PSYCHOPATHY SYMPTOM PROFILES AND NEUROPSYCHOLOGICAL MEASURES SENSITIVE TO ORBITOFRONTAL FUNCTIONING

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This study analyzed the relationship between the OF functioning of 100 incarcerated male offenders and their psychopathy symptoms. The study's rejected hypothesis had predicted a significant relationship between measures of OF functioning and the Defective Affective Experience (DAE) and Impulsive and Irresponsible Behavioral Style (IIB) factors of the Cooke and Michie (2001) three-factor model of psychopathy. Regression analysis failed to demonstrate a relationship between OF functioning and the DAE and IIB factors. Group differences on OF functioning were not demonstrated between participants in the upper and lower quartiles of a summed DAE and IIB factor score. A general role for OF functioning in criminal behavior was suggested as two OF measures accounted for 14.9% of the variance of criminal convictions.

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INTRODUCTION

Although not a DSM-IV diagnosis, psychopathy is defined as a personality disorder with a unique pattern of interpersonal, affective, and behavioral symptoms (Hart & Hare, 1997). The modern description of the psychopath began with Harvey Cleckley's The Mask of Sanity (1941). Following Cleckley's lead, Hart and Hare (1997) describe the psychopathic persona as "grandiose, arrogant, callous, superficial, and manipulative" (p.22). They note that the prototypical psychopath is "short-tempered, unable to form strong emotional bonds with others, and lacking in empathy, guilt or remorse" (p.23). Behaviorally, these individuals are "irresponsible, impulsive, and prone to violate social and legal norms and expectations" (Hart & Hare, 1997, p. 23). Newman (1988) characterizes psychopaths as those who display normal intellectual functioning but manifest a significant affective or inhibitory deficit that renders them unable to conduct themselves properly. The symptoms of psychopathy most often become evident in middle or late childhood (Hare, 1970; Millon, 1981) and are believed to be chronic and global well into adulthood with some changes or reduction in symptoms after age 45 (Hare, 1991). The costs of psychopathy include poor and unstable interpersonal relations, deficient occupational functioning, and an increased risk of involvement in criminal activity and subsequent incarceration (Cleckley, 1982; Hare, 1991).

While a broad array of diagnostic systems and titles have been utilized over the many years of psychopathy research, the most commonly accepted criteria to date is based on the Psychopathy Checklist: Revised (PCL:R, Hare, 1991). The PCL:R is largely based on Cleckley's descriptions of psychopathy, and was developed by Hare and colleagues to increase diagnostic reliability and validity of the psychopathy classification. The PCL:R consists of 20 item ratings that are summed to provide global rating scores that produce three classifications of psychopathy; low, medium, and high. Both the low and medium group represent sub threshold symptom ratings while the high group achieve criteria for a psychopathy diagnosis. Harpur, Hare, and Hakistan (1989) analyzed the factor structure of the PCL:R and provided a two-factor solution. In their analysis, Factor 1 was presented as the personality traits of the psychopath while Factor 2 accounted for the antisocial behavior and unstable lifestyle of the psychopath.

More recently, Cooke and Michie (2001) presented a three-factor structure for the PCL-R and its counterpart screening version (the Psychopathy Checklist: Screening Version, PCL:SV, Hart, Cox, & Hare, 1995). The three factors Cooke and Michie presented were entitled: (a) Arrogant and Deceitful Interpersonal Style (ADI factor), (b) Defective Affective Experience (DAE factor), and (c) Impulsive and Irresponsible Behavioral Style (IIB factor). The three-factor model has been replicated by Hill, Neumann, and Rogers (in press) with the inclusion of one additional item (poor behavioral controls) in the IIB factor. Figure 1 presents the item breakdown for the traditional two-factor model for the PCL-R, as well as the more recent three-factor model. Figure 2 presents these factor breakdowns for the PCL:SV.

Though the scientific investigation of psychopathy began nearly 200 years ago (McCord & McCord, 1964), the etiology of psychopathy remains elusive. A plethora of theories have been forwarded to explain the development and maintenance of this

Figure 1 : Factor Models of the Psychopathy Checklist-Revised

Two-Factor Model of the Psychopathy Checklist-Revised (PCL-R)

Factor 1:

1. Glibness/Superficial Charm
2. Grandiose sense of self-worth
4. Pathological Lying
5. Conning/manipulative
6. Lack of remorse or quilt
7. Shallow affect
8. Callous/lack of empathy
16. Failure to accept responsibility for own actions

Factor 2:

3. Need for stimulation/ proneness to boredom
9. Parasitic Lifestyle
10. Poor behavioral controls
12. Early behavioral problems
13. Lack of realistic, long-term goals
14. Impulsivity
15. Irresponsibility
19. Revocation of conditional release

Three Factor Model of the Psychopathy Checklist-Revised (PCL-R)

Factor 1: Arrogant and Deceitful Interpersonal Style

1. Glibness/Superficial Charm
2. Grandiose sense of self-worth
3. Pathological Lying
4. Conning/manipulative

Factor 2: Defective Affective Experience

1. Shallow affect
2. Callous/lack of empathy
3. Lack of remorse or quilt
4. Failure to accept responsibility for own actions

Factor 3: Impulsive and Irresponsible Behavioral Style

1. Need for stimulation/proneness to boredom
2. Impulsivity
3. Irresponsibility
4. Parasitic Lifestyle
5. Lack of realistic, long-term goals

Figure 2 : Factor Models of the Psychopathy Checklist:Screening Version

Two-Factor Model of the Psychopathy Checklist: Screening Version (PCL:SV))

Factor 1:	Factor 2:
1. Superficial	7. Impulsive
2. Grandiose	8. Poor behavioral controls
3. Deceitful	9. Lacks goals
4. Lacks Remorse	10. Irresponsible
5. Lacks Empathy	11. Adolescent antisocial behavior
6. Doesn't accept responsibility	12. Adult antisocial behavior

Three Factor Model of the Psychopathy Checklist:Screening Version (PCL:SV)

Factor 1: Arrogant and Deceitful Interpersonal Style

1. Superficial
2. Grandiose
3. Deceitful

Factor 2: Defective Affective Experience

4. Lacks Remorse
5. Lacks Empathy
6. Doesn't accept responsibility

Factor 3: Impulsive and Irresponsible Behavioral Style

6. Impulsive
7. Poor behavior controls
8. Lacks goals
9. Irresponsible

disorder. Developmental perspectives have investigated the effects of child abuse and neglect (Widom, 1997), parenting styles and parental attributes (Shaw & Winslow, 1997), peer rejection and drug use (Thornberry & Krohn, 1997), witnessing violence (Widom, 1997), and a host of other risk factors. Learning (Eron, 1997) and social information processing perspectives (Dodge & Schwartz, 1997) have also been forwarded. Along with the above theories, several biological perspectives on the etiology of psychopathy have been forwarded. Perspectives involving maturational lag (Kiloh, McComas, & Osselton, 1972), genetic predisposition (Carey & Goldman, 1997), hormonal influences (Brain & Susman, 1997), psychophysiological arousal (Raine, 1997) and neuropsychological functioning have all been investigated in regards to psychopathy and/or antisocial behavior.

Neuropsychological Functioning

The notion of brain dysfunction as a possible etiology of developmental psychopathy was largely born from the associations between observable brain injuries and neurologic diseases and subsequent psychopathic-like behavior. Though these types of examples represent acquired symptoms of psychopathy that manifest with "hard" signs of neurologic dysfunction, many theorists have attempted to apply the notion of minimal brain dysfunction as a possible etiology of developmental psychopathy. The concept of minimal brain dysfunction has been used to describe individual accounts of abnormal or detrimental behavior that implies organic dysfunction but exists without consistent anatomic, electrophysiologic, biochemical, or neurological correlates (Pincus & Glaser, 1966). The lack of "hard" neurological findings in minimal brain dysfunction, requires that “soft” signs be interpreted as indications of organic damage despite the possibility of other etiologies such as malingering, poor motivation, limited education, or other psychological causes. An important limitation regarding neurologic theories is that brain functioning is not an exhaustive explanation but only an important factor in the interplay of biological, psychological, and environmental variables that result in the expression of psychopathy.

Generalized Brain Damage

In attempting to illustrate the role of observable brain dysfunction among psychopathic-groups, many studies have investigated the rates of reported head injury, neurologic disease, or otherwise-identified presence of brain dysfunction among incarcerated or psychopathic-like individuals. Gibbens, Pond, and Stafford–Clark (1959) may have been one of the first such studies. This study reported that 40% of 72 severely psychopathic individuals reported a history of head injury. As noted by Miller (1999) prevalence estimates of head injury in the general population are notably absent in the professional literature. Incidence rates are widely reported; Kwentus, Hart, Peck, and Kornstein (1985) estimated that between 750,000 and 3 million mild head injuries are sustained in the United States each year. Three studies of mild head injury in college populations presented prevalence rates of reported head injury or prolonged unconsciousness (>20 minutes) with estimate ranging from 10 to 23% (Ryan, O’Jile, Gouvier, Parks, & Betz, 1996; Powell & Holmes, 1995; Holmes & Buzzanga, 1991). Unfortunately, these prevalence rates may not be an appropriate baseline from which to compare forensic populations. Miller (1999) noted that such figures would likely need to be adjusted upward as the generally lower socioeconomic status (SES) of offenders would likely be related to greater head injury prevalence. Martell (1992) reported that out of 50 randomly selected male patients in a maximum-security state hospital for mentally disordered offenders, 22% had a history of head injury with loss of consciousness. 40 of these individuals consented to a neurological examination, with 65% exhibiting hard signs of neurologic dysfunction and 50% exhibiting soft signs. Additional studies with similar results include Back-y-Rita and Veno (1974), and Mednick, Pollock, Volavka, and Gabrielli (1982).

One explanation for the significant level of head injury seen in forensic populations is that the characteristics of sensation-seeking and poor impulse control, often noted in criminal populations, reflect personality traits which predate and in effect cause brain injury (Miller, 1987). These personality traits create a higher likelihood of engaging in risky or dangerous behaviors that result in accidents and head injuries. This theory suggests that the life-long personality traits of the psychopath result in behaviors leading to incarceration as well as an increased incidence of brain injury.

Though these premorbid tendencies may contribute to increased brain injury rates among psychopaths, this explanation does not account for all the available data. Sarapata, Herrmann, Johnson, and Aycock (1998) noted that 83% of felons who reported a history of head injury noted the date of their injury preceded their first encounter with law enforcement. In fact, some participants had no contact with law enforcement until after a head injury in their late thirties. Miller (1999) presented a review of four studies that investigated follow-ups on offense related behavior of head injury victims. Miller used the data in these studies to determine annual arrests rates both pre- and post-injury. The analysis started with the conservative assumption that offending started at age 18. The results indicated a pre-injury arrest rate of 1.6% per year and a post-injury rate of 3.3% per year. This analysis indicates that the head injury victims demonstrated a two-fold increase in arrest rates following their injuries. Clearly the relationship between head injury and criminal offending/psychopathy is a complicated one. The relationship is likely to be bi-directional and may be unique to each individual. As demonstrated by both the Miller (1999) study and the previously noted argument regarding the cause-and-effect relationship between poor impulse control and brain injury, psychopathy may represent both a cause and a consequence of head injury.

Cognitive/Neuropsychological Dysfunction

A plethora of studies have investigated the cognitive functioning of individuals diagnosed with psychopathy, antisocial personality disorder (APD), or conduct disorder (CD), as well as those committing crimes, sex offenses, or violent behavior. Unfortunately, studies displayed very little consistency in how individuals were classified prior to the broad acceptance and utilization of the PCL:R and PCL:SV. This deficiency hampers the ability to replicate and generalize between studies. This unfortunate truth has been blamed for much of the inconsistency in study findings. Despite this difficulty several neuropsychological localization theories have been extensively studied as etiologies for psychopathic-like behavior.

In neuropsychology, the notion of localization refers to the idea that certain functions are completed in specific brain locations. Support for localization of functions comes largely from studies of patients with distinct brain lesions, as well as electroencephalogram (EEG) data, and real-time neuroimaging techniques such as positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) that provide measurements of brain activation during assigned cognitive tasks. A few caveats need to be observed when interpreting evidence of localization of function via neuropsychological testing. First, neuropsychological measures are indirect measures of brain function and a pattern of results or behavior does not imply an automatic relationship to specific brain sites (Lezak, 1995). Secondly, localization of function is more relative than absolute and completion of tasks may rely on the integrity of a specific neural circuit. In other words, it is likely that more than one brain site will be utilized for a given form of information processing (Raine, 1993). Furthermore, more than one type of information processing is often required to complete a given neuropsychological task. In conclusion, neuropsychological testing provides neither absolute sensitivity nor absolute specificity and thus should be viewed as useful in elucidating trends, but allowing only a probabilistic interpretation of localization of function (Morgan & Lilienfeld, 2000). The use of multiple measures purported to measure functioning in the same cortical area help to increase the safety of these interpretations.

<u>Left Hemisphere Dysfunction</u>

Flor-Henry (1974) proposed that dominant (generally left) hemisphere dysfunction contributed to psychopathic behavior. In supporting his theory, Flor-Henry first asserted that exploratory behavior and aggressive psychopathy are more significantly associated with the male gender than the female gender. He notes that exploratory behavior may be construed as manifestations of visual-spatial abilities, and thus suggest a superiority of non-dominant hemisphere functions in the male versus the female. Citing previous research involving tests of spatial abilities, comparisons of verbal and non-verbal tasks, and Wechsler Adult Intelligence Scale® (WAIS®) (Psychological Corporation, San Antonio, TX, www.psychcorp.com) performance patterns, Flor-Henry proposed that females are typically associated with dominant hemisphere superiority relative to males. Flor-Henry extended this finding to suggest that non-psychopaths would show stronger left hemisphere performance than psychopaths. He supported this assertion by citing dominant hemisphere lesion studies showing increased post-injury aggression in males as well as the finding by Wechsler (1958) that the "most outstanding single feature of the sociopath's test profile is his systematic high score on the performance, as opposed to the verbal part of the scale…" (Wechsler, 1958 as cited by Flor-Henry (1974)). This finding has been replicated by several studies (Prentice & Kelly, 1963; Mungas, 1988; Moffitt, 1990).

In a series of studies using an expanded version of the Halstead-Reitan Neuropsychological Battery, Flor-Henry, Yeudall, and others investigated the neuropsychological profiles of criminal psychopaths (as determined by global ratings on Cleckley's 16 criteria). Yeudall and Flor-Henry (1976) compared aggressive psychopaths to depressive patients and concluded that patients with affective disorders demonstrated greater right hemisphere dysfunction relative to their own left hemisphere and that psychopaths displayed greater left hemisphere dysfunction relative to their right. Comparison between alcoholic psychopaths and intermittent affective disordered alcoholic patients provided similar results (Yeudall, 1976), as did comparison of psychopaths and individuals described as suffering severe personality disorders with affective features. Yeudall (1977) compared a group of non-psychopathic criminal patients with severe personality disorders and a group of psychopathic individuals. The study demonstrated a greater proportion of lateralized deficits for the right hemisphere in the non-psychopathic group relative to the psychopathic group. In a summary of these studies, Yeudall (1977) reported that 91% of the criminal psychopaths in these samples demonstrated signs of dysfunction in frontal or temporal regions and that in 70% of these cases the dysfunction was greater for the left cerebral hemisphere. A series of following studies were able to replicate similar findings among sexual offenders, male violent criminals, psychopathic criminals, and juvenile delinquents (Yeudall & Fromm-Auch, 1979; Fedora & Fedora, 1983; Miller, 1987).

Despite these replicated findings, several studies with contradictory findings have also been published. Smith, Arnett, and Newman (1992) investigated the neuropsychological performances of 69 right-handed incarcerated male offenders. Participants were categorized via the PCL-R as psychopathic (scores above 30) and a non-psychopathic (scores below 20). The authors reported no "support for the hypothesis that psychopaths are characterized by verbal or left hemisphere dysfunction" (p.1233). Similarly, Raine and Venables (1988) reported that psychopaths exhibited significantly poorer performance among cognitive tasks associated with the right parietal dysfunction. In a study of juvenile delinquents, Yeudall, Fromm-Auch, and Davies (1982) demonstrated a significantly greater portion of neuropsychological profiles marked by dysfunction in the non-dominant hemisphere. The authors suggested that the lack of dominant hemisphere dysfunction was related to the lower proportion of violent offenders in their sample. The study concluded that the localization of cerebral dysfunction might be more specific to behavioral symptoms of delinquency rather than to the diagnosis of delinquency.

Frontal Lobes and Executive Functioning

Shortly after the early studies by Flor-Henry and Yeudall, the emphasis in localization theories of psychopathy shifted to the frontal lobes. The frontal lobes occupy the region forward of the central sulcus and above the lateral fissure. They encompass nearly one-third of the human cerebral cortex and have developed most recently in our evolutionary progression. At the head of the frontal lobes are the prefrontal cortices. Luria (1973) reports that these areas are crucial for the rise of so called “frontal lobe” or “executive” functions such as strategy formation, setting goals, and regulating and verifying behavior

Gorenstein (1982) represents the first empirical study investigating the frontal lobe performance of adult psychopaths. Gorenstein’s hypotheses were largely based on extrapolations from research in animals investigating lesions involving the prefrontal cortex, septum, and hippocampus, which were posited as an integral system which functioned to regulate goal-directed activity and moderate impulsiveness (Gray, 1972). The findings of animal research as well as Lezak’s (1976) discussion of frontal lobe patients led Gorenstein to propose a relationship between cognitive tasks related to frontal lobe functioning and human disinhibition. Gorenstein compared the performances of 20 male psychopaths and 23 psychiatric controls on the Wisconsin Card Sorting Test™ (WCST™) (Psychological Assessment Resources, Lutz, FL, www.parinc.com), the sequential matching memory task (SMMT), the Stroop Test, an anagrams test, and Necker Cube reversals. Gorenstein believed that three measures, perseverative errors on the WCST, SMMT errors, and Necker Cube reversals, were empirically related to frontal lobe function. He asserted that these measures successfully assessed mental flexibility and perseverance, skills important to successful executive functioning. Mental flexibility was defined as the ability to modify dominant response tendencies. Perseverance was viewed as the ability to resist dominant response tendencies. It was the deficiencies of these skills which Gorenstein believed led to psychopathic-like behavior especially the failure to delay gratification.

Gorenstein (1982) recruited participants from two public hospitals. 23 were receiving psychiatric treatment for substance abuse, 13 for psychological complaints, and 7 for a combination of these difficulties. Group assignment was defined by scores on the Socialization Scale (SO) of the California Personality Inventory™ (CPI™) (Consulting Psychologist Press, Palo Alto, CA, www.cpp-db.com) and a self-report behavioral checklist based on the Research Diagnostic Criteria for APD. To be placed in the psychopathic group, participants needed to meet criteria for APD via the checklist, and score at or below the mean for prison inmates on the SO scale. Gorenstein allowed one exception. Any individual who met twice the number of criteria necessary for APD would be placed in the psychopathic group regardless of his SO scores. These assignment rules classified 20 individuals as psychopathic and 23 as controls. According to group comparisons, Gorenstein concluded "psychopathic subjects, relative to controls, exhibited the performance pattern of frontal lesion patients on every measure empirically related to frontal lobe impairments…Moreover, psychopaths were not differentiated from controls on those measures empirically unrelated to frontal impairment…"(p. 376). He also reported a discriminant function analysis in which the three primary measures (WCST perseverative errors, SMMT errors, and Necker Cube reversals) were able to produce a highly significant discrimination between psychopaths and controls. Gorenstein concluded that the results provided strong reason for further investigations of psychopathy as based upon deficits in cognitive skills mediated by the frontal lobes.

Hare (1984) published a direct rebuttal to Gorenstein's (1982) findings and provided his own comparisons between a high psychopathy group and a low psychopathy group. In introducing his study, Hare put forth several criticisms that he felt limited the validity of Gorenstein's findings, including poor diagnostic procedures. Hare concluded that it was unlikely the participants placed in Gorenstein's psychopathy group would have met criteria for psychopathy as based upon Cleckley's 16-items or the DSM-III criteria for APD. He further noted that group differences in age, education, general ability, medication, and substance abuse were unexamined in Gorenstein's study and may have played an important role in the results. Finally, Hare argued that the measures used by Gorenstein had not been demonstrated as consistently being able to differentiate between frontal lobe and non-frontal lobe patients and therefore their localization value was questionable.

Hare's (1984) study utilized a 22-item psychopathy checklist (the precursor to the PCL) to determine group membership of 46 prison inmates. Based upon previous research, Hare used two cutoff scores to create high, medium, and low psychopathy groups. He then completed a MANOVA analysis using the three primary measures from Gorenstein's study and found no significant differences between the high and low group on task performance. ANOVA analysis of each measure (WCST perseverative errors, SMMT errors, and Necker Cube reversals) was also unable to provide significant differences. Hare reported that the three measures were unable to produce significant correlations casting further doubt on their ability to provide useful localization data. He concluded "there is little support for the position that psychopaths have specific cognitive deficits in the processes associated with frontal lobe functioning" (p.139).

The differing results of Hare (1984) and Gorenstein (1982) appear representative of the inconsistent findings throughout the literature involving frontal lobe or executive functioning measures. Some studies have reported significant findings (Devonshire, Howard, & Sellars, 1988; Smith, Arnett, & Newman, 1992) while others have reported a lack of significance (Hart, Forth, & Hare, 1990; Hoffman, Hall & Bartsch, 1987; Sutker & Allain, 1987). The ability to draw conclusions from this body of literature has been hindered by inconsistent results and diagnostic procedures, failures to account for possible confounding variables, and the use of a wide variety of neuropsychological measures with varying relations to frontal lobe functioning. A review by Kandel and Freed (1989) was only able to conclude that "trends in the data indicate that frontal lobe dysfunction cannot be ruled out in relation to any type of crime" yet "it is very difficult to attribute empirical support to the trends noted" (p. 411).

In an attempt to bring greater clarity to the available literature, Morgan and Lilienfeld (2000) presented a meta-analysis regarding the relationship between antisocial behavior and measures of executive function. The authors sought to provide a more valid summary of the available literature by requiring stricter criteria related to the sample make-up and the cognitive measures. The authors chose to focus their analysis upon measures of executive functioning which encompassed four cognitive domains; volition, planning, purposive action and effective performance. In order to be included in the study the authors set the following requirements for the neuropsychological measures: (a) the tests must task at least one of the four cognitive domains previously noted, and either (b) and/or (c), (b) the test has been demonstrated in several studies as able to differentiate frontal lobe patients from non-frontal lobe patients, (c) neuroimaging data has demonstrated the test has shown preferential activation of the frontal lobes. The authors offered the caveat that executive functions are clearly related to the frontal lobes but that due to the dense interconnections of the frontal lobes it is not possible to say whether these functions are produced by the frontal lobes. They concluded that six measures met this criteria: the Category Test of the Halstead-Reitan Neuropsychological Battery, the qualitative score on the Porteus Mazes test, the Stroop Interference Test, Part B of the Trail Making Test, the perseverative error score on the WCST, and verbal fluency tests.

The meta-analysis utilized studies with a wide variety of diagnostic groups but noted that almost all the studies used either the PCL-R, the Minnesota Multiphasic Personality Inventory Psychopathic Deviate scale, or the CPI SO scale. Acceptable group classifications included: APD, CD, psychopathy, criminality, and delinquency. The goal of the study was to elucidate the relationship between antisocial behavior and executive functioning measures via the differences in effect sizes between antisocial and comparison groups. The analysis involved 39 studies (N=4589) and yielded a grand mean effect size of .62 standard deviations (individual study effect sizes were weighted by sample size). This effect size represented the deficient cognitive performance of the antisocial-type groups relative to the comparison groups. This effect size is generally considered to be in the medium range. Within and between group analysis yielded no significant correlations between effect sizes and age, sex, ethnicity, or IQ. The authors also reported on three measures which they considered to be non-representative of executive functioning measures; categories achieved on the WCST, Trailmaking A, and Porteus Maze Test age scores. Both Trails A and the WCST categories score produced significant grand mean effect sizes (.34 and .37) raising the issue of whether the demonstrated frontal lobe deficits were focal and specific or the result of a more generalized neuropsychological deficit.

Analysis of those studies that compared a psychopathy group with a comparison group (15 studies) produced a grand mean effect size of .25 standard deviations, a magnitude that falls in the small range (Morgan & Lilenfeld, 2000). As indicated by this lower effect size, the authors noted that study effect sizes were generally greater for those study's utilizing indices of criminality and delinquency than for those that used indices of CD, APD, and psychopathy. They suggest that this counterintuitive finding may be the result of differences in comparison groups noting that the latter mentioned studies were much more likely to use clinical comparisons groups rather than normal control comparisons used by the former studies. As presented later in this introduction, an alternative explanation for these finding is that some psychopathic characteristics or dimensions (superficial charm, pathological lying, conning and manipulation) maybe contraindications of frontal lobe dysfunction and a mixed pattern of present and absent psychopathic traits maybe the most likely indicator of possible brain dysfunction. If various psychopathy factors do have differing relationships with cognition, these smaller effect sizes noted by Morgan and Lilienfeld (2000) may be the result of these differing or possible inverse relationships counteracting one another. The authors overall conclusions stated that evidence of a frontal lobe deficit is apparent in psychopathy, but the effect sizes they demonstrated may be smaller than those that would be elucidated by a further differentiation of the frontal lobes. Specifically, the authors suggest that greater effect sizes may be demonstrated by performance measures more specifically related to orbitomedial frontal lobe functioning.

The Orbitofrontal Cortex and Psychopathy

Morgan and Lilienfeld's (2000) remark regarding the orbitomedial frontal lobe derived from recently forwarded theories that have implicated dysfunction in the orbitofrontal (OF) or ventromedial (VM) prefrontal cortex of psychopaths. As with earlier brain dysfunction theories regarding the etiology of psychopathy, the OF/VM cortex garnered interest largely as a result of the symptomatology of patients with focal brain lesions. In these cases, damage was limited to the OF, sparing the dorsal sections of the prefrontal cortex as well as the rest of the brain.

