EVALUATING THE ROLE OF HOT AND COLD EXECUTIVE FUNCTIONING, TRAUMATIC BRAIN INJURY, AND SUBSTANCE ABUSE IN A CRIMINAL JUSTICE SAMPLE

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ABSTRACT

The role that executive functioning (EF) deficits play in incarceration rates in the United States has rarely been researched. This construct consists of hot EF, which includes affective and reward-based decision making, and cold EF, which are purely cognitive processes including inhibition, working memory, and cognitive flexibility. This study aimed to examine hot and cold EF in a criminal justice sample, including subsamples such as violent offenders. Additionally, given that traumatic brain injury (TBI) and substance abuse are highly prevalent within criminal justice populations, additional aims included assessing the relationships between executive functioning, TBI, and substance abuse severity. A community sample of 422 individuals (135 who endorsed a criminal justice history) completed an online assessment composed of interactive measures to assess EF, as well as completing self-report measures on other relevant factors including demographics, intelligence, psychiatric symptoms, TBI, psychopathic traits, and substance use. Partial support was found for an association between criminal justice involvement and deficits in the cold EF components of inhibition and cognitive flexibility, although these were not found to be significant at the multivariate level. Instead, history of TBI, substance abuse, and psychopathic traits were found to be the greatest predictors of criminal justice involvement. Hot EF was not associated with criminal justice involvement. No differences were found in EF between violent and nonviolent offenders. More severe alcohol/substance use was associated with EF deficits, and poorer inhibition and working memory remained significant predictors even in the context of other relevant factors. Discussion of implications, limitations to the study, and future research directions were also included.

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CHAPTER I

INTRODUCTION

The United States (U.S.) incarcerates the highest proportion of its citizens compared to any another country in the world (Hartney, 2006; Walmsley, 2009). The U.S. criminal justice population has significantly higher rates of psychiatric disorders (James & Glaze, 2006; Steadman et al., 2009), traumatic brain injury (Kaba et al., 2014; Shiroma et al, 2010), and substance use disorders (Karberg & James, 2005; Mumola & Karberg, 2006) compared to the general population. Throughout the mid to late 20th century, punitive, "get tough" approaches (e.g., harsher sentencing, longer periods of incarceration) became increasingly popular, but were largely ineffective in reducing recidivism. As a result, there has been a shift toward diversion and rehabilitation programs over the last 30-40 years (Andrews & Bonata, 2010; Lipsey & Cullen, 2007). Diversion programs allow for individuals who are identified as posing minimal risk to others (e.g., drug offenders) to be diverted from a jail or prison sentence and instead be monitored in the community under a community corrections program (Lange et al., 2011). Community corrections rehabilitation efforts include strategies such as drug courts, mental health courts, cognitive-behavioral therapy, vocational rehabilitation, General Education Development (GED) testing preparation, and substance abuse treatment. The collective goal of these programs is to target and ameliorate the factors believed to cause criminal behavior in an effort to reduce recidivism (Duwe, 2017; Lipsey & Cullen, 2007). Diversion and rehabilitation programs in community corrections have generally been found to reduce recidivism (Duwe, 2017; Landenberger & Lipsey, 2005; Lange et al., 2011; Lipsey & Cullen, 2007), as 29-50% of individuals receiving community sentences were rearrested within three years, compared to 68% of individuals released from prisons (Alper et al., 2018). Although recidivism rates are lower for

those in community corrections, there is still a significant need for effective interventions to continue these efforts. Some factors that may contribute to difficulties in reducing recidivism include program dropout (Cullen et al., 2011), resistance to treatment (Shearer & Ogan, 2002), and ineffective implementation of treatment (Lipsey & Cullen, 2007). Additionally, it is likely that there are still unidentified factors that are not being addressed or treated in criminal justice populations that are contributing to high recidivism rates.

One potentially overlooked factor contributing to high recidivism is executive functioning deficits. While other countries have begun to explore the role that executive functioning deficits play in criminal justice involvement (Broomhall, 2005; Ross & Hoaken, 2011; Seruca & Silva, 2016; Meijers et al., 2015), research in the U.S. has largely overlooked this factor. Executive functioning refers to higher-order cognitive processes that are involved in conscious and goal-directed thoughts and behaviors (Diamond, 2013; Zelazo & Muller, 2002). While the domain of executive functioning is complex and there is still some controversy on the specific cognitive processes and brain regions involved, researchers in more recent years have generally agreed on three core cognitive components of executive functioning – inhibition, working memory, and cognitive flexibility (Miyake et al., 2000). Impairments in executive functioning can result in impulsive behaviors, difficulty planning and problem-solving, behavioral disinhibition, aggression, and socially inappropriate behaviors (Diamond, 2013; Young et al., 2009), all of which are exhibited at increased levels by those involved in the criminal justice system (Meijers et al., 2015; Morgan & Lilienfeld, 2000; Ogilvie et al., 2011). Previous meta-analyses have also found associations between antisocial behavior, a trait strongly linked to criminal justice involvement, and impairments in executive functioning (Morgan & Lilienfeld, 2000; Ogilvie et al., 2011). While these meta-analyses included groups beyond those in the criminal justice system,

this research, in addition to research finding evidence of executive functioning deficits in criminal justice populations in other countries (Broomhall, 2005; Ross & Hoaken, 2011; Seruca & Silva, 2016; Meijers et al., 2015), suggests that impairments in executive functioning are also likely to be found in criminal justice populations in the U.S., although this has yet to be empirically examined. Additionally, research in other countries have found that there may be differences in specific executive functioning impairments and types of criminal offenses. Specifically, increased impulsivity, poorer inhibition, and poorer cognitive flexibility have been associated with more violent offenses as compared to non-violent offenses (Hancock et al., 2010; Meijers et al., 2017). In summary, executive functioning has largely been overlooked in criminal justice populations in the U.S., yet related research suggests impairments are an untreated and prevalent issue that could be a potential target of intervention.

Historically, research on executive functioning has focused primarily on “cold” executive functions, which are those components that are purely cognitive, and include the core executive functions of inhibition, cognitive flexibility, and working memory. However, Zelazo and Muller (2002) proposed a distinction between “cold” executive functions and “hot” executive functions. Hot executive functions include the regulation of affect and motivation and thus tend to be used in decision-making and other related skills that include affective and reward-based components (Zelazo & Muller, 2002). It is likely hot executive functioning deficits are prevalent within the criminal justice system, as deficits in emotion regulation are associated with aggression and violence (Roberton et al., 2012) and deficits in affective decision-making (e.g., difficulty delaying gratification when advantageous) are associated with crime (Arantes et al, 2013; Lee et al., 2017). Based on these distinctions between hot and cold executive functioning, it is quite possible that deficits in hot executive functioning would be a greater contributor to criminal behavior than

deficits in cold executive functioning, and this aspect of executive functioning has not been explored in relation to criminal activity in any country.

Two of the most prominent causes of deficits in executive functioning are traumatic brain injury (TBI) and substance use. The role of TBI and substance use as causes of deficits in executive functioning and thus potential pathways to criminal justice involvement needs to be explored in greater detail as the U.S. criminal justice population has high prevalence rates of both conditions. Estimates of TBI in the criminal justice population range from 36-87% (Ferguson et al., 2012; Shiroma et al, 2010; Slaughter et al., 2003). Some of the most common symptoms of TBI are executive functioning impairments, including decreased inhibition, increased impulsivity, and emotion dysregulation (Arciniegas et al., 2002; Barman et al., 2016; McDonald, 2013). Substance use has also been associated with executive functioning deficits (Fernandez-Serrano et al., 2011; Giancola & Tarter, 1999), with more severe substance use generally being associated with greater deficits, although there are variations among substances (Claus et al., 2013; Verdejo et al., 2004). This is noteworthy as lifetime substance use ranges from 70-83% for all individuals involved in the criminal justice system (Karberg & James, 2005; Mumola & Bonczar, 1998; Mumola & Karberg, 2006). These highly prevalent factors not only contribute to the assumption that executive functioning impairments are likely common in the criminal justice population, but each factor may be uniquely associated with specific hot and cold executive functions that could inform interventions.

Purpose of the Study

Due to the general lack of research in the U.S. on executive functioning in criminal justice populations, the goals of the current study are as follows: (1) to evaluate whether deficits in hot executive functioning are higher in offender populations compared to non-offender populations,

while controlling for relevant sociodemographic differences and relevant psychological constructs; (2) to evaluate whether deficits in cold executive functioning are greater in offender populations compared to non-offender populations, while controlling for relevant sociodemographic differences and psychological constructs; (3) to explore whether violent offenders show greater deficits in hot executive functioning compared to non-violent offenders; (4) to assess whether violent offenders show greater deficits in cold executive functioning compared to non-violent offenders; (5) to explore whether deficits in hot executive functioning may serve as a moderator between TBI and later criminal justice involvement; and finally (6) to determine whether the severity of substance abuse is associated with hot and cold executive functioning deficits. Identifying whether executive functioning deficits is a meaningful predictor of criminal justice involvement is important as there has been evidence of some success in improving executive functioning (Diamond & Ling, 2016). As such, this could be a viable, low-cost target of intervention with the potential of lowering recidivism rates and improving other forms of therapy and treatment.

CHAPTER II

LITERATURE REVIEW

When most people think of the criminal justice system in the U.S., they tend to think only of prison which is actually one of the smallest populations within the criminal justice system (Maruschak & Minton, 2020). In reality, our criminal justice system is much more complex as it consists of federal prisons, state prisons, jails, and multiple forms of supervision housed under community corrections (Carson, 2020; Maruschak & Minton, 2020). Federal prisons house offenders who have committed federal crimes, such as drug trafficking, identity theft, tax fraud, and crimes committed on federal properties (U.S. Sentencing Commission, 2020), whereas state prisons house those who have committed state crimes, including homicide, assault, drug possession, and burglary (Carson, 2020). Jail populations tend to be more transient in nature as they consist of individuals who have not yet been convicted, as well as those who have been sentenced to one year or less (Zeng, 2020). Community corrections consists of individuals on probation or parole (Kaeble & Alper, 2020). Individuals on probation are those who have been court-ordered to correctional supervision in the community rather than sentenced to time in prison or jail, whereas individuals on parole are those who are being supervised in the community after being released from serving a sentence in prison (Kaeble & Alper, 2020). For both populations, failure to comply with the conditions of their sentence, such as committing a new crime, failing to remain abstinent from substances, and failing to report to one's correctional officer, can result in additional sanctions or a return to prison or jail (Petersilia, 2011). Taken together, the U.S. criminal justice system is complex and consists of several divisions, and the division that most often goes unnoticed by the public is community corrections.

Community corrections encompasses a wide variety of programs, including mental health court, the Treatment Alternatives for Safer Communities (TASC) program, drug court, and many others that are designed to divert individuals away from prison and jail and into community corrections (Lange et al., 2011; Lipsey & Cullen, 2007; Paterson & MacCarone, 2008). Mental health court is designed for people who currently have a mental illness, do not pose significant harm to others, and voluntarily choose to participate in the program, which includes participation in mental health treatment (Schneider, 2008). TASC is a program created in 1972 that is designed to identify low-risk, recently arrested individuals, evaluate their treatment needs, and provide such treatment (National Criminal Justice Reference Services, 1995; Paterson & MacCarone, 2008). While TASC programs often include mental health and substance abuse treatment, they also tend to be comprehensive in providing additional services such as parent training, GED prep classes, vocational rehabilitation, and medical care (Anglin et al., 1999). Drug courts are similar to, and in some cases intertwined with the TASC program, as they are designed to integrate substance abuse treatment and the criminal justice system with the goal of reducing substance use and related criminal behaviors in non-violent, drug offenders (Belenko, 1998; National Association of Drug Court Professionals, 1997). Participation in drug courts generally involves frequent drug testing, participation in substance abuse treatment, and increased supervision in the community (Belenko, 1998). The overarching goal of these programs is to rehabilitate offenders by targeting and ameliorating factors believed to cause criminal behavior (Duwe, 2017; Lipsey & Cullen, 2007). Due to the scope of community corrections, it may be no surprise that it is the largest division within the U.S. criminal justice system (Kaeble & Cowhig, 2018).

The most recent report from the Bureau of Justice Statistics states that the total population of individuals in the U.S. criminal justice system in 2018 was approximately 6.4 million

individuals (Maruschak & Minton, 2020), which is drastically higher than any other country in the world (Walmsley, 2015). Of that number, approximately 4.4 million individuals were under community corrections, followed by individuals in prison at approximately 1.5 million and individuals in jail at approximately 740,000 (Maruschak & Minton, 2020). Additionally, the majority of those in community corrections (80%) are individuals on probation (3.5 million) and the majority of individuals in prison (88%) are housed in state prisons (1.3 million; Carson, 2020; Kaeble & Alper, 2020). In examining the types of offenses in the various divisions of the criminal justice system, offenses are commonly categorized into four groups: violent offenses (e.g., homicide, assault, robbery), property offenses (e.g., burglary, theft, fraud), drug offenses (e.g., possession, use, distribution), and public order offenses (e.g., DUI/DWIs, traffic offenses, weapons charges, court offenses; Snyder, 2012). Although many individuals may be convicted of multiple offenses, individuals in the criminal justice system are typically categorized by their most serious offense, with violent offenses identified as the most severe, followed by property offenses, drug offenses, and lastly public order offenses (Federal Bureau of Investigation Uniform Crime Reporting, FBI UCR, 2004). For example, if an individual was charged with armed robbery and possession of marijuana, they would be categorized under a violent offense. Table 1 shows the breakdown of offense categories for individuals in the criminal justice system. Over half of individuals housed in state prisons have committed violent offenses whereas approximately half of individuals in federal prisons have committed drug offenses (Carson, 2020). The proportions of offense types are approximately equivalent for those under probation, whereas there are slightly higher proportions of violent and drug offenses for those on parole (Kaeble & Alper, 2020), which is expected considering these are individuals released from prisons. Convicted individuals in jails also have approximately equivalent proportions of offenses, whereas individuals in jail who have

not yet been convicted have slightly higher proportions of violent offenses compared to other types of offenses (James, 2004). While these statistics show more recent trends in regard to population size and offense type, these rates have changed over time.

TABLE 1

PERCENTAGE OF OFFENSES ACROSS CRIMINAL JUSTICE DIVISIONS

	Community Corrections		Prisons		Jails[a]	
	Probation	Parole	State	Federal	Convicted	Unconvicted
Violent	22%	31%	56%	8%	22%	34%
Property	25%	20%	17%	6%	25%	22%
Drug	26%	30%	14%	47%	24%	23%
Public Order	26%	18%	12%	39%	29%	20%

Note: Details may not sum accurately to totals due to rounding. Individuals are categorized by their most severe offense type. Data are from Carson (2020), Kaeble & Alper (2020), and James (2004).

[a] The most recent data on jail populations is from 2002, in comparison to data on prison and community correction populations from 2018.

It is a common perception based on reports in the news and media that crime is increasing, and while this was the case for most of the 20th and early 21st centuries, crime—especially violent crime—is actually declining. Since 2008, the overall correctional population has declined 12.3% (Maruschak & Minton, 2020). In examining specific crime trends, violent crimes have generally been declining in the U.S. since the early 1990s (Morgan & Oudekerk, 2019), although there have been some fluctuations and increases in the violent crime rate in recent years (Bureau of Justice Statistics, BJS, 2020). There has also been a decrease in property crimes over the last 20 years (Morgan & Oudekerk, 2019; FBI UCR, 2018). On the other hand, public order offenses and drug offenses have significantly increased over the years, with drug offenses showing the largest increase as the number of drug-related arrests has tripled since 1980 (FBI UCR, 2018; Karberg & James, 2005; Mumola & Karberg, 2006; Snyder, 2012). The largest increase in drug-related charges has been for the possession of controlled substances, with possession comprising

approximately 85% of drug-related arrests in 2018 (FBI UCR, 2018; Snyder, 2012). This increase in drug offenses is largely the result of major policy changes.

The earliest meaningful policy change was President Richard Nixon's "war on drugs" which began in 1971 and consisted of significantly harsher sentences (e.g., 15-25 years in prison) for possession of illegal substances (Schultz, 2019). Incarceration rates significantly increased during Ronald Reagan's presidency as he expanded upon drug criminalization efforts and influenced zero-tolerance policies in the 1980s, which provided punitive sanctions that extended to occasional users and those in possession of very small amounts of substances (Hawdon, 2001). Additionally, significant increases in the criminal justice population continued to increase during the 1990s when the "three strikes and you're out" laws were implemented, which included a harsh, mandatory sentence (e.g., 25 years to life) after an individual had three offenses, with some states enacting this for rather minor offenses (e.g., petty theft; Schultz, 2019; Stolzenberg & D'Alessio, 1997). These policy changes significantly widened the net of drug-related crimes from primarily focusing on manufacturing and distribution to including the average drug user. Not only did incarceration rates increase as a result of drug policy changes, but they also increased also due to deinstitutionalization.

Deinstitutionalization refers to the closing of state-run mental health hospitals with the goal of shifting mental health patients and treatment to community mental health centers (Harcourt, 2011). While a multitude of laws were passed to promote and facilitate deinstitutionalization, the Community Mental Health Centers Act in 1963 is often credited with enacting this movement (Harcourt, 2011; Hartwell, 2004). Although the deinstitutionalization of mental health hospitals was likely well-intended, it had unintended consequences as community-based mental health services and resources were limited and many individuals found themselves

without support and treatment (Hartwell, 2004). Around this same time, arrest rates of those who had mental illnesses significantly increased as many of these individuals struggled to become integrated back into the community without the necessary resources and support (Hartwell, 2004; Lamb & Bachrach, 2001), and the prevalence of mental illness in the criminal justice system has remained high today.

Estimates of mental illness in the criminal justice population range from 36-64% (Al-Rousan et al., 2017; Green et al., 2005; James & Glaze, 2006; Prins, 2014), with women having a higher prevalence rate of psychiatric disorders compared to men (Bronson & Berzofsky, 2017; Steadman et al., 2009). While wide ranges in the prevalence of specific psychiatric disorders are seen in the literature, often due to differing methodologies and criteria in assessing for such disorders, some of the most common psychiatric disorders seen in the criminal justice populations include antisocial personality disorder, with lifetime prevalence rates ranging from 16-63% (Black et al., 2010; Gunter et al., 2011; Hodgins et al., 2010; Lurigio et al., 2003), followed by depressive disorders (14-62%), posttraumatic stress disorder (PTSD; 15-48%), attention-deficit/hyperactivity disorder (11-26%), anxiety disorders (4-23%), bipolar disorders (5-16%), and psychotic disorders (4-11%; Al-Rousan et al., 2017; Gunter et al., 2009; Lewis, 2005; Prins, 2014). The upper estimates of these prevalence rates are significantly higher than those in the general public (American Psychiatric Association, 2013). Not only is the prevalence rate of psychiatric disorders higher for those in the criminal justice system, so too is the experience of trauma (Ford et al., 2012). Childhood abuse has been linked to involvement in the criminal justice system (Dargis et al., 2016; Widom, 2017), and approximately 15-58% of males (with higher rates in male sexual offenders) and 39-65% of females in the criminal justice system reported having experienced physical or sexual abuse during childhood (Green et al., 2005; Lynch et al., 2014; Messina &

Grella, 2006; Swogger et al., 2011). Generally, prevalence rates of trauma and abuse have been higher in females in the criminal justice system compared to males, which may account for higher rates of PTSD (30-50%) in females (Lynch et al., 2014).

These high prevalence rates are noteworthy as many of these psychiatric disorders are associated with executive functioning deficits. Specifically, impairments in inhibition, cognitive flexibility, and working memory have been found to be associated with antisocial personality disorder (Morgan & Lilienfeld, 2000; Zeier et al., 2012), depressive disorders (Kaiser et al., 2003; Langenecker et al., 2005; Watkins & Brown, 2002), attention-deficit/hyperactivity disorder (Boonstra et al., 2005; Frazier et al., 2004), PTSD (Flaks et al., 2014; Polak et al., 2012), anxiety disorders (Airaksinen et al., 2005; Zainal & Newman, 2018), bipolar disorders (Bora et al., 2009; Shear et al., 2002) and psychotic disorders (Aleman et al., 2006; Orellana & Slachevsky, 2013). Considering the range of psychiatric disorders associated with executive functioning deficits, as well as the high prevalence of psychiatric disorders in the criminal justice system, it can reasonably be assumed that offenders exhibit executive functioning impairments. This is further compounded by the high comorbidity rates (40-72%) of psychiatric disorders with substance use disorders in the criminal justice system (Abram et al., 2003; Belenko et al., 2003; White et al., 2006).

The prevalence of current substance use disorders in the criminal justice system ranges from 53-74% (Bronson et al., 2017; Lynch et al., 2014; Proctor et al., 2019), with even higher lifetime prevalence rates at 70-83% (Karberg & James, 2005; Mumola & Bonczar, 1998; Mumola & Karberg, 2006). Due to varying criteria used to determine substance use disorders, part of which can be attributed to changes in criteria from the fourth to fifth edition in the Diagnostic and Statistical Manual of Mental Disorders (DSM), the prevalence rates for specific types of

substances in the criminal justice system has varied. However, estimates for current substance use disorders generally range from 40-66% for alcohol use (Fazel et al., 2006; Proctor et al., 2019), 26-43% for stimulants (including amphetamine and methamphetamine), 23-39% for cannabis, 14-35% for cocaine, and 19-31% for opioids (including heroin; Bronson et al., 2017; Proctor, 2012; Proctor et al., 2019). Additionally, a significant number of individuals (44-49%) in the criminal justice system who use drugs report polysubstance use, meaning that they commonly use more than one type of drug (Kedia et al., 2007; Proctor, 2012). These high prevalence rates of substance use disorders are important to note because substance abuse has generally been associated with executive functioning impairments, including deficits in working memory, cognitive flexibility, inhibition, and decision-making (Aharonovich et al., 2018; Ramey & Regier, 2019; Verdejo-Garcia et al., 2006). However, there are some variations in the specific impairments depending on the substance, severity of use, and length of time of abstinence (Ramey & Regier, 2019; Verdejo-Garcia et al., 2006). For example, although all substances show some deficits in executive functioning, cocaine has been associated with greater deficits in executive functioning compared to alcohol, opioids, and cannabis (Aharonvich et al., 2018; van der Plas et al., 2009). In summary, substance use disorders are highly prevalent in criminal justice populations and are associated with deficits in executive functioning. Additionally, while substance use disorders are highly comorbid with psychiatric disorders, they are also highly comorbid with traumatic brain injuries (Taylor et al., 2003).

