Cognitive heterogeneity in murderers

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ABSTRACT

Cognitive Heterogeneity in Murderers

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It has long been recognized that damage to one or more brain regions can produce antisocial and aggressive behavior. Unfortunately, however, attempts to develop a replicable neurocognitive profile that characterize serious forms of criminality have been relatively unsuccessful. Evidence of cognitive heterogeneity in violent offender populations may indicate different biobehavioral subtypes underling this complex multidetermined behavior. These subtypes may interact with other clinical and environmental vulnerabilities. In the current study, cluster analytic techniques were applied to a sample of 55 homicide offenders. Using select Halstead-Reitan and Wechsler Adult Intelligence Scale (WAIS) variables four distinct cognitive clusters were derived and externally validated (i.e., "neuropsychologically normal", "verbal learning", "borderline IQ/impaired", and "severely impaired" cognitive clusters). Meaningful differences between the clusters were found on primary violence subtype (i.e., Reactive versus Instrumental), secondary violence variables, history of mental illness/presence of psychotic symptoms at the time of the crime, TBI history, reading grade level, number of perpetrators, and age of the perpetrator at the time of the crime. Findings suggest the presence of theoretically coherent and clinically relevant neuropsychological subtypes.
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CHAPTER 1

INTRODUCTION

Today, there is growing recognition that criminal offenders are heterogeneous with regard to important violence risk factors (biological, psychological, social and environmental) and criminal motivation. Consequently, research attempting to understand violence must take into account these potential differences (Lewis et al., 1994; Moffit, 1997; Golden, Jackson, Peterson-Rohne, & Gontkovsky, 1996; Raine, 2002). Megargee (as quoted in Cornell, Warren, Hawk, Stafford, Oram, & Pine, 1996) recommended that, "instead of attempting to predict 'violence' as if it was a unitary homogeneous mode of behavior, efforts should be directed at differentiating meaningful subtypes or syndromes of violent individuals and then determining the diagnostic signs in the clinical data that will enable us to identify individuals of each types" p. 202. Attempts to identify meaningful subgroups of individuals in this manner are not new; in fact classification based on symptom profiles is a common practice employed in the diagnosis and investigation of many psychiatric and medical illnesses.

In accordance with Megargee's recommendation, typologies of aggression have been enumerated. These typologies, which distinguish between affective and behavioral components of the violent act, have allowed for further investigation into offenders who differ on this important dimension. As a result, the pathological affective characteristics of psychopathic aggression have been highlighted. Evidence that psychopathic offenders engage in qualitatively distinct forms of aggression (i.e., instrumental versus...
reactive) is in agreement with research suggesting that differences in neurological and cognitive functioning may underlie both psychopathic and nonpsychopathic violence and reactive and instrumental forms of aggression. Refocusing attention back onto the neuroanatomical correlates of violence has lead to a renewed interest in utilizing neuropsychological approaches to investigate violent offenders.

Neurological dysfunction has long been recognized as a significant independent risk factor for violence and impulsive violence in particular (Bryant, Scott, Golden, & Tori, 1984; Grafman et al., 1996; Lewis, 1992; Raine, 2002). Using various approaches (e.g., population, statistical design, methodology, neuropsychological measures), studies have found that some offenders exhibit verbal deficits, and/or impaired executive functioning, while others evidence generalized cognitive impairment, and still others appear neurologically intact (for reviews see Brower & Price, 2001; Golden, Jackson, Peterson-Rohne, & Gontkovsky, 1996; Nestor, 1992). Despite the fact that investigations in the area have demonstrated evidence for neurocognitive heterogeneity in violent offenders, surprisingly, attempts to classify violent offenders based on neuropsychological test performance have yet to be accomplished (but see Golden et al., 1996; Teichner, Golden, Crum, Azrin, Donohue, & Van Hasselt, 2000). In addition to very valid issues related to sentencing decisions in individuals with brain dysfunction, heightened interest in cognitive functioning and its underlying neurology in violent populations seems warranted, given that strong relations have been demonstrated to exist between treatment outcome and treatment cost, and level of cognitive functioning in a variety of populations (Gold & Goldberg, 1995; Golden et al., 1996). Also, because traumatic brain injury represents a common risk factor for future neurobehavioral dysfunction (Brown, Fann, & Grant, 1994), greater awareness of this risk and better prevention may represent a potential entry point for reducing future violence.
The purpose of the current investigation is to assess the heterogeneity of cognitive functioning in homicide offenders using a comprehensive neuropsychological battery, namely the Halstead-Reitan Neuropsychological Test Battery (HRB; Reitan & Wolfson, 1993) including the Wechsler Scales of intelligence (Wechsler, 1981; Wechsler, 1997), and a standardized measure of reading grade level (Kaufman Test of Educational Achievement Brief Form). Based on these measures, a taxonomy of homicide offenders will be developed and then evaluated in terms of consistency with prior research in this area (e.g., Brower & Price, 2001; Golden et al., 1996; Raine, Meloy, Bihrlc, Stoddard, LaCasse, & Buchsbaum, 1998; Teichner & Golden, 2000; Teichner et al, 2000). Subtypes of offenders identified in the taxonomy will be examined with regard to proximal and distal offender and crime correlates, in order to better understand the relations between neurocognitive heterogeneity and demographic, clinical, social, and victim variables. The proposed study is designed to link the neuropsychological literature which suggests cognitive heterogeneity, with aggression literature that has documented different clinical and possibly biobehavioral subtypes of this complex multidetermined behavior. This investigation will provide externally validated subtypes derived using cluster analysis which is an empirical statistical approach to classification. Validation will be achieved by comparing empirical derived clusters or subtypes on aggression, clinical, demographic, and social/history measures. By doing this, it will be possible to evaluate whether the derived clusters provide potentially meaningful and clinically useful cognitive subtypes of homicide offenders. Before discussing the details of the current study however, it is necessary to review several key areas of research that provide a foundation for the study at hand.

The discussion begins with an overview of research in the areas of neurological and cognitive functioning in violent and antisocial populations. Later, new typologies of aggression and their neurological correlates in violent and offender populations will be
presented. This will be followed by an introduction to the construct of psychopathy and its associated violence and neurocognitive correlates. Lastly, a past attempt to identify cognitive subtypes in a delinquent population will be presented.
CHAPTER 2

LITERATURE REVIEW

Brain Damage; Antisocial, Aggressive, and Homicidal Behavior

Research into the association between criminally violent behavior and neurological impairment was originally stimulated by the observation that brain injury could produce marked changes in personality, including the onset of antisocial behavior, affective lability, psychosis, and increased impulsivity and aggressiveness (Absher & Cummings, 1995; Damasio, 1994; Blair, 1995; Lange & Reuner, 1990; Silver, Yudofsky, & Hales, 1987). One of the earliest documented cases and possibly most well known example of this transformation occurred in a man named Phineas Gage (Harlow, 1848). Prior to having a tamping iron penetrate his skull, Gage was noted to be a responsible foreman who displayed no antisocial behavior. After the accident, which damaged the left prefrontal region of his brain, he became an obstinate, crude, ill mannered and antisocial man. The change was so dramatic that there after it was often remarked that "he was no longer Gage" (Harlow, 1848).

As this example illustrates, damage to one or more brain regions can produce antisocial and aggressive behavior. The following brain systems have been hypothesized to be central in the development of a behavioral syndrome involving socially inappropriate behavior and aggressive acting out; 1) damage to important prefrontal structures and pathways (cortical and subcortical), and 2) damage to the temporal areas of the brain and associated limbic structures (as cited in Golden et al., 1996). A brief review of the neurology literature with regard to the aforementioned brain
systems and their relationship with antisocial, aggressive, and homicidal behavior will follow, after which, results from studies that have relied on neuropsychological test performance, as a reflection of underlying brain function in violent populations, will be presented.

**Neurological Findings**

With regard to brain systems and evidence for the first mechanism of dysfunction previously noted by Golden and coworkers (1996), findings associating antisocial personality disorder (APD) and aggressive populations with frontal brain abnormality have been robust (for reviews see Bassarath, 2001; Blake et al., 1995; Brower & Price, 2001, Elliot, 1992). Research by Diaz (1995) with an offender population indicated that approximately 50% of participants had positron emission tomography (PET) findings of frontal lobe abnormality. Raine, Buchsbaum, and LaCasse (1997) examined 41 persons charged with murder or manslaughter using PET. Compared with matched controls, offenders as a group showed statistically significant prefrontal metabolic decreases during a frontal lobe activation task.

Diminished frontal electroencephalogram (EEG) activity and reduced prefrontal gray matter volume on magnetic resonance imaging (MRI) have also been consistently identified among individuals with histories of aggression, as well as those diagnosed with APD (for reviews see Bassarath, 2001; Blake et al., 1995; Brower & Price, 2001, Elliot, 1992; also see Raine, Lencz, Bihrlle, La Casse, & Colletti, 2000). Similarly, generalized frontal hypoperfusion on single photon emission computed tomography (SPECT) was found to be characteristic of increased aggressive behavior in a sample of adult and adolescent psychiatric patients (Kuroglu, Arikan, Vural, et al., 1996; Amen, Stubblefield, Carmichael, et al., 1996); while more specific bilateral and left prefrontal hypoperfusion, seen on SPECT, was found to differentiate between aggressive and non-aggressive behavior in a sample of individuals diagnosed with dementia (Hirono, Mega, Dinov, et
al., 2000). Reductions in the left anterior frontolateral cortex were also noted in a group of temporal lobe epilepsy patients with recurrent episodic aggression (Woerman, van Elst, Koepp, et al., 2000). Thus, evidence produced by a variety of neuroimaging and electrophysiological techniques implicates frontal lobe dysfunction in prefrontal regions as central to aggressive behavior.

A high frequency of electroencephalographic and CT abnormalities have been reported in the temporal brain regions of violent populations as well (e.g., Wong, Lunsden, Fenton, & Fenwick, 1994; Volkow and Tancredi, 1987; see Bassarath, 2001; Brower and Price, 2001; Raine & Buchsbaum, 1996 for reviews). Using PET and EEG, Gatzke-Kopp and colleagues (2002) reported reduced prefrontal metabolism as well as significant increases in EEG slow-wave activity in the temporal lobes of 14 murderers. Similarly, Volkow and coworkers (1995) presented PET data indicating reduced prefrontal and temporal metabolism in a sample of habitually violent individuals as compared to normal controls. In a previous study, Volkow & Tancredi, 1987 reported reduced metabolism and blood flow and in the frontal and right temporal cortex on PET, as well as generalized cortical atrophy and abnormal eletrophysiological activity, on CT and EEG respectively.

A well-designed study by Raine and coworkers (2001) compared PET data from abused violent individuals to that of, 1) abused nonviolent individuals, 2) violent individuals who lacked a history of abuse in childhood, and 3) a control group composed of nonviolent, nonabused individuals. Results indicated reduced right hemisphere temporal lobe functioning in severely abused violent offenders. In contrast, abused nonviolent individuals evidence fairly good right hemisphere functioning, but lower activation of left hemisphere. Raine hypothesized that deficits in right hemisphere mediated processes such as fear conditioning, pain perception, behavioral withdrawal,
and anger and fear recognition, may result in a significant predisposition toward violence.

Not only are these brain abnormalities present in adults who have committed violent crimes, they are also prevalent among child and adolescent homicide offenders (Myers, Scott, Burgess, & Burgess, 1995), and may even be predictive of those who will go on to commit violent offenses. In a study of incarcerated adolescent offenders, who several years later went on to commit murder, Otonow-Lewis and colleagues (1985) found that, based upon initial neuropsychiatric evaluations taken between ages 12-18, six of the nine murderers had histories of severe head injuries in childhood, three exhibited grandmal seizures and abnormal EEG's, one was microcephalic and had an abnormal EEG, and the remaining three demonstrated a variety of psychomotor problems. Additionally, all nine had relatives that had been hospitalized for psychiatric problems. When compared to 24 incarcerated delinquents, who on follow-up years later had not murdered, the authors noted that "the most significant symptoms that differentiated the groups were psychotic symptoms and neurological impairment." In addition to increased risk for criminality and violence, severe childhood brain injury, and neurological abnormalities have been linked to inferior academic performance, impaired social and interpersonal interactions, and poorer adaptive functioning (Fletcher, Ewing-Cobbs, Minor, Levin, Eisenberg, 1990; Petersen, Matousek, Mednick, Volavka, & Pollock, 1981).

Cumulative evidence from clinical and neuroimaging studies point to a strong association between increased aggression and reduced prefrontal cortical size or activity, with studies citing bilateral prefrontal abnormalities as well as left anterior frontal and orbitofrontal abnormalities. Findings of generalized dysfunction and temporal lobe pathology in violent individuals support the involvement of other brain regions as well. Interestingly, studies involving individuals who committed murder tended to report more
evidence of frontal and temporal lobe abnormalities, as well as more signs of gross
cortical involvement.

Neuropsychological Findings

The majority of studies utilizing neuropsychological tests to assess the integrity of the
brain have found evidence of a relationship between impaired cognitive functioning and
aggression in antisocial and violent populations (Elliot, 1992; Golden et al., 1996; Jones,
1992; Morgan & Lilienfeld, 2000). In fact, evidence of impaired neurocognition was
noted to be as high as 94% in one sample of homicide offenders (Yeudall & Fromm-
Auch, 1979) and similarly high in another (Blake et al., 1995). These rates are in stark
contrast to reported incident of neuropathology in the general population (i.e., 3%)
(Brown, Fann, & Grant, 1994).

One of the most consistent findings in this area is that of poor performance on
neurocognitive tests believed to measure abilities subsumed by the frontal lobes (Blair &
Price, 2001). Putative functions subsumed by this region include aspects of attention,
cognitive flexibility, problem solving, concept formation, and planning abilities.
Analogous to the role of an executive, these neuroanatomical substrates determine the
allocation of finite resources (e.g. attention and controlled information processing), while
acting in an integrative, decision-making capacity within the brain (Mills & Raine, 1994).
Thus, damage to or dysfunction of the frontal lobes can produce a wide array of
behavioral abnormalities, with some having direct links to behavioral inhibition and
control, affect regulation, and judgment abilities, which are often impaired in violent
offenders.

Investigation of the relationship between frontal executive dysfunction and violence
has been widely studied in a variety of populations. A prospective investigation of
forensic psychiatric inpatients, who had committed a violent crime, found that low scores
on three tests of frontal executive function significantly predicted frequency of
aggression over the course of one year and ultimately accounted for 57% of the variance between patients (Foster, Hillbrand, & Silverstein, 1993). Two studies by Giancola and colleagues (Giancola, Moss, Martin, et al, 1996; Giancola, Mezzich, & Tarter, 1998), one using a sample of adolescent boys with paternal histories of substance misuse and the second involving conduct disordered adolescent females (Giancola, Mezzich, & Tarter, 1998), found low executive functioning scores to be a significant predictor of aggression in both groups as well. Two studies using a laboratory based procedure designed to provoke aggressive behavior also correlated poorer performance on putative executive function tests with increased aggression in community samples of physically and psychologically healthy young men (Giancola & Zeichner, 1994; Lau, Pihl, & Peterson, 1995).

Although deficits in prefrontal functioning appear to predominate in the relationship between cognitive dysfunction and violence, these findings do not rule out the possibility of additional brain correlates involved in the etiology of aggression. It is important to remember that as with all areas of the brain, the frontal lobes are not a closed system, they receive inhibitory and excitatory inputs from other cortical and subcortical regions, including the basal ganglia, limbic system, and the hippocampus. The frontal lobes also project fibers to various cortical and subcortical regions, thus forming feedback loops that regulate complex cognitive and motor operations, including problem solving and, more generally, executive functions. Therefore, problem solving, which is primarily mediated by the frontal lobes, can be deficient if there is damage to any of the cortical structures that make up the feedback loop.

Neuropsychological evidence for a broader picture of dysfunction in aggressive populations has been provided by a number of studies (Brickman, McManus, Grapentine, & Alessi, 1984; Moffitt & Henry, 1991; Nestor, 1992; Teichner & Golden 2000). Brickman, McManus, Grapentine, & Alessi (1984) found that relative to a group
of nonviolent criminals, violent offenders evidenced greater impairment on Luria-Nebraska tests sensitive to temporal lobe dysfunction. This finding was in direct contrast to a study by Bryant and colleagues (1984) which found violent offenders to be significantly impaired on putative frontal tests from the Luria Nebraska Neuropsychological Battery. Mixed findings were reported by Nestor (1992) in a study of forensic psychiatric in-patients, all convicted of committing a violent offense (most murder). Nestor (1992) found unique cognitive profiles among this sample that appeared to be related to age. Specifically, the "younger group" (average age 19.3 years at time of offense) demonstrated significant reading impairments, while the "older group" (average age 41.4 years at time of the offense) performed more poorly on a measure of cognitive flexibility (Trail Making Test Part B).

A link between greater brain pathology and violence was also demonstrated in at least one study (Young Justice, & Erdberg, 1999). Using the Halstead-Reitan Battery, Young Justice, and Erdberg (1999) found that overall level of cognitive impairment, measured by the Halstead Impairment Index (HII), successfully differentiated between high versus low violent behavior in a sample of psychiatric inmates. Impaired concept formation and reasoning ability (determined by the Booklet Category Test), was also found to distinguish between these groups. Thus, neuropsychological studies, while supporting a strong relationship between "executive dysfunction" and increased aggression also suggest a role for generalized pathology and temporal lobe dysfunction among violent offenders, habitually aggressive patients, and antisocial personality-disordered samples (for reviews see Brower & Price, 2001; Dolan, 1994; Golden et al., 1996; Moffitt, 1990; Moffitt & Henry, 1991; Teichner & Golden, 2000).

In contrast with a multitude of studies that have identified a range of neuropsychological deficits, and particularly executive impairment in aggressive populations, a review of the neuropsychological literature by Kandel and Freed (1989)
concluded that, "evidence for the association between specifically violent criminal behavior and frontal lobe dysfunction to be weak at best." (p.410). Additionally, in direct contrast with the majority of investigations, which noted a link between increased aggression and cognitive impairment, there was at least one study that provided contradictory results. Specifically, in a small study of ASPD subjects, the high violence subjects as a group, performed significantly better than the low violence subjects on a widely accepted measure of frontal executive functioning (Wisconsin Card Sorting Test). Although it can not be determined from the study, increased rates of psychopathy in this sample may account for the reversal in findings.