Anatomy of the Frontal Lobes

The differentiation of the prefrontal cortex into at least two subsystems has been forwarded by several authors and studies (Fuster, 1989; Oscar-Berman, McNamara, &

Freedman, 1991; Rolls, 2000). The two subsystems consist of (1) the dorsolateral (DL) prefrontal cortex which derives from the paleocortex and (2) the OF cortex which derives from the archicortex (Cummings, 1993). Rolls (1998) suggests that these systems can also be differentiated by the afferents they receive from the mediodorsal nucleus of the thalamus. The DL receives it projections from the lateral part of the mediodorsal nucleus where as the OF receives it projections from the medial part of the mediodorsal nucleus.

The DL refers to the lateral portion of the dorsal (or superior) surface of the prefrontal cortex. It is connected with the second sensory association areas in the parietal, occipital, and temporal lobes (visual association areas), which are concerned with information processing (Fuster, 1989). These connections are bidirectional and provide support for the suggested roles of the DL, which is to integrate sensory information from multiple modalities (Malloy, Bihrle, Duffy & Cimino, 1993), provide temporal integration of behavior (Lapierre, Braun, & Hodgins, 1995), and provide storage for spatial working memory (Casey et. al., 1997; Freedman, Black, Ebert, & Binns, 1998; Fuster, 1989). Kauffer and Lewis (1999) described the direct connections between the DL and limbic structures (hippocampal formation and amygdala) as "relatively sparse" (p.33). Lesions in the DL often lead to limited self-initiation, poor goal planning, and diminished intellectual functioning including deficits in abstraction, cognitive flexibility, working memory, and sustained attention (Bechara, Damasio, Tranel, & Anderson, 1998; Stuss & Benson, 1986; Roussy & Toupin, 2000). It is the DL that is most often associated with the executive functioning measures previously described.

The OF cortex refers to the orbital (or ventral) surface of the prefrontal cortex. The OF include Areas 11,12,13 and 14 (Rolls, 2000). This area receives projections from the ventral visual stream as well as primary taste and olfactory cortices. Auditory inputs are received from the superior temporal cortex. Somatosensory inputs are received via the somatosensory cortical areas and the insula. The OF also receives "strong inputs from the amygdala" (Rolls, 1999, p. 302) and further indirect efferents from the amygdala through the mediodorsal nucleus of the thalamus. Projections from the OF reach the inferior temporal cortex, entorhinal cortex, cingulate cortex, preoptic region, lateral hypothalamus, ventral tegmental area, and head of the caudate nucleus. Kaufer and Lewis (1999) noted that the medial and orbital sections of the prefrontal cortex demonstrate the greatest proportion of limbic inputs of all portions of the frontal cortex. Due to the OF's greater connections with the limbic system it appears well suited to integrate motivational and emotional processes (Malloy, Bihrle, Duffy, & Cimino, 1993) and behavioral inhibition (Fuster, 1989). Rolls (1998) implicates the OF cortex in rapid reward-punishment association learning. Damasio (1994) suggests the VM (the term VM, used by Damasio and colleagues denotes the medial portion of the orbital (or ventral) surface of the prefrontal cortex) is specifically involved in making advantageous responses when choosing from an array of conflicting response options.

In examining the results of focal frontal lobe lesions, Walsh (1987) concluded that cognitive changes were more strongly associated with DL lesions whereas personality changes were more often associated with OF lesions. Presented below are several case studies of OF-lesioned patients who demonstrated significant personality change and a loss in the ability to make advantageous personal decisions despite the intact neuropsychological abilities of attention, perception, memory, language, and intelligence.

Case Studies of OF Lesion Patients

Eslinger and Damasio (1985) presented the case study of EVR. At the age of 35, EVR was described as a successful professional and happily married father of two. EVR developed an OF meningioma which was removed by surgical resection, a bilateral excision of orbital and lower mesial cortices. Post-surgery EVR's intellectual and memory functioning was found to be uncompromised (WAIS-R Verbal IQ = 129, Performance IQ = 135, Wechlser Memory Scale MQ = 143). It was reported that he passed each neuropsychological measure presented to him including the Wisconsin Card Sorting Test (WCST), the Word Fluency Test, and the Category Test. Despite EVR's apparently intact neuropsychological performance he displayed an obvious change in personality and decision-making abilities post-surgery. EVR became involved in economically disastrous business ventures that left him bankrupt. He was divorced twice; the second marriage, reportedly to a prostitute, lasted just 6 months. EVR was no longer able to hold a paying job and his plans for the future were described as defective. EVR's decision-making proved so poor that he was eventually placed in a sheltered environment. He met the following DSM-III diagnostic criteria for Anti-Social Personality Disorder: an inability to sustain consistent work behavior, inability to maintain enduring attachment to a sexual partner, lack of ability to function as an effective parent, and defective planning. These symptoms persisted despite the noted intact neuropsychological abilities as well an apparently intact social knowledge and ability to correctly reason through verbally presented mock social problems.

Meyers, Berman, Scheibel, and Hayman (1992) present the case of JZ. JZ's case is believed to present the effects of "unilateral, circumscribed orbitofrontal brain injury" (p.123). Before JZ's surgical resection of a pituitary adenoma he was described as an "honest, stable and reliable worker and husband" (p.122). After the resection, JZ exhibited significant personality changes including a marked suspiciousness of others, irresponsible behavior both at work and at home, and involvement in business dealings that led to large losses in personal savings. JZ was soon divorced, unemployed and dependent upon his mother for living quarters. Results of neuropsychological testing indicated average Full Scale IQ (WAIS-R Full Scale = 101), and high average to superior performance on the WCST and the Booklet Category Test. The authors noted that JZ's behavior during the testing was the most noteworthy aspect of the evaluation. He was described as impulsive, disinhibited, and emotionally labile becoming both agitated under some circumstances and euphoric under others. JZ met the following diagnostic criteria for the DSM III-R diagnosis of APD: lack of consistent work behavior, repeated problems honoring financial obligations, impulsive behavior or failure to plan ahead, and a lack of remorse.

Two childhood cases are presented by Anderson et al., (1999). These cases describe two adults who sustained prefrontal damage before 16 months of age. The authors note that the first individual's lesion was restricted to the VM where as the second case involved both medial and dorsal damage to the right prefrontal region. The first child reportedly exhibited no behavioral abnormalities until three years of age, at which time she became unresponsive to both verbal and physical punishment. Although described by teachers as intelligent and capable she became more and more disruptive as she grew older. By the age of 14, she was placed in the first of several treatment centers. She stole from family members and other children and demonstrated frequent shoplifting. She also manifested verbally and physically abusive behavior, early and risky sexual behaviors, and chronic lying. As an adult she makes no plans for the future, can not hold a job and displays a lack of empathy, guilt, or remorse. The second child presented with largely similar adult difficulties.

In both cases, the children were raised in what were described as "stable, middle class homes by college-educated parents who devoted considerable time and resources to their children" (p. 1033). No family history of psychiatric or neurologic disease had been previously noted and both individuals had siblings who appeared socially successful. Both individuals achieved normal performances on the following WAIS-R subtests: Information, Digit Span, Arithmetic, Similarities, Block Design, and Digit Symbol. Unlike the performance of EVR who sustained his injury as an adult, these individuals exhibited significant impairments on verbal tasks of social and moral reasoning. The authors concluded that early dysfunction in these cortical areas may lead to abnormal development of social and moral reasoning and behavior, possibly by destroying cortical modulation of the punishment and reward system and thus compromising learning dependent upon this process. The authors also noted that these individuals displayed more severe symptomatology than most adult-onset injuries, especially in terms of theft and violence towards people and property. They indicated that these individuals' profiles included reduced moral reasoning and abnormal psychophysiological arousal that was similar to what is commonly displayed in psychopathic individuals. However, the authors also made the observation that these individuals' aggression patterns seemed more impulsive and less goal-directed than is often observed in the prototypical psychopathy profile.

<u>Labels & Symptoms</u>

Theorists have used a variety of labels to describe these type of patients and the symptom constellations associated with damage to the OF area: (1) pseudopsychopathy (Kolb & Whishaw, 1993; Miller, 1987), (2) acquired sociopathy (Saver & Damasio, 1991), (3) acquired anti-social personality disorder (Meyers, Berman, Scheibel & Hayman, 1992), (4) disinhibition syndrome (Starkstein & Robinson, 1997) and (5) the orbitomedial frontal syndrome (Malloy, Bihrle, Duffy & Cimino, 1993) are a few examples. Despite the varying labels, the same symptoms have been described over and over again.

Miller (1987) described pseudopsychopathy associated with damage to the orbitomedial frontal area as marked by

> " a notable lack of normal adult tact and restraint. The individual may be coarse, irritable, facetious, hyperkinetic, or promiscuous and may on impulse commit acts that could be superficially described as "antisocial," although lack of impulse control and poor judgment, rather than malice, usually underlies this behavior…such individuals may quickly flare to anger, affect tends to be short-lived…"(p. 131).

Bear (1991) described the results of OF damage as including

> "superficial, reflexive emotional responses to stimuli in the immediate environment. Foresight and consideration of remote consequences of actions are severely impaired…with episodes of transient irritability. Generally such a patient strikes out quickly after trivial provocation with little consideration of the social rules limiting aggressive behavior or the consequences of the impulsive outbursts" (p.56).

Based upon their literature review, Lapierre, Braun and Hodgins (1995) have expanded the list of OF-related symptoms to include: (1) a disturbance of social cognition, (2) lack of ethical behavior, (3) sexual promiscuity, (4) lack of long-term goals or planning in favor of immediate reward or gratification, (5) behavioral disinhibition, (6) chronic irritability, (7) abnormally low galvanic responses to stressful stimuli, and (8) limited empathy. They note that this grouping of symptoms often leads to significant negative life events such as loss of friends, spouses, employment, and financial independence. Undoubtedly, for some individuals these newfound symptoms and behaviors have resulted in incarceration. As demonstrated by the previously noted examples, the behavioral and emotional manifestations of this type of damage are often overt and obvious; however demonstrating cognitive and neuropsychological impairment with traditional measures has often been difficult or impossible. Two recent theories have been forwarded to explain the functioning of the OF, elucidate its role in personal decision-making, and provide possible laboratory based methods to identify its dysfunction.

<u>Rolls (1998, 2000): Rapid stimulus-reinforcement association learning</u>

Based upon lesion studies and neuroanatomical research related to the OF, Rolls (1998, 2000) proposed that the crucial functioning of the OF is to control behavioral execution for alternating contingency situations. Rolls notes that the OF is uniquely capable to both produce and reverse stimulus-reinforcement associations. The OF contains representations for primary reinforcers such as somatosensory, gustatory and olfactory stimuli which can signal reward. The OF also contains auditory and visual representations which may become representative of reward when paired with a primary reinforcer; a stimulus-reinforcement association. Finally, the OF contains neurons which detect non-reward and likely function to reverse or "reset the reinforcement association of neurons" (p.306).

For the sake of clarity, an example will be provided describing the learning and reversal of a stimulus-reinforcer association; in this case, the stimulus is represented by the sight of an object and the reinforcer by the object's reward value. The visual representations in the OF are received via the ventral visual stream which is concerned with object identification, in this example the object is an apple. Through the association of the OF visual neurons and the primary gustatory neurons, the sight of the apple may come to be associated with its reward value of sustenance (though the reward is subjectively experienced as a good taste). In this way the sight of an apple takes on a reinforcement value which spurs one to approach apples and begin eating. Reversal of this association occurs when eating the apple is no longer a reward (i.e. when one has a full stomach). Rolls, Siemkiewicz and Yaxley (1990) demonstrated that the primary gustatory neurons in the OF of a monkey will stop responding to food when the animal is fed to satiety. Once these neurons cease firing the stimulus-reinforcement association between the sight of an apple and a possible reward is extinguished and the behavior is stopped.

Rolls (2000) concludes that the OF's autoassociation network allows much more rapid association learning and reversal than the amygdala and hence plays a role in contexts where reinforcement contingencies are likely to change. He asserts that the OF's connections with the striatum is the likely mechanism by which the OF influences behavioral output based on its decoding of reinforcement contingencies.

The importance of rapid association learning and reversal goes far beyond the eating of an apple. Rolls (2000) hypothesizes that the ability to quickly decode and adjust the reinforcement values of external stimuli is likely very important in social situations in which reinforcement stimuli are continually exchanged. The symptoms of OF lesion patients include an apparent inability to quickly and correctly respond to social reinforcers (Rolls, 1998), such as facial and vocal emotional expression (Hornak, Rolls, & Wade, 1996) as well as the positive and negative affective components of touch (Rolls et al. (1997). These types of deficits may help account for the poor social decision-making, irresponsibility, and lack of concern for present or future consequences that is often demonstrated by individuals who have failed to alter their behavior when it becomes inappropriate to external stimuli (Rolls, 1998). Rolls, Hornak, Wade, and McGrath (1994) described a computer-administered visual discrimination reversal task that is purported to measure rapid stimulus association learning and reversal.

Visual Discrimination/Reversal Task

The task presented by Rolls, Hornak, Wade and McGrath (1994) is a visual discrimination and reversal task that is similar to traditional object alternation (OA) tasks. OA tasks have been linked to OF functioning in humans (Freedman, 1990; Freedman, Black, Ebert, & Binns, 1998;) and have been shown to be more sensitive to OF than DL dysfunction in non-human primates (Miskin, Vest, Waxler, & Rosvold, 1969; as cited by Freedman, 1990).

In their task, Rolls et al. (1994) required participants to touch one of two simple patterns that were presented one at a time on a touch screen. The participants gained one point for touching the correct pattern, and lost one point for touching the incorrect pattern. In addition, the participants were rewarded with a point for not touching the incorrect pattern, and lost a point for not touching the correct pattern. The patterns were displayed on a screen for a maximum of seven seconds. After the participants responded or the seven-second display time expired, the pattern would disappear and a message would follow informing the participant whether or not they had made a correct choice and had gained or lost a point. Correct choices were also indicated by a rising tone, whereas incorrect choices were signaled by a short sound judged as unpleasant. The participants were required to make nine correct responses out of ten successive trials before the reinforcement patterns were reversed. The study also presented an extinction procedure in which two alternate patterns were used and once criterion was reached neither pattern was reinforced, in this way the only way to gain points was to not respond to either pattern.

Rolls et al. administered these tasks to two groups of patients. One group of patients had sustained lesions which included damage to the OF (N=12), but was not necessarily restricted to this region. The non-OF group had sustained damage either outside the frontal lobes (N=6) or only to the DL (N=2). The authors reported that every participant was able to reach the first criterion (9 out of 10) once they came to understand what the task required. However, when the reinforcements were reversed, patients in the OF group repeatedly chose the previously rewarded stimulus despite losing points when doing so. The non-OF group was significantly more likely to correctly alter their choice after the reinforcements reversed. The non-OF group approached a mean of two reversals (mean = 1.9) within thirty trials, where as much of the OF group failed to achieve even one reversal (mean = 0.56). The authors also reported the median trial on which the last error was made in achieving criterion after the first reversal (a maximum of 30 trials was allowed to reach criterion, for those who failed to achieve criterion within these 30 trials the last error made before the end of the test was counted as the last error). The median for the OF group was 30 while for the non-OF it was only 7 (Mann-Whitney U = 9.15, p=0.019). Similar results were reported on the extinction task and the authors noted that all the individuals within the OF group displayed this poor performance.

Rolls et al further analyzed the performances of those individuals in the OF group who were unable to meet criteria within 25 trials of the first reversal (N = 6). The authors noted that after the reversal these individuals did make some correct responses and hence were allowed the opportunity to discover the new reinforcement contingencies. Despite these correct responses, as well as the participant's ability to correctly verbalize the changing reinforcement contingencies, their performance remained near chance levels (obtaining a correct response on approximately 50% of the trials but never approaching the 9 out of 10 criterion). The greatest amount of errors came from the group failing to inhibit responding to the previously rewarded stimulus (perseveration errors). In fact 76% of the errors were of this type, the other 33% were omission errors in which the individual failed to choose the newly rewarded stimulus. The results suggest that members of the patient group found it more difficult to inhibit a previously rewarded response than to learn a newly rewarded response.

The authors concluded that these perseverative deficits are a "failure to break, or adjust, previously learned associations between stimuli and primary reinforcers" (Rolls, Hornak, Wade, & McGrath, 1994, p.1518). Rolls (2000) notes that these perseverative responses likely represent failures to reverse stimulus-reinforcer associations (a sensory to sensory association) and are not equivalent to a motor response perseveration (a stimulus to motor association) which is often attributed to more dorsal damage to the frontal lobes. Rolls (2000) also asserted that the continuing poor choices of participants despite their ability to correctly comment on the changing reinforcement values is consistent with the notion the OF is involved in the execution of behavior in response to the evaluation of reinforcers of environmental stimuli.

In a further analysis, Rolls et al. correlated the participants' task performances with medical staff ratings on a questionnaire designed to measure behavioral difficulties associated with frontal damage. The areas assessed included: disinhibition or social inappropriateness, violence, verbal abusiveness, anger or irritability, misinterpretation of people's moods, inflexibility, perseveration, unconcern about condition, lack of initiative, uncooperativeness, and flat affect. The authors reported a significant correlation between scores on this measure and the percentage of perseverative errors on both the reversal test and the extinction test (Spearman *p*=0.69, p=0.007 (two tailed), Spearman *p* =0.61, p = 0.023 (two-tailed). Of the seven members of the OF group who had further neuropsychological testing, all of them displayed a Wechsler Adult Intelligence Scale® Revised (WAIS-R®) (Psychological Corporation, San Antonio, TX, www.psychcorp.com) Verbal IQ score within the average range, and a Wechsler Memory Scale®-Revised (WMS-R®) (Psychological Corporation, San Antonio, TX, www.psychcorp.com) Paired-Associates learning score within one standard deviation of the mean (Median score = -0.4 SD). Furthermore, no significant correlations were noted between perseverative responses and either the Verbal IQ score or the paired-associates score.

Recently, O'Doherty, Kringelbach, Rolls, and Andrews (2001) presented an fMRI study which provided a dissociation in the OF's responsiveness to abstract rewards and punishments, such as winning and losing money or points during a guessing task. Results of this study concluded the lateral OF cortex is activated subsequent to a punished response while the medial OF is activated subsequent to a rewarding outcome. They suggest that lateral damage may be associated with selecting the previously rewarded stimulus, while medial damage may by associated with a deficit in consistently choosing the currently rewarded stimulus. The study also demonstrated that the magnitude of punishments and rewards were represented by the magnitude of neuronal activation in these areas. O'Doherty et al. (2001) suggest that a dysfunction in the ability to account for the magnitude of rewards and punishments could lead to difficulties judging the extent to which a particular stimulus choice is advantageous. The authors suggest such a deficit may account for poor performance on tasks such as the Bechara Gambling task, which is introduced below.

Damasio (1994): Somatic Marker Hypothesis

Damasio's theory (1994) was based upon his observations of neurology patients with VM damage who demonstrated significant difficulties in social and personal decision-making but manifested largely intact intellectual abilities. Damasio observed that these patients manifested significant difficulties planning their futures and choosing appropriate friends and activities. Premorbidly successful individuals began to make choices which lead to losses in finances, friends, and family, despite general intellect, learning, retention, language, social knowledge, working memory, and attention, all remaining largely intact. Due to Damasio's observation that these individuals display intact neuropsychological functioning but exhibited deficits in expressing emotions and experiencing feelings in emotional-evoking situations he reasoned their poor decision-making was at least partially the result of a defect in emotion and feeling.

In considering these findings, Damasio (1994) proposed that effective decision-making requires both a knowledge of the situation and options for action, as well as an association between that knowledge and the emotional state it has evoked in the past. Damasio's belief is that the results of emotion are represented in the brain in the form of activity patterns in the somatosensory cortices. These emotional changes or signals are referred to as the somatic state. He notes that the VM provides the neural substrates for learning the associations between a given situation or set of circumstances and the emotions previously paired with it in past experience. Damasio argues that when a situation arises, which has some factual similarity to a previous experience, dispositions are activated in higher-order association cortices leading to the recall of previously associated facts. At the same time, VM linkages are activated that allow for the activation of an emotional disposition or somatic state. By these activations occurring together the reconstruction of a learned factual-emotional set becomes possible. The recalled somatic state then acts as a judge by marking a certain option-outcome pair as good or bad. Damasio believes this can be a rather covert mechanism of decision-making in which the somatic state is not consciously explored but instead acts as a biasing mechanism which influences cognitive processing. He proposes this non-conscious influence may be possible through the use of a non-specific neurotransmitter.

Damasio, Tranel, and Damasio (1990) maintain that the somatic state plays a significant role in social decision-making due to the nature of punishment/reward learning. They argue that the outcome of any situation (punishment or reward) effects both visceral and skeletal functions, which activate somatosensory cortices, higher-order association cortices and limbic cortices causing us to experience feelings and emotions. In effect, the reactivation of a somatic state marks the value of current perceptions as well as the outcome of a given choice of action. Important to their theory is the notion that the somatic state not only creates a link between a given choice and the immediate pleasure it may bring, but also any punishment it may incur later. In this way, the somatic marker could cause one to consciously suppress an action that may lead to future disadvantages. The authors argue that this mechanism allows a non-conscious inhibition of the excitatory subcortical neurotransmitter systems that control appetitive behaviors.

Bechara Gambling Task

Bechara, Damasio, Damasio, and Anderson (1994) introduce a gambling task that attempts to simulate real-life decision-making and test the somatic marker hypothesis. The authors argue that this task simulates real-life decisions by creating factors of uncertainty in premises and outcomes involving both reward and punishment. While both a manual and computerized version of the task exists each works essentially the same. The participants are told that they will start with $2000 and the goal of the task is to gain as much profit as possible from the play. The participant is required to pick cards one at a time from four possible decks until the examiner informs them the play is over. Some of the cards will reward the participants with money gained while others will provide both monetary rewards and punishments. The participant is free to switch decks at any time but is not given any further information about the decks other than the cautionary note that some decks may cause more penalties than others.

The four decks contain varying levels of reward and punishment. Each card from decks A and B will yield $100 while cards from decks C and D will yield $50. The ultimate outcome of the decks is determined by the penalty amounts. Decks A and B result in higher penalty amounts than decks C and D. Deck A is structured such that after 10 cards the participant will have earned $1000 but will have suffered $1250 in penalties due to 5 unpredicted punishment cards. A net of negative $250. Deck B will also lead to this negative yield though the punishment cards are less frequent and of greater magnitude. Deck C will provide $500 dollars in reward after 10 selections but only $250 in penalties, netting a positive $250. Deck D also produces this net gain, however the punishments are less frequent and of greater magnitude than deck C. With this breakdown, it becomes apparent that decks C and D provide the more advantageous selections over the long-term.

Bechara et al. (1994) hypothesized that participants with VM damage and a history of abnormal decision-making would perform more poorly than healthy controls on the gambling task. Their study demonstrated that VM patients (N=6) sampled less from the advantageous decks and more from the disadvantageous decks than the healthy controls (N=44). The authors also compared the performance of a group of patients (N=9) with brain damage outside the VM area (lesions in the occipital, temporal and DL) to the performance of the healthy controls. They found that the performance of these patients was no different than that of the healthy controls. The authors noted that the selection profile of the healthy controls was to first sample from all decks and then make several selections from decks A and B but eventually switch to decks C and D with only infrequent returns to A and B. The VM patients first sampled all the decks several times but then return more frequently to decks A and B. The authors noted that EVR (previously discussed) continued to show deficient performances when tested 24 hours, one month, and four months after the original administration. They noted that normal controls tended to show improvements over time.

Bechara et al. (1994) also noted that control subjects who were asked to track the frequency and size of the punishments cards aloud were not able to provide calculations of the net profits and punishments for each deck. The authors suggest that in order to perform well on this task the participants "must rely on their ability to develop an estimate of which decks are risky and which are profitable in the long run" (p.9). The authors continue that "the patients' performance profile is comparable to their real-life inability to decide advantageously, especially in personal and social matters, a domain for which in life, as in the task, an exact calculation of the future outcomes is not possible and choices must be based on approximations" (p.9), via the somatic marker.

Support for a somatic marker has been shown by analyzing skin conductance responses (SCRs) during administration of the gambling task (Bechara, Tranel, Damasio & Damasio, 1996; Bechara, Damasio, Tranel, & Damasio, 1997; Bechara, Damasio, Damasio & Lee, 1999). Bechara et al. (1996) were able to demonstrate that normal subjects produced an anticipatory high amplitude SCR whenever they were about to choose from a bad deck. These anticipatory amplitudes appeared consistently and with greater magnitude as the task progressed, however no such response was associated with good decks. VM patients were unable to produce such anticipatory SCRs though they did show normal SCRs to actual loss of money.

In further demonstrating the decision-making role of anticipatory SCRs, Bechara, Damasio, Tranel, and Damasio (1997) noted that in a group of normal participants, anticipatory SCRs developed previous to the participants being able to verbally report a notion as the positive or negative nature of each deck. Though eventually the majority of normal participants were able to develop a conceptual understanding as to the values of the long-run payoffs of the decks, even those who were unable to state this understanding were able to make the advantageous decisions. Interestingly of 6 patients in the study, three with VM lesions were ultimately able to provide verbal descriptions as to which decks were good and bad, yet despite this knowledge they never developed anticipatory SCRs and continued to choose from the bad decks. The authors note that the results of the normal controls suggest non-conscious biases may guide behavior before conscious knowledge does.