Estimates of the prevalence of traumatic brain injury (TBI) in the criminal justice population range from 36-87% (Ferguson et al., 2012; Shiroma et al, 2010; Slaughter et al., 2003), which is 3-7 times higher than in the general population (Farrer & Hedges, 2011; Frost et al., 2013). TBI is an injury to the brain that can include axonal shearing (tearing), contusions

(bruising), or hemorrhages (bleeding; Kim & Gean, 2011). While the exact sequalae of symptoms varies depending on age, the location and severity of the TBI, the number of TBIs (Rabinowitz & Levin, 2014), and comorbid psychiatric and substance use disorders (Rao & Lyketsos, 2000; Riggio, 2011), there are some common cognitive, behavioral, and somatic symptoms seen in TBIs. Common cognitive symptoms include impairments in memory, processing speed, attention, and executive functioning, although more severe TBIs can also result in impairments in visuospatial processing and language (Rabinowitz & Levin, 2014). Specifically, executive functioning impairments include poor inhibition, cognitive flexibility, planning, judgment, and decision-making (Rabinowitz & Levin, 2014; Rao & Lyketsos, 2000). Behavioral symptoms include impulsivity, apathy, aggression, and irritability (Rabinowitz & Levin, 2014; Rao & Lyketsos, 2000; Riggio, 2011; Tateno et al., 2003) and somatic symptoms include headaches, dizziness, nausea, fatigue, and sleep difficulties (Rao & Lyketsos, 2000; Riggio, 2011). Many of these impairments in executive functioning overlap with impairments seen in psychiatric and substance use disorders. As such, it is likely that the presence of a TBI can exacerbate comorbid disorders, perhaps further impairing existing executive functioning deficits, in addition to TBIs themselves causing impairments in executive functioning. The high prevalence of TBIs, psychiatric disorders, and substance use disorders in the criminal justice system may not be surprising as many individuals involved in the system come from at-risk backgrounds and impoverished conditions, which are associated with these factors (Hetey et al., 2018; Nellis & King, 2009; Rabuy & Kopf, 2015).

Several socioeconomic and demographic factors have been found to be associated with criminal justice involvement. For example, correctional populations have significantly lower education levels (Harlow, 2003), and have median annual incomes approximately two times less

than those in the general population (Rabuy & Kopf, 2015). As such, lower socioeconomic status is associated with involvement in the criminal justice system. As minorities continue to be overrepresented in those with lower socioeconomic status, it is likely not surprising that minorities, and particularly African Americans, continue to be disproportionately involved in the criminal justice system as well (Gradin, 2012; Nellis, 2016). In the most recent update from the Bureau of Justice Statistics, the prison population demographics consisted of approximately 33% African American, 30% White, and 23% Hispanic (Carson, 2020). However, these proportions can vary widely depending on the state as 12 states had prison populations in which over half of their population consisted of African Americans (Nellis, 2016). This is in contrast to the overall proportions of each group in the U.S. population, in which African Americans make up approximately 13% of the population, Hispanics make up approximately 16%, and Whites make up approximately 63% (U.S. Census Bureau, 2011). Overall, African Americans are incarcerated at a rate that is 3-6 times higher than that of Whites (Carson, 2020; Zeng, 2020). This disproportionate overrepresentation can largely be attributed to socioeconomic barriers and discrimination that occurs at all stages within the criminal justice system (Hetey et al., 2018; Nellis & King, 2009). While these are clearly relevant factors, rehabilitation efforts have focused largely on malleable variables at the individual level, as these socioeconomic factors—though undoubtedly important—require much larger changes at the systemic level.

Treatment in Corrections

In 1974, Robert Martinson authored a comprehensive review of the effectiveness of prison treatment programs that became famous for stating that “nothing works” in the rehabilitation of prisoners. While several researchers (e.g., Gendreau & Ross, 1979; Palmer, 1975) quickly criticized the conclusions drawn in this article and advocated that effective treatment in prisons

was possible, the release of the "nothing works" article during the 1970s was widely accepted as the political climate in the U.S. was already gravitating toward harsher criminal justice policies. However, research on rehabilitation efforts was revived with the development of the Risk-Need-Responsivity (RNR) model (Andrews et al., 1990). The goals of the RNR model are to identify risk factors predictive of reoffending (e.g., procriminal attitudes, antisocial personality, substance abuse), determine the unique needs of the offender (e.g., employment, passing the General Educational Development test), and provide effective tailored interventions to remediate risk factors and promote the wellbeing of the individual (Andrews et al., 1990; Andrews & Bonta, 2010). The efficacy of this model has been demonstrated in a number of populations and its popularity has grown rapidly (Hason et al., 2009; Polaschek, 2012).

Following the rise of the RNR model, examples of more recent rehabilitation efforts in prisons include Cognitive-Behavioral Therapy (CBT) and Transcendental Meditation. CBT is a widely used, evidenced-based therapy that targets automatic thoughts and cognitive distortions with the goal of modifying emotional and behavioral responses to stimuli (Hollon & Beck, 2013). CBT has been adapted for criminal justice settings in that it targets "criminal thinking" distortions that can lead to antisocial behavioral responses, and often includes additional components relevant to criminal justice populations such as social skills and cognitive skills training (Landenberger & Lipsey, 2005). Meta-analyses have generally shown CBT programs to have small to moderate effect sizes, resulting in an approximate 20-30% decrease in recidivism (Landenberger & Lipsey, 2005; Lipsey et al., 2007; Pearson et al., 2002; Wilson et al., 2005). Transcendental Meditation is a meditation technique that, when practiced systematically, reduces physiological arousal and promotes a state of restful alertness (Travis & Wallace, 1999). Transcendental Meditation was first widely applied to prison settings in the late 1970s and has been found to reduce depression, trauma

symptoms (Nidich et al., 2016), anxiety, aggression, and rule violations while in prison (Abrams & Siegel, 1978; Alexander et al., 2003b; Ballou, 1977). The few studies that have examined the effectiveness of Transcendental Meditation's effects on recidivism have found that it reduces recidivism by approximately 33-44% (Alexander et al., 2003a; Dillbeck & Abrams, 1987; Rainforth et al., 2003). Despite CBT and Transcendental Meditation's positive effects in reducing recidivism rates, there is clearly still a need for more effective treatments with lasting effects as prison recidivism rates continue to remain high as approximately three-fourths of released prisoners are rearrested within three years (Alper et al., 2018). While rehabilitation efforts are still pursued in prisons, there has been a shift in focusing rehabilitative efforts on the largest criminal justice population – community corrections.

One of the most common treatments in community corrections is substance abuse treatment. Considering the high prevalence rates of substance use disorders among criminal justice populations, it is not surprising that this is one of the most common factors that rehabilitation efforts have attempted to address. Substance abuse treatment may vary depending on the needs of the individual; however, treatment in criminal justice settings generally focuses on increasing motivation to change, addressing barriers, and preventing relapse (SAMHSA, 2005). Strategies from other treatments such as cognitive-behavioral techniques, emotional regulation skills, and interpersonal skills are also frequently incorporated into substance abuse treatment in order to target underlying and comorbid factors such as mental health that are frequently seen in criminal justice populations (SAMHSA, 2005). Substance abuse treatment in criminal justice settings has been shown to reduce substance use and recidivism (Bahr et al., 2012), particularly with longer treatment lengths (Evans et al., 2011), although these effects may be relatively short-lived as just over half of individuals who participated in substance abuse treatment recidivated and

approximately three-fourths of individuals relapsed after five years (Inciardi et al., 2004; Krebs et al., 2009). In summary, substance abuse treatment is commonly used in criminal justice settings to target highly prevalent substance abuse that has shown, at a minimum, short-term effectiveness in reducing recidivism and substance use. In addition to substance abuse treatment, other types of treatment have been implemented in community corrections.

Common examples of treatment in community corrections beyond substance use treatment include CBT, Aggression Replacement Training, Moral Reconation Therapy, and cognitive skills programs. While CBT has been extensively studied and identified as one of the more effective treatments in prisons, significantly less research has examined the effectiveness of CBT in community corrections. However, studies that have examined cognitive-behavioral programs in this population have generally found positive effects as well (Barnes et al., 2016; Lowenkamp et al., 2010). Aggression Replacement Training includes three components: (1) anger control training, (2) teaching moral reasoning; and (3) teaching prosocial behaviors as a replacement for antisocial ones (Glick & Goldstein, 1987). Studies have generally found Aggression Replacement Training to have positive effects on reducing recidivism (e.g., approximately 13% reduction; Brännström et al., 2016; Hatcher et al., 2008). Moral Reconation Therapy assumes offenders committed crimes due to being at a lower level of moral reasoning, characterized by self-centeredness and propensities favoring immediate gratification, and assists offenders in developing a higher level of moral reasoning in which the consideration of others and social rules becomes important (Little & Robinson, 1988). Meta-analyses examining the effectiveness of Moral Reconation Therapy have found significant effects in reducing recidivism by approximately 16-22% (Ferguson & Wormith, 2013; Little, 2005). Cognitive skills programs (e.g., the Reasoning and Rehabilitation Program) generally focus on enhancing cognitive processes through the use of

modules targeting problem-solving, emotion regulation, social skills, decision-making, values enhancement, and critical thinking (Ross & Fabiano, 1985; Ross & Ross, 1995). While these programs have primarily been implemented and studied in other countries, they have reported success in reducing recidivism by approximately 14% (Tong & Farrington, 2006). The few research studies on cognitive skills programs in the U.S. (and not as a component of another treatment or therapy) have also found reductions in recidivism in comparison to those who did not receive treatment (Johnson & Hunter, 1995; Van Voorhis et al., 2004). In summary, there are a variety of therapies which demonstrate moderate effects on recidivism rates; however, despite these positive effects, rehabilitation efforts in community corrections can still be improved as 29-50% of individuals supervised under community corrections are rearrested within three years (Alper et al., 2018). In returning to the RNR model, one possibility for these recidivism rates remaining high is that there are still criminogenic factors that have yet to be addressed in treatment or have yet to be addressed effectively. One such factor may be impairments in executive functioning.

Executive Functioning

Although reference to what we now know as executive functioning has been noted since at least the 1840s with the case study of Phineas Gage, the concept of executive functioning was first defined in the 1970s (Goldstein et al., 2014). Since then, there have been many attempts at defining executive functioning. It has been described as a unitary construct (de Frias et al., 2006; Duncan et al., 1996), as a diverse set of skills (Anderson, 2002; McCloskey et al., 2008), as an overarching term used to describe mental control processes (Best et al., 2009; Corbett et al., 2009), as processes related to the frontal lobe more generally (Stuss et al., 2000), and the prefrontal cortex more specifically (Best et al., 2009; Moriguchi & Hiraki, 2013). Although there has yet to

be an agreed upon operationalized definition of executive functioning, it can generally be defined as higher-order cognitive processes involved in cognitive control (Diamond, 2013; Zelazo & Muller, 2002). The variation in how executive functioning has been described in the literature has led to a variety of models of executive functioning.

Some of the most prominent models that have been proposed over the years include the Supervisory Attentional System (SAS), the Central Executive model, and the Tripartite Model. The SAS model, proposed by Norman and Shallice in 1986, states that there is a supervisory attention system that is activated when presented with novel situations and stimuli and as a result, there is a need for planning and decision making. Norman and Shallice (1986) made the distinction between automatic and controlled processes and proposed that the SAS directs controlled processes such as executive functions. While no distinct brain areas were implicated in their original SAS model, it was proposed that the SAS was generally associated with the frontal lobe (Shallice, 1988). This model later evolved to state that the SAS can be fractionated into seven distinct tasks, each with a unique anatomical basis: sustaining (right frontal lobe), concentrating (cingulate area), sharing (cingulate and orbitofrontal areas), suppressing (dorsolateral prefrontal cortex), preparing (dorsolateral prefrontal cortex), switching (dorsolateral and medial frontal areas), and goal setting (left dorsolateral prefrontal cortex; Shallice & Burgess, 1996; Stuss et al., 1995). The Central Executive was proposed as part of a model of working memory that also includes the phonological loop and the visuospatial sketchpad (Baddeley & Hitch, 1974). The phonological loop and visuospatial sketchpad hold and maintain verbal and visual information respectively, whereas the Central Executive is the attentional system that directs and focuses attention toward relevant stimuli (Baddeley & Hitch, 1974). In this model, executive functions are the products of the Central Executive, directing and controlling subsequent cognitive processes

such as the manipulation of verbal and visual information. The Central Executive model did not provide a proposed anatomical location to where the Central Executive might be located in the brain and touted that it was proposed as a scientific concept (Baddeley, 1998). The Tripartite Model proposed by Stuss and Benson (1986) includes three systems that are involved with monitoring attention and executive functions. The first two systems are primarily involved in the more basic functions of consciousness and alertness and consist of the anterior reticular activating system and diffuse thalamic projection system. However, the third system consists of the fronto-thalamic gating system and is proposed to be involved in supervisory attentional control and higher-level cognitive processes (executive functions) such as planning, decision-making, and monitoring (Stuss & Benson, 1986). While there have been a number of models of executive functioning that have been proposed over the years, there has been some general agreement more recently on a three-factor model.

Miyake and colleagues (2000) conducted a factor analysis using the three most frequently identified executive functions in the literature: inhibition, cognitive flexibility (also known as set-shifting), and working memory. They found that these three executive functions were clearly distinct from each other and concluded that each of these factors represented a unique executive function. At the same time, inhibition, cognitive flexibility, and working memory correlated moderately with each other, indicating that there is an underlying commonality amongst the three functions. Based on their findings, Miyake and colleagues (2000) concluded that executive functioning exhibits “unity and diversity” because there is commonality shared amongst the functions, yet there are still distinct abilities. While the inclusion of other executive functions (e.g., fluency; Fisk & Sharp, 2004; Jurado & Rosselli, 2007; Whiteside et al., 2016) has been debated, the three-factor model has generally been supported and has remained the most popular (Lehto et

al., 2003; Huizinga et al., 2006; Daucourt et al., 2018). In summary, Miyake and colleagues' "unity and diversity" three-factor model proposes that executive functioning consists of at least three core executive functions – cognitive flexibility, working memory, and inhibition.

Inhibition describes the ability to impede automatic, dominant, and impulsive responses to choose a more advantageous response when situationally appropriate (Diamond, 2013; Miyake et al., 2000). In other words, inhibition allows for the control of our attention, thoughts, emotions, and behaviors rather than simply relying on previously learned behaviors, habits, and impulses that may be evoked by certain stimuli and situations (Barkley, 1997). Impairments in inhibition can result in difficulty ignoring distractions, acting impulsively on emotions, making hasty judgments, and subsequently acting on them without obtaining all of the information (Diamond, 2013). There are a number of measures that purportedly measure inhibition including the Stroop task (Stroop, 1935), Simon task (Simon, 1969), Flanker task (Eriksen & Eriksen, 1974), stop-signal task (Logan, 1994), and go/no-go task (Gomez et al., 2007). Many of these tasks require individuals to inhibit their predisposed tendencies or innate responses (e.g., reading) and instead provide a different response (e.g., naming the color of the ink a word is printed in), while other tests require individuals to simply inhibit their response and not do anything (e.g., refraining from responding when a particular stimuli is presented). Inhibition has been associated with the dorsolateral prefrontal cortex, ventrolateral prefrontal cortex, anterior insula, anterior cingulate cortex, inferior frontal junction, and parietal regions (Baumeister et al., 2014; Hung et al., 2018; Levy & Wagner, 2011). To summarize, inhibition is a core executive function that is crucial for control of our behaviors, with impairments in inhibition often resulting in a reliance on our automatic responses. In addition to inhibition, another core executive function proposed by Miyake and colleagues (2000) is working memory.

Working memory can be defined as the ability to hold and manipulate information in our minds, which is necessary for complex tasks such as reasoning, comprehension, and learning (Baddeley, 2010). A number of behaviors rely on working memory, including reasoning, seeing connections between events, considering alternative choices at a time, updating thinking with new and relevant information, and simultaneously remembering past experiences while keeping future goals in mind (Diamond, 2013). Measures of working memory require the individual to manipulate verbal or visual information while holding these ideas in a stable form in their mind. Some examples of working memory measures include backward and sequencing digit span tasks (Wechsler, 2009), the Corsi Block Tapping Test (Corsi, 1972), the Self-Ordered Pointing task (Petrides & Milner, 1982), and n-back tasks (Jaeggi et al., 2010). Working memory has generally been found to be associated with the dorsolateral prefrontal cortex, ventrolateral prefrontal cortex, and lateral parietal cortices (Lemire-Rodger et al., 2019; Rottschy et al., 2012). In summary, working memory is considered a core executive function that allows us to hold and manipulate information in order to learn, consider possible alternative choices, and solve problems. The final core executive functioning component in Miyake and colleagues (2000) model is cognitive flexibility.

Cognitive flexibility, also known as set-shifting, refers to the ability to quickly and flexibly change perspectives, switch tasks or mental sets, and change how we think about a topic (Diamond, 2013; Miyake et al., 2000). Behaviors related to cognitive flexibility include the ability to take another person's perceptive, adapt to changes quickly, flexibly approach and complete tasks, and quickly switch between tasks (Diamond, 2013). As such, deficits in cognitive flexibility generally result in perseverative, nonadaptive behaviors such as concrete and rigid approaches to planning and problem-solving, difficulty in shifting to new stimuli or situations as they arise, and

difficulty in acknowledging alternative perspectives (Lezak et al., 2012). Measures of cognitive flexibility generally require individuals to shift between tasks or mental sets (e.g., switching between numbers and letters), or to adapt to changing rules. Some measures of cognitive flexibility include the Wisconsin Card Sorting Test (Berg, 1948), Trails B of the Trail Making Test (Reitan, 1958), and the Dimensional Change Card Sort (Zelazo, 2006). In regard to areas of the brain, cognitive flexibility has been associated with the dorsolateral prefrontal cortex, ventrolateral prefrontal cortex, inferior frontal junction, anterior cingulate cortex, anterior insula, and posterior parietal cortex (Dajani & Uddin, 2015; Kim et al., 2012; Niendam et al., 2012). Taken together, cognitive flexibility is a central component for being able to adapt to changes in one's environment, with impairments in cognitive flexibility often resulting in nonadaptive, perseverative approaches. Cognitive flexibility, working memory, and inhibition have been proposed to be the three core functions of executive functioning as identified by Miyake and colleagues' (2000) three-factor model.

Until relatively recently, the majority of the research on executive functioning was focused on the aforementioned abilities. However, some researchers have proposed that these executive functions, as they are currently operationalized and measured, do not fully account for affective and motivational components that are inherent to much of our daily lives (Bechara et al., 1994; Damasio, 1996; Zelazo & Muller, 2002). This movement is congruent with shifts toward dual process theories that generally propose distinct processing systems distinguished by automatic, effortless, and emotional processing (i.e., System 1, "hot" cognition) versus controlled, effortful, and emotionally-neutral processing (i.e., System 2, "cold" cognition; Gawronski & Creighton, 2013; Kahneman, 2003; Stanovich & West, 2000). While discrete categories have not been proposed for executive functioning, the influence of dual process theories is apparent as it has

been proposed that executive functioning falls along a continuum ranging from "cold" executive functions to "hot" executive functions (Zelazo & Muller, 2002; Zelazo et al., 2010). Cold executive functions are those that have been discussed thus far (i.e., inhibition, working memory, cognitive flexibility) and are considered in this model as purely cognitive abilities, whereas hot executive functions are those that account for and address the role of emotions and motivations.

Zelazo and Muller (2002) are largely credited with distinguishing between hot and cold executive functioning, although others (e.g., Bechara et al., 1994; Damasio, 1996) have also identified the role of affect in our higher-order cognitive abilities. Hot executive functions are proposed to be elicited in situations that have motivational or affective components, such as social situations and situations where rewards and other motivating factors are at stake (Zelazo & Muller, 2002). Specifically, delaying gratification and affective decision-making (e.g., decision-making about events that have emotional consequences such as experiencing a loss versus obtaining a reward), have been identified as components of hot executive functioning (Hongwanishku et al., 2005). As such, deficits in hot executive functioning include a tendency toward immediate gratification in lieu of long-term, more advantageous rewards, and poor affective decision-making resulting in more losses than gains. While hot executive functions have been associated with theory of mind (Kouklari et al., 2017) and emotional intelligence (Gutierrez-Cobo et al., 2016), it is important to note that these are generally considered to be separate, although closely-related, abilities (Yeh et al., 2017). In adults, hot executive functioning has been most frequently measured by the Iowa Gambling Task (IGT; Bechara et al., 1994), followed by delay discounting tasks (Richards et al., 1999) and delay of gratification tasks (Zelazo & Carlson, 2012). Often using fake money, these tasks require individuals to make a selection from several options that result in a combination of gains and losses. Some options are more advantageous as they result in greater

gains in the long-term, whereas others result in greater losses. Hot executive functioning has been primarily associated with the ventromedial prefrontal cortex and the orbitofrontal cortex (Guo et al., 2017; Happaney et al., 2004). These areas have a close association with the limbic system, which is involved in emotion and the evaluation of rewards (Rolls, 2015), likely accounting for the influence of affective and motivational components in hot executive functioning. Although hot and cold executive functions are proposed to occur on a hot-cold continuum rather than exist as discrete categories, it is still important to note the distinctions between the two.

