich Borg, Sinnott-Armstrong, Calhoun, & Kiehl, 2011). Positive moral decisions have been associated with engagement of the vmPFC, insula, and superior temporal gyrus (STG) during social cognition (E. Ermer, Guerin, Cosmides, Tooby, & Miller, 2006; R. D. Hare & Neumann, 2010; Ma, Wang, & Han, 2011), whereas the caudate, OFC, vmPFC, and ACC have been implicated in reward processing during altruism (Rilling et al., 2008). Additionally, the TPJ, vmPFC, and PCC had greater engagement during processing of controversial moral stimuli (Schaich Borg et al., 2011). This study also illustrated the engagement during controversial stimuli was better elucidated during moral deliberation while the comparison between wrong and not wrong items was clearer during moral verdict.

1.4 Present Study Goals and Hypotheses

The present thesis aims to investigate behavioral and neurological differences in moral processing related to psychopathy in incarcerated adult males. Here we use a fMRI

task of moral judgment to investigate the neural correlates of processing positive, negative, and controversial moral stimuli. We additionally investigated differences between moral verdict and moral deliberation. We hypothesized that there would be no behavioral differences related to psychopathy and that the main effects of our neuroimaging analysis would replicate prior results of this task. Additionally, we hypothesized that psychopathic traits would be inversely related to activity in brain areas implicated in the community study using this task (Schaich Borg et al., 2011), particularly paralimbic regions. Finally, we expected the effects of psychopathy would be more marked during moral deliberation than moral verdict.

Chapter 2

Methodology

2.1 Participants

Participants were incarcerated adult males from prisons in New Mexico and Wisconsin (*N* = 245; see Table 2 for demographics) where we have established research programs. Participants provided written, informed consent and were compensated $1 per hour, comparable to pay for general work in the facilities. IQ ranged from 66 to 134 and ages were between 18 and 65. Exclusion criteria were: English reading level below 4th grade, history of neurological disorder or stroke, head injury with loss of consciousness greater than one hour, or history of psychotic disorder in self or first-degree relative.

Table 2.

*Descriptive Statistics for Sample on Demographics, IQ, Psychopathy, and Substance Dependence (*N = *245)*

Variable	Mean	SD	Percentage
Age	36.14	10.848	
Handedness			
Right			82.4
Left			9.8
Ambidextrous			6.9
Ethnicity/Race			
Hispanic/Latino			40.3
Not Hispanic/Latino			59.7
American Indian/ Alaskan Native			14
Asian			0.5
Black/ African American			10
Native Hawaiian/ Pacific Islander			0
White			50.7
Other/ Decline			24.9
IQ	96.28	13.885	
Psychopathy			
Total	20.73	6.809	
Factor 1	6.18	3.39	
Factor 2	12.19	3.901	
Substance Dependence			
None			35.5
Alcohol			45.7
Sedatives			4.9
Cannabis			26.2
Methamphetamine			22.5
Opioids			18
Cocaine			31
Hallucinogens			4.8
Number of Dependencies	1.52	1.557	

Notes: missing: handedness, n = 2; ethnicity/race, n = 2; IQ, n = 54; substance dependence, n = 14. Race/ethnicity data was collected for NIH reporting purposes.

A supplemental healthy community control sample, where participants were paid $15 per hour, was analyzed separately for main effects only (N = 32).

Data from males only are included in this sample given that female psychopathy may have different behavioral and neurobiological manifestations and due to gender differences in emotional processing during moral decision making.

2.2 Data Collection Procedures

2.2.1 Assessments

A battery of assessments collected by trained research staff, including the author of this thesis, was given to all participants. This assessment battery included approximately 18 hours of a self-report, neuropsychological, and interview assessments.

Only the assessments from which we derived variables for this thesis or for exclusionary purposes are discussed here. All procedures and materials are approved by the University of New Mexico Institutional Review Board (IRB).

Psychopathy was assessed using the Hare Psychopathy Checklist-Revised (PCL-R)(R.D. Hare, 2003), the most widely used assessment of psychopathy in forensic populations. Trained researchers reviewed institutional records and conducted semi-structured interviews covering topics like school and employment, criminality, and interpersonal style. The PCL-R comprises 20 items, each scored 0 *doesn't apply*, 1 *applies somewhat*, or 2 *definitely applies.* Total scores range from 0 to 40, with higher scores indicating higher psychopathic traits. In addition to a total score, a two-factor structure was also examined (R.D. Hare, 2003; Harpur, Hare, & Hakstian, 1989). Factor 1 is composed of interpersonal and affective traits (e.g., lack of remorse, grandiosity)

whereas Factor 2 is made up of lifestyle and antisocial traits (e.g., poor behavioral controls, impulsivity). Interviews were recorded for reliability assessment and a randomly selected portion of the sample (approximately 10%) was double rated (one-way random effects model intraclass correlation coefficient = .91 for PCL-R Total scores) (Shrout & Fleiss, 1979).

IQ was estimated using the Vocabulary and Matrix Reasoning subtests of the Wechsler Adult Intelligence Scale (WAIS) (Ryan, Lopez, & Werth, 1999; Wechsler, 1997) and reading level was assessed with the Wide Range Achievement Test Word Reading subtest (WRAT-3) (Wilkinson, 1993). Psychiatric and substance use histories were assessed with the Structured Clinical Interview for DSM-IV disorders (SCID) (First, Spitzer, Williams, & Gibbon) (See Table 3 for correlations between assessments.)

Table 3.

Table of Correlations Between PCL-R Scores and Other Assessment Variables

	PCL-R Total	**PCL-R Factor 1**	**PCL-R Factor 2**	**Age**	**IQ**
PCL-R Factor 1	.80**				
PCL-R Factor 2	.83**	.50**			
Age	-.14*	.10	-.29**		
IQ	.04	.17*	-.16*	.06	
# Substance Dependencies	.25**	-.04	.31**	-.27**	-.01

Notes: ** denotes significant relationship where $p < .01$; * denotes significant relationship where $p < .05$

2.2.2 Task

Participants were shown words and phrases describing moral acts or concepts adapted from Schaich Borg et al., 2011 (Schaich Borg et al., 2011). One hundred stimuli were considered *noncontroversial*; of these, 50 were classified as *negative* (e.g., murder, lying, slavery) and 50 were classified as *positive*[1] (e.g., charity, kindness, saving lives). An additional 50 stimuli classified as morally *controversial* (e.g.,

animal testing, prostitution, gun control) were also presented. See Appendix A for a list of all stimuli. Participants were presented with a stimulus and asked to press one button to indicate that they thought the word or phrase was wrong and another to indicate that they thought the word or phrase was not wrong. Immediately after the button press or after 10 seconds if no response was given, a black screen was presented for 1 to 6 seconds. Participants completed three runs of 50 stimuli each (evenly split among stimulus types).

Participants were scanned using a 1.5T Siemens Avanto mobile MRI scanner stationed at correctional facilities or at the Mind Research Network. The scans were acquired using an EPI gradient-echo pulse sequence (parameters: TR 2000, TE 39 ms, flip angle 75°, FOV 24 x 24 cm, 64 x 64 matrix, 4 mm slice thickness, 27 slices). The task was presented using E-prime software ("E-Prime,"). Behavioral data and eye movements were monitored in real-time to ensure participants were performing the task.

2.3 Data Analysis Procedure

2.3.1 Behavioral Data Analysis

For noncontroversial items, a correctness value was calculated to determine the proportion of button presses that matched the predetermined classification (i.e., the percentage of positive stimuli responded to with a button press of "not wrong"). Correctness and response times for each stimulus type were correlated with PCL-R Total and factor scores. In the correlation with each factor, the other factor was partialled out to account for shared variance. Additionally, independent samples *t*-tests were performed to investigate differences in response time between negative and positive as well as

controversial and noncontroversial stimuli. Seven participants were excluded for failing to complete the task. IBM SPSS Statistics 20 was used for all behavioral analyses (IBM, 2011).

2.3.2 Image Preprocessing and Analyses

Imaging data were preprocessed using Statistical Parametric Mapping software (SPM5; 44). A multistage procedure was used to address the issue of head motion. First, the ArtRepair Toolbox in SPM (Mazaika, Hoeft, Glover, & Reiss, 2009) was used to identify and remove severe artifacts. Next, head motion was estimated using INRIAlign, an algorithm that is insensitive to eye movements and BOLD activity (Freire, Roche, & Mangin, 2002). Images were then spatially normalized to the Montreal Neurological Institute (MNI) template and smoothed with an 8mm full width at half max Gaussian smoothing kernel. A high pass filter removed low frequency drift at 1/128 HZ. Eight individuals were removed from the analyses who had bad images due to errors in data collection, resulting in a final sample size of $n = 237$.

Three conditions of interest (*positive*, *negative*, and *controversial*) were modeled at the first-level (single-subject) GLM. For the main analyses, we examined the conditions time-locked to stimuli onset. Stimuli were preclassified as *controversial* or *noncontroversial*; within the *noncontroversial* pool, stimuli were classified as *positive* or *negative* by participant response of "not wrong" or "wrong", respectively. Second-level analyses were conducted comparing the conditions of interest using one-sample *t*-tests. The primary contrasts examined were 1) *controversial* > *noncontroversial* and 2) *positive* > *negative*. The effect of psychopathy was examined by regressing PCL-R Total.

To test our hypotheses, *a priori* regions of interest (ROIs) were examined. We used the results of Schaich Borg. et al., 2011 to develop ROIs where we expected to see psychopathy-related activity by creating 10mm radius spheres around peak coordinates of significant clusters in that publication (see Table 5 for regions examined for each contrast[2]). Significant clusters found in the whole-brain level main effects of the forensic sample were used as coordinates to generate exploratory ROIs for the psychopathy regression as well. Masks of ROIs, generated using the Wake Forest University Pick Atlas in SPM (Maldjian, Laurienti, & Burdette, 2004; Maldjian, Laurienti, Kraft, & Burdette, 2003), were used to examine each ROI separately. A small volume correction (SVC) technique was then applied.

Additional analyses were done following the omnibus tests. Conditions were examined compared to implicit baselines. Also, a regression with PCL-R Factor 1 and Factor 2 scores entered separately was examined to isolate the unique contributions of each factor.