Bechara, Damasio, Damasio, and Lee (1999) noted that patients with VM damage as well as patients with amygdala damage were impaired on the Gambling Task and both failed to produce anticipatory SCRs. Additionally, the amygdala patients were unable to develop SCRs to the actual punishment or loss of money. They concluded that the amygdala is crucial for attaching affective attributes to stimuli. Without proper amygdala functioning neither anticipatory nor conditioned SCRs are possible regardless of VM functioning. They conclude that the VM's function is to integrate all the somatic state information that has been supplied via the amygdala, hypothalamus, and brain stem nuclei. The VM then accounts for the numerous and possibly conflicting rewards and punishments previously encountered. If the negative somatic states accounted for by the VM are greater than the positive ones, the amygdala is reactivated to produce an anticipatory SCR before a selection from one of the bad decks.

Bechara, Tranel, and Damasio (2000) attempted to determine the nature of VM patients' poor decision-making on the gambling task. They note three possibilities: (1)

insensitivity to punishment, (2) hypersensitivity to reward, or (3) insensitivity to future consequences. In order to test these possibilities the authors developed a variant of the gambling task that reversed the reward and punishment schedules. They administered this measure while completing SCR recordings and concluded that among VM patients neither hypersensitivity to reward nor insensitivity to punishment account for the poor performance. The VM patients' decision-making was marked by a general unresponsiveness to future consequences, good or bad, and instead their decisions were controlled by a situation's immediate prospects.

Bechara, Damasio, Tranel and Anderson (1998) noted two possible mechanisms for this insensitivity to future consequences. One possibility suggests a deficit in working memory, implicating the DL. Under this model, working memory storage is insufficient to allow consideration of all the scenarios, possible actions, and possible outcomes, for the required amount of time to reach the advantageous decisions. The second model they forward invokes the somatic marker hypothesis. Under this model, working memory would be stable but the representations of possible outcomes expected from specific actions would fail to be "marked" as negative or positive. Without this "marking" the possible action options are not easily accepted or rejected and the reliance on immediate prospects predominates.

Bechara et al. (1998) attempted to distinguish between these two possibilities by demonstrating a complete double dissociation between decision-making and working memory. Based on the performance of focal lesion patients, the study concluded that intact VM cortex was necessary for effective decision-making (as measured via the gambling task) but not efficient working memory (measured via a delayed response task). An intact DL proved necessary for working memory functioning but not decision making, however working memory impairments did negatively influence gambling task performance. The authors posit that effective decision-making may be partially dependent upon working memory, though is largely the result of the somatic marker.

Bechara et al. (1998) also address the role that impulsivity may play in the poor decision-making of these patients. While the authors concede the VM has been shown to be important in response inhibition (Fuster, 1989; Stuss, Gow, & Hetherington, 1992) they do not believe this is responsible for their patients' poor gambling task performance. They suggest that poor response inhibition would be represented by the inability to suppress previously rewarded responses and shift attention to the more advantageous decks. The authors use three findings to conclude that limited response inhibition does not account for the poor performance of VM patients on the gambling task. First, they noted their previous findings that VM patients have shown no abnormal perseverative behavior or attentional deficits on traditional neuropsychological measures. Second, VM patients switched decks following a punished response, similar to the actions of healthy controls. Third, the VM patients were not impaired on the delay tasks that have shown some sensitivity to response inhibition. They conclude, "the ability to select an advantageous response from an array of response options is probably distinct from working memory, from response inhibition, and from selective attention" (p.428).

Though Bechara et al. (1998) dismiss deficient response inhibition as the cause of the decision-making deficits, Bechara, Tranel, and Damasio (2000) differentiate between what they term motor impulsiveness and cognitive impulsiveness. Motor impulsiveness is marked by continuing to respond to a previously rewarded response when it is no longer rewarded, this is the type of response inhibition that Bechara et al. (1998) made their conclusions upon. Bechara et al. (2000) noted that motor impulsiveness is measured by Go/No-Go and OA tasks and is seen clinically when individuals fail to change their responses despite being able to verbally report that contingencies have changed. Bechara et al. (1998) and Rolls (2000) both report this type of behavior in lesion patients, however Bechara et al. (2000) noted that this type of deficit appears specific to individuals whose damage extended either to the basal forebrain or more laterally into the orbitofrontal cortex.

Bechara et al. (2000) describe cognitive impulsiveness as an inability to delay gratification. It is this type of impulsiveness they ascribe as being most likely responsible for the poor gambling task performance of VM patients. They note that the VM patients appear unable to delay gratification and are marked by chronic seeking of reward and the tendency to quickly return to disadvantageous decks that provide high immediate reward despite greater future losses. They conclude that deficiencies in the somatic marker system would result in the failure to suppress seeking of immediate reward in the face of delayed punishment.

No published imaging information regarding the Bechara Gambling Task is available at this time. However, Rogers et al. (1999b) provided regional cerebral blood flow (rCBF) measures on 8 healthy male participants during completion of a risk-taking task which forced choices between small, likely rewards and large, unlikely rewards. They report that the resolution of these decisions was associated with increased rCBF within the OF while no significant differences were noted in the DL. The authors assert that this finding supports the notion that the OF area is involved in choosing between responses options via ambiguous or conflicting information, a task similar to both the Bechara gambling task and much of everyday decision-making. Grant, Contoreggi, and London (2000) note preliminary unpublished data that performance on the Gambling Task correlates equally with regional glucose metabolism in both the VM and the amygdala. Adolphs et al. (2000) demonstrated that epilepsy patients with electrodes implanted in the VM cortex demonstrated increased electrophysiological activity during the period before choosing a card.

Several studies have investigated gambling task performance among drug abusing populations (Grant, Contoreggi & London, 2000; Petry, Bickel, & Arnett, 1998; Mazas, Finn, & Steinmetz, 2000; Bechara et al., 2001) and have concluded that cocaine, opiate, alcohol, and methamphetamine abusers all demonstrate poor performance on the task. As functional neuroimaging studies have demonstrated abnormalities in the VM cortex of cocaine and alcohol abusers (Hommer et al. 1997; Volkow et al. 1991), Bechara et al. (2001) suggest that a decision-making deficit in the VM cortex may contribute to addiction. They note that the question regarding whether the use of drugs contributes to this poor performance remains unanswered. The authors also noted that performance on intelligence and memory tests, as well as the WCST, were unable to predict gambling task performance among drug-abusing populations. Furthermore, depression and anxiety scores as well as age, gender, and education did not show significant correlations with gambling task performance (Bechara et al. 2001).

OF Functioning and Psychopathy

Both Rolls (1998, 2000) and Damasio (1994) provide coherent, reasonably supported arguments for the generation of psychopathic-like symptoms among cases of documented brain injury to the OF region. While this study will be unable to directly test these theories against one another, it will attempt to test their common neuroanatomical correlate, the OF region. This study will investigate the performance of measures related to OF functioning among an incarcerated population in an attempt to validate the claim that dysfunction in the OF cortex will be related to symptoms of psychopathy. To date only minimal empirical data has been collected to investigate this claim.

LaPierre, Braun, and Hodgins (1994) compared 30 psychopathic inmates to 30 non-psychopathic inmates. Inmates with a PCL-R score of 30 or greater were placed in the psychopathy group while those with a score of 20 or less were placed in the non-psychopathy group. Sensorimotor handicaps, neurological dysfunction, and psychosis were exclusionary criteria. The two groups were reported to be equivalent in age, education, and socioeconomic status prior to incarceration. Additionally, the groups showed no significant differences in daily cigarette intake while in prison or alcohol intake before incarceration. In order to investigate OF functioning the authors administered two tasks believed to be sensitive to this area: (a) a visual Go/No-Go discrimination task, and (b) the Modular Smell Identification Test (Doty, Shaman & Dann, 1984). The findings indicated that the psychopaths committed significantly more commission errors on the Go/No-Go task and performed significantly worse on the olfactory identification task. These differences existed despite the groups' similarity on demographic variables as well as comparable performances on additional administered measures (WCST, a mental rotation task, and the Similarities subtest of the Ottawa-Wechsler Intelligence Scale) that were not believed to be related to OF functioning.

Roussy and Toupin (2000) investigated the performances of 25 juvenile psychopaths and 29 juvenile non-psychopaths (as categorized by the PCL-R) on measure of DL and OF functioning. The participants were all French-Canadian incarcerated males between the ages of 14 and 18. The authors defined the WCST, the COWAT, and the Porteus Maze Test (quantitative score) as measures of DL functioning. They utilized the Modular Smell Identification Test, a stopping task modeled off the Stop-Signal Task, the Porteus Maze Test (qualitative score), and a Go/No-Go task as OF measures. The results indicated that psychopaths and non-psychopaths did not differ significantly on measures of DL functioning, however the psychopaths demonstrated significantly worse performance on both the Go/No-Go task and the Stopping task. The Porteus Maze Test qualitative score approached significance (p =.06) with performance in the expected direction. The Modular Smell Identification Test did not produce significant results.

Schmitt, Brinkley, and Newman (1999) assessed the performance of 157 male offenders on the Bechara Gambling Task. The authors created three groups out of their sample. Those individuals who scored at 20 or below on the PCL-R were denoted as controls, those who scored between 20 and 30 were classified as the middle group, and those who scored above 30 were placed in the psychopathy group. The authors broke the card selections into 5 blocks of 20. Although the somatic marker hypothesis would predict a group by block interaction, which would indicate an inverse relationship between psychopathy and risk aversion, no such effect was found. The authors reported a significant block effect indicating decreased risky selections over the course of the test. Next, the authors presented a regression analysis using the number of risky selections in the last 50 trials as the criterion variable. Psychopathy was able to account for only 0.1% of the variance, a non-significant finding. Anxiety, however, accounted for 5.7% of the variance. European-American offenders showed a positive correlation between anxiety and risk aversion. African-American offenders displayed the inverse relationship. The authors noted several possible limitations to the study that may have contributed to the lack of significant findings between the psychopathic groups. First, they note that a non-incarcerated, non-criminal group of controls may show greater risk aversion and hence produce a significant difference. Second, the authors noted that their gambling task was modified to computer use, possibly removing some of the realism of the actual card-using task. They note their modified version used real money and hence significantly lower reward and penalty values which may have lowered risk aversion (Decks A and B yielded $0.10 per rewards and $0.15 to $1.25 per penalty and decks C and D yielded $0.05 per reward with penalties ranging from $0.03 to $0.25). Finally, they noted their task administration directions made no note of possible win-loss differences between decks.

Chang (1998) utilized the Bechara Gambling Task in a study of male adolescents. In this study 30 conduct-disordered adolescents who had been court-referred to residential facilities due to chronic offending were compared to 30 adolescents controls. In this study the Gambling Task did achieve significance (p = .036) in the expected direction, however when Bon Ferroni correction was applied the finding no longer reached significance. This finding was further complicated by a 9-point difference (CD less than non-CD) in mean Verbal IQ between the two groups. Nonetheless, the author does note that the CD group chose more frequently than the non-CD group from deck A, which was characterized by high reward amounts and high punishment frequency. The non-CD group chose more frequently from deck D, which was characterized by low reward amounts and low punishment frequency. The pattern suggests the CD group was more responsive to reward, and less sensitive to punishment cues, however it is not identical to the pattern seen among Bechara and Damasio's VM patients.

Dinn and Harris (2000) presented a study that investigated the neuropsychological performance of 12 adult male volunteers (from a sample of 65) who responded to a newspaper advertisement designed to attract individuals with APD. These individuals were diagnosed with APD via the DSM-IV. Each of these individuals were administered the PCL:SV (mean total score = 18.5, SD = 1.24), with the authors noting they all demonstrated core psychopathic personality traits. Ten male participants matched for age, education level, handedness and gender served as controls (PCL:SV mean total score = 3.4). Current use of psychotropic medications or illicit substances was noted exclusion criteria, as was history of traumatic head injury or central nervous system pathology. The investigators administered five cognitive tasks. In order to investigate OF functioning the authors administered an OA task, the Stroop color-word test, and a Go/No-Go task. Additionally, they administered the COWAT and a divergent thinking task, both of which they asserted were unrelated to OF functioning. The authors reported significant differences on the OA task and the Stroop task interference trial, with the APD group demonstrating significantly poorer performance than the control group. The authors were not able to demonstrate a significant difference for the Go/No-Go task. As predicted, the APD group did not show significant performance deficits on the COWAT or divergent thinking task. The APD group also produced significantly lower mean SCR amplitudes to visually presented aversive words. The authors noted that study limitations included the very limited sample size and a lack of information regarding the socioeconomic status of the participants, but conclude the results do present evidence for the involvement of OF functioning in psychopathy.

Blair, Colledge, and Mitchell (2001) presented comparisons between two groups of adolescent males on two measures believed to be related to OF functioning: the Gambling Task and the Intradimensional/Extradimensional (ID/ED) shift task. The sample consisted of 51 boy participants (aged 9-9 to 17-0, mean approximately 13 years of age) who had previously been labeled "too problematic for mainstream education" (p. 502) due to emotional and behavioral difficulties. Group membership was determined via the Psychopathy Screening Device (Frick & Hare, in press). Those who scored above 25 were included in the psychopathic tendencies group and those scoring below 20 were placed into the comparison group. No differences in age or Verbal IQ as measured by the British Picture Vocabulary Scale (Dunn, Wheklan, & Pintillie, 1982) were noted between the two groups. Since Gambling Task performance was found to be significantly positively correlated with age, ANCOVAs were completed when comparing groups. The psychopathic tendencies group was significantly more likely to choose cards from the disadvantage decks. A group by block interaction (5 blocks of 20 cards each) was also significant, indicating that psychopathic-like children were more likely to fail to avoid the bad decks than the comparison children.

The ID/ED task is a learning task that assess the ability to perform response reversals when reinforcement contingencies change (Intradimensional shift), a function attributed to the OF cortex. It also assesses the ability to shift responses based upon stimulus properties (shape to types of lines covering the stimulus), a function associated with DL functioning. On this task no significant group effects were noted on either index. The authors concluded that the pattern of results in this study suggest that psychopathy in children is not associated with generalized OF dysfunction but may suggest dysfunction in the amygdala – OF circuit, as suggested by the Gambling Task. They suggest that such dysfunction may cause the individual to become less sensitive to changes in reinforcement contingencies. This type of difficulty would explain why poorer performances were demonstrated on the more subtle or ambiguous Gambling Task but not on the more discrete and obvious reinforcement changes of the ID/ED task.

Mitchell, Colledge, Leonard, and Blair (2002) administered the Gambling and ID/ED tasks to a group of adult male inmates. 51 inmates participated (aged 21 to 50, mean of 33.06). Group membership was determined via the PCL-R. Those who scored at or above 30 were placed in the psychopathy group while the comparison group included those who scored below 20. No significant differences were found in age or IQ (as measured by the Raven's Progressive Matrices). A main effect for group was found on the Gambling Test, with the psychopathic group performing more poorly on the Gambling Task than the comparison group. A block by group interaction effect indicated that the comparison group became significantly more risk-aversive than the psychopathic group as the task progressed. As predicted on the ID/ED task, the psychopathic group demonstrated significantly greater errors on the response reversal component (ID shift), however no differences were demonstrated on the ED component. The authors stated that these results might indicate that relative to children, adult psychopaths may demonstrate greater dysfunction in the amygdala – OF circuitry and hence perform more poorly on the ID component of the ID/ED task. They suggest that this greater deficit may in fact be a developmental consequence of the disorder caused by long-term reduced afferent input to the OF from the amygdala, contributing to a deleterious impact on the responsiveness of the OF to changes in reinforcement contingencies. They suggest an alternative explanation; that the long-term drug use that is common in psychopathic adults may contribute to focal OF damage resulting in greater impairment in adults versus adolescents.

Gregory, Murphy, Clikeman, Tucker, and Carlson (2002) investigated the performance of 44 adolescent boys, between the ages of 12 and 17, on a variety of OF and DL measures. 25 treatment center residents and 19 community volunteers were administered the PCL-Youth Version. The participants' performances on four indices of OF functioning was measured, (1) odor identification, (2) Go/No Go performance, (3) Porteus maze qualitative score, and (4) Verbal Response Inhibition Sentence Completion Test (Burgess & Shallis, 1996). A canonical regression failed to demonstrate an association between psychopathy and OF functioning. Follow-up exploratory correlations revealed an association between psychopathy and verbal inhibition deficits ($r = .31$, $p < .05$). A canonical regression that included the WCST perseverative errors score and a verbal fluency measure did demonstrate a significant association between DL measures and psychopathy. The authors conclude that the findings indicate a complex relationship between adolescent psychopathy and generalized prefrontal dysfunction.

Despite the burgeoning amount of literature regarding OF dysfunction and psychopathy, no clear or consistent pattern of results have been demonstrated. Figure 3 provides a short review of each of the eight studies noted above. A simple tallying of results for and against the OF hypothesis indicates that two studies demonstrated unequivocal support, two studies demonstrated unequivocal refutations, and the remaining four studies demonstrated a mixed pattern. Although a wide variety of measures have been used as indicators of OF dysfunction none of these measures have consistently supported or refuted the OF hypothesis. Likewise, findings do not appear to be separable based upon the various samples. Four studies have utilized adolescents with three demonstrating mixed results and one failing to support an OF-psychopathy association. If, as Mitchell et al. (2002) suggest, the severity of OF dysfunction should be greater in adulthood, adult studies should demonstrate more consistent findings. This does not appear to be the case. Four studies utilized adults, of these studies, two supported the hypothesis, one refuted the hypothesis, and one was mixed. Comparisons of those studies involving forensic samples and those involving community samples fail to provide definitive conclusions. Four studies compared different groups of inmates,

Figure 3

Studies Investigating OF functioning in Psychopathic-Like Individuals

Study	Sample	OF Measures	Results
Lapierre, Braun, & Hodgins (1994)	Ex: 30 inmates (PCL-R ≥30) Co: 30 inmates (PCL-R <20)	Go/No-Go Commission errors Porteus Maze Qualitative score Modular Smell Identification	Psychopathic group performed more poorly on all three OF measures In order: d = 2.00, 1.62, .84 No differences found on non-OF measures (WCST, Similarities, Mental Rotation)
Chang (1988)	Ex: 30 CD adolescents Co: 30 adolescent controls	Gambling Task	A significant difference was reported before Bon Ferroni but not after this correction CD group performed worse than non-CD
Roussy & Toupin (2000)	Ex: 25 juvenile inmates (PCL-R ≥30) Co: 29 juvenile inmates (PCL-R<20)	Modular Smell Identification Go/No-Go Commission errors Stopping Task Porteus Maze Qualitative score	Ex group performed more poorly on Go/No Go and Stopping Task. (d = .65, .59) No significant differences noted on Smell, Porteus, or DL/"frontal diffuse" tasks (WCST, Porteus quantitative, COWAT)
Schmitt, Brinkley & Newman (1999)	Hi 38 inmates (PCL-R ≥30) Mid 68 inmates (>20 and <30) Low: 51 inmates (PCL-R ≤ 20)	Gambling Task	No significant differences in avoidance of risky selections. Psychopathy unable to account for a significant amount of variance in BGT

Figure 3 (continued).

Study	Sample	OF Measures	Results
Dinn & Harris (2000)	Ex: 12 APD volunteers (PCL-SV mean 18.5) Co: 10 matched volunteers (PCL-SV mean 3.4)	Object Alternation (trials to criterion) Stroop Interference (response latency) Go/No Go Commission (3 blocks)	APD group worse than controls on OA and Stroop (Color & Word Interference) In order: d = 2.43, 1.76, .31 No significant differences on Go/No-Go or COWAT. APD group performed better on Divergent Thinking Task.
Bair, Colledge, & Mitchell (2001)	Ex: 20 adolescents (PSD >25) Co: 23 adolescents (PSD <20) All Ss "too problematic for mainstream education"	Gambling Task Intradimensional/Extradimensional-Discrimination (ID/ED) Task	Ex group significantly less likely to avoid risky selections on the Gambling task No difference between groups on ID/ED
Mitchell, Colledge, Leonard & Blair (2002)	Ex: Psychopathic Inmates (PCL-R ≥30) Co: Non-psychopathic inmates (PCL-R <20)	Gambling Task (Ex: n=20 Co: n=20) ID/ED Task (Ex: n=15 Co: n=17)	Ex group significantly less likely to avoid risky selections on the Gambling task Ex group made significantly greater reversal errors on ID/ED task (d = 1.20)
Gregory, Murpy, Clikeman Tucker, & Carlson (2002)	Ex: 25 adol treatment center residents Co: 19 volunteers (Matched on age and SES)	Odor Identification Test Verbal Response Inhibition Go/No Go Test Porteus Qualitative Score	Psychopathy not associated with OF tasks Psychopathy was associated with DL tasks (WCST and verbal fluency). Analyses completed via canonical regressions.

two were supportive, one was mixed, and one refuted the hypothesis. Three studies utilized normal controls as the comparison group, of these studies one refuted the hypothesis and two provided mixed findings. This base of literature does not appear to lend itself to many firm conclusions. It seems likely that OF dysfunction may play some role in the psychopathic symptomatology of at least some individuals but this is clearly not a simple relationship. A more complicated relationship may exist but has yet to be uncovered. The current study design, as discussed ahead, was an attempt to investigate one of the possible complications in this relationship.

Neuroimaging

Neuroimaging techniques have also been brought to bear on the issue of prefrontal dysfunction among violent and psychopathic behavior. Raine, Lencz, Bihrle, LaCasse, and Coletti (2000) presented MRI findings regarding prefrontal gray matter volume in individuals diagnosed with APD. The study concluded that the APD group (consisting of "uninstitutionalized, antisocial, violent persons with psychopathic-like behavior" (p.125)) demonstrated 11% less prefrontal gray matter volume than a control group, 13.9% less volume than a substance-dependent group, and 14.0% less than a psychiatric control group. The authors presented Cohen's d effect sizes as 0.76, 0.78, and 0.84 respectively. The ratio of prefrontal gray matter to whole brain volumes show similar effect sizes, d= .83, .76, and 1.1. The authors also demonstrated that individuals with APD who demonstrated the volume reductions showed lowered skin conductance activity during a social stressor than those without reduced prefrontal volumes. The authors further noted that in the APD group, the prefrontal and autonomic deficits were independent of psychosocial risk factors as demonstrated by logistic regression. Unfortunately the authors were unable to further differentiate the prefrontal cortex into smaller subdivisions, though they predicted future research may demonstrate that the OF region would reveal the greatest volumetric reductions while the DL region would be relatively spared.

Raine, Stoddard, Bihrle, and Buchsbaum (1998) compared PET scans of 24 murderers who were pleading not guilty by reason of insanity with 41 PET scans of age- and sex-matched controls during completion of a continuous performance test. It should be noted that this sample presents a very specific group and the generalizability of these findings is likely to be very tenuous, nevertheless, the investigation did present some interesting preliminary findings. The authors compared normal controls, murderers who displayed affective or impulsive violence, and murderers who demonstrated more planned or predatory violence. The authors hypothesized that relative to controls (N=41) those offenders characterized by impulsive violence (N=9) would demonstrate lower prefrontal activity, higher subcortical activity (amygdala, hippocampus, midbrain area, and thalamus), and lowered prefrontal/subcortical ratios than normal controls. Offenders marked by predatory violence (N=15) were hypothesized to show more normal brain functioning. The results supported the hypothesis involving the affectively violent offenders, and while the predatory offenders demonstrated normal prefrontal cortex functioning, they did exhibit greater right subcortical activity relative to controls. The authors suggest that these results may indicate that the sufficient prefrontal functioning of predatory offenders works to modulate an aggressive predisposition, created through increased subcortical activity, in such a way as to manipulate others and achieved desired goals. The impulsive offenders, hampered by reduced prefrontal functioning, lack this modulation resulting in less goal-oriented and more dysregulated outbursts. Their conclusion has been echoed by Davidson, Putnam, and Larson (2000) who propose that the OF and its dense interconnections with other prefrontal cortical zones and the amygdala modulates negative emotion and the impulsive, aggressive outbursts which spurn from them. Davidson et al. (2000) implicates serotonergic abnormalities in the OF as an important possible mechanism responsible for the dysregulation seen in individuals displaying impulsive aggression.

The Partial Psychopath

A review of the current literature clearly indicated that the number of investigations that have analyzed the relationship between OF functioning and psychopathy is rather limited. Furthermore, the results of these studies appeared somewhat tenuous. Nonetheless, it appeared safe to conclude that the early results do not rule-out the possibility of OF dysfunction among samples of incarcerated individuals or developmental psychopaths. Unfortunately, all the studies to date ignore potentially crucial information regarding the symptom profiles of their samples and how they may relate to OF functioning. As noted by Hare (1998) "Many clinicians and researchers have noted that some behavior of frontal patients (e.g. impulsivity, recklessness, irresponsibility) are common in psychopaths, but the differences between these patients, sometimes referred to as 'pseudopsychopathic,' and psychopaths typically are as important as the similarities (p.119)." While there has been a long-standing distinction between the symptom profiles of developmental psychopaths and the symptom profiles of acquired psychopaths (sometimes referred to as partial psychopaths), a comprehensive detailing of these distinctions had not been offered until now. Perhaps the variability found in both groups hampered previous attempts to provide clear distinctions, but some patterns are clearly apparent.

Disinhibition and impulsivity are certainly evident in both of these groups and are likely responsible for producing a large degree of the symptom similarities between these groups. Hare (1998) suggested that the brain mechanisms, which underlie the behavioral components of impulsivity and disinhibition found in the partial psychopath, might be particularly helpful in understanding the aspects of psychopathy both groups share. He suggested these two components are reflected in the following PCL:R criteria: impulsivity, poor behavioral controls, need for stimulation/boredom, susceptibility, lack of realistic long-term goals, and irresponsibility (Hare, 1998). Though the existence of a parasitic life-style is not specifically noted in Hare's grouping, the previously noted case studies did describe individuals with OF damage that often became unable to financially support themselves and instead relied on the financial support of others for room and board.