In summary, the majority of studies support the conclusion that increased aggression is associated with cognitive deficits on neuropsychological testing. Deficits were noted in prefrontal executive and left hemisphere temporal lobe functioning; severe generalized impairment was also found to be incrementally predictive of violence. In addition to supporting the relationship between neuropsychological dysfunction and violence, results also provide support for theories of cognitive heterogeneity underpinning aggression in these populations. Empirical evidence of cognitive heterogeneity is consistent with postulated explanations for the relationship between neuropsychology and violence. Jones (1992) (as cited in Golden et al., 1996) proposed four pathways mediating this relationship including 1) increased activation of the nervous system relative to the ability to think, 2) decreased inhibitory ability relative to activation; 3) impairment of attention, concentration, memory, and subsequent higher mental processes; 4) and misinterpretation of external stimuli and events. It remains to be seen however whether potentially pathogenic differences in cognitive dysfunction relate to diagnostic and demographic heterogeneity within this population itself.
Summary

Neuropsychological testing, clinical observation, and neuroimaging studies have all demonstrated a link between increased aggression and neuropathology. Although there is some disagreement among studies regarding those brain regions and associated neurocognitive abilities that are most strongly associated with aggression in violent offenders, prefrontal abnormalities have emerged as the predominant finding in the literature. Left hemisphere verbal impairment, indicating temporal lobe abnormalities and potential disruption in subcortical limbic structures, has also been demonstrated. Additionally, there appears to be some evidence for a unique relationship between homicidal violence and fronto-temporal profiles. This may be an artifact of sampling or it may be that this pattern of brain disruption, particularly involving the right hemisphere (Raine et al., 2001) actually places individuals at an incrementally greater risk for serious violence. One factor that may account for the variability in findings among these studies is the presence of heterogeneity in brain and cognitive function among violent offenders (Golden et al., 1996; Moffitt, 1990; Teichner & Golden 2000). That is, it may be that while all violent offenders exhibit similar types of criminal behavior, the factors that contribute to these behaviors differ from one individual to the next. Support for heterogeneity in the causes of violence is indicated by evidence that at least two distinct types of violence can be distinguished.

Typologies of Aggression

The theoretical literature on aggression is dominated by two classic models (Bandura, 1973; 1978; 1983; Baron, 1977; Berkowitz, 1989, 1990, 1993; Dollard et al., 1939; Fleshbach, 1964; Parke & Slaby, 1983), the frustration-aggression model and the social learning model. According to the frustration-aggression model, aggression is the result of hostile angry feelings brought about by an aversive stimulus or by the
impedance of some goal. This type of aggression is often directed at the perceived source of the frustration and has been characterized as "...a response to physical or verbal aggression initiated by others with violence that is relatively uncontrolled and emotionally charged" (Raine, 1998, p. 320).

In contrast to the frustration-aggression model, which focuses primarily on the emotional arousal involved in the process of aggression (Berkowitz, 1989, 1993), social learning theory addresses the origins of aggressive behavior that can not be adequately explained in terms of reactive emotion (Bandura, 1973; Parke & Slaby, 1983). According to social learning theory, aggressive behavior is learned through observation and modeling, and maintained through positive and negative reinforcement (Bandura, 1983). As an example, aggression might be learned by witnessing another individual act violently. If the model is desirable and the aggressive behavior is paired with a positive outcome (e.g., acquisition of a desired goal or object), the likelihood for imitation increases. Eventually, via rehearsal and the frequent pairing of aggression with reward, aggressors experience a reduction in negative arousal associated with antisocial acts. An important consequence of the weakening of this association is an increased likelihood for proactive aggression in the future.

Typologies of aggression (Berkowitz, 1983, 1989, 1993; Buss, 1961; Feshbach, 1964; Hartup, 1974), that conform to the frustration-aggression (reactive aggression) and social learning theories (instrumental aggression), have been used to classify violent offenders and their aggressive acts (Cornell et al, 1996). Reactive aggression (affective, angry, impulsive, and retaliatory) has been defined as, "a response to physical or verbal aggression initiated by others with violence that is relatively uncontrolled and emotionally charged" (Raine, 1998, p. 320). In contrast, instrumental or predatory aggression is "controlled, purposeful aggression lacking in emotion that is used to achieve a desired goal" (Raine, 1998, p. 320). These constructs also are consistent with a dichotomy used
by the FBI, which grouped murder offenders into organized or disorganized. Organized offenders planned their offenses and left little evidence. Disorganized offenders committed spontaneous homicides.

Support for the validity of the two modes of aggression has been robust (for a review see McEllistrem, 2004). Animal research has provided evidence for separate neural pathways mediating defensive and predatory responses in cats (Mirskey & Siegal, 1994; Siegal & Pott, 1988; Siegal & Shaikh, 1997). In humans, increased autonomic nervous system (ANS) arousal has been found to play a predominate role in affective/reactive forms of aggression (Raine et al, 1998). Additional biological correlates of reactive aggression include reduced serotonin (see Brown, Botis, & Van Praag, 1994; Dolan, 1994; Linnoila, Virkunnen, Scheinin, Nuutila, Rimon, & Goodwin, 1983; Markowitz & Caccoro, 1995 for reviews), low plasma cortisol levels, abnormal metabolism of monoamine oxidase (MOA) (Boulton, Davis, Yu, Wormith, & Addington, 1983; Virkkunen, Nuutila, Goodwin, & Linnoila, 1987; Dolan, Anderson, & Deakin, 2001), and decreased frontal brain activation.

In a study of normal volunteers asked to imagine both a neutral scenario and one involving their own aggressive behavior, Pietrini, Guazzelli, Basso, et al., (2000), found that lower ventromedial frontal activity on PET was related to the visual evocation of the aggressive scenario only. Two PET studies, which compared forensic psychiatric patients with normal controls, documented decreased frontal cortical blood flow or metabolism associated with "repetitive" and "purposeless" violent behavior (Volkow & Tancredi, 1987; Volkow, Tancredi, Grant, et al., 1995). Another PET study of "impulsive aggression" found that, compared with non-psychiatric controls, patients with personality disorders showed decreased anterior medial and left anterior orbitofrontal metabolism, which correlated with increased scores on a self-reported aggression scale (Goyer, Anderson, Semple, et al., 1994). While these studies provide evidence for the role of
prefrontal brain structures in reactive and purposeless aggression, one study has provided support for differential brain activation in reactive and instrumental offenders (Raine et al., 1998). Raine and colleagues (1998) separated subjects into "predatory" versus "affective" murderers. Using PET they found that higher right subcortical functioning and lower prefrontal activity characterized affective murderers only. Nonaffective predatory murderers, while demonstrating increased right subcortical activity, had relatively normal prefrontal metabolism. Raine (1998, p. 324) postulated that this pattern would lead to "predatory murderers having greater cortical control over subcortical impulses, meaning that behaviors they chose to follow through with may be better planned".

By focusing attention on the affective aspects of aggression, the reactive-instrumental differentiation not only stimulated research into the brain correlates of reactive and instrumental aggression, it also facilitated investigations into subtypes of violent offenders that differ on this important dimension. These studies also provide additional support for heterogeneity of brain function in violent offenders by suggesting at least two types of aggressive behavior, each of which appears to be associated with specific brain regions, as well as unique personality, environmental, and social influences.

**Psychopathy Defined**

Psychopathic personality disorder (PPD) is distinguished by a specific constellation of personality features and behavioral symptoms (Cleckly, 1976; Hare, 1991, 1993). Interpersonally, psychopaths have been described as grandiose, manipulative, deceitful, and callous. Their affective experiences are deficient, including their capacity for empathy, anxiety, and genuine remorse. Behaviorally, they are parasitic, predatory, and evidence a proclivity for engaging in socially deviant and violent behavior (Hare, 1991).
Psychopathic individuals are conceptualized as being different from antisocial personalities. Although persons with antisocial personality disorder (ASPD) and PPD may evidence similar behavioral patterns, individuals with ASPD are not conceptualized as possessing the same core affective and interpersonal attributes as those with PPD. This is an important distinction given that psychopathic traits have been associated with a range of negative outcomes. For example, although only 15-30% of correctional offenders in North America are classified as psychopathic, these offenders are believed to account for almost half of the crimes committed here (Hare, 1998; Hart & Hare, 1997; Medinick et al., 1987). Additionally, there is considerable evidence indicating that individuals characterized as psychopathic as compared to antisocial, engage in more community violence beginning at a younger age; 2) are more prone to violent and nonviolent recidivism, and; 3) are less responsive to conventional treatment (Haapasalo, 1994; Hare et al., 2000; Hemphill et al., 1998; Rice, 1997; Rice Harris, & Cormier, 1992; Salekin, et al., 1996). In addition to the strikingly malignant nature of their offending, characteristic patterns of violence have been found to distinguish psychopathic offenders from other violent offenders (Williamson, Hare, & Wong, 1987).

**Violence Patterns in Psychopathic versus Nonpsychopathic Offenders**

In contrast with nonpsychopathic criminals, who tend to assault intimate or familiar persons during periods of intense emotional arousal, psychopathic offenders tend to kill strangers and are more characteristically instrumental or appetitive in their aggression (Cornell et al., 1996; Williams, Hare, & Wong, 1987). Higher rates of predatory violence among psychopathic offenders is consistent with 1) evidence of reduced arousal/anxiety in psychopathy (Arnett, Howland, Smith, & Newman, 1993; Patrick, Bradley, Lang, 1993; Patrick, Cuthbert,. & Lang, 1994); 2) associations between psychopathy and sadistic sexual arousal (Hemphill, Hart, & Hare, 1994; Rice, Harris, & Quinsey, 1990; Serin et al., 1994) where killing may be the end in itself (Meloy, 2000); 3) nonsignificant correlations...
between psychopathic reoffending and substance abuse, which tends to facilitate reactive forms of violence (Holt, Meloy, & Strack, 1999; Rice, & Harris, 1993; Smith, & Newman, 1990); 4) the tendency to kill males more often than females (except for notably higher rates of sexually sadistic homicide among psychopaths), and; 5) demonstration of little if any remorse on apprehension (Williams, Hare, & Wong, 1987).

Cognitive Functioning in Psychopathy

The terms "acquired sociopathy" and "pseudopsychopathy" are sometimes used to describe patients with frontal lobe damage because of similarities between their behavior and that of individuals characterized as psychopathic. However, the notion that the defining features of psychopathy are associated with the kind and pattern of severe brain dysfunction that occurs in frontal lobe syndromes (Gorenstein, 1982; Lapiere, Braun, and Hodgins, 1995) has not been born out by the literature (Hare, 1984; Hart, Forth & Hare, 1990; Hoffman, Hall, & Bartsch, 1987; Raine, O'Brien, & Scerbo, 1991; Sutker & Allain, 1983).

Despite initial support for the hypothesis of frontal dysfunction in psychopathy (Gorenstein, 1984; Lidberg, Levander, Schalling, & Rosen, 1978; Newman, Patterson, and Kosson, 1987; Schalling & Rosen, 1968), recent research using more stringent and reliable criteria to define the psychopathy construct (PCL-R; Hare, 1991) have not produced positive results (Hare, 1984; Hart, Forth & Hare, 1990; Hoffman, Hall, & Bartsch, 1987; Sutker & Allaine, 1983; Raine, O'Brian, and Scerbo, 1991). In fact, one study (Raine, O'Brian, & Scerbo, 1991) actually demonstrated significantly better performance by adolescent conduct-disordered psychopaths as compared to non-psychopathic conduct-disordered adolescents on measure of executive function (WCST).

Hare (1984) has suggested that comparisons between psychopaths and frontal lobe patients have been so focused on a few apparent similarities (e.g., preoccupation with
sexuality, socially inappropriate conduct, neglecting to consider the long-term consequences of actions, extreme behavioral disinhibition) that they have failed to take proper note of the many dissimilarities. A careful examination of psychopathy and frontal lobe syndromes highlights ways in which the two conditions differ. Although psychopaths have been noted to demonstrate sexual deviancy, which may be demonstrated via socially inappropriate behavior (e.g., rape), the presentation is fundamentally different from that of the classically frontal impaired patient. For example, frontally impaired patients may engage in behaviors that are socially inappropriate (e.g., public masturbation) due to a lack of awareness of prohibitions against such a behavior or because of an inability to inhibit the impulse. On the other hand, there is no evidence to suggest that the actions of the psychopath are motivated by a failure to comprehend prohibitions against their deviant behavior (Cleckley, 1976; Hare, 1996) or an inability to inhibit impulses. In fact, greater degrees of planning, not impulsivity, tend to characterize psychopathic acting out suggesting that psychopaths at least attempt to 'successfully' violate social norms (Cornell et al., 1996; Williams, Hare, & Wong, 1987).

Additionally, in stark contrast to patients with frontal lobe disorders, psychopaths are often described as being quite charming and verbally skilled, which suggests a fundamental understanding of the subtleties of polite society, if a lack of concern for them. Therefore, while psychopaths have been characterized as having a "specific loss of insight" (e.g., they can articulate the prosocial position, but do not follow it) (Cleckley, 1976), their discordant actions are not characterized by the same "extreme behavioral disinhibition" of anterior frontal patients. Damasio (1979) summed this discrepancy up best by noting that "although frontal lobe patients may look psychopathic, they lack the organization of the psychopathic personality" (p. 400).

Although neuropsychological tests (Hare, 1984; Hoffman, Hall, & Bartsch, 1987; Raine, O'Brian, & Scerbo, 1991; Sutker & Allain, 1983) and many neuroimaging studies
have failed to support a theory of anterior/frontal pathology in psychopathy (Hart & Hare, 1997; Intrator et al., 1997; but see Raine, 2001), these studies do not eliminate the possibility that symptoms of psychopathy are related to more subtle forms of brain abnormality. Recent reconceptualizations of psychopathic brain impairment focusing on the amygdala (Blair & Frith, 2000; Blair, Morris, Frith, Perrett, & Dolan, 1999; Patrick, 1994) and the orbitofrontal cortex (Damasio, 1994; LaPierre, Braun, & Hodgins, 1995; Patterson & Newman, 1993) have had better success. These studies have provided evidence for subtle deficits in psychopathy that are likely neurodevelopmental in nature, as the prefrontal regions of the brain are the last to mature and their proper maturation is dependent upon environmental feedback. Whatever the explanation for these contradictory findings, when considered along with the more general literature on violence and brain function, the studies of psychopathy provide further evidence of heterogeneity of neurocognitive function in violent offenders.

Investigation of Cognitive Heterogeneity

Noting the pattern of cognitive heterogeneity across many neuropsychological studies of aggressive populations, Teichner and colleagues (2001) sought to empirically classify “valid and meaningful” subgroups of delinquent adolescents based on measures from the Luria Nebraska Neuropsychological Test Battery. Using cluster analytic methodology, the authors identified four distinct cognitive clusters and explored the relations between differential patterns of neuropsychological functioning and a range of clinical and demographic variables.

Participants were 77 males and females receiving treatment at an outpatient community clinic. All subjects were diagnosed with a substance abuse disorder and conduct disorder. Based on thirty-five scores from the LNNB, cluster analyses derived four cognitive groups. Tiechnen and coworkers described members of one cluster as
cognitively "normal". This group also had with the best academic history, second highest family income, least number of members enrolled in special education, and the lowest nonwhite membership (22%). The second cluster was named "mild-verbal". This cluster evidenced relatively mild impairment across the various neuropsychological measures including on reading comprehension and verbal list learning. The group members had the second most years of education, the highest family income, the second lowest rates of special education attendance, and the second highest number of Caucasians (73%).

A third group described showed significant impairment on a number of verbally mediated tasks. They were named "Verbal/left hemisphere (VLH)". The authors point out the similarities between this cluster and the extensive literature indicating greater rates of verbal impairment among adolescent and adult offenders (for a review see Teichner & Golden, 2000). Demographically, this group was the youngest; they had the fewest years of education, the lowest family income, and the second highest rates of enrollment in special education classes. They evidenced the highest incidence of prior head injury and birth difficulties, and had proportionally greater numbers of males and nonwhites.

Members of a fourth cluster showed the greatest amount of general impairment. The authors note that "deficits appeared to involve memory and higher-level analysis problems, most consistent with a frontal/subcortical type etiology." Thus they were named "subcortical Frontal". Demographically, this group had the fewest years of education, even though they were the oldest, the 2nd lowest family income, and the highest rates of special education enrollment (58%). They were composed of the most males and the fewest Caucasians. This cluster was also noted to have evidenced psychological problems and delinquent behaviors.

Teichner and coworkers (2000) concluded that heterogeneity in cognitive skills among the subgroups was suggestive of differences in the origin of their problems.
Notably, identified subtypes in the study correspond well with the previously presented theories of brain systems and hypothesized pathways linking neuropsychological dysfunction to violence. Thus, in addition to supporting the current literature on neuropsychological correlates of aggression, this study also provides a strong basis for continued investigation into cognitive heterogeneity in aggressive populations.

Summary

Not unexpectedly, brain-behavior correlates associated with violence were found to vary within and across offender groups. For example, in some studies offenders were found to demonstrate primarily an executive dysfunction, while in others they showed evidence of a language deficit and/or generalized impairment. Instrumental and hostile aggression were found to be associated with different brain regions, which suggests that differences in neurocognitive functioning may be present between those whose aggressive acts are predatory (instrumental) and those whose acts are hostile (reactive). Finally, individuals diagnosed with psychopathy appear to be relatively free from executive function deficits, although frontal lobe dysfunction has clearly been associated with violence and aggression. These theoretical models of aggression, corresponding patterns of dysfunction in neurological studies, and mixed findings all suggest that there are real differences in brain functioning among offenders, and furthermore that subgroups of offenders may be developed based on neurocognitive functioning. Unfortunately though, as of yet there has only been one attempt to use the obvious neurocognitive heterogeneity present among violent offenders to develop offender subtypes. Therefore, the distribution and relative contribution of various patterns of neurocognitive function and their association with aggression, and homicidal violence in particular, remains unknown.
Also presented in this review were studies demonstrating the success of using the constructs of psychopathy and aggression as organizing variables to guide investigations into subtypes of violent offenders. Both of these variables have demonstrated impressive explanatory and predictive power, stimulating further research and influencing clinical practice and public policy. Importantly, the literature suggests that cognitive functioning, like the constructs of psychopathy and violence, is not simply a descriptive feature of violent offenders but is likely an independent and etiologically relevant one with respect to both violence and psychopathy and thus might also be expected to provide significant explanatory power when employed as a primary organizing variable in violent populations.

Rationale and Purpose of the Current Study

Based upon the previous review it is clear that violence is not a unitary construct and that violent offenders constitute a heterogeneous population with heterogeneous motivations for their homicidal acts. It should also be clear that neurocognitive abnormalities act as risk factors for violence. While not all individuals who become violent have evidence of brain damage or dysfunction, neurological compromise does appear to be a core component in the violence of some offenders, and a less powerful, but still potentially relevant factor for others. The relative contribution of brain impairment to actual acts of aggression, however, still remains unclear. Also unknown, is the manner and degree to which neurological dysfunction relates to, is influenced by, and influences other clinical, crime, and victim variables.

