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Substance Use, Neurocognitive Deficits, and Criminal Recidivism

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Abstract

Many offenders demonstrate substance use and neurocognitive impairments. Substance use directly impacts executive functioning due to poor impulse control, leading to impaired decision-making. Substance use and neurocognitive deficits also contribute to recidivism. Incarcerated individuals with substance use disorder have higher rates of recidivism, and executive dysfunction has been shown to contribute to recidivism due to low behavioral inhibition skills and deficiency with cognitive flexibility. There is a discontinuity in literature, however, since many studies only investigate either substance use or neurocognitive deficits to predict recidivism. However, it is important to examine the interaction of these factors to predict future criminal behavior. This archival study investigated substance use and neurocognitive functioning on 95 incarcerated individuals to analyze whether recidivism could be predicted. Surprisingly, no significant relationships were found in the current study. It is possible that limitations related to the sample, methods, and statistical validity resulted in these unexpected results. However, the strong theoretical foundation of this study demonstrated that more research should investigate the relationships among substance use, neurocognitive functioning, and criminal recidivism to inform clinical practice and policymaking with those involved in the criminal justice system.

Keywords: substance use, neurocognitive deficits, recidivism, offenders

Substance Use, Neurocognitive Deficits, and Criminal Recidivism

In the United States criminal justice system, many inmates are known to be affected by substance use (Bates et al., 2002) and neurocognitive dysfunctions (Barbosa & Monteiro, 2008). There are many studies regarding the relationship between substance use and neurocognitive impairments, but the research of recidivism with substance use or neurocognitive deficits is somewhat lacking. Nonetheless, previous studies emphasized the importance of the phenomenon between substance use and neurocognitive impairments in regard to criminal recidivism.

The current project begins with a review of substance use, neurocognitive deficits, and criminal recidivism, and if future criminal activity could be predicted by measuring substance use and neurocognitive impairments. First, the literature supporting the importance of substance use and recidivism is reviewed. Then, the literature supporting the importance of neurocognitive impairments and recidivism is examined. Lastly, the literature reinforcing the interaction between substance use and neurocognitive abilities is investigated to determine whether it affects future criminal activity. This literature provides the foundation for the current study investigating the relationships of substance use, neurocognitive impairments, and recidivism in an archival dataset of incarcerated individuals.

Substance Use and Recidivism

The American Psychiatric Association (2013) defined substance use disorder as a pathological pattern of behavior that was related to any type of substances. This disorder ranges from mild to severe on the number of symptoms. To be diagnosed, individuals need to meet certain level of criteria such as impaired control, social impairments and risky use. Unfortunately, about half of incarcerated individuals tend to meet criteria for substance use disorder (Baillargeon et al., 2010). Compared to that number, only a small number of studies

focused solely on substance use and criminal recidivism. Furthermore, comorbidity of mental illness and substance use was a common occurrence (2010). Not surprisingly, compared to the general population, the prison population had more individuals who exhibited mental illness. More importantly, more than half of the prison inmates met criteria for substance use disorder (2010). Comorbidity of mental illness and substance use disorder was shown to have poorer prognosis than having a single disorder as patients with dual diagnosis faced difficulties in receiving proper care for both illnesses (Wilson et al., 2014). To avoid criminal recidivism, many offenders attempted to find care for their illnesses after their release from prison, but they were faced with stigma for dual diagnosis, in addition to having served time in jail (Baillargeon et al., 2010).

Many offenders suffer from alcohol and drug dependence, which is closely related to criminal activities (Håkansson & Berglund, 2012). Baillargeon and colleagues (2010) discovered that comorbidity with substance use disorder and mental illness showed poorer prognosis than having just one disorder. The comorbidity of substance use disorder and a major psychiatric disorder (e.g., major depressive disorder, bipolar disorder, or schizophrenia) was exacerbated by homelessness and suicidality, which put these individuals at higher risk for reincarceration. Wilson and colleagues (2011) also supported the idea that comorbidity was the most predictive factor of criminal recidivism, especially if it was combined with disorders such as schizophrenia. However, the severity or persistence of the illness was not a contributing factor to recidivism. This evidence was also supported by Walter and colleagues (2011), but they stated that the comorbidity of personality disorder and substance use disorder was the biggest contributing factor for future criminal behavior.

