Use Authorization

Substance use, neurocognitive functioning, and crime:

Findings from an incarcerated sample

By

Elizabeth Craun, M. S.

A dissertation

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of the requirements for the degree of

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To the graduate faculty:

The members of the committee appointed to examine the dissertation of

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RE: study number IRB-FY2016-332: Examining Predictors of PTSD and Cognitive Deficits among Inmates

Ms. Kaplan and Ms. Craun:

I have reviewed your application for revision of the study listed above. The requested revision involves the addition of two self-report measures.

You are granted permission to conduct your study as revised effective immediately. The date for renewal remains unchanged at 6/14/17, unless closed before that date.

Please note that any further changes to the study must be promptly reported and approved. Contact Tom Bailey (208-828-2179; email humsubj@isu.edu) if you have any questions or require further information.

Sincerely,

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Substance use, neurocognitive functioning, and crime: Findings from an incarcerated sample

Dissertation Abstract – Idaho State University (2018)

The United States held an estimated 2.2 million prisoners in state and federal custody at the end of 2017 (Bureau of Justice, 2017). Criminology research has made a concerted effort to assess factors that contribute to crime and incarceration, such as psychosocial risk factors, genetics, and cognitive functioning (Marsh & Martinovich, 2006; Sampson & Groves, 1989; Wasserman, 2001). Indeed, cognitive impairments and flawed decision-making processes have been observed among the incarcerated compared with the general population (Meijers, Harte, Jonker, & Meynen, 2015), with new research suggesting significant individual differences between incarcerated individuals as well (Hancock, Tapscott, & Hoaken, 2010). For example, specific domains of executive functioning, such as inhibition, idea-formation, and cognitive flexibility, have been found to predict both frequency and type of crime (Hancock et al., 2010). Both alcohol and illicit substance have been shown to cause impairments in cognitive functioning, including but not limited to inhibition and cognitive flexibility (Simon, Dean, Cordova, Monterosso, & London, 2010; Wong, Brower, Nigg, & Zucker, 2010). The purpose of this study was to assess the associations between drug and alcohol use, cognitive functioning, and type of crime among a sample of 250 incarcerated men and women from two state jails in Northwestern U.S. Analyses revealed several significant, positive main effects of neurocognitive functioning and crime as well substance use and criminal behavior. Additionally, a full, negative mediation model was revealed, where neurocognitive functioning mediated the relationship between alcohol use and frequency of criminal behavior. Implications of the results on prevention and treatment programs for the incarcerated were discussed.

Key Words: alcohol use, drug use, neuropsychology, criminal behavior, incarceration

Chapter I

Introduction

The United States' incarcerated population has grown approximately 500% over the past 40 years (Carson & Anderson, 2016). In 2017, there were nearly 2.2 million prisoners in both the state and federal custody (Bureau of Justice, 2017), making the United States the world's leader in incarceration. It is believed that a fifth of these prisoners are incarcerated due to some type drug offense (e.g., driving under the influence, distribution, possession, etc.; Bureau of Justice, 2006). Not surprisingly, prisoners have higher rates of alcohol and substance dependence than their nonoffending counterparts. Current estimates suggest that 56% of state prisoners are dependent on either alcohol or illicit substance at time of their arrest (Bureau of Justice, 2006). These statistics highlight a strong association between substance use and criminal behavior, suggesting a critical need to better understand this relationship. Therefore, the purpose of the present study was to assess potential mechanisms that may facilitate the relationship between substance and alcohol use and criminal behavior.

Substance Use and Frequency and Severity of Crime

There has been a plethora of research that has established the relationship between substance use and crime (e.g., Benson, Rasmussen, & Zuehlke, 1992; Chaiken & Chaiken, 1990; Inciardi & Pottieger, 1995; McBride, 1981; Nurco, Ball, Shaffer, & Hanlon, 1985). Substance users are more likely to have a relationship with the criminal justice system (e.g., more arrests, warrants, convictions) than their non-using counterparts (Anglin & Speckart, 1988; Inciardi, 1995; Lightfoot & Hodgins, 1988). In the United States, alcohol and illicit substances are associated with approximately 80% of offenses leading to incarceration and more than half of the offender population meets criteria for a history for substance abuse or dependence (National

Council on Alcoholism and Drug Dependence, 2015). Alcohol alone is estimated to be involved in 40% of violent crimes (Bureau of Justice, 2014). Further, rates of intoxication at time of arrest are high. The Arrestee Drug Abuse Monitoring (ADAM II) program is a collection of both intake interviews and bioessays conducted at the time of arrest. The bioessays analyze the offenders' urine for a variety of illicit substances and alcohol. Data revealed that offenders had a 60 to 80% rate of positive drug test results (Office of National Drug Control Policy, 2011). Moreover, there appeared to be an additive effect on the rates of substance use and the offenders' criminal histories. Eighty-one percent of offenders who tested positive for 2 or more illicit substances had a prior criminal record (average 4.64 prior arrests), whereas 71% of those who tested positive for one drug had an average of 2.75 prior arrests and 52% of those who tested negative for any illicit substance had an average of 1.95 prior arrests (Smith & Polsenberg, 1992). Overall, substance use and crime has a strong correlation that has been documented throughout the years.

Substance Use and Violent Crime. Substance use disorders appear to be more prevalent among some types of criminal behavior than others. In general, substance users are more likely to engage in crimes that are not premeditated (or at least demonstrate a lack of preparation), display more irrational behaviors while committing crimes, and have a preference to steal high-value, easily-disposed-of property (Hammond, Bond, & Grant, 2009). More specifically, Kraanen, Scholing, and Emmelkamp (2012) found in their sample of inmates ($N = 187$), 61.6% of general violence offenders (i.e., physical assaults outside of the family) met criteria for a substance use disorder, compared with 30.9% of offenders of intimate partner violence (IPV) and 9.1% those convicted of sex crimes. Moreover, nearly 30% of all offenders were intoxicated by alcohol or some illicit substance at the time to their offense. Nearly 50% of violent offenders, 25% of IPV offenders, and 17% sex offenders were reportedly intoxicated at time of their offense. Overall, compared with offenders of non-violent crime, more of the violent perpetrators met criteria for substance use disorder and were intoxicated at the time of the arrest.

Indeed, drug abuse and dependence have a strong relationship with violent acts, where violent acts are defined as “any behavior involving an intentional act of physical aggression against another individual that is likely to cause physical injury” (Friedman, 1998). Alcohol use/abuse has been shown to be a primary predictor of violent crime (De La Rosa, Khalsa, & Rouse, 1990). This association is found mainly with men. However, it appears that the combination of earlier substance abuse in conjunction with earlier psychopathology, may, to a more significant degree, predict violent behavior in women compared with men (Friedman, 1998).

Chronicity of Use and Crime. Frequency of use also appears to have a strong correlation with criminal behavior. Specifically, among heroin addicts, research has found a positive relationship such that as the rate of heroin consumption goes up for an individual so does the number of criminal offenses (Anglin & Speckart, 1988; Inciardi, 2008; Kinlock & Gordon, 2006; Nurco, 1998). Further, using national survey data, French and colleagues (2000) found that chronicity of use predicted more property crime when compared with non-chronic substance users and non-substance users. For women, chronic substance users committed more predatory crime (e.g., assaults, fighting) when compared with non-chronic substance users and non-substance users. In comparison to nonusers, use of any substance was related to a higher chance of committing either property or predatory crimes. Finally, while holding gender, age, and survey years constant, those who engage in chronic substance use had a higher chance of committing either crime (property or predatory) relative to non-chronic substance users. These results corroborate the positive substance use-crime relationship and, importantly, demonstrate that the chronicity of use is significantly related to an increased chance of committing various types of crime.

Polysubstance Use and Crime. Currently, the majority of research on the association between substance use and crime has focused primarily on single drug use and criminal behavior. The focus on single drug use is not necessarily representative of the substance using population, where abusing multiple substances in tandem (i.e., polysubstance use) appears to be the rule, rather than the exception (Venkatesan & Suresh, 2008). Overall, specific combinations of substances and their relationships to crime have been understudied, although some do exist and highlight what appears to be an additive effect on criminal behavior. It therefore was the purpose of the present study to better understand the relationships between substance use, both a single drug and multiple drugs, and criminal behavior.

For example, among a sample of offenders in Los Angeles, those inmates who engaged in polysubstance use (i.e., used both crack and cocaine) reported higher rates of criminal activity than those inmates who reported only using either cocaine or crack (Shaw, Hser, Anglin, & Boyle, 1999). More recent research found in a sample of 3,135 arrestees differential rates of criminal behavior between single substance and polysubstance users. In a 12 months timeframe, only 33% of single substance users reported committing one or more crimes. In comparison, over 66% of polysusbtance users reported committing one or more crimes in the same time period. Mean number of offenses also significantly differed between the groups, where polysubstance users had nearly double the mean amount of criminal activity than the single users. The researchers also found significant mean differences of crimes between substance-type clusters. Inmates who reported using heroin and crack had the highest rates of offenses when their combination of choice was with either heroin substitutes, recreational drugs (i.e., amphetamines, ecstasy, and cannabis), and tranquilizers. The lowest rates of offending were found among cocaine users who only used recreational drugs (Bennett & Holloway, 2005). These findings suggest that not only does polysubstance use increase the likelihood of committing crimes, but that particular substance-type combination is important. Given the strength and reliability of the substance use-crime relationship, understanding the mechanisms responsible for this relationship could elucidate on the nature of the drug-crime connection and improve both prevention and intervention of substance abuse and criminality.

Rates of substance abuse and dependence are several times higher among those who have committed crime compared with the general population (Substance Abuse & Mental Health Services Administration, 2011). However, the explanations for the high rates of substance abuse and dependence among offenders compared with non-offenders are unclear. It could be that substance use causes crime or that crime causes substance use. Alternatively, substance use and crime are not causally related, but are rather linked by a common association with a third variable. For example, earlier research hypothesized that chronic substance use might impact "higher centers of the brain", which reduced self-control and self-restraint behavior and thus increased the likelihood of crime (Aarens et al., 1977). This type of association is reflected in more recent research which hypothesizes mediators of substance use and crime are dysfunctions in different areas of neurocognitive functioning, including areas that influence inhibition and decision-making processes (Baker, Bezdjian, & Raine, 2006). Neurocognitive functions are cognitive abilities that are closely tied to specific functions of a particular area in the brain (e.g., neuronal pathways, cortical networks, etc.). Neurocognitive dysfunctions or deficits occur when there is a reduction of ability or function in one or more of these cognitive domains, which may lead to neurological illness, psychopathology, drug use, or brain injury.

Overall, the strong relationship between substance use and crime has been long documented. Further, research has demonstrated drug use can predict types of crime and chronicity of use is typically related to higher frequency of crimes committed. Research regarding polysubstance use and crime, a burgeoning area of research, suggests an additive effect to rates of offending, such that the more types of substances abused is related to higher frequency of offending. Even with the current research in this area, the explicit nature of the drug-crime relationship has yet to be elucidated. Therefore, the aims of present study were to examine whether neurocognitive deficits can help explain the established relationship between substance use and criminal behavior.

Neurocognitive Functioning and Crime

A burgeoning area of research has utilized neurocognitive assessment to better gauge different aspects of functioning (e.g., decision-making skills, processing speed, and impulsivity) and their relationship to criminal activity. While neurological dysfunctions are reported at a rate of 1% to 2% in Europe and America, studies suggest with offenders some form neurological dysfunctions occurs within 10% to 67% of the population (Miller, 2002). Rather than focusing on environmental variables, researchers have begun to assess whether there are differences in cognitive abilities among those who commit crime and those who do not. One argument for this emphasis is the brain abnormalities found in violent offenders (Marsh & Martinovich, 2006). Specifically, the prefrontal cortex has received much attention in the forensic literature, where studies have highlighted the abnormalities, both structural and functional, in this area for those who are violent relative those who are not (Bufkin & Luttrell, 2005). It is hypothesized the relationship between these cognitive abnormalities and aggressive behavior may be facilitated by an incapability to adaptively manage one's executive functions (Bufkin & Luttrell, 2005).

Executive functioning is an overarching cognitive construct that consists of three separate domains of ability to support sustained, goal-oriented behavior: “(a) shifting between tasks or mental sets (shifting), (b) updating and monitoring of working memory representations (updating), and (c) inhibition of dominant or prepotent responses (inhibition)” (Miyake, Friedman, Emerson, Witzki, Howerter, & Wager, 2000, page 54). Deficits in executive functioning have been associated with increased substance use and related problems (Tarter et al., 2003), crime (Brower & Price, 2001; Meijers et al., 2015), and psychopathology, such as anti-social personality disorder (Morgan et al., 2012; Pennington & Ozonoff, 1996).

Researchers have identified significant differences between the general and offending population. For example, those who meet criteria for antisocial personality disorder (APD) are overrepresented in the incarcerated population and generally perform .62 standard deviations below the norm on measures of executive functioning (Morgan & Lilienfeld, 2000). However, more resent research suggests these deficits are not limited to those with severe psychopathology. In general, offenders perform significantly worse on measures of executive functions compared with non-offender controls (Meijers et al., 2015).

Specifically, offenders had significant deficits compared with controls in areas of attention (d=0.38), set shifting (d=1.09), working memory (d=1.12), novel problem solving (d=1.66), and inhibition (d=0.8) (Meijers et al., 2015). These dysfunctions were found in both violent and non-violent offenders. However, while many offenders demonstrate cognitive dysfunctions, other studies have found offenders who committed violent crime are different from non-violent offenders on certain cognitive abilities. Indeed, specific domains of executive functioning such as inhibition, switching, and cognitive flexibility have been found to predict both frequency and severity of crime committed for violent offenders, while no significant association was found among non-violent offenders (Hancock et al., 2010).

Violent Crime and Neurocognitive Functioning. Specifically, Hancock and colleague's (2010) study revealed those offenders who were slower in the completion of measures of both inhibition (i.e., inhibiting a prepotent verbal response) and cognitive flexibility were more likely to commit a higher frequency of violent crimes compared with those performed better on such tests. Moreover, those offenders who supplied fewer corrected errors (i.e., recognizing an error and subsequently providing a correct response) on the Switching Condition of the Color-Word Interference Test were also more likely to have a higher frequency of violent crimes. Severity of violent crime also appeared to be related to deficits in inhibition and cognitive flexibility, such that those offenders who preformed worse on these tasks were more likely to been convicted of a severe violent crime (e.g., battery, homicide, etc.).

Among violent offenders, differences in neurocognitive functioning appear to be related to the form of violence (i.e., instrumental versus reactive). Instrumental violence is defined as "when the injury to a person is committed secondary to the attainment of some other external goal" (Woodworth & Porter, 2002, page 437). An example of instrumental violence is when one becomes violent during an attempt to obtain another's property. Conversely, reactive violence occurs when an individual uses violence to defend him or herself against a perceived threat or stressor (Woodworth & Porter, 2002). For example, reactive violence may occur when one becomes violent during a domestic dispute. Broomhall (2015) assessed the neurocognitive functioning among instrumental and reactive violent offenders on several subtests of the D-KEFS. His results demonstrated that on Verbal Fluency Test reactive and instrumental offenders differed significantly on Switching Accuracy (i.e., number of correct semantic or category shifts), number of Interval 1 Responses (i.e., number of correct responses in the first 15 seconds of test administration), Set Loss errors (i.e., number of incorrect responses due to a “loss” of semantic category), and Percent Switching Accuracy (i.e., percentage of all responses that represent correct semantic category switches). Further, instrumental violent offenders did not differ from the normal population in terms of their means scores. Whereas the reactive violent offenders’ mean scores were below that of the norm in all four areas. When assessing differences among offender types and the D-KEFS Color-Word Interference Test, reactive offenders significantly differed from instrumental offenders in the Inhibition/Switching and Primary Contrast scores (i.e., scores that “parcel out” lower-order abilities, such as word reading, and are thought to represent “higher-order” cognitive ability). Again, reactive offenders preformed significantly worse than the normal population in these subtests, whereas instrumental offenders did not. Not only do these results suggest that violent offenders are significantly impaired on tests of executive function compared with their non-offending counterparts, but that primarily reactive violent offenders show the greatest deficits of measures of neurocognitive ability.

Imaging studies shed similar light on cognitive dysfunction among reactive and instrumental violent offenders. Positron emission tomography (PET) brain scans revealed violent reactive offenders have lower prefrontal metabolic activity when compared with control participants, whereas violent instrumental offenders’ metabolic prefrontal activity resembled those of control participants (Raine, Ohil, Stoddard, Bihrle, & Buchsbaum, 1998).

Overall, these results demonstrate offenders vary from their non-offending counterparts in terms of their cognitive abilities. Additionally, these cognitive deficits may further differentiate offenders within the imprisoned population in terms of violent and non-violent crimes. These differences, however, do not appear to be contained solely within the violence of the offending act.

New research has begun to assess if there are differences among those who commit drug-related crimes versus those who do not in an incarcerated sample. Specifically, in terms of decision-making processes, those who committed drug-related offenses demonstrated a preference to outweigh potential gains as compared with losses in the Iowa Gambling Task, while assault and/or murder criminals made more random choices in focus of immediate outcomes (Yechiam et al., 2008).

Recidivism and Neurocognitive Functioning. Finally, those who successfully reintegrated into society and those who reoffended appear to have different neurocognitive functioning. The recidivism rate among drug offenders is hovering around 76.9% within 5 years of release (Bureau of Justice, 2005). Compared with first-time offenders, those who reoffended demonstrated neurocognitive deficits in areas of ability such as monitoring pervious responses, formulating strategies, learning new associations, inhibition of responses as seen on their poorer performance on the Non-spatial Conditional Association Task (NCAT), Go/No-Go Task, and the Wisconsin Card Sorting Task (Ross & Hoaken, 2011).

