The Psychopaths of Everyday Life: An Integrative Study of Neuropsychological and Neurobiological Factors in a Sample of Undergraduate Males

A dissertation presented to
the faculty of
the College of Arts and Sciences of Ohio University

In partial fulfillment
of the requirements for the degree
Doctor of Philosophy

Eric H. Zimak
August 2012
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This dissertation titled
The Psychopaths of Everyday Life: An Integrative Study of Neuropsychological and Neurobiological Factors in a Sample of Undergraduate Males

by

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the Department of Psychology
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Abstract

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The Psychopaths of Everyday Life: An Integrative Study of Neuropsychological and Neurobiological Factors in a Sample of Undergraduate Males

Director of Dissertation: Julie A. Suhr

While considerable research suggests that incarcerated psychopaths have neurobiological and neuropsychological impairments that influence their social-emotional processing and behavior, there is little research on non-incarcerated young adults with high levels of psychopathic traits (i.e., subclinical psychopaths). The present study investigated differences in physiological response, neuropsychological functioning, and cerebral oxygenation among subclinical psychopaths, relative to young adult males with low levels of psychopathic traits (controls). Statistical analyses revealed that subclinical psychopaths had a diminished physiological response to negative affective pictures relative to controls. Additionally, subclinical psychopaths were significantly more impulsive and disinhibited on a motoric response-inhibition task, yet made better decisions than controls on a risky decision-making task. The two groups did not differ in dorsolateral prefrontal cortex cerebral oxygenation levels during a risky decision-making task or motoric response inhibition task. Overall, consistent with previous findings among samples of incarcerated psychopaths, subclinical psychopaths exhibit diminished responses to aversive stimuli, as well as behavioral disinhibition. However, spared decision-making capacities may protect subclinical psychopaths from developing more acute socially deviant behavior. Findings provide some support for Gao and Raine’s
(2010) model of the neurobiological underpinnings of subclinical psychopathy, and provide evidence that subclinical psychopaths have both adaptive and non-adaptive traits.

Approved: ________________________________

Julie A. Suhr

Professor of Psychology
Acknowledgments

I would like to thank Dr. Julie Suhr for her guidance, support, and tremendous mentorship in this project, and over the course of my graduate career. She has shaped my understanding of psychology and neuropsychology, and has been influential in my development as a researcher, clinician, teacher, and student. I was very fortunate to have her as my mentor. I would also like to thank Dr. Steve Patterson, Dr. Chris Gidycz, Dr. Bernadette Heckman, and Dr. Thomas Vander Ven for advising me throughout the course of this dissertation project. Additionally, I am also grateful for the technical and programming support of Mei Ng and Bob Conatser in the project; for their help I was truly fortunate. Finally, I would like to thank my family and friends for their continued support, warmth, and encouragement.
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Introduction

Psychopathy is a personality disorder characterized by affective and interpersonal deficits that may predispose an individual to antisocial behavior (Cleckley, 1941; Fowler, Lilienfeld, & Patrick, 2009). Psychopaths are self-centered and violate social norms, without guilt or remorse (Delisi, 2009; Kantor, 2006). They can be serial killers, rapists, con men, disbarred lawyers, and unscrupulous businesspeople (Hare, 1999). Psychopathy may predict diverse forms of negative behavioral outcomes, such as aggression, offending, institutional misconduct, violence, and criminal recidivism (DeMatteo, Heilbrun, & Marczyk, 2006; Hare, 1999; Walters, 2003). Psychopathic characteristics have historically been divided into two main factors: an interpersonal-affective factor, which includes charm, grandiosity, manipulation, deceitfulness, callousness, and lack of emotion, and a social deviance factor, which focuses on irresponsibility, impulsivity, lack of long-term goals, and failure to conform to social standards (Hare, 1996; Harpur, Hare, & Hakstian, 1989).

Although there is a large body of research on psychopathic individuals in incarcerated settings, much less is known about individuals with high levels of psychopathic traits in the community, who, despite lacking a history of incarceration are also at risk for a variety of negative outcomes, including increased rates of drug use, delinquency, risky sex, and aggression (Czar, Dahlen, Bullock, & Nicholson, 2011; Miller & Lynam, 2003). Psychopaths in the community are frequently labeled subclinical (e.g., Paulhus & Williams, 2002), because they demonstrate psychopathic personality features and engage in socially deviant behavior (and thus mirror the facet structure of incarcerated psychopaths), but rarely confront the criminal justice system and are thought
to be less “extreme” versions of incarcerated psychopaths (Babiak, 2000; Kantor, 2006; Lebreton, Binning, & Adorno, 2006; Williams, Paulhus, & Hare, 2007). Researchers have suggested that the study of subclinical psychopathy can lead to a better understanding of the pathophysiology of the psychopathic personality, and help identify protective factors that prevent those with subclinical psychopathic traits from becoming incarcerated psychopaths (e.g., Lilienfeld, 1994). Furthermore, research in non-incarcerated populations is important as it may suffer from fewer research confounds, such as long-term drug use or the acute effects of institutionalization. Of note, the terms ‘subclinical’ psychopath and ‘successful’ psychopath (Ishikawa et al., 2001) have been used relatively interchangeably in the literature, and for consistency, are referred to as subclinical psychopaths in this paper. The current study examined the neurobiological and neuropsychological functioning of male subclinical psychopaths.

The question of whether psychopathy is taxonic or dimensional in nature (e.g., whether it differs in kind or degree from normality) is a topic of heated debate (Lilienfeld, 1998), and has implications for understanding subclinical forms of the disorder. Notwithstanding the studies that have suggested that incarcerated psychopaths comprise a discrete class of individuals who differ in fundamental and important ways from nonpsychopaths (e.g., Harris, Rice, & Quinsey, 1994; Skilling, Harris, Rice, & Quinsey, 2002), a number of studies in community, university, and incarcerated samples, and using both self-report and interview data collection methods, provide support for a dimensional approach to psychopathy (Edens, Marcus, Lilienfeld, & Poythress, 2006; Guay, Ruscio, Knight, & Hare, 2007; Marcus, John, & Edens, 2004). While the dimensional approach is consistent with the notion that personality disorders are not
discrete, and that psychopathic traits remain on a continuum with normal personality (Lynam & Derefenko, 2006), they still allow for psychopathy to be identified by cutoff points on a scale (Blackburn, 2000). Dimensionality of the psychopathy construct provides strong justification for studying subclinical psychopathy, and suggests that findings from nonclinical samples might be generalizable to incarcerated samples (Lilienfeld, 1998). Recently, theorists have embraced a quasi-dimensional conceptualization that embraces the benefits of categorical and dimensional approaches (Gao & Raine, 2010), and these methods were used in our present study.

The Neurobiology of Psychopathy

Researchers have identified a number of affective and neuropsychological deficits among incarcerated psychopaths. Physiological hypoarousal, including diminished skin conductance responses on affective or classical conditioning tasks and reduced startle blink reflexes, is characteristic of incarcerated psychopaths (e.g., Arnett, 1997; Lorber, 2004). The neuropsychological profile of incarcerated psychopaths is characterized by poor decision-making, impaired response inhibition, difficulty modulating responses to aversive experiences, and deficits in emotional understanding, yet their higher order reasoning skills are generally intact (see Table 1 and Table 2). Incarcerated psychopaths also have functional deficits in the prefrontal cortex and limbic system, brain regions associated with complex reasoning and affective processing (see Table 3 and Table 4). Preliminary research suggests that similar psychophysiological (e.g., Benning, Patrick, & Iacono, 2005a), neuropsychological (e.g., Mahmut, Homewood, & Stevenson, 2008), and functional brain (e.g., Gordon, Baird, & End, 2004) impairments are seen in non-offending, subclinical psychopaths. The present study was intended to clarify the
nature and severity of these deficits in a nonclinical sample, by investigating the physiological, neuropsychological, and brain functioning in a sample of subclinical psychopaths.

Table 1

*Risk-Taking and Response Inhibition in Psychopaths: A Review*

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample</th>
<th>Psych Measure</th>
<th>EF Skill</th>
<th>Task, DV</th>
<th>P</th>
<th>C</th>
<th>ES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arnett et al., 1993</td>
<td>13 low-anxious incarcerated male Ps and 18 low-anxious incarcerated male Cs</td>
<td>PCL-R</td>
<td>Response Inhibition</td>
<td>Go/No-Go, Errors of commission, monetary feedback</td>
<td>-</td>
<td>+</td>
<td>-.67</td>
</tr>
<tr>
<td>Belmore &amp; Quinsey, 1994</td>
<td>15 community male Ps and 15 community male Cs</td>
<td>PCL-R</td>
<td>Risk-taking</td>
<td>CP Task, Total cards played</td>
<td>+</td>
<td>-</td>
<td>.71*</td>
</tr>
<tr>
<td>Blair et al., 2004a</td>
<td>19 incarcerated male Ps and 21 incarcerated male Cs</td>
<td>PCL-R</td>
<td>Risk-taking</td>
<td>Point Task, Errors of commission controlling for IQ, points feedback</td>
<td>+</td>
<td>-</td>
<td>.97*</td>
</tr>
<tr>
<td>Kiehl et al., 2000</td>
<td>12 incarcerated male Ps and 11 incarcerated male Cs</td>
<td>PCL-R</td>
<td>Response Inhibition</td>
<td>Go/No-Go, Errors of commission</td>
<td>+</td>
<td>-</td>
<td>.3</td>
</tr>
<tr>
<td>LaPierre et al., 1995</td>
<td>30 incarcerated male Ps and 30 incarcerated male Cs</td>
<td>PCL</td>
<td>Response Inhibition</td>
<td>Go/No-Go, Errors of commission</td>
<td>+</td>
<td>-</td>
<td>2.03*</td>
</tr>
<tr>
<td>Study</td>
<td>Group Description</td>
<td>Measure</td>
<td>Task/Outcome</td>
<td>Effect Size (p-value)</td>
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<tr>
<td>Losel &amp; Schmucker, 2004</td>
<td>17 incarcerated male Ps with low attention and 32 incarcerated male Cs with low attention</td>
<td>PCL-R Risk-taking</td>
<td>IGT, Total risky choices</td>
<td>+ - .76*</td>
<td></td>
<td></td>
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<tr>
<td>Mahmut et al., 2008</td>
<td>23 undergraduate Ps and 23 undergraduate Cs, both genders</td>
<td>SRP-III Risk-Taking</td>
<td>IGT, Total risky choices</td>
<td>+ - .78*</td>
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<td></td>
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</tr>
<tr>
<td>Mitchell et al., 2002</td>
<td>21 incarcerated male Ps and 21 incarcerated male Cs</td>
<td>PCL-R Risk-Taking</td>
<td>IGT, Total risky choices Risk aversion over blocks</td>
<td>+ - 80*</td>
<td></td>
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<tr>
<td>Munro et al., 2007a</td>
<td>15 violent incarcerated males offenders (mostly Ps) and 15 violent incarcerated male Cs</td>
<td>PCL-R Response Inhibition</td>
<td>Go/No-Go, Errors of commission</td>
<td>+ - .8*</td>
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<tr>
<td>Newman et al., 1987</td>
<td>36 male incarcerated Ps and 36 male incarcerated Cs</td>
<td>PCL Risk-Taking</td>
<td>CP Task, Total cards played</td>
<td>+ - 1.16*</td>
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<td>Newman &amp; Schmitt, 1998</td>
<td>12 low-anxious incarcerated Caucasian male Ps and 17 low-anxious incarcerated Caucasian male Cs</td>
<td>PCL-R Response Inhibition</td>
<td>Go/No-Go, Errors of commission, monetary feedback</td>
<td>+ - .74*</td>
<td></td>
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<td>Schmitt et al., 1999</td>
<td>38 incarcerated male Ps and 51 incarcerated male Cs</td>
<td>PCL-R Risk-Taking</td>
<td>IGT, Total risky choices across blocks</td>
<td>+ - .24</td>
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<tr>
<td>Vitale &amp; Newman, 2001</td>
<td>11 incarcerated female Ps and 73 incarcerated female Cs</td>
<td>PCL-R Risk-Taking CP Task, Total cards played</td>
<td>Total money earned</td>
<td></td>
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<td></td>
<td>- + -.13</td>
<td>+ - -.15</td>
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*Note. Psych Measure = Psychopathy Measure; EF Skill = Executive Function Skill; DV = Dependent Variable; Ps = Psychopaths; Cs = Controls; ES = Effect Size, Cohen’s d; PCL-R = Psychopathy Checklist-Revised; + = Higher Score; CP Task = Card Playing Task; + = higher score; - = lower score; IGT = Iowa Gambling Task; SRP-III = Self-Report Psychopathy Scale-Third Edition; PCL = Psychopathy Checklist

* p < .05

^ No differences when comparing low-anxious male African-American psychopaths to low-anxious male African-American nonpsychopaths
### Table 2

*Emotional Recognition in Psychopaths: A Review*

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample Details</th>
<th>Psych Measure</th>
<th>Emotional Recognition Task</th>
<th>Dependent Variable</th>
<th>Ps</th>
<th>Cs</th>
<th>ES</th>
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</thead>
<tbody>
<tr>
<td>Blair et al., 2002</td>
<td>19 incarcerated male Ps and 20 incarcerated male Cs</td>
<td>PCL-R</td>
<td>Vocal Affect Recognition Test</td>
<td>Rec Er</td>
<td>+</td>
<td>-</td>
<td>1.15*</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fear</td>
<td>+</td>
<td>-</td>
<td>.79*</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rec Er Sad</td>
<td>+</td>
<td>-</td>
<td>1.12*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rec Er Total</td>
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<td></td>
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<tr>
<td>Blair et al., 2004b</td>
<td>19 incarcerated male Ps and 19 incarcerated male Cs</td>
<td>PCL-R</td>
<td>Emotional Expression Multimorph Task</td>
<td>Rec Er</td>
<td>+</td>
<td>=</td>
<td>.90*</td>
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<td></td>
<td></td>
<td>Fear</td>
<td>=</td>
<td>=</td>
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<td></td>
<td></td>
<td></td>
<td>Rec Er Sad</td>
<td>=</td>
<td>=</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Rec Er Total</td>
<td></td>
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<tr>
<td>Dolan &amp; Fullam, 2006</td>
<td>27 incarcerated male Ps with APD and 22 incarcerated male Cs with APD</td>
<td>PCL-SV</td>
<td>Modified AFFECT</td>
<td>Rec Co</td>
<td>-</td>
<td>+</td>
<td>.47</td>
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<td></td>
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<td></td>
<td></td>
<td>Fear</td>
<td>-</td>
<td>+</td>
<td>.68*</td>
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<td></td>
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<td></td>
<td></td>
<td>Rec Co</td>
<td>-</td>
<td>+</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sad</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rec Co Total</td>
<td></td>
<td></td>
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<tr>
<td>Eisenbarth et al., 2008</td>
<td>13 forensic female patient Ps and 15 forensic female patient Cs</td>
<td>PCL-R</td>
<td>KDEF</td>
<td>% correct fear</td>
<td>=</td>
<td>=</td>
<td>0</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>% correct sad</td>
<td>-</td>
<td>+</td>
<td>.35</td>
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<td>Glass &amp; Newman, 2006</td>
<td>50 incarcerated male Ps and 61 incarcerated male Cs</td>
<td>PCL-R</td>
<td>Macbrain Face Stimulus Set</td>
<td>% correct fear</td>
<td>+</td>
<td>-</td>
<td>-.11</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>% correct sad</td>
<td>-</td>
<td>+</td>
<td>.01</td>
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Table 2 (Continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Measure</th>
<th>Outcome</th>
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</thead>
<tbody>
<tr>
<td>Habel et al., 2002</td>
<td>17 male Ps from prison and forensic treatment center and 17 healthy male Cs</td>
<td>PCL-R PENN Facial Discrimination Test</td>
<td>% correct total - + .90*</td>
</tr>
<tr>
<td>Munro et al., 2007b</td>
<td>15 violent male inmates (7 met psychopathic criteria) and 15 male staff controls</td>
<td>PCL-R Face Flanker Task</td>
<td>% Rec Er Fear and Anger + - 3*</td>
</tr>
</tbody>
</table>

Note. Psych Measure = Psychopathy Measure; Ps = Psychopaths; Cs = Controls; ES = Effect Size, Cohen’s d; PCL-R = Psychopathy Checklist-Revised; Rec Er = Recognition Errors; + = Higher Score; - = Lower Score; Rec Co = Total Recognition Correct; = = Same Score; APD = Antisocial Personality Disorder; PCL-SV = Psychopathy Checklist-Short Version; Modified AFFECT: Animated Full Facial Comprehension Test; KDEF = Karolinska Directed Emotional Faces set; PPI = Psychopathic Personality Inventory
* p < .05
<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample</th>
<th>Psych Measure</th>
<th>Task</th>
<th>Findings</th>
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<tr>
<td>Birbaumer et al., 2005</td>
<td>10 emotionally detached male Ps with criminal records and 10 community male Cs</td>
<td>PCL-R</td>
<td>Classical Conditioning Task</td>
<td>Ps had reduced activation in frontolimbic circuit during fear acquisition than Cs</td>
</tr>
<tr>
<td>Dolan &amp; Fullam, 2009</td>
<td>12 schizophrenic male Ps and 12 schizophrenic male Cs</td>
<td>PCL-SV</td>
<td>Affective Recognition Task</td>
<td>Ps had less activation in right amygdala during exposure to fearful faces, and greater activation in right amygdala during exposure to expressions of disgust</td>
</tr>
<tr>
<td>Gordon et al., 2004</td>
<td>9 undergraduate male Ps and 9 undergraduate male Cs</td>
<td>PPI</td>
<td>Affective Recognition Task</td>
<td>Ps had less activation in right inferior frontal and medial prefrontal regions during affective task than Cs Ps had more activation in dorsolateral prefrontal cortex than Cs</td>
</tr>
<tr>
<td>Kiehl et al., 2001</td>
<td>8 incarcerated male Ps and 8 community male Cs</td>
<td>PCL-R</td>
<td>Affective Memory Test</td>
<td>Ps had greater activity in bilateral interior frontal gyrus than Cs for affective than neutral stimuli</td>
</tr>
<tr>
<td>Kiehl et al., 2004</td>
<td>8 incarcerated male Ps and 8 community male Cs</td>
<td>PCL-R</td>
<td>Lexical Decision Task</td>
<td>Ps had reduced activation in the right anterior superior temporal gyrus during processing of abstract words relative to concrete words compared to Cs</td>
</tr>
<tr>
<td>Muller et al., 2003</td>
<td>6 criminal male Ps from a forensic psychiatric facility and 6 healthy male Cs</td>
<td>PCL-R</td>
<td>Affective Exposure Task</td>
<td>Ps had increased activation in bilateral prefrontal cortex for negative and positive affective pictures than Cs</td>
</tr>
<tr>
<td>Muller et al., 2008</td>
<td>10 criminal male Ps from a forensic psychiatric facility and 12 healthy male Cs</td>
<td>PCL-R</td>
<td>Selective Attention Task with Emotional Induction</td>
<td>Ps had reduced activation in prefrontal cortex during attention task than Cs</td>
</tr>
</tbody>
</table>