The purpose of the current investigation is to examine cognitive heterogeneity in homicide offenders. To this end, cluster analyses techniques will be applied to neurocognitive performance variables. Neuropsychological data collected from 62 murderers will be examined in order to describe and delineate cognitive subtypes of
homicide offenders. Validation will be based on correspondence between theoretically proposed groups and their hypothesized clinical and homicidal profiles. Using these techniques four typologies of murderers are hypothesized to emerge from the study sample. Based on previously noted studies, identified clusters are proposed to be differentiated from one another on neuropsychological performance. It is believed that the pattern of difference between groups will relate conceptually to a number of a priori determined clinical and crime-related outcome variables. Additional variables of interest will be evaluated as descriptors. Implications of identified clusters for predicting outcomes in a variety of settings, influencing treatment approaches, and planning for prevention programs, will be discussed.

Hypotheses

Given the research in the area, there appears to be clear evidence of cognitive heterogeneity. The current investigation will assess for the presence of heterogeneity in Halstead-Reitan and WAIS profiles from a sample of homicide offenders through the use of cluster analytic techniques. The focus of the current research is to understand violence dimensions, as well as, phenomenological and demographic characteristics of empirically derived cognitive subtypes of murderers. The goal is to derive and validate useful cognitive clusters of homicide offenders. The hypotheses are:

I. Based on the neuropsychological literature previously reviewed and the Tiechner et al., (2001) findings using cluster analyses with neuropsychological tests, it is hypothesized that four clusters will emerge:

A) A "neuropsychologically normal" cluster defined by overall average mean scores on the WAIS subtest scaled scores and mean HRB scores in the normal range.
B) A “verbal learning” cluster defined by normal to mild impairment on HRB measures and mildly impaired left hemisphere mean scaled scores on WAIS Performance subtests, but mildly to moderately impaired scaled scores on WAIS Verbal subtests.

C) A “borderline IQ/impaired” cluster defined by impaired performance on HRB measures of cognitive reasoning and planning (BCT, TMT, and TPT Location) and borderline intellectual functioning on the WAIS subtest scaled scores.

D) A “severely impaired” cluster defined by severe generalized impairment on all HRB variables as well as borderline to mildly retarded mean scaled scores on the WAIS Verbal and Performance subtests.

II. Cognitive clusters will demonstrate different patterns of violence as measured by the Cornell rating scales (Cornell et al., 1996).

A) The "Neuropsychologically Normal" functioning cluster (1A) will demonstrate:

i) An overall greater degree of instrumentality relative to the other clusters.

ii) Greater degrees of goal directedness and planning relative to the other clusters.

iii) Less provocation and arousal than the other clusters.

   a. Decreased frequency of active psychotic symptoms and intoxication relative to the other clusters.

   b. Greater tendency to kill strangers and males relative to the other clusters.

B) The borderline IQ/impaired functioning cluster (1B) will show greater rates of reactive violence that is most often directed at intimates, except when there are multiple perpetrators involved then the targets will more often be strangers, and the violence more instrumental.
C) The "Verbal Learning" cluster will evidence both reactive and instrumental violence associated with increased rates of intoxication.

D) The "Severely Impaired" cognitive functioning cluster will evidence primarily reactive violence, increased rates of psychosis, and a greater tendency to kill close relations or intimates.

III. It is hypothesized that the empirically-derived cognitive subtypes will not differ on:

a. DSM-IV lifetime diagnoses of alcohol and substance abuse disorders

b. History of physical abuse, sexual abuse, or family dysfunction.

IV. It is hypothesized that the empirically-derived cognitive subtypes will differ on:

A. History and severity of TBI, with the "Severely Impaired" and "Borderline IQ/Impaired" clusters having the worst histories relative to the "neuropsychologically normal" and the "verbal learning" cognitive functioning clusters.

B. Education with the "neuropsychologically normal" cluster differing from all other clusters in the direction of more education.

C. Reading Grade Level as measured by the Kaufman Test of Educational Achievement, which will be significantly lower for all clusters relative to the "Neuropsychologically Normal" functioning cluster, but will particularly differentiate the "verbal learning" cluster from the "neuropsychologically normal" cluster.
CHAPTER 3

METHODOLOGY

Participants

Approval for Use of Human Subjects

The experimental process used in the University of Nevada current investigation was authorized by the Social/Behavioral Committee of the University of Nevada, Las Vegas Institutional Review Board for Psychological Research. The OSP number is 0511-1789.

Population From Which the Sample Was Drawn

The data utilized in the current investigation were derived from the files of a local private practitioner. Study subjects represent a consecutively referred convenience sample of male and female homicide offenders (N = 62), consisting primarily of individuals tried and convicted in the state of Nevada, although individuals from California, Ohio, and Arkansas are represented as well. Subjects were referred for forensic neuropsychological evaluation between the years 1997 and 2005. Subjects obtained for the current study were referred for neuropsychological testing as part of pretrial evaluation, which had one or all of the following goals, 1) determine competence to stand trial, 2) clarification of psychiatric and neurocognitive functioning, and 3) examine potential mitigating factors. Alternatively, subjects were seen as part of a habeas review to look at similar issues. From the sample of 62 individuals who met outcome criteria for participation, data from 55 of those cases was utilized in the current investigation due to missing data or based upon the exclusion criteria.
Selection of Study Subjects

Four guidelines were used to identify individuals appropriate for inclusion in the current study. The criteria include: (1) presence of a full Halstead-Reitan Neuropsychological Battery or an attempt at such an evaluation, (2) sufficient data to make aggression distinctions (Cornell et al., 1996), (3) English as the primary language, and (4) charged with first-degree murder; conviction of first or second. The first three criteria were included for practical and statistical reasons and involve issues of data analyses and interpretability. As an example, English as the primary language has been stipulated in order to prevent the introduction of any potential bias in the neuropsychological test scores. The only exception to the first three inclusionary rules relates to incomplete neuropsychological test data.

Although a full neuropsychological battery is preferred, it must be recognized that indiscriminant exclusion based upon failure to complete the battery would result in a loss of important diagnostic information. This is because, discontinuation of cognitive testing can be necessary for a variety of reasons including 1) severe brain impairment, 2) psychosis, 3) oppositional behavior, 4) fatigue, and 5) physical disability. However, because some of these conditions represent exactly the factors we are interested in and which may have been contributory to the crime, a practice of selective exclusion of subjects with missing cognitive data will be implemented in this study. Accordingly, cases for which there is clear evidence (independent documentation) that incomplete neuropsychological data was the result of discontinuation, due to severe brain impairment or psychosis, or because of a physical disability, leading to only a minimal loss of data (e.g., peripheral nerve damage in hand), will not be excluded. Statistical methods for preserving data points will be discussed under Data Analyses.
There were two primary reasons for the decision to limit study subjects to those convicted of first or second-degree murder. The first reason involves a possible limitation in previous designs. Specifically, samples characterized as seriously violent have frequently included individuals convicted of crimes ranging from assault with a deadly weapon to first-degree murder. Unfortunately, such a design makes certain assumptions about the nature of violence that may not or may not be true. Of greatest concern is the assumption that violence is a continuous variable, with similar causal factors at all levels, or at least at the higher levels. However, contrary to this belief, it may be that some types of violence (e.g., homicidal) are fundamentally different from other types (non-homicidal), involving different etiological paths as well. If this is the case, then averaging across outcomes may dilute the dependant variable leaving the investigation insufficient power to detect real differences on these important factors. In order to minimize the potential for this type of noise in the data, the current study has chosen to employ the stringent and severe outcome criterion of charged with first-degree murder and a conviction of first or second-degree murder.

A second and related reason for using subjects convicted of first or second-degree murder involves the unique opportunity this group offers to expand our understanding of the kind of people who commit murder. As an example, are there some people whose crimes can be understood as representing escalation in violence due to circumstances as opposed to intent, while others whose violence is so foreign that it can only be comprehended as originating from a different breed of human animal? If so, can the source of these differences be ascertained? This question parallels inquiry into whether psychopathic and antisocial individuals differ in degree or kind, and has legal relevance for determining criminal responsibility and risk status. Furthermore, the identification of clinically coherent differences among homicide offenders, offers hope that someday we
may be able to develop treatment programs tailored to the needs of specific types of criminals, as well as those who may be at-risk for offending.

Original Forensic Evaluations

Each study subject was examined for a minimum of 8 and a maximum of 15 hours. All subjects were administered the Halstead-Retain Neuropsychological Test Battery (HRB), which includes the following tests: Reitan-Indiana Aphasia Screening Test, Finger Tapping Test (FTT), Grip strength test (GST), Sensory-perceptual Examination (Tests for perception of Bilateral Sensory Stimulation, Tactile finger recognition, Finger-tip Number Writing Perception), Tactile Form Recognition Test (TFRT), Rhythm Test (RHY), Speech-sounds Perception Test (SPT), Trail Making Test (TMT), Tactual Performance Test (TPT), and the Booklet Category Test (BCT). The revised or third edition of the Weschler Adult Intelligence Scale (WAIS-R; WAIS-III) was used to determine the subjects' intellectual functioning. Personality was objectively assessed with the Minnesota Multiphasic Personality Inventory-II (MMPI-II). The participants were administered the WAIS (Wechsler, 1981; 1997) and HRB tests either by a licensed psychologist or by a trained psychology technician under the direct supervision of a licensed psychologist. The complete HRB battery was administered according to standardized procedures. In general, tests were administered over a period of two days; assessments lasted approximately 5 hours each day. Breaks were given as needed. In addition to psychometric testing, all subjects were given a Mental Status Exam, a clinical interview, and a drug history interview. Beyond eliciting an individual's lifetime history of drug and alcohol use, the drug history interview also covered in detail the individuals actions substance (alcohol and/or drugs) use in the 48 hours prior to the offense. Circumstances surrounding the crime, the individuals state of mind, and a detailed description of the offense were also elicited. Finally, an extensive review of military,
educational, medical/psychiatric, family (including interviews with and/or statements from 
family, friends, and other relevant persons), and criminal justice records was also 
performed.

Chart Review Procedures

The data were compiled from the existing clinical files of a private practitioner. 
Deidentified data was obtained and assigned a unique ID number. Using Cornell's 
(1996) coding guide, a determination of primary mode of violence for the adjudicated 
first-degree murder offense. Secondary features of the homicides were determined at 
this point as well. The primary investigator was trained to rate instrumental and reactive 
violent acts according to guidelines in the codebook established by Cornell and 
colleagues (1996). Hypothetical situations provided by the authors were used for this 
training. In addition to violence ratings, a range of demographic, crime, clinical, and 
neuropsychological variables were extracted from the records and entered into an SPSS 
spreadsheet. The individual data sets (participants) were identified by using a three-digit 
code that included no identifying information. A list of the three-digit codes and the 
corresponding data set is maintained by the participating clinician.

Measures

Support for the Reactive/Instrumental Distinction

Support for the reactive/instrumental distinction is replete throughout the 
literature and has already reviewed.. Meloy laid out additional differences between the 
two forms of aggression. In affective types there is 1) intense ANS arousal, 2) subjective 
experience of conscious emotion, 3) reactive and immediate violence, 4) internal or 
external threat, 5) goal is threat reduction or homeostasis, 6) rapid displacement of 
target, 7) time-limited behavioral sequence, 8) preceded by public posturing, 9) primarily
emotional, 10) heightened and diffuse awareness. Predatory violence is marked by 1) minimal or absent ANS arousal, 2) no conscious emotion, 3) planned and purposeful violence, 4) no or minimal threat, 5) many goals, 6) no target displacement, 7) no time limit on behavior, 8) preceded by private ritual, 9) primarily cognitive-conative, heightened and focused awareness.

**Incident Rating of Reactivity and Instrumentality**

Although some acts are more easily classified as reactive or instrumental, most acts contain characteristics of both and as such are resistant to simple dichotomizations. However, Cornell and colleagues (Cornell et al., 1987; Cornell, 1990; Cornell, 1994; Cornell et al., 1996) have demonstrated that clinicians can make the reactive/instrumental distinction with high reliability using a coding guide. Thus, ratings will be based on the codebook developed by Cornell (1994). Data to be evaluated include an account of the incident, provided by the perpetrator, and all available court documents relating to that incident. The ratings of reactivity and instrumentality are on 4-point scales and reflect the overall degree of reactivity and instrumentality of the participants' actions. Possible ratings are extreme characteristics of reactive (or instrumental) aggression, moderate characteristics of reactive (or instrumental) aggression, a few characteristics of reactive (or instrumental) aggression, or no characteristics of reactive (or instrumental) aggression. Based upon separate dimensional ratings, a single categorical distinction of reactive/instrumental will be made. In making this final rating, greater weight will be given to the presence of instrumental characteristics. This is based on the recommendation of the authors who note that "reactive hostility is the more common pervasive form of aggression in criminal behavior and that instrumental aggression in criminal behavior represents a more pathological development and elaboration of the capacity for reactive violence" and consequently, that the presence of such features should be given precedence.
Although some participants in the study had extensive histories of violence, individuals were evaluated on the most recent violent incident only (i.e., their instant offense). This procedure was followed even if the individual is known to have a previous homicide conviction. Exceptions to this rule would include spree killings, in which the homicides were temporally related; discrete violent incidents that involve the death of multiple persons, and multiple homicides that occur within a restricted time frame (e.g., days or weeks apart), but were tried independently. In all cases, preference will be given to the more instrumental of the homicides. This rationale goes back to the previously noted assumption regarding the more pathological nature of instrumental violence, and research (Vitiello et al., 1990; Cornell et al., 1994), which found that individuals with mixed histories of both instrumental and reactive violence tended to be more similar to purely instrumental offenders.

A special circumstance that may arise entails the categorization of instances in which there are multiple perpetrators involved in a single violent incident. In many such cases it may not be known who actually committed the murder and who is the accomplice. In these instances, the incident will be rated as if the participant committed the crime, unless it is known otherwise. However, even if it is clear that the participant was the accomplice, the rating will still be based upon the characteristics surrounding the instant offense. To do otherwise would require too much speculation on the part of the rater regarding the accomplice's intentions and state of mind at the time of the crime. Still, there are many reasons to suspect that participant characterisations based on such evaluations may not be entirely valid. These are issues that will need to be revisited at the time of the analyses and may require the use of statistical procedures to factor out any potentially confounding effects of multiple perpetrator crimes.

In addition to making a reactive/instrumental rating of the violent incident, information was also gathered about the incident according to six offense characteristics relevant to
the reactive/instrumental distinction (Cornell, 1994) including 1) planning, 2) goal
directedness, 3) provocation, 4) arousal, and 5) relationship with victim. The planning
component reflects the degree of premeditation or preparation involved in the
aggression. Goal directedness items are based on the degree to which the participant
was motivated by specific external incentive or gain. Provocation reflects the extent to
which the participant felt threatened or provoked by the victim, and arousal items assess
emotions such as feeling anger or anxiety. Closeness of the relationship assesses
whether the victim was a relative, partner, friend, acquaintance, or stranger. The
component measures of planning, goal directedness, provocation, arousal, severity of
violence, and relationship with victim will be scored according to a Likert-type scale.

In addition to the six previously noted offense characteristics, information regarding
intoxication and psychosis will also be gathered. Intoxication reflects the degree to
which the individual was impaired as a result of alcohol or drugs, and the question of
psychosis assesses for the presence of active psychotic symptoms and the degree to
which they impaired reality testing at the time of the crime. Although the risk for violence
associated with mental illness is not very large, the presence of active symptoms does
increase risk (Leong & Silva, 1995; Mulvey, 1994). Among a sample of psychotic
homicide offenders, Leong & Silva (1995) found that 60% of the subjects were actively
delusional at the time of their crime. A study by Hafner and Boker (1982), comparing
violent and nonviolent psychotic patients revealed that delusional thinking was more
common among patients who committed violent acts than among nonviolent patients.
Furthermore, among those who committed homicides, evidence that the victim had been
incorporated into the patients delusional system (e.g., the victim was cast in the role of
enemy) was present in approximately 70% of the cases. In light of these findings, the
presence of psychotic symptoms is predicted to be an important factor in "explaining" the
violent behavior of some homicide offenders.
The nature of the psychotic symptomology to be coded includes disorganized and delusional thinking, and auditory, visual, tactile, and gustatory hallucinations; all to be scored as - yes/no/suspected. The content of the delusions (e.g., paranoid, threat/control override) and hallucinations (e.g., command hallucinations) were coded separately. Paranoid delusions were operationalized as delusions in which the person believes that an individual or group is intent on harming them or someone else, such that their hostile actions resonate as necessary and defensive. Threat/control override delusions were operationalized as delusions in which the person believes people are seeking to harm him and that outside forces are in control of his mind (Appelbaum, Robbins, & Roth, 1999).

With regard to intoxication, substance abuse has been forwarded as a preeminent etiological factor or one of several important etiological factors in many homicides. Yarvis (1994) noted that in a sample of 100 murderers almost half were intoxicated at the time of the murder, with alcohol being the drug most often abused. In the current study, mild intoxication was operationalized as 1 or 2 drinks not intoxicated; moderate was defined as intoxicated (i.e., probable BAL of .80), but no evidence of polysubstance abuse and very little psychological disruption (e.g., no memory loss); severe was defined as intoxicated (probable above 1.0; moderate substance abuse or polysubstance abuse), with psychological disruption; very severe is defined as intoxicated (above 1.0, most ever drank; heavy drug use - polysubstance abuse), with severe psychological disruption (memory loss, pass out; lack of sleep).

**DSM-IV Diagnoses**

Lifetime DSM-IV diagnoses of a mental disorder will be established based upon retrospective data (available psychiatric and medical records and diagnoses) and data from the original forensic neuropsychological evaluation. Based on the research clinician's administration of the DSM-IV-R checklist, each patient was coded as yes/no.
for having the following categories of disorder: schizophrenia or schizoaffective disorder; bipolar disorder; alcohol and/or substance abuse disorder.

Rational for the Assessment of Socio-Economic Factors

Previous studies (Silver, Mulvey, & Monahan, 1999) have documented that exposure to economic disadvantage and the ecological characteristics of poor neighborhoods can have a significant negative impact on the development of prosocial beliefs and behavior, which could interact with individual-level risk factors (e.g., brain impairment, mental retardation, mental illness) to elevate this population's risk for violence. Furthermore, certain theories of psychopathy have proposed low SES and pathological environmental contexts to be risk factors in the evolvement of several psychopathic variants (e.g., Lilienfeld's, 1994, and Lyken's 1995, Dysocial Psychopaths; Mealy's 1995 Disadvantaged Psychopath). Consequently, SES ratings (i.e., social disadvantage) are being derived in the current study. Differences between hypothesized subtypes on this variable may have important clinical implications with regard to interventions as well as issues of public policy.

An estimate of the level of social disadvantage that characterized each subject's home environment will be derived from contextual factors such as level of parent education and occupation, single parent household, and public assistance. The classical divisions of poverty, low SES, low/middle, etc were adapted to fit the previously mentioned contextual factors (i.e., poverty = public assistance, single parent household, no high-school diploma/GED, parental income less than minimum wage or unemployed).