Each study differed significantly in their measure of substance use. Substance use was measured by Texas Christian University Drug Screen II (TCUDS II) and Addiction Severity Index (ASI), which are two valid measures of assessment (Baillargeon et al., 2010; Håkansson & Berglund, 2012). Wilson and colleagues (2011) used Medicaid and prison data from 2001 to 2003 to determine whether inmates were diagnosed with any mental illness prior to entering the justice system. By using this large database, they suggested that substance use did contribute to criminal recidivism. Similar findings were found by other researchers where higher rates of substance use increased the risk for future criminal behavior (Baillargeon et al., 2010; Håkansson & Berglund, 2012; Walter et al., 2011).

Since many prison inmates carry a dual diagnosis of substance use disorder and mental illness compared to the general population, it is crucial to recognize that criminal recidivism is a societal problem. Many individuals with mental illness are more likely to use substances in lieu of their psychiatric medications, and may be more likely to engage in violent acts and have more encounters with police (Swartz et al., 1998). High rates of violent acts were associated with substance use and that could be the reasons behind recidivism. To help individuals adjust to society successfully, the rates of recidivism and its mitigation needed to be studied thoroughly.

Neurocognitive Deficits and Recidivism

The relationship between neurocognitive deficits and criminal recidivism was only studied in a handful of studies even though more than half of the offenders studied by Barbosa & Monteiro (2008) showed symptoms of neurocognitive impairments, which is a part of executive functioning. Executive functioning has been widely used to measure neurocognitive skills, which is defined as mental capacities that included: defining objects, anticipating potential consequences, planning future actions, initiating behaviors, controlling actions, exhibiting

cognitive flexibility and organizing behaviors (Groth-Marnat, 2000; Pineda 1996; Pineda, Cadavid, & Mancheno, 1996; Stuss & Benson, 1986; Weyandt & Willis, 1994). However, the results of these studies demonstrate the importance of this relationship since re-offense appeared to be related to self-regulation, which is a part of executive functioning (Meijers et al., 2015). They conducted their study by dividing the offenders into violent and nonviolent groups, and assessed their neurocognitive functions by using Wisconsin Card Sorting Test (WCST), Trail Making Test Part A and B (Trails A and B), and Behavioral Assessment of the Dysexecutive Syndrome (BADS). Level of inhibition was measured by the WCST; inhibition and future planning was measured by Trails A and B; and general executive functioning was measured by the BADS. Violent offenders had trouble with set-shifting while nonviolent offenders had issues with inhibition. However, the major problem that both types of offenders faced was with working memory. Individuals from both groups had difficulties with cognitive flexibility, which measured the ability to change perspectives or thoughts in certain situations. Barbosa and Monteiro (2008) also used the BADS to assess executive dysfunction such as selective attention and actions to plan and organize. In addition, learning disorder and Attention Hyperactivity Disorder (ADHD), which impacted executive functioning, were significant factors that predicted criminal behavior (Langevin & Curnoe, 2011). Based on previous literature, recidivism may be caused by inmates who had significant difficulties learning new rules and controlling their impulses.

Another factor to observe with criminals who recidivated was their level of aggression, since aggression could be related to recidivism indirectly by criminal behavior. Nazmie and colleagues (2013) found that the offenders who demonstrated poor planning, cognitive flexibility, and inhibition were more likely to engage in aggressive manner. Recurrent aggressive

behavior could be related to frontal lobe damage that could possibly contribute to criminality due to poor reasoning (Brower & Price, 2001). However, this idea of frontal lobe damage leading to violent criminal behavior was not heavily supported by Ogilvie and colleagues (2011) since they argued that executive functioning was interconnected with other cognitive functions. Furthermore, Greenfield and Valliant (2007) disputed that moral reasoning did not related to aggression since many violent offenders demonstrated high moral reasoning, but they made the conscious choice to ignore it.