*Note.* Psych Measure = Psychopathy Measure; Ps = Psychopaths; Cs = Controls; PCL-SV = Psychopathy Checklist-Short Version; PPI = Psychopathic Personality Inventory; PCL-R = Psychopathy Checklist-Revised
Table 4

*Electroencephalography (EEGs) in the Frontal Regions of Psychopaths: A Review*

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample</th>
<th>Psych Measure</th>
<th>Neuropsych Measure</th>
<th>DV</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil et al., 2009</td>
<td>16 male Ps at forensic psychiatric institute and 18 healthy male Cs</td>
<td>PCL-R</td>
<td>Eriksen</td>
<td>ERN</td>
<td>No group differences in ERN amplitudes at frontal and central sites</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Flanker Task:</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Attention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Howard &amp; McCullagh, 2007</td>
<td>17 incarcerated male Ps and incarcerated male Cs</td>
<td>PCL-SV</td>
<td>Categorization Task:</td>
<td>N350/P300</td>
<td>Larger prefrontal N350 amplitude in Ps relative to Cs in Categorization</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Other Vigilance Task:</td>
<td>P450/50</td>
<td>Task, no other differences emerged</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Attention</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Kiehl et al., 1999</td>
<td>11 incarcerated male Ps and 10 incarcerated male Cs</td>
<td>PCL-R</td>
<td>Visual Oddball Task:</td>
<td>N350/P300</td>
<td>Reduced P300 amplitude to target stimuli for Ps relative to Cs and Ps had</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Attention</td>
<td>300</td>
<td>reduced late centrofronfral negativity in N350</td>
</tr>
<tr>
<td>Kiehl et al., 2000</td>
<td>12 incarcerated male Ps and 11 incarcerated male Cs</td>
<td>PCL-R</td>
<td>Go/No-Go Task:</td>
<td>N275/P375</td>
<td>Cs had reduced frontal negativity to the No Go stimuli than the Go stimuli, a pattern which was absent in Ps. The Cs had reduced frontal positivity to the Go relative to the No-Go trials, while the Ps had the opposite pattern</td>
</tr>
</tbody>
</table>
Table 4 (Continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Task/Paradigm</th>
<th>Condition 1</th>
<th>Condition 2</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kiehl et al., 2006a</td>
<td>Sample 1: 23 incarcerated male Ps and 21 incarcerated male Cs; Sample 2: 18 incarcerated male Ps and 18 incarcerated male Cs</td>
<td>PCL-R Auditory oddball task: Attention</td>
<td>N2 N550 P3</td>
<td>Larger N2 (one sample) and N500 peak amplitude for target stimuli for Ps than Cs at frontocentral sites No consistent P3 frontocentral differences</td>
<td></td>
</tr>
<tr>
<td>Kiehl et al., 2006b</td>
<td>25 incarcerated male Ps and 25 incarcerated male Cs</td>
<td>PCL-R Semantic Sentence Processing Paradigm: Other</td>
<td>N400 P600</td>
<td>No differences found in frontocentral negativities (N400) or positivities (P600) Higher P300 amplitudes at frontal sites for deception than honesty items for Cs but not Ps N2s did not differ between groups Ps had smaller peak P3 amplitude at most frontal sites than Cs</td>
<td></td>
</tr>
<tr>
<td>Miller &amp; Rosenfeld, 2004</td>
<td>13 community Ps and 11 community Cs, both genders</td>
<td>PPI Honesty and Deception Task: Other</td>
<td>P300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Munro et al., 2007a</td>
<td>15 incarcerated male violent offenders (9 Ps) and 15 non-incarcerated male Cs</td>
<td>PCL-R Go/No-Go Task: Inhibition</td>
<td>N2 P3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Munro et al., 2007b</td>
<td>15 incarcerated male violent offenders (9 Ps) and 15 non-incarcerated male Cs</td>
<td>PCL-R Emotion Discrimination Task: Other</td>
<td>ERN P300</td>
<td>Reduced ERN peak frontocentral amplitude for offenders relative to Cs for emotional discrimination errors, but no P300 differences</td>
<td></td>
</tr>
</tbody>
</table>
It is generally agreed that a primary feature of psychopathy is an inability to have emotional involvement with others (Hare, 1996). A common measure of physiological arousal to emotional stimuli is electrodermal activity (Lorber, 2004); the most common measure of electrodermal activity is skin conductance response. Incarcerated psychopaths demonstrate fewer skin conductance responses following punishment (Arnett, Howland, Smith, & Newman, 1993), and smaller skin conductance responses to fearful images (Patrick, Cuthbert, & Lang, 1994), as well as reductions in the startle blink reflex (Patrick, Bradley, & Lang, 1993) during the imagery of unpleasant or threatening experiences, relative to nonpsychopathic controls. Similar findings have been reported in community samples (e.g., recruited from temporary employment agencies), where male participants with high levels of interpersonal-affective psychopathic traits have reduced skin conductance responses to aversive pictures (Benning et al., 2005a), and reduced startle modification between pleasant and unpleasant picture slides (Vanman, Mejia, Dawson, Schell & Raine, 2003). In the present study, we examined evidence for a selective physiological deficit to aversive images in subclinical psychopaths, and included self-report measures of emotional arousal and valence to explore participants’ understanding of their affective reactions to the images.

Some researchers believe that risk-taking and disinhibited behavior characteristic of psychopathy may be related to, or even a consequence of, affective impairments (e.g.,
Cooke & Michie, 2001). When normal control individuals prepare to make a risky decision, their performance is marked by enhanced skin conductance response immediately prior to making the risky decision (e.g., an anticipatory response). Several cortical areas, including the prefrontal cortex and amygdala, are known to play a role in this response (e.g., Dawson, Schell, & Courtney, 2011). There is evidence that “acquired sociopaths” (e.g., Tranel, 1994), who develop similar social and interpersonal impairments to psychopaths as a result of damage to the amygdala or ventromedial prefrontal cortex (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Damasio, Damasio, & Lee, 1999), not only tend to make more frequent risky decisions than normal controls on decision-making tasks, but also do not show an anticipatory physiological response when making risky decisions. The somatic marker theory suggests that brain-damaged individuals with psychopathic traits have impaired “somatic markers”, or emotion-based biasing signals that are critical to making advantageous decisions and selecting appropriate behavior (see Damasio, 1994, for a review). While both incarcerated psychopaths and subclinical psychopaths have been shown to make riskier and less optimal decisions on risky-decision making tasks compared to nonpsychopaths (Losel & Schmucker, 2004; Mahmut et al., 2008; Mitchell, Colledge, Leonard, & Blair, 2002), no studies to date have measured electrodermal responsivity on risky decision–making tasks in incarcerated or subclinical psychopaths without significant neurological history. In the present study, we examined not only whether subclinical psychopaths make more risky decisions, but also whether they show diminished anticipatory physiological reactivity when making risky decisions, which would be consistent with the somatic marker theory.
Deficits in response inhibition, or the ability to suppress behavior, may also play a role in poor decision-making among psychopaths. On go/no-go tasks, incarcerated psychopaths consistently make more commission errors than incarcerated non-psychopaths (Kiehl, Smith, Hare, & Liddle, 2000; LaPierre, Braun, & Hodgins, 1995; Munro et al., 2007a), reflecting motor impulsivity and inability to withhold responses to stimuli. Additionally, incarcerated psychopaths make more commission errors in the presence of rewards or punishment, regardless of the form of reinforcement (e.g., money, cigarettes, or candy) (Newman & Schmitt, 1998; Newman, Widom, & Nathan, 1985; Thornquist & Zuckerman, 1995). Three studies have examined the relationship of psychopathic traits to response inhibition in a non-incarcerated sample, showing that response inhibition deficits were related to higher levels of social deviance traits (Lynam Whiteside, & Jones, 1999; Sellbom & Verona, 2007; Wilkowski & Robinson, 2008), but only related to higher interpersonal-affective traits in one study (Lynam et al., 1999). In the present study, we further examined response inhibition in subclinical psychopaths relative to controls, and explored the relationship of psychopathic traits to response inhibition within the sample of subclinical psychopaths.

In addition to the physiological and neuropsychological deficits characteristic of psychopathy, burgeoning evidence suggests that psychopaths may rely more on brain regions used in working memory and problem-solving (e.g., dorsolateral prefrontal cortex), rather than those involved more in social and emotional processing (e.g., limbic structures, orbitofrontal cortex), in affective and moral reasoning tasks. Specifically, incarcerated psychopaths have demonstrated increased activation in dorsolateral prefrontal regions, with reduced activation in limbic (e.g., amygdala, hippocampus) and
temporal structures (Kiehl, et al., 2001; Muller et al., 2003), during affective memory and affective face exposure tasks. Similarly, when undergraduates with higher levels of psychopathic characteristics are shown affective pictures and complete social cooperation tasks, they show increased activation in the right dorsolateral prefrontal cortex (Gordon et al., 2004; Rilling et al., 2007), and reductions in orbitofrontal and right amygdala regions (Rilling et al., 2007). Collectively these studies suggest that psychopathic individuals may rely more on cognitive strategies during affective tasks, whereas non-psychopathic participants rely on emotional processes. These neural-based differences may have implications for psychopaths’ responses in social situations, which rely on the ability to recognize and respond to emotional stimuli (Gordon et al., 2004). However, given the very small sample sizes of the only two studies of subclinical psychopaths, further investigation of the relationship of functional brain changes to affective, decision-making, and other neuropsychological tasks in this population are warranted.

**The Current Study**

The current study is, to our knowledge, the first to concurrently examine the physiological, neuropsychological, and neurological characteristics of subclinical psychopaths in the same sample. The primary purpose of the study was to determine whether specific aspects of psychophysiological response and neuropsychological processing differentiate subclinical psychopaths from controls. It was hypothesized that subclinical psychopaths would exhibit reduced skin conductance response magnitudes during exposure to negatively-valenced images in an affective-picture viewing task. It was also hypothesized that subclinical psychopaths would demonstrate reduced anticipatory skin conductance response magnitudes to risky choices on a decision-making
task relative to controls. With regard to neuropsychological functioning, we hypothesized that subclinical psychopaths would select more cards from risky card decks on a decision-making task and have more difficulty inhibiting inappropriate motor responses on a task of response inhibition. Due to the newer technology of the Near-Infrared Spectroscopy (NIRS), we did not offer specific hypotheses regarding changes in brain activity during a risky decision-making task and a response inhibition task. Given some suggestions in the literature that the two factors of psychopathy may relate differently to physiological, neuropsychological, and neurological findings, we also explored the relationship of these factors to our outcome variables within the subclinical psychopath sample.
Method

Participants

Participants were 79 college undergraduates at a Midwestern university enrolled in introductory-level psychology courses. All participants fell in the age range of 18 to 26 (\(M = 19.32, SD = 1.54\)). The majority of the sample consisted of underclassmen (87%). Most of the sample was Caucasian (95%), 1% identified as Asian/Pacific Islander, and 4% identified as multi-racial. General intellect, as estimated by standard scores on the Wechsler Test of Adult Reading, was in the average range (\(M = 108, SD = 12\)).

Participants were recruited from an undergraduate psychology participant pool, based on responses to a laboratory session questionnaire and the Psychopathic Personality Inventory-Short Form (PPI-SF). Participants for both groups included individuals who: 1) reported no history of a head injury resulting in a loss of consciousness of greater than 30 minutes, 2) indicated an absence of other neurological history (e.g., epilepsy), 3) denied a history of psychosis, 4) were not currently in treatment for substance abuse problems, and, 5) reported English as a first language. Participants who met these criteria, and whose total PPI-SF scores fell in the top 25% or bottom 30% of male students for the given quarter, were eligible to sign-up for the study.

At the testing session, participants were re-administered the PPI-SF, a demographics questionnaire, and a laboratory session questionnaire to assess whether they continued to meet criteria for the study; if they did not, their data was excluded from analyses (\(N = 29\)). Of those who were excluded from data analysis, 21 did not continue to meet group criteria on the PPI-SF, 4 reported head injury with loss of consciousness for greater than 30 minutes, and 1 reported a history of Tourette’s syndrome. In addition to
these 26, participants were also excluded if they reported caffeine use in the 3 hours prior to participation ($N = 2$), or alcohol or illicit drug use in the 12 hours prior to participation ($N = 2$); of note, 1 participant who reported illicit drug use was able to return the following week and then qualified for participation. No participants were excluded based on additional potential exclusionary criteria (blood alcohol level above .02 on the BACtrack S80, scoring below the cutoff scores on a measure of noncredible responding).

The subclinical psychopath group ($n = 37$) consisted of male undergraduates who scored above the top 25% cutoff on the PPI-SF online screen, continued to score in the top 30% when re-administered the PPI-SF at the testing session, and did not meet any exclusion criteria. The controls ($n = 42$) consisted of male undergraduates who scored below the bottom 30% cutoff on the PPI-SF online screen, continued to score in the bottom 30% when re-administered the PPI-SF at the testing session, and did not meet any other exclusion criteria.

**Measures**

Detailed below is a brief description of the measures used in the current investigation. Please see Appendix A for further details of the psychometric properties of individual measures, as well as copies of non-copywritten measures.

**Self-report instruments.**

**Psychopathic traits.**

The Psychopathic Personality Inventory-Short Form (PPI-SF; Lilienfeld, 1990), a 56-item version of the Psychopathic Personality Inventory (PPI; Lilienfeld, 1990), assesses psychopathic personality characteristics in non-incarcerated samples. The PPI-
SF total score correlates strongly with the PPI total score ($r = .90$) (Lilienfeld & Andrews, 1996) and has similarly impressive psychometric properties as the full PPI (Vaughn & Howard, 2005). The PPI-SF yields a total psychopathy score, with higher scores indicating higher levels of psychopathic traits. It also yields two subscale scores for Fearless Dominance and Impulsive Antisociality, which reflect the interpersonal-affective and social deviance traits of psychopathy, respectively. In the current study, the PPI-SF had good internal consistency, with Cronbach’s $\alpha = .89$.

**Substance use.**

The Alcohol Use Disorders Identification Test (Saunders, Aasland, Babor, de la Fuente, & Grant, 1993) is a 10-item measure that assesses harmful and hazardous alcohol use. The Alcohol Use Disorders Identification Test has strong internal consistency and reliability, as well as acceptable construct validity, among college samples (Fleming, Barry, & MacDonald, 1991; Kokotailo et al., 2004; O’Hare & Sherrer, 1999; Shields, Guttmannova, & Caruso, 2004). A composite score on the Alcohol Use Disorders Identification Test was used as the dependent variable, with higher scores suggesting more problematic alcohol usage. Internal consistency of the Alcohol Use Disorders Identification Test was acceptable, with Cronbach’s $\alpha = .79$.

The Drug Abuse Screening Test—Short Form (McCabe, Boyd, Cranford, Morales, & Slayden, 2006) is a 10-item screening measure for drug abuse over the past 12 months in university samples (McCabe et al., 2006). The Drug Abuse Screening Test-Short Form has adequate internal reliability in undergraduate samples (McCabe et al., 2006; Taylor, James, Bobadilla, & Reeves, 2008) and has been shown to be effective in identifying individuals with severe substance abuse problems (Cocco & Carey, 1998). A
composite score on the Drug Abuse Screening Test-Short Form was used in the present study, with higher scores indicating more problematic drug use. Internal consistency of the Drug Abuse Screening Test-Short Form was adequate, with Cronbach’s $\alpha = .76$. An additional item inquired about type and frequency of illicit drug use (e.g., marijuana, methamphetamine, heroine) (McCabe et al., 2006).

**Criminality.**

The Adult Criminality Scale (K. Beaver, personal communication, 4/5/10; Appendix A) is a 12-item scale that asks about the frequency of committing criminal acts over the past year. Items were coded on a 0 to 3 scale (Never = 0, 1 or 2 times = 1, 3 or 4 times = 2, 5 or more times = 3). This scale demonstrated adequate internal reliability (Cronbach’s $\alpha = .76$) in a community sample of young adults (Beaver, 2008), although this was lower (Cronbach’s $\alpha = .67$) in the current study. Higher scores on the scale represent more frequent illegal activity.