Kauffman Test of Educational Achievement (KTEA)

The reading component from the KTEA was administered to assess reading grade level. Reading impairment has implications for academic attainment and may be indicative of left hemisphere dysfunction, which has been hypothesized to characterize a subgroup of homicide offenders in the current study.
Abuse and Maltreatment

A plethora of research (Windom, 1989, 1992; Lewis, Moy, and Jackson, 1985; Lewis, 1992) has linked childhood and adolescent abuse and antisocial parenting to violent behavior in adulthood. One study (Windom, 1992) estimated that childhood abuse increased the likelihood of future criminality by 40%. In the current study, physical abuse, sexual abuse, and family disruption and dysfunction were recorded. Each category was measured on a scale of 0 to 3 with three representing worse abuse or disruption (i.e., physical abuse -scale 0 - 3; sexual abuse scale 0 -3; family disruption and dysfunction scale 0-3).

Demographic Factors

In addition to the previously noted variables, a range of demographic data was recorded including the participant's age at the time they committed the crime and age at time of the evaluation, number of years of education completed, legal sentence (e.g., death sentence), history of birth complications and traumatic brain injury (TBI), the number of perpetrators involve in the offense, the number of victims that were killed, and the gender of the victim(s). These variables were recorded for descriptive purposes and in some cases for their hypothesized relations to predicted cognitive subtypes.

Neuropsychological Assessment

The participants were administered the Halstead-Retain Neuropsychological battery (HRB) and the WAIS-R (Wechsler, 1981) or the WAIS-III (Wechsler, 1997) as part of the original forensic evaluation. The Weschler Adult Intelligence Scale (WAIS), has been found to demonstrate high inter-item consistency and good test-retest reliability on non-speeded tests. Additionally, construct and criterion related validity for the test has been established over the course of many studies. Similarly, there is robust data regarding the ability of the HRB to differentiate between groups with and without cerebral damage.
(Reitan, 1955; Reitan & Wolfson, 1981; 1993), as well as the batteries capability to specify the regional localization (Doehring & Reitan, 1961b; Heimburger & Reitan, 1961; Wheeler & Reitan, 1962) and chronicity of damage (Fitzhugh, Fitzhugh, & Reitan, 1961, 1962a, 1962b, 1963), and the validity of these findings when applied to individual subjects (Reitan, 1964; Reitan & Wolfson 1981, 1993). The complete Halstead-Reitan Battery (Reitan & Wolfson, 1981, 1993) and WAIS scales (Wechsler, 1981; WAIS-III, Wechsler, 1997) were administered according to standardized procedures by a trained clinical neuropsychologist, or by a graduate level psychology student working under the direct supervision of a licensed psychologist.

**Variable Selection for the Cluster Analyses.**

The focus of variable selection in cluster analytic research is to choose variables likely to be "characteristic of the objects being clustered" and pertinent to the goals of the analysis (Hair et al., 1992). Measures of neurocognitive functioning were included in the present study because of the plethora of research indicating a relationship between certain types of brain damage, and impulsive disinhibited behavior. Neuropsychological tests are behavioral measures that assess the integrity and functional capacity of the brain and the individual's ability to think logically. It is this ability to think logically and to plan and carry out intended actions that is hypothesized to reflect many qualitative differences in violent acts, which have bearing on perceptions of the degree of malice of an act and frequently are used to guide decisions regarding criminal charges and sentencing.

Many studies have employed scores on neuropsychological measures as dependent variables to describe differences in violent offender samples grouped based on clinical person variables (e.g., psychopathic PD, antisocial PD, psychotic disorders, substance abusers etc.) and/or violence characteristics (reactive versus instrumental). This preference given to indirect measures of brain function over direct measures of brain function...
function as the primary organizing variables in developing a taxonomy is puzzling given that these distinctions are ostensibly based on brain function differences between violent offenders. Subtyping based upon cognitive function has been used in other clinical populations to reduce heterogeneity with good results (Goldstein, 1990; Goldstein & Shemansky, 1995).

This approach evidences a number of advantages over the use of clinical or violence variables for creating a taxonomy of violent offenders. In addition to having the strength of being directly related to brain function, neuropsychological measures are more stable over time than are psychiatric symptoms, which are notoriously unstable, or the diagnosis of personality disorder, which is notoriously unreliable. It does not make sense to develop a classification system based on variables that are not reliable over time, because if you use a feature that is present one day and gone the next, your classification system will not be valid because it will not be reliable, and thus will not distinguish between the subjects in any meaningful way (Goldstein, 1990).

The Halstead-Retain Neuropsychological battery and Wechsler Adult Intelligence Scale are made up of a number of tests that measure a broad range of cognitive abilities. Thus, scores on these tests make ideal variables for the investigation of cognitive heterogeneity in homicide offenders. However, not all indices from the HRB and WAIS were selected for clustering, instead only measures thought to be capable of maximally differentiating between persons on cognition-related constructs were selected. In all, sixteen variables from the HRB and WAIS were selected for clustering. They were the BCT, TMT A and B, TPT time per block, TPT memory, TPT location, SRT, SPT, and FTT (dominant and nondominant hand) from the HRB, and the Vocabulary, Similarities, Arithmetic, Digit Span, Block Design, and Digit Symbol from the WAIS subtest scales. Derived Full Scale, Performance Scale, and Verbal Scale IQ were reported as descriptive data but were not entered into the cluster analyses. The following
paragraphs provide a description of the HRB and WAIS tests selected for clustering. Measures included for descriptive purposes are discussed as well.

**Lateral Dominance**

The Lateral Dominance Examination (Reitan & Wolfson, 1985) is a valid and reliable measure of handedness. The examination consists of a series of performances used to determine an individual's preference for using the left or right hand on a unimanual task and the left or right foot on a unipedal task. Establishing handedness is important in order to administer and interpret a number of the tests in the HRB (as cited in Reitan & Wolfson, 1985).

**Frontal/Executive Abilities**

**Attention**

The Seashore Rhythm Test (Reitan & Wolfson, 1985; Seashore et al., 1960) requires the subject to differentiate between 30 pairs of rhythmic beats. This test is a measure of nonverbal auditory perception and requires alertness, sustained attention to the task, and the ability to perceive and compare different rhythmic sequences. The test seems to be an indicator of the general adequacy of cerebral functioning, and has no lateralizing significance (as cited in Reitan, & Wolfson, 1989). Test-retest reliabilities for the Seashore Rhythm Test (SRT) range from .50 to .77 (Borenstein, Baker, & Douglas, 1987; Goldstein & Watson, 1989).

The Speech Sounds Perception Test (Boll, 1981; Reitan & Wolfson, 1985) consists of 60 spoken nonsense words. The subject underlines one of four choices per presentation. This test requires the subject to (1) maintain attention through 60 items, (2) perceive the spoken stimulus sound through hearing, and (3) relate the perception through vision to the correct configuration of letters on the test. Research results demonstrate that some persons with left cerebral lesions are sometimes more impaired on this test than persons with right cerebral lesions (Reitan & Wolfson, 1990), but usually
no striking Lateralization effects are found. Overall the SPT appears to be a good indicator of the general integrity of cerebral cortical functions regardless of the location or lateralization of the brain lesion, or whether the lesion is focal or diffuse. The authors note that, the factor that probably is most often responsible for poor performances on the speech-sounds perception test is "impairment in the ability to pay close and continued attention to the stimulus material" (as cited in Reitan & Wolfson, 1985). Test-retest reliabilities have been noted to run no lower than .60 and often much higher, although older patients with decreased auditory acuity may have greater difficulty (as cited in Lezak, 1995).

The Trail Making Tests Part A (Reitan & Wolfson, 1985) has been established as a valid test of visual search, attention, and motor function (desRosiers & Kavanagh, 1987; Reitan & Wolfson, 1985). Test-retest reliability varies depending upon the population sampled, but in general reliability coefficients have ranged from .46 to .94 (Goldstein & Watson, 1989; Matarazzo et al., 1974).

Part A consists of 25 circles; each contains a number from 1 to 25. The subject has to connect the circles by drawing lines with a pencil as quickly as possible beginning with 1 and proceeding in numerical order to number 25. The Trail Making Test requires immediate recognition of the symbolic significance of numbers, ability to scan the page continuously to identify the next number in sequence, and completion of these requirements under the pressure of time (Reitan & Wolfson, 1985). The visual scanning task necessary to perceive the spatial distribution of the stimulus material is represented by the right cerebral hemisphere, and speed and efficiency of performance may be a general characteristic of adequate brain function (as cited in Reitan & Wolfson, 1985). Time required to complete the tasks is used as a measure of performance.

Digit Span (Forward & Backward) is an individual subtest from the Wechsler Adult Intelligence Scale (Wechsler, 1997) and is a measure of immediate verbal recall. In the
digits forward subtest, a sequence of digits is presented aurally to the examinee. The examinee is then asked to repeat the same digits in the same sequence. The test is thought to measure efficiency of attention or "passive span of apprehension" (Kaufman, McLean, Reynolds, 1991; Hayslip & Kennelly, 1980, from Lezak, 1995). The backward version is exactly the same except following the presentation of the number series examinees are asked to repeat the number series in the reverse order. In addition to indexing attention, the digits backward portion is thought to tap working memory. Kaufman (1990) reports test-retest reliability of .83.

The Arithmetic subtest (Wechsler, 1997) is a test of computational skill, auditory memory, sequencing ability, numerical reasoning and speed of numerical manipulation and concentration and attention. This test is not a purely attentional task since it is affected by school experience and the ability to manipulate mental information as well (Kaufman, 1990). Its split-half and test-retest reliabilities have been reported as .84 and .85, respectively (Kaufman, 1990).

Reasoning and Mental Flexibility

The Trail Making Test Part B (Reitan & Wolfson, 1985) has been established as valid test of visual search, attention, mental flexibility, and motor function (desRosiers & Kavanagh, 1987; Reitan & Wolfson, 1985). Test-retest reliability varies depending upon the population sampled, but in general reliability coefficients have ranged from .44 to .86 (Goldstein & Watson, 1989; Matarazzo et al., 1974).

Trail Making Test Part B consists of circles numbered from 1 to 13 and lettered from A to L. The task in part B is to connect the circles in sequence, alternating between numbers and letters. The Trail Making Test B requires immediate recognition of the symbolic significance of numbers and letters, ability to scan the page continuously to identify the next number or letter in sequence, flexibility in integrating the numerical and alphabetical series, and completion of these requirements under the pressure of time (as
cited in Reitan & Wolfson, 1985). The visual scanning task necessary to perceive the spatial distribution of the stimulus material is represented by the right cerebral hemisphere, and speed and efficiency of performance may be a general characteristic of adequate brain functions (as cited in Reitan & Wolfson, 1985). Time required to complete the tasks is used as a measure of performance.

In the Booklet Category test (Halstead, 1947; Reitan & Wolfson, 1985), subjects are instructed that the test is divided into seven groups or subtests of items, with a single principle or theme that runs through each entire group from beginning to end. They are then instructed to try to figure out the principle for each group. As the subject responds to each item, the examiner lets the individual know if their choice was correct or incorrect. This allows the subject to test each hypothesized principle. The subjects are never told the principle for any subtest. At the end of each subtest and at the beginning of each new subtest, the examiner tells the subject that the principle might be the same as it has been for the previous subtest or that it might be different. The subject's task is to figure out the principal running through each subtest (as cited in Reitan & Wolfson, 1985).

The Category Test has several characteristics that make it unique compared to many other tests. It is a relatively complex concept formation test which requires ability (1) to note recurring similarities and differences in stimulus material, (2) to postulate reasonable hypotheses about these similarities and differences, (3) to test these hypotheses by receiving positive or negative information, and (4) to adapt hypotheses based on the reinforcement following each response (as cited in Reitan & Wolfson, 1985).

The Category Test requires subjects to come up with solutions in a structured context, and appears to require particular competence in abstraction ability (Reitan & Wolfson, 1985; Reitan & Wolfson, 1994). The HRB assesses concept formation and is probably the best measure in the HRB of abstraction, reasoning, and logical analysis.
abilities; abilities which are essential for organized planning (as cited in Reitan & Wolfson, 1985). Although Halstead (1947) viewed the Category Test as a frontal lobe test, extensive additional research (Allen et al, 1999; Reitan, 1955f, 1964) has shown that the Category Test is multifactorial in nature and represents a measure of abstract reasoning skills that do not appear to be dependant on any specific modality or domain, which makes it sensitive to cerebral damage regardless of the location of the lesion. The Category test has been found to demonstrate high internal consistency values (above .95) for each subtest in both normal and neuropsychologically impaired populations (Charter et al., 1987; Moses 1985; Shaw, 1966; as cited in Spreen & Strauss, 1991). However, analysis of the low correlation's between the subtests of the Category Test (a median coefficient of 0.15) suggests that it does not agree with itself, and depends on the total score for its overall validity (Reitan & Wolfson, 1994). The total score for the BCT does evidence high test-retest reliability in the range of .90 and above (Goldstein & Watson, 1989).

**Verbal Ability**

The Vocabulary subtest is a verbal test that (Wechsler, 1981; 1997) consists of 33 items that require the subject to provide definitions for words of varying degrees of difficulty. This test assesses the individuals language development, long-term memory, and ability for concept formation (Lezak, 1995). The Vocabulary subtest is affected by school experience and cultural opportunities (Kaufman, 1990). Vocabulary shows very good test-retest (.92) and split-half (.96) reliability (Kaufman, 1990). Its inclusion in the present investigation makes theoretical sense since can have implications for left-hemisphere functioning (Kaufman, 1990).

The similarities subtest (Wechsler, 1981; 1997) consists of 19 items which require the capacity for logical abstract reasoning, verbal concept formation, associative skills and language facility (Kaufman, 1990). For each item the subject is presented two
words and asked to describe how the two objects or concepts are alike (e.g., fork, and
spoon are both utensils). Its split-half and test-retest reliabilities are both .84 (Kaufman,
1990). The inclusion of Similarities is of particular interest given the demands it places
on abstraction and problem-solving skills. Similarities performance is especially
associated with left-frontal dysfunction (Lezak, 1995), which is important given the
literature suggesting left frontal impairment in violent offenders (Brickman, McManus,

The Information subtest (Wechsler, 1981; 1997) consists of 28 items that require a
general knowledge of current and historical events, which might be affected by one's
cultural experiences and school learning abilities. This subtest shows good split-half
reliability (.89) and test-retest stability (.91; Kaufman, 1990). Items are scored as either
correct or incorrect and the total number of correct items serves as the raw score. The
subtest was not included in the cluster analyses, but has been reported for descriptive
purposes.

Learning and Memory

The Tactual Performance Test (Reitan & Wolfson, 1985) requires the subject to fit a
group of blocks into their proper place on the board while blindfolded. Time per block is
the total time it took for the subject to complete all trails divided by the number of block
they placed over the three trials.

After the subject has completed the trials, the subject is then asked to draw a picture
of the board with the blocks in their proper spaces. This drawing reflects the memory
and localization components of the test. Research has demonstrated that, on average,
subjects with cerebral lesions require about twice as much time as control subjects to
complete the three trials of the Tactual Performance Test (as cited in Reitan & Wolfson,
1985). Reliability studies indicate adequate test-retest correlation's ranging from .63 to
.93 (Thompson & Parsons, 1985).
Psychomotor Speed/Perceptual Organization

Visual Organization

The Picture Completion subtest (Wechsler, 1981; 1997) is a measure of visual alertness and organization, visual conceptual ability, and is a nonverbal test of general information (Groth & Mamet, 1999). The Picture Completion test consists of 25 items (pictures) presented in a stimulus book. The examinee is instructed that for each item (picture) there is an important part missing, after viewing the picture for no longer than 20 seconds the examinee must say which part is missing or point out where it is missing on the picture if they do not know the word for the missing part. Test-retest and split-half reliabilities are .88 and .81, respectively (Kaufman, 1990). This task is appropriate for inclusion given its ability to provide a useful measure of premorbid functioning that is less affected by school exposure (though may be affected by cultural opportunities) and is particularly resilient to brain damage (Kaufman, 1990; Lezak, 1995).

The Block Design subtest (Wechsler, 1981; 1997) is a nonverbal problem-solving test that requires skills in perceptual organization, spatial visualization, and abstract conceptualization (Groth & Marnet, 1999). In this test subjects are asked to replicate pictures of designs, presented via a stimulus book, using three-dimensional blocks. All blocks are identical with 2 red sides, 2 white sides, and 2 red and white sides. The test consists of 9 items; block designs progress in difficulty with each new item. Performance on each item is timed in addition to being scored as correct or incorrect. Split-half reliability is .87 while test-retest reliability is .86 (Kaufman, 1990). Block Design appears appropriate for inclusion given its sensitivity to the effects of brain impairment on visuospatial functioning (Lezak, 1995). Block Design is especially sensitive to right parietal lobe dysfunction, though it can be sensitive to general impairment as well.

The Digit Symbol substitution task (Wechsler, 1997) consists of rows of blank squares; each has a randomly assigned number (1-9) printed above. A key is printed
above these rows showing each number paired with a different nonsense symbol. The subject's task is to fill the blanks with the corresponding symbols as rapidly as possible. The Digit Symbol test requires a number of skills for good performance including attentional skills, good hand-eye coordination, the ability to learn an unfamiliar task, and good visual short-term memory. Test-retest reliability is adequate ranging from .82 to .88 (Lezak, 1995).

**Motor**

The Finger tapping test is an index of motor speed and the integrity of the motor cortex for the contralateral side of the brain as the hand used (Reitan & Wolfson, 1985). The finger tapping test has been found to demonstrate adequate reliability ($r = .64 - .94$) depending upon the population and hand sampled. Subjects are instructed to tap as quickly as possible with the index finger of the preferred hand after which they are instructed to perform the same task with their nonpreferred hand. Ideally, five consecutive 10 second trials are given for each hand. However, too much variation in performance (i.e., a score five taps slower or faster is considered to be an outlier) within the five 10-second trials necessitates the administration of more trials, the maximum number being 10 for each hand. Final scores are calculated by taking the mean of the valid trials, five trials within 5 points of each other, or if this criterion is not met, the mean of 10 trials. Results are interpreted primarily in relation to a disparity in measurement on the two sides of the body, which are hypothesized to have significance for the biological status of the contralateral cerebral hemisphere (Reitan & Wolfson, 1985). This test was included as a measure of frontal cortical integrity and as a localizing index.

With regard to homicide offenders, the HRB and WAIS variables selected for clustering appear likely to be able to effectively quantify cognitive and intellectual functioning as well as measure individual aspects of cognition including premorbid functioning, abstract reasoning and concept formation, attention/concentration, verbal
skills, and non-verbal, perceptual-organizational skills that are believed to vary across this population.

