2020

Gender Differences and Neurocognitive Function in Cocaine and Methamphetamine Addiction

Gwendolyn F. Royal-Smith
Walden University

Walden University

College of Social and Behavioral Sciences

This is to certify that the doctoral dissertation by

Gwendolyn Royal-Smith

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Stephen Rice, Committee Chairperson, Psychology Faculty
Dr. Elisha Galaif, Committee Member, Psychology Faculty
Dr. Tracy Mallett, University Reviewer, Psychology Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2020

Abstract

Gender Differences and Neurocognitive Function in Cocaine and Methamphetamine Addiction

by

Gwendolyn Royal-Smith

MA, University of Memphis, 1988

BS, Fayetteville State University, 1981

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

General Psychology

Walden University

December 2019

Abstract

Cocaine and methamphetamine-addicted women are more likely to suffer from personal life traumas that lead to persistent and committed drug abuse. In addition to social-psychological problems associated with drug abuse are neuropsychological processes involving specific regions of the brain responsible for working memory, decision-making, and impulse control. Classical and operant conditioning theories of learning provide a paradigm foundation for this quantitative, correlational study that utilized archival data from the National Institute on Drug Abuse (NIDA). I analyzed a randomly selected sample of 186 adults who voluntarily participated in an eight-week treatment program for cocaine and methamphetamine (MA) addiction. In my study, I found that the level of participation in the eight-week treatment program was statistically significant for women when compared to the level of participation for men; however, the level of participation did not vary significantly by age, race/ethnicity or the Stroop Word Color Task score (SWCT). I also concluded that to a statistically significant degree, women experienced more of a participation drop-off than did men as the treatment program progressed; however, participants' attrition did not vary significantly by age, race/ethnicity or SWCT score. Studies detailing neuropsychological experiences in relationship to executive function in cocaine and MA-addicted women are not plentiful and have not reached maximum significance in current research. It is expected that this study will add to existing drug addiction studies and provoke greater interest in neuropsychological experiences of women in all phases of addiction.

Gender Differences and Neurocognitive Function in Cocaine and Methamphetamine Addiction

by

Gwendolyn Royal-Smith

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

General Psychology

Walden University

December 2019

Acknowledgments

I would like to thank the endless stream of family members (including my amazing daughters and their families, my parents (especially my Mother), my brothers and sisters (and their wonderful spouses), close friends, and colleagues for their love, patience, and nothing less than fantastic support of my efforts in pursuing my doctoral studies. I am forever grateful to the love of my life, my late husband; our time together was all too short. I was (somewhat) prepared to be the wife of an active duty soldier; I was not prepared to be the young widow of an active duty soldier, or for our young daughters to have to face life without their father. Looking back, I realize that military spouses are always being prepared for the *possibility* that life can change in an instant, yet no feeling on earth quite compares to the day when the word *possibility* is replaced by a painful and unforgiving reality. I can breathe a little easier now, because I am finally completing this journey that was so important to both of us. I am so very proud of our two amazing and very accomplished daughters; I see so much of their father in them. I am truly thankful that I have been sustained by my faith and the wonderful love of family and friends. I also wish to thank the members of my doctoral committee, Dr. Stephen Rice and Dr. Elisha Galaif. Dr. Rice, I especially want to thank you for "venturing into the waters" of neuropsychology, gender and drug addiction with me. I have a greater appreciation for those who provide constant guidance and often unmerited encouragement during the exceptionally challenging times in a doctoral student's life

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

Historically the abuse of cocaine and methamphetamine (MA) has been categorized as largely a male phenomenon in the United States. Drug abuse researchers conclude that the gender gap is narrowing as increasing numbers of females face life-threatening risks related to drug addiction and addiction outcomes (Levandowski et al., 2016; Pedraz, 2015). This chapter provides the following information: the study background, the problem that was addressed, the purpose of the study, the research questions and hypotheses, the theoretical framework, the nature of the study, the definitions and assumptions, the research scope and delimitations, and the summary.

Cocaine and MA rank as two of the most addictive and abused stimulant drugs in the world (United Nations Office on Drugs and Crime [UNODC], 2016). The United States leads the world in the recreational use of cocaine, reporting well over 40% of all consumption (Department of Justice [DOJ], 2015). North America, the world's largest cocaine market, has seen a steady rise in the expansion of the cocaine production and distribution (UNODC, 2018). This report indicates that cocaine-related deaths in the United States doubled between 2013 and 2016, from fewer than 5,000 to more than 10, 000 individuals. In addition, the illegal use of MA is exceeded only by that of marijuana, with the United States ranked as 5th in the world for MA abuse (Center for Behavioral Health Statistics and Quality [CBHSQ], 2015).

Although the abuse of cocaine and MA can produce serious consequences for any use social, psychological and physiological effects appear to be more immediate, enduring and destructive for female abusers (Clingan, Fisher, Pendersen, Reynolds, &

Xandre, 2016; Shrestha, Huedo-Medina, & Copenhaver, 2015). Since early 2000, more than 500,00 new cases of abuse or addiction have been reported annually among females over the age of sixteen, although drug agencies estimate that the actual number of new cases among female users is much higher (DOJ, 2015; National Institute on Drug Abuse [NIDA], 2017; UNODC, 2018).

Psychological studies reveal that suicide attempts and suicide completions among females are closely related to drug addiction. In their research, Dragisic, Dickov, Dickov, and Mitjatovic (2015) found that among female substance abusers the risk of suicide was 6.5 to 9 times higher compared to nonaddicted women. Clingan et al. (2016) observed that females addicted to cocaine and MA were more likely to engage in sexually criminal activities (i.e. prostitution, pornography, sex trafficking etc.), thereby increasing the likelihood of exposure to bodily harm, susceptibility to HIV/AIDS, and other sexually transmitted diseases. Carson and Anderson (2016), in a report to United States Department of Justice confirmed that the number of females incarcerated for drug-related offenses surpassed these same offenses for incarcerated males. These reports indicated that approximately 59% of females housed in federal prisons were convicted of drug offenses compared with 49% of males who were convicted of similar offenses in 2015 (Carson & Anderson, 2016).

It is projected that there are more than 750,000 cocaine and MA exposed pregnancies each year in the United States (NIDA, 2014). Studies of prenatal drug contact indicate that children under the age of two exhibit a 50% higher risk of physical, emotional, and neurocognitive impairments compared with children who were not

prenatally subjected to drugs (Ballard, Weafer, Gallo, & de Wit, 2015; Du, Huang, Zhao, & Hser, 2013). Pregnant women and care-giving mothers who abuse drugs can present greater threats to the safety and well-being of their children than women who do not abuse drugs (Ballard et al., 2015; Brogly, Link, & Newman, 2018).

Drug abuse and drug addiction are complicated processes involving numerous psychological and physiological consequences. Among the most complex and challenging processes of drug addiction are neurocognitive events that take place in the brain of the abuser, producing dominant and long-term changes that can interrupt normal neural functions (Bell, Garavan, & Foxe, 2014). Neuropsychological studies maintain that while not all drug users will become addicted, users increase their risk of addiction when specific regions of the brain evoke new patterns to accommodate drug introduction (Becker, McClellan, & Reed, 2017). These studies are vital in that they offer insight regarding special functions of the brain responsible for decision-making, working memory and impulse control, all of which serve as predictors of continuing addiction behaviors patterns in cocaine and MA-dependent individuals (Jasinka et al., 2014; Moeller et al., 2014).

Neurocognitive studies involving tests of executive function reveal that while cocaine and MA-addicted males and females exhibit similar problems in working memory and decision-making tasks, stark differences between addicted males and females emerge in tests of impulsivity (Moeller, 2014; Ray, 2013). In executive function tests, females were more likely to demonstrate highly impulsive behaviors in responding to drug use events compared with males. These impulsivity responses are also related to

the likelihood of how females respond to drug treatment participation and completion (Balconi et al., 2015; Jaskina et al., 2014).

Conducting pertinent psychological tests to assess executive function performance can provide further insight in predicting treatment participation and treatment attrition of substance-abusing females. One such test is the Stroop Word Color Task (SWCT), a neuropsychological test used extensively in evaluating cognitive interference related to executive function in drug addiction (Scarpina & Tagini, 2017). This study attempts to add to existing knowledge by: (a) comparing how cocaine and MA-addicted people differ by gender in their hours of participation in a treatment program; and (b) whether a person's degree of executive-function impairment is correlated with the person's hours of participation in a treatment program.

This study also supports professional practitioners in drug addiction evaluation and treatment by providing further proof that diagnosis, treatment protocols, and posttreatment assessment must include the significance of gender and neurocognitive experiences. It is imperative that practitioners rigorously explore how specific brain-based behaviors in executive function among female addicts influences their ability to successfully participate in drug treatment programs and avoid continued substance abuse. Studies detailing neuropsychological experiences of adult female cocaine and MA addiction are not plentiful in psychological literature and have not attained maximum levels of diversity and inclusion. The implication in this study for positive social change includes the necessity of eliminating gender-based stigmas and life-threatening

vulnerabilities that often impede short- and long-term assistance for drug-addicted women (Cockroft, Adams, Bonnet, Matlock, & Schlundt, 2019; Keane, 2017).

Background

Neuropsychological studies of the brain's neural circuitry in substance abuse indicate that women are more sensitive than men to the rewarding and motivational effects of cocaine and MA. These same factors can propel prolonged drug abuse while acting as strong deterrents in seeking treatment (Ballard et al., 2015). There is abundant neuropsychological evidence that the prefrontal cortex (PFC) and associated circuits are affected by cocaine and MA dependence (Kennedy et al., 2013; Pinel, 2011; Shrestha et al., 2015). Anatomic studies of cocaine addiction identified the following changes in the PFC: reduced gray matter, decreased white matter integrity, and increased white matter intensities (Balconi & Finocchiaro, 2014; Ballard et al., 2015). Neuropsychological researchers have indicated that decreased performance on executive function tests is associated with impairment of prefrontal structures among cocaine abusers (Kober et al., 2016). Researchers have substantiated that notable changes in the brain of the substance abuser are causally related to the consumption and continued use of cocaine and MA. Regardless of the stage of use (active consumption or abstinence), the user has no control over neural circuitry changes, the duration of the effect, or new patterns of brain behavior that might emerge (Ballard et al., 2015).

There is extensive confirmation that for cocaine and MA-abusing individuals, prefrontal structures and functions dependent on PFC regions of the brain are different compared with noncocaine and MA-abusing individuals (Balconi, et al., 2014; Nephew &

Febo, 2012). In addition to localized brain behavior effects, cocaine and MA users respond to environmental stimuli in the form of drug salience with attentional bias, a type of involuntary attention and impaired working memory. Increases in working memory demands are related to decreased performance on tests of cognitive control in female substance abusers (Becker et al., 2017; Bickel et al., 2011; Simpson et al., 2016).

Clinical psychology researchers have strongly supported therapeutic drug treatment programs in alleviating participant substance dependence; however, fewer than half of participants complete recommended programs (Worhunsky et al., 2013). Female participants with low attendance or high incompletion rates during active drug treatment are more likely to return to substance abuse than program completers (Fernandez-Montalvo, Lopez-Goni, Azana, Arteaga, & Cacho, 2017). Neuropsychological evidence found that the onset, maintenance and rehabilitation experiences of cocaine and MA-addicted individuals differ by sex; however, treatment outcomes are related to critical areas of decision-making, planning, and impulsivity control are less well-known for female addicts. These issues are problematic in that drug treatment success hinges, at least in part on the amount of time a participant spends in treatment and, whether participation is satisfactorily completed during a prescribed period.

In this research, I addressed gaps in the existing literature concerning drug treatment participation and attrition (failure to complete treatment) in comparing cocaine and MA-addicted females and males. In this study, I attempted to fill this void by examining a test of executive function in conjunction with treatment participation of cocaine and MA-addicted males and females enrolled in a drug treatment program.

Given the multitude of problems faced by many cocaine and MA-addicted women, more gender-based studies are needed to evaluate how executive function processes (including impairments) might impact a woman's level of participation in a drug treatment program. The importance of furthering this research is connected to the high-risk lifestyle of many addicted females and the need for intervention beyond traditional treatment schemas (Fattore, 2015). Practitioners should work with other professionals regarding improved initial treatment assessment, ongoing evaluation, and follow-up in the posttreatment phase. Professionals must understand that due to the criminal nature of illicit cocaine and MA use, abusers will often go to great lengths to avoid detection; therefore, they may refuse any form of help that will expose them, including seeking drug treatment (Barratt, Lenton, Maddox, & Allen, 2016; NIDA, 2017). Powerful negative social stigmas and stereotypes associated with drug abuse also hinder efforts in identification, evaluation, and treatment for women (Adinoff et al., 2010; Tull, Gratz, & Weiss, 2011).

Problem Statement

In this study, I explored a test of executive function, extent of participation in drug treatment, and treatment attrition in a substance abuse treatment program for cocaine and MA-addicted adult males and females. The *Diagnostic* and *Statistical Manual of Mental Disorders* (5^{th} ed.; *DSM*-5; American Psychiatric Association [APA], 2013) defines substance abuse as the frequent and often disruptive patterned use of drugs evidenced by at least one significant event during a 12-month period in which an individual is unable to fulfill a primary life role (APA, 2013).

While there is little benefit for illegal drug use and substance abuse, the costs are astronomical and negatively impact lives across every spectrum of society (National Survey on Drug Use and Health, 2017). It is important to note that while much of the recent emphasis on substance use and addiction has shifted to the growing opioid epidemic in the United States, the abuse of cocaine and MA is viewed as a further complication of opioid abuse (Economist, 2017; UNODC, 2016).

Completion of drug addiction treatment is one of the strongest indicators of favorable rehabilitation and posttreatment abstinence; however, lower treatment participation places females at higher risk for relapse and a deeper commitment to substance abuse (Becker et al., 2017). These problems are often complicated by a lack of access to affordable and comprehensive drug treatment programs, therefore reducing positive therapeutic outcomes for cocaine and MA-addicted females (Becker, 2017; NIDA, 2017).