Hot and cold executive functioning differ in regard to the situations that elicit them, the areas of the brain they are associated with, their developmental trajectories, and the specific disorders in which impairments are more commonly seen. Cold executive functioning is proposed to be elicited in abstract and non-affective situations, whereas hot executive functioning is proposed to be elicited in affective and highly motivational situations (Zelazo, 2020). This difference can also be seen in the tasks that are used to measure each type, as cold executive functioning measures (e.g., Stroop, WCST, digit span) are decontextualized and do not have an emotional component. This is in contrast to measures of hot executive functioning (e.g., IGT, delay discounting tasks) as they involve the consideration of rewards and losses. Furthermore, cold executive functioning is associated with more lateral parts of the prefrontal cortex, whereas hot executive functioning is associated with more orbital and medial regions of the prefrontal cortex (Tsermentseli & Poland, 2016; Zelazo & Muller, 2002), providing further evidence of their distinction. Developmental studies that have directly compared cold and hot executive functions have found that hot executive functions have a more delayed developmental trajectory compared to cold executive functions, as performance on hot executive functioning measures does not show substantial gains until mid- to late- adolescence whereas performance on cold executive

functioning tasks tend to develop earlier, with the largest improvements occurring around ages 10-11 (Hooper et al., 2004; Prencipe et al., 2011). Additionally, some studies have examined the profile of hot and cold executive functioning in specific disorders. Research has found that individuals with autism spectrum disorder tend to exhibit more notable deficits in hot executive functioning (Zimmerman et al., 2016), whereas individuals with attention-deficit/hyperactivity disorder (depending on the presentation type) tend to exhibit more deficits in cold executive functions (Skogli et al., 2014; Zelazo & Muller, 2002). In summary, while acknowledging that hot and cold executive functions are likely not discrete categories but rather fall along an executive functioning continuum (Nejati et al., 2018), previous research has generally found evidence of their distinctions which can have implications for addressing impairments. This is particularly relevant as there have been studies examining cold executive functioning impairment in individuals in the criminal justice system, but none that have yet examined both hot and cold executive functions.

Interventions in Executive Functioning

While there is no agreed upon gold-standard treatment for executive functioning deficits, a number of different interventions have been proposed to target cold executive functioning. These include Goal Management Training (Robertson, 1996; Levine et al., 2000), mindfulness interventions (Kabat-Zinn, 2003; Zeidan et al., 2010), and computerized cognitive training approaches. Goal Management Training is a standardized, metacognitive training program designed to assist individuals in developing an awareness of their executive functioning deficits and to teach them how to improve these deficits in order to reach their overarching goals through psychoeducation, mindfulness components, and homework assignments (Robertson, 1996; Levine et al., 2000). Goal Management Training was based on a theory that humans have a system of

sustained attention that allows us to keep overarching goals in mind, while inhibiting automatic and impulsive processes (Robertson & Garavan, 2000). When a person has executive functioning impairments, their automatic and impulsive processes tend to dominate, disrupting the sustained attentional system (Robertson & Garavan, 2000). Thus, Goal Management Training teaches individuals to recognize and monitor these automatic processes, interrupt them, and bring their goals back to the forefront (Levine et al., 2000). Goal management training has been applied in a variety of populations including older adults (Levine et al., 2007; van Hooren et al., 2007), TBI (Krasny-Pacini et al., 2014; Tornas et al., 2016), substance use (Alfonso et al., 2011), and schizophrenia (Levaux et al., 2012). A meta-analysis found that Goal Management Training appears to have positive effects in improving cold executive functioning deficits with small-to-medium effect sizes (0.14-0.34), that generally appear to have lasting effects (Stamenova & Levine, 2019). Although Goal Management Training includes mindfulness components, mindfulness interventions themselves have also been used to address executive functioning deficits.

Mindfulness interventions used to target executive functioning impairment range from more formal treatment programs such as Mindfulness-Based Cognitive Therapy (Segal et al., 2004) and Mindfulness-Based Stress Reduction (Kabat-Zinn, 2003) to more informal components that teach aspects of mindfulness and meditation (Zeidan et al., 2010). Since the use of mindfulness interventions in treating executive functioning impairment has been relatively recent, a systematic review examining the effectiveness of mindfulness interventions combined all studies examining the aforementioned types of mindfulness together (N =16; Gallant, 2016). This review found that mindfulness interventions appeared to improve deficits in inhibition, but not working memory or cognitive flexibility (Gallant, 2016). Specifically, there appeared to be some evidence

that mindfulness interventions have lasting effects (up to at least 5 months; Sahdra et al., 2011) and that more practice and time spent engaging in the mindfulness intervention appeared to result in greater improvements in inhibition (Moore & Malinowski, 2009; Teper & Inzlicht, 2013). While research on mindfulness interventions is still relatively recent, evidence thus far appears to support specific rather than global improvements in cold executive functioning. In addition to mindfulness interventions, computerized cognitive training programs have also been used to improve cold executive functioning.

Computerized cognitive training programs have been the most researched interventions for executive functioning. As the name implies, computerized cognitive training programs aim to improve cognitive functions through various training exercises administered through a computer or other device (Harvey et al., 2018). One subgroup of computerized cognitive training programs focuses on working memory, which include Cogmed (Roche & Johnson, 2014), Jungle Memory (Alloway & Alloway, 2008), and n-back training (Soveri et al., 2017). Cogmed is the most well-known of the working memory training programs and is purportedly based on Baddeley and Hitch's (1974) working memory model that contains the central executive, as well as the concept of neuroplasticity, which is the brain's ability to reorganize its structure and create new connections (Cheng et al., 2010). Cogmed includes daily training sessions in which users engage in computerized exercises, in addition to feedback on training and assistance with compliance by a certified coach (Roche & Johnson, 2014). While meta-analyses and systematic reviews provide evidence that Cogmed is generally effective in improving working memory and other related memory tasks (i.e., near transfer; Aksayli et al., 2019; Shinaver et al., 2014; Spencer-Smith & Klingberg, 2015), with some evidence of generalizability of training to attention (i.e., far-transfer; Shinaver et al., 2014; Spencer-Smith & Klingberg, 2015), a more recent meta-analysis found no

evidence of far-transfer to other cognitive skills (Aksayli et al., 2019). In summary, computerized cognitive training programs have received considerable research attention since their debut, and while they have been shown to be effective in improving the skill being trained (i.e., working memory), there is inconsistent evidence of transferability to skills beyond that.

While there have been several different types of interventions aimed at addressing cold executive functioning deficits, research on interventions for hot executive functioning deficits is lacking. There have not been any studies proposing possible interventions for hot executive functioning deficits and only one study has examined whether interventions for cold executive functioning deficits are also effective for improving hot executive functioning. In this study, researchers developed a training program for 5-year-old children that was intended to improve inhibition, cognitive flexibility, and working memory (Traverso et al., 2015). While they found that their training program effectively improved these specific cold executive functioning abilities, their results were mixed regarding improvements in hot executive functioning, suggesting that the training program did not consistently improve these abilities (Traverso et al., 2015). Considering that there are distinctions between hot and cold executive functioning, it is perhaps not surprising that such an intervention did not effectively transfer to hot executive functions. However, only one study thus far has examined the application of cold executive functioning interventions to hot executive functioning deficits, indicating a need for more research on possible interventions for hot executive functioning. This need for more research may be especially relevant for the current study should deficits in hot executive functioning be found in criminal justice populations.

Executive Functioning in Corrections

Behaviors associated with executive functioning impairment are commonly seen in the criminal justice population. Such behaviors include difficulty suppressing aggressive impulses,

misinterpreting social situations, making rash judgments (Lipsey et al., 2007; Meijers et al., 2015), and experiencing difficulties problem solving (Spenser et al., 2015). Additionally, individuals in the criminal justice system often struggle with updating their existing schemas to include and encapsulate new information (Herrero et al., 2010), exhibit difficulties taking others' perspectives, and have a tendency to perseverate in their responses, which may contribute to persistent engagement in antisocial behaviors (Meijers et al., 2015; Vila-Ballo et al., 2015). Given these observed behaviors, it would be expected that criminal justice populations would exhibit executive functioning impairments; however, this assumption has yet to be directly examined. Meta-analyses examining the relationship between executive functioning and antisocial behavior have found a robust relationship between poorer executive functioning and antisocial behaviors, as evidenced by medium effect sizes (e.g., Cohen's d = .44 - .62; Morgan & Lilienfeld, 2000; Ogilvie et al., 2011). Although these meta-analyses examined antisocial behaviors broadly, antisocial behavior is strongly linked to criminal justice involvement (Morgan & Lilienfeld, 2000; Ogilvie et al., 2011). Consequently, these meta-analyses, in addition to the behaviors commonly exhibited in offenders, suggest that criminal justice populations likely have executive functioning deficits.

Research examining executive functioning in criminal justice populations has only been conducted in other countries (i.e., Australia, Canada, Netherlands, Portugal, United Kingdom) and has focused solely on cold executive functions. However, these studies have generally found that criminal justice populations in various countries exhibit broad executive functioning deficits, including deficits in inhibition, cognitive flexibility, and working memory (Bergeron & Valliant, 2001; Meijers et al., 2015; Syngelaki et al., 2009), although there have been some studies indicating that impairment may only be exhibited for specific executive functions (Seruca & Silva, 2016; Adjorlolo & Egbenya, 2016). Some of this variation in executive functioning deficits may

be explained by differences between countries in regard to their laws, especially substance-related laws, and sentencing (Newcombe, 2004). On the other hand, the variation in executive functioning may also be attributed to heterogeneity within criminal justice populations.

One way in which the criminal justice population can be considered heterogenous is by the types of crimes offenders commit. Research examining differences between violent and non-violent offenders has generally found that violent offenders perform significantly worse than non-violent offenders on cold executive functioning measures (Hancock et al., 2010; Seruca & Silva, 2016); however, there is only partial agreement on the specific executive functions in which violent offenders show greater deficits. While research supports that violent offenders exhibit worse performance on tasks of inhibition (Hancock et al., 2010; Meijers et al., 2017), some studies have also reported worse performance on cognitive flexibility tasks (Hancock et al., 2010), whereas others have not (Hoaken et al., 2007; Meijers et al., 2017). Additionally, Broomhall (2005) examined executive functioning in subtypes of violent offenders: those who engaged in reactive violence (impulsive crimes that lacked planning) and those who engaged in instrumental violence (goal-oriented, premeditated crimes). In this study, Broomhall (2005) found that the reactive violence group performed significantly worse than both the instrumental violence group and the non-offender group on tasks of inhibition and cognitive flexibility, whereas the instrumental violence group generally did not differ significantly from non-offenders. One study compared offenders who committed different types of crime (i.e., violent crimes, property crimes, and drug trafficking crimes) to non-offenders and found that property offenders exhibited greater impairment in cognitive flexibility compared to non-offenders, and violent offenders exhibited greater impairment in planning abilities (Seruca & Silva, 2016). Unfortunately, this study only compared each category of offender to non-offenders and did not make direct comparisons

between the different categories of offenders. Comparing executive functioning profiles among each offense category to determine if certain categories of offenders exhibit worse performance on specific executive functions would be useful in identifying specific deficits that could be targeted in treatment. In summary, the few studies that have examined differences in executive functioning among subgroups of offenders indicate that violent offenders tend to exhibit more severe impairments compared to nonviolent offenders; however, no studies have yet explored for potential differences in executive functioning between offense types (e.g., property, drug, and public order offenses) beyond this.

It is possible these distinctions among offense types have yet to be examined as these studies were conducted in other countries where criminal justice populations are primarily composed of violent offenders (Australian Bureau of Statistics, 2019; Cuthbertson, 2017; Tonry & Bijleveld, 2007). While the U.S. criminal justice population also includes violent offenders, the U.S. has a much more diverse group of offenders in regard to proportions of offenses (e.g., drug, property, and public order offenses), with a significantly larger proportion of drug offenders than in other countries (Cuthbertson, 2017; Tonry & Bijleveld, 2007). Thus, even though research in other countries has found evidence of cold executive functioning impairments, it is not apparent whether these deficits will also be found in criminal justice populations in the U.S. Additionally, the research on executive functioning in criminal justice populations, even in other countries, has some significant limitations. For example, many studies examining cold executive functioning in offenders do not include comparison groups of non-offenders. This is evidenced by a meta-analysis on executive functioning in prison populations that consisted of only seven studies. It included such a low number because these were the only studies that included both offenders and non-offenders (Meijers et al., 2015). Another limitation in many of these studies is small sample

sizes (e.g., *n* = 15-40; Barbosa & Monteiro, 2008; Munro et al., 2007; Seruca & Silva, 2016). In summary, research is needed to investigate cold executive functioning in criminal justice populations in the U.S. and specifically to examine possible differences in cold executive functioning among category offenses. Another area in which there is a dearth in the literature is in regard to hot executive functioning in the criminal justice system.

There have not been any studies that have explicitly examined hot executive functioning in criminal justice populations. However, there have been a few studies examining performance on the Iowa Gambling Task (IGT), which is a commonly used measure of hot executive functioning, in criminal justice populations in the U.S. These studies found that offenders generally made disadvantageous choices in the IGT that resulted in lower long-term gains (Broomhall, 2005; Yechiam et al., 2008), indicating deficits in affective decision-making and delaying gratification, both of which are components of hot executive functioning. Additionally, there has been some evidence that violent offenders show greater impairments in affective decision-making than nonviolent offenders (Umbach et al., 2019), as indicated by their performance on the IGT, with a tendency toward focusing on immediate outcomes and inconsistent performance over time (Yechiam et al., 2008). While other categories of offenders have not yet been thoroughly examined, one study that examined drug offenders found that these individuals tended to make choices favoring higher potential gains rather than considering losses (Yechiam et al., 2008). These differences suggest categories of offenders (i.e., by offense type) may exhibit different profiles in affective decision-making impairments. Finally, recidivists have also been found to exhibit more impairments in affective decision-making compared to their non-recidivist offender counterparts (Beszterczey et al., 2013). In summary, individuals in the criminal justice system exhibit deficits in hot executive functioning, as measured by the IGT, and specifically violent

offenders and recidivists appear to exhibit the greatest impairments. While offenders appear to exhibit impairments in both hot executive functioning and cold executive functioning, as discussed in previous paragraphs, there have yet to be any studies that directly compare hot and cold executive functioning in criminal justice populations.

Current Study

To summarize the literature, individuals in the U.S. criminal justice system exhibit behaviors that are associated with executive functioning impairments. Additionally, conditions such as TBI and substance use disorders are highly prevalent within U.S. criminal justice populations, both of which are also associated with executive functioning deficits. While other countries have directly examined and found executive functioning deficits in their criminal justice populations, it is not clear whether these results will generalize to the criminal justice population in the U.S. due to meaningful demographic differences and incarceration rates. Furthermore, research on executive functioning in criminal justice populations has primarily looked at cold executive functions, yet the behaviors exhibited by these populations may be more accurately characterized by hot executive functioning deficits. Thus, there is a need to examine both hot and cold executive functioning in a U.S. criminal justice sample to assess for possible deficits that could be addressed through interventions. Considering the RNR model, it is important to identify the unique needs and risk factors of offenders to provide tailored interventions to improve rehabilitation efforts and reduce recidivism. Thus, it will be useful to identify if specific types of offenders, as categorized by their offense categories (i.e., violent, property, drug, public order), exhibit different profiles of hot and cold executive functioning deficits to determine if certain offenders may benefit from interventions targeting executive functioning more so than others. Research in other countries have begun to examine these differences as studies have found that

violent offenders tend to have greater deficits in cold executive functioning compared to nonviolent offenders; however, there has yet to be any studies examining a further breakdown of nonviolent offense categories (drug, property, public order) in regard to executive functioning.

The present study aims to fill in some of the gaps identified in the literature by examining hot and cold executive functioning in a community corrections sample in the U.S., as this is the largest population in the criminal justice system. This study will compare an offender population with a non-offender population on various measures of hot and cold executive functioning to determine if offenders exhibit deficits as evidenced by poorer performance on these measures compared to non-offenders. Additionally, this study will examine differences between offense categories to determine if different types of offenders exhibit different executive functioning profiles. Since substance use disorders and TBI are highly prevalent in criminal justice populations and both are associated with executive functioning deficits, this study will also assess whether hot and cold executive functioning deficits are associated with substance abuse severity, and whether they moderate the relationship between TBI and criminal justice involvement. Considering these aims of the current study, the hypotheses are as follows:

1. Considering criminal justice populations frequently exhibit behaviors associated with deficits in hot executive functioning, it is hypothesized that offenders will exhibit deficits in hot executive functioning, as indicated by poorer performance on the Iowa Gambling Task, compared to non-offenders, while controlling for relevant sociodemographic and psychological covariates.
2. Consistent with research conducted in other countries, it is expected that offenders will exhibit deficits in cold executive functioning, as evidenced by poorer performance on measures of inhibition (go-no go task), cognitive flexibility

(Wisconsin Card Sorting Task), and working memory (Corsi Block Tapping Test), compared to non-offenders, while controlling for relevant sociodemographic and psychological covariates.

3. Considering the nature of the crimes and the influence that affective and motivational aspects play in hot executive functioning, it is expected that violent offenders will exhibit greater deficits in hot executive functioning (i.e., Iowa Gambling Task) compared to drug, property, and public order offenders.
4. Congruent with previous research, it is expected violent offenders will exhibit greater impairments in cold executive functioning compared to drug, property, and public order offenders. We expect this group to show deficits in inhibition (go-no go task), cognitive flexibility (Wisconsin Card Sorting Task), and working memory (Corsi Block Tapping Test), compared to non-violent offenders. However, we expect the magnitude of difference to be larger for hot executive functioning than for cold executive functioning.
5. Based on both the TBI literature and symptom presentation, it is hypothesized that hot executive functioning impairment will be identified as a significant moderator between incidence of TBI and later criminal justice involvement.
6. Consistent with previous research, substance abuse (indicated by moderate and severe levels on the Alcohol, Smoking and Substance Involvement Screening Test) is expected to be associated with cold executive functioning deficits, as evidenced by poorer performance on measures of inhibition (go-no go task), cognitive flexibility (Wisconsin Card Sorting Task), and working memory (Corsi Block

Tapping Test), compared to nonsubstance abusers. These analyses will also control for relevant sociodemographic and psychological covariates.

In addition to these hypotheses, we plan to conduct several exploratory analyses. Specifically, we will compare hot and cold executive functioning in the overall offender group to determine if offenders generally exhibit worse impairments in one domain of executive functioning compared to the other as previous research has yet to make this comparison. We will also examine for potential differences in hot and cold executive functioning performances based on offense categories subsumed under nonviolent offenses (drug, property, and public order) as there has not been any previous research comparing executive functioning between these offense categories. Finally, we will examine the relationship between substance abuse and hot executive functioning as research thus far has been limited to cold executive functioning.

CHAPTER III

METHOD

Participants

Four hundred and ninety-three individuals completed this online study. Inclusionary criteria included being between the ages of 18-89 years old, residing in the United States, and being an English speaker. Exclusionary criteria included living outside of the United States (participants were excluded using a Mechanical Turk qualifier) and if participants responded to a question indicating that they were currently incarcerated in jail or prison. Out of the 493 individuals who completed the study, 19 individuals selected the option indicating they were currently in jail or prison, which automatically discontinued the remainder of the study, and they were removed from analysis. Another 52 individuals failed at least one validity check and were also removed. Thus, the final sample for this study was comprised of 422 participants. The sample was primarily male (*n* = 275; 65.2%) and the median age was 35.00 years (*SD* = 10.12 years). Participants self-identified as White/Non-Hispanic (*n* = 293; 69.4%), African-American/Black (*n* = 81; 19.2%); Hispanic/Latino (*n* = 27; 6.4%), Asian/Pacific Islander (15; 3.6%), bi-racial (*n* = 3; 0.7%), and American Indian, Native Alaskan, Aleutian, or Eskimo (*n* = 2, 0.5%). Participants were also primarily college graduates (*n* = 301; 71.3%), married (*n* = 340; 80.6%), and employed full-time (*n* = 372, 88.2%).

One-hundred forty-two individuals reported they had been arrested at least once, while 135 individuals of these individuals also reported they had been in jail or prison and/or involved in community corrections. Thus, while seven individuals reported having been arrested but were not otherwise involved in the criminal justice system, they were excluded from the criminal

justice group as they may not have been convicted. Thus, there were 135 individuals who fell within the criminal justice group and 287 in the comparison group.

Procedure

Participants were recruited through Mechanical Turk. Individuals who were interested could select to complete this study and were provided a link to complete this study on PsyToolkit, a website that allows for the use of surveys and interactive measures (Stoet, 2010, 2017). Participants were required to complete the study using a computer or laptop as the interactive measures required the use of a mouse or touchpad. PsyToolkit provides the option to exclude mobile phone and tablet users on their platform and this requirement of needing a computer/laptop was additionally listed in the informed consent form. All measures were administered online using PsyToolkit and took approximately 20-30 minutes to complete. Skip logic was used in several of the questionnaires to reduce administration time. The measures were implemented in the same order for all participants: the demographics form, Iowa Gambling Task, Go/No-Go task, Wisconsin Card Sorting Task, Corsi Block Tapping Test, Raven's Standard Progressive Matrices, HELPS Brain Injury Screening Tool, Short Dark Triad (psychopathy subscale only), Depression Anxiety Stress Scales-21 (depression and anxiety subscales only), and Alcohol, Smoking and Substance Involvement Screening Test. As aforementioned, there were several validity checks throughout the study. One of these validity checks was an embedded performance validity test within the Wisconsin Card Sorting Task that was used to assess whether participants were providing a valid performance within the interactive measures. Other validity checks assessed whether participants were adequately reading questions (e.g., please select "almost always" for this item). Participants were compensated $2.00 through Mechanical Turk in congruence with the platform's going rates for similar assessment lengths.