Offenders are unlikely to be assessed for their neurocognitive abilities upon their entry to prison (Kavanaugh et al., 2010). Not only is there a lack of data on neurocognitive abilities, but it is also difficult to accurately measure abilities like executive functioning. Many inmates may not demonstrate significant neurocognitive impairments on the assessments, but they may exhibit significant difficulties with real-life tasks that required executive functioning (Brower & Price, 2001). There were mixed findings that neurocognitive deficits were difficult to detect with assessments with offenders. Furthermore, the different results with various neuropsychological assessments indicated the need to further investigate the association between neurocognitive impairments and recidivism.

Substance Use, Neurocognitive Deficits, and Criminal Recidivism

Previous studies demonstrate the relationship between substance use and neurocognitive impairments, which was shown in brain scans as well as batteries of neuropsychological assessments in offenders. Neurocognitive deficits were measured by a variety of instruments such as WCST, BADS, Delis-Kaplan Executive Function System (D-KEFS), Symbol Digit Modalities Test (SDMT) and Trails A and B (Broomhall, 2005; Grant et al., 2000; Manning, Verdejo-Garcia, & Lubman, 2017; O'Malley et al., 1992, Stavro et al., 2013). These

neuropsychological assessments examined executive functions which included working memory, planning, goal selection, cognitive flexibility, and initiation and inhibition of actions. While there was a general consensus that neurocognitive impairments were caused by the damages to prefrontal and temporal brain areas (Bates et al., 2002; Broomhall, 2005; Manning et al., 2017; Meet, Clark, & Solana, 1989; O'Malley et al., 1992; Rogers & Robbins, 2001; Schlaepfer et al., 2006), two studies demonstrated that the whole brain was affected by drugs and could potentially cause impairments to neurocognitive abilities (Grant et al., 2000; Stavro et al., 2013).

According to previous studies, different substances illustrate distinct impairments within the brain. With alcohol use disorder, brain volume changes were observed along with neurocognitive difficulties with the loss of cerebral tissue and larger ventricles (Bates et al., 2002; Schlaepfer et al., 2006). Chronic and heavy alcohol drinkers even demonstrated personality changes due to their usage and their recovery of executive functioning happened at different rates (Bates et al., 2002). Further, Bates and colleagues (2002) argued that neurocognitive dysfunctions subsided within six months of sobriety, while Stavro and colleagues (2013) stated that recovery took at least one year of sobriety for functions to be restored. Schlaepfer and colleagues (2006) argued that due to the volume loss of frontal white matter, full rehabilitation of neurocognitive functions was unlikely.

About half of chronic cocaine users showed impairments on neuropsychological screening exams, which demonstrated problems with concentration and working memory (O'Malley et al., 1992). Rogers and Robbins (2001) also found that cocaine users had difficulties not only with attention and working memory, but also with psychomotor speed and manual dexterity. Cognitive functions were restored when cocaine usage was disrupted in conjunction with cognitive rehabilitation (Manning et al., 2017).

Additionally, Tuominen (2018) evaluated that both neurocognitive and academic deficits and substance use were risk factors for criminal offense in Finnish offenders. This was the first study that recognized the importance of evaluating the connections between neurocognitive deficits and substance dependence in regard to criminal behavior. Furthermore, offenders with several convictions displayed comorbidity of neurocognitive dysfunctions and substance dependence. Since this study was conducted with Finnish offenders, generalizations to offenders in the United States was difficult. However, the general trend of findings indicated that substance use impacted neurocognitive abilities especially with attention span, memory, and cognitive flexibility. Based on previous studies, neurocognitive deficit has been a constant, but an overlooked factor with offenders in the United States as well. The interaction of these two factors of substance use and neurocognitive impairments could predict future criminal behavior. Since criminal recidivism is an issue that impacts our society greatly, and the data from the U.S. Department of Justice (2018) indicated that 68% of released offenders recidivated to the criminal justice system within three years, the risk factors for recidivism needs to be examined. This literature provides the foundation for the current study investigating the relationship of substance use, neurocognitive impairments, and criminal recidivism in an archival dataset of incarcerated individuals.