While these behavioral symptoms appear universal across both groups, it is evident that the emotional symptoms share both similarities and differences. As previously noted the partial psychopath does display the characteristic lack of remorse, shallow affect, and lack of empathy that is seen in the developmental psychopath. Although some case studies of partial psychopaths have provided descriptions of euphoria and grandiose beliefs about current or future plans, they have not provided any indications of an inflated sense of self-worth, a cardinal characteristic of the developmental psychopath (Hare, 1998). Also missing in these descriptions is the attribution of superficial charm or glibness that is accorded the prototypical developmental psychopath. In fact, the partial psychopath is often described as coarse or socially unsophisticated, and lacking poise (Cleckley, 1982, Miller, 1987).

One of the most widely accepted distinctions between these groups relates to styles of aggression. The commission of violent and aggressive acts is not requisite criteria for a psychopathy diagnosis, though they are certainly more commonly demonstrated by both developmental and partial psychopaths than normal controls (Cleckley, 1982; LaPierre, Braun & Hodgins, 1994). Despite the increased incidence of aggression in both psychopathic groups, the types of aggression demonstrated appeared quite distinct. While the developmental psychopath is generally seen as partaking in instrumental aggression against individuals in order to further his/her own gains, the aggression most often described in acquired psychopathy appears reactive and stress-related often with little goal-direction (Hare, 1988; Blair & Cipolotti, 2000). In further analyzing the PCL:R criteria and noting the previously stated conclusions by Raine et al. (1998) it appears likely the criteria of pathological lying, and conning and manipulation may adequately capture this difference between instrumental and reactive aggression.

Figures 4 and 5 present breakdowns of the PCL:R and PCL:SV items within the Cooke and Michie (2001) three-factor model and note the absence or presence of each item in prototypical examples of both the development and the partial psychopath. The

Figure 4

<u>Symptom Constellations for Developmental Psychopathy and Partial Psychopathy on the PCL:R.</u>

	Developmental:	Partial:
Factor 1: ADI		
Glibness/Superficial Charm	Present	Absent
Grandiose sense of self-worth	Present	Absent
Pathological Lying	Present	Absent
Conning/manipulative	Present	Absent
Factor 2: DEA		
Shallow affect	Present	Present
Callous/lack of empathy	Present	Present
Lack of remorse or quilt	Present	Present
Failure to accept responsibility	Present	Present
Factor 3: IIB		
Need for stimulation/boredom	Present	Present
Impulsivity	Present	Present
Irresponsibility	Present	Present
Parasitic Lifestyle	Present	Present
Lack of realistic, long-term goals	Present	Present

Figure 5

Symptom Constellations for Developmental Psychopathy and Partial Psychopathy on the PCL:SV

	Developmental:	Partial:
Factor 1: ADI		
Superficial	Present	Absent
Grandiose	Present	Absent
Deceitful	Present	Absent
Factor 2: DEA		
Lacks Remorse	Present	Present
Lacks Empathy	Present	Present
Doesn't accept responsibility	Present	Present
Factor 3: IIB		
Impulsive	Present	Present
Poor Behavioral Controls	Present	Present
Lacks Goals	Present	Present
Irresponsible	Present	Present

figures led to an interesting conclusion. The prototypical partial psychopath, who is identified by OF injury, fulfills all the criteria for the DAE and IIB factor, but none of the criteria for the ADI factor. Given this distinction, it appeared likely that OF dysfunction, as measured by cognitive performance, would specifically account for the DAE and IIB symptoms but not the ADI symptoms. Such a distinction had not been investigated previously. The design of earlier studies was posited as limiting the ability to demonstrate strong associations between performances on OF measures and psychopathy, as based upon global scores.

It was further noted that different symptom profiles among psychopaths might reflect different neurological involvements. Individuals who exhibit high DAE and IIB scores, but lower ADI scores were hypothesized to more specifically reflect OF dysfunction. These individuals may present as less socially successful and generally more inept than individuals who exhibit higher ADI symptoms and retain the social and planning skills needed to demonstrate more sophisticated criminal pursuits marked by favorable goal attainment. OF dysfunction may in fact explain the distinction seen by Raine et al. (1998) in which affective murderers, marked by impulsive dysregulation demonstrated lower prefrontal glucose metabolism relative to comparisons, but predatory murderers who retained the ability to plan and regulate aggressive behavior, evidenced prefrontal functioning equivalent to comparisons. Interestingly, Cooke and Michie (2001) noted a personal communication with Tiihonen and colleagues who reported right amygdala volume correlated significantly more highly with the ADI factor score than either the

PCL:R Factor One score or total score. Unfortunately no data is noted regarding correlations with the other factor scores.

Hypotheses

Psychopathy is clearly a very complicated syndrome and a mountain of research suggests it is likely to have multiple contributory antecedents both in the neurologic and the psychosocial realm. The variability in symptom profiles and behavioral correlates, as well as distinctions in psychopathy classifications (primary versus secondary, violent versus non-violent, affective-impulsive versus predatory) also suggests important intra-group differences that are likely to be differentially influenced by this complex interplay of contributory factors. The argument presented in this introduction led to the investigation of the following hypotheses:

1. The Cooke and Michie (2001) three-factor solution would be replicated in this incarcerated population.

2. Cognitive measures related to OF functioning would demonstrate a greater relationship to the DAE and IIB factor symptoms than would non-OF related measures.

3. The OF related measures would demonstrate greater clinical relevance than non-OF related measures as indicated by a stronger empirical relationship to institutional infractions.

4. A subgroup of offenders marked by high DAE and IIB scores and low ADI scores would demonstrate greater OF dysfunction than those who demonstrate high scores across all three factors.

METHOD

Participants

Participants consisted of 100 male inmates detained at the Grayson County Jail. The participants ranged in age from 18 to 51 and were incarcerated for a variety of offenses.

Exclusion criteria included limited reading skills as well as any hearing, vision, or physical difficulties that may have interfered with completion of the interview, cognitive tasks, or symptom-surveys.

Apparatus

Computer-administration of neuropsychological measures was performed via a 166 Mhz, Pentium II, Compaq Presario laptop computer with a 12-inch monitor. Non-computer-administered cognitive tasks used standard administration apparatus.

Measures

The measures used fell into three categories: (1) cognitive measures related to OF functioning, (2) cognitive measures not associated with OF functioning, and (3) symptom-based measures. OF measures included the Cross-Cultural Smell Identification Test™ (CC-SIT™) (Sensonics, Inc., Haddon Heights, NJ, www.sensonics.com), a test of facial emotional expression identification, the Stop-Signal Task, a visual object discrimination task, and the Bechara Gambling Task. Non-OF based measures included the Wechsler Abbreviated Scale of Intelligence™ (WASI™) (Psychological Corporation, San Antonio, TX, www.psychcorp.com), the Wechsler Memory Scale®-Third Edition (WMS®-III) (Psychological Corporation, San Antonio, TX, www.psychcorp.com) Spatial Span subtest, the COWAT, and the Wide Range Achievement Test™ – Third Edition (WRAT™-3) (Psychological Corporation, San Antonio, TX, www.psychcorp.com) Reading subtest. The WCST was also administered, however since its relationship to OF functioning remains in dispute (Freedman, Black, Ebert, & Binns, 1998) it was not placed in either group. Symptom-based measures included the

PCL:SV, the Welsh Anxiety Scale (WAS), the Center for Epidemiological Studies-Depression Scale (CES-D), and the Wender Utah Rating Scale (WURS). Additionally, the Michigan Alcoholism Screening Test (MAST) and the Drug Abuse Screening Test (DAST) were administered.

Cross-Cultural Smell Identification Test (CC-SIT)

Rolls (1998) description of the OF cortex noted that olfactory representation is one of the many functions attributed to this area. Tanabe, Yarita, Iino, Ooshima, and Takagi (1975) exhibited that bilateral lesions to the OF cortex in monkeys was associated with significant deficits in olfactory discrimination. Potter and Butters (1980) reported on four patients with OF lesions who displayed severe impairment on an odor-quality discrimination task as compared to normal controls. They noted that this impairment was specific to the nostril ipsilateral to the OF lesion. Gotman and Zatorre (1987) completed an investigation of olfactory identification abilities by using the University of Pennsylvania Smell Identification Test (UPSIT; Doty, Shaman, & Dann, 1984) among patients with focal cerebral excisions. Their study found that compared to normal controls significant olfactory identification impairment was found in patients with unilateral excision in the temporal lobe or OF. These impairments were found despite each patient group obtaining normal olfactory detection thresholds; the noted deficits were therefore not the result of a simple sensory impairment. The authors reported that those patients with an OF excision demonstrated the most impaired discrimination performance and concluded that the OF may be essential for complex olfactory processing, especially discrimination.

The current study will utilize the CC-SIT (Doty, Marcus, & Lee, 1996). This is a 12-item "scratch and sniff" task to assess smell discrimination. The CC-SIT provides gender and age-corrected norms to account for age-related declines in smell thresholds. The CC-SIT items were selected from the UPSIT, and the UPSIT normative sample of 3760 participants was utilized to provide the normative data on the CC-SIT. The CC-SIT demonstrated a test-retest reliability of .71 (Doty et al. 1996). The 12 items consist of banana, chocolate, cinnamon, gasoline, lemon, onion, paint thinner, pineapple, rose, soap, smoke, and turpentine, and were selected based on their universal identification by individuals of North American, European, South American, and Asian cultures. Standard administration procedures was followed with the exception that each item booklet was be utilized twice. The approximately one inch strip was divided in half with each side being used by one participant. Although this negated the use of normative data it was hoped this strategy would not produce any significant decreases in the measures validity or reliability.

Facial Expression Identification

The use of facial expression identification as a measure of OF functioning derives from Rolls (1998) discussion of OF neuroanatomy. Rolls (1998) reported the existence of neurons in the OF which responded to faces and more specifically to face movements or gestures. Rolls suggests that the importance of these neurons is to be able to decode social reinforcement by facial expression, thus allowing one to appropriately alter his/her behavior based upon social feedback. Hornak, Rolls, and Wade (1995) completed a study of facial expression identification among patients with OF damage that exhibited socially inappropriate behavior. When compared to normal controls as well as a brain injured group with damage outside the OF who did not show socially inappropriate behavior, the OF group was significantly more impaired on the facial expression identification task. Nine of the 12 OF patients were severely impaired (1.96 standard deviations from the mean, $p < .01$) whereas only 1 of the 11 non-OF patients demonstrated severe impairment (one additional patient demonstrated impairment at the $p < .05$ level). Their findings indicated that these deficits were impaired even though the ability to recognize the identity of faces remained intact, a finding which agrees with previous studies (Humphreys, Donelly, & Riddoch, 1993; Young et al., 1993). Hornak, Rolls and Wade (1995) concluded that the expression identification deficits are not simply the result of basic perceptual difficulties but related more specifically to the emotional nature of the stimuli. The results further demonstrated that the poor performance of the OF patients on this task was associated with deficient performances on a measure of vocal expression identification and a visual discrimination and reversal task. Furthermore, the poor performances by these OF patients were associated with behavioral problems marked by disinhibition.

An important consideration in interpreting the performance of this task is the existence of additional cortical areas that respond to facial expression. In primates, both the temporal visual cortex and the amygdala contain neurons which are responsive to face expression and have direct projections to the OF (Hornak, Rolls & Wade, 1995). Clearly, dysfunction on this task does not allow for an automatic attribution of the OF functioning as demonstrated by Calder et al. (1996) who documented dysfunction in facial emotional expression, especially fear expressions, following bilateral amygdala damage. Blair, Morris, Frith, Perret, and Dolan (1999) used PET recordings to demonstrate the enhanced activity of the right OF during exposure to angry facial expressions, though no such activity was noted for sad faces. The authors suggest that an angry facial expression maybe a particularly important social cue for behavioral extinction and response reversal.

The current study used a procedure similar to the one presented by Hornak, Rolls, and Wade (1995). Facial expression photographs from the Ekman and Friesen series (1975) were be presented on the computer monitor one at a time for 10 seconds. Four photographs of each of the following expressions will be presented: sad, angry, frightened, disgusted, surprised, happy, and neutral. Although the 28 photographs were presented in one block, they were organized into four blocks with each block containing one photograph of each expression. The presentation order within these four smaller blocks was random. As each photograph was presented the participant was asked to choose from a list of the seven adjectives which best describes the presented facial expression. Ekman and Friesen (1975) present the initial validation of these pictures and the percentage of correct judgements each photograph elicited. All the photographs used in this study demonstrated a correct answer rate of 90% or greater in the standardization sample.

Stop-Signal Task

Quay (1997) reported that Logan's stop-signal task is the "best test of 'pure' disinhibition, that is not compounded by reward seeking" (p.8). Since the task does not provide immediate feedback or reward the participant's attention is not shaped by the immediate environment but must instead be self-directed. The stop-signal task, which is computer-administered, requires the participant to complete two tasks at the same time. The first task is a go task in which the subject must discriminate between an X and an O with an appropriate keystroke. The second task is a stop task that occurs on 25% of the go-task trials. This task is indicated by a tone that is presented after the presentation of the letter. The tone is a signal to the participant to inhibit the prepotent response and make no keystrokes on that trial. Since the tone is presented only after the letter (or go-task) the participant must stop an operation (striking the correct key) already in process. The participant's ability to inhibit the response is then determined statistically by a race between the go task and the stop task.

Logan et al. (1984) likened this task to the check swing of baseball. As the pitch is delivered the batter identifies the pitch as having a good location to hit. The batter decides to swing at the ball and the motor commands are sent; the go-task. As the ball travels however the batter decides the ball is no longer in a good location. He decides not to swing and the command to inhibit or stop the swing is sent; the stop-task. In order for the batter to check his swing the inhibitory process must catch the go process. Thus the success of the inhibitory process is determined by the go-task reaction time or the latency of the response to the go signal and the stop-signal reaction time or the latency of the response to the stop signal. From this model it follows that deficient inhibition of the prepotent response can be a product of responding too quickly to the go signal or too slowly to the stop signal.

The stop-signal task uses a tracking procedure, which varies the delay between the go signal and the stop signal. The stop-signal delay is changed after each trial. If the participant was able to inhibit the prepotent response on a trial the delay is lengthened 50msec on the next trial. If the participant was unable to inhibit the response the delay is shortened 50 msec. The go reaction time, the stop-signal reaction time (SSRT) and the stop-signal delay determine the race. Over numerous trials this procedure converges on a mean delay in which the success rate for inhibition is nearly 50% indicating that at that delay the stop process and the go process finish at the same time, therefore the mean delay must represent the average point in time at which the stop task is completed. The mean delay ties the race and the winner is now a product of random variation. Since participants are able to stop the prepotent response on 50% of the trials at the mean delay, the go reaction time must be equal to the stop-signal delay and the stop-signal reaction time. The task allows a recording of both the mean go reaction time and the stop-signal delay, subtracting the two produces the SSRT. The longer the SSRT is the slower the inhibitory process (Logan, 1994).

A key distinction to be made in determining impulsivity as measured by the stop-signal task is to determine whether the inability to inhibit a response is caused by an overly quick go task process (indicated by a short go reaction time) or an overly slow stop task process (i.e. slow inhibitory processing, indicated by a long SSRT). Logan, Schachar and Tannock (1997) completed a stop-signal task study with 136 undergraduate students who's impulsivity level was rated by the Impulsivity subscale of the Eysenck Personality Inventory. The study showed that relative to low impulsive participants, high impulsive participants showed significantly longer SSRTs. This was the only significant difference between the groups. It suggests that the inability to inhibit responding among the high impulsivity group is a factor of poor inhibitory control not excessively quick prepotent responses.

Although the Stop-Signal Task has yet to be widely used in adult studies, it has been empirically investigated in several studies involving children with ADHD, another group with documented difficulties in response inhibition (Barkley, 1997). Oosterlaan, Logan, and Sergeant (1998) published a meta-analysis of eight studies, which concluded that, relative to controls, ADHD children demonstrated a significantly slower inhibitory process. Their analysis also indicated that deficient inhibition was apparent in children with Conduct Disorder, but not in those with anxiety disorders. An adult study completed by Wodushek and Neumann (2003) found that these significantly slower inhibition times also appeared among adults with ADHD relative to adults without ADHD. At this time, no imaging or lesion research appears to have been completed in regards to the Stop-Signal task. Its attribution as a measure of OF functioning has generally been made on the basis of Fuster's (1997) theory asserting that the localization of response inhibition resides in the OF.

As the Stop-Signal task can be somewhat confusing to participants, each administration consisted of two parts. The first section completed included the standard administration block and the first experimental block. After completion of this block each participant's data was scored and reviewed by the examiner. Feedback was provided to each participant regarding whether they had performed the task correctly or not. Additional explanation was provided to those who demonstrated any difficulties. The second section of the task, four experimental blocks, was then completed.

Visual object discrimination task

This task was largely based off the measure presented by Hornak, Rolls, Wade and McGrath (1994). This was a computer-administered task that generally replicated the previous measure, however responses required a keystroke rather than employing the use of a touch screen. Though the visual stimuli presented on this task were different than the one employed in the aforementioned study, the measure presented the same general task and performance expectations. A description of the task parameters is presented in the introduction.

Gambling Task

The previously described Bechara Gambling Task was also computer-administered. This measure was identical to the one presented in the introduction.

Wechsler Abbreviated Scale of Intelligence (WASI)

The WASI is a brief, valid, and reliable measure of intelligence that provides Verbal, Performance, and Full Scale IQ scores (VIQ, PIQ, and FSIQ respectively). The WASI is composed of four subtests, Vocabulary, Similarities, Block Design, and Matrix Reasoning. Each of these subtests is generally based upon their WAIS-III counterparts and was utilized on the WASI because they represent the subtests that presented the highest loadings on g (Wechsler, 1997). The Vocabulary subtest is a 38-item subtest in which participants are required to orally define visually and orally presented words. The Similarities subtest includes 22 items in which a pair of words is presented orally and the participant is asked to explain the similarity between them. These two tests make up the Verbal IQ score. The Performance IQ score is constructed based upon the Block Design and Matrix Reasoning subtests. Block Design requires the participant to replicate 13 printed two-dimensional geometric patterns within a specified time limit while utilizing two-color cubes. Matrix Reasoning presents 35 incomplete gridded visual maps that the participant must complete by the selection of one of 5 presented choices. The following psychometric data was presented in the WASI manual (1999). WASI subtest and IQ scores have demonstrated adequate test-retest reliability (adult average stability coefficients for subtest scores range from .77 to .86, IQ scores coefficients range from .87 to .92). The subtest scores also demonstrate strong correlations with their counterpart WAIS-III subtests (.88 for Vocabulary, .76 for Similarities, .83 for Block Design, and .66 for Matrix Reasoning). These significant correlations are also demonstrated for the IQ scores (.88 for VIQ, .84 for PIQ, and .92 for FSIQ).

WMS-III Spatial Span

The WMS-III Spatial Span subtest is composed of two parts; Spatial Span Forward and Spatial Span Backward. In Spatial Span Forward the examiner points to a series of blocks in a specific order and the participant is to reproduce the same series of blocks in the same order as the examiner, a task likely to test focused attention (WAIS-III/WMS-III Technical Manual, 1997). Spatial Span Backward requires reproducing the series of blocks in the opposite order that they were presented and more likely reflects spatial working memory (WAIS-III/WMS-III Technical Manual, 1997) that has been relegated to the DL (Courtney, Ungerleider, Keil, & Haxby, 1996). The technical manual reports an average reliability coefficient for this subtest of .79.

Benton Controlled Oral Word Association Test (COWAT)

The COWAT is a test of verbal fluency which requires the participant to recite, in 60 seconds, all the words they can recall which begin with a particular letter (Milner, 1964). This task is completed three times with new letters being provided on each occasion. Several versions of the test exist, one of which uses the letters F, A, and S, one with C, F and L and one with P, R, and W.

Milner (1964), Benton (1968), and Perret (1974) demonstrated that left frontal lobe lesion patients show decreased ability to list words on the COWAT. Ramier and Hecain (1970) found that right, non-frontal, lesions also produce a decrement in COWAT performance, however, those with right frontal lesions showed an even greater decrement. The authors concluded that verbal fluency relies on a verbal factor mostly dependent on the left hemisphere, as well as a spontaneity factor, which has been relegated to the frontal lobes bilaterally. DesRosier and Kavanagh (1987) reported good alternate form reliability for the COWAT CFL and PRW forms ($r=.91$, $p<.001$) and sufficient stability (CFL form $r=.91$, $p<.001$, and PRW form $r=.86$, $p<.001$). The COWAT is viewed as a diffuse measure of frontal lobe functioning and is not specific to the OF (Roussy & Toupin, 2000).

Wide Range Achievement Test – 3rd Edition (WRAT-3) Reading Subtest

The WRAT-3 Reading subtest consists of a list of 36 words of increasing difficulty which the participant must read aloud. The WRAT-3 manual allows for both a grade equivalent score and a standard score.

Psychopathy Checklist: Screening Version (PCL:SV)

The PCL:SV is a 12-item scale derived from the PCL:R. It is used as a shorter alternative to the PCL:R for the assessment or screening of psychopathy and is completed via a semi-structured interview and a file review. All scale items are rated on a 3-point scale: (0) not present, (1) possibly present, and (2) definitely present. The PCL:SV has demonstrated strong internal consistency and inter-rater reliability (weighted mean alphas = .84, interclass coefficients = .92; Hart, Cox, & Hare, 1995). PCL:SV scores have also demonstrated high correlations with the PCL:R (r = .80), and independent APD ratings (r = .70; Hart et al., 1995). Figure 2 provides the PCL:SV items and their respective factors for both the traditional 2 factor model and the Cooke and Michie (2001) three-factor model.

Center for Epidemiological Studies Depression Scale (CES-D)

The CES-D is a 20-item self-report symptom rating scale that assesses for depressed mood. Each item is rated by participants based on four choices: (a) rarely or none of the time (Less than 1 day), (b) some or little of the time (1-2 days), (c) occasionally or a moderate amount of time (3-4 days), and (d) most or all of the time (5-7 days). Radloff (1977) reported high internal consistency across three different samples with alpha coefficients near .85. Weissman, Sholomskas, Pottenger, Prusoff and Locke (1977) reported significant correlations between the CES-D and the Symptom Checklist 90® (SCL-90®) (NCS Pearson Inc., Bloomington, MN, assessments.ncspearson.com), the Raskin Depression Scale, and the Hamilton Rating Scale across five psychiatric groups (acutely depressed, recovered depressed, drug or alcohol dependence, and schizophrenia).

Welsh Anxiety Scale (WAS)

The Welsh Anxiety Scale (Welsh, 1965) of the Minnesota Multiphasic Personality Inventory – 2nd Edition is composed of 23 True/False items. The scale is purported to measure five factors of anxiety related symptoms, including mental efficiency, negative emotional tone, pessimism and loss of energy, interpersonal oversensitivity and schizoid mentation. Welsh (1965) provided a split half reliability estimate equal to .88. The WAS has been commonly used to measure anxiety among psychopaths (Lykken, 1957; Newman, Patterson, Howland, & Nichols, 1990; Smith, Arnett & Newman, 1992).

Wender Utah Rating Scale (WURS)

The WURS is a 61-item scale for adults to rate their childhood behavior in order to aid in the retrospective diagnosis of childhood ADHD (Ward, Wender & Reimherr, 1993). The items are rated on a five point scale: (1) not at all/very slightly, (2) mildly, (3) moderately, (4) quite a bit, (5) very much. Ward, Wender, and Reimherr (1993) reported that a cutoff score of 46 was able to correctly identify 86% of adult patients with ADHD, 99% of controls, and 81% of adult patients with depression. The authors also correlated WURS scores with a 10-item Parents' Rating Scale. They reported significant Pearson correlation coefficients for both the control participants, $r=0.49$ ($p<.0005$) and for ADHD participants, $r=0.41$ ($p<.0005$).

Michigan Alcoholism Screening Test (MAST)

The MAST (Selzer, 1971) is a 25-item self-report measure, which utilizes a "yes/no" format to measure behavioral consequences of chronic or problematic alcohol use. The MAST has demonstrated strong test-retest reliability in psychiatric samples ($r = .95$), which falls only slightly below its performance among non-clinical samples (Teitelbaum & Carey, 2000). Teitelbuam and Mullen (1998) presented a meta-analytic review of the MAST and concluded the measure demonstrates strong performance in the ability to identify individuals with alcohol-use disorders.

Drug Abuse Screening Test (DAST)

The DAST (Skinner, 1982) is a 28-item self-report scale, which uses a "yes/no" format to assess problems associated with drug use. The DAST has demonstrated strong internal consistency (alpha = .92; Skinner, 1982). Cocco and Carey (1998) and Staley and El-Buebaly (1990) reported adequate validity and reliability of the DAST in mixed samples of both psychiatric inpatients and outpatients. The DAST has been commonly used in studies involving various groups of offenders (Abracem, Looman, & Anderson, 2000; Saltstone, Halliwel, & Hayslip, 1994).

Wisconsin Card Sorting Test (WCST)

The Wisconsin Card Sorting Test is a measure of cognitive flexibility, problem-solving, and concept formation (Heaton, 1981). This test requires the participant to match response cards to four stimulus cards based upon a categorizing principle known only to the examiner. The first stimulus card displays a red triangle, the second, two green stars, the third, three yellow crosses and the fourth, four blue circles. Cards may be sorted according to color, number, or geometric shape. The participant is first required to sort by color. After each attempt the participant is informed whether he/she has matched correctly. After the participant has correctly matched 10 consecutive cards the sorting criteria switches to shape without warning. When the participant has successfully sorted 10 more cards the sorting principle again changes without warning, this time to number. This sorting principle returns to color after the participant has successfully matched 10 cards by number. The test is discontinued when the participant has completed 6 categories or has used 128 cards. Three dependent variables commonly used to identify brain dysfunction are the number of categories completed, perseverative responses, and perseverative errors. The number of categories completed refers to the number of sorting strategies (color, number, shape) that were properly identified on ten successive presentations. Perseverative response is defined as a response that would have been correct using the previous strategy. Perseverative errors are the perseverative responses that are also errors. (Not all perseverative responses are errors as some may be ambiguous responses, that is, responses that may match on more than one strategy.)