A supplementary analysis was done to explore qualitatively the difference between moral deliberation and moral verdict. In order to do this, a whole brain analysis of the aforementioned contrasts were done for conditions modeled time locked to stimuli presentation as well as those modeled time locked to participant button press.

Chapter 3

Results

3.1 Behavioral Results

(See Table 4 for statistics) On average, participants rated approximately one-half of the stimuli as "wrong", and one-half as "not wrong". There was a significant correlation between the number of items identified as "not wrong" and PCL-R Total score. This relationship was driven by PCL-R Factor 2 score, controlling for Factor 1.

PCL-R Total score was significantly inversely correlated with overall correctness, specifically on negative but not positive stimuli. PCL-R Factor 1 score was not significantly partially correlated with correctness on any stimuli type, whereas PCL-R Factor 2 score was significantly partially correlated with correctness on all noncontroversial stimuli and on negative items specifically.

Response time did not differ between negative and positive stimuli (t = .057, p =

Table 4.

Table of Behavioral Results

	Mean	Standard Deviation	Correlation with PCL-R Total	Partial Correlation with PCL-R Factor 1	Partial Correlation with PCL-R Factor 2
"Not Wrong" Button Presses	74.70	9.11	.20***	.09	.11
"Wrong" Button Presses	74.28	9.44	-.19***	-.05	-.14*
Correctness, overall	.93	.11	-.15*	-.02	-.13*
Correctness, positive items	.95	.12	-.07	.02	-.08
Correctness, negative items	.91	.12	-.21****	-.06	-.16*
Response Time, overall	2248 ms	472 ms	.02	-.02	.05
Response Time, positive items	2013 ms	584 ms	-.02	-.01	-.01
Response Time, negative items	2018 ms	572 ms	-.04	-.00	-.04
Response Time, controversial items	2507 ms	648 ms	-.06	-.02	-.04
Response Time, noncontroversial items	2016 ms	568 ms	-.03	-.01	-.02

Notes: ***, denotes significant relationship where p < .005, **** denotes significant relationship where p < .001, ** denotes significant relationship where p < .01; * denotes significant relationship where p < .05. Correlations for Factor 1 and Factor 2 scores are partial correlations with variance from the other factor partialled out.

.96), but response time to controversial stimuli was significantly greater compared to noncontroversial stimuli ($t = 6.00$, $p < .001$). Response times were not significantly related to PCL-R Total or factor scores for any stimulus type.

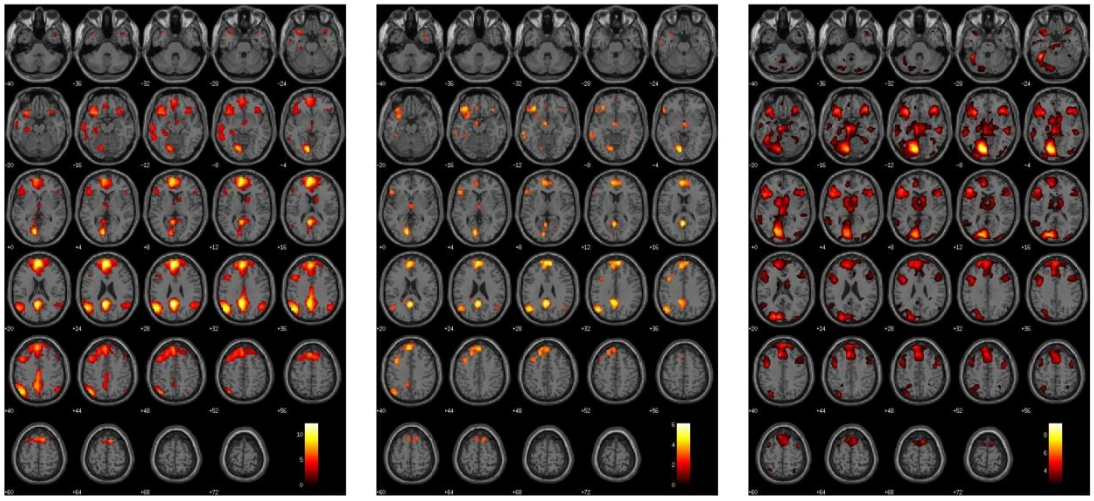
3.2 Main Effects of Moral Processing

(See Figure 1 and Table 5) In both community and forensic main effects analyses, results were consistent with those shown in previous work using this task (Schaich Borg et al., 2011) for the contrast of *controversial* > *noncontroversial* items. For the contrast of *positive* > *negative*, activity in frontal ROIs was present in both samples; however, the community sample did not show activation in temporal, occipital and subcortical ROIs and the forensic sample showed inverse response in occipital ROIs (see Appendix B).

3.3 Controversial Moral Processing by Psychopathy

(See Table 5A and Figure 2A for statistics) In the main ROI analysis, a significant inverse relationship between hemodynamic response and PCL-R total score was present in the right TPJ ($x = 54$, $y = -60$, $z = 39$) and right dlPFC ($x = 42$, $y = 24$, $z = 42$). When examining these ROIs in a regression with PCL-R factor scores, activity in the dlPFC was significantly inversely related to PCL-R Factor 1 score while activity in the TPJ was inversely correlated with PCL-R Factor 2 score at a trend level. In analysis of exploratory ROIs, an additional cluster of engagement in the left TPJ was negatively.

Figure 1A. Hemodynamic activity in *controversial* > *noncontroversial*. Results are thresholded to illustrate similarity: (Left) Results from Schaich Borg et al., 2011 (n = 26, FDR corrected p < .05 shown). (Middle) Results from healthy pilot sample (n = 32, uncorrected p < .01 shown). (Right) Results from forensic sample (n = 237, FDR corrected p < .05 shown).



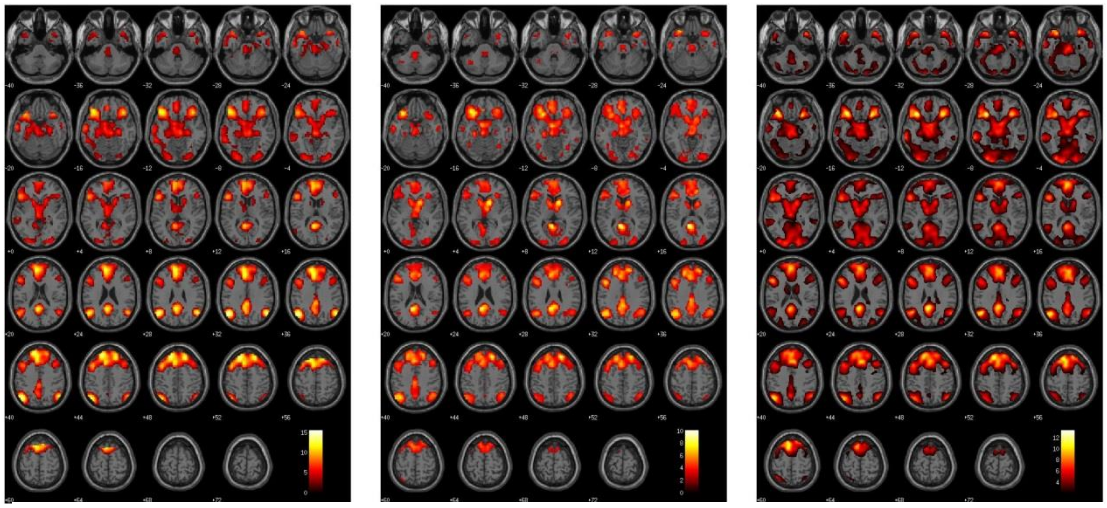


Figure 1B. Hemodynamic activity in *negative* > *positive* (top) and *positive* > *negative* (bottom). Results are thresholded to show similarity: (Left) Results from Schaich Borg et al., 2011 (n = 26, FDR corrected p < .05 shown). (Middle) Results from healthy pilot sample (n = 32, uncorrected p < .01 shown). (Right) Results from forensic sample (n = 237, FDR corrected p < .05 shown).

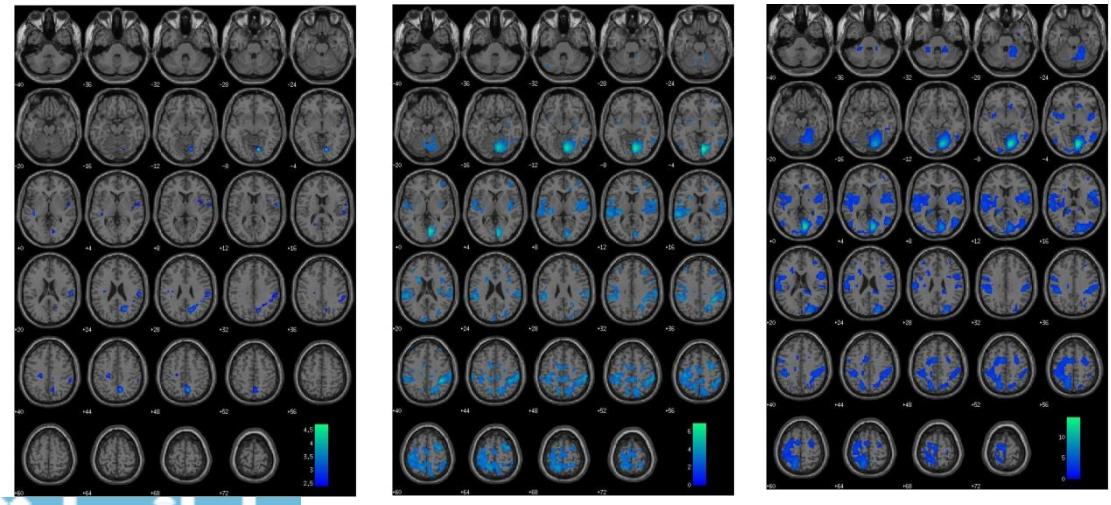


Table 5A.