**Mood.**

The Positive and Negative Affect Scale (Watson, Clark, & Tellegen, 1988) assesses positive and negative mood states. The measure contains brief Positive Affect and Negative Affect scales of 10 items each. Participants were asked how they experience different mood states at the present moment. The Positive and Negative Affect Scale is a widely referenced instrument with good internal consistency and strong convergent validity across clinical and non-clinical samples (e.g., Crawford & Henry, 2004; Egloff, Schmulke, Burns, Kohlmann, & Hock, 2003; Watson et al., 1988). Internal consistency of the Negative Affect Scale was Cronbach $\alpha = .88$, and the internal consistency for the Positive Affect Scale was Cronbach’s $\alpha = .71$. Total negative affect
and total positive affect scores were used, with higher scores on the scales indicating higher negative and positive mood, respectively.

**Family conflict.**

The Family Conflict subscale of the Family Environment Scale (Moos & Moos, 1981) was used to assess past verbal and physical family conflict that the participant perceived within his family of origin. The Family Conflict subscale has demonstrated adequate internal reliability in other college student samples, with Cronbach’s $\alpha = .75$ (e.g., Wise & King, 2008). Internal consistency was adequate in the current sample with Cronbach’s $\alpha = .78$. A composite score was used, with higher scores suggesting higher family of origin conflict.

**Demographics and health information.**

Participants completed a demographics questionnaire (Appendix A) that asked about age, race/ethnicity, native language, college GPA, level of education, handedness, neurological history, and psychiatric history. Socioeconomic status was estimated by creating a composite measure of parents’ formal educational status and parents’ occupational status (similar to the method used by Hollingshead, 1975).

Participants also completed a brief laboratory session questionnaire (Appendix A) that assessed for the use of caffeine in the 3 hours prior to the study; alcohol, cigarette use, and recreational drug use in the 12 hours prior; and prescription/non-prescription medication use in the 24 hours prior to the study.
Neuropsychological measures.

Estimate of general intellectual functioning.

The Wechsler Test of Adult Reading (Wechsler, 2001) is a 50-item test of reading recognition that was developed as a means of estimating general intellectual functioning. The Wechsler Test of Adult Reading has excellent internal consistency and test-retest reliability among non-clinical adult samples (Wechsler, 2001), and scores correlate highly with performance on the Wechsler Adult Intelligence Scale—III full scale IQ in both 18-19 year olds ($r = .70$) and 20-24 year olds ($r = .74$). Standard scores from this measure were used as an estimate of general intellect.

Noncredible responding.

The Word Memory Test (Green, Allen, & Astner, 1996) is a behavioral measure of noncredible responding. In the current study, participants completed the immediate recognition portion of the Word Memory Test, which has strong diagnostic accuracy as a screening tool for noncredible performance (Bauer, O’Bryant, Lynch, McCaffrey, & Fisher, 2007). Total words recognized were used as the dependent variable.

Risky decision-making.

The Iowa Gambling Task (Bechara, 2007; Bechara et al., 1994) is a computerized task designed to measure risk-taking and decision-making. Participants attempt to maximize the amount of money earned, or minimize money lost, over the course of the task. For each individual trial, participants must select one card at a time from four decks labeled ‘A’, ‘B’, ‘C’, and ‘D’ on the computer screen. Participants are allowed to switch from one deck to another at any point during the task. In the long run, Decks ‘A’ and ‘B’ are disadvantageous because consistent selections produce net losses, while consistent
selections of Decks ‘C’ and ‘D’ produce net gains. The Iowa Gambling Task has strong construct validity in populations known to engage in risky decision-making, such as adults with ventromedial brain damage, substance abusers, pathological gamblers, and psychopaths, when compared to normal controls (Buelow & Suhr, 2009). In undergraduate samples, higher levels of reward sensitivity and sensation seeking may relate to more selections from disadvantageous decks as well (Suhr & Tsanadis, 2007).

For the present study, participants first completed 60 trials of the Iowa Gambling Task using similar parameters to the original study (see Bechara et al., 1994); the only exception was that the inter-trial interval was only \( \frac{1}{2} \) second. Participants were then asked to complete the same game again, and completed 40 trials using the same parameters as the seminal Bechara and colleagues’ (1994) study in order to allow for physiological recording. This time, however, participants were told they would receive a small sum of money at the end of the experiment if they were “successful at making more play money than the “average” participant who completes this task” at the Midwestern university where the study was run. The dependent measure was the number of disadvantageous selections subtracted from the advantageous selections over the final 40 trials, with higher scores suggesting less risky decision-making.

Response inhibition.

The Stop-Signal Task (Logan & Cowan, 1984) is an experimental computerized measure of response inhibition. The current study utilized a modified version of the computerized Stop-Signal paradigm (Verbruggen, Logan, & Stevens, 2007). In this task, participants were asked to discriminate between a square and a circle by pressing one of two designated keys on the computer keyboard as quickly and accurately as possible. On
25% of the trials, participants heard an auditory tone soon after presentation of the stimulus, indicating they should withhold their response to the stimulus. The stop tone occurred unpredictably, and the timing of the tone varied based on the participants’ performance. Participants first completed 32 practice trials, followed by three experimental blocks of 64 trials each. Elevations in stop-signal reaction time are seen in undergraduates with elevated sensitivity to reward and reduced sensitivity to punishment, and in those with higher self-reported impulsivity, suggesting construct validity for the measure (Avila & Parcet, 2001; Logan, Schachar, & Tannock, 1997). The primary dependent variable in the current study was stop-signal reaction time, and longer times indicate difficulties with response inhibition (Schachar, Mota, Logan, Tannock, & Klim, 2000). Probability of responding on stop-signal trials, mean reaction time on signal-respond, and mean reaction time on no-signal trials, were also used to measure impulsive response patterns and difficulties with response inhibition.

**Pictorial stimuli.**

Pictures were selected from the International Affective Picture System that varied in affective valence based on normative samples of male undergraduates (Lang, Bradley, & Cuthbert, 2008). Participants saw three sample pictures to become acquainted with the procedure of watching and rating pictures, followed by nine pleasant pictures and nine aversive pictures that were in a randomized, fixed order. Prior to the presentation of each image on the affective picture-viewing task, participants were asked to rest for 15 seconds, and then a dark screen appeared for approximately 2.5 seconds. Participants then viewed each image for 6 seconds. After each image was presented, participants completed self-report ratings of their affective experience. Pleasant pictures consisted of
women in erotic poses and adventure scenes, among other images that were selected to be maximally pleasant to participants. Aversive pictures consisted of mutilated bodies, disease, and disgusting scenes, among others. One pleasant (P), neutral, and negative (N) sample stimulus, respectively, preceded the experimental stimuli. Experimental stimuli included pleasant and negative stimuli that were presented in the following order on the computer screen: N, P, N, N, N, P, N, P, N, P, N, P, N, P, N, P, N, P, P, P.

**Self-reported emotional reaction.**

Self-reported reactions to the pictures were made with a paper-and-pencil version of the Self-Assessment Manikin (Bradley & Lang, 1994). Participants completed separate ratings of subjective valence (happy-sad), arousal (aroused-calm), and dominance (in control-controlled) in reaction to each picture. Self-reported ratings were made immediately after viewing pictures. There is strong evidence for the validity of the Self-Assessment Manikin, particularly the dimensions of valence and arousal (e.g., Ito et al., 1998), and participants who report lower levels of pleasure on the valence dimension demonstrate diminished aversive startle reflexes (Lang, Bradley, & Cuthbert, 1990). In the current study, dependent variables were scores on valence, arousal, and dominance; high scores on valence indicated greater sadness, high scores on arousal indicated greater calmness, and high scores on dominance indicated greater control.

**Skin conductance.**

Skin conductance response was recorded using a constant voltage (.5 V) signal. Participants washed and dried their hands before electrodes were attached. A pair of Ag-AgCl electrodes was attached to the palmar side of the distal phalanges of the index and middle fingers of the participant’s non-dominant hand. The wells of the electrodes were
lined with BIOPAC GEL 101 as a conducting medium. Skin conductance signals were filtered through high pass DC amplifiers. The galvanic skin response gain switch was set to 5 µmho/V, the low-pass filter was set to 1 Hz, and no high-pass filters were used. The sampling rate was set at 200Hz.

Participants were asked to rest their nondominant hand on either their lap or a desk, and keep it as still as possible in order to avoid movement artifacts (Cahill & Alkire, 2003). Skin conductance data was recorded continuously during the picture-viewing and risky decision-making tasks in microsiemens (mho).

On the picture-viewing task, skin conductance magnitude was scored as a baseline to peak difference for each trial. The baseline score was calculated as the mean of samples during the 1 second prior to picture onset for negative and positive trials, respectively (similar to Benning et al., 2005). The peak skin conductance responses reached between 900 and 4000ms after the onset of each picture were averaged over negative and positive trials, respectively.

On the Iowa Gambling Test, anticipatory skin conductance response was recorded during the period between the end of the 5-second outcome skin conductance response and the following selection of a card deck. Average anticipatory skin conductance response time is approximately 4 seconds, with a minimum of 1-second prior to the selection (Bechara et al., 1999). Anticipatory skin conductance was the dependent variable, and was calculated as the area under the curve after the outcome skin conductance response had elapsed until a deck was selected. This measurement is derived by averaging area under the curve during the selected time window and dividing by the
correspondent time interval (Bechara et al., 1999; Denburg, Recknore, Bechara, & Tranel, 2006; Miu, Heilman, & Houser, 2008).

**Cerebral oxygenation.**

**Near-infrared spectroscopy.**

The fNIR 300 Control Unit, a non-invasive, portable, and low-cost optical imaging device was used to measure brain activity (Zabel & Chute, 2002). Participants wore a flexible sensor on the forehead that incorporated four light-emitting sources and 10 light-collecting detectors. The sensor was located above participants’ eyebrows, and across the length of the forehead. A headband was placed over the sensor to secure it on the forehead. A flexible, self-adhesive bandage was wrapped over the headband to block out excess light that might interfere with hemoglobin readings. Relative changes in the concentration of oxygenated hemoglobin from the light attenuation were measured using a modified Beer-Lambert law. Individual oxygenated hemoglobin values were calculated every .5-.75 seconds. The data were transferred from the fNIR 300 recording computer to an excel file to be further analyzed.

The analysis focused on between group differences in mean changes of oxygenated hemoglobin over the course of the last 40 trials of the Iowa Gambling Task and over the entire Stop-Signal Task. Due to significant movement artifacts, oxygenated hemoglobin could not be recorded during the affective picture-viewing task. For the Iowa Gambling Task, the mean of a 10-second pre-task baseline (similar to methods in previous studies, e.g., Hermann, Plichta, Ehlis, & Fallgatter, 2005) was compared to mean relative changes in oxygenation over the course of the 40 trials of the Iowa Gambling Task. For the Stop-Signal Task, the mean of a 10-second pre-task baseline was
compared to mean relative changes in oxygenation over the three blocks of the Stop-Signal Task. Participants’ data that clearly contained motion artifacts, based both on our observation of the real-time Near-Infrared Spectroscopy recording and the data output, were excluded from statistical analyses.

**Experimental Procedure**

Participants were invited to the study after completing an online screen, which included the PPI-SF and questions from the demographic questionnaire, as part of a larger battery of questionnaires. Eligible participants received an email notifying them that they qualified for the study, and were provided an opportunity to sign-up for a timeslot.

At the testing session, participants first completed informed consent (see Table 5 for order of procedure administration). They were then asked to complete self-report measures to determine whether they continued to qualify for the study. Blood alcohol levels were measured using the BACTRACK S80. Participants who qualified for the study completed additional self-report questionnaires, the Wechsler Test of Adult Reading, and the Word Memory Test. Two trained graduate students, or a graduate student and a trained undergraduate student, ran the testing session.

Participants walked with the experimenters to a different room that housed the neuroimaging and physiological equipment. Participants were asked to wash and dry their hands. Participants were seated in a padded chair in a dimly lit room in front of the fNIR300 computer monitor. After participants were connected to the fNIR300 control unit and BIOPAC equipment, they were asked to sit quietly and rest for a five-minute baseline period. Participants then completed either the Iowa Gambling Task or viewed
pictures from the International Affective Picture System. These tasks were counterbalanced to prevent any confounding of order of presentation and task. After the completion of these two tasks, participants removed electrodes from their nondominant hand. Participants then completed the Stop-Signal Task; following this task, participants were disconnected from the fNIR300 control unit. A brief rest period preceded the second and third task. Participants were then debriefed. The entire procedure took approximately 2 hours. Each participant received course credit for completing the experiment. They also were given a “small monetary incentive” to encourage strong effort on the Iowa Gambling Task; all participants received $2 at the end of the experiment, regardless of task performance.

Table 5

Final Procedure for the Testing Session

<table>
<thead>
<tr>
<th>Time Required</th>
<th>Task</th>
</tr>
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<tbody>
<tr>
<td>5 minutes</td>
<td>Informed Consent</td>
</tr>
<tr>
<td>10 minutes</td>
<td>Screening Measures: Demographic Questionnaire, PPI-SF, Laboratory Questionnaire, Bactrack S80</td>
</tr>
<tr>
<td>15 minutes</td>
<td>Other Questionnaires: Alcohol Use Disorders Identification Test, Drug Abuse Screening Test-Short Form, Adult Criminality Scale, Family Conflict Subscale of Family Environment Scale, Positive and Negative Affect Scale</td>
</tr>
<tr>
<td>15 minutes</td>
<td>Cognitive Tasks: Word Memory Test, Wechsler Test of Adult Reading</td>
</tr>
<tr>
<td>5 minutes</td>
<td>Connection to NIRS and BIOPAC</td>
</tr>
</tbody>
</table>
Table 5 (Continued)

<table>
<thead>
<tr>
<th>Duration</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 minutes</td>
<td>Baseline recording</td>
</tr>
<tr>
<td></td>
<td>Viewing pictures from International Affective Picture System, Self-Assessment Manikin</td>
</tr>
<tr>
<td>15 minutes</td>
<td></td>
</tr>
<tr>
<td>3 minutes</td>
<td>Rest</td>
</tr>
<tr>
<td>15 minutes</td>
<td>Iowa Gambling Task</td>
</tr>
<tr>
<td>3 minutes</td>
<td>Rest</td>
</tr>
<tr>
<td>10 minutes</td>
<td>Stop-signal Task</td>
</tr>
<tr>
<td>5 minutes</td>
<td>Disconnect from NIRS and BIOPAC</td>
</tr>
<tr>
<td>10 minutes</td>
<td>Manipulation Check, Debriefing, Monetary Payment</td>
</tr>
</tbody>
</table>
Results

Data were hand entered into the Statistical Package for the Social Sciences (SPSS, 2008). As described previously, the control \((n = 42)\) and subclinical psychopath \((n = 37)\) groups were created using the PPI-SF. Tests for violations of normality and homogeneity of variance were also run, where appropriate, and are reported when significant.

Groups were examined for differences in age, intellect, affect, and socioeconomic status to determine their utility as covariates (see Table 6). Using t-tests, no group differences were found in age, \(t(77) = .92, p = .36\), estimated general intellect, \(t(77) = .24, p = .81\), positive affect, \(t(77) = -.38, p = .70\), or negative affect, \(t(76) = -.62, p = .54\), or estimated socioeconomic status, \(t(73) = .37, p = .72\). Consistent with previous literature and supportive of the validity of the two groups, the subclinical psychopath group self-reported significantly greater levels of high-risk alcohol use, \(t(77) = 5.54, p = .00\), higher degree of problems related to drug use, \(t(77) = 3.41, p = .00\), higher rates of polysubstance illicit drug use over the past year, \(\chi^2(1, N = 79) = 13.82, p = .00\), more frequent and diverse criminal behavior over the past year, \(t(74) = 5.18, p = .00\), and higher past family conflict, \(t(77) = 2.14, p = .04\).

Hypotheses

Hypothesis 1.