Several studies have indicated that patients with frontal lobe lesions show more impaired performance than patients with lesions in non-frontal areas (Bornstein, 1986, Milner, 1963 and 1964, Robinson, Heaton, Lehman, & Stilson, 1980). However, Mountain and Snow (1993) and Axelrod et al., (1996) concluded that while the WCST may be useful in detecting brain damage, its specificity to frontal lobe damage is limited. A wealth of imaging studies does support the notion that the WCST taxes functions of the DL (Berman et al.,1995, Berman, Zec, & Weinberger, 1986, Weinberger, Berman, &

Zec, 1986, Marceno, Coppola, Daniel, Zigun, & Weinberger, 1993, Rubin et al., 1991, Rezaiet al.,1993). However, image and lesion studies have also indicated the OF may be involved in some aspects of WCST performance (Freedman, Black, Ebert, & Binns, 1998). For this reason the WCST will not be considered as a comparison measure. Test-retest reliability estimates on the WCST show minimal values, as Lezak (1995) reports this is most likely due to the learning effect of the test and a suitable way of determining reliability of the WCST may not be available.

Head Injury Screen

Information relevant to head injury will be gathered via interview questions. Though significant drawbacks are inherent in this approach the extent of injury will be quantified on a 0 to 5 scale as presented by Goldstein (1998): (0) no history of head injury; (1) reported history of concussion symptoms such as dizziness, confusion, numbness, or nausea due to a head injury subsequent to a fall, sports-related injury, motor vehicle accident, or assault; (2) reported history of two or more incidents resulting in concussion symptoms; (3) history of head injury incident with questionable loss of consciousness such as the report of a memory loss for the event but the lack of hospitalization or treatment for altered consciousness; (4) history of definite loss of consciousness due to head injury as confirmed by participant or noted hospital treatment which confirmed loss of consciousness; (5) history of two or more head injuries with loss of consciousness.

Procedure

Participants were recruited via verbal solicitations by the primary researcher made to each of the general population pods of the Grayson County Jail. Those individuals that expressed interest and provided their name on a sign-up sheet were later brought to the testing room and presented an informed consent. Participants were informed that their participation in the study was completely voluntary and that they were allowed to discontinue participation at any time.

An initial screen was used to ensure the participants were between 18 and 55 years of age, had at least a 6th grade reading level (verified via the WRAT-3), and had no significant physical handicaps that would preclude their ability to complete the administered tasks and surveys. This screen also gathered basic demographic information as well as any history of psychological illness or neurological insult or injury for which the participant had been previously diagnosed. After obtaining informed consent, each testing session began with administration of the PCL: SV in order to help build rapport and engender motivation for completing the rest of the measures and surveys. The cognitive and symptom measures were organized into three administration blocks. Each block was ordered in a way thought most likely to engender cooperative and optimal effort. Inmates were never asked to complete more than 2 symptom checklists in a row. Cognitive measures were ordered such that researcher administered and computer administered measures were distributed throughout each block. The three blocks were completed as follows. Block 1 was ordered as Spatial Span, Vocabulary, Gambling Task, WAS, and the Smell Identification test. Block 2 was ordered as 1st run of Stop-Signal, WURS, 2nd run of Stop-Signal, Similarities, Block Design, MAST, DAST, and Facial emotional expression identification. Block 3 was ordered as Visual Discrimination, Matrix Reasoning, CES, COWAT, and the WCST. These blocks were presented in three different orders (1,2,3; 2,3,1; and 3,1,2) each order being completed by one-third of the sample. On most occasions the entire battery was able to be completed in one testing session, however on approximately 15 occasions the battery had to be discontinued due to conflicts with jail programming and were completed at a later time, generally within a few days of the first testing session. Each participant's file was reviewed in order to ascertain the current offense that had the inmate incarcerated, the number of convictions in Grayson County, and the number of institutional infractions.

RESULTS

100 inmate volunteers met inclusion/exclusion criteria and began the interview and testing process. The sample was 64% European-American, 23% African-American, 8% Hispanic, 3% Native American, and 2% Asian. The mean age for this sample was 30.9 years of age (SD = 8.7, Range = 18-51). Mean years of education was 11.4 (SD = 1.9, Range = 5-16). 32 participants reported a history of psychiatric diagnosis and 11 reported current psychotropic medication usage. Nearly the entire sample (95 participants) reported a previous history of substance use and 80 participants identified themselves as smokers. In terms of neurological insult, 62 participants reported a history of head injury or concussion and 9 participants reported a history of seizures. See Table 1 for further details.

Full batteries were obtained on 89 participants. Reasons for missing data included participants' inability to complete the smell test due to sickness or allergies, spoiled protocols due to misplaced item answers, and released or relocated inmates between testing sessions.

Table 1

Demographic Information for Full sample and Upper and Lower Quartiles of DAE+IIB

Demographics	Full Sample	Upper Quartile	Lower Quartile
Age	30.85 (8.66)	32.04 (8.29)	30.08 (8.54)
Years of Education	11.49 (1.93)	10.92 (2.18)	11.92 (2.12)
Ethnicity			
Caucasian	64	18	15
African-American	23	4	8
Hispanic	8	2	1
Native American	3	1	1
Pacific Islander	2	0	0
Psychiatric Diagnosis[1]			
ADHD	12	5	2
Major Depressive	15	2	4
Bipolar	10	5	3
PTSD	2	0	1
Schizophrenia	4	4	1
Generalized Anxiety	3	1	1
Drug Use			
Polysubstance Use[2]	74	22	13
Marijuana only	17	1	7
Cocaine only	3	1	0
Methamphetamine only	1	1	0
Head Injury			
No history	38	6	13
Concussion symptoms (1)[3]	10	1	3
Concussion symptoms ($\geq$2)[4]	4	0	2
Questionable LOC	8	2	1
Definite LOC	23	7	3
Definite LOC (>2)	18	9	3

[1]Participants may have had more than one diagnosis

[2] Most common substances in order (Marijuana, Methamphetamine, Cocaine)

[3] One occasion of symptoms induced by head injury [4] 2 or more occasions of symptoms

Factor Structure

The first analysis completed explored the factor structure of the PCL:SV. A confirmatory factor analysis (CFA) based upon the factor structure presented by Hill, Neumann, and Rogers (in press) indicated good fit for this three-factor model of psychopathy, $\underline{X}^2$ (32) = 55.84, $\underline{p} < .01$. Table 2 presents the standardized parameter and error/unique loadings. All hypothesized factor and error/unique loadings were significant (ps ranged from <.01 to .001). Strong goodness-of-fit was also demonstrated by a high comparative fit index (CFI = .928). CFI values greater than .9 are considered as demonstrating adequate fit (Dunn, Everitt, & Pickles, 1993). The standardized root mean square (SRMR) index also indicated good fit, SRMR=.069. SRMR values below .08 are indicative of good fit (Hu & Bentler, 1999). In this model, the ADI factor correlated significantly with both the DAE factor (.65) and the IIB factor (.16). The DAE and IIB factors were also significantly correlated (.50). A CFA utilizing the traditional Harpur, Hare and Hakistan (1989) two-factor model demonstrated poor fit; ($\underline{X}^2$ (53) = 110.172, $\underline{p} < .001$; CFI = .84, SRMR = .081).

A third CFA was completed that explored the factor structure of the PCL:SV and its relationship with IQ. This model was based upon the factor structure presented by Salekin and Neumann (manuscript submitted) and indicated good fit for this five-factor model of psychopathy and IQ, $\underline{X}^2$ (67) = 88.24, $\underline{p} < .05$. Table 3 presents the standardized parameter and error/unique loadings. All hypothesized factor and error/unique loadings were significant (ps ranged from <.01 to .001). Strong goodness-of-fit was also demonstrated by a CFI = .959 and a SRMR=.061.

Table 2

Factor Loadings and Uniqueness: Confirmatory Factor Model of PCL:SV

Items	Standardized Parameter Loading			
	ADI Factor	DAE Factor	IIB Factor	Error/Unique
1. Superficial	.850			.526
2. Grandiose	.765			.644
3. Manipulative	.367			.930
4. Lacks Remorse		.867		.499
5. Lacks Empathy		.853		.522
6. No Responsibility		.340		.940
7. Impulsive			.580	.815
8. Poor Beh. Cont.			.554	.833
9. Lacks Goals			.708	.706
10. Irresponsible			.883	.470

Note: All loading significant, $p < .01$-.001.
Correlations: ADI*DAE = .65, ADI*IIB = .16, DAE*IIB=.50

Table 3

Factor Loadings and Uniqueness : Confirmatory Factor Model of PCL:SV and IQ

Items	Standardized Parameter Loading					
	ADI	DAE	Factor 3	Factor 4	IQ	Error/Unique
1. Superficial	.814					.581
2. Grandiose	.799					.602
3. Manipulative	.369					.929
4. Lacks Remorse		.877				.480
5. Lacks Empathy		.843				.538
6. No Responsibility		.335				.942
7. Impulsive			.590			.807
8. Poor Beh. Cont.				.718		.696
9. Lacks Goals			.730			.684
10. Irresponsible			.867			.498
11. Adol Antisocial				.501		.865
12. Adult antisocial				.391		.920
13. Verbal IQ					.881	.473
14. Performance IQ					.615	.788

Note: All loading significant, p < .01-.001.
Correlations: ADI*DAE = .663, ADI*F3 = .167, ADI*F4 =.259, ADI*IQ = .218
DAE*F3 = ..481, DAE*F4 =.523, DAE*IQ = -.100, F3*F4 = .775,

Inter-rater Reliability

In order to assess reliability of PCL ratings, 12 interviews were completed in the presence of another rater (an advanced graduate student in clinical psychology with an emphasis in forensics). Overall inter-rater reliability was moderate as demonstrated by the PCL total score Pearson correlations, $r = .782$, $p < .001$. Table 4 presents the Pearson correlations for each PCL:SV item as well as the total and factor scores. All factor scores and individual items demonstrated Pearson correlations greater than .6 except for items 7 (Impulsive) and 9 (Lacks Goals). Except for item 7 (Impulsive), all items demonstrated significant correlations.

Composite Variables

An OF and a Non-OF composite variable were created in order to lower the number of variables used in further analyses. These composite variables were created by summing the standardized z-scores of their component variables. The OF variable composite was based on four measures, (1) number correct on facial expression test, (2) number correct on the smell-identification test, (3) commission errors on the visual discrimination task, and (4) number of disadvantage choices in the last 50 responses of the gambling task. For simplicity sake these variables will hereafter be referred to as FACES, SMELL, VDCOM, and GAMBLE, respectively. The Non-OF composite variable was based on three measures, (1) Spatial Span scaled score, (2) WRAT- 3 Reading subtest standard score, and (3) the COWAT raw score. These variables will be referred to as SPATIAL, READ, and FAS, respectively. Pearson correlations were used to investigate whether the component variables had any significant relationships to one another. Two significant

Table 4

Interrater Reliability (Pearson Correlations) for PCL Items, Factors, and Total Score.

Items & Factors	r	p
1. Superficial	.816	<.01
2. Grandiose	.822	<.01
3. Manipulative	.879	<.001
4. Lacks Remorse	.692	<.05
5. Lacks Empathy	.819	<.01
6. Doesn't Accept Responsibility	.603	<.05
7. Impulsive	.455	.137
8. Poor Behavior Controls	.771	.01
9. Lacks Goals	.589	<.05
10. Irresponsible	.634	<.05
11. Adolescent Antisocial Behavior	.875	.001
12. Adult Antisocial Behavior	1.000	<.001
1. ADI Factor	.893	<.001
2. DAE Factor	.818	<.01
3. IIB Factor	.687	<.05
4. DAE+IIB	.733	<.01
5. Total Score	.782	<.01

correlations were noted among the OF variables (FACES-GAMBLE r = -.212, p < .05; VDCOM-GAMBLE r = .216, p < .05.). Two significant correlations were noted among the Non-OF variables (READ-SPATIAL r = .252, p < .05; READ-FAS r = .311, p < .01). Table 5 presents the complete correlation matrix for these cognitive variables. Given the limited correlations between these variables, many analyses first investigated the composite variables and then the individual component variables of these composites.

Regression Investigations

The first set of analyses completed via multiple regressions, was designed to assess how well the variance in the IIB and DAE factor scores of the PCL could be predicted by demographic and cognitive variables. The first regression equation used the IIB score as the criterion variable. The following predictor variables were entered in a stepwise fashion: participant age, years of education, age at first crime, WASI FSIQ, OF composite, and Non-OF composite. Results of this regression demonstrated that age at first crime was the only variable that contributed significantly to the model. This variable (standardized beta = -.218) achieved significance, F (1, 90) = 4.26, $p < .05$, accounting for 3.7% of the variance (all variance estimates reported are adjusted R Squares). A regression that used the DAE variable as the criterion failed to demonstrate any variables that contributed significantly to the model. Additional regression equations used the sum of the DAE and IIB factor scores (DAE+IIB) and the PCL total score as criterion variables. In both equations, only age at first crime contributed significantly to the model. For the DAE+IIB score, age at first crime accounted for 3.6% of the variance

Table 5

Cognitive Variable Pearson Correlations

r (p)	Gamble	VDCom	Smell	Reading	Spatial	FAS
Faces	-.212 (.036)	-.085 (.406)	-.150 (.149)	.370 (.000)	.283 (.005)	.151 (.138)
Gamble		.216 (.031)	-.078 (.450)	-.252 (.012)	.030 (.773)	-.130 (.196)
VD Com			-.144 (.163)	-.083 (.415)	-.058 (.573)	.033 (.743)
Smell				-.040 (.699)	.056 (.595)	.060 (.559)
Reading					.252 (.012)	.311 (.002)
Spatial						.114 (.262)

Note: Faces = # correct. Gamble = # of disadvantageous choices in final 50 cards. VD Com = commission errors on visual discrimination task. Reading = WRAT-3 T-Score. Spatial = scaled score on Spatial Span. FAS = COWAT raw score.

(standardized beta = -.216, F (1, 90) = 4.17, $p < .05$). For the PCL total score, age at first crime accounted for 4.2% of the variance (standardized beta = -.230, F (1, 90) = 4.79, $p < .05$).

Regression analyses that utilized the individual components of the composite variables (FACES, SMELL, GAMBLE, VDCOM, SPATIAL, READ, and FAS) as dependent variables failed to identify any variables that could account for a significant portion of the variance of either the PCL total score or the DAE+IIB score. Table 6 reveals that no significant correlations between the OF variable components and the PCL total or the DAE+IIB scores were found.

The next regression analyses assessed how much variance of the various PCL scores could be predicted by symptom variables. The first regression equation used the IIB score as the criterion variable. The following predictor variables were entered in a stepwise fashion: the total scores on the DAST and MAST, the WURS 25-item score, the WAS total score, and the CES-D total score. For simplicity sake these variables will hereafter be referred as DASTOTAL, MASTOTAL WURS25S, WASTOTAL, and CESTOTAL. DASTOTAL (standardized beta = .436) achieved significance, F (1, 94) = 22.11, $p < .001$, most strongly, accounting for 18.2% of the variance. Following DASTOTAL, WURS25S (standardized beta = .288) was added to the model, F (1, 93) = 6.03, $p < .05$, accounting for an additional 4.1% of the variance. The two variable model accounted for 22.3% of the variance. A regression equation that used the DAE score as the criterion failed to identify any symptom variables that explained a significant amount

Table 6

PCL:SV Scores and Cognitive Variable Pearson Correlations

PCL:SV Scores and OF Cognitive Variable Pearson Correlations

r (p)	Gamble	VD Com	Smell	Faces
PCL:SV Total	.005 (.960)	.072 (.479)	.066 (.521)	-.078 (.443)
DAE+ IIB	-.022 (.830)	-.095 (.347)	.106 (.308)	-.151 (.140)

Note: Gamble = # of disadvantageous choices in final 50 cards. VD Com = commission errors on visual discrimination task. Smell = # correct. Faces = # correct.

PCL:SV Scores and Non-OF Cognitive Variable Pearson Correlations

r (p)	FAS	Reading	Spatial Span
PCL:SV Total	-.030 (.767)	-.058 (.569)	.000 (.999)
DAE+ IIB	-.105 (.301)	-.159 (.118)	-.055 (.590)

Note: FAS = COWAT raw score. Reading = T-Score on WRAT –3. Spatial = scaled score on Spatial Span.

of the variance. Regression equations that utilized the DAE+IIB score as the criterion indicated that only DASTOTAL (standardized beta weight=.322) contributed significantly to model $\underline{F}$ (1, 94) = 10.86, $\underline{p} < .01$, accounting for 9.4% of the variance. A regression that utilized the PCL total score as the criterion again indicated that the DASTOTAL (standardized beta weight = .317) contributed significantly to the model, $\underline{F}$ (1, 94) = 10.64, $\underline{p} < .01$, accounting for 9.1% of the variance.

The next multiple regressions investigated how well the variance in the participants' numbers of convictions could be predicted by demographic and cognitive variables. For the first regression the following predictor variables were entered in a stepwise fashion: participant age, years of education, age at first crime, WASI FSIQ, OF composite, and Non-OF composite. Results of this regression demonstrated that the OF composite was the only variable that contributed significantly to the model. This variable (standardized beta = -.271) achieved significance, $\underline{F}$ (1, 80) = 6.24, $\underline{p} < .05$, accounting for 6.1% of the variance. A regression that used the component variables of the OF composite variable (FACES, SMELL, GAMBLE, and VDCOM) as predictors of the number of convictions demonstrated that two variables contributed significantly to the model. FACES (standardized beta = -.345) achieved significance, $\underline{F}$ (1, 79) = 10.54, $\underline{p} < .01$, most strongly, accounting for 10.8% of the variance. Following FACES, GAMBLE (standardized beta = .233) was added to the model, $\underline{F}$ (2, 78) = 7.90, $\underline{p} <.01$, accounting for an additional 4.1% of the variance. The two variable model accounted for 14.9% of the variance. As expected, Pearson correlations demonstrated a significant negative correlation between FACES and number of convictions ($r = -.368$, $p < .001$), and a significant positive correlation between GAMBLE and number of convictions ($r = .283$, $p < .01$). A second regression that attempted to utilize the symptom variables (WASTOTAL, CESTOTAL, WURS25S, MASTOTAL, and DASTOTAL) to predict number of convictions was unable to demonstrate any variable that contributed significantly to the model.

This study originally intended to complete a regression equation to determine whether any cognitive variables would be able to explain a significant amount of the variance in participants' jail infractions. Unfortunately the infraction numbers were highly negatively skewed. 62% of the sample failed to commit any infractions, 23 % committed one infraction, 10% committed two infractions and the remaining 5% fell between three and ten infractions. The number of infractions did not significantly correlate with any cognitive variables. Number of infractions correlated with DASTOTAL ($r = .265$, $p < .05$) but no other symptoms variables. Number of infractions also correlated with several PCL values (total score $r = .293$, $p < .01$; DAE+IIB score $r = .323$, $p < .01$; IIB score $r = .271$, $p < .01$; DAE score $r = .274$, $p < .01$).

Group Comparisons of Cognitive Variables

In order to make group comparisons across the DAE+IIB score, those participants in the upper and lower quartiles of this score were placed into two groups. Independent samples t-tests failed to demonstrate any significant differences in age or education between the upper quartile (n=24) and lower quartile (n=22). A multivariate analysis of variance (MANOVA) failed to demonstrate any significant difference between these groups on the OF and Non-OF composite variables. A MANOVA that used each OF component variable (FACES, SMELL, VDCOM, and GAMBLE) also failed to demonstrate a significant difference. In addition, no significant difference was found for the Non-OF variable components (SPATIAL, FAS, and READ). MANOVA analysis also failed to demonstrate a difference for the WASIFSIQ, VIQ, or PIQ variables between these groups. Table 7 presents the means and standard deviations for each of the cognitive variables for the full sample, and the upper and lower quartiles.

MANOVA analyses were used to investigate whether the symptom variables (WURS25S, MASTOTAL, DASTOTAL, WASTOTAL, CESTOTAL) demonstrated a significant difference between the DAE+IIB groups. For the groups defined by the upper and lower quartiles, a significant difference was indicated $F\ (5, 42) = 4.58$, $p < .01$. Follow-up univariate ANOVAs demonstrated significant differences for WASTOTAL ($F\ (1, 46) = 4.93$, $p < .05$) and DASTOTAL ($F\ (1, 46) = 17.56$, $p < .001$), and WURS25S ($F\ (1, 46) = 17.56$, $p < .001$), all of which demonstrated higher scores in the upper quartile. Table 8 presents the means and standard deviations for each of the cognitive variables for the full sample, and the upper and lower quartile groups.

Next, MANCOVAs utilizing WASTOTAL as a covariate were conducted. WASTOTAL was used as covariate since it was significantly correlated with three cognitive variables: (1) Non-OF Composite (r=-.294, $p < .01$), (2) VDCOM (r=-.203, $p < .05$), and (3) SPATIAL ($r = -.369$, $p < .001$), but was not significantly correlated with the DAE+IIB score. The first MANCOVA failed to demonstrate a significant difference between the upper and lower quartile groups of the DAE+IIB score on the OF and Non-

Table 7

Cognitive Variable Means and Standard Deviations for Full Sample and Upper and Lower Quartiles of DAE+IIB score

Variable	Sample (N=100) Mean (SD)	Upper Quartile Mean (SD)	Lower Quartile Mean (SD)
WASI FSIQ	93.90(12.29)	93.16(12.10)	96.16 (9.57)
VIQ	89.81(11.91)	89.64(12.70)	91.12(10.29)
PIQ	99.34(13.40)	98.32(12.76)	102.16(10.52)
Vocabulary	42.45 (9.15)	41.12 (8.72)	43.48 (8.14)
Block Design	51.12 (8.52)	50.64 (9.10)	51.84 (7.52)
Similarities	42.31 (8.79)	42.04 (8.09)	44.2 (7.43)
Matrix Reasoning	49.10 (9.51)	49.52 (9.18)	51.32 (6.85)
FAS (Raw Score)	36.18(10.29)	34.44 (9.42)	37.40 (8.55)
WRAT-Reading	92.06 (9.74)	90.60 (9.22)	94.79 (8.83)
Spatial Span	9.14 (2.22)	9.25 (2.63)	9.33 (2.26)
Faces (# Correct)	21.42 (2.70)	20.88 (3.07)	22.00 (2.55)
Smell ID (# Correct)	10.10 (1.43)	10.36 (1.22)	9.87 (1.77)
Gamble	24.06 (9.00)	24.24 (8.56)	23.76 (7.31)
VD Com	4.10 (2.75)	4.96 (3.00)	4.08 (3.13)

Note: WASI Subtest scores are T scores. WASI IQ scores and WRAT-Reading are standard scores. Spatial Span is scaled score. Gamble = # of disadvantageous choices in last 50 choices. VD Com = # of commission errors.

Table 8

Symptom Variable Means and Standard Deviations for Full Sample and Upper and Lower Quartiles of DAE+IIB score

Variable	Sample (N=100) Mean (SD)	Upper Quartile Mean (SD)	Lower Quartile Mean (SD)
PCL Total	10.42 (4.55)	16.08 (2.47)	5.16 (1.91)
ADI Factor	1.26 (1.47)	2.28 (1.79)	.68 (1.07)
DAE Factor	1.59 (1.57)	3.52 (1.38)	.56 (.77)
IIB Factor	4.40 (2.30)	6.72 (1.02)	1.36 (1.11)
DAE+IIB	6.01 (3.25)	10.24 (1.23)	1.92 (1.11)
WURS (25-item)	41.69(20.09)	60.46(15.82)	37.08(19.78)
CES-D	22.85(12.11)	25.11(11.87)	19.60(11.50)
WAS	10.98 (5.42)	12.86 (5.22)	12.04 (4.97)
MAST	7.53 (5.42)	7.91 (5.07)	8.60 (5.50)
DAST	12.50 (6.45)	14.00 (4.84)	14.32 (4.85)

Note: All PCL and symptom inventory values are raw scores.

OF composite scores. A second MANCOVA that utilized the OF component variables (FACES, SMELL, VDCOM, and GAMBLE) as dependent variables also failed to demonstrate a significant difference. This was also true for MANCOVAs that used the Non-OF components (SPATIAL, FAS, and READ) and one that utilized VIQ, PIQ, and FSIQ.

The final set of primary analyses were designed to compare the group deemed most likely to demonstrate OF dysfunction with a group that demonstrated significant psychopathy symptoms but were deemed unlikely to demonstrate OF dysfunction. The first group was comprised of individuals who had DAE+IIB scores that fell in the upper quartile and ADI scores that fell below three (n=23). The second group demonstrated high DAE+IIB scores and ADI scores above three (n=9). Independent samples t-test analyses failed to demonstrate any significant group differences on any of the OF component variables (FACES, SMELL, GAMBLE, and VDCOM).

Supplementary analyses

As previously noted a significant correlation between the WASTOTAL scores and the VDCOM score was found. Earlier studies have indicated differences in task performances across high and low anxious subgroups (e.g., Newman, Howland, Patterson, & Nichols, 1990). Given these previous findings, a 2X3 ANOVA investigating the interaction between WASTOTAL and the DAE+IIB score across the OF variables were completed.   The WASTOTAL variable was broken into two groups (upper half and bottom half). The DAE+IIB score was divided into upper and lower quartiles and the middle half. No significant main or interaction effects were found.

Ethnicity Effects

The next set of analyses was conducted to identify possible effects of ethnicity. Each of the following analyses represents comparisons between two groups: European-American (n=65) and Non-European-American (n=35). Independent samples t-test demonstrated no differences in age or education. Further t-test analyses also failed to demonstrated significant differences on the PCL total score or the IIB+DAE score. MANOVA analyses failed to demonstrate a significant difference for the symptom variables (WURS25S, MASTOTAL, DASTOTAL, CESTOTAL, WASTOTAL). Table 9 presents means and standard deviations for these symptom variables in the full sample, European-American sample, and Non-European-American sample.