Results Compared to Previous Study Using Moral Decision Making Task for Contrast of Controversial > Noncontroversial

ROIs from Schaich Borg et al (2011)					Schaich Borg et al., 2011	Healthy Control Sample	Forensic Sample	
Label	**BA**	**X**	**y**	**z**	***t*-value**	***t*-value**	***t*-value Main Effect**	***t*-value Psychopathy Regression**
Frontal Lobes					*n* = 26	*n* = 32	*n* = 237	
Dorsomedial superior frontal gyrus	6	-6	21	60	12.12	6.58****	12.77****	-2.70°°°
Dorsomedial superior frontal gyrus	8	-9	48	48	13.19	6.25****	14.16****	-2.23°
L. Middle Frontal Gyrus	6/8/9	-45	18	48	9.29	5.22***	10.46****	-1.83°
R. Middle Frontal Gyrus	6/8/9	42	21	51	9.68	5.10***	7.12****	-3.12*
Dorsomedial Superior Frontal Gyrus (extending into Anterior Cingulate)	9/10 (32)	-6	48	15	11.21	5.63****	13.22****	n.s.
Ventromedial Superior Frontal Gyrus	10	-3	54	-6	8.55	5.60****	8.04****	-1.88°
(extending into rectal gyrus)	11	0	42	-21	6.17	5.47****	7.81****	-1.68°
L. Anterior Insula	13	-33	18	-9	11.55	7.75****	11.85****	-2.36°°
R. Anterior Insula	13	36	21	-9	9.51	5.17***	10.9****	-2.01°
(extending into inferior frontal gyrus, orbital gyrus on L)	47/11	-39	24	-18	10.25	8.7****	12.29****	-2.36°°
(extending into inferior frontal gryus, orbital gyrus on R)	47/11	30	18	-18	12.80	5.00***	9.53****	-1.75°
(extending into inferior frontal gryus, orbital gyrus on R)	*	-30	15	-24	14.44	8.64****	10.47****	-2.63°°°
(extending into temporal pole on L)	38	-39	21	-24	9.68	8.64****	11.39****	2.63°°°
(extending into temporal pole on R)	38	33	18	-24	9.63	4.90***	8.82****	n.s.
Temporal Lobes								
L. Middle Temporal Gyrus	21	-63	-39	-9	6.29	2.45°	6.26****	n.s.
R. Middle Temporal Gyrus	21	66	-40	-6	4.47	2.92°°°	2.20°	-2.34°°
Parietal Lobes								
L. Angular Gyrus/Supramarginal Gyrus	39/40	-51	-69	36	9.68	7.51****	15.53****	-2.33°°
R. Angular Gyrus/Supramarginal Gyrus	39/40	57	-63	30	7.98	5.35****	14.23****	-3.57*
Occipital Lobes								
L. lingual gyrus/ cuneus/ middle occipital gyrus/ inferior occipital gyrus	17/18/19	-18	-102	-9	7.93	2.80 †	5.86****	n.s.
R. lingual gyrus/ cuneus/ middle occipital gyrus/ inferior occipital gyrus	17/18/19	27	-96	-9	4.47	4.28**	5.96****	-2.27°
Cingulate/ Subcortical								
Posterior cingulate gyrus	31	-3	-51	27	11.21	10.03****	13.07****	-2.13°
L. caudate head/ putamen/ globus pallidus/ thalamus	*	-9	0	9	8.10	5.52****	5.83****	n.s.
R. caudate head/ putamen/ globus pallidus/ thalamus	*	12	3	9	8.78	8.43****	6.34****	-2.22°
L. Brainstem	*	-9	-12	-18	6.51	7.12****	6.97****	n.s.
R. Brainstem	*	6	-12	-15	6.68	7.12****	7.16****	-2.26°
L. Parahippocampal gyrus (extending into amygdala)	34/28	-15	-3	-18	6.85	6.76****	6.56****	-2.22°
R. Parahippocampal gyrus (extending into amygdala)	34/28	15	-6	-15	4.98	5.22****	5.76****	-1.77°

For new results, significance indicated as follows: FWE corrected: $p<.10^{\dagger}$, $p<.05$*, $p<.01$**, $p<.005$***, $p<.001$****, uncorrected $p<.05$°, $p<.01$°°, $p<.005$°°°, $p<.001$°°°°. n.s. indicates no suprathreshold clusters found during SVC. Results from Schaich Borg et al., 2011 reported based on a combined *p* value and *t*-value threshold (specific *p*-values not reported). Labels from Schaich Borg et al., 2011.

Table 5B.

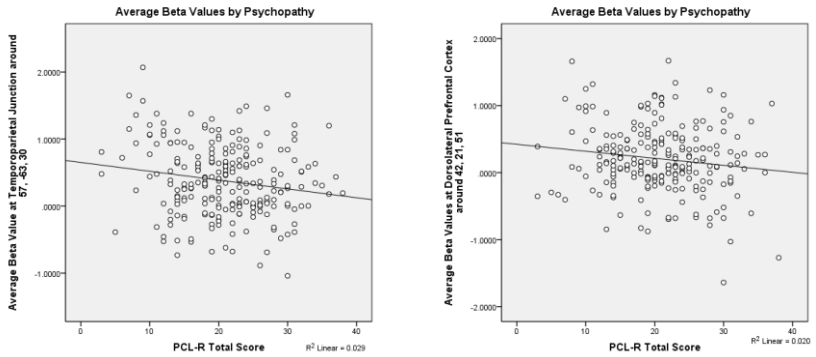
Results Compared to Previous Study Using Moral Decision Making Task for Contrast of Noncontroversial Wrong > Noncontroversial Not Wrong

ROIs					Schaich Borg et al., 2011	Healthy Control Sample	Forensic Sample	
Label	**BA**	**x**	**Y**	**z**	***t*-value**	***t*-value**	***t*-value Main Effect**	***t*-value Psychopathy Regression**
Frontal Lobes					*n* = 26	*n* = 32	*n* = 237	
Dorsomedial Superior Frontal Gyrus	6/8	-6	33	42	6.41	3.88*	7.3****	2.86 †
Dorsomedial Superior Frontal Gyrus	9	-3	51	30	5.95	5.37***	11.82****	2.17°
Dorsomedial Superior Frontal Gyrus/ Anterior Cingulate Gyrus	10/32	-6	48	15	4.70	4.97***	11.43****	1.82°
L. Superior Frontal Gyrus	9/10	-18	60	33	6.30	3.92*	7.72****	2.11°
L. Middle Frontal Gyrus	6/8	-45	12	54	5.30	3.08°°°	5.70****	2.60°°°
R. Middle Frontal Gyrus	6/8	57	6	45	5.60	0.56 n.s.	1.67°	2.18°
(extending inferiorly on the L)	9	-39	9	30	4.37	3.93*	5.54****	n.s.
L. Anterior Insula	13	-33	18	-9	7.37	3.74*	7.40****	3.20*
R. Anterior Insula	13	39	24	-3	6.33	2.70°°	4.52****	2.08°
(extending into inferior frontal gyrus, orbital gyrus on the L.)	47/11	-36	27	-15	6.70	4.66***	7.18****	1.65°
(extending into inferior frontal gyrus, orbital gyrus on the R.)	47/11	39	30	-15	6.89	3.44*	5.10****	1.67°
(extending into temporal pole on L.)	38	-39	24	-24	4.99	4.2**	7.08****	n.s.
(extending into temporal pole on R.)	38	36	27	-21	5.35	3.44*	5.10****	-3.07*
Temporal Lobes								
R. Temporal Pole	21/38	45	12	-36	3.96	2.53°°	3.02°°°	n.s.
L. Inferior Temporal Gyrus	20	-33	-6	-39	4.28	2.73°°	1.10 n.s.	-2.30°
L. Middle Temporal Gyrus	*	-57	-33	-9	5.31	4.08*	4.47***	1.92°
R. Middle Temporal Gyrus	*	51	-27	-9	5.64	1.97°	2.17°	-3.03 †
L. Middle Temporal Gyrus	21	-57	-57	6	4.87	1.14 n.s.	2.32°	2.16°
L. Temporal Occipital Junction	19/39	-48	-69	9	3.72	2.14°	-4.17***	1.83°
Parietal Lobes								
L. Angular Gyrus	22/39	-51	-54	21	4.10	3.91*	9.45****	-2.10°
Occipital Lobes								
L. Lingual gyrus	18	-9	-75	-9	7.80	5.35***	10.03****	2.58°°°
(extending into L. cuneus)	17	-12	-87	12	7.09	4.51***	8.36****	n.s.
L. Middle Occipital Gyrus	19	-33	-96	15	5.35	0.21 n.s.	-3.31*	n.s.
R. Middle Occipital Gyrus	19	30	-93	21	4.85	0.15 n.s.	-6.77****	n.s.
L. Inferior Occipital Gyrus	18/19	-27	-96	-9	4.00	1.10 n.s.	-3.66**	n.s.
R. Inferior Occipital Gyrus	18/19	48	-72	-9	4.60	0.57 n.s.	-4.68****	n.s.
L. Fusiform Gyrus	37	-48	-60	-18	6.12	1.63 n.s.	2.45°°	-2.26°
R. Fusiform Gyrus	37	42	-57	-12	4.99	0.21 n.s.	-3.39*	n.s.
L. Fusiform Gyrus	20	-42	-48	-21	6.42	3.30°°	2.66°°°	-2.71°°°
R. Fusiform Gyrus	20	36	-45	-24	3.82	0.36 n.s.	-3.47*	2.01°
Subcortical								
R. Parahippocampal Gyrus	30	15	-39	-6	4.07	0.72 n.s.	-2.66°°°	2.44°°
R. Parahippocampal Gyrus	28	27	-21	-9	4.09	1.86°	-1.95°	1.67°
L. Hippocampus	*	-30	-21	-15	4.96	2.08°	4.28***	-2.19°
L. Caudate head/ putamen/ globus pallidus/ thalamus	*	-15	-6	3	5.47	2.34°	3.45*	-2.82 †
R. Caudate head/ putamen/ globus pallidus/ thalamus	*	9	6	9	4.70	1.09 n.s.	3.93***	-2.84 †
L. Amygdala	*	-18	-6	-21	3.88	2.18°	2.98 †	n.s.
R. Amygdala	*	27	-3	-18	3.96	1.56 n.s.	1.74°	-2.29°
L. Brainstem	*	-9	-18	-18	5.78	3.39*	2.51°°	1.66°
R. Brainstem	*	9	-21	-15	5.14	2.54°°	2.51°°	-1.88°

For new results, significance indicated as follows: FWE corrected: p<.10†, p <.05*, p < .01**, p < .005***, p < .001****, uncorrected p < .05°, p < .01°°, p <.005°°°, p < .001°°°°. n.s. indicates no suprathreshold clusters found during SVC. Results from Schaich Borg et al., 2011 reported based on a combined p value and t-value threshold (specific p-values not reported). Labels from Schaich Borg et al., 2011.

related to PCL-R Total score (x = -39, y = -63, z = 33; See Appendix B for complete results of exploratory ROI analysis). In the whole brain regression, no regions survived correction for multiple comparisons.