Current Study

The current study aimed to examine whether criminal recidivism could be predicted by observing offenders' substance use history and neurocognitive deficits. Based on previous literature, it was predicted that substance use and neurocognitive dysfunctions were crucial factors that foretold whether an offender would commit another crime. This study expanded on past literature suggesting that there was sufficient evidence for predictability of recidivism based

on an offender's substance use history and neurocognitive performance. Specifically, it was hypothesized that:

Hypothesis 1: Substance use history would predict criminal recidivism,

Hypothesis 2: Neurocognitive impairments would predict criminal recidivism.

Hypothesis 3: Substance use history and neurocognitive impairments would interact to predict criminal recidivism.

Method

Research Design

The current study used archival data to determine whether substance use and neurocognitive deficits could predict criminal recidivism. The original study (LaDuke, 2015) explored whether results from neuropsychological assessments predicted violence risk. The current study expanded upon the original study by focusing on the data from neuropsychological assessments in a different way by doing a secondary analysis. The current study measured criminal recidivism by analyzing the participants' substance use and neurocognitive abilities.

Participants

All participants in the original study were residents of a private correctional facility in a large mid-Atlantic state. Women were excluded due to insufficient number of women residents at the correctional facility, and because violence risk factors vary for this population. Individuals from county jail were excluded since the research aimed to study participants who were already sentenced. Individuals who had violated their parole were excluded to ensure consistency that all participants were directly from correctional facilities, not from the community. Individuals with major psychotic and mood disorders were excluded due to the variation of violence risk factors for the population. Individuals with blindness, deafness, and upper extremity impairments were

excluded so that their performance on the assessments were not affected by sensory, perceptual, or motor disabilities. Comprehension of spoken and written English was required to give informed consent to the study and to complete numerous study measures.

The participants were recruited between February 2014 and April 2015. From this facility, a total of 217 individuals were randomly selected and approached for participation, from which 122 individuals were recruited to participate, and 100 participants were consented to participate. Those who were not consented were not interested in the study anymore (n=21) or had conflicting work schedules (n=1). From the 100 participants who consented for the original study, 96 participants completed Session 1 and 89 participants completed Session 2. Those who did not complete the second session were not interested in the study any longer (n=3), administratively returned before the second session (n=2), or had a work schedule conflict (n=1), making the attrition rate of 6% between the two sessions. Out of the 96 participants, one participant was a pilot participant and was excluded from further analysis due to the difference in administration. The final sample included 95 participants who completed Session 1 and 89 participants who completed both Session 1 and Session 2.

Out of the 95 participants, 53 (56%) identified as Black of African American; 26 (27%) as White of Caucasian; 18 (19%) as Hispanic, Latino, or Spanish; 7 (7%) as American Indian or Native Alaskan; 1 (1%) as Asian or Asian American; 7 as Other. The average age of participants was 33.71 years (SD = 10.75 years). Average education level was 11.92 years (SD = 1.49 years). The following participants reported their handedness: 74 (78%) reported right-hand dominance, 10 (11%) reported left-hand dominance, and 11 (12%) did not report.