Data Analysis

Cluster Analyses

Cluster analysis is a multivariate procedure that groups data into clusters based on natural interrelations, so that groups will show high levels of homogeneity within each cluster and high levels of heterogeneity between clusters (Hair et al., 1992). Hair et al. suggest that the strength of cluster analysis is that it allows for classification based on inherent characteristics of individuals within the sample. In the current study, cluster analytic methods were used to classify subjects convicted of homicide based upon their scores on tests from the Halstead-Retain Neuropsychological Test Battery (HRB) and Wechsler Adult Intelligence Scales (e.g., WAIS-R, Wechsler, 1981; WAIS-III, Wechsler, 1997).

It is often recommended that the data entered into cluster analyses be measured on the same scale to ensure that variability in the scale of measurement does not unduly influence the clustering of data (see Hair et al., 1992). Based on this recommendation, all of the raw HRB data was converted to z-scores prior to clustering. Although WAIS subtest scaled scores are standard scores \((x = 10, sd = 3)\), for comparability with the other neurocognitive measures, WAIS subtest scores were also converted to z-scores.

Several steps are required in cluster analyses including: (a) identifying the participants of the study; (b) selecting the variables to be used in the analysis; (c) choosing the clustering procedure and way to measure similarity, and (d) choosing the number of clusters to include in the final solution (Hair et al., 1992; Morris, Blashfield, & Satz, 1981). The participants and variables have been described in some detail above. The clustering procedures will now be described.
A hierarchical agglomerative clustering method, Ward’s method, was utilized in the current study. This method of cluster analysis begins by pairing together objects (subjects in this application) that are most like each other first (as measured by squared Euclidean distance), followed by objects that share the next highest degree of similarity, and so on, until all of the subjects in the data matrix have been placed into one general cluster (Romesburg & Charles, 1984). Though there are several methods that might be used, the current investigation utilized Ward’s method. This allowed for consistency with the cluster analytic methodology used in a past attempts to investigate cognitive heterogeneity in a delinquent sample (see Teichner et al., 2000) and in other psychiatric and substance abuse samples (Allen et al., 1999). In this method, the package analyzes possible associations among subjects, and clusters those in a manner that attempts to keep the error sum of squares as low as possible (Morris et al., 1981).

**Measure of Similarity**

Similarity between participants is measured utilizing distance measures. By measuring how different two participants are on the measures of interest, one is able to gain information about their level of similarity. The Squared Euclidean distance measure was utilized in the current investigation as the measure of similarity. Squared Euclidean distance is a coefficient that reflects "the actual distance between pairs of objects when the attributes are plotted in two dimensional space" (Romesburg & Charles, 1984) and is among the most widely used distance measure. It is chosen in this case to be consistent with previous research in this area.
CHAPTER 4

RESULTS

Data Screening

In the first stage of data screening, all neurocognitive variables for the entire sample of 62 subjects were examined for missing data. It was determined that 10 subjects had missing data on one or more of the cognitive variables. The largest contributor to incidence of missing data (n = 6) occurred as a result of subject inability to perform the tasks because they were too impaired to complete the test. Rather than excluding these six participants from the analyses, they were initially retained because their lack of data was an indicator of severe impairment, thus representing "real" data points that characterized the neurocognitive functioning of at least a subset of individuals convicted of homicide. Additionally, it is not uncommon in clinical practice for "Severely Impaired" subjects to be unable to perform some tests due to difficulty level of the test and/or the severity of impairment in the cognitive domain being assessed. Thus, eliminating these six participants from the data set introduces the possibility that derived cognitive clusters would not accurately reflect the full range of neurocognitive function in homicide offenders.

Given these considerations, it was decided to preserve these subjects' data by replacing missing values with a score one unit greater than the next highest score in the distribution. This technique holds the ordinal place of the data, thus maintaining its influence as an extreme score in the distribution, but decreases the likelihood that the
data point will be an outlier and unduly influence the main parametric analyses (Tabachnick & Fidell, 1989). Ultimately, three of the six identified cases were retained using this procedure. The three cases that were dropped from the data set had suffered significant neurological insult after being incarcerated, but before undergoing the neuropsychological evaluation used in this study. This factor was sufficient to warrant exclusion of these three individuals, as neurocognitive functioning at the time of evaluation was not reflective of cognitive status at the time of the offense.

Of the four remaining cases, missing data for three was determined to be the result of procedural difficulties with testing (e.g., prisoners hands were shackled). All three cases were excluded given that missing data points were not related to cognitive function and thus reasonable estimates of subject scores could not be determined. Use of sample mean replacement was considered but it was decided that such a procedure would not be appropriate with cluster analysis, as it would decrease differences among the subjects and thus obscure unique clusters within the sample. Finally, one subject had missing data due to suspicion of inadequate effort on testing. In addition to being unreliable, this subject was excluded on the same premise noted for the previous three exclusions. After excluding these individuals, 55 subjects were available for clustering on the HRB and WAIS variables.

In order to determine if there were data entry errors, each variable from the WAIS and HRB was examined to detect out of range values by computing frequency counts for each of the cognitive variables under consideration. Also, the means and standard deviations were examined to determine if the values for each variable were plausible. Table 2 summarizes HRB raw scores and WAIS subtest scaled score means and standard deviations for the study sample. This procedure did not reveal any out of range scores, and variable means fell within expected ranges, so no modifications were made to the data at this stage of data screening.
In order to evaluate whether cognitive variables were normally distributed, boxplots were used to examine the data for outliers, and skewness and kurtosis were calculated for each of the cognitive variables used in the analyses. As can be seen from Table 3, most variables were relatively normally distributed with skewness and kurtosis values of |1| or less. However, distributions for TPT time per block, Seashore Rhythm Test, Speech Sounds Perception Test, and Trails A and B, were all skewed and kurtotic. Because all variables except the Seashore Rhythm Test (SRT) were markedly positively skewed, log transformation was utilized in an attempt to normalize the distribution on these variables. This method substantially decreased the skewness and kurtosis estimates for all the variables. Because the SRT was negatively skewed, the inverse of the raw scores were subjected to log transformation, which produced an improvement in skewness and kurtosis estimates. The means and standard deviations for the transformed scores are also presented in Table 2, and the skewness and kurtosis estimates are presented in Table 3. Thus, analyses were conducted using transformed scores for all variables. To determine the effect that transformation had on the results, analyses were performed with the raw scores as well.

In the second step of data screening, demographic, violence, and clinical measures were dealt with in the same manner previously discussed. Of the subjects who had complete cognitive data sets (n = 55), none had missing data for any of these variables, and these variables were normally distributed.

Descriptive Statistics

A comparison of subjects included (n = 55) and excluded (n = 7) from the analyses indicated no significant differences between the groups on ethnicity, education, or sentence. However, the excluded group was found to be significantly older at the time of their crime, $F(1,60) = 5.81, p < .05$, and at the time of their assessment, $F(1,60)$
= 8.22, \( p < .05 \). Inspection of the frequency data revealed that the difference between the groups for age was largely accounted for by a single outlier. This individual was almost three standard deviations above the mean on the variables age at crime and age at evaluation (age = 69 years). This individual was one of the three subjects excluded for confounding neurological history (e.g., Alzheimers). Descriptive statistics and F-test results are presented in Table 4.

The resultant study sample was composed primarily of males (95%) Caucasian (40%) and African Americans (40%) were the most represented ethnicity's, followed by Hispanic (10.9%), Asian (5.5%), and Native American (3.6%). Approximately 71% of the sample were characterized as having come from an economically disadvantaged background. Histories of physical abuse were noted for 44.5% of the sample; sexual abuse was 23.6%, and; family dysfunction in 67.3% of the sample. High rates of DSM-IV diagnosed alcohol (61.8%) and substance (61.8%) abuse disorders characterized the sample as a whole. The group had a mean age at crime of 27 years old, mean age at evaluation of 35 years old. The mean KTEA Reading grade level was 9th year 7th month. Approximately 62% were serving a death sentence, 22% life without the possibility of parole, 13% life with the possibility of parole, one with 20 years to life, and one with probation time served.

Choosing the Number of Clusters

Three to five cluster solutions were calculated in order to determine which solution best fit with the data. Choosing the number of clusters to be derived began with inspection of the graphical output of the cluster analysis software. A visual determination of the degree of similarity was made by inspecting the hierarchical trees, after which, cluster coefficient outputs were inspected. Based on these examinations a four cluster solution appeared to be appropriate. Specifically, the distance coefficient
showed a dramatic increase when agglomerating between three and four clusters, but not between four and five, as seen in Figure 1. Such increases can represent a point where dissimilar clusters are being joined, or agglomerated and are an objective way to identify the points of greatest variance and to confirm the appropriateness of the visually determined cuts and final cluster solutions (Romesburg & Charles, 1984).

By graphing the clusters in discriminant function space, the overlap between each cluster was inspected as a graphical way to assess the cluster solution (as suggested by Aldenderfer & Blashfield, 1984). As can be seen in Figure 2, the four clusters are fairly well separated when plotted in discriminant function space, though there is some overlap. Inspection of five cluster solutions, as seen in Figures 3, revealed no better separation between the clusters on this qualitative, graphical measure of the goodness of the cluster solution. In fact, for the five cluster solution, clusters 1 and 5 shared substantial overlap, suggesting poor separation between the clusters. In the four cluster solution, these two clusters were combined to form cluster 1. The three cluster solution, as seen in Figure 4, combined clusters 1 and 3 from the four cluster solution to form cluster 1. As these clusters (i.e. cluster 1 and cluster 3) were well separated in discriminant function space in the four cluster solution, combining them in a three cluster solution appeared inappropriate. Examination of the dendogram presented in Figure 1 supports this suggestion.

External Validation of the Four Cluster Solution.

Because the nature of cluster analytic techniques is such that they will impose structure even when there is none, it is important to externally validate a cluster solution. There are a number of ways in which this was undertaken in the current investigation. First, z-scores for the Halstead-Retain and WAIS variables were plotted for each cluster solution allowing for inspection of differences between clusters in cognitive profiles (see
Figures 5, 6, and 7). Qualitative analysis of the group mean profiles on Figure 5 revealed cluster profiles very similar to what had been hypothesized.

**Hypothesis 1 Cognitive Profiles**

Cluster One's mean profile shows average performance in relation to the study sample. However, when compared to the WAIS standardization sample mean scaled scores and recommended cut-off scores for the Halstead-Reitan Battery, cluster 1 is in the normal to mildly impaired range on neuropsychological variables but is performing almost a full standard deviation below the standardization sample mean scaled score of ten on the WAIS variables and Verbal Scale subtests in particular (Wechsler, 1981, 1997). Thus, Cluster One demonstrates mild deficits in reasoning and relatively greater Verbal Scale deficits and is similar to what had been hypothesized for the "Verbal Learning" cluster.

Cluster Two's mean profile is approximately one standard deviation below the sample mean on at least 50% of the cognitive variables. This performance is equivalent to approximately two standard deviations below the standardization sample mean for WAIS variables, and is significantly past cutoffs designating moderate to severe impairment on measures from the HRB. Cluster Two's mean profile does show some peaks and valleys. For instance, they performed relatively better on measures of auditory attention and discrimination as well as visual attention and sequencing. Also, Cluster 2 evidenced relative sparing of motor functioning, however, they did not display the expected dominant hand advantage, instead they tapped at approximately the same speed with their nondominant hand. In addition to evidencing slowed and inefficient mental processing, they also demonstrated significant deficits in higher-order cognitive abilities (e.g., reasoning). Cluster Two presents a profile with moderate to "Severely Impaired" scores on the HRB variables, and poor performance across both Verbal and
Performance Scale subtests, and is very similar to the hypothesized "Borderline IQ/Impaired" cognitive cluster.

Inspection of the profile of the mean z-scores for the Halstead-Retain (Reitan & Wolfson, 1993) and WAIS (Wechsler, 1981, 1997) subtests for Cluster Three shows a profile with most mean scores equal to or greater than those of all other clusters. Relative to Cluster One in particular, Cluster Three demonstrated better performance on both Verbal and Nonverbal WAIS variables, suggesting that Cluster three functions in the average range intellectually. Although this group did almost equally as poorly as Cluster One on the BCT, a measure of nonverbal reasoning, overall their mean scores were not in the impaired range. Thus, this cluster is consistent with the hypothesized "Neuropsychologically Normal" functioning group.

Cluster Four's profile reveals mean scores that range anywhere from 1 standard deviation to 4 standard deviations below the sample mean. This group performed poorly on all neurocognitive measures; WAIS subtest scaled scores ranged between 2 and 4. These scores are not only indicative of severe cognitive impairment and mild mentally retarded intellectual functioning when compared to WAIS standardization sample means and cutoff's designating severe impairment on the HRB, they are also strikingly poor scores in relation to the sample means. Relatively lower Verbal subtests scores in relation to Performance Scale subtests scores is suggestive of a decline in cognitive functioning in Cluster four, with the possibility of adequate premorbid functioning. Despite the apparent peaks and valleys, however, Cluster Four's profile is actually relatively flat with few strengths and many weaknesses and is qualitatively consistent with the hypothesized "Severely Impaired" cognitive cluster.

ANOVA and post hoc testing using Student-Newman-Keuls were undertaken to determine whether identified clusters differ in the predicted manner on the clustering variables, indicated statistically significant differences between the four groups on all 16
clustering variables. Descriptive statistics are presented in Table 4; contrast results are presented in Table 5.

**Hypothesis 2 Primary and Secondary Violence Ratings**

The relevance and validity of identified clusters can only be established by observing whether the identified groups differ in theoretically coherent ways across measures that were not used to cluster the groups. Thus the second step in validation of the cluster solution was to examine potential differences between clusters on external validation variables. Violence ratings, clinical factors, and demographic data were evaluated using one-way analyses of variance (ANOVA). Chi-Squared analyses were used to make comparisons among derived clusters on categorical variables (e.g., incident ratings, primary violence subtype, psychiatric diagnoses, and various crime-related factors). Measures for which there was a significant or borderline significant result from the univariate comparisons were further examined utilizing planned post hoc contrasts (using Student-Newman-Keuls) in order to clarify where the differences existed between groups.

**Hypothesis 2A**

Chi-square analyses revealed significant differences between the clusters on primary violence subtype, $\chi^2 (3, 1) = 8.28, p<.05$. As predicted, an inspection of the frequencies in each cluster revealed that a greater number of "instrumental offenders" were represented in the "Neuropsychologically Normal" functioning cluster relative to all others. The "Verbal Learning" cluster was next, then the "Borderline IQ/Impaired" cluster, and lastly the "Severely Impaired" cluster. Descriptive statistics are presented in Table 6.

**Hypothesis 2Ai**

Secondary violence ratings were evaluated using ANOVA and chi-square analyses. It was predicted that the "Neuropsychologically Normal" functioning cluster would
demonstrate greater degrees of planning and goal-directedness relative to the "Borderline IQ/Impaired" and "Severely Impaired" cognitive functioning groups. Chi-square analyses indicated no significant difference between the clusters for either planning, $F(3, 51) = 1.03, p > .05$, or goal-directedness, $F(3, 51) = 3.02, p > .05$. Inspection of the frequencies in each cluster revealed that for the variable planning there was not enough variability to find differences. Specifically, 90% of the sample was ranked as either having engaged in "very little" to "only some" planning, leaving only 10% that engaged in "moderate" to "extensive" planning. Lack of significant findings on goal-directedness could not be attributed to lack of variability, but may have been influenced by the variable number of perpetrators. This possibility will be explored under hypothesis 2B.

Hypothesis 2Ai

Results of the ANOVA indicated no significant differences across the derived clusters for provocation, $F(3, 51) = 1.23, p > .05$, however, arousal was significant, $F(3, 51) = 3.02, p < .05$. Post hoc comparisons indicated that the "Severely Impaired" cognitive functioning cluster demonstrated significantly greater arousal at the time of their crimes than all other groups. Differences between the other clusters were not significant. Thus, the general prediction that the high functioning cognitive cluster would demonstrate less provocation and arousal than both of the lower functioning clusters (i.e., "Severely Impaired", and "Borderline IQ/Impaired") was partially supported. Once again, this may be due to the number of multiple perpetrator crimes in the "Borderline IQ/Impaired" cluster.

Hypothesis 2Aii

It was predicted that the "Neuropsychologically Normal" functioning cluster would evidence less intoxication and fewer psychotic characteristics at the time of the crime than the other clusters, but particularly the "Severely Impaired" cluster. The mental
status variable intoxication, $F(3, 51) = 0.09, p > .05$, failed to reach significance across the cognitive clusters. However, psychosis, $F(3, 51) = 2.42, p = .07$, approached significance. However, when the ordinal rating scale derived by Cornell was dichotomized into psychotic vs. not psychotic at the time of the crime results of the chi-square analysis were significant across the derived clusters, $\chi^2(3, 1) = 7.92, p < .05$, and were in the expected direction. Thus, hypotheses regarding the mental status variables intoxication and psychosis was partially supported.

Hypothesis 2Aiv

It was predicted that the "Neuropsychologically Normal" functioning cluster would demonstrate a greater tendency to kill strangers and males than the "Borderline IQ/Impaired" and "Severely Impaired" cognitive clusters. No significant differences were noted across the groups with regard to a greater tendency to kill males or females, $\chi^2(1, 6) = 3.84, p > .05$. Using the Cornell rating scale, which recognizes six different levels of relatedness, there were no significant differences across derived clusters on the variable of relation, $\chi^2(12,12) = 11.58, p > .05$. However, it was suspected that nonsignificant findings might be due to a lack of power. Thus, it was decided to group subjects as intimate (i.e., close friend, relative, girl/boy friend, spouse) and nonintimate (i.e., stranger, acquaintance, specific relationship such as teacher) using median splits on the ordinal relatedness ratings from the Cornell measure. This approach still did not reveal a significant chi-square across the clusters on the dichotomized variable of relatedness, $\chi^2(1,3) = 2.34, p > .05$.

Hypothesis 2B

It was predicted that the significantly impaired clusters (i.e., "Borderline IQ/Impaired" and "Severely Impaired") would evidence a significantly greater tendency to kill intimates and females than the "Neuropsychologically Normal" and "Verbal Learning" clusters.
However, it was proposed that the number of perpetrators involved would mediate this relationship for the two lower functioning clusters such that, while in general they are expected to demonstrate a greater tendency to kill intimates and women, the opposite pattern is expected when more than one perpetrator is involved.