Although it was not the goal of this study to identify specific drug abuse treatment protocols, psychological researchers disclosed that gender disparities during all phases of clinical intervention are more likely to produce negative long-term consequences for addicted women compared with addicted men (Hagen et al., 2016). Drug abuse researchers indicate that while cocaine addiction can present numerous struggles during the treatment phase, MA addiction presents special hardships in that the abuse of MA is often tied to group behavior; therefore, posttreatment success is highly dependent upon breaking group cooperation and drug-reinforcing relationships (Lester & Lagasse, 2010; NIDA, 2017).

Neuropsychological researchers determined that interruptions in normal brain functions of substance-abusing females include problems with speech-language patterns, decision-making, strategic planning, behavior inhibition, and impulsivity control (Balconi et al., 2015; Fridberg, Gerst, & Finn, 2013; Levandowski et al., 2016; Luo et al., 2013). Drug addiction researchers indicated that specific brain activations induced by exposure to drugs increase female substance vulnerabilities to habitual use (Balconi et al., 2015; Du et al., 2013; Everitt, 2014; Quinones-Jenab, & Jenab, 2012). Neurocognitive processes and drug treatment outcomes specific to female cocaine and MA abusers remain relatively unexplored aspects of drug abuse. This omission represented a major gap in the literature as substantiated by current research findings that treatment participation is positively correlated to executive function deficits (Du, Zhao & Hser, 2013; Everitt, 2014; Shrestha et al., 2015).

Executive function impairments in the brain are strongly associated with neurocognitive interference in individuals, which in turn has been linked to treatment attrition and relapse behaviors (Ballard et al., 2015; Morie, De Sanctis, Garavan & Foxe, 2014). Neuropsychological tests reveal that female cocaine and MA abusers are more likely to experience neurocognitive interference in processing congruent and incongruent task stimuli compared with addicted males (Kennedy, Epstein, Phillips, & Preston, 2013; Mitchell & Potenza, 2015).

Cocaine and MA dependence involves various networks of neurocognitive patterns that can lead to serious neuropsychological deficits and executive functioning impairments (Ballard et al., 2015; Ide, Zhang, Hu, Mazure, & Li, 2014). Researchers

examining executive function patterns have demonstrated that cue-conditioned reactivity propels impulse cravings and continued drug-seeking behavior in cocaine and MA-addicted females (Clingan et al., 2016; Moreno-Lopez, Stamatakis, Fernanado-Serrano, Gomez-Rio, & Verdejo-Garcia, 2012; Volkow et al., 2011). Neurocognitive events associated with executive function interruptions are extremely useful in explaining how cocaine and MA reactive cues influence regional metabolic changes in females more so than in addicted males (Kornreich et al., 2012; Luo et al., 2013).

Volkow and Tomasi (2011a) found gender differences in brain reactivity events that were supported in the following ways: (a) cocaine and MA use in females affected a larger portion of the female's brain and, (b) cocaine and MA cues were significantly stronger in females than in males as revealed in tests of neural changes in brain glucose metabolism rates. In addition, these researchers established that neural system processes associated with neurocognitive functions were not similar for males and females, and therefore required further investigation. Van der Plas, Crone, van den Wildenberg, Tranel, and Bechara (2009) compared the performance of 133 alcohol, cocaine, and MA-dependent males and females with healthy controls on complex decision-making, working memory, and neurocognitive flexibility tasks. They concluded that decision-making abilities were significantly more impaired in female addicts than in male addicts, especially in tasks requiring high levels of cognition and impulse control. Neurocognitive studies represent an important aspect of female drug addiction; however, significant gaps remain in terms of explaining how and why neurocognitive pathways of drug addiction can lead to very different therapeutic outcomes for women compared with male addicts.

Purpose of the Study

This quantitative, correlational research method examined whether the level of attendance and attrition of cocaine and MA-addicted participants in a substance abuse treatment program is associated with the participants' demographic characteristics and the participants' performance on a test of executive function. A quantitative, correlational research design is appropriate because this study analyzes relationships between two or more variables that can be quantified (Gregory, 2011).

In this study, there are four independent variables: (a) participants' performance on the SWCT, (b) participants' gender, (c) participants' age, and (d) participants' race/ethnicity. There are two dependent variables: (a) the total number of hours of treatment received during the eight-week period, and (b) the differential between the number of hours of treatment received during the first four weeks and the number of hours of treatment received during the last four weeks. The second measure was included to address the issue of participant attrition. Multiple regression analysis was used to examine: (a) the relationship between the four independent variables and the first dependent variable, and (b) the relationship between the four independent variables and the second dependent variable. The SPSS statistical software program and NIDA codebook were utilized in analyzing the data.

Research Questions and Hypotheses

This study addressed the following research questions and hypotheses, using a randomly selected sample of 186 addicted individuals:

Research Question 1: Does the Stroop Word Color Task (SWCT) predict the level of participation when controlling for all other variables?

$H_0 1$: The SWCT does not significantly predict the level of participation when controlling for all other variables.

$H_a 1$: The SWCT significantly predicts the level of participation when controlling for all other variables.

Research Question 2: Does gender predict the level of participation when controlling for all other variables?

$H_0 2$: Gender does not significantly predict the level of participation when controlling for all other variables.

$H_a 2$: Gender significantly predicts the level of participation when controlling for all other variables.

Research Question 3: Does age predict the level of participation when controlling for all other variables?

$H_0 3$: Age does not significantly predict the level of participation when controlling for all other variables.

$H_a 3$: Age significantly predicts the level of participation when controlling for all other variables.

Research Question 4: Does race/ethnicity predict the level of participation when controlling for all other variables?

$H_0 4$: Race/ethnicity does not significantly predict the level of participation when controlling for all other variables.

H_a4: Race/ethnicity significantly predicts the level of participation when controlling for all other variables.

Research Question 5: Does the SWCT predict the level of attrition in participation when controlling for all other variables?

H_05: The SWCT does not significantly predict the level of attrition in participation when controlling for all other variables.

H_a5: The SWCT significantly predicts the level of attrition in participation when controlling for all other variables.

Research Question 6: Does gender predict the level of attrition in participation when controlling for all other variables?

H_06: Gender does not significantly predict the level of attrition in participation when controlling for all other variables.

H_a6: Gender significantly predicts the level of attrition in participation when controlling for all other variables

Research Question 7: Does age predict the level of attrition in participation when controlling for all other variables?

H_07: Age does not significantly predict the level of attrition in participation when controlling for all other variables.

H_a7: Age significantly predicts the level of attrition in participation when controlling for all other variables

Research Question 8: Does race/ethnicity predict the level of attrition in participation when controlling for all other variables?

$H_0$8: Race/ethnicity does not significantly predict the level of attrition in participation when controlling for all other variables.

H_a8: Race/ethnicity significantly predicts the level of attrition in participation when controlling for all other variables.

Theoretical Foundation

In my study, I utilized two theoretical models of learning, classical and operant conditioning. Classical (Pavlovian) and operant (Instrumental) conditioning learning theories support the view that neuroadaptations of brain systems affected by illicit drugs subsequently produce conflicting events (tolerance as well as avoidance behavior) in male and female addicts (Everitt, 2014; Yager & Robinson, 2014).

Major theoretical propositions of both classical and operant learning in this addiction study are predicated on the following assumptions: (a) brain behaviors in addiction are contingent on conditioned associations in terms of initial and continued drug use for female and male addicts, and (b) cognitive and executive function impairment associated with positive and negative reinforcement attributes differ by gender in drug treatment and posttreatment relapse (Kober et al., 2016). These psychological models of learning suggest that brain activation processes responsible for mapping drug patterns, including impulse, motivation, and neurocognitive functions, are different in female addicts compared with male addicts (Becker, Perry, & Westenbroek, 2012; Kerstetter, Zu-in, Ettenberg, & Kippin, 2013; Mahoney, Hawkina, De LaGarza, Kalechstein, & Newton, 2010).

Studies involving neurocognitive processes and gender have demonstrated that significant differences exist between males and females, particularly in cue-conditioned reactivity and drug reward mechanisms with females exhibiting stronger and more enduring drug cue associations than for addicted males (Moreno-Lopez et al., 2012; Nephew & Febo, 2012; Volkow et al., 2011b). In the realm of executive function these differences are especially problematic because impaired decision-making, learning deficits, and poor impulse control are the very mechanisms that impede successful treatment and encourage relapse to drug-seeking behaviors in female addicts (Becker, McClellan, & Reed, 2016; Kornreich et al., 2012; Luo et al., 2013).

The research questions and hypotheses in this study are predicated on a neuropsychological test of executive function performance among cocaine and MA-addicted males and females. In addition, researchers have demonstrated that executive impairments influence treatment attendance and attrition rates differently by gender (Bell, et al., 2014; Luo et al., 2013; Woicik et al., 2011). Classical and Operant conditioning theories of learning are discussed in more detail in Chapter 2.

Nature of the Study

In this study, I examined the level of participation among 186 randomly selected cocaine and MA-addicted men and women enrolled in an eight-week drug treatment program. Multiple regression analysis was used to investigate whether the level of participation varied, in a statistically significant manner, according to a participant's executive-function capability and a participant's gender, age and race/ethnicity. A quantitative, correlational method of analysis, such as multiple regression is appropriate

for assessing the potential relationship between two or more variables measured for members of a group (Gregory, 2011). The research design used in this study was deemed appropriate for secondary data analysis in which new theoretical questions were formed from an existing study population (Creswell, 2009).

Definitions

Classical learning theory: Ivan Pavlov's theory of learning associated with classical conditioning as a reflexive or automatic type of learning in which a stimulus (S) acquires the capacity to evoke a response (R) that was originally evoked by another stimulus (Flagel, Akil, & Robinson, 2009).

Cocaine and methamphetamine abuse/addiction: The *Diagnostic* and *Statistical Manual of Mental Disorders* (5th ed.; *DSM*-5; APA, 2013) defines substance abuse as the frequent and often disruptive patterned use of drugs evidenced by at least one significant event during a twelve month period in which an individual is unable to fulfill a primary life role (APA, 2013).

Comalli-Kaplan Version of the Stroop Word Color Task: The Comalli-Kaplan version of the SWCT comprises three subsections designed to assess a subject's ability to suppress interfering stimuli. These tasks are contained on three stimulus card sets, each containing 100 stimuli (Strauss et al., 2005). This version is relevant to the present study because modifications of this task require that the color naming card be presented first, that errors are recorded, and that allowances are made for self-correction of errors before moving on to the next stimuli (Strauss et al., 2005; Winhusen 2013). These test modifications serve two purposes in neurocognitive function and drug addiction studies:

(a) individuals who are color-blind will be quickly identified, and (b) this test procedure maximizes the interference effect by presenting the word condition just prior to the interference task (Strauss et al., 2005).

Executive function (cognitive interference): Defined as the frontal area of the brain, including the stratum, prefrontal cortex, anterior cingulate cortex and amygdala, and largely responsible for learning, memory, complex decision-making, complex task execution, ability to control impulses and other critical information processes (Herbeck & Brecht, 2013).

Operant conditioning theory: B.F. Skinner's theory of learning based on the idea that learning is a function of change in overt behavior. Changes in behavior are the result of an individual's response to events (stimuli) that occurs in the environment and produces a consequence because of that response (Flagel, Akil, & Robinson, 2009).

Length of treatment participation: Defined as the total number of hours of treatment received during the eight-week treatment program.

Treatment attrition: Defined as the differential between the number of hours of treatment received during the first four weeks of the eight-week treatment program and the number of hours of treatment received during the last four weeks.

Assumptions

Assumptions in this study include the following: (a) that the participants in the archival study met all requirements in terms of eligibility and provided honest answers regarding their active use of cocaine and MA while enrolled in the eight-week drug treatment program; (b) that all treatment program participation was voluntary, that there

was no "hostile" or "coercive" participation involved, and that participation was not court-ordered or otherwise mandated; (c) that the participants' responses in completing the SWCT were accurately recorded; and (d) that the number of hours of participant attendance in the eight-week treatment program was accurately recorded. I assumed that the subjects understood questions that were asked in all phases of the archival study. These assumptions are necessary in the context of this research because the requirement that all eligible participants provide truthful answers regarding their current drug use status is paramount to their acceptance in an 8-week substance use treatment program. It was also important that all phases of program participation are completely voluntary and without duress because "forced" participation can create a "hostile" environment toward staff and other participants, thereby threatening study validity.

Scope and Delimitations

In this research, I investigated whether the level of attendance and attrition of cocaine and MA-addicted participants in an 8-week drug abuse treatment program was associated with participant's performance on a test of executive function. This specific aspect was chosen because I wanted to determine whether treatment program participation and attrition differ by gender, age, or race/ethnicity of a participant. In addition, I was interested in whether performance on a test of executive function is associated with a participant's attendance in the specified treatment program.

In the CTN-0031A study, 186 participants were deemed eligible for participation. It was expected that this research would have limited generalizability in that all participants were active cocaine and MA-addicted individuals, therefore representing a

much smaller portion of the general adult population in the United States. In my study, there were 61 male participants compared to 145 female participants, constricting my ability to draw conclusions about male addicts as a subgroup. Although this was a randomly selected sample of adult males and females, there remained possible threats to internal validity in terms of rate of attrition due to unknown factors associated with a participant's late entrance or early exit from the treatment program. The ability to generalize study results to those who do not complete versus completers of the treatment program study was an external validity issue. In both cases, internal and external validity issues were addressed.

Limitations

My research most notably had several limitations. In the archival study, six psychometric tests were evaluated; in this study only one psychometric test, the SWCT, was assessed. It is possible that one or more of the missing psychometric tests would demonstrate a stronger association of executive function and treatment participation than the SWCT. Also, the ability of psychometric tests to predict functional behaviors can be problematic due to the presence of confounding or unknown variables (Gregory, 2011). Psychometric tests, including the SWCT, present special challenges because a situation is structured in which a participant must demonstrate proficiency in reasoning, planning and flexibility on a variety of timed tests. In formal testing, the examiner determines participation eligibility, which materials are employed, where and how testing takes place, duration of tests and how performance on tests is documented (Gregory, 2011). In the archival study, issues of possible selection bias and researcher bias were addressed to

ensure that study participants were able to fully understand instructions and were able to complete the SWCT using computer-based aids.