Measures

Demographics Form

The demographics form (see Appendix A) assessed for the participant's age, sex, race, education, marital status, and colorblindness (to rule out possible effects on WCST performance). It also assessed for previous criminal justice history including how often a person has been arrested, been in prison/jail, and been supervised in the community. Skip logic was used for the criminal history portion so that only participants who endorsed a history of criminal justice involvement received follow-up questions. Individuals who endorsed a criminal history were asked about the length of time in which they were in prison/jail and/or were supervised in the community. They were also asked to select which type of crime(s) they were convicted of (i.e., violent, property, drug, and/or public order), with examples of each category (e.g., murder, rape, assault for violent crime) listed beside it to aid in categorization. Endorsement of serving time in prison/jail and/or community corrections resulted in the categorization of that participant into the offender group.

Iowa Gambling Task

The Iowa Gambling Task (IGT; Bechara et al., 1994) measures decision-making abilities and has been considered to be a measure of hot executive functioning. This study followed Bechara and colleagues' (1994) original standardized procedure, with the exception that it was computerized and moved to an online platform. When conducted in person, participants are presented with four decks of cards labeled A, B, C, and D, which have been turned facedown. In this specific computerized version on PsyToolkit (Stoet, 2010, 2017), the four decks of cards were replaced with four buttons, similar to a slot machine button, that were still labeled A, B, C, and D. Participants were given a $2,000 loan of play money at the beginning of the task. They

were then instructed to select cards—or in this case, buttons—with the goal of trying to earn as much money as they can from the $2,000 loan. For all selections, participants won a predetermined amount of money based on the button they chose. However, during some instances in "pressing" the button, they had to pay a penalty in addition to earning money. These penalties were not constant and occurred at quasi-random intervals. Participants were provided information on their earnings and penalties (if any) after they made their selection and they could view their running total for the duration of the task. Buttons A and B always yielded $100 and buttons C and D always yielded $50; however, the higher-yielding buttons also had larger penalties ($250) compared to the lower-yielding buttons ($50). The button presses in which a penalty was incurred was preset in the simulation, with some button categories (e.g., A, B, C, D) having a higher frequency of penalties than others. Buttons A and B were "disadvantageous" choices because even though they present opportunities to earn higher rewards, the larger penalties incurred in these decks resulted in greater costs and subsequently less profit over time. Decks C and D were "advantageous" choices because they yielded an overall gain over time. Participants made 100 total selections in this task. Two common scores are typically used to assess poor decision-making, which include the overall net return and the frequency in which advantageous and disadvantageous decks are selected (Barry & Petry, 2007; Brown et al., 2012). These same scores were utilized within this study, with lower net return and higher frequency of disadvantageous decks indicating poorer decision-making abilities and hot executive functioning deficits.

Test-retest reliability for the IGT has been variable, ranging from 0.35 to 0.65 over two weeks (Xu et al., 2013). Part of this variability may be due to evidence that individuals with significant impairments on the IGT tend to have stable test-retest reliability over time, whereas

healthy controls tend to improve over time (Bechara et al., 1994). In regard to validity, poor performance on the IGT, as indicated by a higher frequency of selecting disadvantageous decks, has been associated with ventromedial prefrontal cortex lesions (Bechara et al., 1994), an area of the brain commonly associated with difficulties in risky decision-making (Bechara et al., 2000). Additionally, the IGT has been associated with the balloon analogue risk task, which is another measure of risk-taking behaviors (Lejuez et al., 2002). The IGT has demonstrated discriminant validity in that it has weak correlations with inhibition (.18), set-shifting (.15), and working memory (.06; Toplak et al., 2010), which is expected considering the differentiation between hot and cold executive functioning. This was also demonstrated within this study, as total net return and disadvantageous selections were weakly correlated with Go/No-Go commission errors (-0.80 – 0.88), perseverative errors on the WCST (-.175 - .173), Corsi Block forward span (-.163 - .148), and Corsi Block backward span (-.191 - .175). One area of contention in the literature regarding the IGT is what is known as the "prominent deck B phenomenon." Previous research (e.g., Lin et al., 2013) has criticized the IGT for this phenomenon as they found that even normal controls were selecting this particular "disadvantageous" deck. In the original IGT, deck B has a much less frequent, although significantly higher loss schedule (e.g., -$1250) resulting in some healthy controls selecting this deck frequently despite it resulting in a greater net loss than the "advantageous" decks. Regardless, this potential problem was eliminated in this variation of the IGT used for this study as both the A and B buttons were similar in their gains and losses.

Go/No-Go Task

The go/no-go task (Gomez et al., 2007) is a measure of response inhibition. Participants were presented with "go" stimuli that required them to respond as quickly as they can, as well as "no-go" stimuli that required individuals to inhibit their response and simply do nothing. In the

computerized variation from PsyToolkit (Stoet, 2010, 2017) that was used for this study, the "go" stimuli was a green oval that said "go" whereas the "no-go" stimuli was a red oval that said "no-go." Participants were instructed to press the space bar for go trials and refrain from pressing the space bar for no-go trials. Corrective feedback was provided if an individual either did not press the space bar when they should (on go trials) or pressed the space bar when they should not have (on no-go trials). There were 100 trials, 20 of which were no-go trials. Inhibition was measured by the frequency of commission errors (pressing the space bar when they should not have on no-go trials), with a higher number of commission errors indicating more difficulties with inhibition. The go/no-go task has shown adequate internal consistency (α = 0.87-0.89) and test-retest reliability (0.84) for commission errors (Wöstmann et al., 2013). The go/no-go task has also demonstrated good convergent validity as it has been correlated with other measures of inhibition, such as the stop-signal task (Zheng et al., 2008) and Stroop task (Langenecker et al., 2007).

Wisconsin Card Sorting Task

The Wisconsin Card Sorting Task (WCST; Berg, 1948; Heaton, 1981) is a measure of cognitive flexibility and abstract reasoning. The original task included 128 cards, although shorter forms (i.e., WCST-64 that uses 64 cards) are commonly used to reduce administration time. This study used a computerized version of the WCST from PsyToolkit (Stoet, 2010, 2017) that is very similar to the WCST-64, except that it only has 60 cards. The WCST requires individuals to sort their response cards to match one of four stimulus cards, each depicting different shapes (circles, triangles, crosses, or stars), colors (red, green, blue, or yellow), and a different number of figures (one, two, three, or four). In the computerized variation used in this study, the stimulus cards were as follows: one red circle, two green triangles, three blue crosses,

and four yellow stars. Participants were instructed to match their response card to one of the four stimulus cards based on either color, shape, or number. They were provided feedback on whether their choice was correct or incorrect, but participants were never told what the sorting "rule" is. Unbeknownst to the participants, the sorting rule changed (e.g., from color to number) every ten cards, requiring participants to make adjustments to their sorting strategy. The total administration time was approximately five to seven minutes. Cognitive flexibility was measured by the number of perseverative responses, which are failures to adapt to rule changes by continuing to apply an old rule despite feedback indicating that response was now incorrect. While all participants inevitably make some perseverations as they require feedback to know that the rule has been changed, individuals who struggle with cognitive flexibility tend to make more perseverative responses. The short form of the WCST has been found to be strongly correlated (0.70-0.91) with the original WCST (Robinson et al., 1991). Additionally, the WCST has shown adequate split-half reliability (r_{SB} = 0.90-0.95; Kopp et al., 2021) and test-retest reliability (0.60 for nonperseverative errors to 0.85 for total number of errors; Kongs et al., 2000). Factor analyses have consistently found set shifting to be one of the key factors in the WCST (Greve et al., 2005; Miyake et al., 2000), providing evidence for its construct validity.

In addition to measuring perseverations, the WCST also yields a measure of failure to maintain set, which is the number of trials in which a participant fails to continue to adhere to the rule (also known as completing the category) after five consecutive correct matches (Rickards et al., 2017). For example, if an individual correctly matches their cards based on shape for five consecutive times, and then they switch to matching their next card based on color without receiving corrective feedback, this is considered a failure to maintain set. Failure to maintain set has been examined as an embedded performance validity test, with a cutoff of $\geq$3 yielding

approximately 30% sensitivity while maintaining adequate specificity (≥90%; Bernard et al., 1996; King et al., 2002). Although previous studies have largely examined the use of this embedded validity measure in TBI populations, this cutoff for failure to maintain set was also used in this study to serve as a validity check.

Corsi Block Tapping Test

The Corsi Block Tapping Test (Corsi, 1972) is a nonverbal measure of working memory. The original Corsi Block Tapping Test uses a stimulus board that has nine cubes attached to the board in a random fashion. In administering the task, the examiner points to a sequence of several blocks. The participant is then asked to point to the same blocks in the same order. The span of the number of blocks in a sequence continues to increase until the participant successfully completes a span of nine blocks or until they fail on two consecutive trials of the same block span. In the computerized version from PsyToolkit (Stoet, 2010, 2017) that was used for this study, there were nine purple squares that were randomly placed on a black background. The participant was instructed that some of these squares will "light up" (turn yellow) in a sequence. Once the sequence was complete, they heard an audio stating "go" and they needed to use their mouse to select the sequence in the same order that they were presented with. The sequence of blocks started at two and increased by one with each correct response. However, if a person failed to select the correct sequence, they were administered another trial of the same block span. If they failed both trials of the same sequence span, the task was discontinued and their highest correct block span was noted. Participants were also administered the backward Corsi Block Tapping Test (Isaacs & Vargha-Khadem, 1989) in which they were presented with the same stimuli squares and presented with a block sequence; however, during these trials, they were instructed to select the blocks in the reverse order that they were shown. The same

discontinuation rules and sequencing advancements used in the forward task were also applied to the backward task. In the computerized version used for this study, participants received feedback on whether their response was correct (denoted by a green smiley face) or incorrect (denoted by a red sad face). They were also informed of their highest block span at the end of the task. To assess for participants' overall working memory abilities, their highest correct span for both forward and backward will be added together, with 18 being the maximum score. Higher scores are indicative of better working memory abilities. Internal reliability has been shown to be adequate for both the forward block span (α = 0.75-0.86) and the backward block span (α = 0.78; de Paula et al., 2016), and test-retest reliability has also been shown to be adequate (0.75-0.85; Saggino et al., 2004). The Corsi Block Tapping Test has been found to be moderately correlated (0.40-0.47) with the forward and backward components of digit span (Saggino et al., 2004).

Raven's Standard Progressive Matrices – Short Form

Raven's Standard Progressive Matrices – Short Form (RSPM-SF; Bilker et al., 2012) is an abbreviated 9-item measure adapted from the 60-item Raven's Standard Progressive Matrices (RSPM; Raven, 1938) that is designed as a nonverbal measure of estimated intelligence (see Appendix B). Participants were shown a matrix-like puzzle with one part of it missing. They were then asked to choose the image, from six to eight options, that they think best fit within the pattern to complete the puzzle. The total number of correct responses were calculated, with a higher total score indicating higher estimated intelligence. The short-form is highly correlated with the original 60-item test (0.98) and internal consistency (α = 0.80) and test-retest reliability (>.80) remains high (Bilker et al., 2012; Strauss et al., 2006). Cronbach's alpha for this sample was similar to previous studies (α = 0.76). Although convergent validity has not been

specifically examined with the short-form, the original RSPM has been found to be moderately correlated (0.5-0.7) with other measures of general intelligence such as the Wechsler scales, Stanford-Binet scales, and the North American Reading Test (Strauss et al., 2006).

HELPS Brain Injury Screening Tool

The HELPS brain injury screening tool (Picard et al., 1991) screens for possible TBI by assessing five domains outlined by each letter of the acronym "HELPS": (H) **H**ead injury; (E) been to the **E**mergency room, hospital or a doctor due to a head injury; (L) **L**ost consciousness or was dazed and confused due to a head injury; (P) experience **P**roblems in daily life due to a head injury; (S) experience significant **S**ickness that could result in a brain injury (see Appendix C). Individuals responded either "yes" or "no" to each question. If an individual endorsed experiencing problems in their daily life following a head injury, they were asked to select specific problems (e.g., headaches, difficulty concentrating, depression, poor judgment) they have experienced from a checklist of commonly experienced TBI symptoms. In accordance with the scoring procedures, an individual was considered to have a history of a possible TBI if they endorsed the following: 1) an event that could have caused a brain injury (e.g., reported head injury, sickness); 2) an indication that the brain injury was severe (e.g., if they report a change in consciousness or had medical attention after the injury); and 3) endorsement of at least two chronic problems from the checklist provided. While reliability and validity of this measure have not been conducted thus far, the HELPS brain injury screening tool has been commonly used in a number of research studies (e.g., Hux et al., 2009; Jackson et al., 2002; Zieman et al., 2017) to screen for possible TBI and the criteria included in the HELPS is similar to criteria used in diagnosing traumatic brain injury (American Psychiatric Association, 2013; Menon et al., 2010).

Short Dark Triad

The Short Dark Triad (SD3; Jones & Paulhus, 2013) is a 27-item, self-report measure designed to measure three "dark" or socially aversive patterns of behaviors and values: Narcissism, Machiavellianism, and Psychopathy (see Appendix D). Each domain has its own subscale consisting of nine items. For this study, only the Psychopathy subscale was used. Responses were scored on a five-point Likert scale anchored at "Strongly Disagree" to "Strongly Agree." The score for the Psychopathy subscale was calculated according to the scoring procedures outlined in the SD3, with a higher averaged score indicating the presence of more psychopathy-related traits. Sample items from the Psychopathy subscale include "I like to get revenge on authorities" and "I'll say anything to get what I want." The Psychopathy subscale has been shown to have adequate internal reliability ($\alpha = 0.77$; Jones & Paulhus, 2013) and test-retest reliability (0.73; Malesza et al., 2019). It also demonstrates good convergent validity as it is highly correlated (0.78) with the Self-Report Psychopathy Scale (Jones & Paulhus, 2013). The subscale also showed adequate internal consistency for this study's sample ($\alpha = 0.82$).

Depression Anxiety Stress Scales-21

The Depression Anxiety Stress Scales-21 (DASS-21; Lovibond & Lovibond, 1995), is a 21-item questionnaire adapted from the original 42-item DASS (Lovibond & Lovibond, 1995) designed to measure depression, anxiety, and stress (see Appendix E). Each of these three domains (Depression, Anxiety, Stress) consists of seven items. For the purpose of this study, only the Depression and Anxiety subscales were used. The DASS-21 uses a four-point scale, ranging from "Did not apply to me at all" to "Applied to me very much or most of the time." Scores were calculated for each subscale according to the scoring procedures noted in the DASS-21, with higher scores indicating higher severity. Sample items include, "I feel down-hearted and

blue" (Depression), and "I felt I was close to panic" (Anxiety). Internal consistency has been shown to be good for both the Depression (α = .85) and Anxiety (α = .81) subscales (Osman et al., 2012). This was also the case for this sample for both the Depression (α = .90) and Anxiety (α = .91) subscales. Test-retest reliability is adequate for anxiety (0.64-0.80) and depression (0.75-0.86; Bottesi et al., 2015; da Silva et al., 2016). The DASS-21 has also shown good convergent validity as the Anxiety subscale is highly correlated (0.81) with the Beck Anxiety Inventory and the Depression subscale is highly correlated (0.74) with the Beck Depression Inventory (Lovibond & Lovibond, 1995).

The Alcohol, Smoking and Substance Involvement Screening Test

The Alcohol, Smoking and Substance Involvement Screening Test (ASSIST, version 3.0; World Health Organization, 2010) is a brief questionnaire designed to screen for lifetime and recent substance use (see Appendix F). The ASSIST consists of eight questions that screens for the following substances: tobacco products, alcohol, cannabis, cocaine, amphetamine-type stimulants, inhalants, sedatives/sleeping pills, hallucinogens, opiates, and 'other' drugs. It assesses whether individuals have ever used any of these drugs and then follows up with additional questions if the participant endorses the use of any substances. If a participant endorses recent use (in the past three months), they are asked about their frequency of use, how often they experience desires or urges to use, the frequency in which substance use has led to health, social, legal, or financial problems, and how often substance use has affected their ability to do what was normally expected of them. Regardless of recent use, if participants endorse lifetime use, they are asked if anyone has ever expressed concern about their substance use, ever tried and failed to control, cut down, or stop using the substance(s), and whether they have ever used drugs by injection. Scores were calculated across all questions in accordance with the

scoring procedures outlined in the ASSIST, with higher scores indicating more severe use and a higher risk of associated problems. Although the ASSIST is generally administered in an interview format, this study adapted the ASSIST to be used as an online survey format using skip logic in accordance with the instructions provided in the interview format (i.e., "if 'no' to all items, stop interview" will result in skipping the remainder of the survey questions). The ASSIST's internal consistency ranges from acceptable (α = 0.77 for hallucinogens) to good (α = 0.94 for amphetamine-type stimulants; Humeniuk et al., 2008). Cronbach's alpha for this sample ranged from 0.90 (alcohol) to 0.95 (cocaine, inhalants, hallucinogens, other substances). Test-retest reliability over a span of one to four weeks has been shown to be high (0.90-0.97; Humeniuk & Ali, 2006; McNeely et al., 2014). The ASSIST has also demonstrated good concurrent validity as it his highly correlated with the Addition Severity Index (0.76-0.88) and the Alcohol Use Disorders Identification Test (0.82; Humeniuk et al., 2008).

Analyses

Missing data. In examining the data from the interactive measures, there was only one participant who did not complete one of the measures (i.e., IGT) and this person was excluded from analyses that included the IGT. Regarding the questionnaires, missing data were accounted for before measure scales were calculated. Missing data for each measure was examined using missing value analysis to determine the pattern of missing data. When taken together, there was no individual variable item that had more than 5% of the data missing. Upon further inspection, as well as with conducting Little's MCAR test, data were determined to be missing completely at random (χ^2 = 17.28, DF = 15, p = .302). Little's MCAR test was also run for each individual measure. See Table 2 for more detailed information regarding missing data.

TABLE 2

SUMMARY OF MISSSING AND AVAILABLE CASES

Measure	Number of Missing Cases	Number of Cases with Too Few Items to Estimate Missing	Total Number of Cases Available for Analysis	Little's MCAR significance test
SD3: Psychopathy	58	1	421	.780
Raven's Matrices	13	0	422	.244
DASS-21: Depression	19	0	422	.302
DASS-21: Anxiety	13	0	422	.297
ASSIST: Alcohol	21	0	422	.340
ASSIST: Cannabis	35	0	422	.815
ASSIST: Cocaine	30	1	421	.240
ASSIST: Amphetamine	24	1	421	.854
ASSIST: Inhalants	30	1	421	.043
ASSIST: Sedatives	27	0	422	.058
ASSIST: Hallucinogens	20	0	422	.246
ASSIST: Opioids	24	2	420	.656
ASSIST: Other	34	6	416	.996

Note: SD3 = Short Dark Triad, DASS-21 = Depression Anxiety Stress Scales-21, ASSIST = Alcohol, Smoking and Substance Involvement Screening Test

The Psychopathic subscale of the Short Dark Triad had the largest number of missing data, with 58 participants not responding to at least one item on the scale. The data were determined to be missing at random. The SD3 psychopathy scale is calculated by summing items. Item scores were calculated for missing items if the participant responded to at least 60% of the items (6 of 9) by calculating the mean of the available items for each participant and entering the mean as the value for the missing item. Of the 58 participants with at least one missing item, only one case had less than 60% of the items completed and this case was excluded from analysis.

For Raven's Matrices, a total score is calculated by summing the total items correct. There were 13 participants who did not respond to one item (i.e., responded to 8 of 9 items). The data were also determined to be missing completely at random. The mean of the available items for each participant were calculated and entered as the value for the missing item.

The DASS-21 included both a depression subscale and an anxiety subscale. Taken together, there were a total of 31 participants who did not respond to at least one item. On the anxiety subscale, there were 13 participants who did not answer one item on the subscale (i.e., responded to 6 of 7 items). On the depression subscale, there were 19 participants who did not respond to at least one item, and all of which responded to at least 70% of the items (i.e., 5 of 7 items). The data were determined to be missing completely at random both when taken together and when examined separately. A total score was calculated for each subscale by summing all of the items for each subscale and multiplying the sum by two, in accordance with scoring procedures outlined by this measure's authors. The mean of the available items for each participant for the subscale in which an item was missing was calculated and entered as the value for the missing item.

On the ASSIST, the subscales for each substance are calculated by summing items for each respective substance. Item scores were calculated for missing items if the participant responded to at least 60% of the items (4 of 6 items) by calculating the mean of the available items for each participant. There were 21 participants who did not respond to at least one item on the alcohol subscale; however, all participants responded to at least 60% of the items. For the cannabis subscale, there were 35 participants who did not respond to at least one item, and all responded to at least 60% of the items. For the cocaine subscale, there were 30 participants who did not respond to at least one item. There was one participant who did not respond to at least 60% of the items and this case was excluded from analysis. On the amphetamine subscale, there were 24 participants with at least one item missing and one of these participants was excluded from analysis due to much missing data (over 40%). There were 30 participants who did not respond to at least one item included on the inhalants subscale. On Little's MCAR test, the

inhalants subscale fell just under the significance range (p = .043); however, under closer examination, these items still appeared to be missing at random as individuals who had missing data were not more likely to be associated with a criminal justice history (p = .953), nor any other relevant variables (p = .083 - .961). One participant was missing too much data and this case was excluded from analysis. On the sedatives subscale, there were 27 participants who were missing at least one item but all responded to at least 60% of the items. There were 20 participants who were missing at least one item on the hallucinogens subscale with none missing more than 40%. On the opioids subscale, there were 24 participants who did not respond to at least one item and two participants were excluded from analyses due to missing too much data. Lastly, on the 'other' substances subscale, there were 34 participants who had missing data and there were 6 participants who were missing more than 40% of the data and thus were excluded from analyses.