A 2 (group) by 2 (baseline, picture) mixed-model ANOVA was used to test the first hypothesis which proposed that subclinical psychopaths would demonstrate reduced autonomic responses during exposure to aversive images from the International Affective Picture System relative to controls. Autonomic skin conductance responses appeared to be normally distributed as the skewness and kurtosis variables fell between +1.0 and -1.0.
Homogeneity of variance was achieved on Levene’s test for baseline, $F(1, 75) = .01, p = .94,$ and over the course of the task, $F(1, 75), p = .79.$ As predicted, the interaction effect between group status and skin conductance change was significant, $F(1, 75) = 5.42, p = .02, \eta^2 = .07.$ Follow-up Bonferroni pairwise comparisons indicated that subclinical psychopaths demonstrated an attenuated change in skin conductance relative to the control group (see Table 7 for skin conductance data). Groups were not different in skin conductance level at baseline, $t(75) = -1.25, p = .21, \eta^2 = .02,$ or while viewing negative pictures, $t(75) = -1.40, p = .17, \eta^2 = .03.$

Although no specific hypotheses were made regarding responses to positive images, differences between groups on skin conductance responses to positive pictures were also tested. Assumptions were met for normality, as well as homogeneity of variance on Levene’s test for baseline, $F(1, 75) = .02, p = .90,$ and over the course of the task, $F(1, 75) = .02, p = .89.$ When comparing subclinical psychopaths and controls on positive pictures, the interaction effect was not significant, $F(1, 75) = 1.82, p = .18, \eta^2 = .02$ (see Figure 1 for skin conductance for positive and negative pictures). There was a significant main effect of time, $F(1, 75) = 38.58, p = .00, \eta^2 = .34.$ Bonferroni post-hoc tests indicated that participants’ skin conductance response significantly increased from baseline to viewing the positive affective pictures, regardless of group membership ($p = .00$). The group effect was not significant, $F(1, 75) = 1.44, p = .23, \eta^2 = .02.$
Table 6

Self-Reported Demographics of Subclinical Psychopathic and Control Groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Psychopathic (n = 37)</th>
<th>Control (n = 42)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Age</td>
<td>19.49</td>
<td>1.66</td>
<td>19.17</td>
</tr>
<tr>
<td>WTAR</td>
<td>108</td>
<td>12.86</td>
<td>107.36</td>
</tr>
<tr>
<td>PANAS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>28.87</td>
<td>8.81</td>
<td>29.57</td>
</tr>
<tr>
<td>NA</td>
<td>12.76</td>
<td>2.99</td>
<td>13.17</td>
</tr>
<tr>
<td>AUDIT</td>
<td>10.38</td>
<td>4.34</td>
<td>4.95</td>
</tr>
<tr>
<td>DAST</td>
<td>10.51</td>
<td>7.40</td>
<td>3.60</td>
</tr>
<tr>
<td>FC</td>
<td>3.92</td>
<td>2.61</td>
<td>2.71</td>
</tr>
<tr>
<td>AC</td>
<td>3.03</td>
<td>3.50</td>
<td>.19</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>0%</td>
<td></td>
<td>2%</td>
</tr>
<tr>
<td>Caucasian</td>
<td>94%</td>
<td></td>
<td>96%</td>
</tr>
<tr>
<td>Multi-racial</td>
<td>6%</td>
<td></td>
<td>2%</td>
</tr>
<tr>
<td>Polydrug</td>
<td>57%</td>
<td></td>
<td>20%</td>
</tr>
</tbody>
</table>

Note. SD = Standard Deviation; WTAR = Wechsler Test of Adult Reading; PANAS = Positive and Negative Affect Scale; PA = Positive Affect Scale; NA = Negative Affect Scale; AUDIT = Alcohol Use Disorders Identification Test; DAST = Drug Abuse Screening Test; FC = Family Conflict Subscale from the Family Environment Scale; AC = Adult Criminality Scale; Polydrug = percent reporting use of 2 or more illicit substances over past year

Given the support for the first hypothesis, we further examined whether the attenuated change in autonomic responses to aversive pictures would be paralleled by changes to self-reported reactions to the pictures, as assessed by the Self-Report Assessment Manikin (see Table 8). In response to negative pictures, subclinical psychopaths reported significantly less sadness, $t(74) = -3.00, p = .00, \eta^2 = .11$, and greater feelings of dominance, $t(75) = 2.20, p = .03, \eta^2 = .06$, relative to controls, but
groups were not different in self-reported arousal, $t(74) = 1, p = .32, \eta^2 = .01$.

Consistent with physiological findings, no self-reported differences in valence, $t(74) = -1.09, p = .28, \eta^2 = .02$, arousal, $t(74) = -1.21, p = .23, \eta^2 = .02$, or dominance, $t(73) = 1.76, p = .08, \eta^2 = .04$, were found in response to positive pictures.

Table 7

*Mean Skin Conductance Variables while Viewing Affective Pictures among Subclinical Psychopathic and Control Groups*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Psychopathic (n = 36)</th>
<th>Control (n = 41)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Negative Pictures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCR</td>
<td>.16</td>
<td>.27</td>
</tr>
<tr>
<td>Baseline</td>
<td>15.51</td>
<td>4.99</td>
</tr>
<tr>
<td>Picture-Viewing</td>
<td>15.67</td>
<td>5.02</td>
</tr>
<tr>
<td>Positive Pictures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCR</td>
<td>.17</td>
<td>.34</td>
</tr>
<tr>
<td>Baseline</td>
<td>15.89</td>
<td>5.24</td>
</tr>
<tr>
<td>Picture-Viewing</td>
<td>16.06</td>
<td>5.34</td>
</tr>
</tbody>
</table>

*Note.* SCR = Skin Conductance Response; SD = Standard Deviation; Baseline = mean skin conductance level 1-second prior to viewing picture; Picture-viewing = mean peak skin conductance level during period .9-4.0 seconds after picture-onset.
Figure 1. Skin conductance response between groups while viewing negative and positive affective pictures from the International Affective Picture System.

Note. Bars represent standard error of the mean.
Table 8

Self-reported Valence, Arousal, and Dominance while Viewing Pictures from the International Affective Picture System among Psychopathic and Normal Control Groups

<table>
<thead>
<tr>
<th>Factor</th>
<th>Psychopathic $(n = 36)$</th>
<th>Control $(n = 41)$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Negative Pictures Valence**</td>
<td>61.89</td>
<td>7.54</td>
</tr>
<tr>
<td>Arousal</td>
<td>50.44</td>
<td>10.52</td>
</tr>
<tr>
<td>Dominance*</td>
<td>39.17</td>
<td>13.35</td>
</tr>
<tr>
<td>Positive Pictures Valence</td>
<td>24.60</td>
<td>8.83</td>
</tr>
<tr>
<td>Arousal</td>
<td>36.77</td>
<td>13.11</td>
</tr>
<tr>
<td>Dominance</td>
<td>56.17</td>
<td>10.90</td>
</tr>
</tbody>
</table>

Note. SD = Standard deviation  
* = $p < .05$  
** = $p < .01$

Hypothesis 2.

The second hypothesis, that subclinical psychopaths ($M = .14, SD = .12$) would demonstrate attenuated autonomic anticipatory responses to risky selections over the final 40 trials of the Iowa Gambling Task compared to controls ($M = .17, SD = .15$), was not supported. No differences were observed when comparing subclinical psychopaths to controls on mean area under the curve of responses generated before selecting cards for risky selections, $t(74) = -.94, p = .35, \eta^2 = .01$. This finding indicates that psychopaths and non-psychopaths did not differ in their mean anticipatory skin conductance response to selection of risky card decks. Because of the relatively small sample sizes and non
normal distribution of the anticipatory skin conductance response among psychopaths and controls on the Shapiro-Wilk test \( (p = .00) \), we re-ran analyses using logarithmic transformations (e.g., \( \log_{10} \)), which did not change the results.

**Hypothesis 3.**

The third hypothesis, that subclinical psychopaths would perform worse on tests of decision-making and response inhibition than nonpsychopaths, was partially supported (see Table 9). Contrary to our hypothesis, on the final 40 trials of the Iowa Gambling Task subclinical psychopaths made marginally less risky decisions relative to controls, \( t(75) = 1.99, p = .05, \eta^2 = .05 \). Specifically, psychopaths performed better than controls on quintile four, \( t(75) = 2.20, p = .03, \eta^2 = .06 \), with findings in the same direction but not significant on quintile five, \( t(75) = 1.31, p = .19, \eta^2 = .02 \). The Shapiro-Wilk test indicated that the subclinical psychopathic group deviated from normality on the final 40 trials \( (p = .01) \). When re-analyzed with logarithmic transformations (e.g, \( \log_{10} \)), results did not change.

Contrary to expectations, there were no group differences on stop-signal reaction time of the Stop-Signal Task, \( t(75) = .89, p = .38, \eta^2 = .01 \). However, as expected, differences were found between groups on other relevant variables of response inhibition and impulsivity. Subclinical psychopaths had greater probability of responding on stop-signal trials, \( t(75) = 2.56, p = .01, \eta^2 = .09 \), in comparison to controls, suggesting greater difficulty with response inhibition. Psychopaths also responded more impulsively on no-signal trials, \( t(73) = 3.10, p = .00, \eta^2 = .12 \), and signal-respond trials, \( t(73) = 3.20, p = .00, \eta^2 = .12 \), relative to controls. The Shapiro-Wilk test indicated that the subclinical psychopath group may have deviated from normality on the mean probability of
responding on stop-signal trials \( (p = .00) \) and mean reaction time on no-signal trials \( (p = .04) \) and mean reaction time on signal trials \( (p = .03) \). Controls deviated on the mean reaction time on signal-respond \( (p = .02) \) and no-signal \( (p = .00) \) trials on the Shapiro-Wilk test. These findings are not surprising given that reaction time data is often strongly positively skewed (Sheskin, 2004). When re-analyzed with logarithmic transformations (e.g., \( \log_{10} \)), results did not change.

Table 9

**Neuropsychological Performance Among Subclinical Psychopathic and Control Groups**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Psychopathic ( (n = 37) )</th>
<th>Control ( (n = 42) )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Stop-Signal Task</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSRT</td>
<td>300.67</td>
<td>44.59</td>
</tr>
<tr>
<td>P response</td>
<td>51.01</td>
<td>10.59</td>
</tr>
<tr>
<td>Mean RT signal</td>
<td>516.01</td>
<td>99.56</td>
</tr>
<tr>
<td>Mean RT no-signal</td>
<td>571.13</td>
<td>140.30</td>
</tr>
<tr>
<td>Iowa Gambling Task</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quintile 4</td>
<td>4.83</td>
<td>7.21</td>
</tr>
<tr>
<td>Quintile 5</td>
<td>8.56</td>
<td>10.27</td>
</tr>
<tr>
<td>Total Q4+Q5</td>
<td>13.39</td>
<td>14.36</td>
</tr>
</tbody>
</table>

*Note.* SD = Standard Deviation; SSRT = Stop-Signal Reaction Time; P response = Mean probability of responding on stop-signal trials; Mean RT signal = Mean reaction time on signal-respond trials; Mean RT no-signal = Mean reaction time on no-signal respond trials; Total Q4+Q5 = Advantageous minus disadvantageous selections during the forty trials of the Iowa Gambling Task.
Exploratory Analyses

Functional brain imaging.

Changes in oxygenated hemoglobin were measured during the Iowa Gambling Task and Stop-Signal Task (see Appendix B for more detailed description of findings). Notably, changes in oxygenated hemoglobin could not be analyzed over the picture-viewing task due to consistent motion artifacts across all participants. Mixed-model ANOVAs were conducted over both the left and right hemispheres to examine change in oxygenation between pre-task baseline and during the individual tasks. No significant interactions were observed between groups across blocks of the Iowa Gambling Task or Stop-Signal Task (see Table 10). Cerebral oxygenation increased over time across groups (all $p$s < .05). The main effect of group also reached significance for the left-hemisphere on the Stop-Signal Task, $F(1, 51) = 3.90$, $p = .05$, $\eta^2 = .07$, with subclinical psychopaths having lower oxygenation than controls.

Psychopathic factors.

Within the subclinical psychopathic group, relationships between scores on the Fearless Dominance and Impulsive Antisociality factors, as well as total psychopathy scores, of the Psychopathic Personality Inventory-Short Form, and relevant neuropsychological, physiological, and neurological, and self-report measures, were explored. No significant correlations were observed between psychopathy factors and the primary physiological, neuropsychological, neurological, or self-report variables in the subclinical psychopath group (see Table 11 and Table 12).
Table 10

*Cerebral Oxygenation in the Dorsolateral Frontal Regions among Subclinical Psychopathic and Control Groups on Risk-Taking and Response Inhibition Tasks*

<table>
<thead>
<tr>
<th>Variable</th>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean (n = 35)</td>
<td>Mean (n = 35)</td>
<td>SD</td>
<td>SD</td>
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<tr>
<td></td>
<td>LH</td>
<td>RH</td>
<td>Pre</td>
<td>Pre</td>
</tr>
<tr>
<td>Iowa Gambling Task</td>
<td>1.59</td>
<td>1.56</td>
<td>2.56</td>
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<td>2.54</td>
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<td>2.69</td>
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<td>Stop-Signal Task</td>
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<td>3.38</td>
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<td>2.76</td>
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<td>2.92</td>
<td>2.87</td>
<td>2.92</td>
<td>2.87</td>
</tr>
</tbody>
</table>

*Note.* SD = Standard Deviation; LH = Left hemisphere; RH = Right hemisphere; Pre = mean cerebral oxygenation change from baseline over the 10-second pre-task baseline; Task = mean cerebral oxygenation change from baseline over the task; Change = mean cerebral oxygenation change from 10-second pre-task baseline to task.
Table 11

Correlation Matrix of Psychopathic Traits, Neuropsychological and Neurobiological Variables in the Subclinical Psychopath Group

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
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</thead>
<tbody>
<tr>
<td>1. PPI-SF</td>
<td>1.00</td>
<td>-0.21</td>
<td>0.63**</td>
<td>0.15</td>
<td>-0.26</td>
<td>0.05</td>
<td>0.05</td>
<td>0.08</td>
<td>0.10</td>
<td>0.14</td>
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<tr>
<td>Fearless</td>
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</tr>
<tr>
<td>Dominance</td>
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<tr>
<td>2. PPI-SF</td>
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<td>0.45**</td>
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<td>Impulsive</td>
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<td>Antisociality</td>
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<td>Total Score</td>
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<tr>
<td>4. SSRT</td>
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<td>-0.13</td>
<td>-0.18</td>
<td>-0.20</td>
<td>0.02</td>
<td>0.08</td>
<td>-0.34</td>
<td>-0.41*</td>
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<tr>
<td>5. IGT Q4 +Q5</td>
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<td>0.20</td>
<td>-0.01</td>
<td>-0.26</td>
<td>-0.29</td>
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<td>Q5</td>
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<td>6. SCR IGT</td>
<td>1.00</td>
<td>0.19</td>
<td>0.00</td>
<td>0.05</td>
<td>0.26</td>
<td>0.28</td>
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<td>Q4 +Q5</td>
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<tr>
<td>7. SCR IAPS NP</td>
<td>1.00</td>
<td>-0.39*</td>
<td>-0.33</td>
<td>0.09</td>
<td>0.09</td>
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<tr>
<td>8. NIRS</td>
<td>1.00</td>
<td>0.94**</td>
<td>0.25</td>
<td>0.18</td>
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Table 11 (Continued)

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<tr>
<td>9</td>
<td>IGT RH</td>
<td>1</td>
<td>.32</td>
<td>.25</td>
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<tr>
<td>10</td>
<td>NIRS SST LH</td>
<td>1</td>
<td>.71**</td>
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<tr>
<td>11</td>
<td>NIRS SST RH</td>
<td>1</td>
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</table>

**Note.** PPI-SF = Psychopathic Personality Inventory-Short Form; IGT = Iowa Gambling Task; Q4 = Quintile 4 of Iowa Gambling Task; Q5 = Quintile 5 of Iowa Gambling task; SCR = Skin Conductance Response; IAPS = International Affective Picture System; NP = Negative Pictures; NIRS = Near Infrared Spectroscopy; SST = Stop-Signal Task Standard Deviation; SSRT = Stop-Signal Reaction Time; LH = Left hemisphere; RH = Right hemisphere  
* = p < .05, ** = p < .01
Table 12

*Correlation Matrix of Self-Report Variables in the Subclinical Psychopath Group*

<table>
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<tr>
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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>8</th>
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<tbody>
<tr>
<td>1. PPI-SF Fearless Dominance</td>
<td>1</td>
<td>-.21</td>
<td>.63**</td>
<td>.25</td>
<td>-.10</td>
<td>.12</td>
<td>-.19</td>
<td>.00</td>
</tr>
<tr>
<td>2. PPI-SF Impulsive Antisociality</td>
<td>1</td>
<td>.45**</td>
<td>.06</td>
<td>.16</td>
<td>-.07</td>
<td>.32</td>
<td>.29</td>
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<tr>
<td>3. PPI-SF Total Score</td>
<td>1</td>
<td>.15</td>
<td>.03</td>
<td>.10</td>
<td>-.12</td>
<td>.10</td>
<td></td>
<td></td>
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<tr>
<td>4. PANAS Positive Affect</td>
<td>1</td>
<td>.15</td>
<td>-.04</td>
<td>-.20</td>
<td>-.15</td>
<td></td>
<td></td>
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<tr>
<td>5. PANAS Negative Affect</td>
<td>1</td>
<td>-.18</td>
<td>-.12</td>
<td>-.02</td>
<td></td>
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<tr>
<td>6. AUDIT total</td>
<td>1</td>
<td>.26</td>
<td>.27</td>
<td></td>
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<td>7. DAST Total</td>
<td>1</td>
<td>.58**</td>
<td></td>
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<tr>
<td>8. Adult Criminality Scale Total</td>
<td>1</td>
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</table>

*Note. PPI-SF = Psychopathic Personality Inventory-Short Form; PANAS = Positive and Negative Affect Scale; AUDIT = Alcohol Use Disorders Identification Test; DAST = Drug Abuse Screening Test*

* = $p < .05$, ** = $p < .01$
Discussion

The current study examined neurobiological and neuropsychological differences between young adult college students who self-reported high levels of psychopathic traits and college students who self-reported lower levels of psychopathic traits. The study rationale and hypotheses were drawn primarily from findings in previous studies of incarcerated psychopaths, along with the limited number of studies conducted on subclinical psychopaths. Consistent with previous literature and the current study hypotheses, subclinical psychopaths demonstrated attenuated skin conductance responses while viewing negative affective pictures, and also self-reported less negative emotions while viewing the pictures, relative to controls. Furthermore, subclinical psychopaths had poorer response inhibition and higher levels of impulsivity relative to controls. In contrast to study hypotheses, on a test of risky decision-making, subclinical psychopaths and controls did not demonstrate differences in anticipatory skin conductance responses, and the former group actually made better decisions than controls on this task. To our knowledge, this is the first study to explore psychopaths’ physiological, neuropsychological, and neurological functioning within the same sample. Findings will be discussed in light of the existing empirical literature and theories of psychopathy.

In the current sample, it was found that subclinical psychopaths had blunted physiological arousal to negative pictures relative to controls. Group differences were not observed for positive pictures. These findings are consistent with one previous study of subclinical psychopaths (e.g., Benning et al., 2005a), and suggest that subclinical psychopaths do not show blunted physiological responses to all affective stimuli. These results suggest that psychopaths may have deficiencies in reactivity to aversive or fear-
provoking situations, which make them more likely to approach dangerous situations that others may purposefully avoid. They do not find distress in others aversive and have lower levels of fear (e.g., Arnett, 1997; Lykken, 1957), which places them at higher risk to harm others and engage in antisocial behavior. Additionally, subclinical psychopaths reported less subjective sadness than controls in response to negative pictorial stimuli. Indeed, this provides even greater support to the notion of the “cold” psychopath who is devoid of emotional processing and true empathic response, even in a non-incarcerated sample (Birbaumer et al., 2005).