Significance of the Study

Neuropsychological researchers have demonstrated that women experience unique challenges in terms of onset, maintenance and recovery from cocaine and MA Pe addiction (Peters, Guille & Mitttal, 2019). In this study, several reasonable measures were reserved to address limitations including understanding limited generalizability and the uniqueness of the study population. The importance of understanding problems of female addiction is relevant not only for identification and assistance in recovery but also for evaluating and documenting measurable progress in rehabilitation efforts. Success in recovery is highly correlated with consistent and comprehensive levels of drug treatment, and ongoing posttreatment program support (Becker et al., 2017).

In this research I explored associated neural processes of addiction unique to women, and how those processes can impact their recovery or prolong their commitment to drug addiction. I also sought to underscore the relevance of executive function impairments and treatment participation among male and female cocaine and MA addicts. I anticipated that this research would further promote universal awareness and intervention in addiction treatment programs for women. In my study, I expected that in examining levels of participation, attrition and performance on a test of executive function would yield new knowledge thus reinforces the importance of additional studies of adult female cocaine and MA addicts. The implications for positive social change

included the recognition that female drug addiction must be given the same priority as any other problem associated with women's health and wellness.

Summary

Neuropsychological researchers have indicated that executive function deficits are more persistent and life-threatening in cocaine and methamphetamine (MA) addicted females compared with addicted males (Fattore, 2015; Hurtado et al., 2016). Neural processes connected to initial use, maintenance and treatment relapse vulnerability have received increasing empirical support, but the role of executive function and gender in drug addiction is less clear (McHugh et al., 2017). Impairments related to executive functions are viewed as high vulnerabilities in terms of identification and screening of abuse, lower treatment participation and a return to drug use pose continued long-term risks of drug use for cocaine and MA-addicted females. This chapter provided: (a) an overview of the association between gender and neurocognitive processes in cocaine and MA addiction; (b) the assumptions, scope and delimitations of the study; and (c) the significance of the study.

Chapter 2: Literature Review

Neuropsychological studies of neurocognitive deficits related to cocaine and MA abuse have demonstrated that vulnerabilities, treatment and relapse differ by sex (Bobzean et al., 2014; Fattore et al., 2014; Kennedy et al., 2013; Ramackers et al., 2016). Recently, NIDA (2017) indicated that abuse and dependence on cocaine and MA has risen significantly among women in the United States. Researchers studying psychological aspects of drug addiction have determined that the experiences of women during drug-seeking, abstinence and relapse stages differ drastically from the experiences of drug-addicted men. In addition, researchers have indicated that women addicted to cocaine and MA may be more prone to developing harmful changes in brain structures related to cognitive and executive function than stimulant-addicted men (Becker et al., 2012; Kerstetter, Zu-in, Ettenberg, & Kippin, 2013; Winhusen et al., 2013).

Researchers conducting neuropsychological studies employ multiple terminologies in defining drug addiction including the terms "substance use disorder" and "substance abuse" (Gould, 2010). The generally accepted definition of drug addiction is a "chronic, relapsing brain disease that is characterized by compulsive drug-seeking and use, despite harmful consequences" (http://www.drugabuse.gov). Addiction researchers define drug addiction in this manner because addiction can interrupt, reconfigure, and modify critical structures in the brain (Pinel, 2011). Researchers maintained that changes in the brain can have adverse short and long-term consequences that often result in dangerous and self-destructive behaviors that can subsequently lead to irreversible brain damage, harm, or death (NIDA, 2013; Pinel, 2011).

Executive functions are those brain functions involved in complex cognitions such as solving novel problems, modifying behavior, considering new information, generating strategies, or sequencing complex actions (Eisinger, Larson, Boulware, Thomas, & Mermelsten, 2018). Executive function tests have also been used to predict differential rates of attrition of female drug abusers compared with male drug abusers (Goldstein & Volkow, 2011; Najavits & Lester, 2008; Marceau, Kelly, & Solowij, 2018). Executive systems coordinate, control, and assist in neural processes of goal-orientation in learning and decision-making (Hart, Marvin, Silver, & Smith, 2012; Potenza et al., 2012).

Drug addiction researchers in examining drug-seeking and drug maintenance behaviors concluded that addictive behaviors are not "normal" occurrences that simply happen at the will of the abuser. Drug addiction is often complicated by a constant need for secrecy, risk-taking, and openly hostile societal stigmas; thus, the reward of the drug's affect must have more importance to an abuser than the threats involved in drug use (Barrett et al., 2016; Everitt, 2014; NIDA, 2017). Cocaine and MA addiction can have noticeably detrimental effects on women's decision making and critical thinking processes (Mehrjerdi et al., 2010). The significance of these impairments in neural systems are also implicated in the increasingly risky, violent and often life-threatening behaviors that drive women to continue drug abuse (Becker, 2012; Bisagno & Cadet, 2014; NIDA, 2014). In this study I examined whether the level of attendance and attrition for cocaine and MA-addicted males and females was associated with the

participants' demographic characteristics and the participants' performance on a test of executive function.

This chapter begins with a comprehensive review of the literatures of classical and operant conditioning theories of cocaine and MA addiction specific to gender. Next, a survey regarding research about the neurochemistry of cocaine and MA relevant to this study is provided. Subsequent sections offer an in-depth examination of literatures that explore the connection between neuropsychological processes of cocaine and MA addiction and gender differences. In addition, relevant studies of cognitive and executive function related to neuropsychological performance and gender are examined. The literature review concludes by focusing on research evidence that supports the need for more empirical studies concentrating on all aspects of the psychological experiences of cocaine and MA addiction in women.

Literature Search Strategy

A thorough review of the literatures for this study was acquired by examining secondary sources published between 2007 to the present. The terms used to find information for this study include, but are not limited to, the following: *addiction, substance use, substance abuse, cocaine, methamphetamine, neurocognitive interference, cognition, executive function, gender, sex, learning and memory, neuropsychology, neurocognition, neuroscience, and neuropsychological tests*. Material for the literatures was obtained from the following databases: EBSCOHOST, MEDLINE, NCBI, NIDA, and PSYCHINFO. Additional information was found on internet sites developed by well-regarded organizations, including the American Psychological Association (APA),

Center for Behavioral Health Statistics and Quality (CBHSQ), Centers for Disease Control (CDC), Department of Justice (DOJ), National Institutes of Health (NIH), European Monitoring Center for Drugs and Addiction (EMCDA), National Center for Biotechnology (NCBI), and the Walden University Library.

Theoretical Foundation

Classical (Pavlovian) and Operant (Instrumental) conditioning theories of learning support the view that neuroadaptations of brain systems affected by illicit drug use subsequently produce conflicting events, a desire to tolerate drugs while seeking avoidance of the same (Everitt, 2014; Yager & Robinson, 2014). The rationale for examining drug addiction models in relationship to classical and operant conditioning is relevant for two important reasons: (a) brain behaviors in addiction are contingent on conditioned associations of drug-seeking and drug-taking activities; and (b) executive function impairment is predicated on positive and negative reinforcements in addiction onset, treatment and avoidance.

Classical Conditioning Theory

Ivan Pavlov's work with animals in classical conditioning and learning provides compelling evidence that an event paired with a stimulus can predict future behaviors based on previous experience (Milton & Everitt, 2012; Jasinska et al., 2014; Pinel, 2011). Milton and Everitt (2012) contend that in both drug-seeking and drug-taking behaviors, "Pavlovian or non-contingent behavior (stimulus-response) occurs with extensive training associations between the drug-conditioned stimulus and of drug-seeking and taking (stimulus-response actions or S-R associations" (p. 1120). Hence, through Pavlovian

conditioning, drug-associated stimuli become wanted and preferred, grab attention and produce a variety of physiological and psychological responses in the user (Goddard et al., 2013). Should this cycle continue unchecked in the user, drug-taking can move beyond voluntary to involuntary; this process becomes the transitory mechanism in forming new brain behavior associations leading to drug addiction (Goddard et al., 2013).

Classical conditioning in animal studies involving drug-seeking tasks have demonstrated that dependence vulnerability is clearly connected to cocaine and MA-related cues rather than solely pharmacological effects; thus, inferring that when these cues are no longer present, drug-seeking is significantly reduced and only recurs when these cues are re-introduced (Lejuez et al., 2007; Koob & Volkow, 2010). Addiction theorists contend that while any user is susceptible to progressive drug use after initial administration, there are some notable differences in how drug-seeking behaviors, frequency and reward mechanisms deviate in terms of gender (Zuloaga et al., 2015). Studies of substance abuse also underscore that women are more prone to develop cue-induced drug cravings and therefore more likely to relapse into cycles of chronic dependence compared with male addicts (Kerstetter et al., 2013; Potenza et al., 2012). In this respect, the continued response to cocaine or MA stimuli reinforces the probability of repeating drug-seeking and drug-taking behaviors (Dalla & Shors, 2009; Milton & Everitt, 2012).

Volkow et al. (2011b) used Positron Emission Tomography (PET) to compare brain metabolism among female and male cocaine addicts. Their study hypothesized that

females would demonstrate greater reactivity when presented with various drug cues, and that distinction could explain their high probability to relapse.

Although these researchers found that men and women who viewed cocaine-cued videos did not differ by gender in self-reported drug cravings, gender differences in brain metabolism were observed. Female subjects exhibited decreased metabolism, whereas metabolic rates increased among male participants. As with other PET studies of cue-conditioning and gender, this research confirmed that gender differences exist in vulnerabilities to continued drug use and in relapse susceptibility (Andersen et al., 2012; Potenza et al., 2012; Volkow et al., 2011). In neuroimaging studies, classical conditioning research proposes that a stronger motivation for continued drug-seeking and drug-taking action occurs because the brain regions responsible for reinforcing substance abuse are the same systems that are most resistant to drug abstinence (Mitchell & Potenza, 2015; Balconi & Finocchaiaro, 2015).

A major premise in classical conditioned response research is that if drug cues are not available, then drug-seeking actions are radically lowered; however, once drug cues are reinstated, drug-seeking behaviors are renewed (Goddard, 2013; Ramoa et al., 2013). Classical conditioning animal research suggests that long-term drug abuse leads to adverse changes in the PFC neuronal structure producing modified functional activation of the orbito-frontal cortex oPFC in cocaine addicts (Everitt, 2014). Pre-Frontal Cortex and oPFC changes may also influence long-term "recovery effects on drug-taking and drug-seeking behaviors" (Everitt, 2014, p. 132).

Conditioning models demonstrate the complexities of neuropsychological processes in female addiction. The processes include drug susceptibilities and repetitive relapse behaviors that can occur even after an extended absence of drug-taking (Kennedy et al., 2013; Najavits et al., 2008; Ramoa et al., 2013). Although neural response studies have been more inclusive of the experiences of female addicts, previous research has failed to determine the strength of associations between stress, drug cues and craving among women (Potenza et al., 2012). To further illustrate gender differences in relationship to stressors and drug-induced cravings, Potenza et al. (2012) employed Functional MRI (fMRI) imaging to evaluate individualized script responses using stress, drug/alcohol cues and neural-relaxing imagery conditions in 30 abstinent cocaine-dependent men and women. This group was compared with 36 healthy (sporadic drinking) participants. Functional MRI results revealed prominent three-way communications visible in several brain regions including "the striatum, insula, and the anterior and posterior cingulate" (p. 406). From this study, these researchers determined that while drug-induced craving cues were positively associated with increased corticostriatal-limbic brain activity in both male and female participants; females experienced significantly greater hyperactivity in this region of the brain when stress-inducing cues were introduced compared with cocaine-dependent males.

Similar studies suggest that corticostriatal-limbic hyperactivity appears to be linked to stress cues in women, drug cues in men, and neural-relaxation conditions in both (Gallop et al., 2007; Ide et al., 2014). Cocaine and MA-addicted females were more likely to link daily stress and unresolved psychological problems as sufficient motivators

to continue risky and even criminal activities (i.e. sex trading, stealing, assault etc.) in drug-seeking and drug-taking (Moeller et al., 2010; Tolliver et al., 2012; Tull et al., 2011). In their studies of cocaine-dependent individuals, Mahoney et al. (2010) found that women report more psychotic symptoms, including paranoid and grand delusions, perceptual disturbances and auditory episodes, tactile and olfactory hallucinations more frequently than men. These findings are consistent with other psychological studies hypothesizing that increases in psychotic symptoms reported by adult females increased drug quantities per day and for longer periods than for addicted adult males (Anker & Carroll, 2011; Fox et al., 2014; Volkow et al., 2011a). Classical conditioning theory relates to the archival study in that the behaviors associated with continued drug use or avoidance are related to learned brain behaviors among addicted individuals. Contemporary drug addiction theories concur that neurocognitive paths to addiction reinforce continued patterns of use or new learning that helps the individual to avoid or break these habits (Yager & Robinson, 2014).

Operant Conditioning Theory

The chief motivation for drug-seeking behavior in laboratory animals is associated with behaviors that produce positive outcomes (the reduction of pain and hunger). These motivational behavior processes are similar in humans (Gould, 2010). While Pavlov's classical conditioning studies offer some explanation of the cue-conditioning and reward process in drug abuse behaviors, it does not fully explain why behaviors continue even when associated actions can cause irreversible harm to the user or others. Operant (instrumental) conditioning originates from the work of E.L.

Thorndike who theorized that conditioning in learning depends upon the consequences of an action to modify the likelihood of that same action occurring in the future (Milton & Everitt, 2012). Thorndike's claim that conditioning in learning depends on the consequences of an individual's actions differs from Pavlovian conditioning in which "contingency between the CS (conditioned stimulus) and US (unconditioned stimulus) is dependent on the individual's behavior" (Milton & Everitt, 2012, p. 1123). In this regard, the motivation to continue the instrumental response relies on whether the action results in a positive or negative consequence (Milton & Everitt, 2012).