Procedure

The original study gathered data from February 2014 to April 2015. Participants were selected at random and given a brief description of the study and screening of inclusion and exclusion criteria. Session 1 started with an informed consent and if the participants agreed to the study, they signed the consent form to demonstrate their voluntary participation. Then, participants' demographic information was gathered verbally and Wide Range Assessment Test (WRAT 4) was given to determine participants' English level. Session 1 then included the following: Beck Depression Inventory (BDI-II), Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID), Color-Word Interference Test (CWIT), FAS Task (FAS), Animal Naming Task (Animals), Trail Making Test (TMT), Ruff 2 & 7 Selective Attention Test (Ruff 2 & 7), and Symbol Digit Modalities Test (SDMT), which were given to participants in a randomized order to ensure that the order of the assessments were not a factor for analysis.

On average, Session 2 took place after 6.96 days after Session 1. In the beginning of Session 2, all participants were reminded of their consent verbally by the investigator and participants were asked to sign the continued consent form. Session 2 included the following: Simple Screening Instrument for Substance Abuse (SSI-SA), Wechsler Abbreviated Scale of Intelligence (WASI-II), Barkley Adult ADHD Rating Scale (BAARS-IV), Structured Clinical Interview for DSM-IV Axis II Personality Disorders (SCID-II), Triarchic Psychopathy Measure (TriPM), and Aggression Questionnaire (AQ). After the conclusion of Session 2, the investigator debriefed each participant.

Upon their release from the correctional facility, all participants' institutional records were reviewed. This included their scores on the Level of Service/Case Management Inventory (LS/CMI) and Texas Christian University Drug Screen II (TCUDS II), which were completed by

institutional staff members within two weeks of their entry into the correctional facility. Approximately 2 years following their release from the correctional facility, all participants' publicly available criminal justice records were reviewed for the original state of data collection as well as all bordering states (i.e., three states total). This included any new charges incurred since their release as a measure of recidivism.

Subsequently, all study files were reviewed and relevant variables were entered into an electronic dataset. Each file was randomly assigned to two trained research assistants for independent data entry. All files were then merged into a single dataset and compared for consistency. This final dataset represents the archival data used in all analyses in this study.[1]

Measures

Neurocognitive deficits

To evaluate neurocognitive deficits, executive functioning was specifically assessed, which involved impulsivity, attention, decision-making, reversal learning and cognitive flexibility (LaDuke, 2015). Specifically, a composite score was created based on scores from the following: Trail Making Test Part B (Trails B) and Color-Word Interference Test (CWIT).

Trail Making Test Part B (Trails B). Trails B was created by Reitan (1958) to measure executive functioning, which included, attention, impulsivity, working memory, set-shifting, and cognitive flexibility. This measure specifically asks participants to alternate between numbered and lettered circles in ascending order (i.e., 1→A→2→B→3→C and so on). Trails B's score is based on the participant's completion time of the test, which was then converted to a standardized score. Faster completion of the assessment demonstrates higher executive

[1] The final dataset could not be completed due to COVID19; therefore, every data point relevant for the current study with disagreement among the coders was removed from further analysis (i.e., n=1 for CWIT Inhibition score; n=0 for CWIT Switch; n=1 for Trails B).

functioning. This assessment showed high internal consistency, high test-retest reliability, and high convergent validity (Strauss et al., 2006).

Color-Word Interference Test (CWIT). The CWIT is part of Delis-Kaplan Executive Function System (Delis-Kaplan et al., 2001b). There are four conditions to this assessment: Color naming (Condition 1), Color-word reading (Condition 2), Inhibition of a response (Condition 3), and Cognitive flexibility (Condition 4). Each condition measured Total Uncorrected Errors, Total Self-Corrected Errors, and Total Time to Complete to get the Raw Score. Then, the Raw Score was converted to a Scaled Score. The current study only used Condition 3 and Condition 4 since those conditions measure impulsivity and cognitive flexibility, which are part of executive functioning. To measure impulsivity, the Contrast Scaled Score for Inhibition and Standard Score for Inhibition Errors were used, which are both from Condition 3. Cognitive flexibility was measured by using the Contrast Scaled Score for Inhibition/Switching and Standard Scores for Inhibition/Switching Errors, which are both from Condition 4. Lower scores reflected higher impairments for both conditions. This assessment demonstrated good test-retest reliability and convergent validity (Delis et al., 2001b).