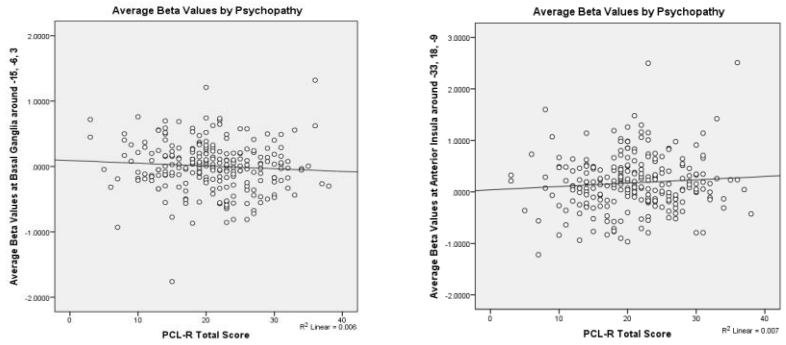
Figure 2A. (Left) Regression of hemodynamic activity associated with PCL-R Total score during *controversial* > *noncontroversial* in the TPJ: average beta values plotted by PCL-R Total score. (Right) Regression of hemodynamic activity associated with PCL-R Total score during *controversial* > *noncontroversial* in the right dlPFC: average beta values plotted by PCL-R Total score.



3.4 Positive and Negative Moral Processing by Psychopathy

(See Table 5B and Figure 2B) In the main ROI analyses, a significant relationship between hemodynamic response and PCL-R total score was present in the left anterior insula (x = -30, y = 21, z = 0), while an extension from the insula into the right temporal pole (x = 27, y = 24, z = -18) was inversely related to PCL-R Total score.

Figure 2B. (Left) Regression of hemodynamic activity associated with PCL-R Total score during *negative* > *positive*in the anterior insula: average beta values plotted by PCL-R Total score. (Right) Regression of hemodynamic activity associated with PCL-R Total score during *negative* > *positive* in the basal ganglia: average beta values plotted by PCL-R Total score.



Additionally, ROIs in the bilateral basal ganglia (left: x = -12, y = -3, z = 9; right: x =9, y = -3, z = 12) and middle temporal gyrus (MTG; x = 57, y = -27, z = -15) indicated an inverse relationship between engagement and PCL-R Total score at a trend level, while a ROI in the medial prefrontal cortex (BA 8) included a cluster of a positive correlation at trend level (x = 0, y = 27, z = 45). In analysis of exploratory ROIs, additional negative correlation clusters in the ACC (x = 12, y = 33, z = -6) and thalamus (x = -12, y =-3, z =9) were found (See Appendix B for complete results of exploratory ROI analysis). In the whole brain regression, no regions survived correction for multiple comparisons.

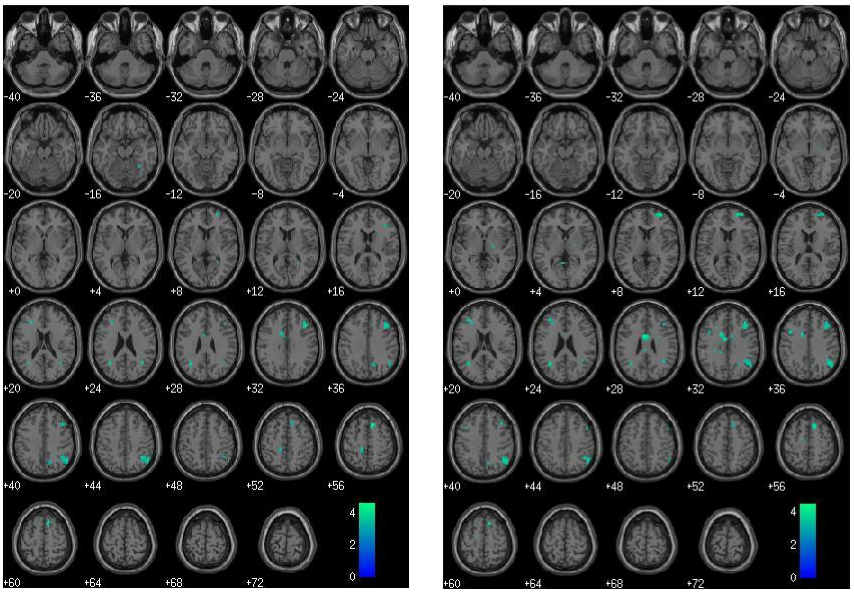
When examining *positive* and *negative* conditions compared to implicit baseline, insula activity was related to PCL-R Total score at a trend level for *negative* > *baseline* (T = 2.94, p = .058 FWE corrected) and did not approach significance in *positive* > *baseline*. This pattern was also reflected in the medial prefrontal cortex (T = 3.0, p = .053 FWE corrected). A positive relationship between basal ganglia activity and PCL-R Total score was present in *positive* > *baseline* (left: T = 2.8, p= .084 FWE corrected; right: T = 3.03, p = .049 FWE corrected), whereas no significant relationship existed in *negative* > *baseline*. This pattern was also reflected in the thalamus (T = 2.80, p = .084 FWE corrected). The ROIs in the temporal pole and MTG did not approach significance in either *negative* > *baseline* or *positive* > *baseline*, while ACC activity was positively related to PCL-R at a lower threshold in *positive* > *baseline* (T = 2.49, p = .007 uncorrected) but did not approach significance in *negative* > *baseline*. Additionally, a cluster in the PCC survived whole brain correction in *positive* > *baseline* with a positive relationship to PCL-R Total score (T = 4.94, p = .016 FWE corrected). When examining these ROIs in a regression with PCL-R Factor 1 score and Factor 2 score, only activity in

the MTG showed a relationship, indicating an inverse correlation at trend level with PCL-R Factor 1 score.

3.5 Moral Verdict versus Moral Deliberation by Psychopathy

Whole brain psychopathy effects done as part of the main analysis (modeled time locked to stimulus) are substantively the same as those done as part of the supplementary analysis. In the *controversial* > *noncontroversial* contrast, an inverse relationship between psychopathy and engagement of the vmPFC is detected at a low threshold of $p <$ .001 unc in the response locked but not the stimulus locked model (See Figure 3A).

Figure 3A. Contrast of *noncontroversial* > *controversial.* (Left) Stimulus-locked model of BOLD response related to psychopathy. (Right) Response-locked model of BOLD response related to psychopathy. Both figures shown at $p <$ .001 uncorrected.



On the other hand, in the *negative* > *positive* contrast, nearly no inverse relationships between hemodynamic response and psychopathy were detected in the response-locked model compared to the primary stimulus-locked model (see Figure 3B).

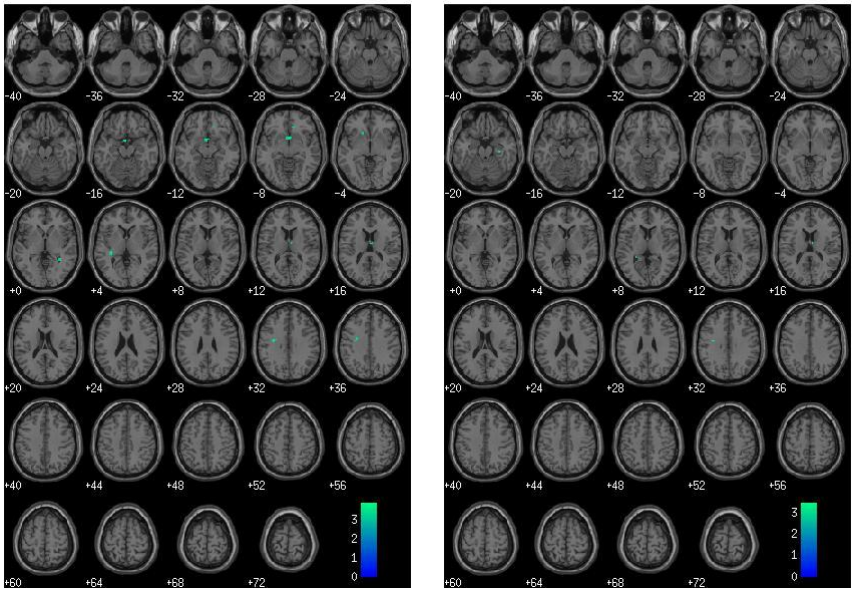
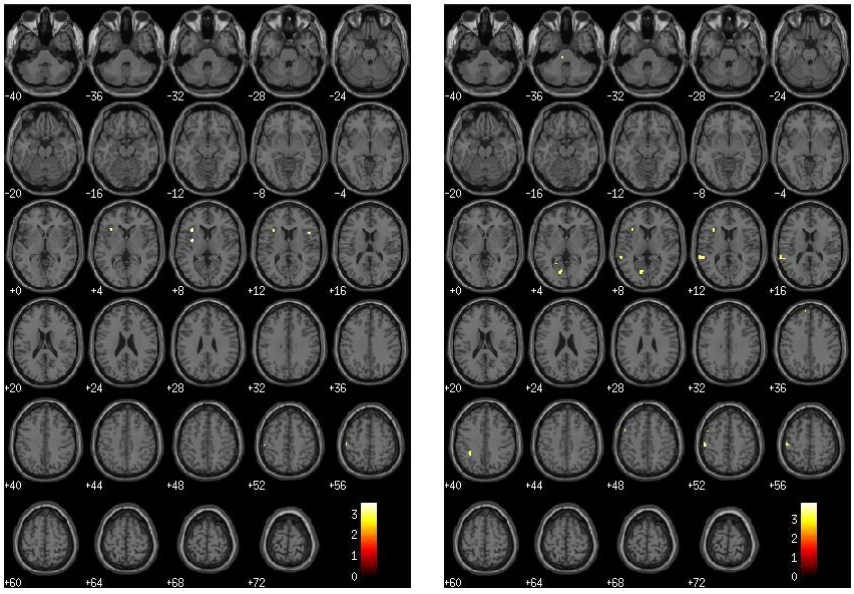


Figure 3B. (Top) Contrast of *positive* > *negative.* (Bottom) Contrast of *negative* > *positive*. (Left) Stimulus-locked model of BOLD response related to psychopathy. (Right) Response-locked model of BOLD response related to psychopathy. Both figures shown at $p < .001$ uncorrected.