Based on the somatic marker hypothesis developed from empirical investigations of “acquired sociopaths” who do show attenuated skin conductance responses in anticipation of risky decisions (e.g., Bechara et al., 1999), it was hypothesized that affective impairments may predispose subclinical psychopaths to risky decision-making (e.g., Cooke & Michie, 2001). Nevertheless, in the current study, we found that subclinical psychopaths had intact autonomic functioning in anticipation of risky card decks on a paradigm mimicking real life uncertainty, reward, and punishment. While this finding did not support our hypotheses, results are consistent with at least one empirical study in which subclinical psychopaths exhibited intact autonomic functioning on stressor tasks (Ishikawa et al., 2001). As a result, subclinical psychopaths may be able to experience unpleasant somatic states to negative outcomes, and use these affective experiences to guide appropriate decision-making. On the other hand, incarcerated psychopaths are less likely to experience autonomic activity in anticipation of negative outcomes, and thus can not use somatic states to improve decision-making.
Another interesting finding was that the subclinical psychopath group made *more advantageous* decisions than controls on the last forty trials of this task. Although these findings run contrary to research conducted with incarcerated psychopaths (e.g., Losel & Shmucker, 2004) and one study of subclinical psychopaths (e.g., Mahmut et al., 2008), it supports the notion that subclinical psychopaths may have better problem-solving skills and cognitive flexibility than incarcerated psychopaths or community controls (Ishikawa et al., 2001). This enhancement in decision-making capacity may be adaptive, and aid in subclinical psychopaths’ ability to con and manipulate others. Subclinical psychopaths may excel in certain professions (e.g., business) that reward individuals who are excessively charming, cunning, and even ruthless, and who are willing to disregard others’ feelings in order to succeed (Babiak, Neumann, & Hare, 2010). Interestingly, in corporate settings, high levels of psychopathic traits are associated with increased ratings of charisma, strategic thinking, and communication skills, yet poorer ratings of performance (e.g., management skills, being a team player) (Babiak et al., 2010). Taken together with the physiological findings on the risk-taking task, adults with psychopathic tendencies who avoid incarceration may not have deficient “somatic markers” (Bechara et al., 1994), allowing them to utilize emotional reactions to facilitate appropriate decision-making, and helping them avoid incarceration.

Our research also focused on impulsivity, thought to be a core deficit of the psychopathic personality. In this sample of non-incarcerated undergraduates, we found that subclinical psychopaths made a greater number of errors on a motoric response inhibition task, relative to controls. The finding of greater inaccuracy replicates previous work in incarcerated samples of male offenders, who were found to consistently make
more commission errors on a go no-go task (e.g., LaPierre et al., 1995; Munro et al., 2007a), suggestive of difficulty inhibiting a prepotent response, and are consistent with studies in undergraduate samples on similar inhibition tasks (Lynam et al., 1999; Sellbom & Verona, 2007; Wilkowski & Robinson, 2008). Additionally, subclinical psychopaths had quicker reaction times on the response inhibition task, a novel association that was not found in a previous dimensional study of subclinical psychopathy (Sellbom & Verona, 2007). Subclinical psychopaths may have difficulty switching from or inhibiting a dominant response to assimilate feedback from the environment, especially when responses need to be made quickly and accurately. In turn, this may result in a propensity towards impulsive, reactive, and “hot-headed” behaviors (Vidal, Skeem, & Camp, 2010, p. 151), and foster psychopathic traits of recklessness and irresponsibility. Notably, on un-timed tasks where subclinical psychopaths have sufficient opportunity to reason, plan, and make a calculated decision as in the risk-taking task, their intact intellectual and executive functions may lead to spared or even enhanced decision-making.

While a good deal of neuroimaging research has contributed to our understanding of the psychopathic personality, relatively little research has been conducted with subclinical psychopaths. In the current study, subclinical psychopaths and controls did not differ in the change in cerebral oxygenation in the dorsolateral frontal regions from baseline to task during a risky-decision making or response inhibition task. Our findings did not support previous studies which suggested that incarcerated and subclinical psychopaths rely more on cognitive strategies during affective tasks, whereas controls rely on emotional processes. In these studies, psychopaths had increased activation in the dorsolateral prefrontal cortex and decreased activation in the orbitofrontal cortex and
limbic structures on affective picture viewing or moral reasoning tasks (e.g., Gordon et al., 2004; Muller et al., 2003). The nature of the tasks used in our study were different than in other undergraduate samples, which employed social cooperation or affect recognition tasks (e.g., Gordon et al., 2004; Rilling et al., 2007), and we were not able to analyze cerebral oxygenation on a similar affective picture-viewing task due to movement artifacts. Furthermore, we were not able to study event-related changes due to limitations in study methodology. Finally, the NIRS only measures dorsolateral brain regions, while the orbitofrontal regions and anterior cingulate play a very important role in impulsivity, response inhibition, and social decision-making as well (e.g., Weber, Habel, Amunts, & Schneider, 2008).

One other finding from our brain functioning results is worthy of mention. Psychopaths had lower absolute change (relative to the start of the experiment) on the left-hemisphere during the Stop-Signal Task, and also trended towards lower absolute change on the right-hemisphere during the Stop-Signal Task and in both hemispheres on the Iowa Gambling Task. These findings suggest that subclinical psychopaths were hypofrontal throughout the course of the experiment, which is consistent with reduced perfusion and metabolism in the frontal lobes among samples of violent incarcerated psychopaths (Pridmore, Chambers, & McArthurs, 2010), as well as in other externalizing disorders such as attention-deficit/hyperactivity disorder (e.g., Zang et al., 2005). Given that we did not find group differences in cerebral oxygenation during completion of tasks, that we could only explore relative changes from each participant’s baseline, as well as concerns with motion artifacts over the course of the study, we must certainly temper any conclusions. Future studies should explore differences in subclinical psychopaths’ brain
activity at rest, as well as during tasks, to best understand how brain-related
functioning may impact neuropsychological abilities.

A secondary purpose of the present study was to examine whether the two
distinct, but interrelated facets of psychopathy differentially relate to neurobiological and
neuropsychological deficits. The two-factor theory of psychopathy (see Patrick & Bernat,
2009, for a review) posits that the interpersonal-affective traits of psychopathy are
classified as fearless and reduced physiological reactivity to aversive stimuli,
while social deviance traits account for disinhibition and impulse control problems.
Burgeoning research in non-incarcerated samples has provided some support for this
type (e.g., Benning et al., 2005a; Sellbom & Verona, 2007). In contrast to what would
be expected based on the two-factor theory, we did not find significant relationships
among the psychopathic factors, neurobiological, neuropsychological, and self-reported
variables in our study. When exploring trends among the data, impulsive responding and
riskier decision-making on the Stop-Signal Task and Iowa Gambling Task were weakly
and moderately related to higher interpersonal-affective traits, respectively, while less
impulsive responding was weakly associated with higher social deviance traits. Skin
conductance was not strongly associated with either psychopathic factor among the
subclinical psychopath group. No significant relationships were observed between the
two psychopathy factors and self-reported alcohol use, drug use, or criminality, though
trends indicated that social deviance may relate more to drug use and criminality.
Overall, we did not find support for the two-factor theory of psychopathy in our
subclinical psychopath sample, which might provide some evidence that psychopathy is a
unified construct represented by deficits in low autonomic reactivity, fearlessness, and
impulsivity. Of note, the methodology of this study differed from previous subclinical studies that used dimensional analyses among large samples of undergraduates (e.g., Sellbom & Verona, 2007) or divided subclinical psychopaths into two groups based on scores on the two psychopathy factors (e.g., Benning et al., 2005). It is also possible that our sample may have been limited by the restricted range problem, because we only explored dimensional relationships among subclinical psychopaths.

The results from the current study provide support for Gao and Raine’s (2010) proposed model of subclinical psychopathy, which describes individuals who have psychopathic traits, but who are able to be “successful” and avoid incarceration. According to this model, subclinical psychopaths do not have structural and functional impairments of the prefrontal cortex, have intact somatic markers, intact or enhanced executive functioning, and intact fear conditioning, all of which are generally impaired in incarcerated psychopaths. On the other hand, subclinical psychopaths have a fundamental deficit in emotional awareness and in emotional empathy, or the ability to feel similar pain and sadness for the distress of others, have poor behavioral inhibition, and high levels of sensation-seeking. The affective deficit may arise from the nuclei in the amygdala involved in the recognition of fear and emotional modulation. Consistent with this theory, our current sample of subclinical psychopaths had reduced affective and physiological response to negative pictures among our group of subclinical psychopaths. Indeed, the amygdala plays a role in autonomic responses, including skin conductance activity (e.g., Ledoux, 1996). Also consistent with Gao and Raine’s (2010) model, the subclinical psychopaths were able to process cues and make advantageous decisions on a risk-taking task, which may assist them in avoiding incarceration. Finally, the subclinical
psychopaths in our sample demonstrated poorer response inhibition and impulsivity on a motoric inhibition task. The neuroanatomical underpinnings of the poor behavioral modulation and increased sensation seeking among subclinical psychopaths may be associated with reduced anterior cingulate activity (Rilling et al., 2007) and heightened sensitivity of the midbrain dopamine system (Buckholtz et al., 2010) in individuals with psychopathic traits relative to controls, yet these regions of interests were not able to be explored in the current study.

While previous research has primarily focused on neurobiological and neuropsychological functioning of incarcerated psychopaths or brain-injured participants, the current study demonstrated that some similarities (and some differences) in functioning may be seen in a non-incarcerated, non-clinical sample. Subclinical psychopaths share some deficits with incarcerated psychopaths, such as affective deficits to aversive pictures and behavioral disinhibition, and higher self-reported levels of alcohol use, drug use, and criminality than controls. These results suggest that there are continuities between subclinical and incarcerated psychopaths in the neurobiological and neuropsychological underpinnings of psychopathy, which should encourage future study in subclinical populations. Nevertheless, subclinical psychopaths may have some protective factors that prevent them from developing into full-blown incarcerated psychopaths. Subclinical psychopaths demonstrated intact behavioral performance and autonomic responses on a risky decision-making task, which runs contrary to research findings in incarcerated samples. The current sample of subclinical psychopaths had similar estimated intellectual functioning, college GPA, and estimated socioeconomic status to the control group, which may help protect against more severe executive
functioning or functional brain related deficits (e.g., Hall & Benning, 2006). Finally, even though the subclinical psychopaths reported higher levels of illegal behavior than controls, the severity and frequency of these acts paled in comparison to incarcerated psychopaths.

**Limitations and Future Directions**

The current sample was drawn from an undergraduate, largely Caucasian population, which may limit its generalizability to a non-offending and diverse community sample. However, considering the increased access to postsecondary education in the last several decades (Salekin, Trobst, & Krioukova, 2001), and that the rates of psychological problems among students on campus may be increasing (Gallagher, 2006), studying this population may have considerable external validity. This study was also limited in its definition of the subclinical psychopath and control groups. More specifically, cutoffs for the subclinical psychopathic and control groups on the PPI-SF were based on samples of male undergraduates completing an online screen rather than empirically-validated normative data. Still, our study cutoffs were consistent with means and standard deviations of the PPI-SF in other undergraduate samples (e.g., Lee & Salekin, 2010; Lilienfeld & Hess, 2001).

While the current study explored dimensional relationships between psychopathic traits and other dependent measures, this was only done within the subclinical psychopath group. The limited range of psychopathic scores within this group, along with a relatively small sample size, significantly decreased power in the exploration of dimensional relationships. For example, we found moderate correlations between social deviance traits on the PPI-SF, drug use, and criminality, though this did not reach significance in
our sample. Future research should compare groups high in interpersonal-affective traits, social deviance traits, or total psychopathic traits, respectively, to best parse out whether psychopathic features are differentially related to psychophysiological and neuropsychological outcomes, and to explore the mechanisms that underlie these deficits. This type of study is particularly important given that there is preliminary support for the two-process theory in extreme-group community samples (e.g., Benning et al., 2005a), and undergraduate samples not selected based on psychopathy scores (e.g., Sellbom & Verona, 2007).

In spite of the increased research on subclinical psychopaths, there are many questions that remain about this subgroup of individuals. In order to best address these questions, more studies are needed that directly compare subclinical and incarcerated psychopaths. To date, only a few studies have conducted such comparisons (e.g., Ishikawa et al., 2001; Yang et al., 2005). This type of research can shed light on the etiology and underlying mechanisms of psychopathy, and help parse out the confounding influences of incarceration, criminality, and antisocial behavior (Gao & Raine, 2010). It could also suggest better methods of differentiating psychopathic individuals (e.g., by whether or not they have intact somatic markers), which could have implications for treatment. Related to this, research in the area of subclinical psychopathy should critically consider ecological validity. For example, are subclinical psychopaths more occupationally successful than nonpsychopaths? Do subclinical psychopaths have more difficulties in interpersonal relationships than nonpsychopaths? Questions such as these are necessary to address to adequately assess the real-world impact, both negative and adaptive, of subclinical psychopathy. Future research also needs to target specific
samples of individuals who are most likely to have subclinical psychopathic traits (e.g., politicians, lawyers, businessmen, stuntpersons) to further determine the types of reckless and conning behavior they engage in, and the protective factors that prevent them from developing serious antisocial behavior.
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Appendix A

Review of Psychometric Properties of Measures

Self-Report Measures

Psychopathic traits.

*Psychopathic Personality Inventory—Short Form.*

The Psychopathic Personality Inventory (PPI; Lilienfeld, 1990) and the condensed Psychopathic Personality Inventory-Short Form (PPI-SF; Lilienfeld, 1990), were developed to assess psychopathic personality characteristics in non-incarcerated samples and are commonly used self-report measures in research settings (Lilienfeld, 1998). The PPI and PPI-SF do not overtly assess antisocial behaviors, and items fall on a 4-point Likert scale (1 = *false* and 4 = *true*). Factor analyses of the PPI in non-incarcerated samples reflect the presence of two, higher-order, orthogonal factors, Fearless Dominance and Impulsive Antisociality (Benning, Patrick, Hicks, Blonigen, & Krueger, 2003; Falkenbach, Poythress, Falki, & Manchak, 2007), which parallel the interpersonal-affective and social deviance traits of the Psychopathic Checklist-Revised (Hare, 1991), respectively. The PPI is composed of eight lower-order factors: Machiavellian Egocentricity, Social Potency, Coldheartedness, Carefree Nonplanfulness, Fearlessness, Blame Externalization, Impulsive Nonconformity, and Stress Immunity. Fearless Dominance is composed of Stress Immunity, Social Potency, and Fearlessness. Impulsive Antisociality reflects scores from Impulsive Nonconformity, Blame Externalization, Machiavellian Egocentricity, and Carefree Nonplanfulness. The Coldheartedness items do not load clearly on either factor of the PPI (Benning et al., 2003).
The current study utilized the 56-item PPI-SF, which was developed by selecting the seven items that loaded most highly on each of the eight factors in a large undergraduate sample (Lilienfeld, 1990). The PPI-SF total score correlates strongly with the PPI total score \( (r = .90) \) (Lilienfeld & Andrews, 1996) and has similarly impressive psychometric properties (Vaughn & Howard, 2005). The PPI-SF was administered during the online screen, and then again during the experimental session, to determine group membership. The subclinical psychopath group consisted of male undergraduates who scored above the top 25% cutoff on the PPI-SF online screen, continued to score in the top 30% when re-administered the PPI-SF at the testing session, and did not meet any exclusion criteria. The controls \( (n = 42) \) consisted of male undergraduates who scored below the bottom 30% cutoff on the PPI-SF online screen, continued to score in the bottom 30% when re-administered the PPI-SF at the testing session, and did not meet any other exclusion criteria.

The internal consistency of the PPI total score ranges from .88 to .93 in undergraduate and community samples, with alpha levels falling between .70 to .90 for the eight individual subscales (Blonigen, Carlson, Krueger, & Patrick, 2003; Falkenbach et al., 2007; Lilienfeld & Andrews, 1996). The internal consistency of the total PPI-SF and its eight subscales are comparable to the original PPI (Lilienfeld, 1990; Lilienfeld & Hess, 2001). The internal consistency of the Fearless Dominance and Impulsive Antisociality factors in a university sample were .89 and .92, respectively (Sellbom & Verona, 2007). Over approximately a one-month time period, the test-retest reliability of the PPI total score \( (r = .95) \) and eight PPI subscales was high \( (rs = .82 \text{ to } .94) \) (Lilienfeld & Andrews, 1996).
There is also considerable support for the construct validity of the PPI in community and undergraduate samples. As evidence for convergent validity, PPI total scores correlate moderately to highly with other self-report psychopathy measures (e.g., Levenson Self-Report Psychopathy Scale) and structured psychopathy interviews (e.g., Psychopathy Checklist-Revised) (Lilienfeld & Andrews, 1996; Poythress, Edens, & Lilienfeld, 1998). PPI total scores also add incremental validity over other self-report measures of psychopathy in predicting psychopathy scores on structured interviews (Lilienfeld & Andrews, 1996). Further, the PPI total score demonstrates adequate discriminant validity from self-report measures of depression, psychosis, and cyclothymia (Lilienfeld & Andrews, 1996). Additionally, Fearful Dominance and Impulsive Antisociality factors demonstrate strong criterion-related validity. High scores on the Fearful Dominance factor relate to lower levels of negative emotionality, anxiety, and neuroticism, and higher openness, dominance, social skills, conning, sensation seeking, and substance use (Benning, Patrick, Salekin, & Leistico, 2005b; Falkenbach et al., 2007). High scores on Impulsive Antisociality relate to elevated levels of negative emotionality, anxiety, sensation seeking, indirect and direct aggression, and substance use (Benning et al., 2005b; Falkenbach et al., 2007).