In congruence with classical conditioning, instrumental conditioning supports the power of reinforcing mechanisms that involve the dopamine and limbic systems creating new patterns of learning and memory (Nyberg, 2012). These neural systems deliver the "rewarding effects of drug use" (positive reinforcement), thus inciting little incentive for the drug abuser to avoid continued drug use. Despite the desire of an individual to abandon these behaviors, ceasing cocaine and MA use can bring on severe and painful withdrawal symptoms, thereby sustaining patterns of drug administration and avoidance of treatment (Milton & Everitt, 2012; Pinel, 2011). Due to the strength of these potent reinforcing drug cues, Koob & Volkow (2010) note that the ingestion of stimulant drugs can overpower the body's natural rewards for eating, drinking, and sexual activity, thus altering the satisfaction of these rewards.

Over time, neglect or abstention of the body's natural rewards can diminish to dangerous levels, leaving the drug abuser at greater risk for more drug-seeking in attempts to satisfy an increasing need for "drug-induced rewards" (Volkow et al., 2015).

Neuropsychological learning and conditioning response processes associated with these behaviors have been examined using laboratory animals (Pinel, 2011). Researchers found that the animals learned to self-administer all drug types except for LSD (Everitt, 2014). These findings support the hypothesis that conditioning in drug-seeking cues in laboratory animals are greatly influenced by motivation and reward, much like drug-seeking in humans is motivated by reward processes (Gould, 2010; Moeller et al., 2014; Todd, Vubric, & Bouton, 2014). New behaviors that result from reward processes due to repeated patterns are categorized as positive reinforcement (Gould, 2010).

In experimental settings, laboratory animals learn to press a level to obtain food, or a dog follows verbal commands to obtain a treat (Gould, 2010). Once this behavior is positively reinforced (obtaining a treat with each correct response) the behavior is likely to continue regardless of new tasks that might be added to obtain "the reward" (Gould, 2010). When drug-seeking behaviors are "rewarded" in the abuser, the desire to continue this positively reinforcing behavior is likely to persist even when new obstacles are added (i.e. family dysfunction, loss of employment, homelessness, court-ordered drug treatment, incarceration etc.). Conditioned learning models refer to "motivation" as an important impetus in drug abuse; it is this motivation that perpetuates avoidance in seeking help and perpetuates a cycle of relapse (Gould, 2010; Milton & Everitt, 2012; Fox et al., 2014).

An increasing dependence on drugs wakens motivational systems in this realm of human behavior; the drug is the "cue" or "reward" and the repetition of drug use links the association between the cue and response; thus "rewards" experienced by the user

become stronger upon successive administration (Milton & Everitt, 2012). Carey et al. (2014) suggest that this model of addiction can be viewed in terms of special paths that involve the development of habitual behavior patterns independent of cognitive processes. Neural transmitters relaying constant messages to the PFC centers of the brain to continue addictive behaviors can prove so robust that impulses associated with self-restraint in drug-seeking and drug-taking are no longer under the control of the drug user (Carey et al., 2014).

Literature Review Related to Key Variables and/or Concepts

Mahoney et al. (2010) found that continued abuse of cocaine and MA can lead to the onset of psychotic symptoms. Active cocaine and MA participants responded to survey questions from the Psychotic Symptom Assessment Scale, which listed an assortment of psychotic symptoms experienced during drug use (Mahoney et al., 2010). These researchers concluded that in the "while abstinent" phase, cocaine-addicted women reported experiencing auditory hallucinations more frequently, while men expressed delusions of grandeur. Among MA addicts, in the "while abstinent" phase, women were more likely than men to report that they experienced severe body image distortions (Mahoney et al., 2010). In each group (whether MA or cocaine) all users reported various psychotic symptoms (auditory and olfactory hallucinations) as being more intense in the "while high" stages of drug use (Mahoney et al., 2010).

Cocaine-dependent women often experience heightened vulnerabilities to social, physical and psychological consequences of substance use, which can encourage a return to use if strong social supports are not available (Winhusen et al., 2013b). Cocaine-

addicted women also differ from similarly dependent men in their neural response to cue-induced cravings and stress (Mahoney et al., 2010; Mitchell & Potenza, 2015). In a study of gender and MA abuse, Zuloaga et al. (2015) proposed that alterations in the hypothalamic-pituitary-adrenal axis can propel repeated drug abuse, not for the desired "high" but rather to counter the worsening levels of stress and anxiety induced when the effects of the drug were no longer present. In substance-abusing pregnant women these events are especially problematic in that stress-induced cortisol levels were significantly higher in MA exposed infants than in those who had not been exposed to MA (Zuloaga et al., 2015).

Complicating the cyclical nature of chronic drug abuse in women, especially among those in drug treatment, are the numerous factors involved in drug-seeking and new problems that arise when women move from drug experimentation to full addiction. Studies in cue association in classical and operant conditioning support other research findings that consistency in activation of the amygdala and Ant Cing in female addicts when exposed to drug cues, increases episodes of drug craving (Colzato et al., 2009; Ersche et al., 2006; Pinel, 2011). Operant conditioning theory is relevant to the archival study in terms of the long-documented associations between positive and negative reinforcement of persistent drug addiction behaviors. Pinel (2011) argued that motivational processes and consequences of actions are connected to the continuation of addiction cycles or the motivation to cease repeating these patterns.

Approaches, strengths, and weaknesses of drug addiction research. Previous studies of cocaine and methamphetamine addiction (MA) have been subsumed under the

auspices of general drug addiction and typically included few (if any) female substance abusers (Becker et al., 2017). Two major psychological approaches are discussed in terms of their contributions, strengths and weaknesses in female drug addiction. In those studies that focused on brain functions with an expressed interest on neurocognitive and executive function, there was more of an effort to include sex related similarities and differences in long-term cocaine and MA addiction. The strength of neuroimaging technology studies has added significant value to the discipline of psychology in terms of revealing the relevancy of this research in addiction related brain circuits and behavioral outcomes as well as tendencies to relapse. Neuroimaging and PET (Positron Emission Technology) studies have added to drug addiction literatures in that the neuroscience advances in brain-based behavior in drug addiction by examining actual brain pattern differences between female and male addicts. Neuroimaging research has become increasingly valuable in untangling the complications of associations between brain reward and neurocognitive functions related to the onset, maintenance and treatment of addiction in women and men (Ballard et al., 2015).

Theory-based studies of drug addiction, including classical and operant conditioning theory, emphasize the power of brain-based behaviors in terms of conditioning and the power of "rewards" or "punishment" in drug-seeking and drug-taking behavior. These studies also underscore the ranking of individual cue reactivity in drug addiction but also confirm the power of external forces in shaping these behaviors (Volkow et al., 2015). Both approaches contribute to the general understanding of drug addiction among males and females; however, neither approach has comprehensively

included narratives of adult female experiences. Little justification has been provided concerning the omission or marginalization of female participants in neuroscience studies of drug addiction. In addition, the stigma of female drug abuse (even in scientific research) has delayed critical examination of sex differences in neurocognitive studies of brain-based behaviors in drug addiction.

Justification of concepts. Based on current cocaine and MA addiction studies in which adult females more fully participate, there is a growing area of psychological research that supports sex differences in terms of onset, maintenance and treatment success (Fernandez-Montalvo et al., 2017; Keane, 2017). Researchers found that drug treatment program success appeared to be the most relevant to recovery and continued drug abstinence of addicted women. The intent of this study is based on the association of decision-making and other brain-based behaviors that are pivotal to drug treatment program success (Fattore, 2015).

Neurochemistry of Cocaine and Methamphetamine

Cocaine is an alkaloid ester and a tropane alkaloid naturally grown and prepared from the leaves of the coca bush found primarily in Peru, Bolivia, and Columbia (EMCDA, 2016; Jonkman & Kenny, 2013). The processed impure residue derived from pure cocaine is known as “crack cocaine” (Pinel, 2011). In its capacity as a central nervous system (CNS) stimulant, cocaine triggers numerous neurotransmitter systems in the brain (Koob & Volkow, 2010). Two of these systems are the dopamine and limbic reward systems, in which cocaine interactions produce interactions between neurotransmitters leading to some of its most pleasurable and rewarding effects,

including feelings of euphoria, well-being, self-confidence, alertness and a decreased desire for food and sleep (Bell et al., 2014; Ballard et al., 2015; Gould, 2010).

One of cocaine's most important roles in the dopamine system is to prevent the synaptic reuptake of dopamine (Rothman et al., 2008). Unlike other drugs, cocaine does not directly stimulate the dopamine system; however, it does permit neural components of the system to be stimulated by blocking dopamine reuptake transporters' ability to evacuate from the intracellular space (Rothman et al., 2008). Studies of cocaine addiction in women find that cocaine can modify communication pathways between neurons (synaptic plasticity). Exploring communication associations between neural systems and the modifications that occur during use is essential in comprehending the bond of persistence of female cocaine addiction (Garavan et al., 2008; Rothman et al., 2008; Moeller et al., 2014).

Cocaine abusers tend to go on binges also known as "cocaine sprees" in which extremely high levels of intake are maintained for a day or two (Goldstein & Volkow, 2011; Pinel, 2011). During the intake period, users become increasingly tolerant of the euphoria- producing effects of the drug (Nephew & Febo, 2012; NIDA, 2013). Adverse effects of cocaine sprees include bouts of sleeplessness, tremors, nausea, hyperthermia and psychotic behavior; however, more severe reactions can result in a loss of consciousness, heart attack, stroke, or death (Pinel, 2011). Although users can develop a tolerance of cocaine's effects (e.g., to the euphoria), repeated exposure to the drug sensitizes subjects (makes them more responsive) to its motor and convulsive effects (Potenza et al., 2012).

Cocaine and MA use during pregnancy is especially risky to the fetus and can cause complications, including placental abruption, preterm labor and delivery, and maternal seizures (Bhuvaneswar et al., 2008). Pregnant women might also experience other serious problems due to insufficient medical or prenatal care mediated by continued drug use during pregnancy (Malek, 2012).

Methamphetamine (MA) is a derivative of a class of CNS stimulant drugs known as amphetamine and is usually administered orally in its more potent form called d-amphetamine (Taylor et al., 2013). Since the 1990s the popularity of d-amphetamines was surpassed by several of its highly dominant relatives: 3, 4-methylenedioxy methamphetamine (MDMA or ecstasy), which is consumed orally, and methamphetamine, or "meth," typically taken in a smokable, crystalline form known as "crystal" or "ice" (Pinel, 2011).

Methamphetamine can be produced from a wide variety of materials and methods. The ability to cheaply and quickly manufacture MA has increased potential for abuse and financial attraction for both users and manufacturers (NIDA, 2013; Rusyniak, 2013). Methamphetamine's psychological effects, like those of cocaine include a heightened sense of euphoria or well-being, elevated alertness, increased vigor, decreased food intake and decreased sleep time (Bell et al., 2014; Taylor et al., 2013).

Methamphetamine and cocaine exhibit similar physiological effects in administration, including a rise in respiratory rate, increases in dilation of the pupils, elevated heart rate and irreparable damage to small blood vessels in the brain (Pinel, 2011). In addition, critical body system overload such as uncontrolled spikes in

temperature and seizures are indications of an MA overdose, and if immediate medical treatment is not administered, death can occur (Pinel, 2011; Rusyniak, 2013). In prolonged use of MA (as with cocaine), tolerance develops, and in repeated exposure may produce desensitization requiring more frequent and increased quantities of the drug (Andersen et al., 2012; Baicy, 2007; Rusyniak, 2013).

The probability for female cocaine and MA abusers to relapse after treatment is significant in terms of their drug of choice (Fridberg et al., 2013; Volkow et al., 2011a). Although this study does not aim to analyze the independent contributory effects of cocaine or MA in cognitive or executive function impairments, some critical distinctions in terms of their neurologic effects for female users exist (Fridberg et al., 2013; Mahoney et al., 2010). First, methamphetamine is viewed as an aggressor in the pre-synaptic discharge of dopamine in the mesolimbic reward system (Pinel, 2011; Yu et al., 2015). Second, current neuroscience research demonstrates higher neurotoxic effects in animals and in humans, thereby adding to the risk of addiction and adverse physiological events (Herbeck & Brecht; 2013; Siegel et al., 2010).

Unlike cocaine, MA does cross neuronal cell membranes and enters the microscopic sacs (called vesicles) where neurons store dopamine (Yu et al., 2015). Methamphetamine is believed to damage the storage sacs and the neuron's axonal endings, causing dopamine to leak uncontrollably into the synapse (Everitt, 2014). Methamphetamine can also cause neurotoxicity indirectly by mobilizing dopamine out of the safe storage vesicles within the neuron and into the neuron's cytoplasm (the inner core of matter), where it is changed to noxious and volatile chemicals (Everitt, 2014).

Once administered, MA is speedily absorbed by plasma and tissue enzymes; however, the body processes MA more gradually, which frequently results in a prolonged "desirous" state, despite the probability of dangerous neurotoxic effects (Volkow et al., 2015). Although the half–life (effective duration of action) of cocaine is 1-2 hours, a single dose of MA may produce an effect for 8-12 hours (Yu et al., 2015). The abuse of MA can also carry significant health risks to pregnant women and their unborn children. Pediatric studies support that MA abuse during pregnancy is associated with increased stress, lower birthweight and more developmental problems in babies born to MA-abusing mothers (Pinel, 2011).

Gender and Addiction

National data reports estimate that in 2012, more than 22.2 million people over the age of 12 were categorized as substance abusers or substance dependent in the United States (NIDA, 2013). These data also demonstrate the significance of gender in substance abuse patterns, including drug of choice, onset, and frequency of use (Bobzean et al., 2014; Du et al., 2013: Greenfield et al., 2010). A report from the National Survey on Drug Use and Health (CBHSQ, 2015) found that the rate of illegal drug use, including cocaine and MA, among males was higher (11.5%) than for females (7.3%). A similar study revealed that females use substances more frequently due to stressful life events and exhibit higher relapse behaviors than males (Bisagno et al., 2014). Addiction research suggests that while men are more likely to abuse cocaine and MA, women are three to four times more likely to become addicted within 24 months of initial use (Becker, 2012; Kerstetter, 2013; Volkow et al., 2011).

Although national data show that the overall abuse of cocaine has decreased slightly for women, annual health studies as recent as 2015 report that the rate of abuse of methamphetamines has significantly increased (CBHSCQ, 2015). These studies also indicate the rise in MA use among pregnant women has risen from 8% to over 24% in the past decade, leading investigators to infer that MA is the most commonly abused drug for which pregnant women seek help (Greenfield, 2010; NIDA, 2014).