Chapter 4

Discussion

4.1 Summary

This study investigated the neural correlates of moral processing in incarcerated adult males with psychopathic traits using morally negative, positive, and controversial stimuli. We expected to replicate prior results from this task and extend previous work on negatively valenced moral stimuli in psychopathy. This was the first large-scale fMRI study of psychopathy to include positively valenced moral stimuli and to specifically investigate controversial moral stimuli.

Consistent with our prior work in healthy controls (Schaich Borg et al., 2011), here both community and forensic samples engaged frontal regions during moral processing. We found negative relationships between psychopathy scores and activity in hypothesized temporal regions and a positive relationship in the anterior insula in response to negative moral stimuli. Additionally, processing of positively valenced moral stimuli had a distinct relationship to psychopathy, including a correlation to activity in the ACC, PCC, thalamus, and basal ganglia. An inverse relationship between psychopathy and hemodynamic response was also found in the hypothesized regions of the TPJ and dlPFC in response to controversial moral stimuli. These imaging results as a whole lend additional support to the paralimbic dysfunction hypothesis of psychopathy (Kiehl, 2006).

4.2 Discussion of Results

In our investigation of main effects across all study participants, our results were consistent with previous findings (Schaich Borg et al., 2011) of this task. Processing of controversial moral stimuli showed increased engagement of frontal cognitive and moral processing regions in both our community and forensic samples; however, in our incarcerated sample, many of the findings were in the opposite direction than expected. However, it should also be noted that given the sample size here (N = 237) compared to the prior work (N = 26), this study had greater power to detect effects.

When comparing negative to positive stimuli, psychopathy scores were inversely related to engagement in right temporal regions. Negative MTG engagement was driven by interpersonal and affective deficiencies in psychopathy, consistent with that region's role in rational assessment and attribution of intention to others (Brunet, Sarfati, Hardy-Bayle, & Decety, 2000; Jastorff, Clavagnier, Gergely, & Orban, 2010). The temporal pole is also implicated in social and emotional processing in healthy populations (Olson, Plotzker, & Ezzyat, 2007). Temporal regions have been found in prior studies of psychopathy with effects in the direction seen here (Cope, Ermer, Nyalakanti, Calhoun, & Kiehl, 2014; E. Ermer et al., 2012; Elsa Ermer, Cope, Nyalakanti, Calhoun, & Kiehl, 2013).

Psychopathy was also related to increased engagement in the anterior insula during processing of negative moral stimuli. Other studies of psychopathy have found reduced gray matter volume (Cope et al., 2014; E. Ermer et al., 2012; Elsa Ermer et al., 2013) and less activity related to psychopathy during emotional conditioning (Birbaumer et al., 2005; Veit et al., 2002) in the insula. However, our results support a growing

literature indicating that psychopaths have greater activation of the anterior insula than non-psychopaths in response to viewing negatively valenced stimuli including others in pain (Decety, Skelly, & Kiehl, 2013), fear, and sadness (Decety, Skelly, Yoder, & Kiehl, 2014). One possible explanation for this effect comes from the insula's diverse functionality and the highly salient nature of negatively valenced emotional and moral stimuli. A highly salient stimulus detection process, rather than empathic processes, might be recruited by psychopaths to evaluate negative emotional stimuli specifically (Decety et al., 2013).

In response to positive moral stimuli, psychopathy was related to increased rostral ACC engagement. Rostral ACC activity is related to error detection(Menon, Adleman, White, Glover, & Reiss, 2001), inappropriate behavioral responses (Kiehl, Hare, McDonald, & Brink, 2000), and reward processes during social cooperation (Rilling et al., 2002). One possible explanation for this finding is that although psychopaths correctly identified prosocial activities like *charity* as "not wrong," they instinctually identified self-sacrificing practices as an error. Additionally, psychopaths may engage in increased reward evaluation during processing of these positive moral stimuli. In addition to the ACC's role in reward processes, previous literature indicates that psychopaths are particularly sensitive to reward (Blair et al., 2004; Obrien & Frick, 1996). This explanation is also supported by the positive association found here between hemodynamic response in basal ganglia and thalamic regions and psychopathy; the basal ganglia also plays a role in reward processing during altruism (Rilling et al., 2008), while the thalamus plays a role in regulating the reward circuit (Haber & Knutson, 2010).

Additionally, a positive relationship between psychopathy and activity in the PCC, an area related to theory of mind and integrating emotions into decision making, was found during processing of positive stimuli. This was surprising considering the literature finds reduced grey matter volume (Cope et al., 2014; E. Ermer et al., 2012; Elsa Ermer et al., 2013) and activity during negative moral decision making (Glenn, Raine, & Schug, 2009; Harenski et al., 2010) related to psychopathy in this region. However, this may indicate a double dissociation between positive and negative moral processing in psychopathy where the former is associated with increased basal ganglia, ACC, and PCC engagement while the latter is related to increased anterior insula activity. In other words, psychopaths may engage in reward processing and theory of mind in response to positive moral stimuli like *charity*, whereas they may use salience detection to evaluate negative moral stimuli like *murder*. Additional neuroimaging research designed specifically to look at positive moral processing in psychopathy is needed to further elucidate these distinct processes.

During controversial moral stimuli, we found negative associations between psychopathy and brain engagement in the TPJ and dlPFC. The TPJ is recruited during processing of controversial moral stimuli in healthy controls (Schaich Borg et al., 2011) and with attributing intention to others during moral reasoning (L. Young, Camprodon, Hauser, Pascual-Leone, & Saxe, 2010). Previous work found that psychopaths, but not non-psychopaths, had a negative correlation between TPJ activity and moral severity ratings (Harenski et al., 2010). The dlPFC plays an important role in moral judgment as well, being implicated in cognitive control over emotions during dilemmas, abstract reasoning, and generation of aversive emotions (Tassy, Oullier, Cermolacce, & Wicker,

2009). In previous work, Glenn and colleagues found a positive relationship between dlPFC activity and psychopathy during moral decision making (Glenn, Raine, Schug, Young, & Hauser, 2009), which the authors suggest indicates that psychopaths recruit abstract reasoning processes during moral decision making. Our results do not support this conclusion. Together with results from the TPJ, our study indicates psychopaths do not recruit moral decision making or cognitive neural resources to the same extent that non-psychopaths and healthy controls do during challenging moral dilemmas. This was consistent with other studies finding decreased hemodynamic response during moral processing and moral judgment in psychopathy (Glenn, Raine, & Schug, 2009; Harenski et al., 2010). Methodological differences between Glenn et al. and our study should be considered when interpreting the dissimilar results. Here we used a forensic rather than community sample and had a larger sample. Additionally, we have investigated morally valenced stimuli compared to complex moral personal dilemmas.

Higher psychopathy scores were also related to poorer performance on the moral processing task. Higher psychopathy total scores were associated with more incorrect responses, specifically by more button presses indicating "not wrong." This effect was driven by antisocial/developmental/lifestyle traits; in fact, PCL-R Factor 2 scores were related to less correct responses while Factor 1 scores were not significantly related to responding. This is one of the first studies to show an effect of psychopathy on moral judgment. Previous literature is mixed with respect to whether psychopaths perform worse on tasks of moral processing compared to non-psychopaths. Blair and colleagues found that psychopaths were less able to distinguish between moral and conventional violations (Blair, Jones, Clark, & Smith, 1995), indicating that psychopaths may know

something is impermissible but not that it is morally wrong. However, a more recent modification of that study did not find those effects (E. Aharoni et al., 2012). Additionally, other work has found that psychopaths rate moral personal violations as more wrong than moral impersonal violations, consistent with healthy controls (Cima et al., 2010; Koenigs et al., 2012). However, these studies looked at the differentiation of types of violations, not at identifying whether something is wrong or not wrong, as the present study did. The present finding provides evidence that psychopaths may be impaired in distinguishing between right and wrong. Such scientific evidence could be used in legal settings to excuse antisocial behavior with an insanity plea and potentially result in civil commitments that raise civil rights and financial concerns(Eyal Aharoni, Funk, Sinnott-Armstrong, & Gazzaniga, 2008; Morse, 2008). Additional study of this effect is needed.

Regarding the moral verdict versus moral deliberation supplementary analysis, the qualitative results do not seem to support the hypothesis and previous results seen in the main effects of Schaich Borg et al., 2011. It could be that the distributed effect of psychopathy on moral judgment is too small to be greatly influenced by modeling features or that the signal captured at response too significantly overlapped with that at stimulus.

4.3 Limitations of the Study

There are a few limitations that need to be considered when interpreting the results described here. Caution should be taken in generalizing results from this task to the moral decision-making field as a whole. Contradictions in results using different

moral tasks indicate that additional studies are needed to accurately generalize to moral processing as a whole. Additionally, some of our results (i.e., ACC and thalamic results) are exploratory; although consistent with the outcome of the study as a whole, the preliminary nature of these findings should be kept in mind when interpreting these specific effects and merit additional follow-up work. Finally, the differences between moral verdict and moral deliberation in terms of psychopathy merit much more sophisticated analysis; rather than comparing models qualitatively, a study with conditions isolating those phenomena should be developed. Any results from that supplementary analysis are highly preliminary and should be interpreted with extreme caution.