In sum, neurocognitive impairments and flawed decision-making processes are generally reflected among those who are incarcerated, with new research suggesting significant differences among those within this population as well. These results highlight a burgeoning area of research to better understand how these underlying processes influence an inmate’s ability to succeed and rehabilitate.

A better understanding of these etiological factors is necessary for prevention, treatment, and successful rehabilitation. It remains plausible that the neurocognitive impairments reflected in this incarcerated population with regard to their executive functioning abilities (e.g., planning for future consequences, emotional and behavioral regulation, impulse control, etc.), may have increased their chances of committing crimes. These deficits may be predetermined by nature (i.e., genes) or may be influenced by environmental factors. One environmental factor that is prevalent throughout this population, as already mentioned, is the high rates of consumption of alcohol and illicit substances. An estimated 53% to 73% of incarcerated individuals met criteria for dependence or abuse of drugs and alcohol to some extent prior to incarceration (Bureau Of Justice, 2006). Additionally, nearly 30% of jail inmates reported being under the effects of drugs or alcohol at the time of arrest (Bureau of Justice, 2002).

Alcohol and illicit drug use are associated with impairments in neurocognitive functioning, particularly in the domains of executive functioning (Simon, Dean, Cordova, Monterosso, & London, 2010; Wong, Brower, Nigg, & Zucker, 2010). These results have been found in both neurocognitive assessments (Stavro, Pelletier, & Potvin, 2013) and neuro-imaging (Volkow et al., 1992). It is plausible then that one factor that affects neurocognitive deficits in incarcerated populations is heavy substance and alcohol use. It therefore behooves researchers and clinicians to further understand this relationship. The purpose of this study was to explicate the association between drug and alcohol use, neurocognitive functioning, and type (i.e., violent versus nonviolent), severity, and frequency of crime among an incarcerated sample. To our knowledge, very little research has focused on the relationships among these variables.

Substance Use, Neurocognitive Functioning, & Crime

The relationship between substance use and neurocognitive functioning has rarely been assessed within an incarcerated population. Indeed, the author was able to find only one study that specifically assessed this relationship. In that study, Selby and Azrin (1997) examined differences in neuropsychological performance among those who met criteria for cocaine, alcohol, and polysubstance use abuse/dependence (i.e., those who abused multiple substance simultaneously). Group comparisons were made between alcohol dependence only subjects, cocaine, polysubstance dependent or abuse subjects and a matched control group who had no history of drug or alcohol abuse/dependence. Three hundred and fifty-five offenders were administered a neuropsychological battery that measured the following domains of cognitive ability: memory (short- and long-term), executive functioning abilities, intelligence, and visual-motor abilities. Results revealed that the cocaine group demonstrated no statistical difference when compared to controls and performed significantly better than both the alcohol and polysubstance group. In contrast, both the alcohol and polysubstnace group were significantly impaired when compared to the matched controls. Offenders in the alcohol and polysubstance groups had deficits in short- and long-term memory abilities, and those in the polysubstance group had an additional deficit in executive functioning abilities. Moreover, the polysubstance group performed significantly worse than alcoholic offenders in all measured domains of cognitive functioning except for overall intelligence. Researchers also conducted correlations between length of time in abstinence from substance use and cognitive performance. Alcoholic offenders significantly improved in all measured domains; however, offenders in the polusubstnace group demonstrated improvements only in long-term memory and visual-motor abilities.

Overall, these results suggest that inmates who abused multiple substances suffered the greatest degree of chronic impairment. Polysubstance users performed worse and improved least with abstinence than other groups. The average consumption of cocaine and alcohol was the same across all groups, suggesting that it is interaction of substances that produce the greatest degree of chronic cognitive impairment rather than substance use per se.

These results are important in that they highlight overt neurocognitive deficits are demonstrated for incarcerated individuals in regard to their substance use. However, additional research that assesses this relationship within an incarcerated sample appears to be virtually non-existent and represents a true dearth in the research. Moreover, research associating drug use and neurocognitive impairments with specific characteristics of crime within this population appears to be nonexistent and represents a critical need. As such, the current study aims to address this dearth and assess the relationship substance use and neurocognitive deficits and their joint relationship with crime in an incarcerated population.

Specific substances can impact cognitive functioning differently and as such different neurocognitive assessments may be better designed to capture these specific deficits. However, due to time constraints, researchers have to be particular about which assessments to administer to best capture the proposed deficit. A judicial method is to therefore assess commonly abused substance within the geographic location the study will take place. In Idaho the most common substances abused are alcohol, methamphetamine, and marijuana (Substance Abuse and Mental Health Services Administration, 2012). Indeed, it is estimated that 40% of individuals entering drug treatment programs in Idaho will be doing so for dependence on marijuana or stimulants. Each of these substances has demonstrated varied effects in regards to neurocognitive functioning. As studies assessing the relationships between these substances and neurocognitive deficits for incarcerated populations are non-existent, the following sections will explicate the relationship demonstrated with each of these substances and neurocognitive functioning in non-offending populations in hopes to better highlight the thought processes behind picking specific neurocognitive assessments to capture this relationship.

Substance Use and Neurocognitive Functioning

Alcohol and Neurocognitive Functioning. The Department of Justice (2014) estimates that alcohol is an influence in 40% of violent crimes today and that 37% of approximately 2 million incarcerated offenders report that they were intoxicated at the time of their arrest. It is estimated that of those who meet the criteria for alcohol dependence approximately 50% (range 31% to 85%) manifest neurocognitive impairments on neuropsychological testing when abstinent for 3-4 weeks (Eckardt & Martin, 1986). Unfortunately, research assessing specific neurocognitive deficits among those individuals meeting criteria for an alcohol use disorder within a prison population is limited to nonexistent. Therefore, the following section will highlight established neurocognitive differences among those who have problematic relationship with alcohol and those who do not, outside of an incarcerated population.

Deficits exhibited by alcoholics are sustained throughout early abstinence. Although not all abstainers exhibit neurocognitive damage, there has been an identified "typical" profile for those alcoholics who abstain from alcohol for 2-4 weeks. That is, these individuals typically show deficits in areas such as novel problem-solving, abstract reasoning, learning, memory, visual-spatial analysis, complex perceptual-motor integration, and simple motor skills (Rourke & Grant, 2009).

Attention deficits are also often exhibited within alcoholic populations. Specifically, for alcoholics, stark deficits appear when attentional tasks place a higher processing demand (Bartsch et al., 2007). For example, recently abstinent alcoholics do not differ from controls on simple processing tasks (i.e., reading words), but revealed significant deficits when required to perform tasks consecutively (i.e., detect probe while reading words) (Smith & Oscar-Berman, 1992). However, whether these attentional deficits reveal themselves in “lower order” processing tasks is still up for debate (Miller & Orr, 1980).

Executive functioning processes are frequently cited as impaired for chronic alcoholics, such that neuropsychological tests show impairment on tasks that place demands on abstraction, reasoning and problem-solving skills, and cognitive flexibility. This suggests that the damage caused in acute alcoholism is heavily concentrated within the frontal lobe. Indeed, research has postulated that the deficits seen from severe alcoholism is mainly exhibited in the frontal lobe (Tarter, 1975). However, a competing line of thought states that damage from long-term alcohol use is more diffuse, meaning that alcohol produces neurotoxic effects throughout the brain (Tivis, Beatty, Nixon, & Parson, 1995). To make things more difficult, much of the research done to support executive functioning deficits (i.e., frontal lobe damage) used tasks that also involved nonexecutive components, and these tasks had been shown to be impaired as a result of nonfrontal lobe lesions (Burgess, 1997; Stuss et al., 2000). To remedy these methodological difficulties, Noël and colleagues (2001) designed a study that utilized tasks to measure nonexecutive and specific executive operations separately by comparing tasks of “lower-order” to their “high-order” counter parts between controls and alcoholics (i.e., Trail A versus Trail B, color naming versus inhibition on Stroop). Alcoholic men consistently performed worse on higher-order tasks, but performed comparable to controls on lower-order, further supporting a “frontal-lobe” hypothesis. Overall, these results suggest for inhibition, planning, rule detection, and coordination of dual tasks are significantly impaired for recently detoxified alcoholics.

A closer assessment of gendered differences in neurocognitive performance among alcoholics has recently been put under inspection. Most research of alcohol-induced neurocognitive damage has been done with men. However, when female comparisons are available it typically appears that women exhibit relatively the same neurocognitive deficit profile (Fabian, Jenkins, & Parsons, 1981). Importantly, women seem to demonstrate these deficits after shorter drinking histories than men (Glenn & Parksons, 1990). One hypothesized reason for this is that brain atrophy appears at a faster rate for women than men (Mann et al., 2005).

The extent to which neurocognitive abnormalities persist in alcoholics, or recover with increasing length of stable abstinence, is an area of continuing debate. The bulk of research concerning damage associated with alcoholism mainly uses those individuals who are recently detoxified. Therefore, if one were to focus exclusively on these findings, it might be incorrectly assumed that alcohol causes chronic and permanent damage. However, studies have begun to assess alcoholics after longer periods of time to better address this lack of consensus. For example, a meta-analysis conducted by Stavro, Pelletier, and Potvin (2013) assessed cognitive functioning of 12 domains for alcoholics: intelligence quotient (i.e., IQ), verbal fluency, learning, and memory, processing speed, working memory, attention, problem solving, executive functions, inhibition, visual learning, visual memory, and visual-spatial abilities. Studies were sectioned into three groups of length of abstinence: short (i.e., <1 month), intermediate (i.e., 2 to 12 months) and long (i.e., >1 year). Overall, 62 studies were included in the meta-analysis and results demonstrated moderate effect sizes (d=0.328-0.699) across 11 of the cognitive domains during short-term abstinence. Intermediate abstinence generally showed comparable results to short-term abstinence, with moderate effect sizes for 10 domains (IQ and attention were small) and a large effect size for inhibition/impulsivity (d=0.766). For long-term abstinence, effect sizes were generally small in nature. These results suggest that cognitive impairments are typically exhibited within the first 12 months of abstinence, but recovery may be possible with extended abstinence.

In sum, alcoholism is associated with brain injury that is revealed in neuropsychological assessments. Disturbances in the domains of executive functioning are the most noted. When available, gender difference reveal similar neurocognitive patterns (i.e., deficits in novel problem-solving, abstract reasoning, learning, memory, visual-spatial analysis, complex perceptual-motor abilities, and simple motor skills), but diverge when history of consumption is taken into consideration. It is important to recognize the fact that neuropsychological deficits and other brain changes observed in alcoholics have mainly been with those who have recently detoxified. Total or partial recovery of alcohol's effect on the brain is still up for debate. However, research is beginning to highlight that at least some recovery is possible. Ultimately, though, complete recovery is dependent on other factors such as developmental level (i.e., age of onset), polysubstance use (i.e., using multiple substances in tandem), and psychological well-being (e.g., comorbid mood and trauma-related disorders). While the effects of chronic alcohol use is stark and definitive, neurocognitive functioning from chronic cannabis use is not so clear-cut.

Cannabis and Neurocognitive Functioning. Cannabis is the most commonly used illicit substances in the United States, with 40% of Americans over the age of 12 reporting lifetime use during 2005, and 8% reporting use during the past month (Substance Abuse and Mental Health Services Administration, 2006). It is estimated that approximately 2.7% of the world's population has used cannabis—compared to 0.3%-0.4% for cocaine and heroin (United Nations Office on Drugs and Crime, 2004). Given its prevalent use, it is no wonder that a plethora of research has been conducted on the neurocognitive effects of chronic cannabis use.

Unfortunately, the bulk of this research has been conducted with non-offending populations. No research was found that specifically looked at neurocognitive deficits associated with heavy cannabis use and their relationship with crime within an incarcerated population.

Unlike with alcohol and methamphetamine, the long-term effects of cannabis use is still somewhat up for debate. Specifically, early research with moderate to heavy cannabis users found little to no evidence of neurocognitive damage (Bowman & Pihl, 1973; Carlin & Trupin, 1977), while others found significant deficits in areas of verbal memory, attention, speed and accuracy, and perceptual-motor tasks among cannabis users when compared to controls (Entin & Goldzung, 1973; Fletcher et al., 1996).

Possible reasons for these discrepant findings are substantial heterogeneity in research designs and methodological limitations (Gonzalez, Vassileva, & Scott, 2009; Pope, Gruber, & Yurgelun-Todd, 1995). To counter these limitations, several meta-analyses have been conducted. For example, Grant, Gonzalez, Carey, Natarajan, and Wolfson (2003) included studies in their meta-analysis that only met scientific inclusion criteria that would infer the difference in neuropsychological performance were associated with cannabis use, rather than other potential confounds (e.g., neurological disorders, psychiatric disorders, & other drug use). In total, fifteen studies were included. Evidence demonstrated an overall small (albeit detrimental) deficit in neuropsychological functioning (d = -.16). Within specific domains, only learning and recall/retention showed significant, but small effect sizes (d = -.21 and -.27, respectively). Participants in the studies included in their meta-analysis varied substantially in length of abstinence from cannabis, and data points were too few to conduct analyses examining how length of abstinence affected the magnitude of neurocognitive deficits.

To account for these limitations, a more recent meta-analysis by Schreiner and Dunn was conducted in 2012. Schreiner and colleagues conducted two meta-analyses: one updated current efforts in the neurocognitive effects of heavy cannabis use with more recent studies and the other assessed the lasting residual effects of moderate to heavy cannabis use by including studies that only used participants who had been abstinent for at least 25 days. Their results were reported as both a global neurocognitive performance (i.e., overall composite score of neurocognitive performance across 8 domains) as well as assessed the eight domains reported in the Grant and colleagues (2003) article (i.e., abstraction/executive, attention, simple reaction time, verbal/language, perceptual-motor, simple motor, learning, and forgetting/retrieval). Thirty-three studies were included in the initial meta-analysis and results indicated a small, but significant negative residual effect of cannabis use on global neuropsychological performance. Among specific domains, this study was able to replicate the findings front Grant and colleagues (2003), where significant deficits were revealed among learning and forgetting/retrieval. The results also reveal negative effects in the domains of executive functioning, attention, verbal/language, and motor functioning. Thirteen studies were included to assess the lasting residual effects of cannabis use. For this meta-analysis, results revealed no evidence for lasting effects on overall performance. These results were mirrored across all eight domains of functioning.

Overall, these results suggest that cannabis may impact neurocognitive functioning, but that this impact may be contained within the first 25 days of abstinence. However, age was not controlled for in the above analyses, and some evidence suggests that an earlier age of onset for cannabis use may be related to poor neurocognitive performance (Pope et al., 2003). It may be that lasting residual effects of cannabis use are dependent on onset of regular use occurring before a certain age or developmental stage. Additionally, these studies were not able to take into account premorbid functioning in regard to neurocognitive performance.

In sum, there is evidence to suggest that cannabis may affect different domains of neurocognitive functioning, particularly within that of learning, memory, and executive functions. These deficits are striking among current, heavy cannabis users, with less frequent users of cannabis often showing little to no deficits. Some of the more current research suggests that these differences among heavy and irregular users dissipate over time of abstinence. Given that cannabis use is related to detriments in areas of cognitive functioning that are related to crime (i.e., executive functions, learning), it is necessary to evaluate these relationships in tandem in better understand etiological or exacerbating factors that influence criminal behavior and/or recidivism.

Methamphetamine and Neurocognitive Functioning. Methamphetamine is a potent, addictive psychostimulant that has striking effects on the central nervous system (CNS) for up to 12 hours and may be administered in a variety of different ways (e.g., injection, snorting, or smoking). Methamphetamine use has been increasingly widespread in recent years, in part due to its cost-efficient synthesis and inexpensive, over-the-counter ingredients. Estimates suggest that approximately 10 million individuals have tried methamphetamine at some point in their lives (Substance Abuse and Mental Health Services Administration, 2006). While some data suggest that methamphetamine use in the United States may have plateaued, methamphetamine use remains a significant problem in many areas, specifically in the Western region of the United States (Substance Abuse and Mental Health Services Administration, 2006). Indeed, as methamphetamine use is still a concern in the southeastern Idaho area, it is important to better understand its relationship with neurocognitive functioning and whether these areas of cognitive functioning are associated with aspect of crime.

Chronic use of methamphetamine results in neurotoxicity of multiple pathways, but perhaps has the most striking impact on the nigrostriatal dopaminergic projections. This alters dopamine-rich areas, such as the fronto-straito-thalamo-cortical loops (Cass, 1997). Neuroimaging studies have largely supported these findings by demonstrating methamphetamine abuse results in structural and metabolic abnormalities in the prefrontal cortex and striatum (Ernst, Chang, Leonido–Yee, & Speck, 2000; Thompson et al., 2004). Cognitive processes impacted by this pathway are complex information-processing speed, attention/working memory, inhibition, decision-making, and novel problem-solving.

Cognitive strategies, such as those listed above, are in part related to executive functioning abilities. Not surprisingly, methamphetamine abuse has been demonstrated to impact other areas that are considered part of an individual's executive functioning abilities. For example, research has demonstrated significant impairments for methamphetamine dependent individuals in executive function tasks such as switching/flexibility (Hosak et al., 2012), inhibition (Iudicello et al., 2010), and mixed results in updating (Hart, Marvin, Silver, & Smith, 2012). Importantly, deficits in similar areas (e.g., inhibition, flexibility, attention) have been associated with increased violent criminal behavior (Hoaken, Allaby, & Earle, 2010).