Substance Use

Substance use was measured by Simple Screening Instrument for Substance Abuse (SSI-SA). The SSI-SA was designed to measure substance abuse and dependence for individuals, based on their substance use-related behaviors within the prior 6 months. This measure consists of 16 items of yes-or-no questions measuring five domains: substance consumption, preoccupation and loss of control, adverse consequences, problem recognition, and tolerance and withdrawal. The SSI-SA is scored on a scale from 0 to 14, with any score greater than or equal to 4 being considered moderate to high, and therefore indicating a need for further assessment. This

instrument has demonstrated high test-retest reliability and high sensitivity (Peters et al., 2000). In this study, substance use was operationalized into none to low (SSA-SA total score = 0-1), minimal (SSA-SA total score = 2-3), or moderate to high (SSA-SA total score = 4 or above).

Recidivism

Recidivism was operationalized as any new charges incurred by participants within approximately 2 years of their release in the original state of data collection, or any bordering states (i.e., three states total).

Statistical Plan

First, each of the variables selected to represent neurocognitive deficits were transformed to the same standardized metric (i.e., z-scores) and direction (i.e., higher scores indicating worse performance). Preliminary correlational analyses of these transformed variables were conducted, and they were averaged together to form a composite score of neurocognitive deficits. Next, a hierarchical logistic regression was conducted to predict criminal recidivism, based on participants' substance use and neurocognitive deficits. The first hypothesis was tested by using substance use as the independent variable; the second hypothesis was tested by adding neurocognitive deficits as an independent variable, controlling for substance use; the third hypothesis was tested by adding the interaction between substance use and neurocognitive deficits. Significance was interpreted using test statistics, *p*-values (i.e., $p < .05$), variance explained, and odds ratios.

Results

Preliminary Analyses

Preliminary correlational analyses of the transformed variables measuring neurocognitive deficits found significant relationships between some, but not all variables (Table 1, next page).

Despite the somewhat limited statistical relationships among these variables, they nonetheless measure several theoretically related constructs that represent different aspects of executive functioning. Therefore, these measures were still combined into a composite measure of neurocognitive deficits based on theoretical grounds.

Table 1

Summary of Correlational Analyses (r) for Variables Measuring Neurocognitive Deficits

Variable	1	2	3
1. Trail Making Test Trial B	-		
2. CWIT Inhibition	.002	-	
3. CWIT Inhibition/Switching	.082	.383**	-

Note. CWIT = Color-Word Interference Test. * p < .05; ** p < .01; *** p < .001.

Hypothesis Testing

Hypothesis 1

The first step within the hierarchical linear regression tested whether substance use could predict criminal recidivism. The regression slope and p-value demonstrated that the finding was not significant (see Table 2, next page). Additionally, the inclusion of substance use in the regression model increased the amount of variance explained by only 5.2% and Homer and Lemeshow's test demonstrated that substance use history was not the best predictor of criminal recidivism (*p=.456*). The odds of recidivism increased by only 1.248 times with each increase in the substance use measure. Overall, no significant relationship was found between substance use history and criminal recidivism. Therefore, Hypothesis 1 was not supported.

Table 2

Summary of Hierarchical Regression Analysis for Variables Predicting Criminal Recidivism

Variable	*B*	*SE*	*OR*	*95% CI*		*p*
				LL	*UL*	
Step 1						
Substance Use	.222	.132	1.248	.964	1.617	.093
Step 2						
Substance Use	.227	.133	1.254	.967	1.628	.088
Neurocognitive Deficits	.244	.225	1.276	.821	1.983	.279
Step 3						
Substance Use	.133	.237	1.142	.718	1.816	.575
Neurocognitive Deficits	.133	.328	1.142	.600	2.172	.686
*Substance Use*Neurocognitive Deficits*	.088	.183	1.092	.762	1.563	.632

Note. OR = Odds ratio. CI = Confidence interval; LL = lower limit; UL = upper limit.