One of the most complex factors in substance abuse research involves multi-addiction or multi-drug use (i.e. alcohol opioids, depressants etc.) that can hinder the ability to separate the distinguishing effects of cocaine and MA (Covington, 2008; Dean et al., 2013; Glasner-Edwards & Rawson, 2010; Goldstein & Volkow, 2011; Gould, 2010). Another complication of female cocaine and MA addiction involves multiple brain pathways that serve to interrupt, modify and severely damage cognition and executive functions (Everitt, 2014; Thakkar et al., 2014). The increasing use of MA in the general population is evidenced in part by the following; (a) emergency room visits have doubled since 2002; (b) admissions to drug abuse treatment programs for general amphetamine use have grown almost 200% from 1994 to 2004 with a record number of states (44 out of 45) reporting epidemic increases; (c) criminal activity, imprisonment and high socio-economic costs have increased, and (d) suicide and accidental death rates stemming from production, distribution and consumption of MA (DOJ, 2015; NIDA, 2013).

The covert production, generous supply, and increasing abuse of MA during the 1990's resulted in federal legislation to curb the growing problem of MA demand in the

United States. The Comprehensive Methamphetamine Control Act of 1996 and the Methamphetamine and Club Drug Act of 2000 were enacted to specifically address the need to curb this epidemic (Salo et al., 2010). Gender studies of stimulant drug addiction explain that prevalence of abuse is only one measure of gender difference, and other factors that must be considered, from the first experience of cocaine and MA use to the transition to full addiction. These studies also demonstrate that females are more likely to start using stimulant drugs (cocaine, MA) at an earlier age, are more likely to escalate their rate of drug abuse and are more likely to consume greater quantities of drugs than addicted men (Becker, 2011; Greenfield et al., 2010; Taylor et al., 2013).

Neuropsychology of Addiction and Gender

Neuropsychological studies employ multiple terminologies in defining drug addiction including the terms "substance use disorder" and "substance abuse" (Gould, 2011). The generally accepted definition of drug addiction is a "chronic, relapsing brain disease that is characterized by compulsive drug-seeking and use, despite harmful consequences" (http://www.drugabuse.gov). Addiction researchers define drug addiction in this manner because addiction can interrupt, reconfigure and modify critical structures in the brain (Pinel, 2011). Evidence presented in many drug addiction studies indicates that changes in the brain can have adverse short and long-term consequences that often result in dangerous and self-destructive behaviors that can subsequently lead to irreversible physical damage, harm or death (NIDA, 2013; Pinel, 2011).

Executive functions are those brain functions involved in complex cognitions such as solving novel problems, modifying behavior, considering new information,

generating strategies, or sequencing complex actions (Eisinger, Larson, Boulware, Thomas, & Mermelsten, 2018). Executive function tests have also been used to predict differential rates of attrition of female drug abusers compared with male drug abusers (Goldstein & Volkow, 2011; Marceau, Kelly, & Solowij, 2018). Executive systems coordinate, control, and assist in neural processes of goal-orientation in learning and decision-making (Hart, Marvin, Silver, & Smith, 2012; Potenza et al., 2012).

Psychological studies of addiction indicate that only a small portion of individuals (less than 20%) who use illicit drugs, including cocaine and MA, will become addicted (Badiani et al., 2013; Becker et al., 2012). These data suggest that progression from sporadic to chronic substance abuse depends on several factors, including the gender of the individual. In their research, Becker et al. (2012) contend that while males have higher risk factors for MA abuse, cocaine addiction is equally as likely for females as for males, and in many cases, addiction rates are higher for females (Bell et al., 2014; Bobzean et al., 2014).

Psychologists have documented more than 70 risk factors for substance use and dependence including poverty, physical, sexual or emotional abuse or other social dysfunction that can affect an individual's decision to initiate the use of cocaine or MA (DOJ, 2015; NIDA, 2013). Studies of drug dependence reveal that although men report similar risk factors associated with early use, the decision to continue use is commonly related to gender.

Women are more likely to report physical and sexual abuse, earlier use of alcohol, taking drugs with a spouse or partner, or experiencing co-morbidity behaviors

(for example, chronic depression) as likely reasons to commence or continue drug use (Becker et al., 2012; Greenfield et al., 2010; Hartwell, Moallem, Courtney, Glasner-Edwards, & Ray, 2016). These explanations provide some insight in terms of initial drug-taking behaviors; however, they do not fully answer the question of why increasing numbers of women continue their illicit drug use despite complications that substance abuse adds to their lives. Furthermore, these rationalizations do not adequately address why women are more likely to express persistent drug-related cravings or why they are more likely than men to return to drug abuse even after treatment (Becker et al., 2012).

Neuropsychological studies propose that illicit drugs, including cocaine and MA, while targeting different molecular structures, carry the same action potential of escalating dopamine (DA) neurotransmission in the nucleus accumbens (NAcb) particularly in the mesolimbic system of the brain (Everitt, 2014; Koob & Volkow, 2010). The frequency and predictability of these actions have led to widely held views that the DA system is directly responsible for reinforcing substance abuse behaviors and motivating addicted individuals to continue seeking and using drugs in order to avoid the effects of withdrawal (Everitt, 2014; Mitchell & Potenza, 2015).

A review of the neuropsychological literatures reveals that risk factors for drug-seeking, potential addiction and relapse vulnerabilities in females are closely related to conditioning cues associated with brain behaviors in drug abuse (Greenfield, 2010; Fattore, 2014). In addition, theories of brain behavior related to cognitive and executive impairments underscores important sex differences. Although neuroscience studies suggest that the path to cocaine and MA addiction, while similar for males and females,

reveals specific differences in neural processes for female addicts (Greenfield et al., 2010).

Studies of treatment attrition and relapse also substantiate that females demonstrate greater enhancement of the dopamine systems during initial drug exposure than do men. This effect on the dopamine system might impact a woman's ability to maintain abstinence after treatment (Du et al., 2013; Kennedy et al., 2013; Shrestha et al., 2015). While there are fewer gender-specific studies related solely to drug addiction, existing research supports the view that gender differences persist in patterns of activation in neural systems that undergird pathways to drug addiction (Becker et al., 2012).

According to Becker et al. (2012) differences in neural pathways are also useful in understanding how these systems might contribute to higher risk factors of addiction for women. Evidence from neuroscience research demonstrates that the mesolimbic dopamine system, comprising the ventral tegumental area (VTA) and nucleus accumbens (NAc), is the brain's most important reward pathway (Bell et al., 2014; Rusyniak, 2013). The VTA and NAc circuit is a primary sensor of rewarding stimuli in humans (Bell et al., 2014). Under normal operating conditions, the VTA and NAc regulates an individual's response to natural rewards, including food, sex, social interactions, and plays a primary role in motivation and incentives (Goddard et al., 2013). In simpler terms, activation of the circuit instructs an individual to repeat the action that brought about the reward (Goddard et al., 2013).

The mesolimbic system also informs the brain's memory centers to pay special attention to all features of the rewarding experience in order that the experience be repeated in the future (Goddard et al., 2013; Pinel, 2011). The VTA is the site of dopaminergic neurons, which inform the individual whether an environmental stimulus (natural reward, drug of abuse, stress) is rewarding or aversive (Bell et al., 2014). The NAc, also called ventral striatum, is a principal target of VTA dopamine neurons. This region mediates the rewarding effects of natural rewards and drugs of abuse (Gould, 2010; Volkow et al., 2011b). The amygdala is particularly important for conditioned forms of learning (Milton & Everitt, 2012). The amygdala helps an individual establish associations between environmental cues and whether that experience was rewarding or aversive (Pinel, 2011). The hippocampus is critical for declarative memory, the memory of persons, places or things. Along with the amygdala, it establishes memories of drug experiences, which are important mediators of relapse (Pinel, 2011; Rusyniak, 2013).

The limbic reward system (also known as the dopamine or brain reward system) is thought to be the most significant component in terms of the neurological reinforcement structure (Rusyniak, 2013). In addition, every known substance of abuse including, cocaine, methamphetamine, nicotine, alcohol, and heroin in some way produces an effect on the limbic system (Goddard et al., 2013). These drugs, in turn, produce changes in the nucleus accumbens by signaling an increase in the neurotransmitter dopamine, which assists in pleasurable feelings of euphoria and ease (Pinel, 2011). Dopamine is responsible for assistance in the brain's ability to control

movement, executive and cognitive function, motivation and reward processes (Lucantonio et al., 2012; Pinel, 2011).

Increases in dopamine levels are known to encourage short-term highs in emotions, moods and motor activity; however, abnormally elevated dopamine amounts can produce antagonistic effects, including high anxiety, aggressiveness, anger, paranoia, hallucinations and inappropriate behaviors (Volkow et al., 2011b). The role of dopamine and its salient effects on the limbic reward system, including its role in reinforcement and motivation, are considered the common link to drug abuse so much so that dopamine has been labeled as the "master molecule of addiction" (Hegarty et al., 2013; p. 124).

Terminologies associated with cocaine and MA as well as other drugs encompass a wide range of psycho-physiological effects that most commonly include changes in brain behavior, cardiovascular events, mood swings and sleep disturbance (Rothman et al., 2008). Extensive use and increasingly high dosages of these stimulants often lead to even more serious events, including psychotic actions or fractured thought patterns. In tests of chronic duration, laboratory results indicate that the propensity for frequent self-administration is a result of the highly reinforcing properties of these drugs (Ballard et al., 2015; Rothman et al., 2008).

Researchers have theorized that the same neural pathways responsible for natural reinforcers (i.e., food, drink, and sex) potentially provide more than "rewarding" effects during drug use (Balconi et al., 2015; Gould, 2010; Seigel et al., 2010; Taylor et al., 2013). In the progression from occasional use to addiction, the desirable effects formed in neural pathways can become so powerful so quickly that the frequency of use is likely

to increase, thereby rendering the user helpless to control these events (Pinel, 2011). Chronic use of cocaine and other stimulant drugs increases modifications in the brain's normal neurochemistry including changes in "the y-amniobutryic acid and glutamate systems and brain circuitry via synaptic plasticity processes" (Rothman et al., 2008, p. 459). Neuropsychological studies conclude that withdrawal from stimulant drugs is related to deficiencies in DA and 5-HT functioning systems (Everitt, 2014; Moreno-Lopez et al., 2012; Moeller et al., 2010).

Over a noticeably short period, stimulant drugs are most effective in modifying or interfering with normal communications between reward circuits and neurons in the brain (Moeller et al., 2014; Pinel, 2011). When administered, stimulants, including cocaine and MA, disrupt the dopamine neurotransmitter system. These interruptions occur when the post synaptic neurons become hyperactive by immediately elevating dopamine levels in the synaptic area, thus allowing excessive presynaptic releases or preventing the normal pattern of reuptake of dopamine (Koob et al., 2010). For the drug user, these extracellular DA levels and reward system dysfunctions typically leads to pleasurable mood changes (feeling of satisfaction, ease and calmness) and enhanced motor activity.

The psychological effects of cocaine are much shorter in duration than those of MA, and, for females, this shorter duration becomes problematic when administration must occur more often to induce the initial feelings of euphoria (Gould, 2010; Everitt, 2014). Neuropsychological studies of addiction in women demonstrate that the probability of becoming addicted begins with increasing rates of frequency and elevated tolerance for drug repetition in the mesolimbic reward systems of the brain (Fox et al.,

2014; Du et al., 2013; Taylor et al., 2013). Generally, the repetition of drug use is expected if first use is deemed pleasurable (rewarding), which can lead to dependence. However, more recent studies reveal that even initial drug use can extend well beyond the mesolimbic reward system (Saunders et al., 2013). The neural consequences of repeated drug use have the potential for "causing the user to become increasingly sensitive to the both the drug and drug associated cues, which can result in pathological drug-seeking or "wanting" (Taylor et al., 2013, p. 30).

Gender, Cognition, and Executive Function

Complicating the cocaine and MA problem for female addicts is verification that, as a psychostimulant drug, MA provides a neurotoxic affect to dopaminergic frontal areas of the brain and invokes neural deficits in mechanisms of cognition and selective attention (Koob & Volkow, 2010). Cognitive deficits demonstrated by MA users have been linked to neurotoxic events involving numerous neurotransmitter structures located throughout the cortex (Pinel, 2011; Salo et al., 2009). Harm-inducing events linking MA abuse to frontal striatal areas of the brain including the stratum, prefrontal cortex, anterior cingulate cortex and amygdala have led to a wide range of cognitive defects in humans (Baicy, 2007). Methamphetamine-dependent individuals have also demonstrated cognitive deficits in relationship to increased performance problems, specifically on tasks that entail the withholding of extraneous information, decision-making and working memory (Rusyniak, 2011; Salo et al., 2010).

Everitt (2014) notes that while many of the commonly known drugs including

cannabis, alcohol, and heroin have a range of different molecular goals, they also have similar propensities to increase dopamine (DA) transport in the nucleus accumbens (NAcb) region of the brain. Neuropsychological studies indicated that in addition to damage to the mesolimbic system which is vital to dopamine and serotonin neurotransmission, deficits in cognition and executive function are also evident in male and female addicts (Everitt, 2014).

Neuropsychological studies have determined that chronic cocaine and methamphetamine abuse pose a significant threat to cognitive and executive functions in neural processes of humans and animals (Herbeck & Brecht, 2013; Kiluk et al., 2011; Siegel et al., 2010). Cocaine and MA substance-dependent individuals have demonstrated deficits in the domain of executive functioning. Executive function "involves the ability to plan, judge, and weigh several options, to make complex decisions, to have an accurate perception of one's own abilities, and to implement, organize, and control other cognitive functions such as memory" (van der Plas et al., 2009; p. 706).