As already noted no differences across groups emerged for the relatedness and victim gender variables on chi-square analyses. Additionally, chi-square analyses did not demonstrate significant differences across the derived clusters on the number of perpetrators variable $\chi^2 (1,3) = 3.91, p>.05$. However, visual inspection of the frequencies indicated that the "Severely Impaired" cluster lacked crimes involving more than one perpetrator altogether, but that the "Borderline IQ/Impaired" functioning cluster, 46% of the cases involved more than one perpetrator. This compared to 15.4% and 28.6% for the "Verbal Learning" and "Neuropsychologically Normal" functioning groups, respectively. Given that this group evidenced low average to borderline intellectual functioning, number of perpetrators was thought to be a confounding factor in accurately characterizing the group. Thus, to further explore this issue, the "Borderline IQ/Impaired" functioning cluster was divided according to whether the crime involved one or multiple perpetrators. Following this step, chi-square analyses were run for the overall violence rating, victim relatedness, and gender of victim. Results indicated a significant difference between subgroups on overall violence rating, $\chi^2 (1,1) = 7.54, p<.01$, and victim relatedness, $\chi^2 (1,2) = 7.63, p<.01$, but not victim gender ($\chi^2 (1,1) = 2.21, p>.05$). Specifically, for the "Borderline IQ/Impaired" cluster, in 80% of cases in which there was more than one perpetrator the violence was rated as being instrumental. In contrast, in 100% of the cases where there was a single perpetrator the violence was rated as reactive. Moreover, in five of the six cases involving an individual perpetrator, the victim was female and an intimate, while in five of five cases involving more that one perpetrator the victim was a nonintimate and 60% of the time a male.
Hypothesis 3 Clinical and Diagnostic Variables

As predicted, the clinical/diagnostic variables of physical abuse, $F (3,51) = 1.53, p > .05$, sexual abuse, $F (3,51) = 1.37, p > .05$, family dysfunction, $F (3,51) = 2.18, p > .05$, alcohol abuse disorder, $\chi^2 (6, 6) = 6.07, p > .05$, and substance abuse disorders, $\chi^2 (6, 6) = 7.78, p > .05$, revealed no significant differences across the cognitive clusters. Also, as predicted, history of severe mental illness (i.e. DSM-IV diagnosed psychotic disorder or bipolar disorder) was significant across the derived clusters, $\chi^2 (3, 3) = 8.25, p < .05$.

Inspection of the cell frequencies indicated that the differences were in the expected direction with the "Severely Impaired" group evidencing the greatest rates of mental illness, followed by the "Borderline IQ/Impaired", "Verbal Learning", and "Neuropsychologically Normal" functioning clusters, in that order.

It was predicted that differences would emerge across the derived clusters on severity of TBI history with the "Severely Impaired" cluster demonstrating the worst histories relative to all groups but primarily in relation to the "Neuropsychologically Normal" and "Verbal Learning" clusters. The "Borderline IQ/Impaired" cluster was also predicted to evidence a more severe history of head trauma in comparison to the two higher functioning clusters (i.e., "Neuropsychologically Normal" and "Verbal Learning"). ANOVA confirmed that there were significant differences between the clusters, $F (3,51) = 3.31, p < .05$. Post hoc comparisons partially supported expected differences, with cluster four demonstrating a significantly worse history than both the "Neuropsychologically Normal" and "Verbal Learning" clusters, but not the "Borderline IQ/Impaired" cluster. Differences between the "Borderline IQ/Impaired" cluster and the "Neuropsychologically Normal" and "Verbal Learning" cluster's were not statistically significant. Descriptive statistics, Chi-square and $F$-test results are presented in Table 7. Thus, the only significant differences between clusters on diagnostic/clinical variables were for history of severe mental illness and brain injury severity.
Hypothesis 4 Demographic Variables

ANOVA and Chi-squared analyses indicated no significant differences among the derived clusters on the demographic variables ethnicity, $\chi^2 (12,12) = 9.43$, $p > .05$, SES, $\chi^2 (12,12) = 11.6$, $p > .05$, sentence, $\chi^2 (12,12) = 8.40$, $p > .05$, or education, $F (3, 51) = 2.24$, $p = .09$. The negative findings on SES and education were in contrast with the prediction that the "Neuropsychologically Normal" functioning group would show significantly higher levels of education and less economic disadvantage relative to the rest of the sample. Descriptive statistics and Chi-square and ANOVA results are presented in Tables 8 and 9 respectively.

Unexpected differences emerged across the clusters on the demographic variable age at crime, $F (3, 51) = 3.19$, $p < .05$; age at evaluation approached significance, $F (3, 51) = 2.63$, $p = .059$. Comparisons on the age at crime variable revealed that the "Borderline IQ/Impaired" cluster was significantly older (mean = 32.5 years) than both the "Verbal Learning" (mean = 24.5 years) and "Neuropsychologically Normal" (mean = 26.2 years) cognitive clusters at the time of their crimes.

Reading grade level was predicted to be significantly lower for all clusters relative to the "Neuropsychologically Normal" cluster, and importantly relative to the "Verbal Learning" cluster. Results indicated that reading grade level was significantly different between the clusters, $F (3, 51) = 17.57$, $p < .001$. As predicted, the "Neuropsychologically Normal" functioning cluster scored significantly better on the reading measure relative to all other clusters. Also, the "Verbal Learning" cluster scored significantly better than the "Borderline IQ/Impaired" cluster but not the "Severely Impaired" cluster. Inspection of the group means revealed that the "Severely Impaired" cluster (mean = 7.3) demonstrated a higher grade equivalent on reading skills than the "Borderline IQ/Impaired" cluster (mean = 5.8). This finding is interesting and is consistent with the pattern evidenced by the "Severely Impaired" cluster on the
neurocognitive variables, which were marked by generalized impairment but suggested better premorbid functioning relative to the "Borderline IQ/Impaired" group. Descriptive statistics and F-test results are presented in Tables 9.
CHAPTER 4

RESULTS

Evaluation of Major Hypotheses

The results of the Ward's method cluster analysis were consistent with the hypotheses. That is, the clusters derived were essentially congruent with the hypothesized "neuropsychologically normal," "borderline IQ/impaired," "verbal learning," and "severely impaired" cognitive clusters.

Hypothesis 1

"Neuropsychologically Normal" Functioning Cluster

The "neuropsychologically normal" cluster's mean WAIS (Wechsler, 1981; 1997) profile revealed good (i.e., average) Information, Vocabulary, and Similarities subtest scaled scores. This suggested that the typical individual within this cluster would possess a good fund of information, knowledge of words, and verbal conceptual reasoning skills. The mean profile reveals a dip in the scores on the Digit Span subtest. This may suggest lesser attentional skills relative to overall verbal skills though a difference of the magnitude reflected in the mean profile probably would not be considered clinically significant.

The "neuropsychologically normal" cluster also performed well on the Performance Scale subtests where mean scores were equivalent to those of the normative sample. There was a slight dip on the digit symbol, which may be additional evidence of attentional difficulties or may reflect a relative weakness in visuomotor coordination for
this cluster. Once again, this difference in the mean profile was minor and probably would not be considered clinically significant.

The "neuropsychologically normal" cluster performed in the normal range on all the HRB variables except the Booklet Category Test, which was in the borderline mildly impaired range and the Finger Tapping Test, which was a little slow for both the dominant and nondominant hands. Assertions that the BCT is a specific measure of frontal lobe functioning have not been supported (Reitan, 1955; 1964; Reitan & Wolfson, 1994); however, the BCT it is a good measure of concept formation and abstract reasoning abilities. Mildly impaired performance on the BCT may suggest that this group possess lesser reasoning skills relative to their overall intellectual and cognitive abilities. Although the BCT and the FTT do not localize to prefrontal structures, motor functioning is a frontal lobe mediated ability and thus may provide some evidence of very mild dysfunction with a frontal proximity.

"Verbal Learning" Cluster

This cluster's mean profile is very similar to the "neuropsychologically normal functioning" cluster on HRB variables, but then evidences a marked dip in the profile on both the Performance and Verbal subtests from the WAIS. Performance subtest scaled scores were in low average range but suggested a possible strength in visuoconstruction and attention skills, at least relative to verbally mediated abilities. There is a particularly dramatic dip on the Verbal subtests Vocabulary, Similarities, and Arithmetic, such that these scores are at least one standard deviation below those of the "neuropsychologically normal" cluster and are actually in the low average to borderline range in comparison to the normative sample. This weakness in verbal skills might be reflective of a relative reduction in left hemisphere function, deficient educational opportunities, or some combination of both.
In contrast with the discrepant WAIS findings, mean HRB profiles look remarkably similar for the "Verbal Learning" and "Neuropsychologically Normal" cluster. Mild impairment on the BCT was evidenced by both; however, FTT was not impaired for the "Verbal Learning" cluster. The pattern of performance on HRB and WAIS variables is suggestive of mild frontal and left temporal deficits. Given this pattern, a typical person from this group might be expected to have more problems with verbal mediation and impulse control, particularly under stressful conditions.

"Borderline IQ/Impaired" Functioning Cluster.

The "borderline IQ/impaired functioning" cluster's mean WAIS performance places them in the mild to borderline intellectual functioning range. Their mean HRB scores demonstrate a relatively flat profile characterized by moderate to "Severely Impaired" performance on almost all measures from the HRB. As a group, they demonstrate significant deficits in concept formation and reasoning ability. They appear to be having serious difficulties at the highest stages of information processing and thus evidence dramatic slowing and inefficiency as tasks increase in complexity. For example, although they were generally able to perform the TPT, extended exposure to the stimulus did not improve the group's performance on measures of incidental learning and memory. They did do relatively better on Trails A, which may reflect the potential for improved performance when tasks are less complex.

"Severely Impaired" Cognitive Functioning Cluster.

The cluster analysis also derived a "severely impaired" cognitive cluster defined by severe impairment across all HRB variables and borderline to mildly retarded performance on the WAIS Verbal and Performance Scale subtests respectively. Unlike the "Borderline IQ/Impaired" functioning cluster, there is a dramatic dip in the profile on Performance subtest scaled scores, which may reflect a relative weakness in visuomotor speed or visuospatial organization. The marked difference between Performance and
Verbal skills might be reflective of relative reduction in right hemisphere function, poor motor coordination, and/or could reflect attentional impairments. However, the small sample makes it difficult to make strong conclusions about the specific nature of this dysfunction.

This cluster's mean HRB profile parallels that of the "Borderline IQ/Impaired" cluster differing only essentially in magnitude of impairment. However, the relatively dramatic discrepancy between this clusters verbal and nonverbal scores, in addition to their severe impairment on all cognitive measures, strongly suggests a decline from premorbid levels of functioning (better scores on Information, Vocabulary). Thus, the typical individual from this cluster likely experiences substantial difficulty with many activities including integrating novel information and organization and reasoning. Furthermore, these weaknesses may be particularly evident on tasks that are highly dependent on visual motor skills. Despite overwhelming impairment, this cluster's relative strength in verbal knowledge and reasoning may lead the casual observer to overestimate their cognitive competence and underestimate the challenges they face with regard to effective functioning on a day-to-day basis.

Another way to consider the utility of the cognitive clusters is to compare the current findings with those of previous neuropsychological studies of violent and particularly homicide offenders. The identification of a subgroup of offenders with relatively normal neuropsychological functioning and average IQ is consistent with a plethora of data (Brower and Price, 2001; Dolan, 1994; Hare, 1984; Hoffman, Hall, & Bartsch, 1987; Kandel and Freed, 1989; Raine, O'Brian, & Scerbo, 1991; Sutker & Allain, 1983) indicating that many violent offenders have apparently normal brain functioning and similarly intact cognitive profiles. This finding is also consistent with a pattern of cognitive results that are in keeping with those reported for psychopathic offenders.
Particularly as the cognitively normal group in the current study was also found to engage in primarily instrumental violence.

With respect to identification of a "Verbal Learning" group, substantial literature (Bartsch, Lynam, & Moffitt, 1997; Brickman, McManus, Grapentine, & Alessi, 1984; Brower & Price, 2001; Golden & Teichner, 2000; Golden et al., 2001; Golden et al., 1996; Nestor, 1992) has noted the presence of "Verbal Learning" deficits among violent and criminal offenders. Luria (1980) proposed that "verbal ability is the necessary mediator of self-control mechanisms, which develop and internalize overtime through social interactions" (as cited in Teichner et al., 2001). As such, deficits in verbal mediation are thought to result in poorly thought out and impulsive behavior (Teichner et al., 2001).

The presence of a "Borderline IQ/Impaired" group is also consistent with the literature (Brower & Price, 2001; Bryant et al., 1984; Dolan, 1994; Golden et al., 1996; Heilbrun, 1982; 1990; Holland, Becket, and Levi, 1981; Moffitt & Henry, 1991; Reed, 1993; Teichner et al., 2001; Teichner & Golden, 2000). This group is at increased risk for violence for a variety of cognitive reasons including 1) poor reasoning and problem solving abilities, which may be manifest by an inability to recognize potentially dangerous situations and to de-escalate them; 2) poor ability to organize their efforts in an effective manner, reducing opportunity for gainful employment and increasing the likelihood of engaging in criminal activity; 3) impaired ability to comprehend the complexities of their environment and inefficient learning, which may interfere with the ability to predict potential consequences of their behavior, and 4) poor verbal mediation, impairing their ability to verbally manage their own and/or others escalating behavior. All these individually may result in increased impulsivity and reduced behavioral controls; together they likely have an additive effect putting such individuals at incrementally greater risk for criminal and violent outcomes.
The "Severely Impaired" group is represented in the literature as well (Blair & Price, 2001; Golden et al., 1996; Heilbrun, 1982; 1990; Holland, Becket, and Levi, 1981; Jones, 1992; Young, Justice, & Erberg, 1999). Young, Justice, and Erberg (1999) noted that among a group of forensic psychiatric patients, overall level of cognitive impairment significantly differentiated between high and low violent offenders. Additionally, this group’s neuropsychological profile is very similar to the "Borderline IQ/Impaired" group as far as domains of cognitive dysfunction. They have severe deficits in both frontal and temporal mediated processes, with potentially greater involvement of the right hemisphere as indicated by relatively preserved verbal skills. This group is at increased cognitive risk for violence for all the same reasons that applied to the "Borderline IQ/Impaired" group.

In addition to empirical support for the identified clusters, there is also theoretical support for their relationship to violent outcomes. Specifically, the pattern of cognitive deficits in the resultant clusters appear very consistent with hypothesized pathways (Jones, 1992) linking neuropsychological dysfunction and violence (i.e., increased activation of the nervous system relative to the ability to think; decreased inhibitory ability relative to activation; impairment of attention, concentration, memory, and subsequent higher mental processes, and misinterpretation of external stimuli and events). Even more impressive are the parallels between currently identified subtypes and the cluster analytic findings of Teichner et al. (2000).

Like the current investigation, Teichner and colleagues (2000) derived four cognitive clusters from neuropsychological data obtained from a conduct disordered adolescent sample. Using the Luria Nebraska Battery the authors identified cognitively "normal", "mild verbal", "verbal/left hemisphere", and "subcortical/frontal" groups. Thus, given different populations and different cognitive batteries, very similar theoretically relevant and cognitively coherent subtypes were derived. In contrast with the Teichner study
however, clusters identified in the current investigation reflect more significant degrees of brain pathology, and thus may be thought of as caricatures of those derived by Teichner's group. This is not surprising given the chronicity of the current sample and their known severe behavioral outcomes.

**Hypothesis 2 Primary and Secondary Violence Variables**

It was predicted that cognitive clusters would evidence different patterns of violence (Cornell et al., 1996) and that the "Neuropsychologically Normal" cluster in particular would demonstrate an overall greater degree of instrumentality relative to the other clusters. Results of the Chi-square revealed significant differences among the cognitive clusters on the overall rating of reactive vs instrumental violence (Cornell et al., 1996). Inspection of the cell frequencies revealed that the "Neuropsychologically Normal" functioning cluster was rated as significantly more instrumental than all other clusters, followed by the "Verbal Learning" cluster, the "Borderline IQ/Impaired", and finally the "Severely Impaired" cognitive cluster, in that order. This suggests that there were relations between mode of violence (Cornell et al., 1996) and the cognitive cluster solution. In general, as cognitive abilities worsen violence tended to become more reactive, and vice versa. Inspection of the frequency scores across the separate cognitive clusters however, does not support the notion that the clusters represent a simple continuum of reactive to instrumental violence. Incident ratings, which made a finer distinction regarding the degree of reactive and instrumental characteristics of the crime, revealed that "some instrumental qualities" were rated as characteristic of the crimes of each cluster, and that a rating of "clearly instrumental violence" was assigned to some members of all clusters excepting the "Severely Impaired" cluster. Similarly, some members of the "Neuropsychologically Normal" functioning cluster were rated as having engaged in "clearly reactive violence".
Planning and goal-directedness are considered important components of Instrumental violence (Cornell et al., 1996); thus, it was proposed that the "Neuropsychologically Normal" functioning cluster would demonstrate greater degrees of both, relative to the other clusters. This prediction was only partially supported by the analyses, as degrees of planning did not differentiate any of the groups while goal-directedness did. A restriction of range for the entire sample, in the direction of less planning, appears to have diminished the potential for finding significant differences across the groups. Low degrees of planning, despite a substantial number of instrumental ratings, may reflect a greater involvement in opportunistic crimes for this sample.

Provocation and arousal are common characteristic of reactive violence (Cornell et al., 1996). Thus, a relative lack of obvious provocation and lower arousal states were predicted to characterize the violence of the "Neuropsychologically Normal" functioning cluster. Contrary to what was predicted however, arousal was only significant for the "Severely Impaired" cognitive cluster in relation to the others and provocation did not significantly differ across any of the clusters. Failure to obtain a significant finding on provocation may reflect a difference between offenders with respect to autonomic reactivity. It may be that provocation is highly predictive of reactive violence only, while the presence or absence of it may be less sensitive for predicting instrumental violence. For example, low autonomic reactivity has been widely documented among individuals who are characterized as psychopathic (Arnett, Howland, Smith, & Newman, 1993; Patrick, Bradley, Lang, 1993; Patrick, Cuthbert, & Lang, 1994). Thus, while under most circumstances the presence of provocation may be a good predictor of violence and reactive violence in particular, if the stimulus value of provocation is reduced, via diminished autonomic reactivity, the relationship between provocation and violence will be unreliable.
It was proposed that the "Neuropsychologically Normal" functioning cluster would demonstrate a decreased frequency of active psychotic symptoms and reduced rates and degrees of intoxication at the time of their crimes, relative to the other clusters. Furthermore, the "Severely Impaired" and "Borderline IQ/Impaired" clusters were predicted to show a higher rate of individuals who were experiencing psychotic symptoms at the time of their offense, relative to the "Neuropsychologically Normal" cluster. This analysis approached significance in the predicted direction; however, use of the Cornell rating (Cornell et al., 1996) was thought to be causing a loss of power due to poor differentiation of items, thus, an analysis of psychotic symptoms rated as present (yes/no) was pursued. This analysis was statistically significant and revealed that the "Severely Impaired" and the "Borderline IQ/Impaired" clusters contained a disproportionate number of individuals who experienced psychotic symptomology at the time of their crime. This finding supports the connection between reactive violence and psychotic symptomology (Van Voorhis, 1994).