4.4 Implications for Future Research

This is the first study of moral processing of positive moral stimuli and psychopathy. It is also the first to use this task in a clinical population and the first to specifically examine how the controversy of a moral stimulus interacts with psychopathy to lead to differences in hemodynamic response during moral processing. Therefore, replication of this work as well as utilization of tasks specifically designed to investigate positive moral processing are needed. Future studies should also examine the developmental course and gender effects of these abnormalities in other forensic samples. Structural research indicates that youth with callous-unemotional traits have similar gray matter deficiencies to adults with psychopathic traits(Elsa Ermer et al., 2013), but it is unclear if these structural similarities would extend to similar moral processing abnormalities as well. Moreover, women with psychopathic traits may have a distinct

pattern of gray matter abnormalities from male psychopaths (Lushing et al., in prep), leaving it undetermined if we should expect similar abnormal moral processing. Finally, studies employing advanced functional connectivity techniques should be carried out to investigate system-wise dysfunction in psychopathy during all forms of moral processing. This may help to elucidate the way that functional and dysfunctional regions work together in psychopathy to produce moral and non-moral behaviors.

4.5 Conclusions

In summary, here we have replicated existing results of a moral decision making task and extended that work using a forensic sample. Psychopathic traits were found to be related to brain abnormalities in processing negative moral stimuli, consistent with prior work. We also found psychopathy-related effects during processing of positively valenced and controversial moral stimuli. This work helps to elucidate the neurobiological basis of impairments in moral processing in psychopathy. The work also broadly supports paralimbic impairment in psychopathy (Kiehl, 2006). Finally, we have provided some of the first scientific evidence that psychopaths have a deficit in distinguishing right from wrong. In these ways we have investigated and added to the scientific literature on the behavioral and neurological differences in moral processing related to psychopathy in incarcerated adult males.

APPENDIX A: List of Stimuli Presented in Task by Stimulus Type

Non-Controversial Not Wrong Stimuli	Controversial Stimuli	Non-Controversial Wrong Stimuli
comforting those who are sick	smoking in restaurants	prejudice
aiding the homeless	eating meat	racist jokes
Politeness	legalizing drug use	grafitiing national monuments
giving medicine to the sick	sex without protection	under-age drinking
loving another	piercing your private parts	cheating on your girlfriend
volunteering at the soup kitchen	women marrying women	breaking promises
sticking up for your friends	prison lockdown	racism
Justice	illegal immigrants	lying
donating blood	smoking pot	cheating
being faithful	Orgies	breaking the law
being patient	anal sex	cheating on a test
working hard	death penalty	faking your education
honoring elders	prison uniforms	burning down a home
equal rights	gays in the military	poisoning a horse
Charity	animal testing	murder
saving a drowning child	Gambling	torture
having sex with your wife	having sex in public	teasing a handicapped child
hugging a sad child	gay sex	getting a fifteen-year old pregnant
recycling	under-age driving	sex with a minor
Honor	doctor-assisted suicide	eating human flesh
giving an unexpected gift	Abortion	shooting a friend
food drives	men marrying men	drowning a kitten
listening to others	war in Iraq	stalking somebody
keeping promises	Masturbation	hiding a bomb on a plane
teaching a student	Prostitution	drinking alcohol while pregnant
visiting a friend's grave	gun control	slashing tires
caring for others	wearing real fur coats	beating a pregnant woman
encouraging each other	taking steroids	drunk driving
Kindness	nuclear weapons	slavery
donating clothes	black men marrying white women	stealing a car
Courage	burning the American flag	robbery
doing your best	allowing felons to vote	kicking a puppy
saying "thank you"	medicine for illegal immigrants	strangling a baby
watching son's basketball game	joining a gang	terrorism
saving lives	selling drugs	raping a teenager
visiting family in a nursing home	ratting out your friend	killing innocent people
Sharing	snorting cocaine	burglary
medical care	breaking parole	sex with your mother
food shelters	KKK rallies	child pornography
helping an old woman	escaping prison	serial killing
telling the truth	prayer in school	sexual harassment
donating money to charity	Hunting	sexual assault
feeding the hungry	seatbelt laws	kidnapping
respecting another's privacy	Suicide	prison rape
Friendship	medical marijuana	spreading AIDS on purpose
protecting your family	females in the military	sex with sheep
respect for others	police brutality	leaving a baby in a dumpster
giving advice	gay couples adopting children	hitting your wife
Religion	correctional officers beating up prisoners	pornography
Jaywalking	Religion	speeding

APPENDIX B: Significant Clusters in Whole Brain Main Effects Analysis and SVC Results for Exploratory ROIs in the Forensic Sample

B.1 *Contrast of Controversial > Noncontroversial*

Label	Region BA	x	Y	z	Main Effect (whole brain) *t*-value	Psychopathy Regression (exploratory SVC) *t*-value
L. Superior Frontal Gyrus	8	-18	39	48	14.51****	-2.16°
L. Superior Frontal Gyrus	8	-12	48	39	13.54****	-2.32°
L. Medial Frontal Gyrus	9	-6	48	24	13.22****	n.s.
R. Superior Temporal Gyrus	39	51	-63	30	14.23****	-3.77*
L. Angular Gyrus	39	-48	-66	33	15.53****	-2.75 †
R. Middle Occipital Gyrus	18	33	-87	-6	6.05****	-2.27°
R. Lingual Gyrus	18	18	-75	-3	2.65***	-2.07°
R. Uncus	36	30	-3	-39	3.19****	n.s.
R. Declive	*	36	-60	-12	2.55**	-3.16*

Significance indicated as follows: FWE corrected: $p<.10^{\dagger}$, p <.05*, p < .01**, p < .005***, p < .001****, uncorrected p < .05°, p < .01°°, p <.005°°°, p < .001°°°°. n.s. indicates no suprathreshold clusters found during SVC. Only whole brain results surviving FDR correction at p < .05 are reported and used for exploratory ROIs.

APPENDIX B (cont.)

B.2 *Contrast of Negative > Positive and Positive > Negative in the Forensic Sample*

Label	Region BA	x	Y	z	Main Effect (whole brain) *t*-value	Psychopathy Regression (exploratory SVC) *t*-value
L. Superior Frontal Gyrus	9	-6	51	27	11.82****	2.17°
R Superior Frontal Gyrus	6	12	18	63	7.98****	1.99°
L. Superior Frontal Gyrus	8	-3	30	57	6.92****	2.57°°°
L. Middle Frontal Gyrus	10	-36	39	27	-3.21****	n.s.
L. Middle Frontal Gyrus	11	-36	45	-6	3.31****	1.85°
R. Middle Frontal Gyrus	6	27	-15	63	-2.77***	2.01°
R. Middle Frontal Gyrus	10	39	42	21	-3.04****	n.s.
R. Middle Frontal Gyrus	8	39	30	51	2.47**	1.86°
R. Middle Frontal Gyrus	6	33	-3	51	-3.54****	2.17°
R. Middle Frontal Gyrus	8	48	21	42	3.47****	n.s.
R. Middle Frontal Gyrus	9	30	30	36	-2.69***	-1.91°
L. Inferior Frontal Gyrus	47	-30	18	-18	7.4****	1.81°
L. Inferior Frontal Gyrus	45	-48	27	6	5.17****	2.62°°°
L. Inferior Frontal Gyrus	47	-18	30	-3	-2.49**	2.55°°
R. Inferior Frontal Gyrus	47	33	24	-15	5.1****	-3.07*
R. Inferior Frontal Gyrus	45	54	27	6	4.15****	2.25°
R. Inferior Frontal Gyrus	10	39	48	6	-2.58***	-1.91°
R. Sub-gyral Frontal Gyrus	6	24	-3	57	-3.37****	1.95°
R. Precentral Gyrus	4	27	-30	66	-2.74***	-1.86°
R. Precentral Gyrus	6	30	3	27	-2.81***	-1.69°
R. Precentral Gyrus	44	54	6	15	-5.33****	3.09*
R. Insula	13	36	18	6	-2.49**	3.04†
R, Insula	13	36	-42	18	-2.48**	1.72°
L. Middle Temporal Gyrus	21	-60	-18	-12	4.98****	1.85°
L. Middle Temporal Gyrus	20	-54	-45	-12	4.9****	n.s.
R. Superior Temporal Gyrus	39	45	-60	30	5.83****	-2.51°°
R. Superior Temporal Gyrus	38	42	12	-36	3.02****	2.05°
L. Superior Parietal Lobule	7	-15	-60	60	-5.99****	1.80°
L. Inferior Parietal Lobule	40	-42	-33	36	-5.31****	2.45°°
L. Angular Gyrus	39	-48	-66	30	10.16****	-1.73°
L. Precuneus	7	-12	-51	60	-5.72****	n.s.
R. Precuneus	7	9	-60	54	-2.56**	2.11°
R. Precuneus	7	12	-57	57	-2.46**	2.10°
L. Red Nucleus	*	-3	-27	-3	2.96***	-2.44°°
L. Substania Nigra	*	-9	-18	-12	2.51**	1.66°
L. Anterior Lobe	*	-24	-42	-36	-3.04****	n.s.
L. Lingual Gyrus	18	-9	-78	-3	10.03****	3.04†
R. Lingual Gyrus	18	12	-78	-6	-14.83****	2.23°
L. Fusiform Gyrus	19	-36	-72	-18	-2.92***	1.68°
R, Fusiform Gyrus	20	45	-36	-18	-3.23****	-2.48°°
R. Cuneus	18	24	-87	21	-6.77****	1.93°
L. Culmen	*	-3	-54	-15	-2.77***	2.68°°°
R. Culmen	*	12	-27	-18	2.51**	-1.88°
L. Hippocampus	*	-30	-24	-18	4.28****	-1.80°
L. Parahippocampal Gyrus	36	-24	-36	-12	3.97****	-2.00°
L. Posterior Cingulate	31	-6	-54	27	12.15****	-1.79°
R. Posterior Cingulate	23	12	-36	21	-3.35****	-1.98°
R. Posterior Cingulate	31	18	-39	27	-3.19****	1.75°
R. Anterior Cingulate Gyrus	32	21	6	42	-2.61***	-1.74°
L. Anterior Cingulate Gyrus	24	0	-27	39	6.8****	n.s.
R. Caudate Head into Anterior Cingulate	32	15	24	-6	-3.65****	-3.37*
R. Hypothalamus into Anterior Cingulate	25	6	-6	-9	3.86****	-3.01†
R. Globus Pallidus	*	21	-9	0	-2.52**	-2.52°°
R. Caudate Head	*	9	6	0	2.51**	-3.16*
R. Caudate Body	*	12	6	12	3.93****	-2.88†
R. Caudate Tail	*	33	-42	0	-2.72***	-3.30*
L. Caudate Tail	*	-18	-42	12	-4.86****	-2.32°
L. Thalamus/ Anterior Nucleus	*	-6	-6	6	3.45****	-2.82†
L. Amygdala	*	-18	-6	-15	2.98***	-2.10°
R. Amygdala	*	33	-3	-30	-2.78***	2.38°°

Significance indicated as follows: FWE corrected: p<.10†, p <.05*, p < .01**, p < .005***, p < .001****, uncorrected p < .05°, p < .01°°, p <.005°°°, p < .001°°°°. n.s. indicates no suprathreshold clusters found during SVC. Only whole brain results surviving FDR correction at p < .05 are reported and used for exploratory ROIs.