MANOVA analyses were also used to investigate possible differences between ethnic groups on the cognitive variables. MANOVA analysis of the OF component variables (FACES, SMELL, VDCOM, and GAMBLE) revealed a significant difference, F (4, 88) = 3.69, $p < .01$. Follow-up univariate ANOVAs demonstrated a significant difference for FACES F (1, 91) = 14.11, $p < .001$, with higher performance demonstrated in the European-American group. A significant difference was also found on a MANOVA investigating the Non-OF variable components (SPATIAL, READ, FAS) F (3, 92) = 4.26, $p < .01$. Follow-up ANOVAs demonstrated a significant difference for READ F (1, 94) = 7.78, $p < .01$, again the European-American group scored higher. Finally, MANOVA analyses also demonstrated differences in IQ scores F (3, 96) = 5.65, $p < .01$. Follow-up univariate ANOVAs demonstrated significant differences for VIQ (F (1, 98) = 5.68, $p < .01$), PIQ (F (1, 98) = 16.57, $p < .001$) and FSIQ (F (1, 98) = 13.41, $p < .001$), as

Table 9

Symptom Variable Means and Standard Deviations for Full Sample, European-American (n=65), and Non-European-American (n=35)

Variable	Sample (N=100) Mean (SD)	Caucasian Mean (SD)	Non-Caucasian Mean (SD)
PCL Total	10.42 (4.55)	10.71 (4.61)	9.88 (4.47)
ADI Factor	1.26 (1.47)	1.26 (1.51)	1.25 (1.42)
DAE Factor	1.59 (1.57)	1.58 (1.57)	1.60 (1.61)
IIB Factor	4.40 (2.30)	4.66 (2.46)	3.91 (1.91)
DAE+IIB	6.01 (3.25)	6.25 (3.29)	5.56 (3.16)
WURS (25-item)	41.69(20.09)	42.88(20.68)	39.51(19.06)
CES-D	22.85(12.11)	22.43(11.93)	23.63(12.59)
WAS	10.98 (5.42)	10.84 (5.39)	11.23 (5.55)
MAST	7.53 (5.42)	7.88 (5.48)	6.89 (5.34)
DAST	12.50 (6.45)	12.97 (6.49)	11.63 (6.38)

Note: All PCL and symptom inventory values are raw scores.

before the European-American group obtained higher performances. Table 10 presents means and standard deviations of the cognitive variables for the full sample, and the European-American, and Non-European-American groups.

Since significant differences were found on a few cognitive variables, regression analyses investigating the DAE, IIB, and DAE+IIB scores were again completed. The first regressions utilized the European-American sample and entered the OF and Non-OF composite variables as predictors, however neither proved to account for a significant amount of the variance of the DAE, IIB, or DAE+IIB. This was also true for a regression that utilized the non-European-American sample. Regressions that utilized the component variables of the composites also failed to demonstrate any significant findings.

MANOVAs and MANCOVAs that utilized the European-American sample, investigated possible differences between those in the upper and lower thirty percent of the DAE+IIB score (upper n =18, lower n=17) on the cognitive variables. Results of the MANOVA that compared the OF and Non-OF composite variables did not provide a significant difference. This was true of a MANOVA that entered the OF component variables as the dependent variables, and one that entered the Non-OF components as dependent variables. Similarly designed MANCOVAs that utilized WASTOTAL as a covariate also failed to demonstrate significant differences.

Comparisons between those participants in the upper and lower thirty percent of the DAE+IIB score in the non-European-American sample were completed via t-tests due to small sample sizes (upper n=10, lower n=10). The t-test comparing these groups on the

Table 10

Cognitive Variable Means and Standard Deviations for Full Sample, European-American (n=65), and Non-European-American (n=35)

	Sample (N=100)	Caucasian	Non-Caucasian
Variable	Mean (SD)	Mean (SD)	Mean (SD)
WASI FSIQ	93.90(12.29)	97.02(11.39)	88.14(11.97)
VIQ	89.81(11.91)	91.85(11.61)	86.03(11.70)
PIQ	99.34(13.40)	103.06(12.53)	92.43(12.33)
Vocabulary	42.45 (9.15)	43.72 (9.17)	40.09 (8.74)
Block Design	51.12 (8.52)	53.69 (7.77)	46.34 (7.83)
Similarities	42.31 (8.79)	43.42 (8.64)	40.26 (8.84)
Matrix Reasoning	49.10 (9.51)	51.74 (7.72)	44.20(10.65)
FAS (Raw Score)	36.18(10.29)	35.55(10.35)	39.57 (9.16)
WRAT-Reading	92.06 (9.74)	93.75 (9.51)	88.97 (9.52)
Spatial Span	9.14 (2.22)	9.24 (2.36)	8.97 (1.95)
Faces (# Correct)	21.42 (2.70)	22.03 (2.18)	20.26 (3.20)
Smell ID (# Correct)	10.10 (1.43)	10.03 (1.43)	10.24 (1.44)
Gamble	24.06 (9.00)	22.94 (8.98)	26.14 (9.44)
VD Com	4.10 (2.75)	3.88 (2.43)	4.51 (3.27)

Note: WASI Subtest scores are T scores. WASI IQ scores and WRAT-Reading are standard scores. Spatial Span is scaled score. Gamble = # of disadvantageous choices in last 50 choices. VD com = number of commission errors.

OF composite variable approached significance t (18)=2.19, p=.053 with lower performance for those in the upper quartile. Follow-up t-tests of the individual components of the OF composite variables failed to demonstrate any significant differences. The t-test that compared these groups on the Non-OF composite variable failed to demonstrate a significant difference.

Head Injury

The next set of analyses were conducted to investigate the relationship between history of head injury and cognitive and symptom variables. A MANOVA that compared the OF component variables of those who reported a history of head injury (ratings of 1 to 5 on the head injury scale) with those who reported no history of head injury failed to demonstrate a significant difference. This was also true for a MANOVA that compared the Non-OF component variables and one that included WASI FSIQ, PIQ, and VIQ. A MANOVA investigating the symptom variables demonstrated a significant difference, $F\ (6, 86) = 2.22$, $p < .05$. Follow up ANOVAs demonstrated significant differences for WURS25S ($F\ (1, 91) = 8.92$, $p < .01$), and MASTOTAL ($F\ (1, 91) = 7.25$, $p < .01$). In each case the head injury group demonstrated greater symptom levels. A MANOVA that investigated the PCL total and factor scores was not significant. Analysis of the correlations between the head injury ratings (among those who reported a head injury) and the OF and Non-OF component variables failed to produce any significant correlations. No significant correlations were noted for the symptom variables or the PCL variables.

Drug Use

To further investigate possible relationships between drug use and PCL and cognitive variables, specific investigations of three drug types (methamphetamine, marijuana, and cocaine) were conducted. Individuals who reported use of a drug for over 6 months were grouped as users, all others were grouped as experimental/non-users. For methamphetamine this classification system resulted in 50 users and 50 non-users. ANOVA analyses demonstrated significant differences for the PCL total score (F (1, 97) = 9.37, $p < .01$), IIB score (F (1, 97) = 12.12, $p < .01$), and DAE+ IIB score (F (1, 97) = 10.28, $p < .01$). In each case the users group had significantly higher scores than the non-users group. MANOVA analysis demonstrated no significant difference between these two groups for the OF component variables. This also held true for a MANOVA that utilized the Non-OF component variables. To further investigate the possibility of a drug use effect on cognitive variables, correlations between cognitive performance and years of use (this analysis used only those participants that were previously classified as users) were calculated. With the exception of SMELL ($r = -.343$, $p < .05$), no cognitive variables demonstrated significant correlations with years of use. Years of use also failed to demonstrate correlations with any symptom variables or PCL scores.

For Marijuana, 16 individuals were deemed non-users and 84 were deemed users. No significant differences were noted for PCL variables across these two groups. MANOVA analysis failed to demonstrate a significant difference on the OF component variables. MANOVA analysis also failed to demonstrate a significant difference for the Non-OF component variables. Correlations with years of marijuana use were demonstrated for

CESTOTAL ($r = -.229$, $p < .05$) and DASTOTAL ($r = .311$, $p < .01$) but for no other symptom variables or cognitive variables. Significant correlations were demonstrated for PCL variables including the total score ($r = .264$, $p < .05$), the DAE+IIB score ($r = .272$, $p < .05$) and the IIB score ($r = .258$, $p < .05$).

Finally, cocaine use was investigated with 47 participants deemed users and 50 deemed non-users. ANOVA analyses demonstrated a significant difference on the PCL total score ($F (1, 97) = 4.85$, $p < .05$), the DAE score ($F (1, 97) = 4.73$, $p < .05$) and the DAE+IIB ($F (1, 97) = 5.18$, $p < .05$). In each case, the users group demonstrated higher scores that the non-users. MANOVA analysis investigating the OF component variables failed to demonstrate a significant difference. A MANOVA analysis that utilized the Non-OF component variables demonstrated no significant difference. Correlations for years of use with the cognitive and symptom variables produced only one significant correlation (SPATIAL $r = .387$, $p < .05$), which was in the unexpected direction. In terms of PCL scores, years of use correlated only with the ADI score ($r = .367$, $p < .05$).

Gambling Task

Further analyses were also completed on the Gambling task. A paired wise t-test on the full sample found no significant differences in the number of disadvantageous choices between the first half and second half of the test. In order to evaluate the expectation that those in the upper quartile of the DAE+IIB score would demonstrated poorer risk aversion over time (i.e. continue to pick from the disadvantageous decks) than those in the bottom quartile and middle half of this score, a 3X5 mixed factorial MANOVA comparing these three groups across 5 blocks of card selections (Block 1 was made of selections 1 through 20, Block 2 was made up of selections 21-40, and so forth) was completed. A main effect for block was approached (F (4, 93) = 2.42, p = .054), however no simple effect for group, nor any interaction effect were demonstrated. Given this trend, pair wise comparisons were conducted and demonstrated significant differences between blocks 1 and 5, t (99) = 3.27, $p < .001$), and blocks 4 and 5, t (99) = 2.34, $p < .05$. Since ten pairwise comparisons were made it should be noted that the difference between blocks 4 and 5 were not significant after bonferroni correction. Both differences were in the expected direction (i.e., number of disadvantageous choices decreased over time), however the magnitude of this difference was not impressive. Furthermore, as seen in Table 11 the participants' response pattern is not that which is expected from individuals who have truly learned that task (i.e., random responding at the beginning before settling in to good choices at the end).

Stop-Signal Task

Due to unexpected difficulties obtaining valid stop-signal performances this variable was not included in the OF variable composite as originally intended. As administered, the stop-signal task should have provided 5 separate blocks of data. Only 55 cases were judged as providing 5 blocks of valid data. Several types of response patterns were responsible for creating invalid data. As suggested by Logan (1994), discrimination values below 90% were considered indicative of spoiled data and resulted in the elimination of several cases. Poor discrimination could indicate a misunderstanding of the task directions, a lack of attention to the task, or overly quick responding. Invalid protocols were also demonstrated by overly high or overly low percentage inhibition

Table 11

Gambling Task Performance for Full Sample: Means and Standard Deviations of Disadvantageous Choices for 5 Consecutive Blocks of 20 Cards

Card #'s	Mean	Standard Deviation
Block 1 (1-20)	10.89	4.11
Block 2 (21-40)	9.94	3.57
Block 3 (41-60)	9.81	3.90
Block 4 (61-80)	10.06	4.06
Block 5 (81-100)	8.97	4.70
1st half (1-50)	25.66	6.02
2nd half 7 (51-100)	24.06	9.00

Note: T-test between Block 1 and Block 5 t (99) = 3.271, $p < .001$. T-test between 1st and 2nd halves was not significant.

failures. Since the stop-signal task is designed to achieve a 50% failure rate on inhibition trials, blocks in which this value was less than 31.5% or greater than 68.5% were considered indicative of spoiled data. Overly low failure rates generally produced much higher response times and appeared the result of delayed responding presumably designed to decrease failure rates. High failure rates for some cases appeared the result of overly quick responding and were associated with low discrimination values. On other cases these high failure rates were accompanied by poor discrimination values without overly quick response times, in these cases poor attention or failure to understand or remember the task direction was the suspected cause of invalid protocols. Finally, some participants demonstrated large variability in their response times across the blocks. Protocols that demonstrated response time differences of greater than 250 ms between blocks were considered invalid. Variable motivation and attention were thought to be the most likely causes of these types of invalid protocols.

All of the following analyses were completed on the 55 cases that were judged as valid. No significant correlations were found between participants mean Stop-Signal Reaction Time (SSRT) and the PCL factor scores or total score. The SSRT correlated significantly with only one cognitive variable (READ $r = .353$, $p < .01$). No significant correlations were found between the SSRT and the symptom variables or age or education. T-test analysis failed to demonstrate a significant difference on the SSRT between those in the upper and lower quartiles of the DAE+IIB score.

Wisconsin Card Sorting Test

Correlation analysis failed to demonstrate any significant correlations between PCL scores and number of perseverative errors on the WCST. No significant difference on number of perseverative errors across the upper and lower quartiles of DAE+IIB was noted by t-test. Number of perseverative errors was significantly correlated with several cognitive variables including: FACES (r=-.255, p <.05), FAS (r=-.258, p <.05), FSIQ (r=-.472, p <.001), VIQ (r=-.403, p <.001), and PIQ (r=-.434, p <.001). Standardized scores based on age and education stratified norms are presented in Table 12.

DISCUSSION

Based upon a thorough review of case reports, theoretical expositions, and empirical studies, I posited that OF functioning would be inversely related to selected symptoms of psychopathy. The preponderance of these results demonstrated no support for this assertion. More specifically, the analyses did not demonstrate any significant correlations, regressions, or group differences that suggested a robust relationship between performances on OF measures and levels of psychopathic symptoms on the DAE and IIB factors of the PCL:SV.

Our first hypothesis, that the 3-factor model of the PCL:SV would be replicated with good fit in this population was supported (CFI = .928). The confirmatory factor analysis also indicated a strong relationship between the DAE and IIB factors (.50). This was an important finding as it indicated that the factors and symptoms this study focused on (DAE and IIB factors) were empirically supported as discrete but related entities. A second completed CFA, this one of the traditional 2-factor model of psychopathy did not

Table 12

Full Sample Wisconsin Card Sorting Test Performance: Age and Education corrected Standard Scores

WCST Score	Mean SS	Standard Deviation
Total number of errors	97.46	16.81
Total # of Perseverative Responses	103.86	23.62
Total # of Non-perseverative errors	95.67	14.65
Total # of Perseverative errors	102.78	22.77
# of Conceptual responses	97.24	16.52

provide a good fit for the data. This finding further supported the notion that the symptoms of the DAE and ADI factors, which previously were attributed solely to the personality factor, could be conceptualized as different entities and may therefore have different influences or etiologies. It allowed for the notion suggested in my thesis that a subset of psychopaths, previously discussed as the partial psychopath, may demonstrate the symptom constellation we expected, a high DAE+IIB score and a low ADI score. The finding that the ADI and DAE factors were more strongly correlated (.65) suggests that the prevalence rate of "the partial psychopath" in this sample was low.

This investigation had hoped to take advantage of significant correlations between the various OF measures by constructing an OF composite variable, and thereby lowering the total number of needed comparisons. Unfortunately, the OF variables were not strongly correlated and limited the validity of such a composite variable. This was also true of the Non-OF variables. Given these limitations, the primary analyses utilized the composite variables but were followed by analyses utilizing the individual components of these variables.

Hypotheses #2 and #3 stated that multiple regression analyses will indicate that the measures related to OF functioning will be better predictors of the IIB and DAE factors scores than the other cognitive tests. The analyses failed to demonstrate any cognitive variables that could account for a significant amount of the variance of these PCL scores (only age at first crime contributed significantly to any model; never explaining more than 4.2% of the variance). These findings were not entirely unexpected given that no significant correlations were demonstrated between either the OF or the Non-OF component variables and the DAE+IIB score (Table 6). The lack of significant regressions and correlations was true despite adequate sample size and moderate inter-rater reliability.

An additional regression that utilized the symptom variables to predict the DAE+IIB score, demonstrated that only DASTOTAL accounted for a significant amount of the variance (9.4%). The possible role of OF dysfunction in general criminal behavior was suggested by a regression that utilized number of convictions as the criterion variable. On this regression, the OF composite was the only variable that was able to account for a significant amount of the variance. A follow-up regression demonstrated that FACES and GAMBLE both contributed to the model accounting for 14.9% of the variance.

Hypothesis #4 stated that those participants scoring in the top quartile of the DAE+IIB score would demonstrate significantly poorer performance on measures related to OF functioning than the participants who scored in the lowest quartile of the DAE+IIB score. A variety of MANOVA and MANCOVA analyses failed to demonstrate any significant differences between these groups on any cognitive variables. With regard to symptom variables, DASTOTAL, WASTOTAL, and WURS-25 demonstrated significantly higher scores in the upper quartile of DAE+IIB (see Table 8).

Hypothesis #5 predicted that multiple regression analysis would demonstrate the OF measures would be better predictors of institutional infractions than the other cognitive tests. Interpretation of such a regression would have been difficult as the infractions data proved to highly negatively skewed. As previously noted 63% of the sample failed to be cited for even one citation, and 95% of the population had less than 3 citations. Given this distribution and a lack of significant correlations between the cognitive variables and the number of infractions, this regression was not completed.

Hypothesis #6 attempted to maximize possible OF functioning differences by comparing the group deemed most likely to demonstrate OF dysfunction with a group that demonstrated significant symptoms but were deemed unlikely to demonstrate OF dysfunction. As previously noted, the group that was theorized to demonstrate the greatest level of OF dysfunction was marked by high DAE and IIB scores, but low ADI scores. This group was compared to a group that demonstrated high factors on all three factors, a theorized contra-indication to OF dysfunction. Although this analysis significantly restricted the group sizes it was surmised that these two groups would show the largest differences in OF functioning and therefore a significant difference would be easer to detect. This analysis also failed to demonstrate a group difference on the OF variables.

Since the primary analyses demonstrated few significant results, several additional sets of analyses were undertaken to determine if confounding factors were obscuring any true relationship between the cognitive variables and PCL scores. The first supplementary analysis, investigated the possibility of an interaction effect involving performance on OF measures and self-reported level of anxiety (WAS) across the DAE+IIB groups. The 2X3 MANOVA demonstrated no main or interaction effects suggesting that in this sample anxiety had little effect on cognitive performance.

In order to investigate the possibility that ethnicity effects may be obscuring results, the sample was separated into a European-American group (n=65) and a Non-European-

American group (n=35). MANOVA analyses demonstrated that these groups were largely similar in terms of age, education, PCL scores, and symptom measures. Analyses of cognitive variables demonstrated that the European-American group demonstrated significantly higher scores on FACES, READ, and IQ (See Table 10). Due to these differences, regression, MANOVA, and t-test analyses (similar to those that were completed on the entire sample) investigated the relationship between the DAE+IIB score and the cognitive variables for the subsamples defined by these ethnic distinctions. These results, for both the European-American and Non-European-American sample, were largely similar to the previous findings that demonstrated no significant relationship between the variables.

Next, the possible effects of head injury on the posited relationship were examined. Comparisons between those who reported some history of head-injury or concussion (n=62) and those with no head injury history (n=38) demonstrated that the groups were comparable in terms of the PCL total score, factor scores, and DAE+IIB score. No differences were found on any of the OF measures, non-OF measures, or IQ scores. Significant differences were noted on the WURS25S and MASTOTAL scores with the head injury group demonstrating greater scores than the non-head injury group. Although more than one interpretation for this pattern of results is possible, this pattern could be an indication that impulsive personality attributes are more often the cause rather than effect of head injury. This appears especially true given that the WURS is a childhood retrospective diagnosis that would likely be the result of personality traits previous to any head injury. The lack of any significant differences in cognitive variables may be the result of the generally mild level of reported brain injury (no participant reported more than an overnight stay in the hospital as a consequence of their injury and many indicated they received no medical interventions of any kind). It should be noted that correlation analysis failed to demonstrate any relationship between the head injury ratings and the cognitive or symptom variables. This finding may have been compromised by the head injury scale, which has no published reliability or validity studies and may have been subject to reporting biases by the participants. Overall, as with the ethnicity analyses, head injury did not appear to demonstrate significant influence on the variables or relationships this study was focused upon.

Although the effect of drug use upon PCL and cognitive variables was investigated via analyses that utilized the DAST, further analyses that subdivided type of drug abuse were completed. Methamphetamine users and experimental/non-users, marijuana users and experimental/non-users, and cocaine users and experimental/non-users were compared. In regards to the cognitive variables, the users generally did not demonstrate significantly different performances than the non-users. Correlations with years of use and cognitive performance were also generally non-significant, with two exceptions, years of methamphetamine use were significantly negatively correlated with SMELL and years of cocaine use was significantly positively correlated with SPATIAL.

Group differences between users and non-users for both cocaine and methamphetamine were noted on several PCL scores, in each case the users scored significantly more highly than the non-users. The differences in PCL scores highlight the complimentary relationship between personality and drug use. Neurologically speaking this relationship may be most evident via drug effects on the limbic system. It should be noted that this influence might occur in either direction. Poor limbic functioning may lead to a propensity towards drug use as a mechanism for temporarily altering/improving mood. Likewise drug use may originally be independent of limbic functioning but lead to limbic dysfunction. Due to this bi-directionality any analysis of drug use and personality must allow for an either/or relationship, that poor limbic functioning either predated or was caused by drug use. As with head injury, the non-significant findings between drug use and cognition suggest that personality/limbic factors as well as behaviors that revolve around the use and obtainment of drugs may be more influential upon PCL scores than the measured cognitive skills of the participants.

A few caveats regarding these analyses should be noted. First, the users and experimental/non-users were divided on the basis of self-reported use, those that reported greater than six months of use were separated from those who reported no use or only minimal occasions of use for limited times. Second, although the participants were separated as users and non-users on each drug, as noted in Table 1, 74 participants were identified as polysubstance users. Third, years of use was also collected via self-report and was not able to be differentiated by severity use. Participants who reported every day use for 10 years were rated the same as those who reported on-and-off use for that same time period. Given the overall lack of findings on the cognitive variables, drug use does not appear to be an important confounding factor in the relationship between cognitive functioning and PCL scores in this sample.

The next analyses completed more specific investigations with regard to three measures: (1) WCST, (2) Stop-Signal, and (3) BGT. The WCST was investigated separately due to unresolved questions regarding its localization value. T-test analysis demonstrated no significant differences in perseverative errors between the upper and lower quartiles of the DAE+IIB score. Perseverative errors demonstrated significant correlations with FACES, FAS, and FSIQ, suggesting that this measure may be dependent upon extended neural loops and therefore the decision to analyze it separately was valid. The Stop-Signal task was analyzed separately due to the limited number of valid protocols. Analyses completed on the valid protocols failed to demonstrate any relationship between task performance and PCL scores. Both the WCST and the Stop-Signal findings have interesting, but contradictory implications, on the notion of participant effort on cognitive tasks. This topic is revisited later in this discussion.

While the preponderance of the current results fails to suggest a relationship between OF dysfunction and psychopathy or the DAE+IIB score, results of the Gambling task supported the notion that OF dysfunction may be expected in a jail population. In this sample, no significant difference was noted in disadvantageous choices between the first and second halves of the test indicating that as a whole the sample selected poorly throughout the test. Although a significant difference was noted between the first and last blocks, this change appeared rather small. Furthermore, as demonstrated in Table 11, the total sample's response pattern is not that which would have been expected from individuals who had truly learned the task (i.e., random responding at the beginning before a significant and consistent shift to the advantageous decks). Overall, the sample's performance on the Gambling Task failed to provide any clinically significant indication that learning to avoid the risky decks occurred. The notion that the entire sample demonstrated OF dysfunction highlights both strengths and weaknesses of the study design.

Strengths & Limitations

A particular strength of this design was the attempt to demonstrate OF differences within one forensic sample. This design was chosen due to previous complaints that the use of a control group often fails to account for several crucial and possibly confounding variables. Previous studies have been criticized because control groups failed to match on variables such as age, education, drug and alcohol abuse, IQ, history of head injury, psychiatric diagnoses and symptoms, and socioeconomic status. Clearly, the ability to compile an appropriate control group is daunting. In this study, the creation of two groups (upper and lower quartiles of the DEA+IIB score) via one sample allowed for comparisons of OF functioning across groups that were similar in age, education, drug and alcohol abuse, and depression and anxiety symptoms. Unfortunately, this design strength may have limited my ability to demonstrate significant correlations or regressions involving OF measures due to limited variability. Table 13 presents the means, standard deviations, skewness, and kurtosis of the four OF variables. Normality was violated on three of these measures (FACES, SMELL, and VDCOM). Although attempts at variable transformations were undertaken they were not successful in producing more normal distributions. Visual inspection of the FACES and SMELL distributions indicated that both these measures were significantly peaked (kurtotic). Both

Table 13

Cognitive Variable Means, Standard Deviations, Skewness and Kurtosis

Variable	Mean (SD)	Skewness	Kurtosis	K-S (p)
WASI FSIQ	93.90(12.29)	-.369	.345	.200
VIQ	89.81(11.91)	-.111	.365	.191
PIQ	99.34(13.40)	-.653	.592	.038
FAS (Raw Score)	36.18(10.29)	-.075	-.485	.200
WRAT-Reading	92.06 (9.74)	-.020	-.814	.183
Spatial Span	9.14 (2.22)	-.155	-.408	<.001
Faces (# Correct)	21.42 (2.70)	-.568	.819	.001
Smell ID (# Correct)	10.10 (1.43)	-1.413	3.869	<.001
Gamble	24.06 (9.00)	-.360	1.061	.024
VD Com	4.10 (2.75)	1.231	1.470	<.001

Note: WASI Subtest scores are T scores. WASI IQ scores and WRAT-Reading are standard scores. Spatial Span is scaled score. Gambling = # of disadvantageous choices in last 50 choices. VD Com = number of commission errors.

measures appeared to demonstrate small standard deviations, and SMELL was highly negatively skewed. VDCOM was highly peaked, positively skewed, and demonstrated a limited range. It is unclear whether this limited variability reflects general psychometric properties of the OF measures or was caused by the homogeneity of the sample. In the case of the Smell Identification Test, the norms presented by Doty, Marcus, and Lee (1996) indicate a highly skewed distribution rather than a normal curve and hence may have been inappropriate for parametric statistics. Analyzing the current samples performance via the published norms was made impossible by the non-standard administration that utilized each test booklet for two participants.