Attention is a cognitive construct that is in part thought to fuel the utilization of effective executive functioning strategies (Hunt & Ellis, 2004). Deficits in attention are thought to have a cascading effect of other "downstream" processes. It is not surprising then, that methamphetamine dependent individuals, who demonstrate marked global impairments of neurocognitive functioning (i.e., two or more domains), also have significant impairments in their attention processes. Overall, those who suffer from methamphetamine dependence are noted to have impairments in the realm of processing speed, sustained attention, and increased distractibility. Specifically, these deficits become more pronounced the more complex the tasks become, while basic attention and processing abilities appear unaffected (Chang et al., 2002). For example, it is common for methamphetamine abusers to not significantly deviate from controls on tests such simple digit recognition or the Tail-Making Test, Part A, but have significant impairments on complex tasks, such as the n-back task or Digit Symbol (Johanson et al, 2006; Kalechstein, Newton, & Green, 2003). Additionally, sustained attention may also be particularly susceptible to methamphetamine-associated damage (London et al., 2005).

Overall, chronic methamphetamine use impacts neurocognitive functioning in a myriad of deleterious ways. Unlike alcohol, or more specifically cannabis, methamphetamine's effect appears to be more long lasting, which severely impacts one's abilities to recover from significant abuse, even after sustained periods of abstinence. Methamphetamine appears have a wide cast in its ability to degenerate a plethora of domains, such as memory, attention, and executive functioning. Deficits to these areas significantly impact one's decision-making abilities and may make them more susceptible to maladaptive choices, thus making abstinence less likely and imprisonment more likely. These problems may be exacerbated by engaging in polysubstance abuse, which is common in imprisoned populations. However, current research in this area is quite limited. Since polysubstance use is more reflective of the incarcerated population, it behooves both researchers and clinicians to better understand how polysubstance use may impact decision-making skills. Therefore, the purpose of this study was to expand where current research has left off to explicate this association. The next section will review the current research on polysubstance abuse, with a strong emphasis in the combinations of alcohol, cannabis, and methamphetamine.

Polysubstance Use and Neurocognitive Functioning. Most research concerning substance abuse and neurocognitive functioning has primarily focused on single drug use. This research is beneficial in better understanding the unique effects these drugs impart on neurocognitive functioning, but it is not necessarily representative of the using population, where abusing multiple substances in tandem is on the rise (Venkatesan & Suresh, 2008). Polysubstance use is broadly defined as the dependence/abuse of more than one drug in a specified time period. To date there are not many studies that have examined polysubstance use rates. However, one comprehensive study conducted by the National Epidemiological Survey on Alcohol and Related Conditions reported that approximately 215.5 individuals out of 43,093 (0.5%) met requirements for polysubstance abuse/dependence in the United States (Agrawal, Lynskey, Madden, Bucholz, & Heath, 2007). Moreover, within the incarcerated population it is estimated that 22% are addicted to more than one substance at the time of imprisonment (Vreugdenhil, Van den Brink, Wouters, & Doreleijers, 2003).

Research on polysubstance use and its relationship with neurocognitive functioning is more limited, but some research is being brought to light of the additive damage this form of substance use imparts. For example, Bondi, Drake, and Grant (1998) compared alcoholics and polysubstance users (i.e., marijuana, cocaine, amphetamines, opiates, barbiturates, and hallucinogens) on measures of verbal learning and memory using the California Verbal Learning Test. Their results demonstrated that the polysubstance abusers were significantly impaired on a number of CVLT indices, when compared with alcoholics. Interestingly, no differences were found on indices of learning strategies, serial position effects, or response discrimination, which suggests that although alcoholic and polysubstance users appear to have utilized similar strategies, response styles, and error patterns, the polysubstance users still demonstrated deficits in learning and memory relative to the alcoholic participants. These results are not limited to the domains of memory. Other research has found significant differences between alcohol polysubstance users (i.e., methamphetamine, cocaine/crack, and cannabis) in areas of inhibition relative to controls (Noël et al., 2005).

Moreover, when explicitly assessing polysubstance with drugs commonly abused in Idaho (i.e., alcohol, cannabis, and methamphetamine) one also sees additive effects of abusing multiple substance in tandem on neurocognitive functioning. Specifically, global neurocognitive performance appears worse in those who engage in both binge drinking of alcohol (i.e., >4 drinks in one occasion for females and >5 drinks for males) and heavy cannabis use (i.e., >200 lifetime cannabis use episodes) when compared to those who just engage in only binge drinking (Jacobus et al., 2015). While other research has highlighted that deficits in working memory are unique to concomitant users (i.e., those who heavily used both cannabis and alcohol) when compared to single users (Winward, Hanson, Tapert, & Brown, 2014).

Alternatively, conflicting results are revealed when assessing concomitant methamphetamine and cannabis use. Specifically, cannabis use has been found as both a protective (Gonzalez et al., 2004) and detrimental factor (Cuzen, Koopowitz, Ferrett, Stein, & Yurgelun-Todd, 2015) to neurocognitive functioning when compared to methamphetamine use alone. Since this research was conducted with nonoffending participants, they are limited in their generalizability to incarcerated populations. Indeed, research specifically assessing relationship among substance use, polysubstance use, and cognitive functioning within an incarcerated sample are rare to none. Even further, to the best of the author's knowledge, no research has attempted to connect (poly)substance use and cognitive functioning to various aspects of crime. As such, this dearth in the research represents a critical need to better understand these relationships specifically within this population.

Purpose of Study

Review of current literature indicated there are neurocognitive differences among inmates and their non-offending counterparts (Meijers, Harte, Jonker, & Meynen, 2015). Further, there appears to be differences among inmates in regard to their neurocognitive functioning, such that type (i.e., violent versus nonviolent) and frequency of crime may be predicted by specific cognitive impairments of inhibition and cognitive flexibility (Hancock, Tapscott, & Hoaken, 2010; Meijers, Harte, Jonker, & Meynen, 2015). Polysubstance abuse is common among this population. Inmates demonstrate higher rates of substance use than non-offenders and those who engage in polysubstance use typically demonstrate a higher frequency of criminal behavior and arrests (Smith & Polsenberg, 1992). Polysubstance use is also associated with cognitive deficits. Indeed, deficits have been found in the realms of inhibition, cognitive flexibility, and updating (Noël et al., 2005). However, research on the relationship between polysubstance use and neurocognitive functioning is considerably limited. Further, no research has assessed whether these neurocognitive deficits are associated with type and frequency of criminal behavior. Therefore the aims of the present study were to identify whether polysubstance abuse is associated with neurocognitive functioning deficits, and whether these neurocognitive deficits were associated with type and frequency of crime. As the vast majority of research on this population has been conducted primarily with male inmates only, an exploratory goal of this study was to assess gender differences in the relationships among substance use, neurocognitive functioning, and criminal behavior, i.e., the effects of substance use X gender and neurocognitive functioning X gender on criminal behavior. Based on the research reviewed in the previous sections, a heuristic model and four hypotheses are described here (see Figure 1 and 2).

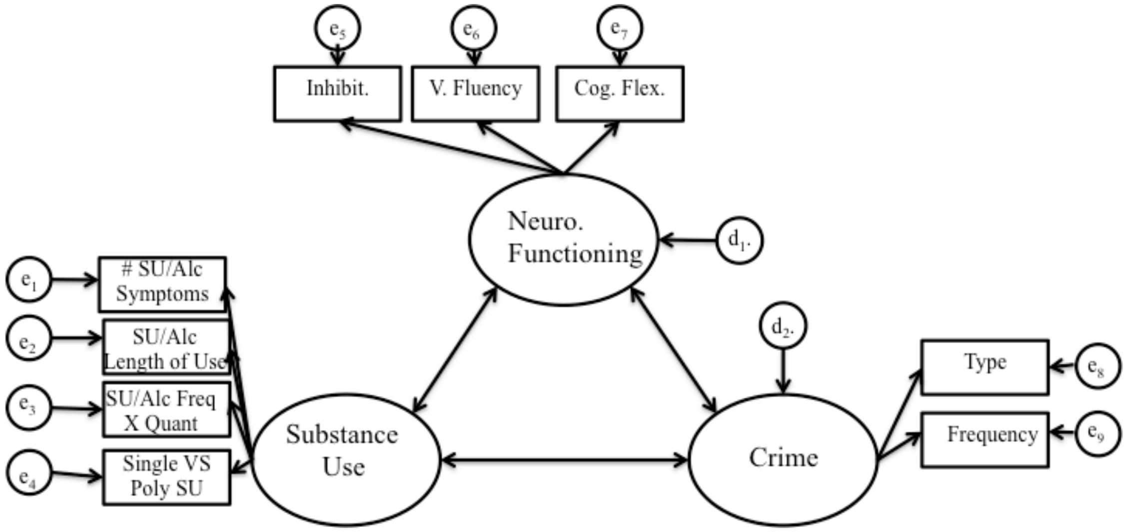

Figure 1. Hypothesized measurement model with observed indicators of *substance use*, *neurocognitive functioning*, and *criminal behavior*.

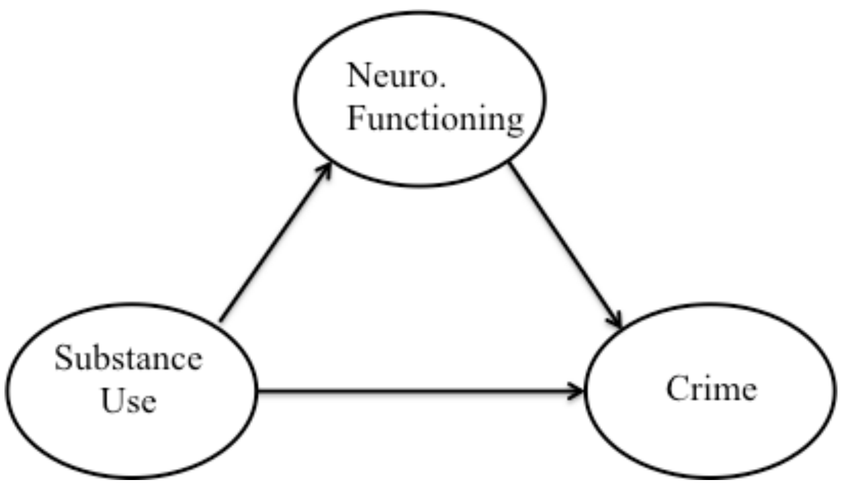

Figure 2. Hypothesized structural model wherein *neurocognitive functioning* mediates the relationship between *substance use* and *criminal behavior*.

Hypotheses

1. **Hypothesis 1:** First, number of substance use disorder and alcohol use disorder symptoms endorsed, length of time of substance and alcohol use, single versus polysubstance use, and frequency and quantity of substance and alcohol use would load

onto a common *substance use* factor. Next, I hypothesized inhibition, verbal fluency, premorbid intelligence, flexibility, and length of abstinence would load onto a common *neurocognitive functioning* factor. Finally, I expected type (i.e., violent or nonviolent) and frequency of crime would load onto a common *criminal behavior* factor.

2. **Hypothesis 2:** *Substance use* would be associated with *neurocognitive deficits*, such that inmates who reported more engagement in *substance use* would demonstrate more *neurocognitive deficits* in areas of inhibition, verbal fluency, and cognitive flexibility.
3. **Hypothesis 3:** While controlling for previous substance use, *neurocognitive deficits* would be associated with the frequency and nature of criminal behavior history (i.e., violent versus nonviolent). Specifically, holding constant previous substance use, I expected inmates who demonstrated neurocognitive deficits in inhibition, cognitive flexibility, and verbal fluency to report more frequent criminal behavior and a history of violent crime.
4. **Hypothesis 4:** *Neurocognitive deficits* would mediate the relationship between *substance use* and *crime*. Specifically, I expected inmates who engaged in substance use would demonstrate deficits in their neurocognitive performance and that this deficit would predict more frequent criminal behavior and a history of violent crime.
5. **Hypothesis 5:** Given the lack of research of gender differences in the relationships among substance use and crime as well as neurocognitive functioning and crime, Hypothesis 5 was exploratory in nature. To test for significant differences between the genders and be in accordance with multiple group analysis (see Plan of Analyses below), I expected no gender differences in the structural relationships among *substance use*,

neurocognitive functioning, and *criminal behavior*. Specifically, I tested differences in any paths in a structural equation mediation model.

CHAPTER II

Methods

Participants

One hundred male and one hundred and fifty female inmates were recruited through random selection from 2 jails in southeastern Idaho for a total of two hundred and fifty participants. Men and women were informed via memos sent to their units with a description of the purpose of the study. The memos outlined that inmates were randomly selected to participate in the present study and would be invited to interview individually. After the study was introduced, and the inmates informed of the procedures, research assistants randomly selected participants and called them out individually to invite them to participate. The study was open to all male and female inmates over the age of 18 and who were fluent in English.

The appropriate sample size was determined using MacCallum, Browne, and Sugawara's method (1996). This method focuses on the power of the data to detect an overall good fit of a theoretical model using the root mean error of approximation (RMSEA) in structural equation modeling (SEM). The RMSEA estimates the lack of fit in a model compared to the saturation model. RMSEA of .06 or below indicates a good model fit (Hu & Bentler, 1999). Using degrees of freedom in a structural model, MaCallum et al. (1996) provided power and sample size recommendations to detect a model of exact fit (H_0=.00 versus H_a=.05), close fit (H_0=.05 versus H_a=.08), and poor fit (H_0=.05 versus H=.10). The target sample size was calculated in order to achieve a conventional statistical power of .8, i.e., the model will yield 80% power to detect a statistically significant relationship between independent and dependent variables if the null hypothesis is false (Cohen, 1992). Past neuropsychological paradigms conducted in prison settings yielded medium to large effect sizes (Baker & Ireland, 2007; Munro et al., 2007; Schiffer & Vonlaugen, 2011). For the current study, the most relevant test is the test of close fit, the ability to differentiate the difference between a null model with a RMSEA of .05 $(\varepsilon_0 = .05)$ and an alternative model with a RMSEA of .08 $(\varepsilon_0 = .08)$. The proposed model included 12 observed variable and 3 latent variables. Research testing SEM models in the incarcerated populations similar to the ones proposed in this dissertation indicated the degrees of freedom vary between 100 and 150 (Johnson & Lynch, 2013; Lynch, DeHart, Belknap, & Green, 2012). According to MacCallum et al. (1996), a df of approximately 100 and a alpha rate of .05, a sample size of at least 200 was necessary to achieve a power of .80. A sample size of 200 should also be sufficient to assess for group differences in the structural paths of the proposed model, as 100 participants for each group is typically recommended (Kline, 2005).

Measures

Substance Use.

Mini International Neuropsychiatric Interview 6.0. (MINI; Sheehan & Lecrubier, 2010). The MINI is a short, structured diagnostic interview that enables researchers and clinicians to diagnose psychiatric disorders according to the DSM-IV or ICD-10. For the purpose of this study, only modules of Alcohol Use Disorder and Substance Use Disorder were used. Research assistants inquired about lifetime usage as well as date of last usage. Additionally, for Substance Use Disorder module, research assistants asked inmates to identify their three mostly commonly used substances and were run through the module for each substance separately to determine previous history of polysubstance use. Questions for both modules are listed in a yes/no format. The MINI has been demonstrated to be both valid and reliable (Sheehan et al., 1997; Sheehan et al., 1998). Inter-rater reliability across all diagnoses is above 0.75. Similarly, correlation with other diagnostic interviews typically yielded kappas of 0.70 and above (Sheehan et al., 1998). Together, the MINI modules of SUD/AUD took approximately 15 minutes to complete.

Alcohol Use Disorder Identification Test. (AUDIT; Saunders, Aasland, Babor, De la Fuente, & Grant, 1993). The AUDIT is a 10-item screening tool developed by the World Health Organization to assess alcohol consumption, drinking behaviors, and alcohol-related problems. Research assistants administered only two questions on the AUDIT. Specifically, the research assistants inquired both the frequency and quantity of alcohol consumption during their heaviest time of use. Answers were given based on a 5-point Likert Scale from 0 to 4. For frequency, an answer of 0 represented no alcohol use and 4 indicated 4 or more separate alcohol usages in a week. For quantity, an answer of 0 represented 1 or 2 alcoholic drinks in a typical day of drinking whereas a 4-response indicated 10 or more alcohol drinks in a typical day of drinking. Validity studies of the AUDIT have revealed same cut-off points (7/8) for ICD-10 diagnoses of alcohol-related disorders with a sensitivity of 100% and a specificity of 76% (Lima, Freire, Silva, Teixeira, Farrell, & Prince, 2005). Intraclass correlation coefficients (ICC) for test-retest reliability conducted for each item yielded values from .39 to .98, with the majority of the ICCs being above .75. The AUDIT's total score produced an ICC of .95 (Dybek et al., 2006).

Drug Use Disorder Identification Test. (DUDIT; Berman, Berman, Palmstierna, & Schlyter, 2005). The DUDIT was developed as a parallel instrument to the AUDIT for identification of drug-related problems. Similar to the AUDIT administration, research assistants only asked two questions from the DUDIT pertaining to both frequency and quantity of drug use during the participant's heaviest time of use. Answers were given on a 5-point Likert Scale of 0 to 4. For frequency, an answer of 0 represented no drug use and 4 indicated 4 or more separate drug usages in a week. For quantity, an answer of 0 represented no drug use whereas a 4-response indicated 10 or more drug usages in a day. Bergman, Bergman, Palmstierna, and Schlyter (2005) assessed both the reliability and validity of the DUDIT in a sample of heavy drug users form prison, probation, and inpatient detoxification settings. Their findings revealed the DUDIT predicted substance dependence with a sensitivity of 90% for both the DSM-4 and ICD-10 and specificity of 78% and 88%, respectively. Reliability was assessed using the Cronbach's ∝ yielding a value of 0.80. Overall, the DUDIT appears to be both a valid and reliable assessment of substance use problems.

Neurocognitive Functioning.