On the HELPS measure, only one participant did not respond to the initial question (e.g., have you ever hit your head or been hit on the head), and the remainder of the questions were not answered. Thus, this participant was excluded from analysis. Regarding demographic information, there were three participants who did provide their age, one participant who did not provide their race, two participants who did not provide their educational attainment, and three participants who did provide their employment status. Given the small numbers of missing data, these individuals were excluded from analyses that included these variables.

Although the data were not missing, the results of the Corsi Block tests had a significant number of participants who had a span of zero on Corsi Forward (n = 194, 46%) and Corsi Backward (n = 187, 44.3%). This is unlikely to represent their actual working memory abilities given that the average span for healthy individuals is around 5-6 (Kessels et al., 2000; Kessels et

al., 2008). In comparing average reaction time to assess whether participants who had a span of zero differed in their approach to the task compared to participants who had a span of at least two, the average reaction times for both Corsi Forward (p = .970) and Corsi Backward (p = .505) were not significantly different between the two groups. In comparing individuals who had a span of zero to those who had a minimum span of two, the two groups were not significantly different in regard to age (p = .194 - .094) or education (p = .046 - .509). There was a significant difference regarding criminal justice history (χ^2 = 15.73; p = <.001) as a greater proportion of individuals with a criminal justice history had a span of zero on Corsi Forward (n = 81, 60%) compared to individuals who had no criminal justice history (n = 113, p = 39.4%). This was also the case for Corsi Backward (χ^2 = 14.58, p = <.001), as 57.8% (n = 78) of individuals with a criminal justice history had a span of zero, compared to 38.0% (n = 109) of individuals without a criminal justice history. Those who had a span of zero also differed significantly from those who had a minimum span of two in other areas that aligned with the observed differences between the criminal justice group and the comparison group. This included significant differences in total net return on the Iowa Gambling task (p = .003 - .005), Go/No-Go commission errors (p = <.001), perseverative errors on the WCST (p = <.001), psychopathy scale (p = <.001), depressive symptoms (p = <.001), anxiety symptoms (p = <.001), overall intelligence (p = <.001), probable TBI (p = <.001), alcohol use (p = <.001), and substance use (p = <.001). Thus, those who had a minimum span of zero on the Corsi Block test were more likely to have a criminal justice history, have a lower net return on the IGT, higher rate of commission errors, more perseverative errors on the WCST, more psychopathic traits, more depressive and anxiety symptoms, lower overall intelligence, more likely to have a TBI, and higher rates of alcohol and substance use.

Given these differences and the high number of individuals with a span of zero, two variables were calculated. One variable was the total span for both Corsi Forward and Corsi Backward that included all participants, even the ones that had a span of zero. It was understood that this variable included factor(s) beyond an assessment of working memory ability, and thus interpretation was significantly limited. A second variable that calculated the total span for both Corsi Forward and Corsi Backward including only participants who had at least a span of two on both the forward and backward components (thus having a minimum total span of four) was also created to reflect a more accurate representation of working memory abilities. However, this included a significantly lower number of participants (n = 179) and thus was not able to be included in all analyses (e.g., logistic regression). Both variables were examined in univariate analyses, with more confidence if the statistical outcome for both variables was consistent (e.g., both found to be statistically significant). If they were inconsistent, more weight was placed on the latter variable.

Preliminary analyses. Several categorical variables (i.e., race, education, employment status) needed to be collapsed into dichotomous variables in order to be included in the proposed logistic regressions. Thus, race was dichotomized into White (69.4%) and non-White (30.3%) individuals, education was dichotomized into college graduate (71.3%) and other than college graduate (28.2%), and employment status was dichotomized into employed full-time (88.2%) and not employed full-time (11.1%).

Due to high levels of multicollinearity (correlations ranging between .806 - .937), a composite of all substances (i.e., cannabis, cocaine, amphetamine-type stimulants, inhalants, sedatives/sleeping pills, hallucinogens, opiates, and ‘other’ drugs), excluding alcohol and tobacco, was created for the purpose of analyses. Similarly, the depression and anxiety subscales

of the DASS-21 were highly correlated with each other (r = .859) and a composite variable (i.e., psychiatric symptoms) was created. Lastly, the IGT total net return and frequency of disadvantageous decks were also highly correlated (r = -.935), and thus only the IGT total net return was used as the measure of hot executive functioning.

Preliminary analyses revealed that the majority of the variables used in analyses were not normally distributed, with only the IGT total net return and the two Corsi Block variables being broadly normally distributed. There were four outliers (beyond three standard deviations of the mean) for age and these four outliers were Windsorized, meaning that they were recoded to the highest acceptable response (i.e., age 68). No other outliers were identified.

Given that one of the categories on the WCST is based on color, participants were asked if they were colorblind on the demographics from so that any possible effects of colorblindness on WCST performance could be assessed. There were 32 participants (7.6% of the sample) who reported colorblindness. Individuals with colorblindness were compared to those without on all measures of the WCST, including variables that were not used for this study (i.e., cards correct, total errors, nonperseverative errors, average reaction time), to assess for any potential differences in performance. Given the non-normality of the variables, Mann-Whitney U analyses were used to examine group differences. There were no significant differences between the two groups on the number of cards correct (p =. 059), total number of errors (p = .059), nonperserverative errors (p = .133), perseverative errors (p = .075), average reaction time (p = .610), or failure to maintain set (p = .758). Since there were no differences between individuals with and without colorblindness on their WCST performance, all participants were included in the WCST analyses.

Analytic strategy. Hypotheses 1 and 2 essentially asked different versions of the same question. They both aimed to identify the relationship between executive functioning deficits and criminal justice involvement while controlling for relevant covariates. The only difference was that hypothesis 1 examined hot executive functioning deficits while hypothesis 2 addressed cold executive functioning deficits. As a result, the same analytical strategies were employed to test both hypotheses. First, relevant sociodemographic characteristics (i.e., age, race, gender, employment status, and education), psychological comorbidities (i.e., depression, anxiety, and antisocial characteristics), and hypothesized variables of interest (i.e., corresponding hot and cold executive functioning measures) were assessed for initial univariate differences between offenders and non-offenders. As the majority of the continuous variables were not normally distributed, Mann-Whitney U analyses were employed to assess for group differences. T-test comparisons were used for the three variables that were normally distributed (IGT total net return and the two Corsi Block variables). Chi-square analyses were used to examine categorical differences. A Bonferroni correction was employed to control for type one error. Variables that were statistically significant between the offender and non-offender groups were loaded into multivariate logistic regressions predicting criminal justice involvement. To test hypothesis 1, a logistic regression including the measure of hot executive functioning (i.e., IGT total net return) was included as a predictor along with other identified relevant predictor variables. To test hypothesis 2, the same approach was taken with the exception of including cold executive functioning measures as predictors instead of the measure of hot executive functioning. It should be noted that only two measures of cold executive functioning (i.e., WCST perseverative errors and Go/No-Go commission errors) were used as predictors along with other identified relevant predictor variables. The third measure of cold executive functioning, total Corsi Block span, was

not included in the regression as using the Corsi total span with only participants who had a minimum span of 2 significantly reduced the sample (n = 34 for offender group, n = 143 for nonoffender group) to a level not acceptable for a logistic regression with the number of predictors included.

Hypotheses 3 and 4 also asked very similar questions and thus employed similar analytic strategies. Hypotheses 3 and 4 posed questions that placed the executive functioning capacities of violent and non-violent offenders in contrast to each other. Participants who endorsed that they committed a violent crime, regardless of whether they also committed other crimes, were placed into the violent crime group. Individuals who completed any other crime(s) (i.e., property crimes, drug crimes, and public order crimes) besides a violent crime were placed into the nonviolent crime group. One individual who was categorized into the criminal justice group (n = 135) did not select any specific crimes, so this individual was excluded from these analyses and thus there were a total of 134 individuals who reported on specific crimes. Of these, 66 individuals committed violent crimes and 68 individuals who committed nonviolent crimes. Similar to hypotheses 1 and 2, Mann-Whitney U analyses and t-tests were employed to assess for group differences on continuous variables and Chi-square analyses were used to examine categorical differences. A Bonferroni correction was employed to control for type one error. Part of hypothesis 4 postulated that violent offenders would have greater impairments in hot executive functioning than cold executive functioning. Effect sizes for each domain of executive functioning were compared to address this part of hypothesis 4. An exploratory analysis assessing for potential differences in hot and cold executive functioning between offenders who commit specific nonviolent offenses (i.e., drug, property, and public order) was conducted by

using one-way ANOVAs and Kruskal-Wallis tests. A Bonferroni correction was also used for these analyses to control for familywise error.

To test hypothesis 5, a moderation analysis using regression was used to examine the moderating effects of hot executive functioning deficits on the relationship between TBI and criminal justice involvement. Bootstrapping procedures were employed with 5000 random bootstrap samples with the PROCESS version 4.0 macro (Hayes, 2022). A 95% bootstrap confidence interval was calculated for the moderation analysis. As is typical of regression techniques, statistical significance is indicated when the confidence intervals do not include zero.

Hypothesis 6 assessed for the relationship between substance abuse and cold executive functioning while controlling for relevant sociodemographic and psychological covariates. To do this, participants were categorized into three groups—low, medium, and high levels of risk of alcohol and substance abuse—using the scoring guidelines outlined in the ASSIST. For alcohol, those with a total score of 0-10 were categorized into the low risk group, a score of 11-26 is considered moderate risk, and a score of 27+ is considered high risk. For substance use, scores of 0-3 are considered low risk, 4-26 are considered moderate risk, and 27+ is considered high risk. As before, given that the majority of the continuous variables were not normally distributed, Kruskal-Wallis analyses were employed to assess for univariate group differences. One-way ANOVAs were used for the three variables that were normally distributed (IGT Total Net Return and the two Corsi Block variables) and chi-square analyses were used to examine categorical differences. A Bonferroni correction was used to control for familywise error. To test this final hypothesis, cold executive functioning measures were loaded into two separate multinomial logistic regressions, along with other relevant variables that were found to be statistically significant at the univariate level, to predict severity (i.e., low, moderate, high) of alcohol use

and substance use, respectively. The relationship between hot executive functioning and alcohol/substance abuse was also examined as an exploratory analysis by including the measure of hot executive functioning as a predictor into each multinomial logistic regression alongside the cold executive functioning measures and other identified relevant variables.

CHAPTER IV

RESULTS

Hypotheses 1 and 2: Executive Functioning and Criminal Justice Involvement

To test the first two hypotheses—that offenders will exhibit deficits in hot and cold executive functioning compared to non-offenders while controlling for relevant covariates—relevant sociodemographic characteristics (i.e., age, race, gender, employment status, and education), psychological comorbidities (i.e., depression/anxiety, antisocial characteristics, and history of TBI), and the hypothesized variables of interest (i.e., corresponding hot and cold executive functioning measures) were assessed for initial differences between offenders and non-offenders. The descriptive statistics and comparisons between both groups can be seen in Table 3. The offender group did not differ from the non-offender group on gender ($p = .321$), age ($p = .119$), education ($p = .538$), or employment status ($p = .241$). They were significantly different with regard to race ($p < .001$), with the criminal justice group having a larger proportion of non-White individuals (40.7%) than the non-criminal justice group (25.8%). The offender group also had a higher proportion ($p < .001$) of probable TBIs (47%) compared the non-offender group (8.4%). The offender group had lower overall intelligence ($p < .001$), higher levels of psychiatric symptoms ($p < .001$), increased alcohol abuse ($p < .001$), increased substance abuse ($p < .001$), and higher levels of psychopathic traits ($p < .001$). While the purpose of these analyses was to determine eligibility for the multivariate follow-ups, it may be worth noting that these results would have remained statistically significant even with the employment of a Bonferroni correction to control for familywise error.

TABLE 3

SAMPLE CHARACTERISTICS AND UNIVARIATE COMPARISONS BETWEEN OFFENDERS AND NON-OFFENDERS

	Offenders		Non-Offenders		*p* value	Effect size[a]
	N	Mean/Md (*SD*) or %	N	Mean/Md (*SD*) or %		
Gender					.321	0.05
Males	93	68.9%	182	63.4%		
Female	42	31.1%	105	36.6%		
Race					**<.001**	**0.25 (medium)**
White/Non-Hispanic	80	59.3%	213	74.5%		
Non-White	55	40.7%	73	25.5%		
Education					.538	0.07
College Graduate	92	69.2%	209	72.8%		
Other than College Graduate	41	30.8%	78	27.2%		
Employment Status					.241	0.07
Full-Time	123	91.8%	249	87.4%		
Other than Full-Time	11	8.2%	36	12.6%		
HELPS TBI					**<.001**	**0.45 (large)**
No TBI	71	53%	263	91.6%		
Probable TBI	63	47%	24	8.4%		
Age	134	35.00 (9.10)	285	35.00 (10.65)	.119	0.08
Raven's Matrices	**135**	**3.00 (2.00)**	**287**	**4.00 (2.52)**	**<.001**	**0.20 (small)**
SD3: Psychopathy	**134**	**31.75 (4.71)**	**287**	**27.00 (7.65)**	**<.001**	**0.35 (medium)**
DASS-21: Depression/Anxiety	**135**	**27.00 (8.20)**	**287**	**20.17 (12.00)**	**<.001**	**0.31 (medium)**
ASSIST: Alcohol	**135**	**28.00 (8.54)**	**287**	**20.00 (13.28)**	**<.001**	**0.30 (medium)**
ASSSIT: Substances	**135**	**26.88 (10.85)**	**287**	**0.50 (11.82)**	**<.001**	**0.52 (large)**
IGT Net Return	134	1638.81 (1146.97)	287	1877.87 (1219.37)	.057	0.20 (small)
Go/No-Go Commission Errors	**135**	**6.00 (5.84)**	**287**	**3.00 (4.74)**	**<.001**	**0.23 (small)**
WCST Perseverative Errors	**135**	**13.00 (5.13)**	**287**	**12.00 (4.91)**	**.002**	**0.15 (small)**
Corsi Block Total Span (All Participants)[b]	**135**	**3.64 (4.20)**	**287**	**6.00 (4.70)**	**<.001**	**0.52 (medium)**
Corsi Block Total Span (Minimum of four span)[c]	35	10.08 (2.23)	144	9.80 (2.22)	.503	0.13

Note: HELPS = HELPS brain injury screening tool, TBI = traumatic brain injury, SD3 = Short Dark Triad, DASS-21 = Depression Anxiety Stress Scales-21, ASSIST = Alcohol, Smoking and Substance Involvement Screening Test, IGT = Iowa Gambling Task, WCST = Wisconsin Card Sorting Test.

[a]Effect sizes were calculated for each variable. Cohen's d was used for the IGT total net return and Corsi Block variables. Cohen's (1988) criteria was used for all other variables. Descriptors of the strength of the effect size are included in parentheses for ease of comparison.

[b]This Corsi Block variable includes all participants, including ones who had a span of zero

[c]This Corsi Block variable includes only those participants who had at least a span of two on both Corsi Forward and Corsi Backward trials for a total minimum span of four

Hypothesis 1 proposed that the criminal justice group would exhibit deficits in hot executive functioning compared to the comparison group. Upon analysis, the two groups were not significantly different in regard to their total IGT net return, although this was approaching significance ($p = .057$). Including variables that are above the traditional p-value level of 0.05 (with some recommendations to consider variables that show significance even as high as $p \leq 0.25$) is common in logistic regression given that univariate comparisons can exclude variables that are known to be important (Bursac et al., 2008; Hosmer et al., 2013; Stoltzfus, 2011). Thus, total IGT net return was still included in a logistic regression as a predictor variable, in addition to other relevant variables that were identified as statistically significant in univariate comparisons concerning criminal justice involvement, to rule out any unique contributions from the hot executive functioning measure. A logistic regression that contained eight predictor variables (IGT total net return, TBI, Raven's Matrices, Psychopathy subscale, psychiatric symptom composite, alcohol use, substance use, and race) was employed. The full model containing all predictor variables was statistically significant, χ^2 (8, N = 418) = 151.72, $p < .001$, indicating that the model was able to distinguish between participants who reported a criminal justice history and those who did not. The model as a whole explained between 30.4% (Cox and Snell R square) and 42.7% (Nagelkerke R square) of the variance in criminal justice history, and correctly identified 80.9% of cases. Table 4 shows the contributions of each predictor variable to the model. There were three variables that made a unique statistically significant contribution to the model, including history of TBI ($p < .001$), substance use ($p < .001$), and psychopathic traits ($p = .020$). The measure of hot executive functioning, total IGT net return, was not found to have a statistical contribution to the model.

TABLE 4

CHARACTERISTICS ASSOCIATED WITH CRIMINAL JUSTICE INVOLVEMENT INCLUDING HOT EXECUTIVE FUNCTIONING AS A PREDICTOR

	B (std. error)	Wald chi-square	*p* value	Odds Ratio	95% C.I. for Odds Ratio	
					Lower	Upper
IGT Total Net Return	.00 (.00)	.34	.559	1.00	1.00	1.00
HELPS TBI	**1.68 (.31)**	**28.40**	**<.001**	**5.34**	**2.88**	**9.88**
Raven's Matrices	-.06 (.08)	1.00	.318	.94	.83	1.06
SD3: Psychopathy	**.08 (.03)**	**5.41**	**.020**	**1.08**	**1.01**	**1.16**
DASS-21: Depression/Anxiety	-.04 (.02)	2.59	.108	.97	.93	1.01
ASSIST: Alcohol	.02 (.01)	1.54	.215	1.02	.99	1.05
ASSIST: Substances	**.06 (.01)**	**15.56**	**<.001**	**1.06**	**1.03**	**1.09**
Race	.54 (.28)	3.66	.056	1.71	.99	2.98
Constant	-3.77 (.82)	21.31	<.001	.02		

Note: IGT = Iowa Gambling Task, HELPS = HELPS brain injury screening tool, TBI = traumatic brain injury, SD3 = Short Dark Triad, DASS-21 = Depression Anxiety Stress Scales-21, ASSIST = Alcohol, Smoking and Substance Involvement Screening Test

In examining hypothesis 2, that the criminal justice group will exhibit deficits in cold executive functioning, the offender group had a higher number of commission errors on the go/no-go task ($p < .001$), perseverative errors on the WCST ($p < .001$), and lower combined Corsi Block Forward and Backward spans ($p < .001$) compared to the non-offender group when all Corsi Block data was included. This difference disappears ($p = .557$) when only individuals who had a minimum combined span of four were included (i.e., had a minimum span of at least 2 for both Corsi Forward and Corsi Backward). Given the lack of statistical significance for the minimum combined span of four, this variable was not included within the logistic regression.

The logistic regression was performed to examine the impact of cold executive functioning and other relevant variables that were identified as statistically significant in univariate comparisons for criminal justice involvement. Thus, the model contained 9 predictor variables (Go/No-Go commission errors, WCST perseverative errors, TBI, Raven's Matrices, Psychopathy subscale, psychiatric symptom composite, alcohol use, substance use, and race). The full model containing all

predictor variables was statistically significant, χ^2 (9, N = 419) = 151.90, $p < .001$, indicating that the model was able to distinguish between participants who reported a criminal justice history and those who did not. The model as a whole explained between 30.4% (Cox and Snell R square) and 42.6% (Nagelkerke R squared) of the variance in criminal justice history, and correctly identified 80.7% of cases. Table 5 shows the contributions of each predictor variable to the model. The same three variables that were identified in the first logistic regression also made a unique statistically significant contribution to this model, specifically history of TBI ($p < .001$), substance use ($p < .001$), and psychopathic traits ($p = .023$). Neither measure of cold executive functioning that was included in this analysis (Go/No-Go commission errors, WCST perseverative errors) were found to have a unique statistical contribution to the model.

TABLE 5

CHARACTERISTICS ASSOCIATED WITH CRIMINAL JUSTICE INVOLVEMENT INCLUDING COLD EXECUTIVE FUNCTIONING AS PREDICTORS

	B (std. error)	Wald chi-square	*p* value	Odds Ratio	95% C.I. for Odds Ratio	
					Lower	Upper
Go/No-Go Commission Errors	.01 (.03)	.16	.689	1.01	.96	1.06
WCST Perseverative Errors	-.01 (.03)	.10	.755	.99	.94	1.05
HELPS TBI	**1.68 (.32)**	**28.26**	**<.001**	**5.39**	**2.90**	**10.02**
Raven's Matrices	-.08 (.07)	1.32	.251	.93	.82	1.06
SD3: Psychopathy	**.08 (.03)**	**5.14**	**.023**	**1.08**	**1.01**	**1.15**
DASS-21: Depression/Anxiety	-.03 (.02)	2.40	.121	.97	.93	1.01
ASSIST: Alcohol	.02 (.01)	1.48	.224	1.02	.99	1.05
ASSIST: Substances	**.06 (.02)**	**14.73**	**<.001**	**1.06**	**1.03**	**1.09**
Race	.51 (.28)	3.24	.072	1.66	.96	2.87
Constant	-3.72 (.87)	17.95	<.001	.02		

Note: WCST = Wisconsin Card Sorting Test, HELPS = HELPS brain injury screening tool, TBI = traumatic brain injury, SD3 = Short Dark Triad, DASS-21 = Depression Anxiety Stress Scales-21, ASSIST = Alcohol, Smoking and Substance Involvement Screening Test.