Additional criticisms regarding the OF variables should be noted. The first criticism is that several of these tests have not had large-scale investigations into their reliability and validity. The current visual discrimination task was an attempt to replicate the task presented in Hornak, Rolls, Wade, and McGrath (1994) and had never been used previously. Its reliability was assumed due to its similarity to previous OA tasks that have been used within similar parameters. The facial emotional expression identification test was similar to that presented by Hornak, Rolls, and Wade (1995). Although Ekman and Friesen (1978) provided accuracy data on each of the individual faces, no specific validity or reliability information regarding this particular format is available. The Gambling Task has extensive use as an experimental measure but as with the previous measures, no large-scale studies involving a broad range of participants have investigated its reliability and validity. None of these measures have extensive use clinically, and no norms suggesting possible cut scores for indications of impairment have been published.

Clinical cutoffs, if available, would help us to explore the possibility that the majority of the current participants were impaired on these measures, as suggested by the total sample's Gambling task performance. If this is true, the failure to demonstrate a relationship between OF functioning and PCL symptoms may be unique to this sample and the result of a significant range restriction due to a floor effect.

A final consideration in regards to the cognitive variables is the issue of participant effort. All participants in this study were volunteers who received no benefits for participating in the study. Any motivation to complete the tasks faithfully must have been internally driven. It is unlikely that all participants provided maximum effort on all tasks, however assessing varying motivation is a difficult task. The use of an effort test, such as the Rey-15 item test or the Test of Memory Malingering (Tombaugh, 1996) may have provided some estimate of participant effort, however these types of tests typically attempt to measure deliberate underperformance, as indicated by scores that fall well below expectations. No participants had a reason to deliberately underperform. Limited or variable effort, which may have been expected in this sample, is less likely to be detected on these generally low-effort demanding tasks. A few findings in this study did suggest that most participants provided a reasonable level of effort. First, all participants were asked to rate their effort level, 87% of the sample rated themselves as a 9 or 10 on a 10-point scale, 8% rated their effort level as an 8 and the remaining 4% rated themselves as a 7. The positive skew, limited variability, and reliance on self-report limit the utility of this rating. Group size differences make statistical comparisons between these groups inappropriate. The sample mean IQ scores also suggest a reasonable degree of effort

(FSIQ = 93.9, VIQ = 89.8, PIQ 99.3). The sample's performance on the WCST (Table 12), also suggest that the sample as a whole demonstrated generally adequate motivation. Although this is somewhat limited information regarding effort, the author is also encouraged by the design of the OF variables. Subjectively, it appears that the facial emotional expression identification test as well as the smell identification test require only minimal effort and hence are less likely to be compromised. The Gambling test appears more game-like and seemed to be an engaging task for many of the participants. The previously noted difficulties with the stop-signal task do point to a motivational concern, but this task was removed from the OF variable composite and all subsequent analyses. Although confounded with ability, Table 14 provides a final index of effort and documents frequency data regarding the number of individuals that provided scores that fell one or more standard deviations (16^{th} percentile) below either the normative mean (for those measures that have had large scale, population-based normative samples) or the current sample mean. The table did not indicate any consistent, significant differences in the number of "impaired" performances between the upper and lower quartiles of the DEA+IIB score suggesting that even if limited effort played a role in participants' performances, there was no significant asymmetry in effort between groups.

Another difficulty with the above analyses could involve the dependent or criterion variables, the PCL scores. In this project, PCL ratings were obtained from only one source, an interview with the participant. A lack of collateral sources of information regarding the participant's history is a significant weakness that could lead to unreliable and invalid ratings. The lead investigator noted that questionable honesty or self-serving

Table 14

Frequency of Sample Falling One or More Standard Deviations Below the Mean

Variable	Sample (N=100) Frequency	Upper Quartile Frequency	Lower Quartile Frequency
WASI FSIQ[1]	24	7	3
VIQ[1]	30	10	5
PIQ[1]	13	4	1
Vocabulary[1]	42	14	8
Block Design[1]	13	5	1
Similarities[1]	38	10	6
Matrix Reasoning[1]	15	3	2
WRAT-Reading[1]	26	9	3
Spatial Span[1]	21	6	6
Faces (# Correct)[2]	11	5	5
Smell ID (# Correct)[2]	9	2	3
Gamble[2]	8	1	1
VD Com[2]	12	3	3

Note: [1] Percentages of current sample that performed one or more standard deviations below mean for standardization samples presented in measure manuals. [2] Percentage of current sample that performed one or more standard deviations below mean of current sample (N=100). $\underline{X}^2$ analysis noted no significant differences in frequencies between high and low quartiles for all variables except WRAT-Reading $\underline{X}^2(1) = 3.95$, $p<.05$.

bias on the part of the participants was often suspected but could not always be directly challenged. An examination of the PCL total score distribution (Table 15) suggests that the participants' self-presentation may have led to an underestimation of their symptom severity by the interviewer. In this sample only 5% of the participants achieved a total score of 18, the customary cut-off to achieve a diagnosis of psychopathy (9% of the sample achieved a score of 17 or above). Previous research suggests that approximately 15-25% of the prison population should reach this level (Hare, 1996). This study's PCL total score mean of 10.4 (SD = 4.56) is also below expectations for a jail population as the PCL:SV manual provided mean scores for three correctional samples that ranged from 12.97 to 16.41 (Hart, Cox, & Hare, 1995).

Although an underestimation of psychopathy may have occurred, it is also possible that these low PCL scores accurately reflect a decreased prevalence of psychopathy that was inherent to this particular sample. As previously noted, all participants were recruited from a non-urban county jail. It is likely a prison population would have generated a study sample that contained a greater proportion of individuals with a lengthy history of serious and violent criminal activity. In addition, the limited distance between this particular rural jail and a major metropolitan area makes it likely that the more sophisticated or sensation-seeking criminals may have migrated to nearby urban areas. The limited number of jail infractions demonstrated by these participants provides further support for the notion that this sample was less troublesome than most. Results of confirmatory factory analyses as well as inter-rater reliability correlations also suggest that reliable and valid ratings were obtained. Confirmatory factor analysis demonstrated

Table 15
Frequency Data for PCL:SV Total Score

PCL Total Score	# of Participants	Cumulative Percent
2	5	5.0
3	2	7.0
4	2	9.0
5	4	13.0
6	8	21.0
7	5	26.0
8	12	38.0
9	8	46.0
10	8	54.0
11	6	60.0
12	4	64.0
13	9	73.0
14	7	80.0
15	7	87.0
16	4	91.0
17	4	95.0
19	1	96.0
20	2	98.0
21	2	100.0

good fit for the Cooke and Michie (2001) three-factor model suggesting that the PCL ratings obtained in this study were similar to those that have been previously demonstrated. Inter-rater reliability for the PCL total score ($r = .78$) and the DAE+IIB score ($r = .73$) were moderate. Even if scores were uniformly depressed, the difference in the DAE+IIB score between those in the upper ($M = 10.24$) and lower quartiles ($M = 1.92$) of this score was statistically and clinically significant. Due to these differences, it is unlikely my limited findings were caused by a range restriction range problem involving the PCL scores.

Insights from Previous Studies

Due to the nature of the hypotheses in this study, a direct comparison between these findings and those of previous OF-psychopathy studies is not possible. However, the results of this and previous studies may provide insights into both the noted inconsistencies in the published literature and the lack of findings in the current study. As previously noted, Schmitt, Brinkley, and Newman (1999) compared Gambling Task performance of three groups from a minimum-security prison. The authors noted a significant block effect for the entire sample with decreasing risky selections over time, but like the current study, they did not find any significant group or interaction effects. Unfortunately, they do not provide the mean number of disadvantageous choices by block for the sample or for any of their three groups. Visual inspection of a provided graph suggests that the controls (PCL $\leq$ 20) and psychopaths (PCL $\geq$ 30) continued to pick from the disadvantageous deck on at least half of their choices in the last block. The middle group (PCL > 20 and < 30) chose from the disadvantageous decks at an even higher rate on the final block (the mean appears to be just greater than eleven). Although the block effect may have been statistically significant, the clinical significance of this learning appears limited. Poor performance by the sample as a whole appears to be indicated as was the case in the current sample. This finding further supports the notion that poor scores on OF measures throughout a forensic sample may be expected and may be responsible for the lack of group differences reported in some studies. By extension, the lack of significant correlations and regressions in this study may be the result of limited variability on all OF measures that resulted from an overall floor effect.

Unlike the current study, Mitchell, Colledge, Leonard, and Blair (2002; see Figure 5), demonstrated poorer risk aversion over time for a psychopathic group (PCL-R M = 33.10) relative to a control group (PCL-R M = 8.65). Mitchell et al.'s control group does appear to demonstrate a clinically significant decrease in risky selections over time, falling from near 12 in the first block to near 7 in the final block. The authors suggested that their findings are contradictory to those of Schmitt et al. (1999) due to varied Gambling task instructions. Their participants received instructions that emphasized that some decks would produce better outcomes than others, an instruction that was not provided in the Schmitt et al. study. With this instruction, the Mitchell et al. control group demonstrated much greater risk aversion over time, hence creating a significant group difference between the control and psychopathy group. The current study, however, also provided those instructions and still produced results more similar to Schmitt et al. Interestingly, Mitchell et al.'s sample was taken from a high security forensic institution yet their control group demonstrated a PCL-R mean score of 8.65, roughly equal to the 5.16 mean PCL-SV score demonstrated by the lower quartile DEA+IIB group in this sample. Since the psychopathy scores were similar, perhaps other differences between these two groups are responsible for the differing levels of learning demonstrated on the Gambling task. This unknown variable may be modifying the relationship between psychopathy and OF functioning. Such a confound may also help to explain the inconsistencies in the published OF studies. One possible explanation is that the Mitchell et al. control group may have been comprised of somewhat more sophisticated or violent criminals as suggested by their disposition to a high security institution.

The strong performance of the control group in Mitchell et al. (2002) may have provided the best opportunity to demonstrate group differences between varied levels of psychopathy. Unfortunately, the authors collected no data on those individuals who scored between 20 and 30 on the PCL-R. Comparison between their control group and a middle level group may have demonstrated that only an elevated PCL-R score (between 20 and 30) rather than a psychopathic level score (greater than 30) would be sufficient to show decreased OF dysfunction relative to their "strong" OF functioning control group. Such a finding would support the thesis that a partial psychopathy group would demonstrate poorer OF dysfunction relative to a control group. Comparing this middle group to the psychopathic group would have further helped to elucidate the relationship between PCL total scores and OF functioning.

Conclusions and Future Directions

As noted above, the body of literature investigating OF dysfunction in psychopathy has provided inconsistent results. The number of positive findings does suggest the possibility of a role of OF dysfunction in the expression of psychopathic symptoms, however, this is likely to be a more complicated relationship than originally proposed. The current study was an attempt to investigate one possible complication in this relationship by further delineating which psychopathic symptoms would be related to OF dysfunction. Although my thesis was not supported, three important findings were noted: (1) performance on two OF measures (FACES and GAMBLE) were able to account for a significant amount of the variance in number of convictions, (2) Gambling Task performance appeared poor throughout the sample, and (3) a significant positive relationship between IQ and the ADI factor was identified. The first finding suggests some general role for OF functioning in the commission of criminal behavior or more specifically in the likelihood of conviction resulting from criminal behavior. The second finding supports the notion that OF dysfunction may be highly prevalent among forensic samples.

The third finding, a positive correlation between IQ and ADI scores, suggests that the ADI factor is unlikely to be explained by deficient cognitive functioning and an interplay between psychopathy factors and cognitive functioning may be likely. This finding has been reported elsewhere (Salekin & Neumann, manuscript submitted). While such a finding is not unexpected given my thesis that significant ADI symptoms would be a contra-indication to OF dysfunction, the ADI-IQ connection does appears contradictory to the previously noted studies that demonstrated a negative relationship between OF functioning and psychopathy. Although the results of previous studies have been inconsistent in many ways, none of these studies demonstrated higher performance on OF measures for the psychopathic groups versus the comparison groups. Such a finding might be expected if OF function and intelligence are positively correlated, or OF dysfunction and high levels of psychopathy (via high ADI scores) are contradictory.

In order to better investigate the proposed relationship between cognitive functioning and psychopathy, futures studies should produce a more selective participant sampling that creates more cleanly differentiated groups. A more thorough investigation of the psychopathy symptoms of a large sample of inmates may be a useful method to identify whether a subset of offenders meet the symptom pattern of the partial psychopath that this investigation proposed. If so, this group could potentially be compared to a true psychopathic group as well as a group of inmates that demonstrated minimal psychopathy symptoms. This methodology would have the advantage of demonstrating whether pre-identified subsamples within a jail population demonstrated varying levels or patterns of cognitive impairment. Alternatively, groups could be constructed on the basis of OF functioning in order to identify psychopathy factors that may be more strongly associated with OF impairment. Using this methodology to investigate PCL factors as well as other personality and affective variables may help to elucidate possible confounds or interactions in the relationship between cognitive functioning and psychopathy.

Future studies should also investigate alternative possible relationships between psychopathy factors/dimensions and cognitive functioning. Although the specific cognitive/psychopathy factor interaction proposed here was not supported, other important relationships (such as the ADI-IQ correlation) may shed light on possible etiologies or subtypes of psychopathy. An important confound to be examined is whether an observed cognitive/psychopathy relationship is actually representative of cognitive performance patterns related to Axis II symptomatology rather than being psychopathy specific. Investigations that compare the ability of cognitive variables to predict psychopathy versus their ability to predict DSM-IV personality disorders would help to clarify whether the noted cognitive performances are specific to psychopathy or representative of co-morbid personality symptoms or disorders.

Although this study failed to note any significant effects of emotional symptomatology on OF dysfunction this does not rule-out the possibility of transient deleterious effects of increased emotional upheaval on the ability of the OF to effectively perform its possible role in behavioral inhibition and personal decision-making. If, as noted by Davidson, Putnam, and Larson (2000), the role of the OF is to help modulate negative emotion and aggressive outbursts, then OF failures may only be apparent under times of increased demand such as moments of intense frustration or anger. This thought leads to the important notion that the OF is only one portion of expanded neural loops that help to shape behavior within a given psychosocial environment. Perhaps OF dysfunction increases the possibility for psychopathic-like behavior or impulsive aggression only for those who demonstrate the lowered prefrontal/subcortical ratios that was demonstrated by Raine, Stoddard, Bihrle, and Buchsbaum (1998). In this way, a delicate balance between amygdala activation and OF functioning may be more important than any single measurement of OF functioning. Although Raine et al. focus upon the amygdala, there exist multiple locations within the limbic system that could alter this crucial relationship; the nucleus accumbens and the ventral tegmental area may be two promising possibilities. Future studies that combined neuropsychological data with functional imaging may help to investigate this possibility.

APPENDIX

Acronym Index

ADHD – Attention-Deficit Hyperactivity Disorder

ADI – Arrogant and Deceitful Interpersonal Style

ANCOVA – Analysis of Covariance

ANOVA – Analysis of Variance

APD – Antisocial Personality Disorder

CC-SIT – Cross Cultural Smell Identification Test

CD – Conduct Disorder

CES-D Center for Epidemiological Studies – Depression Scale

COWAT – Controlled Oral Word Association Test

CPI – California Personality Inventory

DAE – Defective Affective Experience

DAST – Drug Abuse Screening Test

DL – Dorsolateral Prefrontal Cortex

DSM – Diagnostic and Statistical Manual

ED – Extradimensional

EEG – Electroencephalogram

fMRI – Functional Magnetic Resonance Imaging

FSIQ – Full Scale Intelligence Quotient

ID – Intradimensional

IIB – Impulsive and Irresponsible Behavioral Style

IQ – Intelligence Quotient

MANCOVA – Multivariate Analysis of Covariance

MANOVA – Multivariate Analysis of Variance

MAST – Michigan Alcoholism Screening Test

OA – Object Alternation Test

OF – Orbitofrontal Cortex

PCL-R – Psychopathy Checklist-Revised

PCL-SV – Psychopathy Checklist – Screening Version

PET – Positron Emission Tomography

PIQ – Performance Intelligence Quotient

rCBF – Regional Cerebral Blood Flow

SCRs – Skin Conductance Recordings

SES – Socioeconomic Status

SMMT – Sequential Matching Memory Test

SO – Socialization Scale

SSRT – Stop Signal Reaction Time

UPSIT – University of Pennsylvania Smell Identification Test

VIQ – Verbal Intelligence Quotient

VM – Ventral Medial Prefrontal Cortex

WAIS – Wechsler Adult Intelligence Scale

WAIS III – Wechsler Adult Intelligence Scale – Third Edition

WAIS- R – Wechsler Adult Intelligence Scale – Revised

WAS – Welsh Anxiety Scale

WASI – Wechsler Abbreviated Scale of Intelligence

WCST – Wisconsin Card Sorting Test

WMS-III – Wechsler Memory Scale – Third Edition

WMS-R - Wechsler Memory Scale- Revised

WRAT-3 – Wide Range Achievement Test – 3rd Edition

WURS – Wender Utah Rating Scale

REFERENCES

Abracen, J., Looman, J., & Anderson, D. (2000). Alcohol and drug abuse in sexual and nonsexual violent offenders. Sexual Abuse: Journal of Research and Treatment, 12, 263-274.

Adolphs, R., Bechara, A., Kaufmann, O., Kawasaki, H., Bakken, H., Damasio, H., Granner, M., & Howard, M. (2000). Single unit responses in human orbitofrontal cortex: decision-making on a gambling task. Journal of Cognitive Neuroscience, 53, 57.

American Psychiatric Association. (1980). Diagnostic and statistical manual of mental disorders (3rd ed.). Washington, DC: Author.

American Psychiatric Association. (1987). Diagnostic and statistical manual of mental disorders (3rd ed. Revised.). Washington, DC: Author.

American Psychiatric Association. (1994). Diagnostic and statistical manual of mental disorders (4th ed.). Washington, DC: Author.

Anderson, S.W., Bechara, A., Damasio, H., Tranel, D., & Damasio, A.R. (1999). Impairment of social and moral behavior related to early damage in human prefrontal cortex. Nature Neuroscience, 2, 1032-1037

Anderson, S.W., Damasio, H., Jones, R.D., & Tranel, D. (1991). Wisconsin Card Sorting Test performance as a measure of frontal lobe damage. Clinical Experimental Neuropsychology,13, 113-124.

Axelrod, B.N., Goldman, RS, Heaton, R.K., Curtiss, G., Thompson, L.L., Chelune, G.J., & Kay, G.G. (1996). Discriminability of the Wisconsin Card Sorting Test using the standardization sample. Journal of Clinical and Experimental Neuropsychology, 18, 338-351.

Bach-y-Rita, G. & Veno, A.R. (1974) Habitual violence; a profile of 62 men. American Journal of Psychiatry, 131, 1015-1017.

Barkley, R.A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. Psychological Bulletin, 121, 65-86.

Bear, D. (1991). Neurological Perspectives on Aggressive Behavior. Journal of Neuropsychiatry,3, 53-58.

Bechara, A. Damasio, H., Tranel, D., & Anderson, S.W. (1998). Dissociation of working memory from decision making within the human prefrontal cortex. Journal of Neuroscience,18, 428-437.

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

Bechara, A., Damasio, H., Damasio, A. & Lee, G. (1999) Differential contributions of the human amygdala and ventromedial prefrontal cortex to decision-making. The Journal of Neuroscience, 19, 5473-5481.

Bechara, A., Damasio, H., Tranel D., & Damasio, A.R., (1997). Deciding advantageously before knowing the advantageous strategy. Science 275, 1293-1295.

Bechara, A., Dolan, S., Denburg, N., Hindes, A., Anderson, S., & Nathan, P. (2001). Decision-making deficits, linked to a dysfunctional ventromedial prefrontal cortex, revealed in alcohol and stimulant abusers. Neuropsychologia, 39, 376-389.

Bechara, A., Tranel, D., & Damasio, H. (2000). Characterization of the decision-making deficit of patients with ventromedial prefrontal cortex lesions. Brain, 123, 2189-2022.

Bechara, A., Tranel, D., Damasio, H. & Damasio, A.R. (1996). Failure to respond autonomically to anticipated future outcomes following damage to prefrontal cortex. Cerebral Cortex, 6, 215-225.

Bentler, P.M. (1995) EQS structural equations program manual. Encino, CA: Multivariate Software, Inc.

Benton, A.L. (1968). Differential behavioral effects in frontal lobe disease. Neuropsychologia, 6, 53

Berman, K.F., Ostrem, J.L., Randolph, C., Gold, J., Goldberg, T.E., Coppola, R., Carson, R.E., Herscovitch, P., & Weinberger, D.R. (1995). Physiological activation of a cortical network during performance of the Wisconsin Card Sorting Test: A Positron Emission Tomography study. Neuropsychologia, 33, 1027-1046.

Berman, K.F., Zec, R.F., & Weinberger, D.R. (1986). Physiological dysfunction of dorsolateral prefrontal cortex in schizophrenia: II Role of neuroleptic treatment, attention, and mental effort. Archives of General Psychiatry,43, 126-135.

Blair, R.J., & Cipolotti, L. (2000). Impaired social response reversal. A case of 'acquired sociopathy' Brain, 123, 1122-1141.

Blair, R.J., Colledge, E., & Mitchell, D.G. (2001). Somatic markers and response reversal: Is there orbitofrontal cortex dysfunction in boys with psychopathic tendencies? Journal of Abnormal Child Psychology, 6, 499-511.

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

Bornstein, R.A. (1986) Contributions of various neuropsychological measures to detection of frontal lobe impairment. International Journal of Clinical Neuropsychology, 8, 18-22.

Brain, P.F., & Susman, E.J. (1997) Hormonal aspects of aggression and violence. In Stoff, D.M. & Breiling, J. (Eds). Handbook of antisocial behavior. (pp. 314-323). New York, NY, US: John Wiley & Sons, Inc.

Calder, A.J., Young, A.W., Rowland, D., Perrett, D.I., Hodgers, J.R., & Etcoff, N.L. (1996). Facial emotion recognition after bilateral amygdala damage: Differentially severe impairment of fear. Cognitive Neuropsychology, 13, 699-745.

Carey, G., & Goldman, D. (1997). The genetics of antisocial behavior. In Stoff, D.M. & Breiling, J. (Eds) (1997). Handbook of antisocial behavior. (pp. 243-254). New York, NY, US: John Wiley & Sons, Inc.

Carlson, N.R. (1994) Physiology of Behavior (5th ed.). Allyn & Bacon.

Casey, B.J., Trainor, R.J., Orendi, J.L., Schubert, A.B., Nystrom, L.E., Giedd, J.N., Castellanos, X., Haxby, J.V., Noll, D.C., Cohen, J.D., Forman, S.D., Dahl, R.E., & Rapoport, J.L. (1997). A developmental functional MRI study of prefrontal activation during performance of a go-no-go task. Journal of Cognitive Neuroscience, 9, 835-847.

Chang, S.W. (1998). Frontal lobe functioning in adolescent conduct disorder. Unpublished doctoral dissertation, University of New Mexico.

Cleckley, H. (1941). The mask of sanity (1st ed.). St. Louis, Mo: C.V. Mosby.

Cleckley, H. (1982). The mask of sanity (6th ed.). St. Louis, Mo: C.V. Mosby.

Cocco, K.M. & Carey, K.B. (1998). Psychometric properties of the Drug Abuse Screening Test in psychiatric outpatients. Psychological Assessment, 10, 408-414.

Cooke, D.J. & Michie, C. (2001). Refining the construct of psychopath: Towards a hierarchical model. Psychological-Assessment,13, 171-188

Courtney, S.M., Ungerleider, L.G., Keil, K., Haxby, J.V (1996). Object and spatial visual working memory activate separate neural systems in human cortex. Cerebral Cortex, 6, 39-49.

Cummings, J.L. (1993). Frontal-subcortical circuits and human behavior. Archives of Neurology, 50, 873-880.

Damasio, A. & Van Hoesen, G.W. (1983). Emotional disturbances associated with focal lesion of the limbic frontal lobe. In: Helman, KM, Satz P editors. Neuropsychology of human emotion. New York: Guilford Pres. Pp. 85-110.

Damasio, A.R. (1994) Descartes' error; emotion, reason, and the human brain. New York: Grosset/Putnam.

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

Davidson, R., Putnam, K., & Larson, C. (2000). Dysfunction in the neural circuitry of emotion regulation-A possible prelude to violence. Science, 289, 591-594.

DeFilippis, N.A., McCampbell E. (1979) The Booklet Category Test. Odessa, FL: Psychological Assessment Resources, Inc.

DesRosier, G. & Kavanagh, D. (1987). Cognitive assessment in closed head injury. Stability, validity and parallel forms for two neuropsychological measures of recovery. International Journal of Clinical Neuropsychology,9, 162

Devonshire, P.A., Howard, R.C., & Sellars, C. (1988). Frontal lobe functions and personality in mentally abnormal offenders. Personality-and-Individual-Differences, 9, 339-344.

Dinn, W., & Harris, C. (2000). Neurocognitive function in antisocial personality disorder. Psychiatry Research, 97, 173-190.

Dodge, K. & Schwartz, D. (1997). Social information processing mechanisms in aggressive behavior. In Stoff, D.M. & Breiling, J. (Eds). Handbook of antisocial behavior. (pp. 171-180). New York, NY, US: John Wiley & Sons, Inc.