Substance use.

Alcohol Use Disorders Identification Test.

The Alcohol Use Disorders Identification Test (Saunders, Aasland, Babor, de la Fuente, & Grant, 1993) assesses current harmful and hazardous alcohol use. The Alcohol Use Disorders Identification Test is a 10-item scale. Participants responded to items 1 through 8 on a 5-item Likert-scale and questions 9 and 10 on a 3-item Likert scale.
Scores on the Alcohol Use Disorders Identification Test range from 0 to 40. Factor analyses indicate the presence of a Consumption factor (items 1-3) and an Adverse Consequences of Drinking factor (items 4-10). Though the Alcohol Use Disorders Identification Test was originally developed for disordered alcohol use screening in primary care settings, numerous research studies have examined the use of the Alcohol Use Disorders Identification Test in college samples (e.g., Kokotailo et al., 2004; O’Hare & Sherrer, 1999). In the current study, differences in total scores on this measure between psychopaths and nonpsychopaths were assessed.

A recent review suggested that the Alcohol Use Disorders Identification Test has impressive internal consistency and test-retest reliability across diverse samples and settings (Reinert & Allen, 2007). Specifically, in large samples of college students, internal reliability coefficients of the Alcohol Use Disorders Identification Test total scores range from .80 to .94 (Fleming, Barry, & MacDonald, 1991; Kokotailo et al., 2004; O’Hare & Sherrer, 1999; Shields, Guttmannova, & Caruso, 2004). The Alcohol Use Disorders Identification Test demonstrates good construct and criterion validity. Total scores on the Alcohol Use Disorders Identification Test have good convergent validity with other psychometrically-sound measures of alcohol use and abuse, with correlations typically falling in the .5 to .75 range (e.g., Lennings, 1999). Higher scores on the Alcohol Use Disorders Identification Test are associated with DSM-III-R and DSM-IV diagnoses of alcohol abuse and alcohol dependence, in both university and clinical populations (Kokotailo et al., 2004; Reinert & Allen, 2007). Overall, there is strong psychometric support for the use of the Alcohol Use Disorders Identification Test in undergraduate populations.
Drug Abuse Screening Test—Short Form.

The Drug Abuse Screening Test—Short Form (McCabe, Boyd, Cranford, Morales, & Slayden, 2006) is a 10-item measure that uses a yes/no format to screen for drug abuse over the past 12 months, in both clinical and nonclinical settings. Total scores on the Drug Abuse Screening Test—Short Form range from 0 to 10. Most evidence suggests that the Drug Abuse Screening Test—Short Form has a unidimensional factor structure (Carey, Carey, & Chandra, 2003). The current study utilized a modified version of the Drug Abuse Screening Test—Short Form that is used in university samples (McCabe et al., 2006) to screen for drug abuse. Respondents were instructed that drug use refers to drugs other than alcohol including prescription drugs not prescribed, use of prescription drugs in a manner not intended by the prescribing clinician, or the use of other drugs such as cocaine, marijuana, LSD, ecstacy, etc. Differences in Drug Abuse Screening Test—Short Form scores between subclinical psychopaths and nonpsychopaths were examined. An additional item inquired about type and frequency of illicit drug use (e.g., marijuana, methamphetamine, heroine) (McCabe et al., 2006). Drug abuse was important to test in the current study due to its association with neuropsychological impairments and prefrontal cortex dysfunction (e.g., Lubman, Yucel, & Pantelis, 2004).

The Drug Abuse Screening Test—Short Form has proven reliability in psychiatric and undergraduate populations. Alpha coefficients range from .68 to .89 in psychiatric and undergraduate populations (Cocco & Carey, 1998; McCabe et al., 2006; Taylor, James, Bobadilla, & Reeves, 2008), suggesting strong internal consistency. Item-total correlations for most Drug Abuse Screening Test items generally fall from .32 to .79.
(Yudko, Lozhkina, & Fouts, 2007). The Drug Abuse Screening Test—Short Form also has good test-retest reliability over a mean of 15 days, with intraclass correlations of .71 (Cocco & Carey, 1998).

There is considerable support for the construct and criterion validity of the Drug Abuse Screening Test—Short Form. As evidence for criterion validity, high scores on the Drug Abuse Screening Test—Short Form are moderately associated with higher drug ($r = .39$) and alcohol ($r = .31$) composite scores on the Addiction Severity Index (Cocco & Carey, 1998). Moreover, elevated Drug Abuse Screening Test—Short Form scores are related to depression, hypochondriasis, and behavioral deviancy (Yudko et al., 2007), as would be expected given the association between substance use and psychiatric disorders (e.g., Achenbach, Krukowski, Dumenci, & Ivanova, 2005). Additionally, the Drug Abuse Screening Test—Short Form can distinguish reliably between current drug abusers and former drug abusers (Cocco & Carey, 1998).

**Criminality.**

**Adult Criminality Scale.**

Participants were asked about their involvement in illegal activities using the Adult Criminality Scale (K. Beaver, personal communication, 4/5/10). This is a 12-item scale that asks about the frequency of committing criminal acts over the past 12-months. Items were coded on a 0 to 3 scale (Never = 0, 1 or 2 times = 1, 3 or 4 times = 2, 5 or more times = 3). Criminal activities included selling drugs, stealing, and deliberately damaging property, among others. Items were coded on a 0 to 3 scale (Never = 0, 1 or 2 times = 1, 3 or 4 times = 2, 5 or more times = 3). This scale demonstrated good internal
reliability (alpha = .76) in a community sample of young adults (Beaver, 2008). Scores range from 0 to 36, with higher scores representing more frequent illegal activity.

Mood.

*Positive and Negative Affect Scale.*

The Positive and Negative Affect Scale (Watson, Clark, & Tellegen, 1988) assesses positive and negative emotionality. The Positive and Negative Affect Scale has two orthogonal factors, positive and negative affect. Positive affect describes an individual’s enthusiasm, activity level, and alertness. Negative affect refers to aversive mood states, such as anger, contempt, guilt, disgust, nervousness, and guilt. The Positive and Negative Affect Scale contains brief Positive Affect and Negative Affect scales of 10 items each. Participants were asked to rate their experience of mood descriptors on a 5-point Likert scale (1 = *not at all* and 5 = *extremely*). A number of different time frames have been used for the Positive and Negative Affect Scale (e.g., today, the past week, the past month). For the current study, participants were asked how they experience certain mood states at the present moment. Additionally, higher negative mood is associated with riskier performance on the Iowa Gambling Task (Suhr & Tsanadis, 2007), and thus the Positive and Negative Affect Scale was used to control for mood state. The Positive Affect and Negative Affect total scores were used as dependent variables in the current study. Groups were tested for differences on Positive Affect and Negative Affect to assess for their utility as covariates in tests of the study’s hypotheses.

The Positive and Negative Affect Scale is a widely referenced instrument with extensive psychometric support. The Positive Affect and Negative Affect scales generally have strong internal consistencies (most alphas above .8) in clinical and nonclinical
samples, regardless of time instructions (Crawford & Henry, 2004; Egloff, Schmulke, Burns, Kohlmann, & Hock, 2003; Watson et al., 1988). As evidence of convergent validity, lower Positive Affect and higher Negative Affect correlate moderately to strongly with increased levels of depression and anxiety on the Depression Anxiety and Stress Scales in a general community sample (Crawford & Henry, 2004). Investigating situational influences of negative and positive affect can also be helpful to understand how the Positive and Negative Affect Scale can capture mood fluctuations. As expected, experimentally induced success or failure experiences, speeches with threatening topics, and feedback of exam results have been demonstrated to reliably alter mood states on the Positive and Negative Affect Scale (Egloff et al., 2003; Watson et al., 1988).

**Family conflict.**

*Family Environment Scale.*

The Family Environment Scale (Moos & Moos, 1994) explores family of origin dynamics. For the present study, the 9-item Family Conflict subscale of the Family Environment Scale was used to assess past verbal and physical family conflict. Each item was marked as true or false. The Family Conflict subscale has demonstrated adequate internal reliability in college student samples, with Cronbach’s α = .75 (e.g., Wise & King, 2008). As evidence of convergent validity, higher scores on the Family Conflict subscale are moderately associated with higher scores on other measures of family conflict, higher levels of psychological distress, and weakly associated with poorer friendships (Roskos, Handal, & Ubinger, 2010; Wise & King, 2008). Additionally, higher Family Conflict scores are weakly associated with aggression, rule-breaking, and
bullying in children (Ferguson, San Miguel, & Hartley, 2009). A composite score was used, with higher scores suggesting higher family of origin conflict.

**Background information.**

**Demographics Questionnaire.**

Participants completed a demographics questionnaire constructed for the purposes of the current study. The questionnaire asked about personal demographic information such as age, gender, ethnicity, year in college, current college grade point average, handedness, and legal history. Participants were also asked questions that were used as exclusion criteria including head injury history, other neurological history (e.g., epilepsy, brain tumors), severe psychiatric history (e.g., psychosis), whether they were in current treatment for substance abuse, and whether English was their second language. These exclusionary questions were asked during the online screen. Questions were asked again during the testing session as a check on online responses, with undergraduates endorsing exclusionary items excused from the study before completing neuropsychological tests.

Questions related to socioeconomic status were also included. An estimate of parents’ socioeconomic status was derived using items largely based off of Hollingshead (1975) index of social status. Specifically, parents’ formal educational status was scored on a 6-point scale (1 = less than grade 9, 2 = 9-12 grade, no diploma, 3 = high school diploma or equivalent, 4 = some college, no degree, 5 = college degree, 6 = graduate degree). Parents’ occupational status was coded on a 9-point scale (Hollingshead, 1975). Two raters independently coded occupational status; the intra-class correlation of .86, p = .00 suggested good inter-rater reliability. Social status was estimated by combining
information on educational and occupational status (see Hollingshead, 1975 for further detail).

**Laboratory Questionnaire.**

Participants completed a laboratory questionnaire, a brief survey assessing the use of caffeine over the past 3 hours, alcohol over the past 12 hours, cigarette use over the past 12 hours, and prescription/non-prescription medication over the past 24 hours. Participants were emailed prior to their participation in the study to ask them to refrain from use of caffeine for 3 hours prior to the study and use of cigarettes or alcohol for 12 hours prior; those who did not refrain from substances were excluded. Current substance use was essential to assess because it may influence neuropsychological test performance and neuroimaging findings (e.g., Oscar-Berman & Marinković, 2007).

**Neuropsychological Measures**

**General intellectual functioning.**

**Wechsler Test of Adult Reading.**

The Wechsler Test of Adult Reading (Wechsler, 2001) is an assessment of reading recognition that was developed as a means of predicting general intellectual functioning. Participants were asked to pronounce a list of 50 words. One point was awarded for a correct pronunciation of a word, and the maximum raw score was 50. Wechsler Test of Adult Reading standard scores were used as an estimate of general intellect in the current study and were tested for their utility as covariates for the study’s main hypotheses.

According to the Wechsler Test of Adult Reading standardization sample, the Wechsler Test of Adult Reading is a reliable measure (Wechsler, 2001). Alpha
coefficients for non-clinical adult samples range from .90 to .97, indicating excellent
internal consistency (.90 and .92 for 18-19 year olds and 20-24 year olds, respectively).
Furthermore, over an average interval of 35 days, test-retest reliability of the Wechsler
Test of Adult Reading is impressive among individuals 16 to 29 years of age ($r = .90$).

The standardization process also provided evidence for strong validity of the
Wechsler Test of Adult Reading in non-clinical adult samples (Wechsler, 2001). The
Wechsler Test of Adult Reading demonstrates high correlations with four measures of
reading-recognition (e.g., National Adult Reading Test, Wechsler Individual
Achievement Test Basic Reading subtest) in adult and adolescent samples ($r$s between
.73 and .90). Furthermore, the Wechsler Test of Adult Reading correlates highly with the
Wechsler Adult Intelligence Scale—III full scale IQ in both 18-19 year olds ($r = .70$) and
20-24 year olds ($r = .74$) among a large United States standardization sample. Indeed, for
over 70% of adult participants, Wechsler Test of Adult Reading scores predict Wechsler
Adult Intelligence Scale—III full-scale IQ scores within 10 points. As expected, higher
completed educational levels are related to better scores on the Wechsler Test of Adult
Reading ($r = .40$). In sum, substantial evidence exists for the reliability and validity of the
Wechsler Test of Adult Reading in non-clinical samples.

Noncredible responding.

Word Memory Test.

The Word Memory Test (Green, Allen, & Astner, 1996) is a behavioral measure
of noncredible responding. The computerized Word Memory Test measures a
participant’s ability to learn a list of 20 word pairs (e.g., dog-cat, man-woman). Each
word pair was presented for six seconds on the screen, over two consecutive trials.
Participants completed an immediate and delayed recognition task where they were asked to determine which words were part of the original word list, and a delayed recall task where they freely named words from the word list. In the current study participants only completed the immediate recognition portion of the Word Memory Test. The Word Memory Test immediate recognition score has high diagnostic accuracy as a screening tool for noncredible performance (Bauer, O’Bryant, Lynch, McCaffrey, & Fisher, 2007). Total words recognized on the Word Memory Test was used as the dependent variable. Participants not meeting cutoff scores (Green, 2003) were excluded from analyses. Given that manipulation and willingness to deceive are defining characteristics of psychopathy (Porter & Woodworth, 2007), psychopaths may be more willing to fabricate data or perform in a noncredible fashion (e.g., Edens, Buffington, & Tomicic, 2000). To the author’s knowledge, no previous neuropsychological studies of psychopathy have used an objective measure of noncredible performance, and thus inclusion of the Word Memory Test could provide an advancement in the literature.

There is strong psychometric support for the Word Memory Test in a variety of clinical samples, such as psychiatric patients, disability claimants, and adults with mild and severe brain injury. The split-half reliability of the Word Memory Test falls between $r = .86$ to $r = .90$ (Green, 2003). Within a given test session, subtests on the Word Memory Test that assess for noncredible performance correlate highly (Green, 2003). Test-retest correlations are modest for the Word Memory Test ($r = .43$ for immediate recall) (Green, 2003). Concordance rates of passing or failing the Word Memory Test and the Test of Memory Malingering, a commonly used test of noncredible responding, was adequate (69% concordance) in a sample of mild head injury litigants (Bauer et al.,
2007). Additionally, using suggested cutoffs of the Word Memory Test, delayed recognition scores accurately classified 100% of university students feigning brain injury and healthy controls told to give their best effort (Tan, Slick, Strauss, & Hultsch, 2002). Noncredible performance as identified by tests such as the Word Memory Test may account for over 50% in the variance of performance on neuropsychological measures (Green, Rohling, Lees-Haley, & Allen, 2001), and is an important measure to include in a comprehensive neuropsychological battery.

**Risky decision-making task.**

**Iowa Gambling Task.**

The Iowa Gambling Task (Bechara et al., 1994) is a computerized task designed to measure risk-taking and decision-making in a laboratory setting. Participants were given $2000 of play money to start, and were instructed to try and maximize the amount of money earned, or minimize money lost, over the 100 trials. Four cards labeled ‘A’, ‘B’, ‘C’, and ‘D’ were presented on the computer screen. Participants were instructed to choose a card from one of the decks on each individual trial. There were 60 cards in each deck. If participants selected all 60 cards from any individual deck, they were told to choose from a different deck. Participants were allowed to switch from one deck to another at any point during the task. Each time participants selected a card, the computer informed them that they won or lost a certain sum of money. Decks ‘A’ and ‘B’ were associated with larger gains than Decks ‘C’ and ‘D’, but also more significant losses. In the long run, Decks ‘A’ and ‘B’ were disadvantageous because consistent selections produce net losses (on average, $250 net loss over 10 trials), while consistent selections of Decks ‘C’ and ‘D’ produced net gains (on average, $250 net gain over 10 trials).
Previous studies suggest that the latter quintiles of the Iowa Gambling Task may reflect risky decision-making, while the earlier quintiles assess decision-making under conditions of uncertainty (e.g., Brand et al., 2007). In the current study, performance on the Iowa Gambling Task was assessed by subtracting the total number of disadvantageous selections from the total number of advantageous selections, with higher scores equating to less risky decision-making. Of note, a standard 6-second inter-trial interval was set between selection of cards in order to measure skin conductance response data (e.g., Bechara et al., 1999; Guillaume et al., 2009).

Additionally, in the current study, participants were provided a small monetary incentive for participation on the Iowa Gambling Task. Specifically, they were told that they would receive $2 if they made more money on the Iowa Gambling Task than the “average” or “typical” participant at Ohio University. Previous research suggests that a $2 incentive may be an affordable means of increasing motivation in research, and may be nearly as effective as a larger monetary incentive (e.g., $5) (Shaw, Beebe, Jensen, & Adlis, 2001). Research indicates that real monetary incentives motivate participants to make more advantageous selections than play money incentives (Fernie & Tunney, 2006). Overall, monetary rewards are associated with improved performance in the majority of decision-making paradigms (Hertwig & Ortmann, 2001). Thus, the use of real money it is a methodological improvement over the majority of Iowa Gambling Task studies using facsimile money.

There are currently no studies directly assessing the temporal reliability of the Iowa Gambling Task (Buelow & Suhr, 2009). However, research suggests that smokers and nonsmokers may improve Iowa Gambling Task performance (e.g., make fewer risky
decisions) over the course of three administrations during a single testing session (Lejuez, Aklin, Zvolensky, & Pedulla, 2003). Additionally, abstinent cocaine users, abstinent marijuana users, and non-users demonstrate less risky decision-making over a 25-day test-retest interval (Verdejo-Garcia et al., 2007).