References

Aharoni, E., Sinnott-Armstrong, W., & Kiehl, K. A. (2012). Can psychopathic offenders discern moral wrongs? A new look at the moral/conventional distinction. *Journal of abnormal psychology, 121*(2), 484-497. doi: 10.1037/a0024796

Aharoni, Eyal, Funk, Chadd, Sinnott-Armstrong, Walter, & Gazzaniga, Michael. (2008). Can neurological evidence help courts assess criminal responsibility? Lessons from law and neuroscience. *Annals of the New York Academy of Sciences, 1124*(1), 145-160.

Alterman, A.A., Cacciola, J.S., & Rutherford, M.J. (1993). Reliability of the revised psychopathy checklist in substance abuse patients. *Psychological Assessment, 5*, 442-448.

Anderson, D. A. (1999). The aggregate burden of crime. *Journal of Law & Economics, 42*(2), 611-642. doi: Doi 10.1086/467436

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

Birbaumer, N., Veit, R., Lotze, M., Erb, M., Hermann, C., Grodd, W., & Flor, H. (2005). Deficient fear conditioning in psychopathy: a functional magnetic resonance imaging study. *Archives of general psychiatry, 62*(7), 799-805. doi: 10.1001/archpsyc.62.7.799

Blair, R. J. R. (1995). A Cognitive Developmental-Approach to Morality - Investigating the Psychopath. *Cognition, 57*(1), 1-29. doi: Doi 10.1016/0010-0277(95)00676-P

Blair, R. J. R. (2007). The amygdala and ventromedial prefrontal cortex in morality and psychopathy. *Trends in cognitive sciences, 11*(9), 387-392. doi: DOI 10.1016/j.tics.2007.07.003

Blair, R. J. R., Jones, L., Clark, F., & Smith, M. (1995). Is the Psychopath 'morally insane'? *Personality and Individual Differences, 19*(5), 741-752. doi: http://dx.doi.org/10.1016/0191-8869(95)00087-M

Blair, R. J. R., Mitchell, D. G. V., Leonard, A., Budhani, S., Peschardt, K. S., & Newman, C. (2004). Passive avoidance learning in individuals with psychopathy: modulation by reward but not by punishment. *Personality and Individual Differences, 37*(6), 1179-1192. doi: 10.1016/j.paid.2003.12.001

Boccardi, Marina, Frisoni, Giovanni B, Hare, Robert D, Cavedo, Enrica, Najt, Pablo, Pievani, Michela, . . . Repo-Tiihonen, Eila. (2011). Cortex and amygdala morphology in psychopathy. *Psychiatry Research: Neuroimaging, 193*(2), 85-92.

Brunet, E., Sarfati, Y., Hardy-Bayle, M. C., & Decety, J. (2000). A PET investigation of the attribution of intentions with a nonverbal task. *NeuroImage, 11*(2), 157-166. doi: DOI 10.1006/nimg.1999.0525

Cima, M., Tonnaer, F., & Hauser, M. D. (2010). Psychopaths know right from wrong but don't care. *Social cognitive and affective neuroscience, 5*(1), 59-67. doi: 10.1093/scan/nsp051

Cleckley, Hervey M. (1976). The mask of sanity: An attempt to clarify some issues about the so-called psychopathic personality: Mosby (St. Louis).

Cope, L. M., Ermer, E., Nyalakanti, P. K., Calhoun, V. D., & Kiehl, K. A. (2014). Paralimbic gray matter reductions in incarcerated adolescent females with psychopathic traits. *J Abnorm Child Psychol, 42*(4), 659-668. doi: 10.1007/s10802-013-9810-4

Damasio, Antonio R, Tranel, Daniel, & Damasio, Hanna. (1991). Somatic markers and the guidance of behavior: Theory and preliminary testing. *Frontal lobe function and dysfunction*, 217-229.

de Oliveira-Souza, R., Hare, R. D., Bramati, I. E., Garrido, G. J., Ignacio, F. A., Tovar-Moll, F., & Moll, J. (2008). Psychopathy as a disorder of the moral brain: Fronto-temporo-limbic grey matter reductions demonstrated by voxel-based morphometry. *NeuroImage, 40*(3), 1202-1213. doi: DOI 10.1016/j.neuroimage.2007.12.054

Decety, Jean, Skelly, Laurie R, & Kiehl, Kent A. (2013). Brain response to empathy-eliciting scenarios involving pain in incarcerated individuals with psychopathy. *JAMA psychiatry, 70*(6), 638-645.

Decety, Jean, Skelly, Laurie, Yoder, Keith J, & Kiehl, Kent A. (2014). Neural processing of dynamic emotional facial expressions in psychopaths. *Social neuroscience, 9*(1), 36-49.

Dikman, Ziya V, & Allen, John JB. (2000). Error monitoring during reward and avoidance learning in high-and low-socialized individuals. *Psychophysiology, 37*(01), 43-54.

. E-Prime. Pittsburgh, PA: Psychological Software Tools.

Ermer, E., Cope, L. M., Nyalakanti, P. K., Calhoun, V. D., & Kiehl, K. A. (2012). Aberrant paralimbic gray matter in criminal psychopathy. *Journal of abnormal psychology, 121*(3), 649-658. doi: 10.1037/a0026371

Ermer, E., Guerin, S. A., Cosmides, L., Tooby, J., & Miller, M. B. (2006). Theory of mind broad and narrow: Reasoning about social exchange engages ToM areas, precautionary reasoning does not. *Social neuroscience, 1*(3-4), 196-219. doi: Doi 10.1080/17470910600989771

Ermer, E., & Kiehl, K. A. (2010). Psychopaths are impaired in social exchange and precautionary reasoning. *Psychological science, 21*(10), 1399-1405. doi: 10.1177/0956797610384148

Ermer, Elsa, Cope, Lora M, Nyalakanti, Prashanth K, Calhoun, Vince D, & Kiehl, Kent A. (2013). Aberrant paralimbic gray matter in incarcerated male adolescents with psychopathic traits. *Journal of the American Academy of Child & Adolescent Psychiatry, 52*(1), 94-103. e103.

First, MB, Spitzer, RL, Williams, JBW, & Gibbon, M. (1997). Structured clinical interview for DSM-IV (SCID), 1997. *American Psychiatric Association, Washington, DC*.

Fletcher, P. C., Happe, F., Frith, U., Baker, S. C., Dolan, R. J., Frackowiak, R. S. J., & Frith, C. D. (1995). Other Minds in the Brain - a Functional Imaging Study of Theory of Mind in Story Comprehension. *Cognition, 57*(2), 109-128. doi: Doi 10.1016/0010-0277(95)00692-R

Freire, Luis, Roche, Alexis, & Mangin, J-F. (2002). What is the best similarity measure for motion correction in fMRI time series? *Medical Imaging, IEEE Transactions on, 21*(5), 470-484.

Glenn, A. L., Raine, A., & Schug, R. A. (2009). The neural correlates of moral decision-making in psychopathy. *Molecular psychiatry, 14*(1), 5-6. doi: 10.1038/mp.2008.104

Glenn, A. L., Raine, A., Schug, R. A., Young, L., & Hauser, M. (2009). Increased DLPFC activity during moral decision-making in psychopathy. *Molecular Psychiatry, 14*(10), 909-911. doi: Doi 10.1038/Mp.2009.76

Greene, J. D., Sommerville, R. B., Nystrom, L. E., Darley, J. M., & Cohen, J. D. (2001). An fMRI investigation of emotional engagement in moral judgment. *Science, 293*(5537), 2105-2108. doi: 10.1126/science.1062872

Haber, S. N., & Knutson, B. (2010). The Reward Circuit: Linking Primate Anatomy and Human Imaging. *Neuropsychopharmacology, 35*(1), 4-26. doi: 10.1038/npp.2009.129

Hare, R. D. (1996). Psychopathy - A clinical construct whose time has come. *Criminal Justice and Behavior, 23*(1), 25-54. doi: Doi 10.1177/0093854896023001004

Hare, R. D., & Neumann, C. S. (2010). The Role of Antisociality in the Psychopathy Construct: Comment on Skeem and Cooke (2010). *Psychological Assessment, 22*(2), 446-454. doi: Doi 10.1037/A0013635

Hare, R.D. (2003). *Manual for the Hare Psychopathy Checklist-Revised* (2nd ed.). Toronto, CA: Multi-Health Systems.

Hare, Robert D. (1982). Psychopathy and physiological activity during anticipation of an aversive stimulus in a distraction paradigm. *Psychophysiology, 19*(3), 266-271.

Hare, Robert D. (1980). A research scale for the assessment of psychopathy in criminal populations. *Personality and Individual Differences, 1*(2), 111-119. doi: http://dx.doi.org/10.1016/0191-8869(80)90028-8

Harenski, C. L., Harenski, K. A., Shane, M. S., & Kiehl, K. A. (2010). Aberrant neural processing of moral violations in criminal psychopaths. *Journal of abnormal psychology, 119*(4), 863-874. doi: 10.1037/a0020979

Harpur, Timothy J, Hare, Robert D, & Hakstian, A Ralph. (1989). Two-factor conceptualization of psychopathy: Construct validity and assessment implications. *Psychological Assessment: A Journal of consulting and clinical Psychology, 1*(1), 6.

Hart, Stephen D., & Hare, Robert D. (1989). Discriminant validity of the Psychopathy Checklist in a forensic psychiatric population. *1*, 211-218. doi: 10.1037/1040-3590.1.3.211

IBM. (2011). IBM SPSS Statistics for Windows (Version 20.0). Armonk, NY: IBM Corp.