A critical issue related to interrupted cognitive and executive function is the increased likelihood that these impairments will reinforce a cycle of sustained use in the abuser even in after treatment intervention (Ballard et al., 2015). Among the most studied characteristics associated with cognitive and executive function are the disruption of "normal" learning and memory schemas and the development of new learning and memories precipitated by chronic drug use in males and females (Ballard, 2015). Neuroscience data add that stimulant drugs such as cocaine and MA not only exhibit

temporary disruptions but also can modify short and long-term memory by establishing strong associations between drug cues and drug reward mechanisms (Hartwell et.al, 2016; Herbeck & Brecht, 2013). Once these cues and drug reward mechanisms activate, these associations are not easily broken, thus rendering the user less control over drug seeking and use (Winhusen et al., 2013).

Studies comparing the performance of cocaine and MA-addicted males and females on neuropsychological tests of executive function found that females were significantly more likely to demonstrate impairments (van der Plas et al., 2009). These researchers compared the performance of alcohol-dependent individuals, cocaine-dependent individuals, and MA dependent individuals with healthy controls (matched by sex) on various measures of complicated decision-making tests using the Iowa Gambling Task, functional memory (Tic Tac Toe), cognitive elasticity (the Wisconsin Card Sorting Task), and response inhibition (the Stop Signal-RT). Results revealed that cocaine and MA-addicted males and females were impaired in every category of memory and decision-making, except for response inhibition. In addition, cocaine and MA-dependent women exhibited significantly more impairment than men who were addicted. Taken together, these findings suggest that gender and drug of choice have differing effects on executive functions (van der Plas et al., 2009).

The Iowa Gambling Task (IGT) is an experimental decision-making test that requires the integration of different aspects of executive functioning for successful completion (Barry & Petry, 2008). The IGT is used frequently in cognition and executive function research as a means of measuring how well a participant can utilize complex

decision-making skills that require clarity, quick thinking and the ability to delay gratification when presented with various rewards (Verdejo-Garcia et al., 2007). One of the most prominent aspects of the IGT is the requirement that participants give up immediate rewards ("play" money) for delayed profit. In similar studies of addiction and executive impairment, females were more likely than males to make decisions to select temporary rewards over the long-term rewards even at the risk of losing all profits (van der Plas et al., 2009; Morie et al., 2014).

The consistency with which female cocaine and MA addicts were found to have poorer performance on various tests of executive function than men has brought about new questions regarding reward and punishment mechanisms, and whether these reward systems in the brain operate differently for female addicts when compared with male addicts. Adinoff et al. (2010) maintained that neuroimaging tests reveal differences in how reward and punishment mechanisms differ by sex. An important brain region involved in processing many types of reward and punishment in response to environmental changes is the orbitofrontal cortex (OFC), the ventral and medial prefrontal cortex (VMPFC) (Moreno et al., 2012; Shrestha et al., 2015).

Van der Plas et al. (2009) addressed the role that gender differences play in substance use disorders. These researchers found that cocaine and MA-addicted women exhibited serious impairments in decision-making abilities compared with cocaine and MA-addicted men in terms of PFC functioning. Other neuropsychological studies reaffirm that differences in brain activation patterns by sex could be related to reward versus punishment, thus reinforcing problems associated with a woman's decision-

making ability to discontinue drug use (Volkow et al., 2011). Van der Plas et al. (2009) further suggests that biological vulnerabilities in OFC systems could further explain the "telescoping" syndrome, a set of symptoms that includes the progression to drug dependence in which females are believed to progress more quickly to drug dependence even after a late onset of substance use.

As evidenced in their study, Adinoff et al. (2010) revealed that addicted individuals were significantly more likely to show reduced activity in the OFC when performing on the Iowa Gambling Task when compared with nonaddicted subjects. In addition, women demonstrated greater memory deficits than addicted men in terms of decision-making and working memory. Addiction studies suggest that working memory is impaired in both males and females; however, females experienced significantly greater dysfunction in this area of the brain (Adinoff et al., 2010).

Drug abuse studies related to gender propose that deficits in the working memory domain are not simply a matter of memory organization or categorization, rather impairments may be due to executive control problems (Ide et al., 2014). Specifically, van der Plas et al. (2009) found that individuals addicted to alcohol, cocaine, or methamphetamine performed below normal levels on the working-memory task, but found that increasing the memory load did not influence performance. Although stress and drug-cue exposure increase drug cravings and contribute to relapse in cocaine dependence, no previous research has directly examined the neural correlates of stress and drug-induced cravings in cocaine-dependent women and men relative to comparison subjects (Streeter et al., 2008).

Fridberg et al. (2013) administered a neuropsychological test of decision-making (the Iowa Gambling Task) for males and females with substance dependence and a history of childhood conduct disorder (HCCD) compared with healthy controls to assess working memory load. A primary function of working memory is to mediate the ability to sustain or suppress information and to resist distraction. Lower working load memory is associated with increases in impulsive decision-making in healthy adults. Substance-dependent males with HCCD made fewer advantageous decisions than IGT control men. Working memory capacity was reduced more significantly for substance-dependent women with HCCD than in substance-dependent men with HCCD (Fridberg et al., 2013).

Worhunsky et al. (2013) administered a Stroop Word Color Task (SWCT) as part of an exploratory study to examine systems of functional connectivity supporting cognitive control among cocaine-addicted subjects. Independent Component Analysis (ICA) was utilized in fMRI data to assess whether regional activations supporting cognitive control activities operate in functional systems in terms of performance and treatment outcome in cocaine-dependent participants. The study compared the performance of participants on a SWCT task during fMRI before entering treatment and compared these subjects to a control group. Cocaine-addicted males and females demonstrated differences in three out of five networks: (a) reduced involvement of a fronto-cingular network contributing to conflict management in treatment retention, and (b) increased engagement of two bottom-up subcortical, (c) and ventral prefrontal networks linked to cue-elicited motivation correlated with abstinence during treatment (Worhunsky et al., 2013).

Summary

The review of literature evaluating cognitive and executive function in cocaine and methamphetamine use supports the existence of gender differences in onset, maintenance and treatment outcomes (Anker & Carroll, 2011; Bobzean et al., 2014; Fattore et al., 2014). National health data offered statistical information on current use and addiction rates among women in the United States with an emphasis on the detrimental personal and societal costs of this ongoing problem (NIDA, 2017). Cocaine-dependent women often experience heightened vulnerabilities to social, physical and psychological consequences of substance use, which can encourage a return to use if strong social supports are not available (Winhusen et al., 2013a).

In both classical and operant conditioning theories, sex differences have been demonstrated in various areas of human learning (Shors, 2016). Classical and operant theories of drug abuse support that women are more likely respond to the desirable effects of cocaine and MA in the reward systems of the brain and to avoid withdrawal, thereby increasing their likelihood to continue their cycle of abuse (Goddard et al., 2013). Tests performed by researchers in the field of neuropsychology designed to measure cognitive and executive function revealed that cocaine and MA-addicted women were significantly impaired in key regions of the OFC in the brain (the region that controls complex decision-making and error processing) (Everitt, 2014; Saddoris et al., 2011). These problems signal that neural processes in terms of learning and memory affect addicted women differently than addicted men, in heightening vulnerability to relapse and life-threatening outcomes (van der Plas, 2013).

Studies of the literature covered in this chapter contend that the experiences of addicted females are not well-documented. Among the major reasons provided for the lack of empirical studies and female drug addiction are as follows: (a) women are not included as often in neuropsychological studies of drug addiction; (b) issues unique to women are not widely addressed in these studies; and (c) treatment planning often locates the addiction of women in relation to those of male addicts, thus ignoring specialized and relevant treatment to improve outcomes. The studies presented in this chapter attempt to address some of these neglected aspects, particularly the onset, maintenance, withdrawal and relapse women undergo during the addiction cycle. The empirical research offered in this literature review provides valuable information regarding gender differences across a spectrum of neuropsychological issues, including a propensity to develop and sustain cocaine and MA addictions, and the problems that may manifest in cognitive and executive functioning negatively impacting treatment and encouraging relapse.

While prior research on gender differences consistently failed to fully include the participation of female cocaine and MA addicts, current research does not go far enough in investigating neural situations unique to women's addiction experiences, or in pursuing efforts required to curb the rise in abuse, or in conducting extensive research in treatment assessments evaluation (Becker et al., 2017; van der Plas, 2011). While Cocaine and MA addiction researchers are offering greater insight into female addiction, present disparities in examining neurocognitive processes in female addiction emphasizes an intentional and prominent gap in current addiction literature.

Chapter 3: Research Method

In my research I examined an individual's extent of participation and performance on a test of neurocognitive function in a substance abuse treatment program for cocaine and MA-addicted adult males and females. This chapter includes a description of the study design and rationale, research setting, sample and sampling procedures, data collection and analysis, instrumentation and study materials, validity and threats to validity, and ethical protocols and procedures relevant to this research. The research questions and hypotheses guide data analysis procedures for this study. This present study utilized data released by the National Institute on Drug Abuse and made available for public use via the Clinical Trials Network (NIDA, 2013). The primary data for this present study were extracted from (CTN-0031A), an archival study derived from the parent study (CTN-0031), a randomized controlled trial from multiple sites (NIDA, 2013).

Research Design and Rationale

A quantitative, correlational method was employed as the research design for this study. I examined the extent of a person's participation in an eight-week substance abuse treatment program for adults addicted to cocaine and MA. In this study, four independent variables were analyzed: (a) participants' performance on the Comalli-Kaplan version of SWCT, (b) participants' gender, (c) participants' age, and (d) participants' race/ethnicity. There were two dependent variables: (a) the total number of hours of treatment received during the eight-week period, and (b) the differential between the number of hours of treatment received during the first four weeks and the number of

hours of treatment received during the last four weeks. The second measure was included to address the issue of participant attrition. This study did not appear to present any problems in terms of time or resource constraints. In this study, multiple regression and a series of bivariate analyses were used to examine the relationship: (a) between the independent variables and the total number of hours of treatment received during the eight-week period, and (b) between the independent variables and the differential between the number of hours of treatment received during the first four weeks and the number of hours of treatment received during the last four weeks.

Correlational methods in quantitative research examine whether a relationship exists between two or more variables, although correlation does not indicate causation between variables (Creswell, 2009). A correlational design was appropriate for this research in that neuropsychological studies have demonstrated relationships between performance on tests of neurocognitive function and the gender of participants enrolled in drug abuse treatment programs (Ballard et al., 2015; Bingham & Fry, 2010; LoBue et al., 2014; Scarpina & Tagini, 2017). In addition, a correlational method allows for types of testing that are otherwise impractical for human subjects who are active abusers of illicit drugs. Although studies of executive function and gender typically underscore patterns of neurocognitive interference unique to gender, not all associations between these variables demonstrate such distinctions (DeVito et al., 2012).

Correlational design studies related to neurocognitive function and extent of treatment participation for cocaine and MA-addicted males and females are not ample in neuropsychological literature. Contemporary psychological research contends that an

insufficient number of gender-based studies in substance abuse addiction has hindered critical aspects of evaluation and treatment, particularly for females (Crane et al., 2013; LoBue et al., 2014). More recent research has explored neurocognitive processes by specifically comparing drug treatment experiences of females and males (Becker et al., 2017; LoBue et al., 2014). In their research, Becker et al. (2017) found that when compared with men, women had higher attrition and poorer treatment outcomes, thereby prompting greater recovery obstacles. These factors are attributed in part to the greater severity of social and psychological issues women present upon entering treatment programs, including deficits in neurocognitive functioning (i.e., poor decision-making, greater impulse control and inconstant working memory).

According to Creswell (2009), quantitative research is a "means for testing objective theories by examining relationships among variables" (p. 4). A quantitative research design is appropriate for this present study because it attempts to investigate relationships among variables not previously addressed in the original data. In addition, findings from a quantitative research design are likely to support generalizability to a larger population because of the larger sample available from the original study (Choy, 2014). Qualitative research designs were not deemed appropriate for this study because it is not possible to explore the real-life experiences of participants from the CTN-0031A study.

Multivariate regression is used frequently in studies of neurocognitive function and extent of drug treatment program participation among cocaine and MA-addicted individuals. In previous research studies, Shrestha, Huedo-Media, and Copenhaven

(2015) employed multiple regression analysis to explore the relationship between self-reported neurocognitive impairment among high-risk male and female cocaine abusers enrolled in a methadone treatment program. A similar study by Fernandez-Montalvo et al. (2017) used multiple regression analysis to examine gender differences in treatment attrition between addicted males and females enrolled in an outpatient drug treatment program. Fridberg et al. (2013) studied gender differences among MA-dependent males and females enrolled in substance abuse treatment programs, using four domains: drug use history, psychological burden, current symptoms, and coping strategy. Employing multiple regression analysis, Fridberg et al. (2013) found that although men reported earlier abuse of alcohol and drugs than women, women reported greater severity of use of MA, more psychological burdens, and poorer coping strategies than substance-abusing men.

Methodology

Population, Sampling and Sampling Procedures, Study Inclusion and Exclusion

The population for this present study were active cocaine and MA-addicted men and women of at least 18 years of age who met all requirements as participants from the CTN-0031A study (NIDA, 2013). In my study, participants were a randomly selected sample of 186 men and women who (a) participated in drug treatment programs from six sites; and (b) completed the Comalli-Kaplan version of the SWCT. Random selection ensured that each potential participant had an equal probability of being selected, thus confirming that study participants are representative of the target population (Creswell, 2009). NIDA drew the sample and provided the participant-specific data. According to

calculations based on G*Power Version 3.1.9.2, the sample of 186 made available for the present study would yield a power level of 0.99 for an effect size of 0.30, meaning that there is a high probability of finding a significant effect if one exists.

Participants. Participants randomly selected from the CTN-0031A study and deemed eligible for this present study were required to meet the following criteria: (a) be at least 18 years of age at the time of selection for the CTN-0031 study, (b) meet the DSM-V criteria of abuse or dependence on MA and/or cocaine, (c) must declare the use of cocaine and/or MA as the primary drug(s) of choice, (d) be able to understand the relevant content of the study, (e) be able to provide written informed consent in English, (f) be able to sign all appropriate documentation for study access, and (g) be able to fully distinguish the colored stimuli on the Comalli-Kaplan version of the SWCT. In this present study exclusion criteria followed the protocol of the CTN-0031A studies in that research participants were excluded from the study if they had previously experienced strokes or certain seizure disorders.