Hypothesis 2

In the second step, neurocognitive deficits were added while controlling for substance use to predict criminal recidivism. The findings were not significant (Table 2). There was a 7.3% improvement in the regression model when neurocognitive deficits were considered, controlling for substance; therefore, this was not the best predictor of criminal recidivism. With every increase in the composite measure of neurocognitive deficits, the odds of recidivism increased by 1.276 times. No significance was found between neurocognitive deficits and criminal recidivism when controlling for substance use. Therefore, Hypothesis 2 was not supported.

Hypothesis 3

Lastly, the interaction between substance use and neurocognitive deficits was tested to observe whether this factor would predict criminal recidivism. There were no significant findings (Table 2). There was a 7.7% increase with the regression model when the interaction between substance use and neurocognitive deficits was entered, while controlling for substance use history and neurocognitive deficits independently. With every increase in the measure for the interaction between substance use and neurocognitive deficits, the odds of recidivism increased by 1.092 times. No significance was found between the interaction of substance use and neurocognitive deficits with predicting future criminal activity. Hypothesis 3 was not supported.

Discussion

The current study investigated whether future criminal behavior could be predicted by substance use and neurocognitive deficits. Many studies have observed that there is a relationship between substance use history and criminal recidivism, and neurocognitive deficits and criminal activity, but these ideas had not been explored concurrently. It was especially important to investigate this idea since prior studies demonstrated that neither substance use nor neurocognitive deficits were the only causes that contributed to recidivism. There were many factors that contributed to future criminal behavior, but substance use and neurocognitive abilities were the two crucial factors based on past literature. Surprisingly, despite these strong theoretical foundations, no significant relationships were found among substance use, neurocognitive deficits, and criminal recidivism in this sample. This lack of effect may be due to several potential limitations in this study related to its sample, methods, and statistical validity. Further consideration of these limitations is therefore warranted, and may point to important directions for future research.

Limitations and Future Directions

The first limitation of the study was the small sample. The sample only included 95 individuals. The small sample size was an issue since there may have been inadequate power due to lack of sufficient participants. The majority of past literature that found significant relationships among some of these variables included larger samples. For example, Wilson and colleagues (2011) used the Medicaid data and prison record ranging from 2001 to 2003 to investigate their hypothesis and they determined that substance use was a precipitating factor for criminal recidivism. However, current study did not have accessibility to a large dataset. Meijers et al (2015) conducted a study of seven previous studies and found that many offenders had some kind of neurocognitive impairment that possibly led to their recidivism. It was important to note that other studies had more participants, and this was a considerable limitation in the current study. In the future, this study or a similar study could be replicated with a greater sample size.

Not only was the small sample size a problem, but the sample may also have been biased. This data was collected at a single correctional institution in a single state. Although the participants were randomly selected, the study was still voluntary and about half of those who were approached turned down the opportunity to participate. In addition, there were rigorous inclusion and exclusion criteria for offenders to participate in the study, on top of the criteria to enter the minimum-security facility in the first place. The exclusion criteria for this study included being a woman, language proficiency, and physical and psychiatric illnesses. For these reasons, participants were excluded due to demographic characteristics and the severity of their conditions. Excluding women prevents generalization of these findings to this important group. Further, the participants may not have accurately captured the severity of conditions that the current study needed to find significant effects. Barbosa and Monteiro (2008) were able to

identify executive dysfunction in more than 60% of the measures, and the offenders were all less successful than the control group with executive functioning. Prior literature suggested that the theory behind the current study was accurate, but there was loss of power due to lack of representative sample. In future research, the sample could be more inclusive and capture a more accurate representation of offenders.