Wisconsin Card Sorting Task. (WCST; Heaton, 1981). The WCST has been considered one of the premiere tests for executive functions, including maintenance of task set, flexibility in response to feedback or changing circumstances, and perseverative tendencies. For the purpose of this study, the WCST was utilized as a gauge for an individual's set-shifting abilities through their perseverative error responses. Respondents were presented with four stimulus cards that incorporate three stimulus parameters (i.e., color, form, and number). Participants were required to sort numbered response cards according to different principles and to alter their approach during test administration.

Axelrod, Goldman, and Woodard (1992) conducted two studies on the reliability of scoring the WCST. Both studies used WCST data obtained from 30 psychiatric adult inpatients and focused on scoring Perseverative Responses, Perseverative Errors, and Nonperseverative Errors. In the first study, three experienced clinicians of neuropsychological assessments independently scored the WCST data. Inter-scorer agreement was found to be excellent, with interclass correlation coefficients (r_{ICC}) of .96 for Perseverative Responses, .92 for Perseverative

Errors, and .88 for Nonperseverative Errors. Consistency of scorers in scoring the 30 protocols (i.e., intrascorer reliability) was also found to be excellent, $r_{ICC} = .96$, $r_{ICC} = .94$, $r_{ICC} = .91$ for Perseverative Responses, Perseverative Errors, and Nonperseverative Errors, respectively.

In their second study, Axelrod and colleagues used six novice scorers who had not had any previous experience in scoring the WCST. Again, interclass correlation coefficients was excellent, r_{ICC}=.88, r_{ICC}=.97, and r_{ICC}=.75 for Perseverative Responses, Perseverative Errors, and Nonperseverative Errors, respectively. Additionally, consistency was found among scorers in scoring the 30 protocols.

The WCST has successfully been used extensively in clinical and research applications as a measure of executive function. Clinical groups investigated have included subjects with focal and diffuse brain damage (Drewe, 1974; Robinson, Heaton, Lehman, & Stilson, 1980), seizure disorders (Hermann, Wyler, & Richey, 1988), Parkinson’s Disease (Beatty & Monson, 1990), multiple sclerosis (Rao, Hammeke, & Speech, 1987), psychiatric disturbances such as schizophrenia (Van der Does & Van den Bosch, 1992), and incarcerated populations (Ross & Hoaken, 2011).

North American Adult Reading Test. (NAART; Blair & Spreen, 1989). The NAART is a measure of premorbid intelligence by estimating participant’s vocabulary size. Participants orally read 50 phonetically irregular words, varying in frequency of use. The NAART scores correlate reasonably well with the WAIS-R VSIQ ($r = .83$) and the FSIQ ($r = .75$). (Strauss, Sherman, & Spreen, 2006). Further, Uttl (2002) found excellent reliability of the NAART, with a Cronbach’s $\propto$ of .93.

Delis-Kaplan Executive Function System. (D-KEFS; Delis, Kaplan, & Kramer, 2001). The D-KEFS is a battery of nine subtests that comprehensively assess the key components of executive functioning. In light of the available data on the psychometric properties of the D-KEFS, this battery is considered among the most valid means of assessing executive functioning (Baron, 2004). Owing to time constraints, only three of the subtests were administered (i.e., Color-Word Interference Test, Trail Making Test, and Verbal Fluency Test). This decision is not thought to affect the psychometric properties of the subtests, given the that D-KEFS subtests were designed to “stand alone.”

The D-KEFS Color-Word Interference Test is a variation of the classic measure of inhibition, the Stroop Test (Stroop, 1935). The D-KEFS test includes two baseline conditions for evaluating key component skills of the higher-level tasks: basic naming of color patches (Condition1) and basic reading of words that denote color printed in black ink (Condition 2). On the traditional inference task (Condition 3), the participant must inhibit reading the words denoting colors in order to name the dissonant ink colors in which those words are printed. Finally, in Condition 4, participants are required to switch back and forth between naming the dissonant ink colors and reading the conflicting words. Therefore, this condition measures both inhibition and cognitive flexibility. The D-KEFS Color-Word Interference Test provides normative data for completion times for each condition, contrast measure for parceling baseline scores from scores on high-level tasks, and uncorrected and self-corrected error measures.

To determine reliability of the Color-Word Interference Test, the developers used split-half correlations that were computed by correlating performance on each of the conditions and correcting with the Spearman Brown formula. Correlations across age groups were moderate to high (r = 0.75-0.86). Further, Test-Rest Reliability also demonstrated fair to high correlations (r=0.52-0.90) across age groups.

The Color-Word Interference Test has successfully been used to discriminate among varying clinical populations when compared with controls. Among children, the CWIT differentiated fetal alcohol syndrome children and controls among the higher orders conditions of inhibition and switching (i.e., Condition 3 and Condition 4) but not among baseline conditions of color-naming and word-reading (Mattson, Goodman, Caine, Delis, & Riley, 1999). In adult incarcerated populations, the CWIT successfully differentiated among violent and nonviolent offenders, where violent offenders demonstrated more uncorrected errors than their nonviolent counterparts (Hancock, Tapscott, & Hoaken, 2010).

The D-KEFS Trail Making Test (TMT) involves a series of 5 conditions: Visual Scanning, Number Sequencing, Letter Sequencing, Number-Letter Switching, and Motor Speed. In all five conditions, the stimuli are spread over an 11 X 17-inch area, which provides longer trails and more interference stimuli than the traditional TMT (Delis, Kaplan, Kramer, 2001). In the Visual Scanning condition, participants cross out all the 3's that appear on the response sheet. In the Number Sequencing condition, participants draw a line connecting the numbers 1-16 in order; distractor letters appear on the same page. The Letter Sequencing condition requires examinees to connect the letters A through P, with distractor numbers present on the page. The Number-Letter Switching condition, considered the "executive task", requires participants to switch back and forth between connecting numbers and letters in consecutive order (i.e., 1, A, 2, B, 3, C, etc.). Last, a Motor Speed condition is administered in which the participants trance over a dotted line connecting circles on a page as quickly as possible, in order to gauge their motor drawing speed. Each condition is preceded by a short practice trail. In all but the visual scanning condition, the research assistant corrects mistakes by placing an "X" over the wrong connection, and participants are asked to continue from the last correct connection. The stopwatch remains running during such corrections. This measure gauges participant's ability of cognitive flexibility and multitasking.

The TMT utilizes completion time as the primary performance measure. Internal consistency of composite scores were analyzed by treating performance on each condition as equivalent half tests. The developers found, using correlations corrected with the Spearman-Brown formula, moderate to high internal consistency coefficients (r = 0.70-0.81). Moreover, the Test-Retest reliability for the TMT typically fell in the moderate range (r = 0.55-0.74). Overall, performance improved on average from the first testing to the second testing on all primary measures.

Like the CWIT, the TMT of the D-KEFS has been used to successfully differentiate among several clinical populations. Mattson, Goodman, Caine, Delis, and Riley (1999) demonstrated that the high-order condition (i.e., Letter-Number Switching) of the TMT differentiated among those children who exhibited symptoms of FAS than those who were not exposed to alcohol in utero. Further, performance on the TMT significantly correlated with functional status (r = .66) of older adults (Mitchell & Miller, 2008).

The D-KEFS Verbal Fluency Test (VFT) taps the participant's ability to generate words fluently in an effortful, phonemic format, from overlearned concepts, and while simultaneously shifting between overlearned concepts. The test is composed of three conditions: Letter Fluency, Category Fluency, and Category Switching. For the letter fluency condition, the participant is asked to say words that begin with a specified letter as quickly as possible in three trials of 60 seconds each. In the Category Fluency condition, the participant is asked to say words that belong to a designated semantic category as quickly as possible in two trials of 60 seconds each. In the last condition, Category Switching, is a means of evaluating the participant's ability to alternate between saying words from two different semantic categories as quickly as possible for 60 seconds. To gauge reliability, test developers assessed the test-retest reliability of the VFT and found low to high correlations across conditions (r = .24-.81).

Stuss and Knight (2002) demonstrated that the VFT could differentiate among patients with frontal lobe lesions (FLL), where the FLL group generated significantly fewer items than controls on all conditions, particularly on the Letter Fluency condition. Performance of patients with left-hemisphere lesions was poorer than among patients with right-sided lesions. These results confirm the sensitivity of VFT when discerning deficits in verbal fluency ability.

Criminal Behavior.

Demographics. Participants were asked to complete a brief demographics questionnaire that included questions about age, income, educational/occupational history, ethnicity, relationship and parental status, sexual orientation, use of psychotropic medication, and criminal history (i.e., current and previous charges, previous incarcerations, behaviors resulting in incarceration). Information elicited from this questionnaire was used to report the demographic characteristics of the final sample as well as to determine type of crime that led to their current conviction (not used in final analyses).

Idaho Supreme Court Data Repository. The Idaho Supreme Court Data Repository, or more commonly known as the Idaho Repository, is a publicly available database of all pending and closed criminal cases in the state of Idaho. The repository was used to determine criminal variables of interest. Specifically, the repository was used to assess the frequency of all convicted crime and whether the participants exhibited a violent criminal history. Specifically, each participant was found in the Idaho Repository using their name and date of birth. Then, the principal investigator aggregated the number of all convicted criminal behavior in their lifetime.

Type of criminal history was differentiated by violent offenses and nonviolent offenses. Violence has various definitions, but for the purpose of this study, the definition of violence was any behavior involving an intentional act of physical aggression against another individual that is likely to cause physical injury (Hancock, Tapscott, & Hoaken, 2010; Meloy, 2006).

Since the researcher was assembling information about the participant's criminal behavior, additional safety measures were employed to ensure the participant's privacy. The researcher applied and obtained for a Certificate of Confidentiality (CoC) from the National Institute of Health. A CoC allows researchers to refuse to disclose names or other identifying information of research participants in response to legal demands. These certificates are issued to researchers to help protect the privacy of human participants enrolled in sensitive, health-related research.

Procedures

Study Procedures. All procedures were conducted with the approval of Idaho State University Human Subjects Committee. Using publically-accessible online rosters from local jails, potential participants were identified and entered into a database according to their location (i.e., where they are incarcerated) and, if the facility had multiple units, which unit they were held in. Once all available subjects were identified and organized, a random number generator was used to select the order in which they were approached (e.g., generating one set of numbers per location and unit). Given the jails high turnover rate, this roster was updated every 3 weeks. After individuals agreed to participate in the study, they were interviewed and tested in private rooms. To begin, research assistants described the purpose of the study, procedures (e.g., voluntary participation, estimated length of assessment), and the general content of both the screening and neurocognitive battery. Then, researchers reviewed informed consent with participants.

If the inmate chose to continue, they completed a screening and demographics questionnaire. The participant was given the questionnaires and asked to follow along while research assistants read all questionnaire items aloud. This process allowed researchers to control for potential deficits in participants' reading levels. After the self-report battery was completed participants continued on to the neurocognitive battery. Order of the neurocognitive battery was randomized to control for order effects. After the neurocognitive battery was completed, participants were debriefed and thanked for their time. Compensation for participation was provided in the form of a candy bar.

Training. Each research assistant underwent adequate training on jail protocol and neurocognitive assessment administration. Prior to gaining entrance into the jail facilities, each research participant was required to successfully complete an online Prison Rape Elimination Act (PREA) training course. After passing the quiz, research assistants were required to attend an in-person training course on both jail protocols and PREA procedures. Lastly, each research assistant successfully passed a criminal background check. Only after successfully completing each one of these steps did jail administrative staff allow research assistants entry into the jail and access to research participants.

Training on neurocognitive assessment administration was a multi-step process. First, all research assistants met with the researcher to receive a general introduction on each of the neurocognitive measures, administration rules, and a demonstration of the administration. Next, each research assistant met privately with the researcher to administer the neurocognitive battery on the researcher. This allowed the research assistants to practice administering the battery and receive constructive feedback from the researcher. If the research assistant was able to administer the battery with relatively few minor mistakes, they were allowed to collect data in the jail. Additional mock neurocognitive battery administration with the researcher took place if the research assistant demonstrated several errors during administration. This continued until the research assistant could administer the neurocognitive battery without error.

Supervision. Research assistants attended monthly supervision meetings with a licensed psychologist and dissertation committee member, Dr. Nicki Abuchon-Endsley, who has an extensive training history of neuropsychological assessment and administration. These supervision meetings provided research assistants the opportunity to have their questions regarding neuropsychological battery administration answered. Supervision meetings also allowed the researcher to control for consistency of battery administration.

Quality Assurance. In addition to monthly supervision meeting to maintain quality, the researcher employed other measures of quality assurance. Specifically, the researcher scored all neurocognitive batteries on a bi-weekly basis, which ensured proper scoring and timely identification of administration errors.

Exclusion Criteria. Research participants were excluded if they were non-English speaking or were actively psychotic. If it was determined after a review of the criminal history the participant had only a single drug possession or driving under the influence charge, their data were not included in the final analyses. This was done to ensure the participants had a significant substance use involvement. If inmates with no substance use history or only one substance-related charge were included, they may introduce unnecessary variability in the substance use variable, potentially weakening the relationship between substance use and other variables in the study. In total, 3 participants were excluded from analyses for only having a single drug possession or driving under the influence charge.

Plan of Analyses

Data were inspected for missingness, outliers, skewness, and kurtosis using SPSS software. Descriptive statistics are reported based on the demographics questionnaire (e.g., age, ethnicity, etc.). Descriptive statistics were also reported for criminal history, WCST, NAART, CWIT, TMT, and the VFT. To account for any demographic variables that needed to be controlled for in the proposed analyses, I examined the associations between demographic variables and major variables (e.g., substance use, neurocognitive functioning, and criminal behavior). Significant demographics variables were controlled for in the main analyses. Bivariate correlations were then conducted to evaluate the relationships among performance on the WCST, NAART, CWIT, TMT, and VFT. Missing data were addressed using the Full-Information-Maximum-Likelihood approach (FIML; Graham, 2009). FIML is a technique used to estimate parameters and their standard errors in the presence of missing data. Specifically, this method determines the most likely values of the missing data, given the observed data. This technique is useful in that data does not need to be imputed; missing values are estimated in one step.

To answer the proposed hypotheses, I utilized structural equation modeling (SEM) for my statistical analysis. SEM is a statistical method that simultaneously test associations among multiple predictors and outcome variables, thus variables may be both predictors and outcomes. The advantages of using SEM are varied. First, this method allows for the estimation of measurement error for the observed, and the evaluation of whether those observed variables are good indicators of the latent constructs. Second, SEM takes a confirmatory, rather than an exploratory approach to data analysis. It is therefore an excellent data analytic tool for inferential purposes. Finally, SEM offers an easy way to model multivariate relations; it can consider multiple independent variables and dependent variables simultaneously.

The goodness of fit of both measurement and structural models were evaluated by the chi-square test of model fit, the Comparative Fit Index (CFI; Bentler, 1990), the Tucker-Lewis Index (TLI; Tucker & Lewis, 1973), and the Root Mean Square Error of Approximation (RMSEA; Steiger & Lind, 1980, Wong, 2008). For dichotomous or count dependent variables, log likelihood (LL), Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were used as measures of goodness of fit. These statistics represent the degree of differences between the theoretical model and the data. When comparing two models, a numerically larger LL and a smaller AIC and BIC indicate a better fit.

The chi-square test of model fit estimates the discrepancy between a population and sample covariance matrix. A chi-square with a non-significant value suggests a good fit. Both the CFI and TLI assess the degree of congruence between the model and the data. A value of 0.9 indicates acceptable fit and a value of above .95 indicates excellent fit (Hu & Bentler, 1995; West, Taylor, & Wu, 2012). Finally, I reviewed the RMSEA, which estimates the lack of fit in model compared to the saturated model, and values less than .06 suggest good model fit (Hu & Bentler, 1995)

Specifically, I tested the proposed measurement model that included three latent factors. First, number of substance use disorder and alcohol use disorder symptoms endorsed, length of time of substance and alcohol use, single versus polysubstance use, and frequency and quantity of substance and alcohol use would load onto a common *substance use* factor. Second, inhibition, verbal fluency, and cognitive flexibility, would load onto a common *neurocognitive functioning* factor. Length of abstinence, premorbid intelligence, and use of psychotropic medication were used as control variables with *neurocognitive functioning*. Length of abstinence was determined by calculating the length of time in days from the participant's last date of substance use and date of neurocognitive battery. As described above, premorbid intelligence was assessed using the NAART. The use of psychotropic medication was inquired during the demographic questionnaire and coded dichotomously (i.e., 0 for no medication use and 1 for currently taking psychotropic medication). Finally, that type (i.e., violent or nonviolent) and frequency convicted criminal behavior would load onto a common *criminal behavior* factor

After the examination of measurement models, structural models were assessed. While measurement models involve the relationships between observed variables and latent constructs, structural models involve the associations among latent constructs (i.e., *substance use*, *neurocognitive functioning*, and *criminal behavior*). It was predicted that *substance use* would be associated with *neurocognitive functioning* (hypothesis 2). This was answered by regressing *neurocognitive functioning* onto *substance use*. It was also predicted that *neurocognitive functioning* would be associated with *criminal behavior*, while controlling for previous *substance use* (hypothesis 3). This was answered by using *neurocognitive functioning* and *substance use* to predict type and frequency of crime. Significance of individual beta coefficients and the overall model fit were reported. Lastly, it was expected that *neurocognitive functioning* would mediate the relationship between *substance use* and *criminal behavior* (hypothesis 4). To test the proposed mediation model, I used the product of coefficient approach (MacKinnon et al., 2002; MacKinnon, 2008). The approach offers two methods in evaluating the significance of the model. First, the significance of the mediated effect was evaluated using the Sobel *z*-test (Sobel, 1982) ($\frac{\alpha\beta}{\sqrt{\alpha^2 s_\beta^2 + \beta^2 s_\alpha^2}}$). With this approach, the significance of the mediated effect is tested by dividing the product of the alpha and beta paths by its standard error, where the *alpha* path is the unstandardized regression coefficient using *substance use* to predict *neurocognitive functioning*, and the *beta* path is the regression coefficient using *neurocognitive functioning* to predict *criminal behavior*, while controlling for *substance use*). The resulting statistic is then compared to critical values of the normal distribution. The mediation effect is considered significant at p<.05 when the statistic exceed $\pm$1.96. For this model, a significant mediated effect would suggest that *neurocognitive functioning* significantly mediates that relationship between *substance use* and *criminal behavior*.