Materials and procedures for recruitment, consent participation, and data collection. Efforts to enlist participation into the CTN-0031A study specified those individuals who met the DSM-V conditions for current abuse or addiction of cocaine and are approved as their chief drug of choice during intake screening (American Psychiatric Association, 2013). Potential study participants were provided with information about the treatment study and given an opportunity to review, inquire about, and to sign the informed consent document. Any individual presenting problems in understanding the study requirements in the consent form were asked to review this information with the

study staff to ensure that potential participants fully comprehend the study requirements. If a participant exhibited continued difficulties in comprehending informed consent, that participant was exempted from study participation.

Participants who were willing to join the CTN-0031A study, yet demonstrated problems in grasping the scope of the study intent or informed consent material, were asked to review any sections that were misunderstood and discuss those sections with a research staff member until the candidate exhibited complete comprehension of the information and could willingly provide full and signed consent for participation. If considered eligible for the CTN-0031A study, each participant would attend a single research visit that took approximately 1½ hours to complete.

Participant Reimbursement: Participants received compensation related to expense incurred for their transportation, time and inconvenience. Compensations was provided via cash, vouchers or retail scrip at the direction of each study site. A monetary recommendation was set at $50 for those participants completing the entire research visit and $10 for those who did not complete the study or were deemed ineligible. Participant reimbursement would vary across study sites in accordance with study sites and local IRB guidelines (NIDA, 2013).

After a study participant signed the consent form. Participants also completed minimal screening to determine a possible history of stroke and/or seizure disorder, and whether the participant could correctly distinguish the colored stimuli on the SWCT. Based upon this eligibility, participants then completed the research visit, which takes approximately 128 minutes. Visits were expected to occur during the first week of a

participant's acceptance and randomization into the study; however, they could also take place during the second week. In the CTN-0031A study, each participant's treatment attendance, including all information related to the actual dates, number of hours of attendance (for group and individual treatment sessions) over an eight-week period was to be documented by clinic staff (NIDA, 2013).

The NIDA data-share website is an electronic environment that permits data from published clinical trials to be disseminated to scientific researchers and the public for purposes of enhancing understanding, promoting new research and supporting further analysis (NIDA, 2013). The protection of human subjects is paramount for NIDA; data on this site have been completely de-identified to prevent any links to actual research participants. De-identification includes the removal of all Personal Health Information (PHI) and other identifiers that are not contained in PHI but could potentially lead to "deductive disclosure," including comment fields and site participation numbers. De-identifiers specific to the study were documented in the research protocols (NIDA, 2013).

Permission to use CTN-0031A data was obtained from NIDA's Clinical Trials Network (CTN) website by completing the NIDA Data Share and Registration Agreement and by meeting use and responsibility requirements for dataset use. Permission to use the shared datasets is available on the NIDA website (https://www.drugabuse.gov). Shared data files are found at the NIDA clinical trial network site and are available for download in two formats: SAS (transport files and ASCII (CSV).

As part of the NIDA Registration Agreement, the user also agrees (a) not to manipulate any information to establish identities of any of the subjects from whom study material was obtained; (b) to retain control over the received data and not to transfer any portion of the received data with or without charge to any other entity; (c) to notify the user's Institutional Review Board (IRB) operating under guidelines approved by the Office of Human Research Protections (OHRP) as required by the recipient's affiliated university, and in accordance with the Department of Health and Human Service regulations for any new research projects based on the NIDA data; (d) to acknowledge the NIDA database and the specific trials accessed in all oral and written presentations and publications resulting from analyses of the received data; (e) to maintain security and privacy of the received data for as long as necessary per local and federal requirements; and (f) that NIDA or its affiliates may contact the recipient concerning publications of other issues regarding the use of the data (NIDA, 2013).

Instrumentation and Operationalization

Data items specific to participants' gender, age and race/ethnicity was extracted from the general demographic questionnaire section of CTN-0031A. The race/ethnicity categories were White non-Hispanic, Black/African American, Hispanic/Latino, Asian, Native Hawaiian/Pacific Islander, Native American/Alaskan Native, and Other. Any specific identifiers, including name, location, incarcerations and other personal identifiers of study participants were eliminated from the CTN-0031A dataset files.

Participants' gender, age and race/ethnicity constitute three of the four independent variables to be used in this study. The fourth independent variable is the

participants' derived interference reaction time (RT) on the Comalli-Kaplan version of the Stroop Word Color Task (SWCT), expressed in seconds. NIDA calculated the summary RT score by subtracting the seconds required to complete Stroop Task 1 from the seconds required to complete Stroop Task 3. For example, if a participant took 49 seconds to complete Task 1 and 89 seconds to complete Task 3, the RT score would be 40. The lower the RT score for a participant, the better.

Test of executive function: Stroop Word Color Task. The SWCT is one of the most reliable and widely used neuropsychological tests of neurocognitive functions involving selective attention, cognitive control and flexibility, goal-oriented behavior, impulsivity, and response inhibition processes (Kiyonaga & Enger, 2014; Hurtado et al., 2014; Streeter et al., 2008). The SWCT is considered an ideal instrument to screen individuals who may be at risk for lower drug treatment participation and who may be vulnerable for treatment dropout due to their hypothesized inability inhibit or control impulsive behaviors that prevent successful drug use avoidance. The staff supervising the eight-week treatment program recorded daily the number of hours of treatment received by each participant in the study. The recorded number of treatment hours were used in measuring the two dependent variables in the study: (a) the total number of hours of treatment that a participant received over an eight-week period and (b) the differential between the number of hours of treatment received during the first four weeks and the number of hours of treatment received during the last four weeks.

The SWCT was originally developed in 1935 by psychologist John Ridley Stroop to measure selective attention and cognitive flexibility (MacLeod, 2015). The original

Stroop task has been modified and translated into multiple languages, including Chinese, German and Japanese (Homack & Riccio, 2004). While there is no one standard version of the SWCT, there are several editions that are commonly used in neuropsychological research: the Comalli-Kaplan version (1962), Max Trenerry's version (1962), Charles Golden's version (1978), and the Victoria version (1981).

The Comalli-Kaplan version of the SWCT, developed in 1962, consists of three sub-sections designed to assess a subject's ability to suppress interfering stimuli. These tasks are contained on three stimulus card sets, each containing 100 stimuli (Strauss et al., 2005). This version is appropriate for this present study because modifications of this task require that the color-naming card be presented first, that errors be recorded, and that allowances be made for self-correction of errors before moving on the next stimuli (Strauss et al. 2005; Winhusen 2013). These modifications serve two purposes in neurocognitive function and drug addiction studies: (a) individuals who are color-blind will be quickly identified and, (b) this test procedure maximizes the interference effect by presenting the word condition just prior to the interference task (Strauss et al., 2005). The order of the test administration is as follows: color-naming, word-reading and interference. Three scores, including an interference score, are generated using the number of items completed on each page, with higher scores reflecting better performance and less interference on reading ability. Testing for all three SWCT sections has a completion time of five minutes.

Previous neuropsychological studies have provided strong validity and test reliability for the SWCT (Shrestha et al., 2015, Strauss et al., 2005). Test-retest

investigations of the Comalli-Kaplan version indicate that color-naming times are exceptionally reliable (Strauss et al., 2005). Pilli, Naidu, Pingali, Shobha and Reddy (2013) demonstrated in normal, healthy populations that the SCWT appears to be extremely sensitive to the drug effects in terms of complex cognitive skills, including speed of information-processing, long-term memory, and selective memory, all of which are required for maximum performance on SWCT.

Sufficiency of instrumentation. In addition to documented validity and test reliability of the SWCT, this test has demonstrated a relationship between performance on the SWCT (interference) and executive function in cocaine and MA-addicted individuals. Research has found that performance on the SWCT is a predictor of treatment attrition among cocaine and MA drug abusers (Green, Locker, Boyer, & Sturz, 2016; Hagen et al., 2016; Scarpina &Tangini, 2017).

In this present study, it was expected that participants would exhibit greater cognitive interference in RT performance of executive function comparable to similar studies that utilized SWCT instrumentation of neurocognition impairments in male and female cocaine and MA substance abusers (DeVito et al., 2014; King, Alicata, Cloak, & Chang, 2010; LoBue et al., 2014; Mitchell et al., 2013). It should be noted that while the CTN-0031A study administered and assessed six neuropsychological tests, in my study, only the SWCT was evaluated.

The occurrence of decreased color-naming has become known as the "color-word interference effect" (Winhusen, 2013). There are three components in this task, with participants using a computerized version of the Comalli-Kaplan SWCT. Pilli et al.

(2013) noted that the initial task starts when the participant is asked to name a series of color words (Word task). This component is believed to reflect basic reading rate and may be affected by cognitive or learning disabilities. Second, the individual is asked to name the color of a bar (Color task) of X's (e.g. XXX in blue or green ink). As with the Word task, performance might be affected by speech motor function or other neurocognitive function deficits. The final task is the Color-word task on which the individual is shown the names of colors (e.g., the word "blue" in red ink) and is asked to name the color of ink rather than the word (Pilli et al., 2013). The subject's task is to correctly move from one section to another naming words or naming the ink colors as quickly as possible with a given time limit of 45 seconds. Scores obtained from each of the Stroop tasks are derived from interference-reaction time (RT), which is the actual time allotted for a participant to provide a response.

Reaction time of participants is critical for these tasks in that slower response times are hypothesized as indicators of neurocognitive function impairments. Wrong answers, including responses not given in the allotted time, are coded as incorrect responses. Participants are asked to provide responses to the number of words (Word task), number of bar colors (Color) and, the number of color words (Color-Word).

Color-word components of the Stroop are used to establish a baseline for comparison with the Color-Word task. Interference scores involve taking the difference between the Color task and Color-Word task to measure interference effects. Completion time for the three tests combined is five minutes (Kiyonaga, & Egner, 2014; Pilli et al., 2013).

Data Analysis Plan

The collected data were entered into an SPSS statistical software file, and the SPSS software was used to perform the analyses for this study. The data file contained 186 cases, each case representing a participant in the study. For each participant, the file included the demographic variables of gender, age and race/ethnicity, the participant's SWCT score, and the number of hours of treatment that the participant received on each of the 56 days (seven treatment days per week) comprising the treatment program.

SPSS was used to provide the following: (a) descriptive statistics summarizing the demographic characteristics of the 186 participants in the study; (b) descriptive statistics showing how SWCT scores vary according to demographic characteristics; (c) descriptive statistics showing how the level of participation in the treatment program varies according to demographic characteristics; and (d) inferential statistics addressing whether patterns observed in this sample can be generalized to a population. For each participant, SPSS was used to calculate the number of treatment hours for each of the eight weeks of the program. Then the resulting eight numbers were added together to obtain the total number of treatment hours for the eight-week program. This new total number was used as the dependent variable in a regression analysis addressing the first four research questions in this study.

In addition, SPSS was used to calculate the number of hours of treatment received during the first four weeks and the number of hours of treatment received during the last four weeks for each participant. The next step involved calculating the differential between the number of hours of treatment received during the first four weeks and the

number of hours of treatment received during the last four weeks. For example, if a person received 20 hours of treatment during the first four weeks and 10 hours during the last four weeks, that person's differential would be -10. That differential number would be used as the dependent variable in a regression analysis addressing the final four research questions.

Research Questions and Hypotheses

This study addressed the following research questions and hypotheses, using a randomly selected sample of 186 addicted individuals:

Research Question 1: Does the Stroop Word Color Task (SWCT) predict the level of participation when controlling for all other variables?

$H_0 1$: The SWCT does not significantly predict the level of participation when controlling for all other variables.

$H_a 1$: The SWCT significantly predicts the level of participation when controlling for all other variables.

Research Question 2: Does gender predict the level of participation when controlling for all other variables?

$H_0 2$: Gender does not significantly predict the level of participation when controlling for all other variables.

$H_a 2$: Gender significantly predicts the level of participation when controlling for all other variables.

Research Question 3: Does age predict the level of participation when controlling for all other variables?

$H_0$3: Age does not significantly predict the level of participation when controlling for all other variables.

H_a3: Age significantly predicts the level of participation when controlling for all other variables.

Research Question 4: Does race/ethnicity predict the level of participation when controlling for all other variables?

$H_0$4: Race/ethnicity does not significantly predict the level of participation when controlling for all other variables.

H_a4: Race/ethnicity significantly predicts the level of participation when controlling for all other variables.

Research Question 5: Does the SWCT predict the level of attrition in participation when controlling for all other variables?

$H_0$5: The SWCT does not significantly predict the level of attrition in participation when controlling for all other variables.

H_a5: The SWCT significantly predicts the level of attrition in participation when controlling for all other variables.

Research Question 6: Does gender predict the level of attrition in participation when controlling for all other variables?

$H_0$6: Gender does not significantly predict the level of attrition in participation when controlling for all other variables.

H_a6: Gender significantly predicts the level of attrition in participation when controlling for all other variables

Research Question 7: Does age predict the level of attrition in participation when controlling for all other variables?

$H_0$7: Age does not significantly predict the level of attrition in participation when controlling for all other variables.

H_a7: Age significantly predicts the level of attrition in participation when controlling for all other variables

Research Question 8: Does race/ethnicity predict the level of attrition in participation when controlling for all other variables?

$H_0$8: Race/ethnicity does not significantly predict the level of attrition in participation when controlling for all other variables.

H_a8: Race/ethnicity significantly predicts the level of attrition in participation when controlling for all other variables.

This present study used a correlational research design to examine the following: (a) the relationship between participants' demographic characteristics and their level of participation in a treatment program; (b) the relationship between participants' SWCT score and their level of participation in a treatment program; (c) the relationship between participants' demographic characteristics and their level of attrition in a treatment program; and (d) the relationship between participants' SWCT score and their level of attrition in a treatment program.

The hypotheses were tested through multiple regression analysis, with the researcher using an alpha level of .05 and a confidence level of 95% to determine statistical significance. With multiple regression, the researcher can estimate the extent to

which the values of independent variables predict the value of a dependent variable. Consequently, in the present study, multiple regression assisted the research in determining whether treatment participation was associated with SWCT performance, gender, age and race/ethnicity.