A fourth finding with respect to secondary violence characteristics relates to whether the individual was intoxicated at the time of the crime. Based upon a substantial literature noting that substance abuse facilitates more reactive forms of violence, and that intoxication does not appear to play a significant role in the violence of more instrumental offenders (e.g., psychopaths), it was hypothesized that the "Neuropsychologically Normal" functioning group, which evidenced greater rates of instrumental violence, would display lower rates of intoxication (Holt, Meloy, & Strack, 1999; Rice, & Harris, 1993; Smith, & Newman, 1990). The violence of the "Severely Impaired" cluster was also hypothesized to be less influenced by substance intoxication, as their violence is thought to be highly determined by stable cognitive traits and potentially unstable psychological symptoms. No differences in lifetime diagnoses of alcohol and/or substance abuse disorders were hypothesized to emerge between
clusters. While this finding was as predicted, in contrast to what was predicted, mean
ratings with respect to intoxication at the time of the crime were not statistically
significantly different across the clusters.

It was also hypothesized that the "Neuropsychologically Normal" cluster would be
more likely to be involved in stranger killings than the other three but particularly in
comparison to the "Severely Impaired" and "Borderline IQ/Impaired" clusters. Once
again, the initial analysis using Cornell's ranking of degrees of intimacy did not show any
differences across groups. Thus a dichotomous ranking of intimate vs nonintimate was
made. Analyses using this dichotomous ranking also were not statistically significant but
the frequencies were in the predicted direction with the "Neuropsychologically Normal"
cluster killing more nonintimates, then the "Verbal Learning" cluster, then the "Borderline
IQ/Impaired" cluster, and finally the "Severely Impaired" group. Relatedly, the
"Neuropsychologically Normal" and "Verbal Learning" cluster, while not statistically
significant, were more likely to kill males than the "Borderline IQ/Impaired" and "Severely
Impaired" cluster. Additionally, the "Neuropsychologically Normal" and "Verbal
Learning" groups were the only ones where members of the groups killed both males
and females.

**Hypothesis 2B**

As predicted the targets of individuals in the "Borderline IQ/Impaired" cluster were
more often females. In contrast with what was predicted, this cluster did not evidence a
greater tendency to kill intimates overall. However, when the group was divided
according to number perpetrators, reasons for the insignificant finding became clearer.
In five of the six cases involving an individual perpetrator the victim was an intimate (i.e.,
member of family) while in five of five cases involving more than one perpetrator the
victim was a nonintimate (3 were strangers; 2 were acquaintances). This finding
highlights the potentially confounding factor of multiple perpetrators when attempting to
evaluate and characterize the violence of individuals. This problem may be relatively unique to low functioning groups given that members of these clusters may be more vulnerable to undue influence by peers as a result of their severe cognitive and intellectual deficits. Thus, while the nature of a crime itself may be clearly instrumental, extrapolation of that characterization to individual's belonging to the "Borderline IQ/Impaired" cluster appear to be inappropriate.

Hypothesis 3

As predicted, the "Severely Impaired" cognitive cluster evidenced increased rates of severe mental illness (i.e., psychotic disorder or bipolar disorder). They also had the most severe history of TBI. In both instances, the "Borderline IQ/Impaired" cluster followed, then the "Verbal Learning", and lastly the "Neuropsychologically Normal" cluster. However, these differences were significant for the "Severely Impaired" clusters relative to the "Verbal Learning" and "Neuropsychologically Normal" functioning clusters only.

Hypothesis 4

Reading Grade Level as measured by the Kaufman Test of Educational Achievement, was predicted to be significantly lower for the all clusters relative to the "Neuropsychologically Normal" cluster, but was also thought to be important in differentiating the "Verbal Learning" cluster from the "Neuropsychologically Normal" cluster. Consistent with these predictions, reading grade level differentiated the "Neuropsychologically Normal" cluster from all the others, and importantly from the "Verbal Learning" cluster. Years of education did not quite reach significance, which may be due to a failure to differentiate the data by whether an individual was enrolled in special education classes or not. Alternately, it may be that a number of individuals suffered head injuries when they were older and thus cognitive dysfunction did not interfering greatly with secondary schooling.
Differences in age at crime and age at evaluation were not predicted to emerge but did. This difference is not felt to be an issue with respect to cognitive variables, given that the youngest group evidence a specific pattern of cognitive impairment and a demographic profile that might be considered consistent with their involvement in crime at an early age. This issue will be discussed more fully in the following section.

External Validation Descriptors of the Cognitive Clusters

"Neuropsychologically Normal" Functioning

Members of the "Neuropsychologically Normal" cluster evidenced essentially normal performance on measures from the HRB, which is consistent with having the mildest TBI history. On the WAIS tests, they demonstrated average abilities. They had a mean full scale IQ of 98.9. This cluster had the most years of formal education, highest rates of Caucasian members (although this was not significant across groups), and the highest KTEA Reading scores (12 grade level). They also were more likely to act alone, to kill strangers as opposed to intimates, and to have males targets. Additionally the participants in the "Neuropsychologically Normal" cluster were rated as having the most instrumental crimes, which although characterized by only minimal planning, were distinguished by greater degrees of goal-directedness (50% were rated at evidencing clear and unequivocal goal directedness). Thus, their instrumentality appears to have manifested itself in more opportunistic crimes where the goals were instrumental but substantial forethought was absent. Consistent with the assumption that the violence of these individuals is less emotionally driven, the "Neuropsychologically Normal" functioning cluster demonstrated the lowest frequency of active psychotic symptoms at the time of their crime, and fewer members with lifetime diagnoses of a severe mental illness (i.e. psychotic or bipolar disorder). This cluster also had the most severe sentences, with 90% of the members serving a death sentence or life without the possibility of parole.
"Verbal Learning" Cognitive Cluster

This cluster is the youngest of the four clusters, with the average age at the time of the offense being 24 years old. Their cognitive performance is typified by a relatively normal profile on the HRB (mild impairment on the BCT), which is consistent with having the second lowest rates of severe head trauma, but is in substantial contrast with significantly poorer performance on WAIS variables, particularly those related to verbal skills. Verbal IQ is 86.1; Performance IQ is 89.3. Additionally, despite having the second best overall picture of cognitive functioning, this group's reading comprehension skills were measured at only the 8th grade 7-month level. They also evidenced the second fewest years of education (Mean =10.2). Thus, from a developmental standpoint, deficits in verbally mediated skills may have caused a negative chain of events beginning with difficulty in the academic arena, early school drop out, and culminating with early involvement in crime.

The majority of the "verbal learning" group members were from low SES backgrounds (77%), and approximately 70% of the group were nonwhite. Thus, increased vulnerability to poorer social outcomes may also be related to economic disadvantage and greater exposure to antisocial norms. Given their poorer verbal skills and mild deficits in abstracting and concept formation (i.e., fronto-temporal dysfunction), one might expect them to evidence a greater risk for reactive violence, due to difficulty with verbal mediation and poorer impulse control. Contrarily, ratings on the violence measure revealed a mixed picture, with a good portion of the groups participants being rated as reactive (46.2%), but an even larger portion being rated as instrumental (53.8%). This pattern suggests that a combination of factors may be influencing the evolution of their violent behavior. Assuming greater exposure to antisocial norms, it may be that this group learned to use aggression and violence in an instrumental fashion as a means of obtaining material rewards and/or peer respect. Thus, this group may be
equally as likely to aggress based upon learned and environmentally reinforced patterns of behavior as they are to react violently for arousal based reasons. This finding is consistent with the observation that many crimes have both instrumental and reactive qualities, and that offenders may be capable of engaging in both (Bushman & Anderson, 2001). This may also mean that, as a group, they engage in more acts of violence and criminality all around.

"Borderline IQ/Impaired" Functioning Cluster

This cluster evidenced moderate to severe impairment across the HRB tests and borderline to mildly retarded performance on the WAIS subtests. They were the oldest, had the least amount of education ($x = 10.0$ years), and the poorest KTEA reading scores (5th grade 7-month level). Approximately 73% of the group were nonwhite, with the largest proportion being African American (54.5%). Also, the majority of the members of this group were from economically disadvantaged backgrounds (72.8%). This group was characterized by the worst histories of physical abuse and family dysfunction, and the highest rates of DSM-IV diagnosed alcohol abuse (72.7%) and substance abuse (81.8%) disorders (analyses for these variables were not significant across the groups).

A more in depth exploration of this group was undertaken as a result of a pattern that emerged in the data which indicated a sharp, within group contrast, on a number of the external validation variables. For example, despite an overall greater tendency to be involved in reactive violence (63.6%), this group's crimes demonstrated little overlap in violence features, evidencing a rather dichotomous score of either clearly reactive or clearly instrumental. Similar results were noted for ratings of mental illness, psychotic symptomatology and intoxication at the time of the crime, degree of relatedness to victim (intimate, 45.5%; nonintimate 54.5%), and number of perpetrators involved in the instant offense. It had previously been hypothesized that number of perpetrators might be an
important confounding variable in the cases of both the low functioning groups, due to greater vulnerability to peer influence. The emergence of two distinct violence and victim profiles depending upon number of perpetrators seems to provide support for this original concern, at least with respect to the "Borderline IQ/Impaired" cluster. Thus, the cluster was divided according to number of perpetrators involved in the crime and then reevaluated on external validation variables that were predicted to distinguish this group.

These analyses revealed that the single perpetrator subgroup committed clearly reactive crimes exclusively, that half had a diagnosis of severe mental illness and a third were experiencing psychotic symptoms at the time of the crime, and that half were severely intoxicated. Also, 83% of their victims were female and intimates. In contrast, the multiple perpetrator subgroup was rated as committing clearly instrumental crimes in 80% of the cases, they evidenced no psychotic disturbance, and only mild to moderate intoxication. Furthermore, 60% of the victims were male, and all were strangers or acquaintances (i.e., nonintimates). As noted, this subgroup's involvement in violent offending may be predominantly a function of the interaction between an antisocial peer group and cognitive vulnerability.

"Severely Impaired" Cognitive Functioning Cluster

In addition to mildly retarded intellectual functioning, this cluster is typified by severe impairment on the HRB tests. Consonant with their dramatically impaired cognitive abilities, this group evidenced the most significant history of head trauma, the highest rates of severe mental illness, and the greatest frequency of active psychotic symptoms at the time of the crime. They also evidenced a greater tendency to kill females and intimates, high rates of alcohol and substance abuse disorders (although only moderate levels of intoxication at the crime), and uniformly, the tendency to commit crimes that were reactive in nature. Unfortunately, because of the low numbers in this cluster, statements regarding this group have to be considered tentative. What does seem to be
clear however, based upon their educational attainment (mean = 11.3 years) and KTEA reading scores (7th grade 3-month), is that the "Severely Impaired" cognitive cluster likely had better premorbid functioning than the "Borderline IQ/Impaired" cognitive cluster, but that they have experienced a dramatic cognitive decline.

Implications of the Current Findings

The purpose of the current investigation was to assess the potential utility and validity of utilizing empirically-derived, neurocognitive clusters as a means of subtyping homicide offenders. The findings provide support for the utility of neurocognitive subtypes. Although Teichner and colleagues (2001) investigated this issue of cognitive heterogeneity with a group of adolescent delinquents, this investigation is the first to study the relations between cognitive clusters of adult homicide offenders on a range of demographic, clinical, and crime-related variables. Meaningful differences between the clusters were found on violence subtype, secondary violence variables, history of mental illness/presence of psychotic symptoms at the time of the crime, TBI history, reading grade level, number of perpetrators, gender of and relatedness to the victim, and age of the perpetrator at the time of the crime.

The difference between the "Neuropsychologically Normal" functioning clusters and the borderline and "Severely Impaired" cognitive functioning clusters on age at crime, is not felt to reflect differences in age-related cognitive decline. Instead, the age disparity is believed to reflect differences between the groups on levels of antisociality or potentially psychopathy; working under the assumption that individuals who evidence higher rates of antisociality will come into contact with the legal system at an earlier age (Harpur, & Hare, 1994). This assertion cannot be thoroughly evaluated in the current investigation however, since psychopathy was not directly measured. Still, among the "Neuropsychologically Normal" cognitive cluster, the finding of greater degrees of
instrumentality, less psychotic diagnoses, better cognitive functioning, and a greater tendency to kill males than females, does provide at least some phenomenological support for this assertion, as these characteristics typify psychopathic offender profiles (Cornell et al., 1996; Hare, 1991; Williamson, Hare, & Wong, 1987).

Evaluation of the external validity of the cognitive clusters found the most consistent differences between the "Neuropsychologically Normal" and the two low functioning clusters (i.e., borderline IQ and "Severely Impaired" clusters). In contrast, differentiation of the "Neuropsychologically Normal" and "Verbal Learning" cluster was less clearly demonstrated. In fact, these two clusters differed very little in terms of their HRB scores and their violence profiles. Demographic variables revealed the "Verbal Learning" group to be younger, poorer, and constituted by more ethnic minorities. However, of greater relevance was the difference between the groups in education and reading grade level, which was significantly lower for the "Verbal Learning" cluster. These findings suggest potentially distinct neurodevelopmental etiologies (i.e., left hemisphere temporal dysfunction in the "Verbal Learning" cluster) as well as different degrees of socio/cultural vulnerability. Thus, while the violence of these two groups may be very difficult to distinguish based on pattern and outcome, there does appear to be a distinct difference in the etiology/evolvement of their homicidal behavior that may necessitate differences in intervention and treatment.

Although differentiation of the borderline and "Severely Impaired" clusters was originally fairly clearly demonstrated for the primary variable of violence subtype, once the confounding effect of multiple perpetrators was removed the distinction between the groups on this factor was substantially attenuated. Still, involvement in crimes with multiple perpetrators was an outstanding feature of the borderline/IQ impaired cognitive group and was diagnostic in relation to the "Severely Impaired" group, who uniformly acted alone. This difference is likely due to increased rates of mental illness in the
"Severely Impaired" group, as social alienation is a common symptom and outcome of severe mental illness. More years of education and higher reading grade level for the "Severely Impaired" cluster is suggestive of premorbid functioning differences between the groups as well and points to a potentially unique role for familial/cultural influences in the evolvement of criminality and violence within the "Borderline IQ/Impaired" cognitive group. Specifically, diminished cognitive capacity in combination with exposure to economic disadvantage and crime may be particularly detrimental to individuals who possess limited intellectual and cognitive capacity. In contrast, a relatively clear picture of traumatic brain injury involving a substantial decline in cognitive functioning from premorbid levels and concomitant psychiatric disturbance appears to more accurately characterize the pathogenesis of homicidal violence within the "Severely Impaired" cluster.

It is evident, based upon the previous review, that the pattern of differences between the cognitive clusters on the external validation variables fit a complex pattern that is not simply represented by various levels of cognitive impairment falling along a continuum. Rather, cluster analyses based on cognitive tests appear to produce subtypes of homicide offenders that are distinct in level and patterns on a range of external validation variables. Further studies with additional external validity measures and specific prefrontal neurocognitive tests are needed to better understand these relations.

Limitations of the Current Investigation

Cluster Analyses

While the cluster analysis in this study resulted in clusters that fit the hypotheses well, the cluster solution is not beyond criticism. Results of any cluster analytic research must be considered critically since these methods will "find" clusters even in randomly generated data sets (Hair et al., 1992). The discriminant function analysis utilizing the
cognitive clustering variables showed a high correct classification rate; however, the small number of cases in the fourth cluster makes it difficult to be confident regarding the stability of the four-cluster solution, despite the evidence of differences between the clusters with respect to external validation variables.

Taken as a whole, there does appear to be evidence for the external validity of the cognitive clusters based on significant differences between clusters in reading grade level, violence rating, mental illness, psychotic at crime, number of perpetrators, arousal, education, and age at crime. When these measures were placed in a non-stepwise discriminant function analysis, correct classification into the cognitive clusters was 76.36%, suggesting that the correspondence between these measures and cognitive clusters, as derived in this study, was fairly strong.

Lack of a Control Group

While comparisons between the cognitive clusters allow for exploration of the relative differences between the cognitive subtypes, it did not allow for comparisons between the cognitive clusters and normals. The similarities and differences between the "Neuropsychologically Normal" and the "Verbal Learning" clusters and a nonviolent criminal control group might be particularly interesting. Inclusion of a normal control and a nonviolent criminal control group would provide further information about the validity of the cluster solution.

Measures

While extensively used, well-researched, reliable, and valid (Reitan & Wolfson, 1993), the HRB does not provide precise measurements with regard to some areas of cognitive functioning as other measures do (e.g., prefrontal lobe and memory). However, extensive measurement of many of the skills and cognitive competencies needed for adequate adaptation and navigation in real-world circumstances and situations is a strength of this battery and these skills are of particular relevance in
understanding the gestalt with regard to brain-behavior relationships. The relationship between clusters derived from the Halstead-Reitan Battery on a sample of homicide offenders and those derived from the Luria Nebraska on adolescent delinquents (Teichner et al., 2001) provide support for the validity of the cluster solutions. Still, the use of additional neuropsychological tests and psychological measures (e.g., PCL-R; Hare, 1996) needs to be explored.

Sample

While the sample utilized in the cluster analyses was not extremely small (n = 55), it does become less ideal when divided into the four cognitive clusters. The use of a larger sample size would allow for more confident statements about the validity of the cluster solution and the generalizability of the results. This is particularly true given the limited membership in the "Severely Impaired" cognitive cluster. However, it should also be noted that in the current study the "Severely Impaired" cluster, which was by far the smallest (n = 3), was also the most distinct.

Some selection bias was also present because the sample was obtained from a single practitioner, which, at least in this case, means all cases were obtained based upon attorney or court referral. Also, the sample was limited to homicide offenders and even more narrowly to individuals who were charged with first-degree murder and convicted of first or second-degree murder. While this might allow for better understanding of homicide as an entity unto itself, it also limits the generalizability of the study's findings to less violent offenders. The gender composition of the sample is also limited, suggesting limitations in the application of the findings to female samples. Finally, the diagnostic make-up of the sample likely reflects an under representation of individuals with serious mental disorder. Even though cognitive deficits have been found to be a core feature of schizophrenia and are frequently present in many other psychiatric conditions, in the face of prominent psychiatric symptomology even marked
brain impairment may go relatively unnoticed. Consequently, clearly psychiatric individuals may have had fewer referrals for neuropsychological testing. Thus, when considering the results of this study, care should be taken in generalizing the findings to non-male, non-homicidal, and diagnostically different populations.