The Sobel test is a conservative test for mediation (MacKinnon, 2008). Specifically, research has found that the product of two normally distributed variables (i.e., *a* and *b*) is often not normally distributed (MacKinnon et al., 2002). Therefore, the Sobel test is often highly conservative and has low statistical power. To account for these limitations, the mediation effect was evaluated by asymmetric confidence intervals (MacKinnon et al., 2002). This test takes the distribution of the mediated effect into account when calculating the confidence limits and is therefore less conservative and has accurate Type I error compared with the Sobel test (MacKinnon et al., 2002; MacKinnon, 2008). Consequently, in addition to the Sobel Test, I used MacKinnon's asymmetric confidence interval to test the mediated effect. To do this, the ProdClin Program (MacKinnon, Fritz, Williams, & Lockwood, 2007) was used. If the 95% confidence interval did not include zero, the mediated effect was statistically significant.

To determine if there were gender differences in the mediation model (hypothesis 5), multiple group analysis was required. In multiple group analysis, the groups may be compared using two different approaches: 1., assuming that every path and factor loading across male and female groups are the same and then testing for differences; 2., assuming that every path and factor loading is different across the groups and then testing to see if they are the same. Given the apparent dearth in the research within this relationship (i.e., *substance use*, *neurocognitive functioning*, and *criminal behavior*), let alone research accounting for sex differences, the author took the multiple groups approach that assumed all factor loadings and paths to be the same across the study groups and then systematically tested for group differences. To do this, I computed four set of comparisons: 1., compare the loadings between the groups; 2., constrain the model so that the relationship between the IV (*substance use*) and the mediator (*neurocognitive functioning*) to be the same among gender groups and another model that allows them to be different; 3., constrain the model so the relationships between the mediator (*neurocognitive functioning*) and the dependent variable (*criminal behavior*) while controlling for the independent variable (*substance use*) to be the same among groups and another model that allows them to be different; 4., compare the c' path between the groups. Each comparison consists of two nested models differing by one degree of freedom.

The Deviance statistic was used to compare each set of nested models. A significant difference suggests relationships differed across groups, whereas a non-significant difference suggests the groups are similar. All factor loadings and paths were assumed to be the same across gender groups and group differences were then systematically compared. These comparisons consisted of the loadings between the two groups, the a-path of the mediation model (*substance* use and *neurocognitive functioning*), the b-path (*neurocognitive functioning* and *criminal behavior*, controlling for *substance use*), and the c'-path (*substance use* and *criminal behavior*, controlling for *neurocognitive functioning*). If a regression path was significantly different across groups, the more complex model (i.e., the one with group differences) was selected. If there were no significant differences between the two models, the more parsimonious model (i.e., no group differences) was selected.

CHAPTER III
Results

Descriptive Statistics

Data on one hundred men and one hundred and fifty women were collected for a total of two hundred and fifty participants. Means and standard deviations of all variables were reported in Table 4. The majority of the sample was female (58%) and European-American (64%). Eleven percent of participants identified Hispanic, 11% identified as Native American, 5% identified as European, 4% identified as African-American, .5% identified as Asian-American, and 1.2% identified as "Other." Approximately 3% of the sample did not report an ethnicity. The mean age was 32.48 (*SD* = 9.7). Descriptive statistics regarding the sample's age, gender, ethnicity, drug and alcohol dependence status, and polysubstance dependence status are reported in Table 1 and Table 2. Frequencies of self-reported most frequently used substance, including alcohol, are presented in Table 3.

Table 1.
Means and frequencies of age, sex, and ethnicity of sample.

N = 250			
Age	Ethnicity	Sex	Ethnicity (Binary)
M = 32.5 *SD* = 9.7	European-American: 64.4% Hispanic: 10.8% Native American: 10.8% European (non-US citizens): 5.6% African-American: 3.6% Asian-America: 0.4% Other: 1.2%	Male: 40.0% Female: 58.4% Transgender: 0.4% Did not disclose: 1.2%	"White:" 70% "Nonwhite:" 30%

Table 2.
Frequencies for substance use disorder, alcohol use disorder, and polysubstance use disorder.

Lifetime Substance Use Disorder	Lifetime Polysubstance Use Disorder on two or more illicit substances	Lifetime Alcohol Use Disorder	Lifetime Polysubstance Use Disorder on 2 or more illicit substance and alcohol use is considered
0 SUD: 12.4 % 1 SUD: 14.4% 2 SUDs: 20.4% 3 SUDs: 52.8%	No: 26.8% Yes: 73.2%	0 AUD: 22.4% AUD: 77.6%	No: 18% Yes: 82%

Table 3.
Frequencies of most frequently used substances, including alcohol.

Substance	Frequency
Methamphetamine	28%
Alcohol	21.6%
Cannabis	21.2%
Heroin	10%
Oxycontin	1.6%
Xanax	1.2%
Cocaine	0.4%
Percocet	0.4%
Psilocybin	0.4%
Crank	0.4%
Methadone	0.4%
Non applicable/Missing	14.4%

Table 4.
Zero Order Correlations for Drug and Alcohol, Neurocognitive Functioning, and Criminal Behavior Alcohol Use Variables.

	Drug/Alcohol						Neurocognitive			Criminal Behavior		
	1	2	3	4	5	6	7	8	9	10	11	12
1. SUD Sym.												
2. DUDIT Freq.	.54**											
3. DUDIT Quant.	.39**	0.64**										
4. AUD Sym.	.25**	-.05	.03									
5. AUDIT Freq.	.16*	-.04	.00	-.72**								
6. AUDIT Quant.	.22**	.02	.19**	.52**	.51**							
7. VF	-.02	-.03	-.03	.00	-.09	-.11						
8. CWI	-.04	-.07	.04	-.07	-.11	-.04	.79**					
9. TMT	-.05	-.03	.01	-.06	-.06	-.08	.81**	.79**				
10. Tot. Conv.	.07	-.07	-.12	.13*	.07	.02	-.07	-.14*	-.16*			
11. Violent Crime	-	-	-	-	-	-	-	-	-	-		
12. Felonies	-	-	-	-	-	-	-	-	-	-	-	
Mean (SD)	20.3 (10.3)	3.5 (1.1)	2.7 (1.3)	6.8 (4.1)	2.6 (1.4)	3.3 (1.5)	9.8 (3.3)	9.7 (3.5)	9.0 (3.2)	15.8 (11.3)	.5 (.06)	.5 (.5)
Scale Range	0-36	0-4	0-4	0-12	0-4	0-5	3-19	1-16	1-14	0-56	47.2%	53.2%

*Note: *p* <.05, ** *p*<.005; SUD Sym. = Substance Use Disorder Symptom endorsement; DUDIT Freq. = Drug Use Disorder Identification Test Frequency; DUDIT Quant. = Drug Use Disorder Identification Test Quantity; AUD Sym = Alcohol Use Disorder Symptom endorsement; AUDIT Freq. = Alcohol Use Disorder Identification Test Frequency; AUDIT Quant. = Alcohol Use Disorder Identification Test Quantity; VF = Verbal Fluency; CWI = Color-Word Interference Test; TMT = Trail Making Test; Tot. Conv. = Total Convictions.

Due to the small numbers of participants across minority ethnic groups, ethnicity was transformed into a binary variable (i.e., "white" (coded as 1) versus "not white" (coded as 0) for ease of comparison. Independent samples t-tests were used to compare mean total convictions (i.e., felonies, misdemeanors, and infractions), history of violent crimes (0 = no history of violent crime, 1 = history of violent crime), and a history of convicted felonies (0 = no history of felony convictions, 1 = history of felony convictions) across gender and ethnic groups. Men (M = 18.86, SD = 12.51) received more convictions than women (M = 13.67, SD = 9.91). Men (M = 0.71, SD = 0.46) were also more likely to have committed a violent offense (M = 0.34, SD = 0.47). Men (M = 0.72, SD = 0.45) and were more likely to have received a felony conviction than women (M = 0.44, SD = 0.50). Ethnic minority inmates (M = 18.39, SD = 13.44) received more convictions than white inmates (M = 14.73, SD = 10.25) and minority inmates (M = 0.59, SD = 0.50) were more likely to have violent criminal histories than white inmates (M = 0.44, SD = 0.50). Finally, minority inmates and white inmates did not differ on having a history of felony convictions ($ps > .05$). Age, gender, medication use, and ethnicity were used as covariates in subsequent analyses but were dropped if they had no significant association with outcome variables. Age was used as a covariate as younger males commit more violent crime than their older male and female counterparts (Bureau of Justice, 2017).

Skewness and kurtosis for all variables of interest were within the range of normal distribution and therefore no transformations were employed. *Z*-scores for skewness and kurtosis of variables are presented in Table 5. Frequency histograms of the variables of interest also reflected a normal distribution, where scores generally fell within the normal distribution overlay. Similarly, for probability plots, scores for the variables of interest were clustered around detrended diagonals.

Table 5.
Skewness and Kurtosis Z-scores

Variable	Skewness	Kurtosis
AUD Symptoms Endorsed	-.16	-1.3
Alcohol Frequency	-.33	-1.4
Alcohol Quantity	-.28	-1.3
SUD symptoms Endorsed	-.32	-.92
Drug Frequency	.45	.18
Drug Quantity	.45	.18
Color-Word Interference	-.74	.14
Trial Making Test	-1.04	.44
Verbal Fluency	.36	.05
Frequency of Crime	1.01	.87
History of Violent Crime	.06	-2.0
History of Felony Convictions	-.20	-1.98

Zero-order correlations between substance and alcohol use, neurocognitive functioning, and criminal behavior variables are reported in Table 4. There were significant intradomain correlations (i.e., variables that measured the same construct, such as *neurocognitive functioning*, were highly correlated with each other), but interdomain correlations were inconsistent. Specifically, Total AUD symptoms endorsed was correlated with frequency of criminal behavior (r = .13) as was Color-Word Interference (r = -.14) and the Trail Making Test (r = -.16). History of violent crime variable and history of felony convictions variable were both dichotomous, and as such were not used in Pearson correlation analyses.

The North American Adult Reading Test (NAART) and number of days of sobriety were hypothesized to be statically related to neurocognitive functioning, and the original intention for the principal investigator was to control for the influence of crystallized intelligence and sobriety (i.e., Date of Last Use) in all analyses. However, SEM analyses revealed that they were not significantly related to any outcome variables and were subsequently eliminated from further analyses. Please refer to Discussion, page 63, for hypotheses of why these proposed covariates did not have an association with the outcome measures.

In accordance to the DSM-5, scores greater than 2 on the MINI International Neuropsychiatric Interview (MINI) were considered as meeting criteria for a lifetime (or 12-month) substance or alcohol use disorder. Those who met criteria for a substance use disorder on two or more substances were labeled as polysusbtance dependent. Further breakdown of frequency for those within the sample that met criteria for one, two, or three substance use disorders, polysubstance use disorder, alcohol use disorder, and polysubstance use disorder when alcohol was considered are reflected in Table 2.

Missing Data

Missing data were observed across almost all variables. Most data were considered missing at random (e.g., a neurocognitive task was occasionally incorrectly administered, or an inmate did not respond to a question on a questionnaire due to unknown reasons; Graham, 2009; Rubin, 1976). Of the substance and alcohol use variables, there were no missing data. Eleven inmates had reported never using any alcohol or illicit substance in their lifetime and therefore did not complete the questionnaires; however, this data were considered not applicable rather than missing. Of the neurocognitive variables, 22 inmates (11.4%) prematurely discontinued administration for the Color-Word Interference Task due to being frustrated with the task. Twenty-seven inmates prematurely discontinued administration of both the Verbal Fluency and Trail MakingTest also due to self-reported frustration of task. Finally, 8 inmates had no record in the Idaho Repository and therefore their criminal variables were unable to be calculated. These inmates may have committed crimes in another state, but were caught in Idaho and were awaiting transfer. Therefore, their criminal record would not appear in the Idaho Repository.

These missing data patterns were addressed with full information maximum likelihood estimation (FIML), which was automatically implemented as a feature of the MPlus statistical program. FIML uses all available data within the model to find unbiased population parameter values in the presence of missing data (Enders, 2010; Graham, 2009).

Measurement Models

Measurement models were estimated to determine whether the observed indicators were good indicators of the latent variables – *alcohol use*, *drug use* and *criminal behavior*. A latent variable of *drug use* was constructed using total number of symptoms endorsed across the three MINI SUD modules, total frequency of substance use from the DUDIT, and total quantity of drug use during the time period of heaviest use from the DUDIT. A latent variable of *alcohol use* was constructed using the total number of symptoms endorsed on the MINI AUD module, total frequency of alcohol use from the AUDIT, and the total quantity of alcohol use during the time period of heaviest use from the AUDIT. *Neurocognitive functioning* was created using scores from the third trial of the D-KEFS Color-Word Interference Task (i.e., the Inhibition trial), the fourth trial of the D-KEFS Trail Making Test (i.e., the Switching trial, a measure of cognitive flexibility), and the letter fluency condition of the Verbal Fluency test (Figures 3 and 4).

The Chi-square test of model fit for a single measurement model with the three latent variables of *substance use*, *neurocognitive functioning,* and *criminal behavior* revealed a model with poor fit, $\chi^2(24) = 57.04$, $p < .005$. Additionally, factor loadings for observed alcohol and drug use indicators were not significant; these observed indicators did not appear to load onto the same latent factor of general *substance use*. Therefore, two separate measurement models were created: 1) *drug use* and *neurocognitive functioning* and 2) *alcohol use* and *neurocognitive functioning.*

Criminal Behavior was proposed to be measured by frequency of criminal behavior and history of violent crime. However, the measurement model was not satisfactorily estimated due to poor fit of the crime observed variables. Frequency of criminal behavior (i.e., total number of convicted felonies, misdemeanors, and infractions) and history of violent crime (i.e., violent history versus no violent history) were substantially unlike each other and thus could not be used to reliably estimate criminal behavior. Variables that measured crime was therefore treated as observed variables, frequency of criminal behavior and history of violent crime were used as outcome variables in separate SEM models. A third outcome variable, history of felony convictions, was also added as an outcome variable to examine the participants' criminal history. Treating these three variables as observed is also justified on a conceptual level, as all of them measure concrete behaviors that are easily quantified.

The Chi-square test of model fit for the *drug use* and *neurocognitive functioning* latent variables, $\chi^2(8) = 9.53$, $p > .05$, revealed that the model fit was excellent: RMSEA < 0.03, CFI = 1.00, TFI = 0.99. Observed variables significantly loaded onto each of their respective latent constructs for *drug use* (βs = .72 - .91) and *neurocognitive functioning* (βs = .53 - .74; see Figure 3). A similar picture was revealed for the chi-square test of model fit for the *alcohol use* and *neurocognitive functioning* latent variables, $\chi^2(8) = 9.64$, $p > .05$, where there was an excellent model fit, RMSEA < 0.03, CFI = 1.00, TFI = 0.99 (see Figure 4). Observed variables again significantly loaded significantly loaded onto each of latent construct for *alcohol use* (βs = .62 - .88) and *neurocognitive functioning* (βs = .54 - .75).

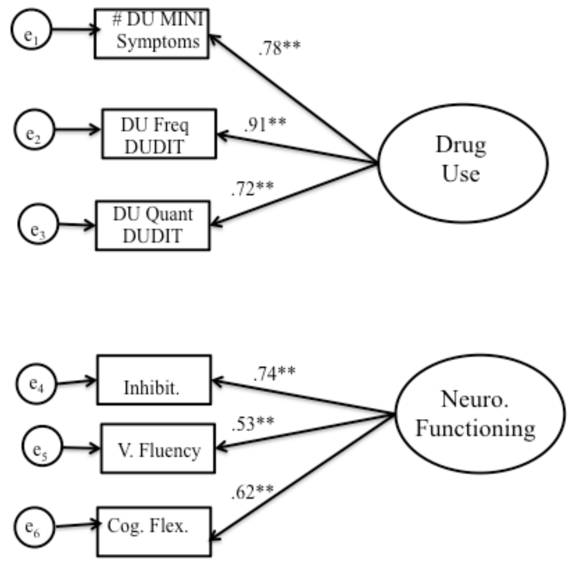

Figure 3. Measurement models of *drug use* and *neurocognitive functioning.*
Note: **p* <.05, ** *p*<.005.

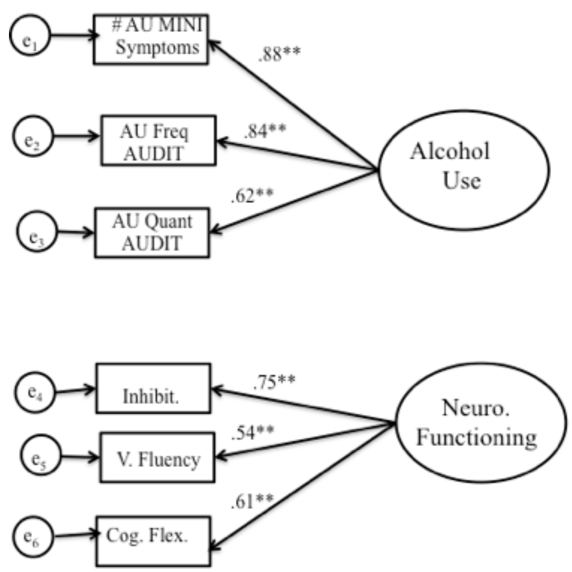

Figure 4. Measurement models of *alcohol use* and *neurocognitive functioning.*
Note: **p* <.05, ** *p*<.005.