Another limitation of the study was the measure of substance use and its assessment. Since Baillargeon et al. (2010) showed that about half of the inmates met criteria for substance use disorder, it was surprising to not find significant results in the current study. The SSI-SA is a general instrument that includes many items assessing individuals' substance use in the past six months and only several lifetime items, which may not be a valid representation of substance use among incarcerated individuals. Additionally, the SSI-SA is a self-report measure; therefore, it may not have been the most valid measure of substance use history in this sample. Even though there were strong theoretical implications that substance use was a significant factor that predicted criminal recidivism, the lack of accurate assessment and restrictive criteria could have withheld power. Since this was an archival study, there was no control over data collection. In future research, a better assessment tool such as Texas Christian University Drug Screening II (TCUDS II) could be used, which was specifically designed to capture substance use in offenders. Additionally, measures of substance use that are not self-report in nature should be considered, for example, a toxicology screen of multiple substances at time of arrest.

The measure of neurocognitive deficits may have been another limitation to the current study. This study combined Trails B and CWIT performance into a composite score, which worked conceptually but may have reduced statistical power. These scores did not statistically correlate to each other, but were still combined because each assessment theoretically examined

different aspects of executive functioning. However, this likely resulted in loss of power since the scores did not correlate. Additionally, these scores may not generalize to the measures of neurocognitive deficits used in other studies. Meijers and colleagues (2015) measured multiple assessments on the inmates that focused on different parts of executive functioning and found significant results that inmates with difficulties with neurocognitive performance led to high future re-offense rate. Since the assessments chosen for the current study could not capture the full neurocognitive functioning of inmates, it would be beneficial for future researchers to consider this factor.

Operationalization of substance use and neurocognitive functioning could have contributed to loss of power. The measures chosen for this study could not have measured the right concept and did not have the best representation of offenders. This was an issue especially for SSI-SA since it did not capture every degree of substance use with the current sample. In combination with limited sample size, there were gaps in the current data, which impacted the overall results. The interaction of substance use and neurocognitive functioning was not demonstrated accurately in the current study. This study was very exploratory and focused mainly on the trends and effect size. There was only one study that was conducted by Tuominen (2018) in Finland that investigated the predictive relationship of criminal recidivism by observing both substance use and neurocognitive deficits. Since this phenomenon was not detected in the current study, future studies could replicate it by measuring what was intended to measure. The new findings could reinforce the reason why substance use history, neurocognitive deficits level and criminal recidivism could be an important connection to note.

The final limitation of this study was that the data for criminal recidivism was collected approximately 2 years following the completion of the original study (LaDuke, 2015). The

follow-up period to evaluate recidivism may have been too brief to establish coherent predictions. The U.S. Department of Justice (2018) reported that 68% of released offenders recidivated to the criminal justice system within 3 years. However, the current study did not reflect the results that was reported by the justice system. Not only was the follow-up period perhaps too short, but the data was only collected in several states. Previously released individuals may have moved away from the area and had committed other crimes in other states. The limited geographical area and collection period for criminal recidivism was another limitation. This limitation could be mitigated by having access to a national database for the released offenders in the future and having a longer period to measure recidivism.

Conclusion

The major findings of the current study do not support that substance use and neurocognitive impairments were significantly aspects to consider when predicting criminal recidivism in this sample. Although the current study does not find significant results, previous literature strongly suggests that the information of substance use history and neurocognitive deficits could be used to predict criminal behavior. The lack of significant findings may be due to small and biased sample, the operationalization and measures of substance use and neurocognitive impairments, and the brief follow-up period for measuring criminal recidivism. Although the current study did not provide preliminary conclusions on how substance use history and neurocognitive deficits could be predicting variables for criminal recidivism, there is much to be uncovered. More work needs to be done to mitigate predictive criminal behavior. If this relationship is to be determined, specific treatment options for these individuals could be provided during their incarceration and this would have a powerful implication for the treating clinicians. Furthermore, if certain behaviors, such as minimization of substance use and

appropriate care for neurocognitive impairments are utilized, the societal problem of criminal recidivism could be reduced. This idea has an immense impact on the policy makers to ensure that proper care and treatments are in place for inmates with certain deficits.

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