The Iowa Gambling Task has strong construct validity on populations known to engage in risky decision-making. For example, adults with ventromedial brain damage select significantly more cards from disadvantageous decks, relative to normal controls or individuals with damage to other brain areas (Anderson, Bechara, Damasio, Tranel, & Damasio, 1999). Additionally, significant impairment on the Iowa Gambling Task is frequently evidenced in patient populations with neurological and medical conditions, substance abusers, pathological gamblers, and psychopaths, when compared to normal controls (Buelow & Suhr, 2009). Personality traits may relate to impaired performance on the Iowa Gambling Task in undergraduate samples (Buelow & Suhr, 2009). For example, elevated scores on Reward Responsiveness and Fun Seeking on Behavioral Inhibition Scale/Behavioral Activation Scale, and negative mood on the Positive and Negative Affect Scale, may relate to more selections from disadvantageous decks on the Iowa Gambling Task (Suhr & Tsanadis, 2007). Finally, as evidence for its discriminant validity, the Iowa Gambling Task shows small, insignificant correlations with a variety of loosely related neuropsychological constructs, such as learning and short-term memory on trials one through five of the Rey-Auditory Verbal Learning Test (Bechara et al., 2001).
Response inhibition task.

*Stop-Signal Task.*

The Stop-Signal Task (Logan & Cowan, 1984) is an experimental computerized measure of response inhibition. The current study utilized a modified version of the computerized Stop-Signal paradigm (Verbruggen, Logan, & Stevens, 2007). On this task, approximately 75% of the trials were “go” trials, in which participants had to discriminate between a square and a circle by pressing one of two designated keys on the computer keyboard as quickly and accurately as possible. 25% of the trials were “stop” trials, where participants heard an auditory tone (750 Hz, 75 msec) soon after presentation of the square or circle, indicating they should withhold a response to the stimulus. Each trial began with the presentation of a fixation sign (‘+’) in the center of the screen. The stimuli were presented after 250 msec. On “stop” trials, the auditory stop-signal was initially set at 250 msec after stimuli presentation. When participants successfully inhibited their response on a “stop” trial, the delay was reset so that it appeared 50 ms later on the subsequent “stop” trial. On the other hand, when participants failed to inhibit their response on a “stop” trial, the delay appeared 50 ms earlier on the following stop signal trial. The Stop-Signal Task consisted of two phases. In phase one, participants completed 32 practice trials. In phase two, participants responded to three experimental blocks of 64 trials each. The primary variable for the current study was stop-signal reaction time (SSRT), which estimates the amount of time needed to inhibit behavior. Stop-signal reaction time is calculated by subtracting the mean time taken to stop a response during “stop” trials from the mean reaction time for the “Go” trials (Logan, Schachar, & Tannock, 1997). Probability of responding on stop-signal trials,
mean reaction time on signal-respond, and mean reaction time on no-signal trials, were also used to measure impulsive response patterns and difficulties with response inhibition.

The Stop-Signal Task has been utilized frequently in both child and adult samples and has moderate psychometric support. Alpha coefficients of .88 were obtained over three blocks of trials for a sample of children with Attention-Deficit/Hyperactivity Disorder (ADHD) and matched normal controls, indicating strong internal consistency (Nigg, 1999). Among children with ADHD, adequate test-retest reliability was demonstrated over a period of 7 days (Soreni, Crosbie, Ickowicz, & Schachar, 2009). There is also considerable construct validity for the Stop-Signal Task. Individuals reporting high levels of impulsivity, children with ADHD, and cocaine abusers have elevated Stop-Signal reaction time relative to control groups (e.g., Aman, Roberts, & Pennington, 1998; Fillmore & Rush, 2002; Logan et al., 1997). Further, personality may be associated with differences in Stop-Signal reaction time. Elevated sensitivity to reward and reduced sensitivity to punishment on the Sensitivity to Punishment and Sensitivity to Reward Questionnaire, along with higher self-reported impulsivity on the Eysenck Personality Questionnaire, are associated with inhibitory delays on the Stop-Signal Task (Avila & Parcet, 2001; Logan et al., 1997). As evidence of discriminant validity, higher reported extraversion on the Eysenck Personality Questionnaire is not associated with Stop-Signal reaction time. Together, growing research suggests that the Stop-Signal Task has adequate reliability and construct validity.
Affective picture-viewing.

*International Affective Picture System and Self-Assessment Manikin.*

The International Affective Picture System (Lang, Bradley, & Cuthbert, 2008) is a standardized set of photographic slides charged with neutral, negative, or positive affective load. The International Affective Picture System currently includes over 700 color pictures and is typically utilized in studies of emotional processing or attention. Pictures were recently standardized for the three basic dimensions of emotional judgment. The two primary dimensions are arousal (ranging from calm to excited) and valence (ranging from pleasant to unpleasant) (Lang et al., 2008). The third less strongly-related dimension is referred to as dominance (ranging from in control to dominated).

Normative data for the International Affective Picture System is available on large samples of male and female undergraduates (e.g., Lang et al., 2008). Hundreds of studies have utilized the International Affective Picture System including at least three studies of psychopaths (Benning et al., 2005a; Pastors, Molto, Vila, & Lang, 2003; Vanman et al., 2003). In the current study, 18 pictures from the IAPS were selected that varied in affective valence (9 positive, 9 negative) among male undergraduates (per the Lang et al., 2008 normative data). Negatively and positively valenced pictures were matched on arousal level (Lang et al., 2008), and also on content (e.g., people, animals, places, other) (e.g., Wrase et al., 2003). A number of pictures from a previous extreme-group investigation of subclinical psychopaths (Benning et al., 2005a) were selected for the current study.

Pictures from the International Affective Picture System have extensive normative data based on participant ratings of the pictures’ arousal, pleasure (valence),
and dominance. Subjective affective ratings on the International Affective Picture System are most commonly made using the Self-Assessment Manikin, a paper-and-pencil measure assessing pleasure, arousal, and dominance. Participants completed separate ratings of their subjective experience based on five figures that represent the bipolar dimensions of valence, arousal, and dominance. Participants rated how they felt about each figure by placing an ‘X’ over or between the appropriate figures. There were five figures, and four spaces between the figures, resulting in a 9 point rating scale of the three dimensions. Valence was described by a continuum that ranges from a smiling figure to a frowning figure. Arousal was rated by a continuum that ranges from a wide-eyed excited figure to a sleepy, calm figure. Dominance was characterized by a continuum that ranges from a large to a small figure. The Self-Assessment Manikin instrument is a relatively efficient self-report method of assessing valence, arousal, and dominance. Participants completed the Self-Assessment Manikin immediately after viewing pictures on the International Affective Picture System.

In the current study, participants viewed pictures from the International Affective Picture System on a computer. Participants were first presented with 3 sample items (one positive, one negative, one neutral) in order to anchor their responses for the Self-Assessment Manikin (Lang et al., 2008). Following this, they viewed the remaining 18 pictures. Pictures were presented in a randomized, fixed order. Participants were first asked to wait for the picture for 15 seconds, which served as a rest period. Pictures were then presented for 6 seconds. Immediately after picture presentation, the computer screen read, “Now complete your ratings” and participants filled out ratings on the Self-Assessment Manikin. A standard 15-second rating period was used (Lang et al., 2008).
Strong psychometric support is available for ratings on the International Affective Picture System using the Self-Assessment Manikin. Internal consistency is considerably higher for arousal than valence; in a college student sample, Cronbach alphas were .98 for arousal and .63 for valence (Backs, da Silva, & Han, 2005). Similar ratings of arousal, valence (pleasure), and dominance are reported on the same subset of International Affective Picture System slides across two different university populations, with correlations exceeding $r = .80$ (Ito et al., 1998; Lang, Bradley, & Cuthbert, 1997). There are strong correlations for arousal ($r = .97$) and valence ($r = .99$) when a subset of 11 pictures was presented twice to participants, evidence for temporal stability of the measure.

Validity information for the International Affective Picture System using the Self-Assessment Manikin was provided in an early validation study (Bradley & Lang, 1994). In this study, undergraduate students were presented with 21 pictures from the International Affective Picture System and asked to describe their arousal and pleasure on the Self-Assessment Manikin and the Semantic Differential Rating System, which consists of 18 bipolar pairs of positive and negative adjectives. As evidence of convergent validity, the two primary affective dimensions of valence and arousal demonstrated strong agreement ($r = .96$ and $r = .95$, respectively) between the Self-Assessment Manikin and the Semantic Differential Rating System. Alternatively, the Dominance dimensions on the Self-Assessment Manikin and Semantic Differential Rating System had much smaller positive correlations ($r = .23$). Furthermore, reports of valence and arousal on the Self-Assessment Manikin relate in expected directions to physiological and behavioral reactivity measures (e.g., Greenwald, Cook, & Lang, 1989).
For example, participants who report lower levels of pleasure on the valence dimension demonstrate diminished aversive startle reflexes (Lang et al., 1990). More recent studies (e.g., Backs, da Silva, & Han, 2005; Ito et al., 1998) have provided further evidence for the Self-Assessment Manikin’s strong psychometric properties. Overall, there is considerable utility for the Self-Assessment Manikin as a psychometrically sound instrument for assessing affective dimensions of pleasure and arousal.

**Functional Brain Activity**

**Near-infrared spectroscopy.**

Near-Infrared Spectroscopy is a non-invasive, minimally intrusive, portable, and low-cost measure of brain activity (Zabel & Chute, 2002). Near-Infrared Spectroscopy is an optical method that assesses neuronal activity in the prefrontal cortex indirectly by monitoring regional changes in superficial cerebral tissue oxygenation (Irani, Platek, Bunce, Ruocco, & Chute, 2007). Optical properties of neurons are related to neuronal activity (Zabel & Chute, 2002). With Near-Infrared Spectroscopy, low-intensity near-infrared light passes through biological tissue, and this light is used to measure changes in blood absorption in the brain. Most cerebral and extracerebral matter (e.g., scalp, cerebrospinal fluid) are transparent to light at wavelengths between 700 and 1000 nm, because little hemoglobin or water is absorbed (Irani et al., 2007; Zabel & Chute, 2002). However, the chromophores oxygenation-hemoglobin ($O_2$Hb) and deoxygenated-hemoglobin (HHb) absorb, scatter, or reflect back wavelengths of these frequencies (Irani et al., 2007). The Near-Infrared Spectroscopy device can record relative changes in the concentration of oxygenated hemoglobin, deoxygenated hemoglobin, and total hemoglobin change ($c$Hb) ($\mu$mol/L), calculated using a modified Lambert-Beer law. As
brain activity increases, region-specific oxygenated hemoglobin level concentrations rise, while deoxygenated hemoglobin concentrations decrease (Ehlis et al., 2005; Fallgatter & Strik, 1998).

The fNIR 300 Control Unit (see figure 2), a noninvasive portable unit, used Near-Infrared Spectroscopy to measure changes in oxygen flow in the brain in the current study. This unit includes the fNIR100 functional brain imaging system with stimulus presentation software, one computer for running the fNIR100 system, one computer for stimulus presentation, and a presentation cart. Participants wore a sensor on the forehead that incorporated 4 light-emitting sources and 10 light-collecting detectors that were mounted in a flexible band (see figure 3). The fNIR sensors recorded oxygen levels in the dorsolateral prefrontal cortex. The fNIR system provided a continuous display of oxygenated hemoglobin and deoxygenated hemoglobin as the participant performs a variety of tasks.

After placing the headband on the participants’ forehead, participants were asked to rest for five minutes. Similar to methods used in previous studies (e.g., Herrmann et al., 2005), we used the 10-seconds before each task as a baseline measure. Of note, each measurement was taken relative to an initial 10-second baseline derived at the beginning of the experiment. Mean concentration of oxygenated hemoglobin was explored over the course of the four blocks of the Iowa Gambling Task and three blocks of the Stop-Signal task, respectively, between the subclinical psychopath and control groups. Cerebral oxygenation over the course of the affective-picture viewing task was not included in analyses due to significant movement artifacts.
Burgeoning research demonstrates the utility of Near-Infrared Spectroscopy in detecting consistent frontal lobe changes on neuropsychological tasks, and demonstrating frontal lobe abnormalities in adults with psychopathology. Healthy control participants demonstrate increases in regional oxygenated hemoglobin levels in the frontal lobes during a variety of executive function tasks (Fallgatter & Strik, 1997; Fallgatter & Strik, 1998; Herrmann et al., 2005; Schroeter, Zysset, Kupka, Kruggel, & von Cramon, 2002). For example, Herrmann and colleagues (2005) measured bilateral ventrolateral and dorsolateral activation among healthy control subjects on a Go/No-Go task using Near Infrared Spectroscopy. They reported significant increases in oxygenated hemoglobin with corresponding decreases in deoxygenated hemoglobin in bilateral inferior frontal regions, in response inhibition phases of a Go/No-Go task paradigm relative to the sustained attention phases (Herrmann et al., 2005). Compared to normal controls, participants with psychopathology demonstrate abnormal patterns of frontal lobe activation (Herrmann, Ehlis, & Fallgatter, 2004; Fallgatter & Strik, 2000). As evidence, although normal controls demonstrate increased right frontal oxygenated hemoglobin, patients with schizophrenia do not demonstrate any changes in oxygenation levels (Fallgatter & Strik, 2000). Finally, one recent study of non-clinical undergraduates (Hammers & Suhr, 2009) explored risky decision-making on the Iowa Gambling Task between an impulsive control group, who reported elevated impulsivity but no drug-related concerns, and a polysubstance group. The polysubstance group made riskier decisions on the last 50 trials of the Iowa Gambling Task and had reduced prefrontal dorsolateral cortex regional oxygenated hemoglobin values bilaterally. Thus, Near
Infrared Spectroscopy may have utility in detecting cerebral oxygenation differences among nonclinical samples as well.

An additional study explored dorsolateral prefrontal cortex functioning using Near-Infrared Spectroscopy on an affective exposure task (Herrmann, Ehlis, & Fallgatter, 2003). Fourteen normal control, mixed-gender adult participants were first presented negative and positive pictures from the International Affective Picture System. Later, they were shown facial expressions and instructed to try and feel similarly to the person in the picture. While there were no differences in oxygenated hemoglobin from baseline to the viewing of emotional pictures from the International Affective Picture System, higher prefrontal oxygenated hemoglobin levels were found relative to baseline on the affective faces task. The authors suggested that the task requirements, specifically the emotional self-monitoring of the facial expressions condition, led to increased dorsolateral oxygenated hemoglobin levels. Despite the small sample size, these findings indicate that brain activity may increase in dorsolateral prefrontal regions on an affective task.

There is considerable data to indicate that Near-Infrared Spectroscopy can be used to find relatively comparable patterns of brain activation to other functional brain imaging devices (Irani et al., 2007). For example, consistent with functional Magnetic Resonance Imaging studies indicating a relative functional hypoactivity in patients with attention-deficit/hyperactivity disorder during executive function tasks (e.g., response inhibition portions of the stop signal task) (Bush, Valera, & Seidman, 2005), adult patients with attention-deficit/hyperactivity disorder have reduced oxygenated hemoglobin levels on Near-Infrared Spectroscopy during a working memory task relative
to normal control adults matched on age and gender (Ehlis, Bahne, Jacob, Hermann, & Fallgatter, 2008). Furthermore, reviews suggest concordance between Near-Infrared Spectroscopy and functional Magnetic Resonance Imaging on response inhibition and face recognition tasks (Irani et al., 2007).

Physiological Arousal

**BIOPAC Systems MP-100.**

Skin conductance response data was collected with the GSR100C amplifier. Recordings of skin conductance response was acquired by the BIOPAC Systems MP-100 software (BioPac Systems, Santa Barbara, CA) and analyzed with AcqKnowledge 3.2.4 software. A pair of Ag-AgCL electrodes was attached to the palmar side of the distal phalanges of the ring and middle fingers of the participant’s non-dominant hand. The wells of the electrodes were lined with electrode gel (BioPac systems) before placement to ensure appropriate contact. Electrode sites were cleaned with an alcohol swab before attaching them. Participants were asked to keep their left hand as still as possible in order to avoid movement artifacts in the recordings (Cahill & Alkire, 2003). Skin conductance data was recorded continuously during the Iowa Gambling Task and affective picture-viewing task in microsiemens (mho).

On the affective picture-viewing task, skin conductance response analyses were similar to previous community-based studies of psychopathy (e.g., Benning et al., 2005a). The baseline score was calculated as the mean of all samples during the 1 second prior to picture onset (Benning et al., 2005a). The peak skin conductance response reached between 900 and 4000ms after the onset of the picture was averaged over negative and positive trials, respectively. Skin conductance response was compared across mean
baseline values and mean peak magnitude scores between the subclinical psychopath and control groups in the respective picture-viewing conditions (see Figure 2 for description of skin conductance recording on the picture-viewing task).

On the Iowa Gambling Task, the method for acquiring skin conductance response was similar to previous methodologies used by Bechara et al. (1999) and Guillaume et al. (2009). During the Iowa Gambling Task, the inter-trial interval was set at 6 seconds (Bechara et al., 1999); the participant typically needs a few additional seconds to make a response. Outcome skin conductance response was recorded during the five seconds after the selection of a card. Anticipatory skin conductance response was recorded during the period between the end of the 5-second outcome skin conductance response and the following selection of a card deck. The average intertrial interval is 9-10 seconds (Bechara et al., 1999; Guilluame et al., 2009); thus, the average anticipatory skin conductance response time is approximately 4-5 seconds, with a minimum of 1-second prior to the selection (Bechara et al., 1999; Guillaume et al., 2009). Anticipatory skin conductance responses, the primary variable of interest in the current study, were calculated as the area under the curve after the outcome skin conductance response had elapsed until a deck was selected. This measurement is derived by averaging area under the curve during the selected time window and dividing by the correspondent time interval (Bechara et al., 1999; Denburg et al., 2006; Miu et al., 2008) (see Figure 3 for description of skin conductance response recording on the Iowa Gambling Task).
Figure 2. An Example of Skin Conductance Response Measurement Recording on a Trial of the Picture Viewing Task. The first recording, baseline, is recorded as a mean SCR from 0-1 seconds and the second recording, during picture viewing, is recorded as a median peak magnitude SCR from 1.9-5 seconds. No recording is taken immediately after picture onset from 1-1.9 seconds.