Structural Models

There were six separate structural models, one for each outcome variable – *alcohol use* (latent), *drug use* (latent) and three observed variables of criminal behavior. First, the latent variable of *alcohol use* was used to predict to the three observed crime variables in separate models. Next, the *drug use* variable was used to predict to the three observed crime variables in three separate models.

Models of alcohol use.

Frequency of Criminal Behavior.

An inspection of the final structural model revealed that *alcohol use* significantly predicted *neurocognitive functioning* (β = -0.28, $p < .005$). *Neurocognitive functioning* also predicted total number of convictions (β = -0.77, $p < .005$; see Figure 5). *Neurocognitive functioning* was a significant mediator of the relationship between *alcohol use* and frequency of criminal behavior (Sobel z = 3.10, $p < 0.01$; 95% asymmetric ACI= 0.11 – 0.48, $p < .05$). Overall, these results suggest that those who engage in more alcohol use have reduced neurocognitive ability and have an associated increase in the frequency of criminal acts.

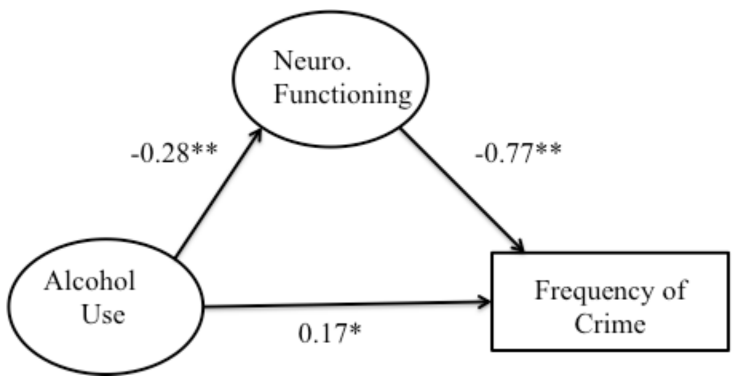

Figure 5. Relationships between alcohol use, neuro. functioning, and frequency of criminal behavior.
Note. Numbers listed are standardized betas. *p <.05, **p <.01, ***p <.001; Model fit: Loglikelihood H_0 = -7250.60, AIC = 14545.10, BIC = 14622.22.

History of Violent Crimes.

Alcohol use predicting to *neurocognitive functioning* (β = 0.11, p = 0.20) and *neurocognitive functioning* predicting to history of violent crime, while controlling for *alcohol use* (β = 0.04, p = 0.66) were not significant for the structural model (see Figure 6). Similarly, the overall mediation model did not yield significant results either (Sobel z = 0.94, p=0.35; 95% asymmetric ACI= -0.02 – 0.04, p>.05).

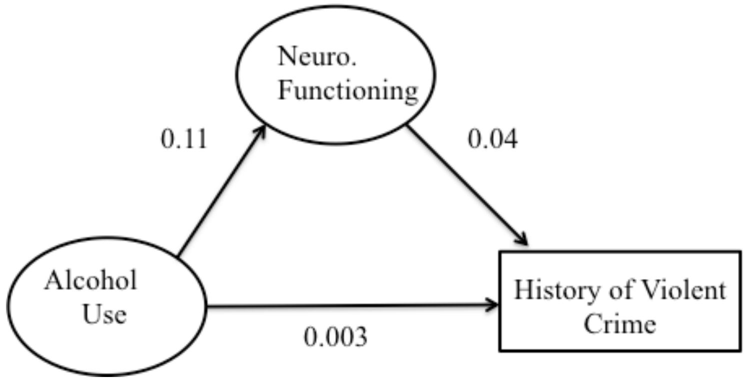

Figure 6. Relationships between alcohol use, neuro. functioning, and history of violent crime.
Note. Numbers listed are standardized betas. **p* <.05, ***p* <.01, ****p* <.001; Model fit: Loglikelihood H_0 = -6416.09, AIC = 12878.17, BIC = 12958.61.

History of Felony Convictions. Indirect effects yielded differential results (see Figure 7). Specifically, *alcohol use* predicting to *neurocognitive functioning* was not significant (β = 0.11, p = .20), whereas *neurocognitive functioning* predicting a history of felony convictions was approaching significance (β = 0.16, p = .07). Moreover, *alcohol use* predicting to a history of felony convictions, while controlling for *neurocognitive functioning* was significant (β = 0.17, p < 0.05). However, the overall mediation model was not significant (Sobel z = 0.59, p=0.56; 95% asymmetric CI= -0.01 – 0.06, p>.05).

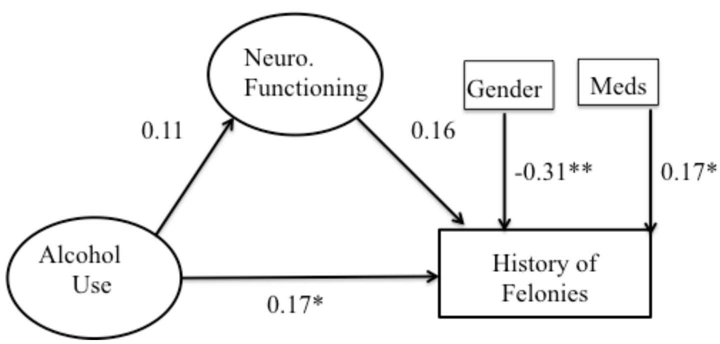

Figure 7. Relationships between alcohol use, neuro. functioning, and history of felonies.
Note. Numbers listed are standardized betas. **p* <.05, ***p* <.01, ****p* <.001; Model fit: Loglikelihood H_0 = -6288.29, AIC = 12628.58, BIC = 12719.08.

Models of Drug Use.

Frequency of Criminal Behavior. Within the final structural model, *drug use* predicting to *neurocognitive functioning* was not significant (β = 0.55, p = 0.25; see Figure 8). However, *neurocognitive functioning* predicting to total convictions (i.e., frequency of criminal behavior) was significant (β = 0.90, p < 0.05). The c'-path of *drug use* predicting to total convictions, while controlling for *neurocognitive functioning* (β = -0.65, p = 0.45), was not significant. Therefore, the overall mediation model did not yield significant findings (Sobel z = 0.43, p=0.67; 95% asymmetric CI= -0.75 – 2.36, p>.05).

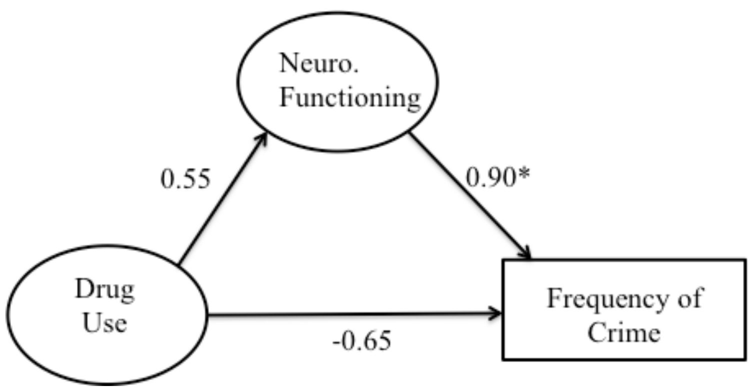

Figure 8. Relationships between drug use, neuro. functioning, and frequency of criminal behavior.
Note. Numbers listed are standardized betas. *p <.05, **p <.01, ***p <.001; Model fit: Loglikelihood H_0 = -7402.11, AIC = 14848.22, BIC = 14925.16.

History of Violent Crimes.

Both *drug use* predicting to *neurocognitive functioning* (β = -0.07, p = 0.45) and *neurocognitive functioning* predicting to history of violent crimes (β = -0.07, p = 0.35) yielded insignificant relationship (see Figure 9). The mediation model was not significant (Sobel z = 0.58, p=0.56; 95% asymmetric CI= -0.01 – 0.03, p>.05). However, *drug use* predicted a history of violent crimes, while controlling for *neurocognitive functioning* (β = 0.24, p < 0.05) was significant.

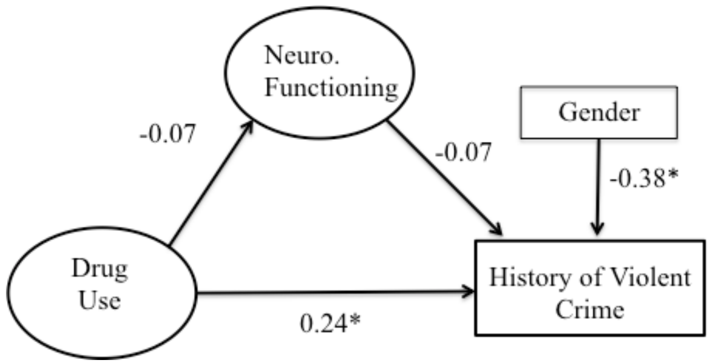

Figure 9. Relationships between drug use, neuro. functioning, and history of violent crime.
Note. Numbers listed are standardized betas. *p <.05, **p <.01, ***p <.001; Model fit: Loglikelihood H_0 = -6569.37, AIC = 13186.75, BIC = 13270.28.

History of Felony Convictions.

The indirect effects in the structural model produced differential results (see Figure 10). *Drug use* predicting to *neurocognitive functioning* was not significant (β = 0.01, p = 0.85). However, *neurocognitive functioning* predicting to a history of felony convictions did yield significant results (β = 0.23, p < .0.05). Similarly, the c'-path of *drug use* predicting to a history of felony convictions, while controlling for *neurocognitive functioning*, was also significant (β = 0.24, p < .005). However, the overall mediation model was not significant (Sobel z = 0.12, p=0.90; 95% asymmetric CI= -0.04 – 0.04, p>.05). Additionally, age and gender of the participants significantly predicted to a history of felony convictions, suggesting an increase in age was associated with an increased chance of a history of felony convictions and being female was associated with a reduced chance of a history of felony convictions.

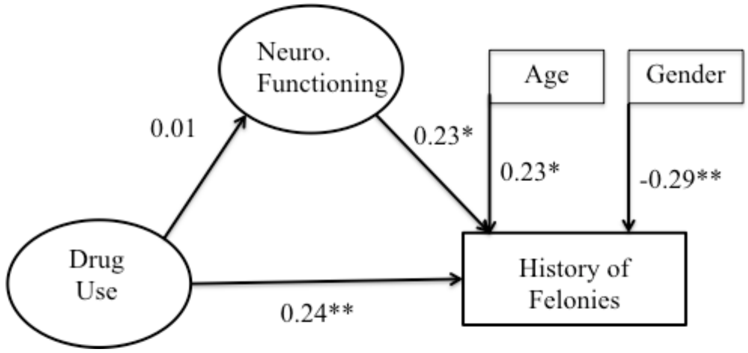

Figure 10. Relationships between drug use, neuro. functioning, and history of felony convictions.
Note. Numbers listed are standardized betas. **p* <.05, ***p* <.01, ****p* <.001; Model fit: Loglikelihood H_0 = - 6571.77, AIC = 13193.54, BIC = 13280.56

Group Comparisons

Multiple group analyses were conducted to explore gender differences in the structural mediation model. For a more detailed explanation for group comparisons, please refer to the plan of analysis section. Overall, there were no significant group differences across any of the 6 models. Specific chi-squares are described below.

Models of Alcohol Use.

Frequency of Criminal Behavior. Results indicated that the relationships between *alcohol use* and *neurocognitive functioning* ($\chi^2(1) = 0.00$, p = n.s.), *neurocognitive functioning* and total number of convictions ($\chi^2(1) = 0.00$, p = n.s.), and *neurocognitive functioning* and total number of convictions, while controlling for *alcohol use* ($\chi^2(1) = 0.00$, p = n.s.) were the same across groups.

History of Violent Crime. No significant differences between male and female inmates were revealed for *alcohol* predicting to *neurocognitive functioning* ($\chi^2(1) = 0.52$, p= n.s.), *neurocognitive functioning* predicting to a history of violent crime ($\chi^2(1) = 0.43$, p = n.s.), or *neurocognitive functioning* predicting to a history of violent crime, while controlling for *alcohol use* (χ^2(1) = 0.12, *p* = n.s.).

History of Felony Convictions. Similar to other alcohol models, there were no significant gender differences in the structural paths of the mediation model using history of felony convictions as the observed dependent variable. Specifically, *alcohol* predicting to *neurocognitive functioning* (χ^2(1) = 0.41, *p* = n.s.), *neurocognitive functioning* predicting to a history of felony convictions (χ^2(1) = 0.01, *p* = n.s.), and c'-path of *neurocognitive functioning* predicting to a history of felony convictions, while controlling for *alcohol use* (χ^2(1) = 01.15, *p* = n.s.) were not significantly different across groups.

Models of Drug Use.

Frequency of Criminal Behavior. No significant differences between male and female inmates were revealed when *drug use* predicted to *neurocognitive functioning* (χ^2(1) = 0.00, *p* = n.s.), *neurocognitive functioning* predicted to frequency of criminal behavior (χ^2(1) = 0.00, *p* = n.s.), or *neurocognitive functioning* predicted to frequency of criminal behavior, while controlling for *drug use* (χ^2(1) = 0.00, *p* = n.s.).

History of Violent Crime. When using a history of violent crime as the observed dependent variable, male and female inmates did not significantly differ for *drug use* predicting to *neurocognitive functioning* (χ^2(1) = 0.002, *p* = n.s.), *neurocognitive functioning* predicting to a history of violent crime (χ^2(1) = 0.33, *p* = n.s.), or *neurocognitive functioning* predicting to a history of violent crime, while controlling for *drug use* (χ^2(1) = 0.87, *p* = n.s.).

History of Felony Convictions. There were no significant differences across gender when *drug use* predicted *neurocognitive functioning* (χ^2(1) = 0.03, *p* = n.s.), *neurocognitive functioning* predicted to history of felony convictions ($\chi^2(1) = 0.10$, p = n.s.), and *neurocognitive functioning* predicted to history of felony convictions, while controlling for *drug use* ($\chi^2(1) = 0.05$, p = n.s.).

CHAPTER IV

Discussion

The United States has the largest incarcerated population, per capita, than any other nation, with an estimated 2.2 million individuals (Bureau of Justice, 2017). It is estimated that 20% of this growing population are incarcerated because of nonviolent substance-related charges (Bureau of Justice, 2017), suggesting a strong association between inmates and substance use. Indeed, approximately 56% of all inmates meet criteria for a drug or alcohol use disorder (Bureau of Justice, 2006). Given that chronic use of alcohol and illicit substances have been shown to have deleterious effects on neurocognition, it is perhaps unsurprising that approximately 10% to 67% of inmates demonstrate some type of cognitive deficit (Miller, 2002). It is therefore plausible that these deficits in cognitive functioning may have a maladaptive influence on an inmate’s decision-making skills, leading to high rates of recidivism and other crimes. Research with inmates has shown differential relationships with some deficits in cognitive performance and various aspects of crime (Hancock, Tapscott, & Hoaken, 2010). However, the relationships between the variables of substance use, cognitive functioning, and criminal behavior have not been studied simultaneously. This population is worth special consideration as inmates are susceptible to high rates of recidivism (Bureau of Justice, 2005), chronic psychopathology (Coolidge, Marle, Van Horn, & Segal, 2011), and substance abuse (Bureau of Justice, 2017). Research in this area could inform treatment and prevention programs to help reduce these troubling statistics.

This study used structural equation modeling to examine the influences of drug use, alcohol use, and neurocognitive functioning on criminal behavior in an incarcerated population. Neurocognitive functioning significantly mediated the relationship between alcohol use and frequency of criminal behavior. Additionally, while other hypothesized mediation models were not found, specific pathways within these models were significant. Specifically, for alcohol models, the association between neurocognitive functioning and a history of felony convictions was approaching significance. For drug models, neurocognitive functioning predicted frequency of criminal behavior as well as a history of felony convictions. This relationship was in the opposite direction than what current theory posits, though. Finally, drug use predicted history of violent crimes as well as a history of felony convictions. A more detailed analysis of our findings is included below.

Hypothesis 1

Contrary to our hypothesized findings, alcohol and illicit drug use did not load onto a single factor of *substance use*. Specifically, alcohol and drug variables had to be separated into their own latent factors as the hypothesized single latent factor showed poor model fit. Moreover, for each of these separate factors, two additional hypothesized observed variables had to be dropped, as including them caused a poor model fit. These variables measured length of time of drug and alcohol use and a differentiation between single and polysubstance use. The remaining alcohol variables were the number of symptoms endorsed on the MINI Alcohol Use Disorder module, frequency of alcohol use during time of heaviest use, and quantity of alcohol use during time of heaviest use. Similarly, the remaining drug variables included the summation of symptoms endorsed on the MINI Substance Use Disorder modules for the inmate's top three most frequently used drugs, frequency of drug use during time of heaviest use, and quantity of drug use during time of heaviest use. Each of these variables loaded onto respective *alcohol use* and *drug use* factors.