Doty, R.L., Marcus, A., & Lee, W.W. (1996). Development of the 12-item Cross Cultural Smell Identification Test (CC-SIT). Laryngoscope, 106, 353-356.

Doty, R.L., Shaman, P. & Dann, M. (1984). Development of the University of Pennsylvania Smell Identification Test: a standardized microencapsulated test of olfactory function. Physiology and Behavior, 32, 489-502.

Dunn, L. M., Wheklan, C., & Pintillie, D. (1982) British Picture Vocabulary Scale, Windsor, Auk: NFER-Nelson.

Ekman, P., & Friesen, W.V. (1975). Unmasking the Face. Englewood Cliffs, N.J.: Prentice-Hall, 1975.

Eron, L.D. (1997). The development of antisocial behavior from a learning perspective. In Stoff, D.M. & Breiling, J. (Eds) Handbook of antisocial behavior. (pp.

140-147). New York, NY, US: John Wiley & Sons, Inc.

Eslinger, P.J., & Damasio, A.R. (1985). Severe disturbance of higher cognition after bilateral frontal ablation: Patient EVR. Neurology, 35, 1731-1741.

Fedora, O., & Fedora, S. (1983) Some neuropsychological and psychophysiological aspects of psychopathic and nonpscyhopathic criminals. In Flor-Henry, P. & Gruzelier, J. (Eds), Laterality and psychopathology (pp.41-48). Amsterdam: Elsevier

Flor-Henry, P. (1974). Psychosis, neurosis, and epilepsy. British Journal of Psychiatry, 124, 144-150.

Flor-Henry, P. (1983). Cerebral basis of psychopathology. Boston, Bristol, and London, John Wright and Sons.

Flor-Henry, P., Fromm-Auch, D., & Schopflocher, D. (1983). Neuropsychological dimensions in psychopathology. In Flor-Henry, P., and Gruzelier, J . (eds.), Laterality and Psychopathology. Elsevier, Amsterdam.

Freedman, M., Black, S., Ebert, P., & Binns, M. (1998). Orbitofrontal function, object alternation, and perseveration. Cerebral Cortex, 1998, 18-27.

Fuster, J.M. (1989). The Prefrontal Cortex. New York: Raven Press.

Gibbens, T.C., Pond, D.A., & Stafford-Clark, D. (1959). A follow-up study of criminal psychopaths. Mental Science,105, 108-115.

Goldstein, D. (1998). Assessment of Frontal Lobe Functioning in Psychopathy. Unpublished doctoral dissertation, Finch University of Health Sciences/The Chicago Medical School – School of Graduate and Postdoctoral Studies.

Gorenstein, E.E. (1982). Frontal lobe functions in psychopaths. Journal of Abnormal

Psychology, 91, 368-379.

Gotman, M.J. & Zatorre, R.J. (1988). Olfactory identification deficits in patients with focal cerebral excision. Neuropsychologia 26, 387-400.

Grafman, J., Vance S.C. Weingartner, H., Salazar, A.M., Amin, D. (1986). The effects of lateralized frontal lesions on mood regulation. Brain 109, 1127-1148.

Grant, S., Contoreggi, C., & London, E. (2000). Drug abusers show impaired performance in a laboratory test of decision making. Neuropsychologia, 38, 1180-1187.

Gray, J.A. (1972). The psychophysiological nature of introversion-extraversion: A modification of Eysenck's theory. In Gray, J.A., & Nebylitism V.D. (Eds.) Biological bases of individual behavior. New York: Academic Press.

Gregory, A., Murphy, J., Clikeman, M.S., Tucker, D., & Carlson, C. (2002, October). Orbitofrontal and Dorsolateral Neuropsychological Functioning in Adolescent Psychopathy and Conduct Disorder. Poster session presented at the Annual North American conference of the International Neuropsychological Society, Toronto, ON.

Hall, R.E., Livingston, R.B. & Bloor, C.M. (1977) Orbital cortical influences on cardiovascular dynamics and nyocardial structure in conscious monkeys. Journal of Neurosurgery, 46, 638-847.

Hare, R.D. (1970). Psychopathy: Theory and Research. New York: Wiley.

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

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

Hare (1996). Psychopathy: A clinical construct who's time has come. Criminal Justice and Behavior, 23, 25-54.

Hare, R.D. (1998). Psychopathy, Affect and Behavior. In D.J. Cooke et al (Eds.), Psychopathy: Theory, Research and Implications for Society. Netherlands: Kluwer Academic Publishers.

Harpur, T.J., Hare, R.D. & Hakistan, A.R. (1989) Two-factor conceptualization of psychopathy; Construct validity and assessment implications. Journal of Consulting and Clinical Psychology, 1, 6-17.

Hart, S.D. & Hare, R.D. (1997). Psychopathy: Assessment and Association with Criminal Conduct. In D.M. Stoff, J. Breiling, & J.D. Maser (Eds.), Handbook of antisocial behavior (pp.25-35). New York: John Wiley & Sons, Inc.

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

Heaton, R.K. (1981). The Wisconsin Card Sorting Test. Odessa, FL: Psychological Assessment Resources, Inc.

Heaton, R.K. (1981). A manual for the Wisconsin Card Sorting Test. Odessa, FL: Psychological Assessment Resources.

Hoffman,J.J., Hall, R.W., & Bartsch, T.W. (1987) On the relative importance of "psychopathic" personality and alcoholism on neuropsychological measures of frontal lobe dysfunction. Journal of Abnormal Psychology, 96, 158-160.

Holmes, C. & Buzzanga, V. (1991). Head injury prevalence among community college students. Perceptual and Motor Skills, 73, 497-498.

Hommer, D., Andreasen, P., Rio, D., Williams, W. Ruttimann, U., Momenan, R., Zametkin, A., Rawlings, R., Linnoila, M. (1997). Effects of m-chlorophenylpiperazine on regional brain glucose utilization: a positron emission tomographic comparison of alcoholic and control subjects. The Journal of Neuroscience, 17, 2796- 2806.

Hornak, J., Rolls, E.T., & Wade, D. (1996). Face and voice expression identification in patients with emotional and behavioural changes following ventral frontal lobe damage. Neuropsychologia, 34, 247-261.

Humphreys, G.R., Donelly, N., & Riddoch, M.J. (1993). Expression is computed separately from facial identity, and is computed separately for moving and static faces; neuropsychological evidence. Neuropsychologia, 31, 173-181.

Kandel E., & Freed, D. (1989) Frontal-lobe dysfunction following closed head injury: a review of the literature. Journal of the Nervous and Mental Diseases, 178, 282-291.

Kaufer, D.I. & Lewis, D.A. (1999). Frontal Lobe Anatomy and Cortical Connectivity. In B.L. Miller& J.L. Cummings (Eds.), The Human Frontal Lobes (pp.27-41). New York, NY: The Guilford Press.

Kolb, B. & Whishaw, I.Q. (1996). Fundamental of Human Neuropsychology New York: W.H. Freeman and Company.

Kwentus, J., Hart, R., Peck, E., & Kornstein, S. (1985). Psychiatric complications of closed head trauma. Psychosomatics, 26, 8-17.

LaPierre, D.L., Braun, C.M.J & Hodgins, S. (1995). Ventral frontal deficits in psychopathy: Neuropsychological test findings. Neuropsycologia, 33, 139-151.

Lewis, D.O., Pincus, J.H., Feldman, M., Jackson, L. and Bard. B. (1986) Psychiatric, neurological, and psychoeducational characteristics of 15 death row inmnates in the United States. American Journal of Psychiatry, 145, 584-589.

Lezak, J. (1995). Neuropsychological Assessment: 3rd Edition New York: Oxford University Press

Logan, G.D. (1994). On the ability to inhibit though and action: A users' guide to the stop signal paradigm. In D. Dagenback & TH Carr (Eds.), Inhibitory process in attention, memory, and language (pp.189

Logan, G.D., Cowan, W.B., Davis, K.A. (1984) On the ability of inhibiting simple and choice reaction time responses: A model and a method. Journal of Experiment Psychology Human Perception and Performance, 10, 276-291

Logan, G.D., Schachar, R.J., & Tannock, R. (1997) Impulsivity and Inhibitory Control. Psychological Science,8, 60-64.

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

Malloy,P., Bihrle, A., Duffy, J., & Cimino, C. (1993) The orbitomedial frontal syndrome. Archives of Clinical Neuropsychology, 8, 185-201.

Marenco, S., Coppola, R., Daniel, D.G., Zigun, J.R., & Weinberger, D.R. (1993) Regional cerebral blood flow during the Wisconsin Card Sorting Test in normal participants studied by Xenon-133 dynamic SPECT: comparison of absolute values, percent distribution values, and covariance analysis. Psychiatric Research, 50, 177-192.

Mark, V.H. & Erwin, F.R. (1970) Violence and the Brain. New York: Harper & Row.

Martell, D.A. (1992). Estimating the prevalence of organic brain dysfunction in maximum-security forensic psychiatric patients. Journal of Forensic Sciences, 37, 878-893.

Mazas, C., Finn, P., Steinmetz, J. (2000). Decision making biases, antisocial personality, and early-onset alcoholism. Alcoholism: Clinical and Experimental Research, 24, 1036-1040.

McCord, W. and McCord, J. (1964). The psychopath: An essay on the criminal mind. New York: Van Nostrand Reinhold Company

Mednick, S.A. Pollock, V., Volavka, J. & Bagrielli, W.F. (1982) Biology and Violence. In M.B. Wolfganag and N.A. Weiner (Eds.,) Criminal Violence. Newbury Park: Sage.

Meyers, C.A., Berman, S.A., Scheibel, R.S., & Hayman, A. (1992). Case report: Acquired Antisocial Personality Disorder Associated with Unilateral Left Orbital Frontal Lobe Damage. Journal of Psychiatry and Neuroscience, 17, 121-125.

Miller, E. (1999). Head injury and offending. Journal of Forensic Psychiatry, 10, 157-166.

Miller, E. (1999). The neuropsychology of offending. Psychology, Crime, & Law, 5, 297-318.

Miller, L. (1987). Neuropsychology of the Aggressive Psychopath: An Integrative Review. Aggressive Behavior, 13, 119-140.

Millon, T. (1981). Disorders of Personality: DSM-III Axis II. New York: Wiley

Milner, B. (1963). Effect of different brain lesions on card sorting. Archives of Neurology, 9, 100-110.

Milner, B. (1964). Some effects of frontal lobotomy in man. In J.M. Warren & G. Aker (Ed.), The Frontal Granular Cortex and Behavior (pp.313-334). New York: McGraw-Hill.

Mishkin, M., Vest, B., Waxler, M., & Rosvold, H.E. (1969). A re-examination of the effects of frontal lesions on object alternation. Neuropsychologia, 7, 357-363.

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

Moffitt, T.E., (1990). Juvenile delinquency and Attention Deficit Disorder: Boys' developmental trajectories from age 3 to age 15. Child Development, 61, 893-910

Morgan, A.B. & Lilienfeld, S.O. (2000). A meta-analytic review of the relation between antisocial behavior and neuropsychological measures of executive function. Clinical Psychology Review, 20, 113-136.

Mountain, M.A., & Snow, W.G. (1993). Wisconsin Card Sorting Test as a measure of frontal pathology: A review. Clinical Neuropsychologist, 7, 108-118.

Mungas, D. (1988). Psychometric correlates of episodic violent behaviour: A multidimensional neuropsychological approach. British Journal of Psychiatry,152, 180-187.

Nauta, W.J.H. (1971) The problem of the frontal lobe: a reinterpretation. Journal of Psychiatry Research, 8, 167-187.

Newman, J.P. (1998). Psychopathic Behavior: An Information Processing Perspective. In D.J. Cooke et al. (Eds.), Psychopathy: Theory, Reseearch and Implications for Society.

(pp.81-104) Netherlands: Kluwer Academic Publishers.

Newman, J.P., Patterson, C.M., Howland, E.W., & Nichols, S.L. (1990). Passive avoidance in psychopaths: The effects of reward. Personality and Individual Differences, 11, 1101-1114.

O'Doherty, J., Kringelbach, M.L., Rolls, E.T., Hornak, J., Andrews, C. (2001). Abstract reward and punishment represented in the human orbitofrontal cortex. Nature Neuroscience, 4, 95-102.

Oscar-Berman, M., McNamara, P., & Freedman, M. (1991) Delayed response tasks: Parallels between experimentatl ablation studies and findings in patients with frontal lesions. In H.S. Levin, J.M. Eisenberg, & A.L. Benton (Eds) Frontal lobe function and injury (p. 230-255) New York. Oxford University Press.

Patton, J.H., Stanford, M.S., & Barratt, E.S. (1995). Factor structure of the Barratt Impulsiveness Scale, Journal of Clinical Psychology, 51, 768

Perret, E. (1974). The left frontal lobe of man and the suppression of habitual responses in verbal categorical behaviour. Neuropsychologia, 12, 323

Petrides M. & Pandya, D.N. (1994) Comparative architectonic analysis of the human and macaque frontal cortex. In: J Grafman, F Boller (Eds), Handbook of neuropsychology. Elsevier Science Publishers, Amsterdam p.17-58.

Petry, N., Bickel, W., Arnett, M. (1998). Shortened time horizons and insensitivity to future consequences in heroin addicts. Addiction, 93, 729-738.

Pincus, J.H. & Glaser, G.H. (1966). The syndrome of "Minimal Brain Damage" in childhood. New England Journal of Medicine, 275, 27-35.

Potter, H. & Nauta, W.J.J. (1980). A note on the problem of olfactory associations of the orbitofrontal cortex in the monkey. Neuroscience, 4, 361-367.

Powell, B. & Holmes, C. (1995). Prevalence of head injury among four-year college students: A replication and combined results. Perceptual and Motor Skills, 81, 227-230.

Prentice, N.M., & Kelly, F.J. (1963). Intelligence and delinquency: A reconsideration. Journal of Social Psychology, 60, 327-337.

Quay, H.C. (1997). Inhibition and Attention Deficit Hyperactivity Disorder. Journal of Abnormal Child Psychology, 25, 7-13.

Radloff, L.S. (1977). The CES-D Scale: A self-report depression scale for research in the general population. Applied Psychological Measurement, 1, 385-401.

Raine, A. (1993). The psychopathology of crime. San Diego: Academic Press.

Raine, A., & Venables, P.H. (1988). Enhanced PC evoked potentials during a continuous performance task in psychopaths. Psychophysiology, 25, 30-38.

Raine, A., Buchsbaum, M. & LaCasse, L. (1997). Brain abnormalities in murderers indicated by positron emission tomography. Biological Psychiatry, 42, 495-508.

Raine, A., Buchsbaum, M.S., Stanley, J., Lottenberg, S., Abel L. & Stoddard. J (1994). Selective reductions in prefrontal glucose metabolism in murderers. Biological Psychiatry, 36, 365-373.

Raine, A., Lencz, T., Bihrle, S., LaCasse, L., Colletti, P. (2000). Reduced prefontal gray matter volume and reduced autonomic activity in antisocial personality disorder. Archives of General Psychiatry, 57, 119-127.

Raine, A., Meloy, J., Bihrle, S., Stoddard, J., LaCasse, L., Buchsbuam, M.S. (1998).

Reduced prefrontal and increased subcortical brain functioning assessed using positron emission tomography in predatory and affective murderers. Behavioral Sciences and the Law, 16, 319-332.

Raine, A., Stoddard, J., Bihrle, S., Buchsbaum, M. (1998). Prefrontal glucose deficits in murderers lacking psychosocial deprivation. Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 11, 1-7.

Rezai, K. Andreasen, N.C., Alliger, R., Cohen, G., Swayze, V., O'Leary, D.S. (1993). The neuropsychology of the prefrontal cortex. Archives of Neurology, 50, 636-642.

Robinson, A.L., Heaton, R.K., Lehman, R.A.W., & Stilson, D.W. (1980) The utility of the Wisconsin Card Sorting Test in detecting and localizing in frontal lobe lesions. Journal of Consulting and Clinical Psychology, 48, 605-614.

Rogers, R., Owen, M., Middleton, H., Williams, E., Pickard, J., Sahakian, B. & Robbins, T. (1999). Choosing between small, likely rewards and large, unlikely rewards activiates inferior and orbital prefrontal cortex. The Journal of Neuroscience, 20, 9029-9038.

Rogers, R.D., Everitt, B.J., Bladacchino, A., Blackshaw, A.J., Swainson, R., Wynne, K., Baker, N., Hunter, J., Carthy, T., Booker, E., London, M., Deakin, J., Sahakian, B., Robbins, T. (1999). Dissociable deficits in the decision-making cognition of chronic amphetamine abusers, opiate abusers, patients with focal damage to prefrontal cortex, and tryptophan-depleted normal volunteers: Evidence for monoaminergic mechanisms. Neuropsychopharmacology, 20, 322-339.

Rolls, E.T. (1988). The orbitofrontal cortex. In Roberts, A.C. & Robbins, T.W. (Eds.).

The prefrontal cortex: Executive and cognitive functions. (pp. 67-86). New York, NY, US: Oxford University Press.

Rolls, E.T. (2000). The orbitofrontal cortex and reward. Cerebral-Cortex, 10, 284-294.

Rolls, E.T., Yaxley, S., & Sienkiewicz,, Z.J. (1990) Gustatory responses of single neurons in the caudolateral orbitofrontal cortex of the macaque monkey. Journal of Neurophysiology, 64, 1055-1066

Rolls, E.T., Francis, S., Bowtell, R., Browning, D., Clare S., Smith, E. (1997). Pleasant touch activiates the orbitofrontal cortex. Neuroimage, 5, 132-144.

Rolls, E.T., Hornak, J., Wade, D., McGrath, J. (1994). Emotion-related learning in patients with social and emotional changes associated with frontal lobe damage. Journal of Neurology, Neurosurgery and Psychiatry, 57, 1518-1524.

Roussy, S. & Toupin, J. (2000). Behavioral inhibition deficits in juvenile psychopaths. Aggressive Behavior, 26, 314-424.

Rubin, P., Holm, S., Friberg, L., Videbech, P., Anderson, H.S., Bendsen, B.B., Stromso, N., Larsen, J.K., Lassen, N.A., & Hemmingsen. R. (1991). Alterated modulation of prefrontal and subcortical brain activity in novel diagnosed schizophrenia and schizophreniform disorder: A regional cerebral blood flow study. Archives of General Psychiatry, 48, 987-995.

Ryan, L., O'Jile, J., Gouvier, W., Parks, L., & Betz, B. (1996). Head injury in a college population: Analysis of epidemiological factors. Applied Neuropsychology, 3, 49-54.

Saltstone, R., Halliwell, S., & Hayslip, M.A. (1994). A multivariate evaluation of the

Michigan Alcoholism Screening Test and the Drug Abuse Screening Test in a female offender population. Addictive Behaviors, 19, 455-462.

Sarapata, M., Herrmann, D., Johnson, T., & Aycock, R. (1998). The role of head injury in cognitive functioning, emotional adjustment and criminal behaviour. Brain Injury, 12, 821-842.

Saver, J.L. & Damasio, A.R. (1991). Preserved access and processing of social knowledge in a patient with acquired sociopathy due to ventromedial frontal damage. Neuropsychologia, 29, 1241-1249.

Schmitt, W.A., Brinkley, C.A, & Newman, J.P. (1999). Testing Damasio's Somatic Marker Hypothesis with psychopathic individuals: Risk takers or risk averse? Journal of Abnormal Psychology, 108, 538-543.

Seidman, L.J., Talbot, M.L., Kalinowski, A.G., McCarely, R.W., Faraone, S. V., Kremen, W.S., Pepple, J.R., & Tsuang, M.T. (1992). Neuropsychological probes of fronto-limbic system dysfunction in schizophrenia: Olfactory identification and Wisconsin Card Sorting Performance. Schizophrenia Research, 6, 55-65.

Selzer, M.L. (1971). The Michigan Alcoholism Screening Test: The quest for a new diagnostic instrument. American Journal of Psychiatry, 127, 1653-1658.

Shaw, D.S., Winslow, E.B. (1997). Precursors and correlates of antisocial behavior from infancy to preschool. In Stoff, D.M. & Breiling, J. (Eds.) Handbook of antisocial behavior. (pp. 148-158). New York, NY, US: John Wiley & Sons, Inc.

Skinner, H. (1982). The Drug Abuse Screening Test. Addictive Behaviors, 7, 363-371.

Smith, S.S., Arnett, P.A., &Newman, J.P. (1992). Neuropsychological differentiation of psychopathic and nonpsychopathic criminal offenders. Personality and Individual Differences, 13, 1233-1243.

Staley, D., & El-Guebaly, N. (1990). Psychometric properties of the Drug Abuse Screening Test in a psychiatric population. Addictive Behaviors, 15, 257-264.

Starkstein, S.E. & Robinson, R.G. (1997). Mechanism of disinhibition after brain lesions. The Journal of Nervous and Mental Disease, 185, 108-114.

Starkstein, S.E. Mayberg, H.S., Berthier, M.L., Fedoroff, P., Price, T.R., Dannals, R.F., Wagner, H.N., Leiguarda,R., & Robinson, R.G. (1990). Mania after brain injury; neuroradiological and metabolic findings. Annuals of Neurology, 27, 652-659.

Stuss, D.T., & Benson, D.F. (1986) The frontal lobes. New York: Raven Press.

Stuss, D.T., Gow, C.A., & Hetherington, C.R. (1992). "No longer Gage": frontal lobe dysfunction and emotional changes. Journal of Consulting and Clinical Psychology,60, 349-359.

Sutker, P.B., & Allain, A.N. (1987). Cognitive abstraction, shifting, and control: Clinical sample comparisons of psychopaths and nonpsychopaths. Journal-of-Abnormal-Psychology, 96, 73-75

Tanabe, T., Yarita, H., Iino, M., Ooshima, Y. & Takagi, S.F. (1975). An olfactory projection area in orbitofrontal cortex of the monkey. Journal of Neurophysiology, 38, 1269-1283.

Teitelbaum, L. & Mullen, B. (1998). The validity of the MAST in psychiatric settings: A Meta-analytic integration. Journal of Studies on Alcohol, 61, 254-261.

Teitelbaum, L.M. & Carey, K.B. (2000). Temporal stability of alcohol screening measures in a psychiatric setting. Psychology of Addictive Behaviors, 14, 401-404

Thornberry, T.P., & Krohn, M.D., (1997). Peers, drug use, and delinquency. In Stoff, D.M. & Breiling, J. (Eds) Handbook of antisocial behavior. (pp. 218-233). New York, NY, US: John Wiley & Sons, Inc.

Tombaugh, T. N. (1996). Test of Memory Malingering. North Tonawanda, NY: Multi-Health Systems.

Vanderploeg, R.D., & Haley, J.A. (1990) Pseudosociopathy with intact higher-order cognitive abilities in patients with orbitofrontal cortical damage. Journal of Clinical Experimental Neuropsychology, 12, 54-55.

Volkow, N.D., Fowler, J.S., Wolf, A.P., Hitzemann, R., Dewey, S., Bendriem, B., Alpert, R., & Hoff, A. (1991). Changes in brain glucose metabolism in cocaine dependence and withdrawal. American Journal of Psychiatry, 148I 621-626.

Walsh, K. (1987). Neuropsychology: A clinical approach. 2nd Edition. Edinborough: Churchill Livingstone.

Ward, M.F., Wender, P.H., & Reimherr, F.W. (1993) The Wender Utah Rating Scale: An aid in the retrospective diagnosis of childhood attention deficit hyperactivity disorder. American Journal of Psychiatry, 150, 885-890.

WASI Manual. (1999). San Antonio, TX: The Psychological Corporation: Harcourt, Brace, & Company

Wechsler, D. (1997) Wechsler Adult Intelligence Scale –Third Edition. San Antonio, TX: The Psychological Corporation.

Weinberger, D.R., Berman, K.F., & Zec, R.F. (1986). Physiological dysfunction of dorsolateral prefrontal cortex in schizophrenia: I. Regional cerebral blood flow (rCBF) evidence. Archives of General Psychiatry, 43, 114

Weissman, M.W., Scholomoskas, D., Pottenger, M., Prusoff, B.A. & Locke, B.Z. (1977). Assessing depressive symptoms in five psychiatric populations: A validation study. American Journal of Epidemiology, 106, 203

Weller, M.P.I. (1985). Compensation issues in grand mal epilepsy. Medicine, Science, and Law, 25, 143-149.

Welsh, G.S. (1965). An anxiety index and an internalization ratio for the MMPI. Journal of Consulting Psychology, 16, 65-72.

Widom, C.S. (1997). Child abuse, neglect, and witnessing violence. In Stoff, D.M. & Breiling, J. (Eds) Handbook of antisocial behavior (pp.159-170) New York, NY, US: John Wiley & Sons, Inc.

Wodushek, T.R. & Neumann, C.S. (2003). Inhibitory capacity in adults with symptoms of Attention Deficit/Hyperactivity Disorder (ADHD). Archives of Clinical Neuropsychology, 18, 317-330.

Yeudall, L. (1977). Neuropsychological assessment of forensic disorders. Canadian Mental Health, 25, 7-16.

Yeudall, L. & Flor-Henry, P. (1976). Lateralized neuropsychological impairments in depression and criminal psychopathy. Journal of Nervous and Mental Disease, 162, 7-16.

Yeudall, L.T., & Fromm-Auch, D. (1979). Neuropsychological impairments in various psychopathological populations. In Gruzelier & Flor-Henry, P. (Eds.), Hemispheric Asymmetries of Function in Psychopathology. Amsterdam: Elsevier.

Yeudall, L.T., Fromm-Auch, D., & Davies, P. (1982). Neuropsychological impairment of persistent delinquency. The Journal of Nervous and Mental Disease, 170, 257-265.

Young, A.W., Newcombe, F., De Hann, E.H.F., Small, M., & Hay, D.C. (1993) Face perception after brain injury. Brain, 116, 941-959.