To ensure that excluding the Corsi Block total span of all participants (including those with a zero span) did not significantly change the results, a logistic regression including the Corsi Block total span in addition to the aforementioned nine predictor variables was run. The overall model essentially remained the same and the Corsi Block total span did not have a unique statistical contribution to the model (p = .718). Additionally, the three variables identified to have statistically significant contributions to the model (i.e., TBI, substance use, psychopathic traits) remained the same. As mentioned before, the Corsi Block total span including participants who had at least a span of two on both Corsi Forward and Corsi Backward was not included as a predictor variable given 1) that it was not found to be statistically significant between the offender and nonoffender group and 2) that it significantly reduced the sample (n = 34 for offender group, n = 143 for nonoffender group) to an unacceptable level given the number of predictors included.

Hypotheses 3 and 4: Executive Functioning in Violent Vs. Non-Violent Offenders

In examining differences between individuals who committed violent crimes (n = 66) versus those who committed non-violent crimes (i.e., property crimes, drug crimes, and public order crimes; n = 68), relevant sociodemographic characteristics and psychological comorbidities were examined to assess for possible covariates, in addition to the executive functioning measures. The descriptive statistics and comparisons between both groups can be seen in Table 6. The violent offender group did not statistically differ from the nonviolent offender group in regard to age (p = .097), gender (p = .907), employment status (p = .070), history of a TBI (p = .194), or alcohol use (p = .279). After using a Bonferroni correction to account for type one error, race (p = .008), education (p = .046), overall intelligence (p = .039), psychopathic traits (p = .013), and psychological symptoms (p = .045) were not statistically significant. The violent

offender group was only found to be statistically different than the nonviolent group on substance use ($p < .001$), with the violent offender group reporting more severe substance use than the nonviolent offender group. Regarding hypothesis 3, that the violent offender group would exhibit greater deficits in hot executive functioning, this hypothesis was not supported as there was no significant difference between the two groups on IGT total net return ($p = .768$). Hypothesis 4, that violent offenders will exhibit greater impairments in cold executive functioning compared to nonviolent offenders, was also not supported, as there were no significant differences on Go/No-Go commission errors ($p = .061$) or WCST perseverative errors ($p = .599$). Additionally, there were no significant differences between the two groups on Corsi Block total span ($p = .210$) with all participants included or Corsi Block total span with only participants with a minimum total span of four ($p = .563$).

TABLE 6

SAMPLE CHARACTERISTICS AND UNIVARIATE COMPARISONS BETWEEN VIOLENT AND NONVIOLENT OFFENDERS

	Violent Offenders		Nonviolent Offenders		*p* value	Effect size[a]
	N	Mean or Md (*SD*) or %	N	Mean or Md (*SD*) or %		
Gender					.907	0.01
Males	45	68.2%	47	69.1%		
Female	21	31.8%	21	30.9%		
Race					.008	0.27 (med)
White/Non-Hispanic	32	48.5%	47	69.1%		
Non-White	34	51.5%	21	30.9%		
Education					.046	0.25 (medium)
College Graduate	50	76.9%	42	62.7%		
Other than College Graduate	15	23.1%	25	37.3%		
Employment Status					.070	0.18 (small)
Full-Time	63	96.9%	59	86.8%		
Other than Full-Time	2	3.1%	9	13.2%		
HELPS TBI					.194	0.13 (small)
No TBI	31	47.0%	40	59.7%		
Probable TBI	35	53.0%	27	40.3%		
Age	65	36.00 (8.90)	68	34.50 (9.32)	.097	0.14 (small)
Raven's Matrices	66	2.00 (1.73)	68	3.00 (2.14)	.039	0.18 (small)
SD3: Psychopathy Scale	66	32.57 (3.55)	67	30.00 (5.46)	.013	0.22 (small)
DASS-21: Depression/Anxiety	66	28.00 (6.36)	68	26.00 (9.38)	.045	0.17 (small)
ASSIST: Alcohol	66	29.00 (6.15)	68	28.00 (10.06)	.279	0.09
ASSSIT: Substances	**66**	**28.25 (6.54)**	**68**	**24.13 (12.53)**	**<.001**	**0.32 (medium)**
IGT Net Return	66	1668.94 (1220.02)	67	1609.70 (1087.82)	.768	0.05
Go/No-Go Commission Errors	66	6.50 (6.05)	68	4.00 (5.58)	.061	0.16 (small)
WCST Perseverative Errors	66	13.00 (5.16)	68	13.50 (5.15)	.599	0.10 (small)
Corsi Block Total Span (All Participants)[b]	66	2.00 (3.99)	68	2.00 (4.34)	.210	0.22 (small)
Corsi Block Total Span (Minimum of four span)[c]	13	11.00 (2.10)	21	10.00 (2.40)	.563	0.20 (small)

Note: HELPS = HELPS brain injury screening tool, TBI = traumatic brain injury, SD3 = Short Dark Triad, DASS-21 = Depression Anxiety Stress Scales-21, ASSIST = Alcohol, Smoking and Substance Involvement Screening Test, IGT = Iowa Gambling Task, WCST = Wisconsin Card Sorting Test.

[a]Effect sizes were calculated for each variable. Cohen's d was used for the IGT total net return and Corsi Block variables. Cohen's (1988) criteria was used for all other variables. Descriptors of the strength of the effect size are included in parentheses for ease of comparison.

[b]This Corsi Block variable includes all participants, including ones who had a span of zero

[c]This Corsi Block variable includes only those participants who had at least a span of two on both Corsi Forward and Corsi Backward trials for a total minimum span of four

Hypothesis 4 postulated that the magnitude of difference would be larger for hot executive functioning than for cold executive functioning in violent offenders. While none of the executive functioning measures were statistically significant between the violent offender and nonviolent offender group, effect sizes were still calculated for each of the measures. Effect sizes for the cold executive functioning measures were small (r = 0.10 - 0.16; Cohen's d = 0.20 – 0.22) while the effect size for the hot executive functioning measure was minimal (Cohen's d = 0.05).

An exploratory analysis related to these hypotheses was to examine for potential differences in hot and cold executive functioning performances based on offense categories subsumed under nonviolent offenses (i.e., drug, property, and public order). Consistent with previous research (FBI UCR, 2004), offenders were categorized under their most severe crime committed. Thus, there were 27 participants who's most severe crime was a property crime, 11 who committed a drug crime, and 30 who committed a public order crime. A set of one-way ANOVAs did not find any significant differences between the three types of nonviolent crimes in regard to the total net return on the IGT (p = .910), nor either Corsi Block Tapping variable (p = .259 - .516). A Kruskal-Wallis Test was not significantly different between groups in Go-No/Go commission errors (p = .860) but was significantly different for WCST perseverative errors (p = .017). Mann-Whitney U analyses revealed that individuals who committed a drug crime as their most severe crime had significantly more perseverative errors on the WCST (p = .009) compared to individuals who committed property crimes, suggesting poorer cognitive flexibility in drug offenders. There were no differences in perseverative errors between drug and public order offenders (p = .259), nor between property and public order offenders (p = .035) after using a Bonferroni correction to control for familywise error.

Hypothesis 5: TBI, Hot Executive Functioning, and Criminal Justice Involvement

To examine hypothesis 5, that hot executive functioning will moderate the relationship between incidence of TBI and criminal justice involvement a moderation analysis was used. The outcome variable was criminal justice involvement, and the predictor variable was history of a TBI. The IGT total net return was used as the moderator variable. The total IGT net return was not a significant contributor to the model [B = -.0002, 95% C.I. (<-.01, <.01), p = .157]. Similarly, the interaction between history of TBI and hot executive functioning was not statistically significant [B = .0000, 95% C.I. (<-.01, <.01), p = .946]. Thus, hot executive functioning was not a moderator of the relationship between TBI and criminal justice involvement.

Hypothesis 6: Substance Abuse and Executive Functioning

To examine hypothesis 6, that substance and alcohol abuse will be associated with cold executive functioning deficits, participants were categorized into low, moderate, and high-risk users based on their scores on the ASSIST for both alcohol and substance use. Regarding alcohol use, there were 125 participants in the low alcohol use group (i.e., no to low alcohol use that does not rise to a level concerning for alcohol abuse/dependence), 107 in the moderate alcohol use group, and 190 in the high alcohol use group. The descriptive statistics and comparisons between the three alcohol use groups can be seen in Table 7. Univariate comparisons between the three groups revealed significant differences in Go/No-Go commission errors (p < .001), WCST perseverative errors (p < .001), Corsi Block total span (for all participants, p < .001, and participants with a minimum total span of four; p = .011), psychopathic traits (p < .001), Raven's Matrices (p < .001), psychiatric symptoms (p < .001), TBI (p < .001), education (p = .033), and employment status (p < .001). There were no significant differences for gender (p = .664), race

(p = .825), or IGT total net return (p = .085). More severe use (i.e., both moderate and high alcohol abuse) was associated with more commission errors, more perseverative errors, lower working memory span, more psychopathic traits, lower intelligence, more psychiatric symptoms, higher proportions of TBI history, and higher proportions of a college graduate education and full-time employment. Although IGT total net return was not significantly different between the two groups, this variable was included in the multinomial logistic regression (similar to what was done in hypothesis 1 given previous research including relevant variables above traditional p-values in logistic regressions) as the relationship between hot executive functioning and alcohol abuse was examined as an exploratory analysis. Additionally, since both Corsi Block variables were significantly different between groups, each of the Corsi Block variables was loaded into separate multinomial logistic regressions with all the same additional predictor variables, to assess whether any possible contributions from the Corsi Block span including all participants remained when including only participants who had a minimum span of four.

TABLE 7

SAMPLE CHARACTERISTICS AND UNIVARIATE COMPARISONS OF ALCOHOL USE SEVERITY

	Low Alcohol Use		Moderate Alcohol Use		High Alcohol Use	
	N	Mean/Md (*SD*) or %	N	Mean/Md (*SD*) or %	N	Mean/Md (*SD*) or %
Gender						
Male	82	65.6%	66	61.7%	127	66.8%
Female	43	34.4%	41	38.3%	63	33.2%
Race						
White/Non-Hispanic	85	68.5%	77	72.0%	131	68.9%
Non-White	39	31.5%	30	28.0%	59	31.1%
Education						
College Graduate	**80**	**64.0%**	85	79.4%	136	72.3%
Other than College Graduate	**45**	**36.0%**	22	20.6%	52	27.7%
Employment						
Full-Time	**97**	**77.6%**	98	92.5%	**177**	**94.1%**
Other than Full-Time	**28**	**22.4%**	8	7.5%	**11**	**5.9%**
HELPS TBI						
No TBI	**118**	**94.4%**	82	76.6%	**134**	**70.9%**
Probable TBI	**7**	**5.6%**	25	23.4%	**55**	**29.1%**
Age	124	35.00 (11.77)	106	34.50 (9.62)	189	35.00 (9.06)
Raven's Matrices[ab]	**125**	**4.00 (2.82)**	**107**	**3.00 (2.23)**	**190**	**3.00 (2.09)**
SD3: Psychopathy[abc]	**125**	**19.13 (7.90)**	**107**	**29.00 (5.32)**	**190**	**31.50 (4.96)**
DASS-21: Depression/Anxiety[abc]	**125**	**5.00 (11.40)**	**107**	**24.00 (8.57)**	**190**	**27.00 (8.89)**
IGT Net Return	125	1872.80 (1134.09)	106	1965.57 (1195.24)	190	1663.68 (1236.26)
Go/No-Go Commission Errors[ab]	**125**	**2.00 (3.29)**	**107**	**3.00 (5.59)**	**190**	**4.00 (5.69)**
WCST Perseverative Errors[ab]	**125**	**9.00 (5.32)**	**107**	**13.00 (4.61)**	**190**	**13.00 (4.76)**
Corsi Block Total Span (All Participants)$_a$[abc]	**125**	**7.67 (4.58)**	**107**	**5.02 (4.36)**	**190**	**3.78 (4.25)**
Corsi Block Total Span (Minimum of four span)$_b$[a]	**82**	**10.56 (2.16)**	42	9.67 (2.15)	**55**	**9.51 (2.22)**

Note: HELPS = HELPS brain injury screening tool, TBI = traumatic brain injury, SD3 = Short Dark Triad, DASS-21 = Depression Anxiety Stress Scales-21, IGT = Iowa Gambling Task, WCST = Wisconsin Card Sorting Test. Significant results appear in **bold.** [a]Indicates a significant difference between the low and high alcohol use groups. [b]Indicates a significant difference between the low and medium alcohol use groups. [c]Indicates a significant difference between medium and high use groups.

$_a$This Corsi Block variable includes all participants, including ones who had a span of zero

$_b$This Corsi Block variable includes only those participants who had at least a span of two on both Corsi Forward and Corsi Backward trials for a total minimum span of four

Ten predictor variables (i.e., Go/No-Go commission errors, WCST perseverative errors, Corsi Block total span, IGT total net return, Raven's Matrices, Psychopathy subscale, psychiatric symptom composite, TBI, education, and employment status) were loaded into a multinomial logistic regression predicting moderate and high alcohol use using low alcohol use as the reference group (see Table 8). The full model containing all predictor variables was statistically significant, χ^2 (20, N = 414) = 187.42, $p < .001$. The full model explained between 36.4% (Cox and Snell R square) and 41.3% (Nagelkerke R square) of the variance in alcohol use severity, and correctly identified 60.4% of cases. Compared to low alcohol use, moderate alcohol use was associated with more psychopathic traits ($p = .026$) and a higher probability of having a history of a TBI ($p = .018$). Similarly, compared to low alcohol use, high alcohol use was associated with more psychopathic traits ($p < .001$), a higher probability of a history of a TBI ($p = .014$), as well as with more psychiatric symptoms ($p = .001$). There were no significant associations for the measures of hot and cold executive functioning.

TABLE 8

CHARACTERISTICS ASSOCIATED WITH ALCOHOL USE SEVERITY

Predictors	Moderate Risk Alcohol Users			High Risk Alcohol Users		
	B (std. error)	*Wald chi-square*	*Sig.*	*B (std. error)*	*Wald chi-square*	*Sig.*
IGT Net Return	0.00 (0.00)	3.14	0.076	0.00 (0.00)	0.14	0.705
Go/No-Go Commission Errors	0.04 (0.04)	1.06	0.303	0.04 (0.04)	0.93	0.335
WCST Perseverative Errors	0.03 (0.03)	1.04	0.309	0.03 (0.03)	1.08	0.299
Corsi Block Total Span	-0.01 (0.04)	0.02	0.885	-0.05 (0.04)	1.72	0.190
Raven's Matrices	0.01 (0.08)	0.01	0.921	0.09 (0.07)	1.53	0.217
Psychopathy	**0.07 (0.03)**	**4.93**	**0.026**	**0.12 (0.03)**	**12.02**	**<0.001**
Depression/Anxiety	0.04 (0.02)	3.13	0.077	**0.06 (0.02)**	**10.23**	**0.001**
TBI	**-1.20 (0.51)**	**5.61**	**0.018**	**-1.19 (0.48)**	**6.03**	**0.014**
Education	0.68 (0.36)	3.61	0.057	0.19 (0.33)	0.31	0.577
Employment Status	0.75 (0.52)	2.10	0.147	0.87 (0.51)	2.86	0.091

Note: Low risk alcohol users were used as the reference group for this analysis. IGT = Iowa Gambling Task, WCST = Wisconsin Card Sorting Test, TBI = traumatic brain injury.

Regarding substance use, there were 196 participants in the low substance use group, 107 in the moderate substance use group, and 119 in the high substance use group. Table 9 shows the descriptive statistics and comparisons between the three substance use groups. Univariate comparisons between the three groups revealed significant differences in Go/No-Go commission errors ($p < .001$), WCST perseverative errors ($p < .001$), Corsi Block total span (both including all participants and including only participants with a minimum total span of four; $p < .001$), IGT total net return ($p = .008$), psychopathic traits ($p < .001$), Raven's Matrices ($p < .001$), psychiatric symptoms ($p < .001$), TBI ($p < .001$), age ($p = .002$), gender ($p = .046$), race ($p = .009$), and employment status ($p = .003$). There was no significant difference between the groups regarding education ($p = .365$). More severe use (i.e., both moderate and severe use groups), had more commission errors, more perseverative errors, lower working memory spans, lower net returns on the IGT, more psychopathic traits, lower intelligence, more psychiatric symptoms, and higher proportions of individuals with a history of TBI and full-time employment. The moderate substance use group was younger and had a higher proportion of males whereas the high substance use group had a higher proportion of non-White individuals. Similar to the analysis regarding alcohol use, the IGT total net return was included as a predictor in the multinomial logistic regression as an exploratory analysis to assess whether it is a significant predictor of substance use severity. As both Corsi Block variables were again significantly different between groups, each variable was loaded into separate multinomial logistic regressions with all the same additional predictor variables, to assess whether any possible contributions from the Corsi Block span including all participants remained when including only participants who had a minimum span of four.

TABLE 9

SAMPLE CHARACTERISTICS AND UNIVARIATE COMPARISONS OF SUBSTANCE USE SEVERITY

	Low Substance Use		Moderate Substance Use		High Substance Use	
	N	Mean/Md (*SD*) or %	N	Mean/Md (*SD*) or %	N	Mean/Md (*SD*) or %
Gender						
Male	119	60.7%	**80**	**74.8%**	76	63.9%
Female	77	39.3%	**27**	**25.2%**	43	36.1%
Race						
White/Non-Hispanic	142	72.8%	81	75.7%	**70**	**58.8%**
Non-White	53	27.2%	26	24.3%	**49**	**41.2%**
Education						
College Graduate	134	68.4%	79	75.2%	88	73.9%
Other than College Graduate	62	31.6%	26	24.8%	31	26.1%
Employment						
Full-Time	**164**	**83.7%**	**101**	**96.2%**	107	90.7%
Other than Full-Time	**32**	**16.3%**	**4**	**3.8%**	11	9.3%
HELPS TBI						
No TBI	**187**	**95.4%**	81	75.7%	**66**	**55.9%**
Probable TBI	**9**	**4.6%**	26	24.3%	**52**	**44.1%**
Age[bc]	**195**	**36.00 (10.71)**	**105**	**32.00 (9.43)**	**119**	**36.00 (9.29)**
Raven's Matrices[abc]	**196**	**4.00 (2.57)**	**107**	**3.00 (2.02)**	**119**	**2.00 (1.91)**
SD3: Psychopathy[abc]	**196**	**24.00 (7.62)**	**107**	**29.58 (5.02)**	**118**	**32.81 (3.25)**
DASS-21: Depression/Anxiety[abc]	**196**	**11.58 (11.22)**	**107**	**24.00 (7.68)**	**119**	**29.00 (5.34)**
IGT Net Return[a]	**196**	**1992.60 (1146.17)**	**107**	**1684.58 (1184.98)**	**118**	**1591.10 (1262.81)**
Go/No-Go Commission Errors[abc]	**196**	**2.00 (3.28)**	**107**	**4.00 (5.17)**	**119**	**7.00 (6.34)**
WCST Perseverative Errors[ab]	**196**	**10.50 (5.05)**	**107**	**13.00 (4.80)**	**119**	**14.00 (4.68)**
Corsi Block Total Span (All Participants)$_a$[abc]	**196**	**7.32 (4.70)**	**107**	**4.38 (4.03)**	**119**	**2.61 (3.45)**
Corsi Block Total Span (Minimum of four span)$_b$[ab]	**124**	**10.48 (2.13)**	**34**	**9.32 (1.80)**	**21**	**8.48 (2.42)**

Note: HELPS = HELPS brain injury screening tool, TBI = traumatic brain injury, SD3 = Short Dark Triad, DASS-21 = Depression Anxiety Stress Scales-21, IGT = Iowa Gambling Task, WCST = Wisconsin Card Sorting Test. Significant results appear in **bold.** [a]Indicates a significant difference between the low and high alcohol use groups. [b]Indicates a significant difference between the low and medium alcohol use groups. [c]Indicates a significant difference between medium and high use groups.

$_a$This Corsi Block variable includes all participants, including ones who had a span of zero

$_b$This Corsi Block variable includes only those participants who had at least a span of two on both Corsi Forward and Corsi Backward trials for a total minimum span of four

Twelve predictor variables (i.e., Go/No-Go commission errors, WCST perseverative errors, Corsi Block span, IGT total net return, Raven's Matrices, Psychopathy subscale, psychiatric symptom composite, TBI, age, gender, race, and employment status) were included in another multinomial logistic regression, this time predicting moderate and high substance use while using low substance use as the reference group (see Table 10). The full model was statistically significant, χ^2 (24, N = 412) = 325.66, $p < .001$. The full model explained between 54.6% (Cox and Snell R square) and 62.1% (Nagelkerke R square) of the variance in substance use severity. It correctly identified 69.7% of cases. Compared to low substance users, moderate substance users had more commission errors ($p = .012$), more psychiatric symptoms ($p = .004$), and a higher probability of having a TBI ($p < .001$). Similarly, in comparison to low substance use, high substance use was also associated with more commission errors ($p = .004$), more psychiatric symptoms ($p < .001$), and a higher probability of having a TBI ($p < .001$), in addition to lower Corsi Block span ($p = .007$), more psychopathic traits ($p < .001$), and lower intelligence ($p = .005$). The Corsi Block total span including all participants was chosen to remain in the model given that when a multinomial regression was used including only those who had a minimum span of four as a predictor variable, it significantly reduced the sample size ($n = 20$ for high substance users, $n = 31$ for moderate substance users), yet notably remained a significant predictor ($p = .038$). Research has shown that larger sample sizes (e.g., 500 participants), are closer approximations of the targeted population that can more readily detect low to large effect sizes compared to small sample sizes and increase our confidence in the results (Bujang et al., 2018; Bujang et al.., 2015; Bujang et al., 2012; Nemes et al., 2009). Thus, the Corsi Block total span including all participants was used within the model in order to retain a larger sample size. Additionally, when Corsi Block variables were excluded from the model, the other relevant

significant predictors that were identified remained the same. Thus, poor inhibition, as measured by more commission errors, was found to be associated with both moderate and high substance use, and poor working memory, as measured by Corsi Block total span, was associated with high substance use. However, cognitive flexibility and hot executive functioning were not associated with more severe substance use.