These alterations to the original hypothesis may be due to several factors. First, many researchers regard drug and alcohol to be separate substances as they are associated with different developmental trajectories and outcomes, such as neurocognitive effects (Hosak et al., 2012; Rourke & Grant, 2009). While it seems understandable to examine both alcohol and illicit drug use into a single category, the data indicate they are not significantly associated with one another and therefore should be assessed as separate constructs. Second, duration of drug and alcohol use was gathered by the inmate's self-report. Given the limitations associated with self-report (Stone, Bachrachm Jobe, Kurtzman, & Cain, 1999), it is plausible the values given were not representative of the true duration of inmates' substance use histories. Moreover, the construction of the variable did not account for brief periods of sobriety or other variability in consumption that is typical for drug and alcohol use. For example, while an inmate may have reported 15 years of alcohol use, alcohol intake may have actually been 10 years of social drinking with only 5 years heavy, problematic use. There were also several administrative errors while collecting the length of time of substance use. In the beginning of data collection, research assistants did not inquire about the inmate's history of substance use. This was contrary to the original training procedure, but might have occurred as the question was in a section of the MINI that was difficult to see. As a result, 40 participants, approximately a fifth of the sample, had missing data on this variable. The missing data likely restricted the variance of the variable. Lastly, the differentiation between single versus polysubstance use had to be dropped because nearly 70% to 80% of the sample met criteria for polysubstance use, which severely reduced any variance in the variable as well.

Several changes had to be made that were contrary to the original hypothesis while constructing the latent *neurocognitive functioning* factor. Specifically, premorbid intelligence and length of abstinence were not used as covariates in the final analyses, as these did not have significant relationships with the *neurocognitive factor*. There may be a few reasons why these variables were not significantly related to neurocognitive functioning. First, the NAART approximates one's crystalized intelligence by assessing one's vocabulary recognition. Vocabulary, while typically used to calculate one's overall intelligence quotient, is only one factor in several factors that can account for one's intelligence (e.g., visuospatial abilities, working memory, processing speed). Moreover, vocabulary is highly dependent on one's level of education and cultural exposure. Given that this population has a relatively low education attainment, it may be that performance on NAART produced artificially low scores of the inmates and thus no longer varied with other neurocognitive abilities, as we would typically expect. Second, the length of sobriety was calculated based on the inmate's self-report of their last date of use. Relying solely on inmates' memory for an exact time might have created poor measures of sobriety. For future research it would be beneficial to capture more precise measurements of sobriety, with such tools as urine or hair analyses.

Finally, the original hypothesized *criminal behavior* factor was altered. Specifically, frequency of crime and history of violent or nonviolent crime did not converge onto a single factor. This may be due to the fact the variables did not use the same scale; frequency of crime was a count variable and a history of violent/nonviolent crime was a dichotomous variable. Observed variables using different scales will typically not converge onto a single factor (Ullman & Bentler, 2003). Therefore, these variables were then used in separate models as observed dependent variables. In addition to these changes, a third observed crime variable was added to account for whether the inmate had ever been convicted of a felony, as this was estimated to be an approximation of the severity of criminal behavior. All three variables of criminality are conceptually more appropriate to be considered as observed rather than latent variables, as they measure concrete and quantifiable behaviors that can be verified. In total, six new models were constructed to account for these changes: three models using the *alcohol* latent variable to predict to each measure of criminality and three models using the *drug* latent variable to predict to each measure of criminality.

Hypothesis 2

This research also assessed whether alcohol and drug use were associated with neurocognitive deficits. Our results primarily did not support this relationship. Specifically, nearly all our models found null a-paths; that is, alcohol or drug use did not predict neurocognitive functioning. This is contrary to the extant research that demonstrates a robust relationship between both alcohol and drug use and cognitive deficits (e.g., Hosak et al., 2012; Iudicello et al. 2010; Rourke & Grant, 2009). While it is unlikely, it is still plausible that alcohol and drug use may not be associated with lasting neurocognitive damage. However, This contradiction between the present study and existing research may be due to the limitations in our methodology. For example, this study assessed drug and alcohol use disorders based on those substances that were reported to be the most frequently used and not those substances that were found to be the most problematic for the individual. It was assumed that the frequency of use was a more important variable, as it would theoretically lead to the most cognitive damage. However, a substance that is frequently used is not necessarily causing the user functional impairment, a necessary condition to meet criteria for an alcohol or drug use disorder. Extant drug and alcohol research typically utilizes a clinical sample population who are diagnosed with drug or alcohol use disorders. They do not include participants who use frequently but do not meet DSM-5 criteria for a disorder, which may account for why our results differed from current research.

While many of our participants did meet criteria for an alcohol or drug use disorder, approximately 12% of our sample did not meet criteria for any substance use disorder and 22% did not meet criteria for an alcohol use disorder. Perhaps the relationship between alcohol and drug use and neurocognitive functioning would have been more robust if the study constrained the sample to only those inmates who met criteria for a severe alcohol or substance use disorder.

Due to time limitations, the present study used a limited neurocognitive battery. Many domains of neurocognitive functioning were not captured (e.g., attention, visuospatial abilities, short- and long-term memory, learning, etc.). It is possible that those drug and alcohol dependent inmates did have significant neurocognitive deficits but in domains that were not measured in the present study. Future research could include a more comprehensive neuropsychological battery when assessing for this relationship.

Lastly, it is plausible that combining the number of symptoms endorsed across the three substance use modules on the MINI may have masked the relationship between drug use and neurocognitive functioning. For example, over 20% of the sample reported cannabis as one of their most frequently used substance. The relationship cannabis has with impaired neurocognition appears to be minimal (Bowman & Pihl, 1973; Carlin & Trupin, 1977). That is, the plurality of research suggests cannabis may only be deleterious for long-term memory, which the present study did not assess, and has little to no relationship with deficits in executive functioning (Grant, Gonzalez, Carey, Natarajan, & Wolfson, 2003; Schreiner & Dunn, 2012). Moreover, requiring inmates to choose three substances when they were interviewed probably led to the inclusion of substances that were only used sporadically and thus weakening the relationship between substance use and neurocognitive deficits.

Hypothesis 3

Our analyses revealed differential results when assessing the relationship between neurocognitive deficits and criminal behavior. Specifically, for drug models, neurocognitive deficits had a relationship with a history of felony convictions. For alcohol models, the relationship between neurocognitive functioning and a history of felony convictions was approaching significance (i.e., $p = 0.07$). These results do align with previous research that has demonstrated an association between cognitive functioning and criminality (Brower & Price 2001; Meijers, Harte, Jonker, & Meynen, 2015; Hancock, Tapscott, & Hoaken, 2010). However, our results deviate from past findings in that the association was a positive relationship, such that stronger neurocognitive performance predicted an increase in felony convictions. If these results are to be taken as face valid, our results suggest that having stronger cognitive functioning may have an unexpected side effect of more criminal behaviors. One potential explanation is because these inmates have enjoyed stronger cognitive abilities throughout life, they might have overestimated what they were able to get away with while engaging in criminal activities and therefore got caught more often. Another potential explanation may be the assumption that all criminals exhibit deficits in executive functioning is masking individual differences within this population. Indeed, emerging research suggests some criminal acts, such as white-collar crime, are actually associated with better performance on measures of executive functioning (Raine, Laufer, Yang, Narr, Thompson, & Toga, 2011). However, before further assessment of the clinical significance of these results, given our modest sample size and cross-sectional research design, additional research is needed to better understand this relationship.

This research did reveal several significant relationships between drug and alcohol use and criminal behavior (c'-paths). Specifically, for drug models, substance use was associated with having a history of having felony convictions and violent crimes, such that an increase in drug use was associated with a similar increase in criminal behavior. For alcohol models, an increase in alcohol use was associated with a history of felony convictions. These results reflect research that also suggests a strong association between drug and alcohol use and criminal behavior (e.g., Benson, Rasmussen, & Zuehlke, 1992; Chaiken & Chaiken, 1990; Inciardi & Pottieger, 1995; McBride, 1981; Nurco, Ball, Shaffer, & Hanlon, 1985). Therefore it appears, however unsurprisingly, those who engage in more substance use have a greater chance of committing a felony or violent crime than those who consume less alcohol and drugs.

These findings suggest a useful point of intervention. Our results indicated that drug use increased engagement in criminal activity. Indeed, there is a plethora of research supporting drug use treatment to reduce recidivism (Peters & Murrin, 2000; Wilson, Mitchell, & MacKenzie, 2006). However, most of this research has been conducted on the effectiveness of drug courts in reducing criminal behavior and are tentative at best (Wilson, Mitchell, & MacKenzie, 2006). Moreover, most research designs conclude after participants graduate from drug courts, begging the question of whether their effectiveness extend after the conclusion of treatment. Future research could assess whether other forms of empirically-based treatments, such as cognitive-behavior treatments, Motivational Interviewing, Contingency Management, and certain drug therapies (e.g., methadone, buprenorphine, and naltrexone) are equally or more effective at reducing future criminal behavior, both while in treatment and long-term.

These findings also lend themselves to a broader discussion of our current policies of public health surrounding drug and alcohol use in the United States. Specifically, finding significant, positive associations between drug use and criminal behavior across multiple models suggest that our current strategies in reducing both variables in the general public may not be effective. Indeed, the policy-level position that drug use is an issue of morality, needing to be treated or handled by incarceration, appears to be doing a disservice to those currently suffering from addiction as well as the general public. Our data suggest that we should approach those currently suffering from the debilitating effects of addiction without punition, instead helping them find effective and affordable methods of treatment. By reducing drug and alcohol use, we may see an associated decrease in criminal behavior for these individuals.

Hypothesis 4

One of the most exciting results of this study was the significant mediation model for alcohol use, neurocognitive functioning, and frequency of criminal behavior (i.e., total number of convictions). Specifically, increased alcohol use was associated with deficits in neurocognitive functioning, which were then associated with an increase in total number of convictions.

This mediation model aligns itself well with previous research. While to our knowledge no previous research has assessed this specific model in an incarcerated population, a plethora of research has demonstrated support for the main effects in this model. Specifically, an abundance of research has highlighted the strong association between problematic alcohol use and cognitive functioning, particularly deficits in executive functioning (Noël et al., 2001; Rourke & Grant, 2009, Stavro, Pelletier, & Potvin, 2013). Past research has also revealed significant associations between neurocognitive deficits and aspects of criminal behavior for inmates (Brower & Price 2001; Meijers, Harte, Jonker, & Meynen, 2015; Hancock, Tapscott, & Hoaken, 2010). The present research is important in that it brings together these two arms of research to demonstrate how neurocognitive ability may explain the relationship between alcohol use and frequency of criminal behavior.

These findings are useful in that they can aid the development of both treatment and prevention strategies. Specifically, neurocognitive functioning may offer a useful point of intervention. Clinicians can develop educational and treatment strategies that keep these limitations in mind. Examples of such treatment strategies may be utilizing compensatory approaches (e.g., reducing distractions, using notebooks to take notes in conversations) to help inmates navigate their environment with these limitations in mind. Also, pharmacological interventions may be of use in improving cognitive efficiency in tasks that require inhibition and cognitive flexibility. There is also bourgeoning experimental research that targets strengthening certain neurocognitive abilities through various cognitive training exercises (Klingberd, 2010; Klingberd et al., 2005; Turley-Ames & Whitfeld, 2003). This may be beneficial for inmates; however, this area of research still needs to demonstrate its clinical applications before being incorporated into jail facilities. Targeting alcohol use also offers a potential point of intervention. This model suggests that alcohol use may indirectly influence criminal behavior. Therefore, if clinicians were better able to reduce inmates' alcohol use once they are released, their neurocognitive functioning abilities may improve over time, which could theoretical reduce recidivism and the number of future convictions.

Hypothesis 5

Finally, the present study investigated whether there were gender differences in the proposed structural relationships between alcohol and drug use, neurocognitive functioning, and criminal behavior. Our analyses did not reveal significant gender differences on any of the six models. At present, the research on sex differences for neurocognitive deficits due to heavy alcohol and drug use is still inconclusive. While it is known that men and women differ in their physiological reactions to alcohol and drugs (Gallant, 1990; Lynch, Roth, & Carroll, 2002), there appears to be a conflicting body of research on whether these physiological differences result in unique cognitive deficits (Crane, Schuster, Fusar-Poli, & Gonzalez, 2013; Fabian & Parsons, 1983; Flannery et al., 2007). To the author's knowledge, there has been no research on gender differences on the relations among substance use, neurocognitive functioning, and criminal behavior. This study indicates that men and women are not different from one another on these relations. As such, this study suggests that researchers and clinicians may not need different approaches for men and women when formulating preventative and treatment measures, as the relations among substance use, neurocognitive functions and criminal behavior appear to be the same among men and women. However, it is important to note that while men and women may not differ substantially in their response to heavy alcohol and drug use, they may still react differently to the *mechanisms* of treatment and prevention. Therefore, before implementing similar preventative and treatment measures to both genders, future research should ensure men and women do not differ significantly in their reactions to the mechanisms of treatment.

While this study demonstrate a lack of gender differences along the structural pathways between substance use, neurocognitive functioning, and criminal behavior, it is important to note the present study may not have adequate power to reveal such differences. While this study is powered to examine the six models for the whole sample, it may not have enough power to reveal group differences. Future research should account for this by accruing more participants if they were to replicate the current study.

In summary, the present study revealed significant relations between neurocognitive functioning and a history of felony convictions and frequency of criminal behavior. Significant relationships were also established between drug use and a history of convicted felonies and violent crimes. Finally, a significant mediation model was revealed for alcohol use, neurocognitive performance, and total convictions, such that increases in alcohol use resulted in deficits in neurocognition that was associated with an increase in total number of convictions. However, no relationship was found between drug and alcohol use and neurocognitive functioning for 5 models.

Strengths of the Current Study

To my knowledge, this is the first study to measure the potential mediational role neurocognitive functioning has in relationship between chronic drug and alcohol use and criminal behavior. In contrast to much of the extant research, the present study combined two arms of research that have been studied in isolation (e.g., substance use and cognitive functioning as well as cognitive functioning and criminal behavior). By using structural equation modeling, I was able to examine the relationships among alcohol use, drug use, neurocognitive functioning, and criminal behavior simultaneously, making it possible for me to examine whether neurocognitive functioning mediates the relationship between substance use and criminal behaviors.

Second, this study utilized both female and male inmates in its data collection. Research on substance use, cognition, and behavior within the incarcerated population has been considerably sparse. Moreover, most of the extant research within this population has primarily been reduced to only investigating male inmates. Female inmates have largely been excluded from the body of research. This study attempted to remedy this by incorporating both female and male participants.

Third, this study was able to assess the impacts of polysubstance use and its relations with neurocognitive functioning and criminal behavior. Due to methodological difficulties, most substance use studies focus on the impact of single substance abuse on neurocognition or criminality. While this research is important in its own right, it does not encompass the substance use population, which typically abuses multiple substances in tandem (Venkatesan & Suresh, 2008). Therefore, this study is unique in that it includes participants' top three most frequently used substances and demonstrates how polysubstance abuse can increase the likelihood of committing violent crime and felonies. Moreover, this study also demonstrated that men and women may not substantially differ in how substance use may affect their neurocognitive abilities and criminal behavior.

Finally, these results support prior research that has outlined important distinctions between executive abilities (Miyake et al., 2000), with some caveats that would be vital to consider in future neuropsychological research. The latent factor of neurocognitive functioning that was initially proposed combined the domains of inhibition, set-shifting, and working memory. Despite the fact that executive abilities may be collectively described as a set of functions that permit the pursuit of goal-oriented behaviors, our model did not support a unified construct of executive functioning. Specifically, performance on the Wisconsin Card Sorting Test was significantly unlike performance on the D-KEFS Trail Making Test, Verbal Fluency, or Color-Word Inhibition Test. These results are intriguing in that they partially support prior research positing that executive domains are indeed distinct (Miyake et al., 2000) despite their unified goals and, to a certain extent, shared neurological activations (Collette et al., 2005). Indeed, Miyake and colleagues (2000) identified these distinct executive domains by performing an elegant series of exploratory and confirmatory factor analyses to identify appropriate distinctions for common neuropsychological tests. Curiously, however, performance on the Trail Making Test, Color-Word Interference, and Verbal Fluency were sufficiently alike to yield a satisfactory latent factor for this study's data.

While the lack of fit between the letter-number sequencing subtest of the Trail Making Test and the WCST may at first appear contradictory, as they are both hypothesized to measure the same aspect of cognitive functioning (i.e., cognitive flexibility), we would argue that these measures are potentially capturing different aspects of cognitive functioning. The letter-number sequencing subtest of the Trail Making Test requires participants to correctly alternate between connecting number and letters in numerical and alphabetical order. This test may measure flexibility in thinking while engaging in a visual-motor sequencing task. In contrast, the WCST requires participants to problem solve, using corrective feedback, to formulate the concept being tested (i.e., color, form, or number). After ten consecutive matches, the concept or sort changes, and the participant must utilize new corrective feedback to properly identify the next concept being assessed. It is plausible that the Trail Making Test and WCST, while generally viewed as measures of cognitive flexibility, are measuring different aspects of neuropsychological functioning. The Trail Making Test may be measuring the ability and speed of one's cognitive flexibility, whereas the WCST may be capturing more of one's ability in problem-solving and concept formation.

Limitations of the Current Study

This study had several weaknesses. One of the most notable was the amount of missing data for certain cognitive tests. The missing data were due to administrative errors on the neuropsychological assessments that rendered the tests invalid; however, a large amount of missing data was also a result of inmates discontinuing certain tasks early perhaps due to low frustration tolerance. While low frustration tolerance may be difficult to navigate for future research, mitigation of administrative error is possible by using computer neuropsychological assessments (i.e., Wisconsin Card Sorting Task – Computer Version) whenever possible.

However, the ability to use computerized neuropsychological assessments will be dependent on individual jail and prison policies and were unfortunately not permitted for the present study.