Conclusions

Megagree recommended that meaningful subtypes should be derived within groups of violent offenders. Using cluster analyses, Golden and colleagues (2000) identified four distinct and externally relevant cognitive clusters from a sample of adolescent delinquents. In the current study, cluster analytic techniques were applied to a sample of homicide offenders. Using select Halstead-Reitan and WAIS variables four distinct cognitive clusters were derived and externally validated. The findings suggest that the use of these cognitive measures with homicide offenders provide clinically useful information. Support for the "Neuropsychologically Normal" functioning cluster was demonstrated by their significantly higher reading grade level, greater frequencies of instrumental violence, and having the most years of education. In addition to a markedly different performance on the WAIS subtests, the "Verbal Learning" cognitive functioning cluster was differentiated from the "Neuropsychologically Normal" functioning cluster by a significantly lower reading grade level, an almost equal frequency of instrumental and reactive crimes, poorer educational attainment, and youngest age at the time of the crime. The two very low functioning groups demonstrated significant cognitive deficits, such that floor effects made it difficult to portray what was incrementally worse performance by the "Severely Impaired" group. Extraordinarily, a pattern emerged on the WAIS variables, which is suggestive of a different etiological pathology for each group; this finding was also supported by differences on external validity measures. Specifically, the "Severely Impaired" cluster evidenced the greatest rates of mental
illness and corresponding psychotic symptomology at the time of the crime, the highest levels of arousal, which was associated with exclusively reactive crimes, and the worst history of TBI, despite having the second highest levels of education. In contrast, the "Borderline IQ/Impaired"/borderline cluster had the fewest years of education, the lowest reading grade level, and the greatest frequency of multiple perpetrator involved crimes.

The identification of unique cognitive subtypes also has clinical implications with respect to developing effective risk intervention strategies with violent offenders and vulnerable populations. As an example, low to borderline IQ, poor reading skills, and school drop out, appear to be predictive of a greater risk for group-related violence among some economically disadvantaged ethnic minority individuals. Documentation of this combination of risk factors may allow for the development of effective interventions as well as for more appropriate patient-treatment matching. For example, there is some evidence to suggest that early health prevention (Olds et al., 1998), environmental enrichment (Raine, Venables, et al., 2001), and community outreach/governmental assistance (e.g., Big Brothers and Big Sisters; Social Security Insurance), may improve the chances for a positive outcome among dually (biologically and environmentally) vulnerable children (see Raine, 2002).

Among adult offenders, brain damage is a frequently overlooked yet vitally important factor in determining expectations regarding client progress as well as the appropriateness of a specific intervention (Golden, Jackson, Peterson-Rohne, and Gontkovsky, 1996). Golden and colleagues (1996) note that "individuals with brain damage are unlikely to respond to traditional forensic and mental health interventions and thus will repeat their behaviors if placed back into similar stressors and environmental conditions." pg. 23. Thus, decreasing future aggression and improving overall prognosis in brain-injured populations requires an integrative approach that takes
into account the interaction between neurobiological factors and psychosocial factors in
the evolvement and maintenance of aggression (Golden, et al., 1996).

Though this study provides good evidence for the external validity of cognitive
clusters of homicide offenders, it is not without limitations. Future studies should attempt
to replicate these findings in a larger group with more diverse samples in terms of
gender, diagnoses, and violent and nonviolent controls. Additionally, research in this
area should utilize additional neuropsychological tests with more specificity to memory
deficits and "prefrontal" dysfunction. The influence of psychopathy on group
membership should also be pursued in future investigations. The positive findings of this
research warrant further investigation of the utility of identified cognitive clusters as
potential subtypes of homicide offenders.
APPENDIX A

TABLES
Table 1
Means and Standard Deviations of Halstead-Retain Neuropsychological Test Scores
and, WAIS Composite and IQ Scale Scores for the Entire Study Sample

<table>
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<th>n</th>
</tr>
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<td>3.13</td>
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<td>2.82</td>
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<td>55</td>
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<td>Digit Span</td>
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<td><strong>WAIS Performance Subtests</strong></td>
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<td>Block Design</td>
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<td>Letter Number</td>
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*Note: Sec. = Seconds to completion; TPT = Tactual Performance Test; Time Per Block = number of blocks placed over number of seconds to place blocks; WAIS = Weschler Adult Intelligence Scale Revised & Third Edition. Missing subjects on Matrices reflects individuals who received the WAIS-R.*

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Table 2
Skewness and Kurtosis statistics for cognitive variables

<table>
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<tr>
<th>Variable</th>
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<th>Kurtosis</th>
<th>Skewness</th>
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<td>Trails B (Sec.)</td>
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Table 3
Descriptive Statistics for Demographic Variables for Excluded Subjects, the Study Sample, and the Entire Sample

<table>
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<tr>
<th>Variable</th>
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<th>Study Sample (n=55)</th>
<th>Excluded Subjects (n=7)</th>
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<td>SD</td>
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<td>18.37</td>
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<td>Age at Evaluation**</td>
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Note: ANOVA's and Chi-square's were greater than .05, unless otherwise indicated. P < .05 = **.
Table 4
Means and Standard Deviations for the HRB & WAIS Subtest and Composite Scaled Scores by Cognitive Cluster (n = 55)

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<tr>
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<td>10.5</td>
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<td>5.4</td>
<td>1.9</td>
<td>9.1</td>
<td>2.5</td>
<td>2.0</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Full Scale IQ</td>
<td>86.7</td>
<td>11.5</td>
<td>75.4</td>
<td>8.6</td>
<td>99.5</td>
<td>9.1</td>
<td>61.7</td>
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<tr>
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<td>86.1</td>
<td>11.2</td>
<td>78.9</td>
<td>13.1</td>
<td>100.</td>
<td>8.6</td>
<td>67.7</td>
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<td>Performance Scale IQ</td>
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<td>74.3</td>
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<td>99.7</td>
<td>13.3</td>
<td>60.0</td>
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</table>

Note. ANOVA's for all Halstead Retain Tests and WAIS subtest and Composite Scores were less than .01. Cluster 1 = "Verbal learning" cluster; Cluster 2 = "Borderline/IQ impaired" functioning cluster; Cluster 3 = "Neuropsychologically normal" cognitive cluster; and Cluster 4 = "Severely impaired" cognitive cluster.
Table 5. F-test results, and post hoc comparisons for Halstead-Retain Tests and WAIS Subtest and Composite Scaled Scores by Cognitive Cluster (n = 55)

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<thead>
<tr>
<th>Variable</th>
<th>E</th>
<th>Post hoc Comparisons</th>
</tr>
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<td>Category Test</td>
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<td>TMT A (Sec)</td>
<td>27.19</td>
<td>4 &gt; 1, 2, 3 &amp; 2 &gt; 1, 3</td>
</tr>
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<td>TMT B (Sec)</td>
<td>30.39</td>
<td>4 &gt; 1, 2, 3 &amp; 2 &gt; 1, 3</td>
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<tr>
<td>TPT Block</td>
<td>51.51</td>
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</tr>
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<td>TPT Memory</td>
<td>31.2</td>
<td>3 &gt; 4, 2 &amp; 1 &gt; 4, 2 &amp; 2 &gt; 4</td>
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<tr>
<td>TPT Location</td>
<td>12.94</td>
<td>3 &gt; 4, 2 &amp; 1 &gt; 4, 2</td>
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<td>SRT</td>
<td>26.83</td>
<td>3 &gt; 2, 4</td>
</tr>
<tr>
<td>SPT</td>
<td>10.21</td>
<td>4 &gt; 1, 3 &amp; 2 &gt; 1, 3</td>
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<tr>
<td>Finger Tapping D</td>
<td>11.1</td>
<td>1 &gt; 4, 3, 2 &amp; 3 &gt; 4, 2 &amp; 2 &gt; 4</td>
</tr>
<tr>
<td>Finger Tapping ND</td>
<td>7.16</td>
<td>1 &gt; 4, 3, 2 &amp; 3 &gt; 4 &amp; 2 &gt; 4</td>
</tr>
<tr>
<td><strong>WAIS Composite Scores</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full Scale IQ</td>
<td>26.28</td>
<td>3 &gt; 4, 2, 1 &amp; 1 &gt; 4, 2 &amp; 2 &gt; 4</td>
</tr>
<tr>
<td>Verbal IQ</td>
<td>19.16</td>
<td>3 &gt; 4, 2, 1 &amp; 1 &gt; 4, 2</td>
</tr>
<tr>
<td>Performance IQ</td>
<td>18.51</td>
<td>3 &gt; 4, 2, 1 &amp; 1 &gt; 4, 2</td>
</tr>
<tr>
<td><strong>Verbal Subtests</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary</td>
<td>17.86</td>
<td>3 &gt; 4, 2, 1</td>
</tr>
<tr>
<td>Similarities</td>
<td>29.72</td>
<td>3 &gt; 4, 2, 1</td>
</tr>
<tr>
<td>Arithmetic</td>
<td>16.97</td>
<td>3 &gt; 4, 2, 1 &amp; 1 &gt; 4</td>
</tr>
<tr>
<td>Digit Span</td>
<td>7.46</td>
<td>3 &gt; 4, 2 &amp; 1 &gt; 4 &amp; 2 &gt; 4</td>
</tr>
<tr>
<td>Information</td>
<td>26.3</td>
<td>3 &gt; 4, 2, 1</td>
</tr>
<tr>
<td><strong>Performance Subtests</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picture Completion</td>
<td>13.3</td>
<td>3 &gt; 4, 2 &amp; 1 &gt; 4, 2</td>
</tr>
<tr>
<td>Block Design</td>
<td>24.33</td>
<td>3 &gt; 4, 2, 1 &amp; 1 &gt; 4, 2 &amp; 2 &gt; 4</td>
</tr>
<tr>
<td>Digit Symbol</td>
<td>14.24</td>
<td>3 &gt; 4, 2 &amp; 1 &gt; 4, 2 &amp; 2 &gt; 4</td>
</tr>
</tbody>
</table>

Note. All ANOVA's were significant at the p<.01 level. Post hoc comparisons using Student-Newman Keuls; TMT = Trail Making Test; TPT = Tactile Performance Test; SRT = Seashore Rhythm Test; SPT = Speech Sounds Perception Test; WAIS = Weschler Adult Intelligence Test (Revised & Third Edition).
Table 6

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cognitive Cluster</th>
</tr>
</thead>
</table>
|                        | 1 (n = 13) | 2 (n = 11) | 3 (n = 28) | 4 (n = 3) | Total (%)
| Primary Subtype**      |            |            |            |           |
| Reactive               | 6 (46%)    | 7 (64%)    | 8 (29%)    | 3         | 24 (43.6) |
| Instrumental           | 7 (54%)    | 4 (36%)    | 20 (71%)   | 0         | 31 (56.4) |
| Psychotic Symptoms**   |            |            |            |           |
| No                     | 11         | 9          | 26         | 1         | 47 (85.5) |
| Yes                    | 2          | 2          | 2          | 2         | 8 (14.5)  |
| Arousal**              |            |            |            |           |
| Calm or Tense          | 4          | 2          | 4          | 0         | 10 (18.2) |
| Excited Nervous        | 4          | 3          | 10         | 0         | 17 (30.9) |
| Angry, frightened      | 5          | 6          | 12         | 1         | 24 (43.6) |
| Enraged                | 0          | 0          | 2          | 2         | 4 (7.3)   |
| Intoxication           |            |            |            |           |
| Not Intoxicated        | 3          | 2          | 4          | 1         | 10 (18.2) |
| Mild Intoxication      | 4          | 3          | 10         | 0         | c. (30.9) |
| Intoxicated            | 4          | 3          | 10         | 2         | 19 (34.5) |
| Severe Intoxication    | 1          | 3          | 2          | 0         | V. (10.9) |
| Blackout               | 1          | 0          | 2          | 0         | 3 (5.5)   |

Note. Chi-Squares for Primary violence subtype was significant p<.05. Psychotic symptoms at the time of the crime and Arousal were significant at the .05 level; Intoxication was greater than .05; Cluster 1 = "Verbal learning" cluster; Cluster 2 = "Borderline/IQ impaired" functioning cluster; Cluster 3 = "Neuropsychologically normal" cognitive cluster; and Cluster 4 = "Severely impaired" cognitive cluster.
Table 7
Relative Frequencies of Axis I Diagnoses, and History of Traumatic Brain Injury, Physical and Sexual Abuse, and Family Dysfunction by Cognitive Cluster

<table>
<thead>
<tr>
<th>Variable</th>
<th>1 (n = 13)</th>
<th>2 (n = 11)</th>
<th>3 (n = 28)</th>
<th>4 (n = 3)</th>
<th>Total N = 55</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DSM-IV Axis I</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Diagnoses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychotic Disorder**</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6 (10.9%)</td>
</tr>
<tr>
<td>Bipolar Disorder**</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3 (5.5%)</td>
</tr>
<tr>
<td>Alcohol Abuse</td>
<td>8</td>
<td>8</td>
<td>16</td>
<td>2</td>
<td>34 (61.5%)</td>
</tr>
<tr>
<td>Substance Abuse</td>
<td>5</td>
<td>9</td>
<td>18</td>
<td>2</td>
<td>34 (61.5%)</td>
</tr>
<tr>
<td>**Brain Injury ***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>6</td>
<td>3</td>
<td>10</td>
<td>0</td>
<td>19 (34.5%)</td>
</tr>
<tr>
<td>Mild</td>
<td>6</td>
<td>2</td>
<td>13</td>
<td>1</td>
<td>22 (40.0%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>11 (20.0%)</td>
</tr>
<tr>
<td>Severe</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>3 (5.5%)</td>
</tr>
<tr>
<td><strong>Physical Abuse</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>10</td>
<td>4</td>
<td>15</td>
<td>1</td>
<td>30 (54.5%)</td>
</tr>
<tr>
<td>Mild</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>8 (14.5%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>0</td>
<td>7 (12.7%)</td>
</tr>
<tr>
<td>Severe</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>10 (18.2%)</td>
</tr>
<tr>
<td><strong>Sexual Abuse</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>None</td>
<td>11</td>
<td>8</td>
<td>22</td>
<td>1</td>
<td>42 (76.4%)</td>
</tr>
<tr>
<td>Mild</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>6 (10.9%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>6 (10.9%)</td>
</tr>
<tr>
<td>Severe</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1 (1.8%)</td>
</tr>
<tr>
<td><strong>Family Dysfunction</strong></td>
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<tr>
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<td>2</td>
<td>8</td>
<td>1</td>
<td>18 (32.7%)</td>
</tr>
<tr>
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<td>1</td>
<td>2</td>
<td>0</td>
<td>4 (7.3%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>12 (21.8%)</td>
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<tr>
<td>Severe</td>
<td>3</td>
<td>4</td>
<td>13</td>
<td>1</td>
<td>21 (38.2%)</td>
</tr>
</tbody>
</table>

**Note.** All Chi-Squares greater than .05, except diagnosis of a Psychotic Disorder, and Bipolar disorder p<.05, History of Traumatic Brain Injury (TBI) was significant at the .000 level; DSM-IV-R = Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Revised. Cluster 1 = verbal learning cluster; Cluster 2 = Borderline/IQ impaired functioning cluster; Cluster 3 = Neuropsychologically normal cognitive cluster; and Cluster 4 = severely impaired cognitive cluster.
Table 8
Relative Frequencies of Sentence, Ethnicity, SES, Gender of Victim, and Number of Perpetrators by Cognitive Cluster

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cognitive Cluster</th>
<th>1 (n = 13)</th>
<th>2 (n = 11)</th>
<th>3 (n = 28)</th>
<th>4 (n = 3)</th>
<th>Total N = 55</th>
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<tbody>
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<td>Sentence</td>
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<td>Death Penalty</td>
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<td>19</td>
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<td>Life; No Parole</td>
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<td>2</td>
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<td>12</td>
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<tr>
<td>Life; Possibility of Parole</td>
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<td>3</td>
<td>6</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>20 years to life</td>
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<td>0</td>
<td>0</td>
<td>1</td>
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<td>0</td>
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<td>10</td>
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<td>6</td>
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</tr>
<tr>
<td>Female</td>
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<td>6</td>
<td>7</td>
<td>14</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>Number of Perpetrators</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One</td>
<td></td>
<td>11</td>
<td>6</td>
<td>20</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td>More than one</td>
<td></td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>0</td>
<td>15</td>
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</tbody>
</table>

Note. All Chi-Squares greater than .05; SES = Level of Economic Disadvantage. Cluster 1 = Low cognitive functioning cluster; Cluster 2 = High cognitive functioning cluster; Cluster 3 = Low average cognitive cluster; and Cluster 4 = Low average/low motor cognitive functioning cluster.
Table 9.
Means and Standard Deviations for Education, Reading Grade Level, Age at Evaluation, Age at crime, and Number of Victims by Cognitive Cluster

<table>
<thead>
<tr>
<th>Variable</th>
<th>1 (n = 13)</th>
<th>2 (n = 11)</th>
<th>3 (n = 28)</th>
<th>4 (n = 3)</th>
<th>Total N = 55</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>10.2</td>
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<td>11.5</td>
<td>11.3</td>
<td>10.8</td>
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<td>1.8</td>
<td>2.1</td>
<td>.57</td>
<td>2.0</td>
</tr>
<tr>
<td>Reading Grade Level**</td>
<td>8.7</td>
<td>5.8</td>
<td>12.1</td>
<td>7.3</td>
<td>9.8</td>
</tr>
<tr>
<td>SD</td>
<td>3.0</td>
<td>3.7</td>
<td>1.4</td>
<td>4.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Age at Evaluation</td>
<td>32.4</td>
<td>39.5</td>
<td>33.9</td>
<td>41.6</td>
<td>35.1</td>
</tr>
<tr>
<td>SD</td>
<td>6.9</td>
<td>9.2</td>
<td>7.6</td>
<td>6.6</td>
<td>8.1</td>
</tr>
<tr>
<td>Age at Crime**</td>
<td>24.5</td>
<td>32.5</td>
<td>26.2</td>
<td>27.0</td>
<td>27.0</td>
</tr>
<tr>
<td>SD</td>
<td>3.5</td>
<td>10.0</td>
<td>6.6</td>
<td>1.0</td>
<td>7.1</td>
</tr>
</tbody>
</table>

Note. ANOVA**p<.05; Education = highest grade completed p = .09; Age at evaluation p = .059; Cluster 1 = verbal learning cluster; Cluster 2 = Borderline/IQ impaired functioning cluster; Cluster 3 = Neuropsychologically normal cognitive cluster; and Cluster 4 = severely impaired cognitive cluster.
APPENDIX B

FIGURES
Figure 1

Hierarchical Cluster Analysis, Dendogram Using Ward Method
Figure 3. Five Cluster Solution Plotted in Discriminant Function Space.
Figure 4. Three Cluster Solution Plotted in Discriminant Function Space.

Three Group Centroids
Z-Scores

Figure 6. Z-scores HRB & WAIS Variables for the Three Cluster Solution

Cluster 1

Cluster 2

Cluster 3
REFERENCES


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