Figure 3. An Example of Skin Conductance Response Measurement Recording on a Trial of the Iowa Gambling Task. The first recording, anticipation of card selection, is recorded as area under the curve for approximately the 4-5 seconds before card selection. The second recording, outcome of card selection, is recorded as area under the curve for the 5 seconds after card selection.

Measures of autonomic arousal have utility during risky decision-making and affective picture-viewing tasks. Autonomic activity may help discriminate between advantageous and disadvantageous decision-making in undergraduates, such that greater skin conductance increases are seen in anticipation of card selection from disadvantageous decks relative to advantageous decks (Jenkinson, Baker, Edelstyn, &
Ellis, 2008). Further studies indicate that damage to the ventromedial and medial prefrontal cortices, right inferior parietal regions, and anterior cingulate gyrus are associated with abnormal skin conductance responses during risky decision-making tasks (e.g., Bechara et al., 1999; Bechara, Damasio, Tranel, & Damasio, 1997). On affective picture-viewing tasks, healthy controls produce increase skin conductance responses during exposure to pleasant and unpleasant pictures, or affectively-laden faces, relative to neutral stimuli (e.g., Lane et al., 1997). Furthermore, during picture-viewing tasks, electrodermal activity is correlated with self-reported experiences of arousal (Anders, Lotze, Erb, Grodd, & Birbaumer, 2004). Clearly, measures of autonomic arousal have utility on risky decision-making and affectively-mediated tasks.

Considerable research has been devoted to the study of reliability and validity of skin conductance. Physiological response patterns of general autonomic arousal and arousal to external stimuli can be reliably produced over a time lapse of several months or longer, in non-clinical control adults and schizophrenic patients (Edgerly & Levis, 2005; Schell, Dawson, Nuechterlein, Ventura, & Subotnik, 2002). Many studies confirm the convergent validity of skin conductance measures with self-reports of emotion and other physiological assessment methods (e.g., Tamaren, Carney, & Allen, 1985). For example, undergraduate females were grouped into a high, medium, or low fear group based on responses to behavioral measures, self-report measures, skin conductance response, skin conductance level, or heart rate. Classifications made based on self-reported fear and skin conductance response were most effective at reliably distinguishing the three groups. This suggests that skin conductance response may be an
effective method of distinguishing fear responses in a non-clinical sample, though
generalizability to the current study may be limited given that this sample consisted
entirely of females (Edgerly & Levis, 2005).
Consent Form

Title of Research: Personality and Brain Function

Researchers: Eric Zimak, M.S., Julie Suhr, Ph.D.

You are being asked to participate in research. For you to be able to decide whether you want to participate in this project, you should understand what the project is about, as well as the possible risks and benefits in order to make an informed decision. This process is known as informed consent. This form describes the purpose, procedures, possible benefits, and risks. It also explains how your personal information will be used and protected. Once you have read this form and your questions about the study are answered, you will be asked to sign it. This will allow your participation in this study. You should receive a copy of this document to take with you.

Explanation of Study
You are invited to participate in a research study exploring the relationships between personality traits, cognition, and brain functioning. In the first part of this study, you will be asked to complete three self-report questionnaires. Additionally, your blood alcohol level will be assessed. Based on responses to these questionnaires and your tested blood alcohol level, you may be eligible to participate in the remainder of the study. If you do not meet eligibility requirements or choose not to participate in the rest of the study, you will receive 1 experimental credit for your participation.

Following this, you will complete additional self-report questionnaires, followed by a series of oral, computerized, and written activities that assess cognitive functions such as verbal skills, inhibition, and emotional recognition. During two of these tasks, the experimenter will assist in attaching electrodes to fingers on your left hand to measure physiological activity and sensors on your forehead to record brain activity. Some of the surveys are explicit in nature and others contain questions about possible illegal activity (e.g., drug use). Further, one of the tasks asks participants to view pictures that may be troubling or upsetting. Please consider whether you may be embarrassed, offended, or upset by the sensitive content of such materials before you participate. Participation is voluntary and may be discontinued at any time without penalty.

All activities will be administered by a trained graduate or undergraduate student who is supervised by the study advisor. If you meet eligibility criteria and choose to participate in the study, it is expected that your participation will take approximately 2 hours. You will receive 2 experimental credit points toward your psychology class at the end of the
session. All responses are confidential. Following completion of the activities, you will receive post-study information.

**Risks and Discomforts**
Risks or discomforts that you might experience are discomfort in answering questions about personal or private information, including questions about sexual activities and illegal behaviors. Additionally, it may be uncomfortable to view emotionally charged pictures during the study. While it is unlikely that attaching electrodes to your fingers or placing sensors on your forehead will cause temporary discomfort, the participant should be aware of this possibility. Risks to participants will be minimized because all study information is confidential, and participants can withdraw from the study without penalty at any time. Additionally, a list of counseling resources will be provided upon study completion.

**Benefits**
Benefits of this research are primarily for others, as your participation will enhance our understanding of the potential impact of personality traits on cognition, brain activity, and physiological responses. These findings could also have important implications for the prevention, assessment, and treatment of certain psychological concerns. Individually, you may benefit by learning more about the nature of psychological research during the post-study information that is provided to you.

**Confidentiality and Records**
All information obtained from you in this study will be kept strictly confidential. This information will be identified according to a randomized, unique 4-digit subject identification number. In addition, the data from this study will be kept in a locked storage facility and accessible only by authorized individuals. Your name only appears on the consent form, which will be separated from your study data immediately after your participation and stored in a separate folder in a locked storage facility.

Additionally, while every effort will be made to keep your study-related information confidential, there may be circumstances where this information must be shared with:

* Federal agencies, for example the Office of Human Research Protections, whose responsibility is to protect human subjects in research;
* Representatives of Ohio University (OU), including the Institutional Review Board, a committee that oversees the research at OU;

**Compensation**
As compensation for your time/effort, you will receive 2 experimental points for your participation in this study. If you do not meet eligibility requirements or choose not to
participate after completing the two questionnaires, you will receive 1 experimental point for your time/effort.

**Contact Information**
If you have any questions regarding this study, please do not hesitate to ask the experimenter. If you have additional questions or comments, you may contact the study’s primary investigator, Eric H. Zimak (ez331705@ohio.edu, (740)593-1707) or study’s advisor, Julie A. Suhr, Ph.D. (suhr@ohio.edu, (740)593-1091) if you have additional questions or concerns.

If you have any questions regarding your rights as a research participant, please contact Jo Ellen Sherow, Director of Research Compliance, Ohio University, (740)593-0664.

By signing below, you are agreeing that:
- you have read this consent form (or it has been read to you) and have been given the opportunity to ask questions and have them answered
- you have been informed of potential risks and they have been explained to your satisfaction.
- you understand Ohio University has no funds set aside for any injuries you might receive as a result of participating in this study
- you are 18 years of age or older
- your participation in this research is completely voluntary
- you may leave the study at any time. If you decide to stop participating in the study, there will be no penalty to you and you will not lose any benefits to which you are otherwise entitled.

Signature_________________________________________ Date______________
Printed Name________________________________________

Version Date: [12/28/09]
Laboratory Session Questionnaire

Directions: Please circle the answer that is correct for you and explain, if appropriate.

1. Have you consumed any caffeine in the past 3 hours? NO YES
If yes, please describe:____________________________________________________

2. Have you consumed any alcohol in the past 12 hours? NO YES
If yes, please indicate the number and type(s) of alcoholic drinks consumed:
______________________________________________________________________

3. Have you smoked any cigarettes in the past 12 hours? NO YES
If yes, approximately how long has it been since you last smoked a cigarette? (circle one)
15 minutes 1 hour 3 hours 6 hours 12 hours
If yes, please indicate the number of cigarettes smoked in the past 12 hours:
______________________________________________________________________

4. Have you used any recreational drugs in the past 12 hours? NO YES
If yes, please indicate the type of drug and quantity used:
______________________________________________________________________

5. Have you taken any prescription medication within the past 24 hours? NO YES
If yes, please describe:___________________________________________________

6. Have you taken any non-prescription medication within the past 24 hours? NO YES
If yes, please describe:___________________________________________________
Demographics Questionnaire

Age: _____

Gender (circle one):  male  female

Current level of education (circle one):  freshman  sophomore  junior  senior

High School Grade Point Average (GPA): _____

College Grade Point Average (GPA): _____

Handedness (circle one):  left  right

Is English your native language (circle one):  No  Yes

Directions: Circle the response that is most correct for you.

1. What is your racial/ethnic identity?
   A. Caucasian, Non-Hispanic
   B. African American
   C. Latino or Hispanic
   D. Asian or Pacific Islander
   E. American Indian or Alaska Native
   F. Two or more races
   G. Other

2. Have you ever received a blow to the head that caused you to lose consciousness for greater than 30 minutes?
   A. No
   B. Yes

3. Do you have any neurological history other than head injury (e.g., epilepsy, brain tumor)?
   A. No
   B. Yes
   If yes, please list diagnosis ____________________________________________

4. Are you currently diagnosed with depression, anxiety, attention deficit disorder (ADD/ADHD), learning disability, bipolar disorder, schizophrenia, or any other psychological condition?
   A. No
   B. Yes
   If yes, what condition(s)___________________________________________
5. Are you currently receiving treatment (e.g., prescription medication, counseling, herbal supplements) for depression, anxiety, attention deficit disorder (ADD/ADHD), learning disability, bipolar disorder, schizophrenia, or another psychological condition?
   A. No
   B. Yes
   If yes, what treatment(s)_____________________________

6. Are you currently receiving treatment for substance use problems?
   A. No
   B. Yes

7. What is your mother’s highest level of school she completed or highest degree received?
   A. Less than grade 9
   B. 9-12 grade, no diploma
   C. High school diploma or equivalent
   D. Some college, no degree
   E. College degree
   F. Graduate degree

8. What is your father’s highest level of school he completed or highest degree received?
   A. Less than grade 9
   B. 9-12 grade, no diploma
   C. High school diploma or equivalent
   D. Some college, no degree
   E. College degree
   F. Graduate degree

9. What is your mother’s current occupation?________________________________

10. What is your father’s current occupation? ________________________________

11. What is your parent’s marital status?
    A. Married
    B. Separated
    C. Widowed
    D. Divorced
    E. Never married
Debriefing Form

Title of Research: Personality and Brain Function
Researchers: Eric H. Zimak, M.S. & Julie A. Suhr, Ph.D., Ohio University
Department: Psychology

Thank you for your participation in this research investigation. The goal of this study is to explore the brain function and cognitive abilities of individuals with certain personality traits. In this study, you completed questionnaires asking about personality traits, risk-taking behaviors, and aspects of psychological functioning. Cognitive activities were administered to assess verbal skills, disinhibition, emotional recognition, and risk-taking. Your brain activity and physiological reactions were measured while you were exposed to a variety of images and completed a cognitive activity. Specifically, the images you viewed will inform research about how emotionally stimulating pictures influence brain activity. More generally, results from this investigation may indicate that individuals who have a specific personality profile have cognitive or brain functioning differences from those individuals with other personality characteristics. This research is meant to inform psychological research and practice.

Previous research has utilized small monetary incentives to increase motivation to give strong effort on psychological tasks. In order to increase motivation to give good effort on the computerized card task, we told participants that they would receive $2 if they made more money on the task than the “average” or “typical” participant at Ohio University. In reality, all participants will receive the $2 monetary incentive, regardless of task performance. As many other people will be participating in this study during the quarter, we ask that you please do not share details about this study with anyone else, so that people remain unaware of the specific details of the study given above.

As a reminder, all of your questionnaire responses, cognitive testing results, and brain and physiological recordings will remain strictly anonymous and confidential. If you have additional questions or concerns about your participation, please do not hesitate to contact the study co-investigators:

Graduate Researcher: Eric Zimak  
311H Porter Hall  
(740)593-1707  
ez331705@ohio.edu.

Faculty Advisor: Julie Suhr, Ph.D. 
250 Porter Hall  
(740)593-1091  
suhr@ohio.edu
In addition, if you are concerned about the study materials used or questions asked and wish to speak with a professional, or if you would like more information or reading material on this topic, please contact one of the following resources:

Ohio University Counseling and Psychological Services: 593-1616

Ohio University Psychology and Social Work Clinic: 593-1092

If you have any questions regarding your rights as a research participant, please contact Jo Ellen Sherow, Director of Research Compliance, Ohio University, (740)593-0664.
Appendix B
Supplemental Analyses

Cerebral Oxygenation

Changes in oxygenated hemoglobin were measured during the Iowa Gambling Task and Stop-Signal Task (see Table 10). Notably, changes in oxygenated hemoglobin during the course of the picture-viewing task could not be analyzed due to consistent motion artifacts across all participants. 2 (group) by 2 (baseline, task) mixed-model ANOVAs were run over the left and right hemisphere data, respectively, to examine change between groups over course of the tasks.

Iowa Gambling Task.

For the left hemisphere, normality of the distribution was met as the skewness fell between +1.0 and -1.0, and kurtosis fell between +1.5 and -1.0. Homogeneity of variance was achieved on Levene’s test for baseline, $F(1, 68) = .24, p = .63$, and during the task, $F(1, 68) = 0, p = .95$. For the left hemisphere, the interaction effect between group status and time was not significant, $F(1, 68) = .14, p = .71, \eta^2 = .00$. There was a significant main effect of time, $F(1, 68) = 4.35, p = .04, \eta^2 = .06$. Bonferroni post-hoc tests indicated that participants’ cerebral brain oxygenation in the left hemisphere did not increase significantly from the baseline to the task for either group ($ps > .05$). The group effect was not significant $F(1, 68) = 1.91, p = .17, \eta^2 = .03$.

For the right hemisphere, normality of the distribution was met as the skewness and kurtosis variables fell between +1.0 and -1.0. Homogeneity of variance was achieved on Levene’s test for baseline, $F(1, 68) = .31, p = .58$, and during the task, $F(1, 68) = 0, p = .39$. For the right hemisphere, the interaction effect between group status and time was
not significant, $F(1, 68) = .08, p = .77, \eta^2 = .00$. There was a significant main effect of time, $F(1, 68) = 4.32, p = .04, \eta^2 = .06$. Bonferroni post-hoc tests indicated that participants’ cerebral brain oxygenation in the right hemisphere did not increase significantly from the baseline to the task for either group ($p > .05$). The group effect was not significant $F(1, 68) = 1.75, p = .19, \eta^2 = .03$.

**Stop-Signal Task.**

For the left hemisphere, normality of the distribution was met as the skewness and kurtosis variables fell between $+1.0$ and $-1.0$. Homogeneity of variance was achieved on Levene’s test for baseline, $F(1, 51) = .96, p = .33$, and during the task, $F(1, 51) = .49, p = .49$. For the left hemisphere, the interaction effect between group status and time was not significant, $F(1, 51) = .41, p = .53, \eta^2 = .01$. There was a significant main effect of time, $F(1, 51) = 26.01, p = .00, \eta^2 = .34$. Bonferroni post-hoc tests indicated that participants’ cerebral brain oxygenation in the left hemisphere increased from baseline to task in each group ($p = .00$). The main effect of group also reached significance, $F(1, 51) = 3.90, p = .05, \eta^2 = .07$, with subclinical psychopaths having lower left-hemispheric oxygenation than controls.

For the right hemisphere, normality of the distribution was met as the skewness and kurtosis variables fell between $+1.0$ and $-1.0$. Homogeneity of variance was achieved on Levene’s test for baseline, $F(1, 51) = 1.44, p = .24$, and during the task, $F(1, 51) = .89, p = .35$. For the right hemisphere, the interaction effect between group status and time was not significant, $F(1, 51) = .59, p = .21, \eta^2 = .03$. There was a significant main effect of time, $F(1, 51) = 8.42, p = .00, \eta^2 = .30$. Bonferroni post-hoc tests indicated that participants’ cerebral brain oxygenation in the right hemisphere increased from baseline
to task for the subclinical psychopaths \( (p = .02) \) and controls \( (p = .00) \). The main effect of group was not significant \( F(1, 51) = 2.10, p = .15, \eta^2 = .04 \).

**Psychopathic Factors**

Within the subclinical psychopathic group, relationships between scores on the Fearless Dominance and Impulsive Antisociality factors, as well as total psychopathy scores, of the Psychopathic Personality Inventory-Short Form, and relevant neuropsychological, physiological, and neurological, and self-report measures, were explored. No significant correlations were observed between psychopathy scores and stop-signal reaction time on the Stop-Signal Task, disadvantageous selections on the final 40 trials of the Iowa Gambling Task, anticipatory skin conductance response magnitudes before disadvantageous selections on the final 40 trials of the Iowa Gambling Task, mean skin conductance response during viewing of aversive pictures on the International Affective Picture System. Additionally, there were no significant correlations between psychopathic traits and cerebral oxygenation change the course of Iowa Gambling Task or stop-signal task over the left and right hemispheres (see Table 11 for correlation matrix). Finally, no significant associations were observed between psychopathic traits and self-reported scores of mood, substance use, and criminality as measured by the Positive and Negative Affect Scale, Alcohol Use Disorders Identification Test, and the Drug Abuse Screening Test—Short Form, and Adult Criminality Scale (see Table 12 for correlation matrix).