Another limitation of the current study is the researcher's lack of knowledge regarding the minutia of the participant's alcohol and drug history. Specifically, the researchers relied on retroactive self-report questionnaires to gather information regarding alcohol and drug use. The questionnaires used did not account for periods of sobriety that could have mitigated any long-term neurocognitive damage, but rather asked general questions regarding substance use over one's lifetime. Moreover, the research was unable to use any way to validate an inmate's length of abstinence that may have resulted in some improvements in cognitive performance, depending on when the neuropsychological battery was administered. Future research should utilize data gathering techniques to confirm length of sobriety beyond self-report, such as urine or hair analysis, in addition to more in-depth analysis regarding substance use histories.

In addition to drug and alcohol histories, this study did not ask questions regarding the participant's most problematic substance of use. Instead, it framed its questions for those substances that were most frequently used. While this was originally asked because it was hypothesized that those substances that were most frequently used would have a higher likelihood of impacting cognitive performance, some of the most frequently used substances, like cannabis, have minimal long-term cognitive effects. Framing questions in the context of those substances that are most functionally problematic theoretically allows for researchers to measure possible cognitive deficits as well as exclude those substances that may be more benign.

The timing of the measurements in the present study was also a limitation. Specifically, substance and criminal behavior questions were retrospective, gathering information over the course of the inmate's lifetime. Conversely, only current neurocognitive functioning was measured. Measuring these constructs across different time points ran the risk of criminal behavior and the neurocognitive functioning not lining up with the timeframe of heavy substance use. As such, future researchers may want to abandon cross-sectional research designs when assessing the relationship among these variables, instead employing a repeated measure design. Indeed, future researchers could measure substance use, neurocognitive functioning, and criminal behavior initially while participants are incarcerated and then follow participants upon release, periodically measuring the three domains overtime to better assess antecedents and mechanisms of criminal behavior.

The present study tried to mitigate the impact of multiple timeframes by controlling for the amount of time the participant had been sober, however there were issues with this variable. First, there were a lot of missing data associated with this variable due to administration error. Second, the measurement of sobriety was a single variable; research assistants inquired about the last date of use of substances in general, they did not inquire about the last date of use for each of the inmate's most frequently used drugs as well as alcohol. If future research continues to employ cross-sectional research designs to measure the relationship among these variables, researchers should ensure information is collected regarding length of time of sobriety for all major drugs of choice and alcohol. Researchers could also use more objective indicators of sobriety, such as urine or hair analysis.

Lastly, fine distinctions in the relationships between substance use, neurocognitive functioning, and specific criminal outcomes were not addressed by our analyses. Although the measurement model suggested that drug and alcohol use fit the data well, the combination of indicators of alcohol and drug consumption could have obscured certain nuanced findings that were originally hypothesized, such as better inhibition to predict to reduced number of total convictions. Even so, combining these and other variables into broad latent factors permitted examination of the constructs more generally, which is more practical in its interpretation. Future research could examine the relationships between individual domains of executive functioning and criminal behavior.

Summary and Future Directions

Research into the risk factors for criminal behavior has previously identified neurocognitive deficits as a target of concern for incarcerated individuals (Brower & Price 2001; Meijers, Harte, Jonker, & Meynen, 2015; Hancock, Tapscott, & Hoaken, 2010), with heavy substance use being the hypothesized culprit for reduced neurocognition (Selby & Azrin, 1997). Our sample revealed differential results in the main effects of the hypothesized models, with only one model revealing a significant mediation. While these results are unfortunate they do give future researchers evidence to continue pursuing this relationship in future studies.

Given this study’s curious trend suggesting a positive relationship between cognitive ability and criminal behavior, future models of inmate criminal behavior could explore the characteristics and criminal patterns of inmates with exceptional cognitive abilities, particularly when assessing a criminal history of felony convictions. Previous studies have demonstrated similar positive correlations, such as Raine and colleagues (2011) who evidenced better set-shifting, problem-solving, and increase cortical thickness was present for white-collar criminals relative to offending controls. Our study analyses loaded inhibition, verbal fluency, and set-shifting onto a single factor of neurocognitive functioning, so this study was not able to explore the distinctions between those variables. The present study also did not gather data regarding the type of criminal behavior beyond simple distinctions of violent and nonviolent crime. Additional research is needed to probe the contribution of alternative criminal practices among individuals with greater executive abilities.

Our study demonstrated a lack of relationships between drug and alcohol use and neurocognitive functioning that is inconsistent with initial hypotheses and extant research. However, this study utilized a relative modest neurocognitive battery when assessing for various aspect of cognitive ability. Therefore, we suggest future research utilize a more comprehensive neurocognitive battery when measuring inmate cognitive performance. The DSM-5 outlines 5 neurocognitive domains that should be assessed when making determinations about one's cognitive abilities: perceptual-motor function, executive function, attention, language, and learning and memory. Future models should attempt to develop batteries that measure each of these domains in hopes of capturing the extent of the effect chronic substance use may have on criminal behavior.

Finally, the present study asked about general questions regarding drug and alcohol use that may have obscured its effect with neurocognitive ability and criminal behavior. Specifically, the present study assessed for the most frequently used substances over the course one's lifetime. This type of framing and subsequent summation of endorsed symptomology across substances may have masked or hidden the fine distinctions in the relationships between distinct substance use and neurocognitive abilities. Future research may find it more beneficial to constrain questions to substance use for those that the inmate finds currently most functionally problematic. In addition, future models may benefit from forgoing collapsing endorsed symptomatology across substances as that may hide detailed relationships.

A hypothetical research study that utilizes many of our recommendations may be accomplished by the following: First, researchers could utilize a prospective design to better navigate the temporal issue of measurement the present study had. Specifically, future research could access inmate participants to measure substance use immediately prior to incarceration and current neurocognitive functioning. Then, researchers should follow these participants after release, periodically measuring substance use and cognitive abilities. After a certain time period, researchers could assess criminal behavior post the initial measurement period to better understand how current substance use and neurocognitive ability may impact future criminality. Second, researchers could utilize more drug and alcohol use questionnaires to better understand the specificity of each inmates drug-seeking behavior. These drug and alcohol use questionnaires should focus primarily on substances the inmates find most functionally problematic. Third, researchers could utilize a more robust neurocognitive battery than the present study's measurement, including cognitive domains such as memory, updating, attention, and problem solving, to understand how drug and alcohol use impacts a variety of cognitive abilities and how these abilities may relate to criminal behavior. Fourth, an evaluation of criminal behavior outside of simple distinctions of violent or nonviolent crime, history of felony convictions, and a summation of criminal acts should be executed. This will allow researchers to evaluate other forms of criminal behavior, such as white-collar crimes. Finally, researchers should make special effort in excluding or controlling for those inmates who only have a criminal history of drug or alcohol use-related crimes.

In conclusion, this study sought to examine the relative risk of alcohol and drug use and neurocognitive functioning for criminal behavior in a sample of incarcerated males and females. Results indicated that the D-KEFS Color-Word Interference (Inhibition), Letter Fluency (Verbal Fluency), and Trail Making Test (Cognitive Flexibility) were a better fit for a unified factor of neurocognitive functioning than the Wisconsin Card Sorting Test and D-KEFS measures combined. There was a significant, positive relationship for several of the main effects within the hypothesized mediation models. Specifically, inmates who evidenced neurocognitive deficits were less likely to have felony convictions. There were also significant, positive relationships between substance use and criminal behavior. For example, drug use was associated with a history of felony convictions and violent crimes. Alcohol use was also associated with a history of felony convictions. Finally, a full negative mediation model was revealed when using alcohol use and total convictions. Meaning, inmates who displayed chronic alcohol use tended to have reduced neurocognitive capabilities, which in turn increased their number of convicted crimes. These results have implications for the theoretical structure and applied measurement of neurocognition, as well as the nuances involved in the assessment of criminal behavior in incarcerated populations.

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APPENDICES

APPENDIX A

____ Participant #
The biographical information on this page is used to provide summaries of those who participate in this study without providing details about any one individual.

1. Age: ____

2. Education
____ 6th or less
____ Completed 8th grade
____ Some high school
____ Completed high school
____ GED
____ Technical degree
____ Some college
____ 4 year college degree
____ Some graduate school
____ Completed a graduate program

3a. What is your religion or spiritual faith? ____
3b. How important is it in your life? ____
____

4a. When did you last work? _____________
4b. When you last worked, what was your employment status?
____ (1) full-time
____ (2) part-time
____ (3) occasional
____ (4) disability/SSI
____ (5) no income
4c. What was your income when you last worked? _________________ (circle one: per week/month/year)

5. Current marital/relationship status:
____ (1) single
____ (2) divorced
____ (3) widowed
____ (4) married
____ (5) living with partner
____ (6) not living with current partner

6a. Parent: ____ Yes ____ No
6b. # of children under 18: ____
6c. Where do your children under 18 live?____
6d. How often do you see them? ____ daily ____2-3times/week ____weekly ____2x/month ____monthly ____less than monthly ____ never

7a. Ethnicity (check all that apply):
____ (1) African-American/Black
____ (2) Caribbean/Haitian
____ (3) African
____ (4) Asian-American
____ (6) White/European-American/Caucasian
____ (7) European
____ (8) Hispanic-American/Hispanic
____ (9) Native-American/American-Indian

____ (5) Asian/Pacific-Islander ____ (10) Other: ________________________
7b. Which ethnicity do you identify with the most? _________________________________

8. For what behavior(s) are you CURRENTLY incarcerated? ______________________
____
____

9. What is the legal charge(s) for which you are currently incarcerated? ______________
____
____

10a. Are you currently waiting for trial/sentencing? ___ Yes / ___ No, already sentenced
10b. If sentenced, how long is your current sentence? ____________________________
____

11a. Was the crime for which you are currently incarcerated your first offense? Yes/No
11b. If not, how many times before the current charge have you been convicted of/pled guilty to:

Murder, manslaughter, or homicide: ________ times
Assault: ________ times
Sex offenses: ________ times
Illegal drug charges: ________ times (specific charges: e.g., possession, use) _______________
Larceny, theft, robbery, burglary, or fraud: ________ times
Disorderly conduct, public drunkenness, or driving under the influence: ________ time
Vandalism or trespassing: ________ times

On what date were you incarcerated? ____________________

How many previous convictions have you had? ____________________

For what were you convicted of? ____

Are you currently on any medications? ________Yes ________No

What medications are you currently taking? _________________________________

____

APPENDIX B

I. ALCOHOL DEPENDENCE / ABUSE

(➡ MEANS: GO TO DIAGNOSTIC BOXES, CIRCLE NO IN BOTH AND MOVE TO THE NEXT MODULE)

			➡	
I1		**In the past 12 months,** have you had 3 or more alcoholic drinks, - within a 3 hour period, - on 3 or more occasions?	NO	YES
I2		**In the past 12 months:**		
	a	Did you need to drink a lot more in order to get the same effect that you got when you first started drinking or did you get much less effect with continued use of the same amount?	NO	YES
	b	When you cut down on drinking did your hands shake, did you sweat or feel agitated? Did you drink to avoid these symptoms (for example, "the shakes", sweating or agitation) or to avoid being hungover? IF YES TO ANY, CODE YES.	NO	YES
	c	During the times when you drank alcohol, did you end up drinking more than you planned when you started?	NO	YES
	d	Have you tried to reduce or stop drinking alcohol but failed?	NO	YES
	e	On the days that you drank, did you spend substantial time in obtaining alcohol, drinking, or in recovering from the effects of alcohol?	NO	YES
	f	Did you spend less time working, enjoying hobbies, or being with others because of your drinking?	NO	YES
	g	If your drinking caused you health or mental problems, did you still keep on drinking?	NO	YES

ARE 3 OR MORE **I2** ANSWERS CODED **YES**?

* IF YES, SKIP I3 QUESTIONS AND GO TO NEXT MODULE. "DEPENDENCE PREEMPTS ABUSE" IN DSM IV TR.

NO	YES*
ALCOHOL DEPENDENCE **CURRENT**	

I3		**In the past 12 months:**		
	a	Have you been intoxicated, high, or hungover more than once when you had other responsibilities at school, at work, or at home? Did this cause any problems? (CODE YES ONLY IF THIS CAUSED PROBLEMS.)	NO	YES
	b	Were you intoxicated more than once in any situation where you were physically at risk, for example, driving a car, riding a motorbike, using machinery, boating, etc.?	NO	YES
	c	Did you have legal problems more than once because of your drinking, for example, an arrest or disorderly conduct?	NO	YES
	d	If your drinking caused problems with your family or other people, did you still keep on drinking?	NO	YES
	e	Did you experience a craving, urge, or strong desire to drink?	NO	YES

ARE 1 OR MORE I3 ANSWERS CODED YES?

NO	YES
ALCOHOL ABUSE CURRENT	

APPENDIX C

J. SUBSTANCE DEPENDENCE / ABUSE (NON-ALCOHOL)

(➡ MEANS : GO TO THE DIAGNOSTIC BOXES, CIRCLE NO IN ALL DIAGNOSTIC BOXES, AND MOVE TO THE NEXT MODULE)

Now I am going to show you / read to you a list of street drugs or medicines.

J1 a **In the past 12 months,** did you take any of these drugs more than once, to get high, to feel elated, to get "a buzz" or to change your mood? ➡ NO YES

CIRCLE EACH DRUG TAKEN:

Stimulants: amphetamines, "speed", crystal meth, "crank", "rush", Dexedrine, Ritalin, diet pills.

Cocaine: snorting, IV, freebase, crack, "speedball".

Narcotics: heroin, morphine, Dilaudid, opium, Demerol, methadone, Darvon, codeine, Percodan, Vicodin, OxyContin.

Hallucinogens: LSD ("acid"), mescaline, peyote, psilocybin, STP, "mushrooms", "ecstasy", MDA, MDMA.

Phencyclidine: PCP ("Angel Dust", "PeaCe Pill", "Tranq", "Hog"), or ketamine ("special K").

Inhalants: "glue", ethyl chloride, "rush", nitrous oxide ("laughing gas"), amyl or butyl nitrate ("poppers").

Cannabis: marijuana, hashish ("hash"), THC, "pot", "grass", "weed", "reefer".

Tranquilizers: Quaalude, Seconal ("reds"), Valium, Xanax, Librium, Ativan, Dalmane, Halcion, barbiturates, Miltown, GHB, Roofinol, "Roofies".

Miscellaneous: steroids, nonprescription sleep or diet pills. Cough Medicine? Any others?

SPECIFY THE MOST USED DRUG(S): ______________________________

WHICH DRUG(S) CAUSE THE BIGGEST PROBLEMS?: ______________________________

FIRST EXPLORE THE DRUG CAUSING THE BIGGEST PROBLEMS AND MOST LIKELY TO MEET DEPENDENCE / ABUSE CRITERIA.

IF MEETS CRITERIA FOR ABUSE OR DEPENDENCE, SKIP TO THE NEXT MODULE. OTHERWISE, EXPLORE THE NEXT MOST PROBLEMATIC DRUG.

J2 **Considering your use of (NAME THE DRUG / DRUG CLASS SELECTED), in the past 12 months:**

a Have you found that you needed to use much more (NAME OF DRUG / DRUG CLASS SELECTED) to get the same effect that you did when you first started taking it? NO YES

b When you reduced or stopped using (NAME OF DRUG / DRUG CLASS SELECTED), did you have withdrawal symptoms (aches, shaking, fever, weakness, diarrhea, nausea, sweating, heart pounding, difficulty sleeping, or feeling agitated, anxious, irritable, or depressed)? Did you use any drug(s) to keep yourself from getting sick (withdrawal symptoms) or so that you would feel better? NO YES

IF **YES** TO EITHER, CODE **YES**.

c Have you often found that when you used (NAME OF DRUG / DRUG CLASS SELECTED), you ended up taking more than you thought you would? NO YES

d Have you tried to reduce or stop taking (NAME OF DRUG / DRUG CLASS SELECTED) but failed? NO YES

e On the days that you used (NAME OF DRUG / DRUG CLASS SELECTED), did you spend substantial time (>2 HOURS), obtaining, using or in recovering from the drug, or thinking about the drug? NO YES

f Did you spend less time working, enjoying hobbies, or being with family or friends because of your drug use? NO YES

g If (NAME OF DRUG / DRUG CLASS SELECTED) caused you health or mental problems, did you still keep on using it? NO YES

ARE **3** OR MORE **J2** ANSWERS CODED **YES**?

SPECIFY DRUG(S): ___________________________

* IF YES, SKIP J3 QUESTIONS, MOVE TO NEXT DISORDER.
"DEPENDENCE PREEMPTS ABUSE" IN DSM IV TR.

NO	YES *
SUBSTANCE DEPENDENCE **CURRENT**	

Considering your use of (NAME THE DRUG CLASS SELECTED), in the past 12 months:

J3	a	Have you been intoxicated, high, or hungover from (NAME OF DRUG / DRUG CLASS SELECTED) more than once, when you had other responsibilities at school, at work, or at home? Did this cause any problem? (CODE **YES** ONLY IF THIS CAUSED PROBLEMS.)	NO	YES
	b	Have you been high or intoxicated from (NAME OF DRUG / DRUG CLASS SELECTED) more than once in any situation where you were physically at risk (for example, driving a car, riding a motorbike, using machinery, boating, etc.)?	NO	YES
	c	Did you have legal problems more than once because of your drug use, for example, an arrest or disorderly conduct?	NO	YES
	d	If (NAME OF DRUG / DRUG CLASS SELECTED) caused problems with your family or other people, did you still keep on using it?	NO	YES
	e	Did you experience a craving, urge, or strong desire to use (name of drug)?	NO	YES

ARE **1** OR MORE **J3** ANSWERS CODED **YES**?

SPECIFY DRUG(S): ___________________________

NO	YES
SUBSTANCE ABUSE **CURRENT**	