Jastorff, Jan, Clavagnier, Simon, Gergely, György, & Orban, Guy A. (2010). Neural mechanisms of understanding rational actions: middle temporal gyrus activation by contextual violation. *Cerebral Cortex*, bhq098.

Johnson, M. K., Raye, C. L., Mitchell, K. J., Touryan, S. R., Greene, E. J., & Nolen-Hoeksema, S. (2006). Dissociating medial frontal and posterior cingulate activity during self-reflection. *Social cognitive and affective neuroscience, 1*(1), 56-64. doi: 10.1093/scan/nsl004

Kiehl, K. A. (2006). A cognitive neuroscience perspective on psychopathy: Evidence for paralimbic system dysfunction. *Psychiatry research, 142*(2-3), 107-128. doi: DOI 10.1016/j.psychres.2005.09.013

Kiehl, K. A., Hare, R. D., McDonald, J. J., & Brink, J. (2000). Semantic and affective processing in psychopaths: An event-related potential (ERP) study. (vol 36, pg 765, 1999). *Psychophysiology, 37*(2), 267-267. doi: Doi 10.1017/S0048577200999980

Kiehl, K. A., Liddle, P. F., & Hopfinger, J. B. (2000). Error processing and the rostral anterior cingulate: An event-related fMRI study. *Journal of Cognitive Neuroscience*, 111-111.

Kiehl, K.A. (2014). *The Psychopath Whisperer: The Science of Those Without Conscience*. United States of America: Crown.

Kiehl, K.A., & Hoffman, M.B. (2011). The criminal psychopath: history, neuroscience, treatment, and economics. *Section of Science & Technology Law: American Bar Association.*

Koenigs, Michael, Kruepke, Michael, Zeier, Joshua, & Newman, Joseph P. (2012). Utilitarian moral judgment in psychopathy. *Social Cognitive and Affective Neuroscience, 7*(6), 708-714. doi: 10.1093/scan/nsr048

Ly, M., Motzkin, J. C., Philippi, C. L., Kirk, G. R., Newman, J. P., Kiehl, K. A., & Koenigs, M. (2012). Cortical thinning in psychopathy. *The American journal of psychiatry, 169*(7), 743-749. doi: 10.1176/appi.ajp.2012.11111627

Lykken, David Thoreson. (1995). *The antisocial personalities*: Psychology Press.

Ma, Y. N., Wang, C. B., & Han, S. H. (2011). Neural responses to perceived pain in others predict real-life monetary donations in different socioeconomic contexts. *NeuroImage, 57*(3), 1273-1280. doi: DOI 10.1016/j.neuroimage.2011.05.003

Maldjian, J. A., Laurienti, P. J., & Burdette, J. H. (2004). Precentral gyrus discrepancy in electronic versions of the Talairach atlas. *Neuroimage, 21*(1), 450-455.

Maldjian, J. A., Laurienti, P. J., Kraft, R. A., & Burdette, J. H. (2003). An automated method for neuroanatomic and cytoarchitectonic atlas-based interrogation of fMRI data sets. *NeuroImage, 19*(3), 1233-1239. doi: Doi 10.1016/S1053-8119(03)00169-1

Mazaika, Paul K, Hoeft, Fumiko, Glover, GH, & Reiss, Allan L. (2009). Methods and software for fMRI analysis of clinical subjects. *NeuroImage, 47*, S58.

McDermott, Paul A., Alterman, Arthur I., Cacciola, John S., Rutherford, Megan J., Newman, Joseph P., & Mulholland, Ellen M. (2000). Generality of Psychopathy Checklist—Revised factors over prisoners and substance-dependent patients. *Journal of Consulting and Clinical Psychology, 68*(1), 181-186. doi: 10.1037/0022-006X.68.1.181

Menon, Vinod, Adleman, Nancy E, White, Christopher D, Glover, Gary H, & Reiss, Allan L. (2001). Error-related brain activation during a Go/NoGo response inhibition task. *Human brain mapping, 12*(3), 131-143.

Morse, Stephen J. (2008). Psychopathy and criminal responsibility. *Neuroethics, 1*(3), 205-212.

Muller, J. L., Sommer, M., Wagner, V., Lange, K., Taschler, H., Roder, C. H., . . . Hajak, G. (2003). Abnormalities in emotion processing within cortical and subcortical regions in criminal psychopaths: evidence from a functional magnetic resonance imaging study using pictures with emotional content. *Biological Psychiatry, 54*(2), 152-162.

Newman, Joseph P. (1998). Psychopathic behavior: An information processing perspective *Psychopathy: Theory, research and implications for society* (pp. 81-104): Springer.

O'Kane, Aisling, Fawcett, Diane, & Blackburn, Ronald. (1996). Psychopathy and moral reasoning: Comparison of two classifications. *Personality and Individual Differences, 20*(4), 505-514.

Obrien, B. S., & Frick, P. J. (1996). Reward dominance: Associations with anxiety, conduct problems, and psychopathy in children. *Journal of Abnormal Child Psychology, 24*(2), 223-240. doi: 10.1007/bf01441486

Ochsner, Kevin N, & Gross, James J. (2005). The cognitive control of emotion. *Trends in cognitive sciences, 9*(5), 242-249.

Olson, Ingrid R., Plotzker, Alan, & Ezzyat, Youssef. (2007). The Enigmatic temporal pole: a review of findings on social and emotional processing. *Brain, 130*(7), 1718-1731. doi: 10.1093/brain/awm052

Patrick, Christopher J, Bradley, Margaret M, & Lang, Peter J. (1993). Emotion in the criminal psychopath: startle reflex modulation. *Journal of abnormal psychology, 102*(1), 82.

Rilling, J. K., Glenn, A. L., Jairam, M. R., Pagnoni, G., Goldsmith, D. R., Elfenbein, H. A., & Lilienfeld, S. O. (2007). Neural correlates of social cooperation and non-cooperation as a function of psychopathy. *Biological Psychiatry, 61*(11), 1260-1271. doi: DOI 10.1016/j.biopsych.2006.07.021

Rilling, J. K., Goldsmith, D. R., Glenn, A. L., Jairam, M. R., Elfenbein, H. A., Dagenais, J. E., . . . Pagnoni, G. (2008). The neural correlates of the affective response to unreciprocated cooperation. *Neuropsychologia, 46*(5), 1256-1266. doi: DOI 10.1016/j.neuropsychologia.2007.11.033

Rilling, J. K., Gutman, D. A., Zeh, T. R., Pagnoni, G., Berns, G. S., & Kilts, C. D. (2002). A neural basis for social cooperation. *Neuron, 35*(2), 395-405. doi: 10.1016/s0896-6273(02)00755-9

Ryan, J. J., Lopez, S. J., & Werth, T. R. (1999). Development and preliminary validation of a Satz-Mogel short form of the WAIS-III in a sample of persons with substance abuse disorders. *International Journal of Neuroscience, 98*(1-2), 131-140. doi: Doi 10.3109/00207459908994796

Schaich Borg, J., Sinnott-Armstrong, W., Calhoun, V. D., & Kiehl, K. A. (2011). Neural basis of moral verdict and moral deliberation. *Social neuroscience, 6*(4), 398-413. doi: 10.1080/17470919.2011.559363

Schmitt, William A, Brinkley, Chad A, & Newman, Joseph P. (1999). Testing Damasio's somatic marker hypothesis with psychopathic individuals: risk takers or risk averse? *Journal of abnormal psychology, 108*(3), 538.

Schneider, F., Habel, U., Kessler, C., Posse, S., Grodd, W., & Muller-Gartner, H. W. (2000). Functional imaging of conditioned aversive emotional responses in antisocial personality disorder. *Neuropsychobiology, 42*(4), 192-201. doi: 26693

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: uses in assessing rater reliability. *Psychol Bull, 86*(2), 420-428.

Simon, B., Holzberg, J. D., & Unger, J. F. (1951). A study of judgment in the psychopathic personality. *The Psychiatric quarterly, 25*(1), 132-150.

Tassy, S, Oullier, O, Cermolacce, M, & Wicker, B. (2009). Do psychopathic patients use their DLPFC when making decisions in moral dilemmas&quest. *Molecular psychiatry, 14*(10), 908-909.

Tiihonen, J., Rossi, R., Laakso, M. P., Hodgins, S., Testa, C., Perez, J., . . . Frisoni, G. B. (2008). Brain anatomy of persistent violent offenders: more rather than less. *Psychiatry research, 163*(3), 201-212. doi: 10.1016/j.pscychresns.2007.08.012

Veit, R., Flor, H., Erb, M., Hermann, C., Lotze, M., Grodd, W., & Birbaumer, N. (2002). Brain circuits involved in emotional learning in antisocial behavior and social phobia in humans. *Neuroscience letters, 328*(3), 233-236.

Wechsler, David. (1997). *WAIS-III: Administration and scoring manual: Wechsler adult intelligence scale*: Psychological Corporation.

Wilkinson, G. (1993). WRAT-3 Wide Range Achievement Test. Wide Range. *Inc., Wilmington, DE*.

Wintrup, A., Coles, M., Hart, S., & Webster, C. D. (1994). The Predictive-Validity of the Pcl-R in High-Risk Mentally Disordered Offenders. *Canadian Psychology-Psychologie Canadienne, 35*(2A), 47-47.

Yang, Y., Raine, A., Narr, K. L., Colletti, P., & Toga, A. W. (2009). Localization of deformations within the amygdala in individuals with psychopathy. *Archives of general psychiatry, 66*(9), 986-994. doi: 10.1001/archgenpsychiatry.2009.110

Young, L., Camprodon, J. A., Hauser, M., Pascual-Leone, A., & Saxe, R. (2010). Disruption of the right temporoparietal junction with transcranial magnetic stimulation reduces the role of beliefs in moral judgments. *Proc Natl Acad Sci U S A, 107*(15), 6753-6758. doi: 10.1073/pnas.0914826107

Young, Liane, Koenigs, Michael, Kruepke, Michael, & Newman, Joseph P. (2012). Psychopathy increases perceived moral permissibility of accidents. *Journal of Abnormal Psychology, 121*(3), 659-667. doi: 10.1037/a0027489