TABLE 10

CHARACTERISTICS ASSOCIATED WITH SUBSTANCE USE SEVERITY

Predictors	Moderate Risk Substance Users			High Risk Substance Users		
	B (std. error)	*Wald chi-square*	*Sig.*	*B (std. error)*	*Wald chi-square*	*Sig.*
IGT Net Return	0.00 (0.00)	0.28	0.596	0.00 (0.00)	0.00	1.000
Go/No-Go Commission Errors	**0.09 (0.04)**	**6.31**	**0.012**	**0.11 (0.04)**	**8.23**	**0.004**
WCST Perseverative Errors	0.01 (0.03)	0.10	0.756	0.01 (0.04)	0.02	0.887
Corsi Block Total Span	-0.04 (0.04)	1.09	0.298	**-0.13 (0.05)**	**7.31**	**0.007**
Raven's Matrices	-0.06 (0.07)	0.77	0.382	**-0.26 (0.10)**	**7.72**	**0.005**
Psychopathy	0.05 (0.03)	1.81	0.179	**0.17 (0.05)**	**11.04**	**<0.001**
Depression/Anxiety	**0.06 (0.02)**	**8.07**	**0.004**	**0.18 (0.03)**	**27.29**	**<0.001**
TBI	**-1.97 (0.48)**	**16.52**	**<0.001**	**-2.84 (0.53)**	**29.28**	**<0.001**
Age	-0.01 (0.02)	0.61	0.435	0.01 (0.02)	0.18	0.669
Race	0.47 (0.35)	1.80	0.180	-0.11 (0.39)	0.08	0.774
Gender	0.42 (0.33)	1.64	0.200	-0.24 (0.39)	0.39	0.533
Employment Status	0.58 (0.64)	0.83	0.362	-1.45 (0.80)	3.32	0.069

Note: Low risk substance users were used as the reference group for this analysis. IGT = Iowa Gambling Task, WCST = Wisconsin Card Sorting Test, TBI = traumatic brain injury.

CHAPTER V

DISCUSSION

The primary purpose of this study was to determine whether individuals with a criminal justice history show deficits in hot and cold executive functioning compared to individuals who do not have a criminal justice history. Beyond this primary aim, this study also explored for differences in hot and cold executive functioning between violent offenders and non-violent offenders, assessed for a possible moderating influence of hot executive functioning on the relationship between history of TBI and criminal justice involvement, and explored for relationships between hot and cold executive functioning and substance use.

Executive Functioning and Criminal Justice Involvement

Considering that criminal justice populations frequently exhibit behaviors that are associated with deficits in executive functioning (e.g., fighting, poor decision making), it was hypothesized that individuals with a criminal justice history would exhibit deficits in hot and cold executive functioning compared to those who did not have a criminal justice history. Hot executive functioning was not found to differ significantly between individuals with and without a criminal justice history, and thus was also not found to be a significant predictor of criminal justice involvement. Therefore, there was no support for our primary hypothesis.

There are several possible explanations for this lack of significance. The most obvious is that individuals with a criminal history simply do not have deficits in hot executive functioning. However, previous research has found that offenders made more disadvantageous choices in the IGT (Broomhall, 2005) in comparison to non-offenders (Yechiam et al., 2008), suggesting poorer hot executive functioning abilities. Additionally, behaviors that are suggestive of deficits in hot executive functioning, such as difficulty delaying gratification (Aratnes et al., 2012;

Mishra & Lalumiere) and suppressing aggressive impulses, are commonly seen in criminal justice populations (Lipsey et al., 2007; Meijers et al., 2015). Another possibility is that the use of hypothetical money in the IGT with no additional "real" incentives may not have elicited strong enough motivation and/or emotional responses related to rewards versus losses that are commonly evoked in hot executive functioning. This use of real versus hypothetical incentives or rewards in research has been debated in the literature, with some studies finding no difference in outcomes between the two types of incentives (Gillis & Hettler, 2007; Madden et al., 2003), whereas others have found significant and meaningful differences (Fatino et al., 2007; Xu et al., 2018). Lastly, another possibility is that the present study's sample of individuals who endorsed a criminal justice history may be a higher functioning subset of individuals that are not representative of the criminal justice population as a whole. For example, this was a highly educated sample with most individuals working full-time. This is in contrast to data on criminal justice populations that show a high proportion of individuals with lower educational levels (Harlow, 2003) and lower socioeconomic status (Rabuy & Kopf, 2015). It is possible that this may be a higher functioning group of individuals who may have more subtle difficulties in hot executive functioning as a difference between the offender and non-offender group was approaching significance (p = .057). Individuals who may be more representative of the general criminal justice population may exhibit more significant impairments in hot executive functioning, although future research would need to examine this hypothesis further. While hot executive functioning was not found to be associated with criminal justice involvement, a different pattern emerged regarding cold executive functioning.

Partial support was found for the hypothesis that offenders would exhibit deficits in cold executive functioning, as offenders were found to show greater deficits in inhibition and

cognitive flexibility compared to non-offenders. Given the significant number of participants who did not complete a minimum span for either the forward and/or backward component of the Corsi Block Tapping test, limited conclusions can be made regarding the relationship between working memory and criminal justice history. When including only participants who minimally completed at least the first span for both forward and backward (and thus thought to be more representative of true working memory ability), there was no significant difference between offenders and non-offenders, although it should be noted that the sample size was significantly smaller for the offender group (n = 35).

The findings that poorer inhibition and cognitive flexibility are associated with criminal justice involvement is consistent with the majority of research conducted in other countries that has shown that their criminal justice populations exhibit deficits in cold executive functioning (Adjorlolo & Egbenya, 2016; Meijers et al., 2015; Syngelaki et al., 2009). It is also consistent with meta-analyses that have examined the association between cold executive functioning deficits and antisocial behavior, which is strongly linked to criminal justice involvement (Morgan & Lilienfeld, 2000; Ogilvie et al., 2011), although this study found small effect sizes (Cohen's d = .15 - .23) compared to the medium effect sizes found in the meta-analyses. However, for working memory specifically, the results have been mixed. For example, there has been one study that found deficits in working memory compared to non-offenders (Hoaken et al., 2007), whereas there was no difference in another study (Kavanagh et al., 2010), although this latter study included only individuals who committed impulsive drug-related crimes in the criminal justice group. Thus, this study was not able to add to the literature regarding working memory difficulties given the limitations with the Corsi Block Tapping test data but given the

deficits in other cold executive functioning measures, further investigation on working memory abilities is warranted.

When executive functioning was examined within the context of relevant sociodemographic characteristics and psychological comorbidities, neither hot nor cold executive functioning was found to be significant predictors of criminal justice involvement. Instead, history of TBI, substance abuse, and psychopathic traits were the greatest predictors of criminal justice involvement. This is consistent with previous research that has found that the strongest predictor of criminal justice involvement is antisocial/psychopathic traits (Gaudet et al., 2016; Sanz-Garcia et al., 2021). Additionally, the literature has also identified that TBI (Clark et al. 2020, Williams et al., 2010) and substance use (Davies et al., 2012; Fazel et al., 2006) are important predictors as well and these three factors continue to be identified as the strongest predictors even in a higher-functioning criminal justice sample. Interestingly, TBI and substance use are two prominent causes of deficits in executive functioning (Arciniegas et al., 2002; Barman et al., 2016; Fernandez-Serrano et al., 2011; Giancola & Tarter, 1999; McDonald, 2013), but also have other effects, related symptoms, and changes in the brain that may also be contributing to increased likelihood for criminal behavior. In summary, although poorer inhibition and cognitive flexibility were associated with criminal justice involvement, they were not identified as significant predictors once other covariates were included. However, given the heterogeneity of the criminal justice population, executive functioning was also compared between individuals who committed violent crimes compared to nonviolent crimes to assess for possible differences.

Executive Functioning in Violent and Non-Violent Offenders

It was hypothesized that violent offenders would have greater deficits in both hot and cold executive functioning compared to non-violent offenders, which included individuals who committed drug, property, and/or public order crimes. However, these hypotheses were not supported as there was no significant difference between violent offenders and non-violent offenders in either hot or cold executive functioning. These results are inconsistent with previous research that has generally supported that violent offenders exhibit poorer outcomes on the IGT (Umbach et al., 2019; Yechiam et al., 2008), suggesting poorer hot executive functioning abilities, as well as having poorer performance on cold executive functioning measures (Hancock et al., 2010; Seruca & Silva, 2016). One possibility for this difference is that previous research used prison populations whereas all the individuals in this sample were currently living in the community. Additionally, while most individuals in this criminal justice sample (86%) reported serving time in either jail or prison, a much smaller percentage (9%), reported spending one year or greater in jail or prison. Overall, the sample in this present study likely represents a much less "severe" population than previous research has examined, which may account for the absence in differences between violent and nonviolent offenders.

While overall research has found poorer cold executive functioning in violent offenders compared to nonviolent offenders, the research regarding specific cold executive functioning deficits has been variable, with studies typically finding that violent offenders performed worse on tasks of inhibition as compared to nonviolent offenders (Kennedy et al., 2011; Seruca & Silva, 2016). The findings on cognitive flexibility are somewhat mixed. For example, Hancock and colleagues (2010) found that violent offenders had a poorer performance compared to nonviolent offenders; however, others have not found any differences (Hoaken et al., 2007;

Meijers et al., 2017). Prior research has also not found any differences between violent and nonviolent offenders regarding working memory (Hoaken et al., 2007; Meijers et al., 2017). Thus, it is also possible that while overall, violent offenders exhibit greater deficits in cold executive functioning, the majority of these differences are due to deficits in inhibition specifically, although this study did not find this difference and more research will need to be conducted to more fully assess specific executive functioning differences.

Even amongst other relevant sociodemographic and psychological variables, the only difference that was found between the two types of offenders in the present study was in regard to substance use, with violent offenders reporting more severe substance use. This is consistent with earlier work that also found that drug dependence was a significant predictor of violent offenses (Kopak et al., 2014). An exploratory analysis assessing for executive functioning differences among nonviolent offenders revealed that the executive functioning profile was similar between nonviolent offenders who committed property, drug, and public order crimes, with the exception that drug offenders exhibited poorer cognitive flexibility than property offenders. This finding is in contrast to Seruca and Silva's study (2016) that found that property offenders performed worse on a measure of cognitive flexibility compared to drug trafficking offenders. This discrepancy may be due to the differences in types of drug offenses, as this study included any drug offense, including less severe crimes such as possession. Taken together, this study did not find any differences in executive functioning between violent and nonviolent offenders, and minimal differences between the groups of nonviolent offenders, suggesting more global weaknesses in executive functioning in this criminal justice sample.

Hot Executive Functioning, TBI, and Criminal Justice Involvement

The fifth hypothesis, that hot executive functioning would be identified as a moderator between incidence of TBI and later criminal justice involvement, was not supported. While TBI was found to be a significant predictor of criminal justice involvement, hot executive functioning was not, nor did it serve as a moderator between history of TBI and criminal justice involvement. As noted above, several possibilities for this include (1) that there is no relationship between hot executive functioning and criminal justice and involvement or (2) that the use of hypothetical money in the IGT may not have elicited strong enough motivation and/or emotional responses related to rewards versus losses that are commonly evoked in hot executive functioning. Alternatively, since TBI was such a strong predictor of criminal justice involvement, any moderating effects of hot executive functioning was unlikely to be detected. Previous research has shown a relationship between TBI and performance on the IGT suggesting that individuals who sustained a TBI exhibited poorer performance on the IGT compared to healthy controls (Bonatti et al., 2008; Cotrena et al., 2014; Levine et al., 2005). Additionally, factors such as the severity of the TBI, number of total TBIs, location of damage, and time since the most recent TBI may also influence TBI's relationship with hot executive functioning. For example, meta-analyses have found that individuals with uncomplicated, mild TBI typically see a full recovery in any cognitive sequalae (including executive functioning deficits, although hot executive functioning has not been examined) within weeks, with no lasting impairment attributed to the TBI beyond three months (Binder et al., 1997; Frencham et al., 2005; Rohling et al., 2011; Shretlen & Shapiro, 2003). On the other hand, individuals with more moderate to severe TBIs have a slower recovery and may have more lasting cognitive impairments more than two years post-injury (Ruttan et al., 2008; Shretlan & Shapiro, 2003). The present study used a screener to

assess for a history of traumatic brain injury and thus additional information about factors such as the severity of the TBI and time since their most recent TBI was not collected. If the majority of individuals in this sample had milder TBIs and/or the head injury occurred years ago, hot executive functioning deficits may not be as prominently associated with TBI. Regardless, while hot executive functioning was not found to moderate the relationship between TBI and criminal justice involvement in this study, it is worth noting that this study provided further evidence that incidence of TBI is one of the strongest predictors of criminal justice involvement. In addition to TBI, substance abuse was also found to be a significant predictor of criminal justice involvement in this study, and its relationship with executive functioning was also examined.

Substance Abuse and Executive Functioning

The final hypothesis was that substance and alcohol abuse (as measured by moderate and severe users) would be associated with cold executive functioning deficits compared to nonsubstance/alcohol abusers. This study examined alcohol alone and then a composite of all other substances given the high correlations between substances. This final hypothesis was supported as both alcohol and substance abuse were associated with worse performance on tasks of inhibition, cognitive flexibility, and working memory compared to nonalcohol/nonsubstance abusers. This study also explored the relationship between hot executive functioning and alcohol and substance abuse. There was not a significant relationship between hot executive functioning performance and alcohol severity; however, more severe substance use was associated with poorer hot executive functioning.

When executive functioning was examined within the context of relevant psychological and sociodemographic characteristics, neither hot nor cold executive functioning measures were found to be significant predictors of alcohol severity. However, for substance use, poorer

inhibition and working memory remained associated with substance use severity at the multivariate level, although cognitive flexibility and hot executive functioning were not. These results are partially consistent with previous research as poorer cold executive functioning has generally been found to be associated with substance use, however the specific aspects of executive functioning can vary depending on the specific substance (Aharonovich et al., 2018; Fernandez-Serrano et al., 2010; Fillmore et al., 2002; Jovanovski et al., 2005; Verdejo-Garcia et al., 2006). Research on this has been challenging, given that many individuals who use substances are polysubstance users (Crummy et al., 2020; Liu et al., 2018). This was also the case for this study's sample, as 74.2% of individuals who endorsed alcohol and/or substance use reported using more than one substance. Polysubstance use is also highly prevalent in criminal justice populations, with research estimating that approximately half of individuals in the criminal justice system are polysubstance users (Kedia et al., 2007; Proctor, 2012). The criminal justice sample in this study had an even higher prevalence rate (93.3%) of reported lifetime polysubstance use. The high prevalence rates are alarming as polysubstance use is often associated with more severe outcomes (Dutra et al., 2008; Timko et al., 2018), although the literature is mixed as several other studies have not found significant outcomes or more severe criminal justice involvement in criminal justice populations (Clark et al., 2018; Listwan et al., 2009). Regardless, the results of this study examining more severe substance use (with a high prevalence of polysubstance use) is more consistent with the former studies as not only did the criminal justice sample report higher alcohol and substance use, but moderate to severe alcohol and substance use was also associated with TBI, psychiatric symptoms, and psychopathic traits. At the very least, these results suggest that more severe alcohol/substance use is likely further compounded by significant co-morbid factors that could also contribute to poorer outcomes if

not adequately addressed. For substance abuse in particular, inhibition and working memory deficits, in addition to the aforementioned comorbidities, will also need to be considered when treating substance use.

Implications

Identifying the most significant predictors associated with criminal justice involvement can help to focus rehabilitative efforts, as recidivism continues to remain high (Alper et al., 2018). The data from this study suggests that some of the most significant factors are a history of TBI, substance use, and psychopathic traits. While cold executive functioning deficits were related to a history of criminal justice involvement, and thus could still be a target for rehabilitative efforts, treatment targeting substance use and TBI recovery may aid not only in targeting these unique and significant predictors of criminal justice involvement, but also would likely improve cold executive functioning difficulties given that they are associated with both these conditions (Arciniegas et al., 2002; Barman et al., 2016; Fernandez-Serrano et al., 2011; Giancola & Tarter, 1999; McDonald, 2013). While substance use treatment has become more prevalent at all levels of the criminal justice system, and especially so in community corrections, TBI has largely remained overlooked. Optimizing TBI recovery will be an especially important avenue to pursue for future research. While recovery varies depending on the circumstances of the TBI, individuals have been shown to benefit from cognitive rehabilitation, cognitive behavioral therapy, and pharmacotherapy (Barman et al., 2016; Cernich et al., 2010). Unfortunately, research on treatments for psychopathy is grim. Thus far, there has been minimal evidence to support various treatment approaches (Hecht et al., 2018), although cognitive-behavioral therapy approaches remain the most promising (Bailey et al., 2015; Salekin, 2002). It also should be noted that previous research has been confounded by varying definitions of

psychopathy and methodological limitations, further complicating conclusions that can be made regarding possible treatments. Future empirical research is needed to further investigate the efficacy of treatments for psychopathy. In sum, identifying the most salient predictors of criminal justice involvement can help focus future research endeavors on further assessment and rehabilitation of these factors.

Within this sample, we found no difference between violent and non-violent offenders on any of the variables with the exception of substance use. This finding further supports the importance of addressing substance use and providing treatment, not only for individuals in the criminal justice system, but even more so for individuals who have committed violent crimes. The importance of substance use may be further illustrated as more severe chronic substance users exhibited poorer hot and cold executive functioning, lower intelligence, higher likelihood of a history of TBI, more psychopathic traits, higher alcohol use, and more psychiatric symptoms.

Strengths and Limitations

The most prominent strength of this study is that it is the first to assess and compare hot and cold executive functioning in a U.S. criminal justice sample. The concept of hot executive functioning has not yet been explicitly examined in any criminal justice population in the world. While cold executive functioning has been examined in other countries, this study is the first to examine cold executive functioning in a U.S. criminal justice sample, which is notable considering that the U.S. has the largest criminal justice population in the world (Walmsley, 2015). Another strength is that this study had a comparison group of individuals who have not been involved in the criminal justice system. This allowed for a direct comparison of executive functioning measures, as well as other relevant psychosocial and psychological factors that have

been commonly found within criminal justice populations, which increases the confidence that observed deficits and difficulties are due to group differences. Given the heterogeneity in the U.S. criminal justice system, another strength of this study was that it investigated differences between violent and nonviolent offenders to assess whether certain factors may be more prevalent in certain types of offenders, which again could inform more specific rehabilitative efforts.

This study had a number of limitations. Most notable is that this study used an online format, which limits the control of the environment. This may be most impactful on the embedded measures as it is difficult to control for any extraneous variables (e.g., limited task engagement, distracting environment) that can affect results. Ideally, these types of cognitive measures are administered in quiet, well-controlled environments to limit the impact of extraneous variables on the results. However, research examining the quality of data obtained from participants on Mechanical Turk suggests that participants produce reliable self-report data (Rand, 2012; Shapiro et al., 2013) and exhibit comparable performances in attention with other samples of convenience on interactive measures (Thomas & Clifford, 2017). The strongest support for the quality of mTurk data comes from replication studies that show high correlations (r = .75 - .83) between data collected online through mTurk and data collected through more traditional laboratory studies (Casler et al., 2013; Clifford & Jerit, 2014; Coppock, 2016; Mullinix et al., 2015; Rand, 2012). Of course, mTurk is not without its limitations. One research study found that participants on mTurk made more careless mistakes than an in-person college student sample (Aruguete et al., 2019), bringing attention to the importance of validity checks on this platform. This study did utilize an embedded validity measure within one of the interactive measures as well as additional validity checks within questionnaires to try to identify individuals

who were insufficiently engaged in the study. Despite these validity checks, a significant number of participants did not complete a single span (i.e., a minimum of two span) on the forward and/or backward components of the Corsi Block Tapping test. There are several possible explanations for this, including misunderstanding the task instructions, inattention, and/or insufficient engagement in the task. However, there were not any identifiable issues with the data from other interactive measures, and thus it is also possible that participants misunderstood the instructions for this particular task or there may have been a glitch in the task itself (e.g., this particular task may not have been compatible with certain devices or internet browsers). Regardless of the reason, it limited the conclusions that could be made regarding working memory in this study.

Another limitation is the use of self-report data and screening measures. Asking individuals about their criminal justice history, psychopathic traits, psychological symptoms, and TBI and substance use histories can be sensitive topics. While there is more anonymity online than while endorsing these factors within the presence of another person, participants may feel hesitant to disclose such information. Additionally, while the use of screening measures was necessary to reduce the burden on participants, they are inherently limiting in the information that can be assessed. For example, additional information on factors related to TBI (e.g., severity, number of TBIs, time since last TBI) and substance use (e.g., acute versus past use, age on onset) could have provided additional information regarding their relationship with criminal justice involvement and executive functioning deficits.

Lastly, as mentioned before, this sample is not representative of a typical criminal justice population. The platform that was used to recruit individuals (i.e., Amazon's mTurk) likely biased the type of participants who may be recruited as individuals have to be aware of the

platform and have access to internet and a computer/laptop. Previous research using mTurk have noted that participants are generally younger (Difallah et al., 2018) and more educated (Shapiro et al., 2013) than the overall population which can affect the generalizability of results. This was also the case in this sample, which was comprised primarily of college-educated individuals who were employed full-time, which is not as representative of the typical demographic makeup of individuals involved in community corrections (Harlow, 2003; Rabuy & Kopf, 2015). Thus, the generalizability of this study to the U.S. criminal justice population may be somewhat limited, although interestingly, even in this higher functioning sample, aspects of cold executive functioning deficits were still noted.

Future Research Directions

Future research could address the limitations noted above. Specifically, conducting the study in person in a private setting would allow for more control over the environment. This could reduce the possibility of distractions in the environment, allow for qualitative observations of test approaches and performance, as well as ensure that task instructions are adequately understood. A more comprehensive evaluation that relies on clinical or diagnostic interviewing to assess for history of TBI, substance use, and psychiatric history may also provide more thorough and accurate data that relies less heavily on self-report data. Additionally, external measures such as urinalyses would also be ideal to assess for more acute substance use, as acute use has been shown to affect executive functioning in ways that can differ from individuals with prolonged abstinence (Schulte et al., 2014; Stavro et al., 2013; Janke van Holst & Schilt, 2011), although this research is mixed as chronic use has also been found to be associated with long-term impairment (Crowe et al., 2020; Di Sclafani et al., 2002). Ideally, ensuring individuals are not actively using would provide more information about more lasting effects on cognition, and

specifically on executive functioning, that would be more applicable to rehabilitative efforts. Similarly, having access criminal records to verify the specific crimes that individuals committed would also provide further reliability of the data to ensure accurate categorization of individuals. Future research should also aim to obtain a more accurate representation of a typical community corrections/criminal justice population. This would improve the generalizability of results.

Considering the heterogeneity in the U.S. criminal justice population, future research could compare prison populations to community corrections populations (and more specifically to individuals on probation). It would be interesting to explore for possible differences in executive functioning, history of TBI, psychopathic traits, substance use, and psychiatric symptoms, given that prison populations generally house more severe (violent) offenders than individuals on probation (Carson, 2020; Kaeble & Alper, 2020). Should differences be found, this may inform treatment and rehabilitation efforts that could be tailored to prison populations and to community corrections populations accordingly.

Conclusion

This study was the first to examine the relationship between hot and cold executive functioning in a U.S. criminal justice sample. Cold executive functioning, and specifically inhibition and cognitive flexibility, was associated with criminal justice involvement, but was not found to be a significant predictor at the multivariate level. Rather, history of TBI, substance abuse, and psychopathic traits were identified as the most significant predictors of criminal justice involvement and future research and rehabilitative efforts should focus on targeting these factors. Hot executive functioning was not found to be associated with criminal justice involvement, although due to possible limitations in this study, hot executive functioning should continue to be explored as a possible factor associated with criminal justice involvement,

because this study had several limitations which may have confounded its ability to find such a relationship. Future research should also continue to examine the relationship between significant predictors of criminal justice involvement (i.e., history of TBI, substance abuse, psychopathic traits), as well as their relationship with hot and cold executive functioning, as consideration of executive functioning deficits is likely to improve treatment and rehabilitation programs. While it is evident that criminal justice populations are complex with many comorbid difficulties, identifying barriers to addressing the most salient and impactful factors can streamline rehabilitative efforts, which is necessary for optimizing outcomes (i.e., reduce recidivism).

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APPENDICES

APPENDIX A

DEMOGRAPHIC FORM

1. Date of Birth (mm/dd/yyyy): _____

2. Sex:
   - O Male
   - O Female

3. What race/ethnicity do you consider yourself? (check one)
   - O White/non-Hispanic
   - O African-American/Black
   - O Hispanic/Latino
   - O Asian/Pacific Islander
   - O American Indian, Native Alaskan, Aleutian, or Eskimo
   - O Bi-racial

4. How much formal education have you completed? (check one)
   - O 8^{th} grade or less
   - O Some high school or trade school instead of high school
   - O High school graduate or GED
   - O Trade school or business school graduate
   - O Some college or associates degree
   - O College graduate
   - O Some graduate courses

5. How many total years of education have you completed _____

6. What best describes your marital status? (check one)
   - O Never been married
   - O Married
   - O Divorced/Separated
   - O Widow

7. What is your employment status?
   - O Unemployed
   - O Part-time employment
   - O Full-time employment
   - O Retired

8. Do you have any colorblindness?
   - O Yes
   - O No

9. How many times have you been arrested? _____

*Skip all remaining questions if ‘0’

10. What crime(s) have you been *convicted* of? Please select all that apply.
    - O Violent crime (such as homicide, assault, robbery)
    - O Property crime (such as burglary, theft, fraud)
    - O Drug crime (such as possession, use, distribution)
    - O Public order crime (such as DUI/DWIs, traffic offenses, weapons charges, court offenses)

11. How many times have you been in jail/prison? _____
    *Skip to question 13 if ‘0’

12. What is the total number of months you have spent in jail/prison? _____

13. Have many times have you been supervised in the community (e.g., probation, parole)? ____
    *Skip question 14 if ‘0’

14. What is the total number of months you have spent supervised in the community? _____

APPENDIX B

HELPS BRAIN INJURY SCREENING TOOL

HELPS BRAIN INJURY SCREENING TOOL

H Have you ever **H**it your **H**ead or been **H**it on the **H**ead? □ Yes □ No

Note: Prompt client to think about all incidents that may have occurred at any age, even those that did not seem serious: vehicle accidents, falls, assault, abuse, sports, etc. Screen for domestic violence and child abuse, and also for service related injuries. A TBI can also occur from violent shaking of the head, such as being shaken as a baby or child.

E Were you ever seen in the **E**mergency room, hospital, or by a doctor because of an injury to your head? □ Yes □ No

Note: Many people are seen for treatment. However, there are those who cannot afford treatment, or who do not think they require medical attention.

L Did you ever **L**ose consciousness or experience a period of being dazed and confused because of an injury to your head? □ Yes □ No

Note: People with TBI may not lose consciousness but experience an "alteration of consciousness." This may include feeling dazed, confused, or disoriented at the time of the injury, or being unable to remember the events surrounding the injury.

P Do you experience any of these **P**roblems in your daily life since you hit your head? □ Yes □ No

Note: Ask your client if s/he experiences any of the following problems, and ask when the problem presented. You are looking for a combination of two or more problems that were not present prior to the injury.

- □ headaches
- □ dizziness
- □ anxiety
- □ depression
- □ difficulty concentrating
- □ difficulty remembering
- □ difficulty reading, writing, calculating
- □ poor problem solving
- □ difficulty performing your job/school work
- □ change in relationships with others
- □ poor judgment (being fired from jobs, arrests, fights)

S Any significant **S**icknesses? □ Yes □ No

Note: Traumatic brain injury implies a physical blow to the head, but acquired brain injury may also be caused by medical conditions, such as: brain tumor, meningitis, West Nile virus, stroke, seizures. Also screen for instances of oxygen deprivation such as following a heart attack, carbon monoxide poisoning, near drowning, or near suffocation.

Scoring the HELPS Screening Tool

A HELPS screening is considered positive for a possible TBI when the following 3 items are identified:

1.) An event that could have caused a brain injury (yes to H, E **or** S), **and**

2.) A period of loss of consciousness or altered consciousness after the injury or another indication that the injury was severe (yes to L or E), **and**

3.) The presence of two or more chronic problems listed under P that were not present before the injury.

Note:

③ A positive screening is **not sufficient to diagnose TBI** as the reason for current symptoms and difficulties - other possible causes may need to be ruled out

- **Some individuals could present exceptions** to the screening results, such as people who do have TBI-related problems but answered “no” to some questions
- Consider positive responses within the context of the person’s self-report and documentation of altered behavioral and/or cognitive functioning

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The original HELPS TBI screening tool was developed by M. Picard, D. Scarisbrick, R. Paluck, 9/91, International Center for the Disabled, TBI-NET, U.S. Department of Education, Rehabilitation Services Administration, Grant #H128A00022. The Helps Tool was updated by project personnel to reflect recent recommendations by the CDC on the diagnosis of TBI. See http://www.cdc.gov/ncipc/pub-res/tbi_toolkit/physicians/mtbi/diagnosis.htm.

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APPENDIX C

SHORT DARK TRIAD

Please rate your agreement or disagreement with each item using the following guidelines.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Psychopathy

1. I like to get revenge on authorities.
2. I avoid dangerous situations.
3. Payback needs to be quick and nasty.
4. People often say I'm out of control.
5. It's true that I can be mean to others.
6. People who mess with me always regret it.
7. I have never gotten into trouble with the law.
8. I enjoy having sex with people I hardly know
9. I'll say anything to get what I want.

Note: Numbers 2 and 7 are reverse-scored.

APPENDIX D

DEPRESSION, ANXIETY AND STRESS SCALE - 21

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you **over the past week**. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree or a good part of time
3 Applied to me very much or most of the time

1 (a)	I was aware of dryness of my mouth	0	1	2	3
2 (d)	I couldn't seem to experience any positive feeling at all	0	1	2	3
3 (a)	I experienced breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
4 (d)	I found it difficult to work up the initiative to do things	0	1	2	3
5 (a)	I experienced trembling (e.g. in the hands)	0	1	2	3
6 (a)	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
7 (d)	I felt that I had nothing to look forward to	0	1	2	3
8 (d)	I felt down-hearted and blue	0	1	2	3
9 (a)	I felt I was close to panic	0	1	2	3
10 (d)	I was unable to become enthusiastic about anything	0	1	2	3
11 (d)	I felt I wasn't worth much as a person	0	1	2	3
12 (a)	I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat)	0	1	2	3
13 (a)	I felt scared without any good reason	0	1	2	3
14 (d)	I felt that life was meaningless	0	1	2	3

APPENDIX E

ALCOHOL, SMOKING AND SUBSTANCE INVOLVEMENT SCREENING TEST

A WHO - ASSIST V3 . 0

INTRODUCTION ***(Please read to patient)***

Thank you for agreeing to take part in this brief interview about alcohol, tobacco products and other drugs. I am going to ask you some questions about your experience of using these substances across your lifetime and in the past three months. These substances can be smoked, swallowed, snorted, inhaled, injected or taken in the form of pills (show drug card).

Some of the substances listed may be prescribed by a doctor (like amphetamines, sedatives, pain medications). For this interview, we will not record medications that are used as prescribed by your doctor. However, if you have taken such medications for reasons other than prescription, or taken them more frequently or at higher doses than prescribed, please let me know. While we are also interested in knowing about your use of various illicit drugs, please be assured that information on such use will be treated as strictly confidential.

NOTE: BEFORE ASKING QUESTIONSS, GIVE ASSIST RESPONSE CARD TO PATIENT

Question 1

(if completing follow-up please cross check the patient's answers with the answers given for Q1 at baseline. Any differences on this question should be queried)

In your life, which of the following substances have you ever used? *(NON--MEDICAL USE ONLY)*	**No**	**Yes**
a. Tobacco products (cigarettes, chewing tobacco, cigars, etc.)	**0**	**3**
b. Alcoholic beverages (beer, wine, spirits, etc.)	**0**	**3**
c. Cannabis (marijuana, pot, grass, hash, etc.)	**0**	**3**
d. Cocaine (coke, crack, etc.)	**0**	**3**
e. Amphetamine type stimulants (speed, diet pills, ecstasy, etc.)	**0**	**3**
f. Inhalants (nitrous, glue, petrol, paint thinner, etc.)	**0**	**3**
g. Sedatives or Sleeping Pills (Valium, Serepax, Rohypnol, etc.)	**0**	**3**
h. Hallucinogens (LSD, acid, mushrooms, PCP, Special K, etc.)	**0**	**3**
i. Opioids (heroin, morphine, methadone, codeine, etc.)	**0**	**3**
j. Other - specify:	**0**	**3**

Probe if all answers are negative:
"Not even when you were in school?"

If "No" to all items, stop interview.

If "Yes" to any of these items, ask Question 2 for each substance ever used.

Question 2

In the past three months, how often have you used the substances you mentioned *(FIRST DRUG, SECOND DRUG, ETC)*?	Never	Once or Twice	Monthly	Weekly	Daily or Almost Daily
a. Tobacco products (cigarettes, chewing tobacco, cigars, etc.)	0	2	3	4	6
b. Alcoholic beverages (beer, wine, spirits, etc.)	0	2	3	4	6
c. Cannabis (marijuana, pot, grass, hash, etc.)	0	2	3	4	6
d. Cocaine (coke, crack, etc.)	0	2	3	4	6
e. Amphetamine type stimulants (speed, diet pills, ecstasy, etc.)	0	2	3	4	6
f. Inhalants (nitrous, glue, petrol, paint thinner, etc.)	0	2	3	4	6
g. Sedatives or Sleeping Pills (Valium, Serepax, Rohypnol, etc.)	0	2	3	4	6
h. Hallucinogens (LSD, acid, mushrooms, PCP, Special K, etc.)	0	2	3	4	6
i. Opioids (heroin, morphine, methadone, codeine, etc.)	0	2	3	4	6
j. Other - specify:	0	2	3	4	6

If "Never" to all items in Question 2, skip to Question 6.

If any substances in Question 2 were used in the previous three months, continue with Questions 3, 4 & 5 for each substance used.

Question 3

During the past three months, how often have you had a strong desire or urge to use *(FIRST DRUG, SECOND DRUG, ETC)*?	Never	Once or Twice	Monthly	Weekly	Daily or Almost Daily
a. Tobacco products (cigarettes, chewing tobacco, cigars, etc.)	0	3	4	5	6
b. Alcoholic beverages (beer, wine, spirits, etc.)	0	3	4	5	6
c. Cannabis (marijuana, pot, grass, hash, etc.)	0	3	4	5	6
d. Cocaine (coke, crack, etc.)	0	3	4	5	6
e. Amphetamine type stimulants (speed, diet pills, ecstasy, etc.)	0	3	4	5	6
f. Inhalants (nitrous, glue, petrol, paint thinner, etc.)	0	3	4	5	6
g. Sedatives or Sleeping Pills (Valium, Serepax, Rohypnol, etc.)	0	3	4	5	6
h. Hallucinogens (LSD, acid, mushrooms, PCP, Special K, etc.)	0	3	4	5	6
i. Opioids (heroin, morphine, methadone, codeine, etc.)	0	3	4	5	6
j. Other - specify:	0	3	4	5	6

Question 4

During the past three months, how often has your use of *(FIRST DRUG, SECOND DRUG, ETC)* led to health, social, legal or financial problems?	Never	Once or Twice	Monthly	Weekly	Daily or Almost Daily
a. Tobacco products (cigarettes, chewing tobacco, cigars, etc.)	0	4	5	6	7
b. Alcoholic beverages (beer, wine, spirits, etc.)	0	4	5	6	7
c. Cannabis (marijuana, pot, grass, hash, etc.)	0	4	5	6	7
d. Cocaine (coke, crack, etc.)	0	4	5	6	7
e. Amphetamine type stimulants (speed, diet pills, ecstasy, etc.)	0	4	5	6	7
f. Inhalants (nitrous, glue, petrol, paint thinner, etc.)	0	4	5	6	7
g. Sedatives or Sleeping Pills (Valium, Serepax, Rohypnol, etc.)	0	4	5	6	7
h. Hallucinogens (LSD, acid, mushrooms, PCP, Special K, etc.)	0	4	5	6	7
i. Opioids (heroin, morphine, methadone, codeine, etc.)	0	4	5	6	7
j. Other - specify:	0	4	5	6	7

Question 5

During the past three months, how often have you failed to do what was normally expected of you because of your use of *(FIRST DRUG, SECOND DRUG, ETC)*?	Never	Once or Twice	Monthly	Weekly	Daily or Almost Daily
a. Tobacco products					
b. Alcoholic beverages (beer, wine, spirits, etc.)	0	5	6	7	8
c. Cannabis (marijuana, pot, grass, hash, etc.)	0	5	6	7	8
d. Cocaine (coke, crack, etc.)	0	5	6	7	8
e. Amphetamine type stimulants (speed, diet pills, ecstasy, etc.)	0	5	6	7	8
f. Inhalants (nitrous, glue, petrol, paint thinner, etc.)	0	5	6	7	8
g. Sedatives or Sleeping Pills (Valium, Serepax, Rohypnol, etc.)	0	5	6	7	8
h. Hallucinogens (LSD, acid, mushrooms, PCP, Special K, etc.)	0	5	6	7	8
i. Opioids (heroin, morphine, methadone, codeine, etc.)	0	5	6	7	8
j. Other - specify:	0	5	6	7	8

Ask Questions 6 & 7 for all substances ever used (i.e. those endorsed in Question 1)

Question 6

Has a friend or relative or anyone else ever expressed concern about your use of *(FIRST DRUG, SECOND DRUG, ETC.)?*	**No, Never**	**Yes, in the past 3 months**	**Yes, but not in the past 3 months**
a. Tobacco products (cigarettes, chewing tobacco, cigars, etc.)	**0**	**6**	**3**
b. Alcoholic beverages (beer, wine, spirits, etc.)	**0**	**6**	**3**
c. Cannabis (marijuana, pot, grass, hash, etc.)	**0**	**6**	**3**
d. Cocaine (coke, crack, etc.)	**0**	**6**	**3**
e. Amphetamine type stimulants (speed, diet pills, ecstasy, etc.)	**0**	**6**	**3**
f. Inhalants (nitrous, glue, petrol, paint thinner, etc.)	**0**	**6**	**3**
g. Sedatives or Sleeping Pills (Valium, Serepax, Rohypnol, etc.)	**0**	**6**	**3**
h. Hallucinogens (LSD, acid, mushrooms, PCP, Special K, etc.)	**0**	**6**	**3**
i. Opioids (heroin, morphine, methadone, codeine, etc.)	**0**	**6**	**3**
j. Other – specify:	**0**	**6**	**3**

Question 7

Have you ever tried and failed to control, cut down or stop using *(FIRST DRUG, SECOND DRUG, ETC.)?*	**No, Never**	**Yes, in the past 3 months**	**Yes, but**
a. Tobacco products (cigarettes, chewing tobacco, cigars, etc.)	**0**	**6**	**3**
b. Alcoholic beverages (beer, wine, spirits, etc.)	**0**	**6**	**3**
c. Cannabis (marijuana, pot, grass, hash, etc.)	**0**	**6**	**3**
d. Cocaine (coke, crack, etc.)	**0**	**6**	**3**
e. Amphetamine type stimulants (speed, diet pills, ecstasy, etc.)	**0**	**6**	**3**
f. Inhalants (nitrous, glue, petrol, paint thinner, etc.)	**0**	**6**	**3**
g. Sedatives or Sleeping Pills (Valium, Serepax, Rohypnol, etc.)	**0**	**6**	**3**
h. Hallucinogens (LSD, acid, mushrooms, PCP, Special K, etc.)	**0**	**6**	**3**
i. Opioids (heroin, morphine, methadone, codeine, etc.)	**0**	**6**	**3**
j. Other – specify:	**0**	**6**	**3**

Question 8

	No, Never	Yes, in the past 3 months	Yes, but not in the past 3 months
Have you <u>ever</u> used any drug by injection? ***(NON- MEDICAL USE ONLY)***	**0**	**2**	**1**

IMPORTANT NOTE:

Patients who have injected drugs in the last 3 months should be asked about their pattern of injecting during this period, to determine their risk levels and the best course of intervention.

PATTERN OF INJECTING	INTERVENTION GUIDELINES
Once weekly or less or Fewer than 3 days in a row	Brief Intervention including "risks associated with injecting" card
More than once per week or 3 or more days in a row	Further assessment and more intensive treatment*

HOW TO CALCULATE A SPECIFIC SUBSTANCE INVOLVEMENT SCORE .

For each substance (labelled a. to j.) add up the scores received for questions 2 through 7 inclusive. Do not include the results from either Q1 or Q8 in this score. For example, a score for cannabis would be calculated as: Q2c + Q3c + Q4c + Q5c + Q6c + Q7c

Note that Q5 for tobacco is not coded, and is calculated as: Q2a + Q3a + Q4a + Q6a + Q7a

THE TYPE OF INTERVENTION IS DETERMINED BY THE PATIENT'S SPECIFIC SUBSTANCE INVOLVEMENT SCORE

	Record specific substance score	no intervention	receive brief intervention	more intensive treatment *
a. tobacco		**0 - 3**	**4 - 26**	**27 +**
b. alcohol		**0 - 10**	**11 - 26**	**27 +**
c. cannabis		**0 - 3**	**4 - 26**	**27 +**
d. cocaine		**0 - 3**	**4 - 26**	**27 +**
e. amphetamine		**0 - 3**	**4 - 26**	**27 +**
f. inhalants		**0 - 3**	**4 - 26**	**27 +**
g. sedatives		**0 - 3**	**4 - 26**	**27 +**
h. hallucinogens		**0 - 3**	**4 - 26**	**27 +**
i. opioids		**0 - 3**	**4 - 26**	**27 +**

j. other drugs		**0 - 3**	**4 - 26**	**27 +**

Specific Substance Involvement Scores

Substance	Score	Risk Level
a. Tobacco products		**0-3 Low** **4-26 Moderate** **27 + High**
b. Alcoholic Beverages		**0-10 Low** **11-26 Moderate** **27 + High**
c. Cannabis		**0-3 Low** **4-26 Moderate** **27 + High**
d. Cocaine		**0-3 Low** **4-26 Moderate** **27 + High**
e. Amphetamine type stimulants		**0-3 Low** **4-26 Moderate** **27 + High**
f. Inhalants		**0-3 Low** **4-26 Moderate** **27 + High**
g. Sedatives or Sleeping Pills		**0-3 Low** **4-26 Moderate** **27 + High**
h. Hallucinogens		**0-3 Low** **4-26 Moderate** **27 + High**
i. Opioids		**0-3 Low** **4-26 Moderate** **27 + High**
j. Other - specify		**0-3 Low** **4-26 Moderate** **27 + High**