Threats to Validity

External Validity

Validity issues, including test reliability, are present to some extent in all psychometric tests (Gregory, 2011). Possible threats to external validity (the extent to which conclusions from a research study can be generalized) have been minimized by random sampling. In addition, there are other issues specific to external validity because; (a) the participants in this study represent a unique population (active cocaine and methamphetamine abusers), (b) polysubstance abuse (use of other drugs) will not be verified, and (c) individual differences in terms of testing cannot be controlled. Threats to internal validity in this research are as follows: (a) the ability to control for differences in individuals, including age, education or reading levels; (b) accuracy in reporting current use of drugs and unreported drug use; (c) environmental factors associated with living conditions; (d) emotional stress or physical traumas; (e) legal or impending incarceration issues; and (f) pregnancy or other recent medical diagnosis.

Internal Validity

Internal validity threats primarily include issues associated with treatments, procedures or participant experiences that can hinder or threaten the ability to draw correct conclusions about a research population (Creswell, 2009). Specific types of

possible internal validity problems associated with this present study include but are not limited to "selection" and "mortality." The fact that eligible study participants must be active abusers of cocaine and/or MA, makes it more difficult predict categorical actions or behaviors during the treatment process (a sudden illness, actions that threaten themselves others, non-compliance with treatment protocol), thus presenting challenges in drawing accurate conclusions about treatment related outcomes. Although it was expected that some participants might drop out of the drug treatment study (mortality), there was no way to predict how many or at what point in the treatment phase this would occur. If a significant number of participants failed to complete the study, drawing accurate inferences about the population of this research might be more difficult. In addition to issues of "history" and "maturation" are problems inherent in self-report and social desirability bias in drug addiction studies.

While self-reporting is a common approach in gathering data in scientific research, there are several problems that can arise in this reporting method. However, when utilized properly these data can provide useful in obtaining information related to a subject's views, opinions and perspectives regarding a research topic (Althubaiti, 2016). There are several aspects that accompany self-reported data that should be considered when designing the self-reporting instrument (Pannucci, & Wilkins, 2010)

Self-reporting data can be affected by an external bias caused by social desirability or approval, especially in cases where anonymity and confidentiality cannot be guaranteed at the time of data collection. For instance, when detailing drug usage among a sample of individuals, the results could underestimate the exact drug use,

including types of drugs, amounts, frequency of use and other relevant factors. In the archival study, subjects were asked to respond to a series of questions that included these specifics (types, amounts, times, etc.) as well as any poly-drug use, including alcohol, prescription and other forms of illicit drugs. Even when attempting to avoid bias in this research, it might be necessary to account for any simultaneous effects of other factors that could bear at least some responsibility for successful participation in the 8-week drug treatment program study. To better control for reporting common psychiatric illnesses including depression, the archival study administered the Patient Health Questionnaire to assist in screening and diagnosis of anxiety, alcohol and eating disorders. In addition, the Wender Utah Rating Scale was used to screen for ADHD in participants. A structured interview designed to assess whether a participant had experienced traumatic brain injury was employed as was participant HIV status using four questions self-reported via the Multicenter Aids Cohort Study (NIDA, 2013).

Statistical Conclusion Validity

According to Garcia-Perez (2012), statistical conclusion validity is related to the extent by which data from a research study can be "reasonably regarded as revealing a link (or lack thereof) between independent and dependent variables as far as statistical issues are concerned" (Garcia-Perez, 2012, p. 1). In the case of this research, it is important to be aware of issues that arise in presenting inadequate statistical power, sample size, effect size, alpha level or violation of statistical assumptions.

Test-retest investigations of the card version indicate that color-naming times are exceptionally reliable (Strauss et al., 2005). Garcia-Perez (2012) cautions that the

assumption of validity can be assessed in predictor variables by correlational methods investigating bivariate relationships. This assumption also holds true in the case of psychometric functions describing the form of the relationship between physical magnitude and the performance in a detection, discrimination, or identification task.

Ethical Considerations

Permission for this researcher to use the shared datasets is available on the NIDA website (https://www.drugabuse.gov/). Shared data files are found at the NIDA clinical trial network site and are available for download in two formats: SAS (transport files or sas7bdat) and ASCII (CSV). Completion of the NIDA Registration and Data Share Agreement are required for accessing data for this present study. The CTN-0031 and CTN-0031A studies met protocol and regulatory standards as recommended by the American Psychological Association.

One of the most pressing ethical issues associated with substance abuse research lies in the fact that unauthorized use of cocaine and methamphetamine in the United States is illegal and fully punishable by law; therefore, those who conduct research in this area must be fully cognizant and compliant with legal and ethical protocols in working with active substance abusers (DOJ, 2013; NIDA, 2017). Ethical issues involving the use of secondary data and the protection and confidentiality of study participants takes on greater urgency as access to new technologies becomes more readily available (Bersoff, 2008; Tripathy, 2013).

Confidentiality of data. In the archival study, the following information regarding participant confidentiality and anonymity was provided: (a) all Case Report

Forms (CRF's) were identified only by a coded participant number, (b) all study information was maintained in confidence with complete divulgence to the IRB, Ethical Review Committee, or similar expert committee, affiliated institution, and employees under appropriate understanding of confidentiality with such board or committee, affiliated institution and employees, and (c) NIDA administrators clarified that no participant study information would be available for release without written permission, except as required for monitoring (NIDA, 2015).

In the archival study, data were anonymously collected. Protections for the data storage and public usage were provided as follows: (a) secondary data were transmitted to a central depository as requested by NIDA, (b) the database was checked and "locked" by the Central Data Management to prevent further modification, (c) the data was archived and stored by NIDA, and (d) the dataset was made available for public data sharing under NIDA rules and regulations. In addition, this investigator agreed to abide by all confidentiality protocols associated with the Clinical Trials and data share network sponsored by NIDA. The investigator reported no conflicts of interest (NIDA, 2013).

Summary

This chapter described a plan for a research study that examines how a person's level of neurocognitive function and a person's gender, age and race/ethnicity seem to affect the extent of a person's participation in a substance abuse treatment program for cocaine and methamphetamine-addicted adults. A total of 186 cocaine and MA-addicted adults participated in the study. Eight hypotheses were tested.

Four of the hypotheses addressed the relationship between four independent variables and the total number of hours of treatment received during an eight-week period. The other four hypotheses addressed the relationship between the same four independent variables and the differential between the number of hours of treatment received during the first four weeks and the number of hours of treatment received during the last four weeks. The four independent variables are participants' performance on the Comalli-Kaplan version of the SWCT, participants' gender, participants' age, and participants' race/ethnicity. Multiple regression analysis and a series of bivariate analyses were used to test the hypotheses.

Chapter 4: Results

Cocaine and MA addiction in the United States is well documented, yet the onset, maintenance, and treatment outcomes of drug addiction specifically for adult females is less well known. An individual's level of participation and rate of program completion are two of the most significant factors in successful drug treatment recovery and post program success. This quantitative, correlational study was designed to examine whether the level of attendance and level of attrition of cocaine and MA-addicted participants in a substance abuse treatment program is associated with participants' demographic characteristics. In addition, this study explored whether a participant's level of attendance and attrition is related to the participant's performance on a test of neurocognitive executive function.

In my research, I examined secondary data from an archival drug treatment study (CTN-0031A) provided by the National Institute on Drug Abuse (NIDA, 2015). Researchers in the archival drug treatment study collected and analyzed data from six community drug treatment sites across the United States that included (a) the participants' gender, age and race/ethnicity; (b) the participants' performance on the SWCT test and (c) the participants' level of participation in the treatment program.

I obtained IRB approval **(#03-26-19-0245789)** through Walden University to conduct with my study using the CTN-0031A dataset. I analyzed data for 186 adults who participated in an eight-week treatment program for cocaine and MA addiction, and who had completed the SWCT before beginning treatment. In this study, there are four independent variables: (a) a participant's performance on the SWCT, (b) a participant's

gender, (c) a participant's age, and (d) a participant's race/ethnicity. There are two dependent variables: (a) the total number of hours of treatment a participant received during the eight-week period and (b) the differential between the number of hours of treatment received during the first four weeks and the number of hours of treatment received during the last four weeks. The second measure was included to address the issue of participant attrition. Multiple regression analysis was used to examine: (a) the relationship between the four independent variables and the first dependent variable and (b) the relationship between the four independent variables and the second dependent variable. The SPSS statistical software program and a NIDA codebook were utilized in analyzing the data.

In this chapter, I provide the research hypotheses, a description of the data collection process used in the study, the demographic characteristics of study participants, descriptive statistics for all variables, and the results of statistical procedures used to test the hypotheses.

Research Questions and Hypotheses

This study addressed the following research questions and hypotheses, using a randomly selected sample of 186 addicted individuals:

Research Question 1: Does the Stroop Word Color Task (SWCT) predict the level of participation when controlling for all other variables?

$H_0$1: The SWCT does not significantly predict the level of participation when controlling for all other variables.

H_a1: The SWCT significantly predicts the level of participation when controlling for all other variables.

Research Question 2: Does gender predict the level of participation when controlling for all other variables?

H_02: Gender does not significantly predict the level of participation when controlling for all other variables.

H_a2: Gender significantly predicts the level of participation when controlling for all other variables.

Research Question 3: Does age predict the level of participation when controlling for all other variables?

H_03: Age does not significantly predict the level of participation when controlling for all other variables.

H_a3: Age significantly predicts the level of participation when controlling for all other variables.

Research Question 4: Does race/ethnicity predict the level of participation when controlling for all other variables?

H_04: Race/ethnicity does not significantly predict the level of participation when controlling for all other variables.

H_a4: Race/ethnicity significantly predicts the level of participation when controlling for all other variables.

Research Question 5: Does the SWCT predict the level of attrition in participation when controlling for all other variables?

$H_0$5: The SWCT does not significantly predict the level of attrition in participation when controlling for all other variables.

H_a5: The SWCT significantly predicts the level of attrition in participation when controlling for all other variables.

Research Question 6: Does gender predict the level of attrition in participation when controlling for all other variables?

$H_0$6: Gender does not significantly predict the level of attrition in participation when controlling for all other variables.

H_a6: Gender significantly predicts the level of attrition in participation when controlling for all other variables

Research Question 7: Does age predict the level of attrition in participation when controlling for all other variables?

$H_0$7: Age does not significantly predict the level of attrition in participation when controlling for all other variables.

H_a7: Age significantly predicts the level of attrition in participation when controlling for all other variables

Research Question 8: Does race/ethnicity predict the level of attrition in participation when controlling for all other variables?

$H_0$8: Race/ethnicity does not significantly predict the level of attrition in participation when controlling for all other variables.

H_a8: Race/ethnicity significantly predicts the level of attrition in participation when controlling for all other variables.

Data Collection

The present study utilized an archival dataset released by the Clinical Trials Network of the National Institute on Drug Abuse. The population for the present study were active cocaine and MA-addicted men and women of at least 18 years of age who met all requirements as participants from the CTN-0031A study (NIDA, 2013). The study analyzed a randomly selected sample of 186 people who (a) participated in treatment programs offered at six community sites and (b) completed the Comalli-Kaplan version of the SWCT. Random selection ensures that each potential participant has an equal probability of being selected, thus confirming that study participants are representative of the target population (Creswell, 2009). NIDA drew the sample and provided the participant-specific data. According to calculations based on G*Power Version 3.1.9.2, the sample of 186 made available for the present study would yield a power level of 0.99 for an effect size of 0.30, meaning that there is a high probability of finding a significant effect if one exists.

Description of the Participants

In this study, there were 186 participants, of which 125 (67%) were female and 61 (33%) were male (Table 1). Among participants, 21 were under the age of 21 (11.3%), 53 participants were between the ages of 21 and 29 (28.5%), 63 (33.9%) participants were between the ages of 30 and 39, and 49 (26.3%) participants were aged 40 and above (Table 1). Among the 186 study participants, the percentage who were non-Hispanic white and the percentage who were non-Hispanic black was identical, 82 individuals—

44.1%. Ten Hispanics comprised 5.4% of the participants, and 12 (6.5%) of the participants did not disclose their race or ethnicity (Table 1).

Table 1
Demographic Characteristics of the Participants

	n	Percent	Valid percent
Gender			
Male	61	32.8	32.8
Female	125	67.2	67.2
Total	186	100.0	100.0
Age			
<21	21	11.3	11.3
21-29	53	28.5	28.5
30-39	63	33.9	33.9
40+	49	26.3	26.3
Total	186	100.0	100.0
Race/Ethnicity			
Non-Hispanic white	82	44.1	47.1
Non-Hispanic black	82	44.1	47.1
Hispanic	10	5.4	5.7
Total	174	93.5	100.0
Missing	12	6.5	
Total	186	100.0	

Note: The even split between non-Hispanic white and non-Hispanic black was accidental.

Results

The demographic variables constituted three of the four independent variables used in producing the major findings of this study. The fourth independent variable used in the analysis was the score summarizing participants' performance on the SWCT test.

The summary score was calculated by subtracting the seconds required to complete Stroop Task 1 from the seconds required to complete Stroop Task 3. The lower the summary SWCT score for a participant, the better.

Among the 186 participants, 15.1% had a score of less than 35 seconds, 34.9% had a score between 35 and 49 seconds, 24.7% had a score of between 50 and 64 seconds, and 25.3% had a score of at least 65 seconds (Table 2).

Table 2
Participants' Summary Score on the Stroop Word Color test

	n	Percent	Valid percent
<35 points	28	15.1	15.1
35-49	65	34.9	34.9
50-64	46	24.7	24.7
65+	47	25.3	25.3
Total	186	100.0	100.0

Note: The lower the score, the better.

The mean summary score was 53.4 seconds (Table 3). SWCT scores were analyzed to determine how they varied according to participants' gender, age and race/ethnicity. The mean for male participants (*N = 61*) was 54.1, and the mean for female participants (*N = 125*) was 53.1 (Table 3). A t-test for equality of means confirmed that the small difference between men and women in the SWCT score was not statistically significant ($p = .723$).

The mean score for white non-Hispanic participants ($N = 82$) was 48.3 and the mean score for black non-Hispanic participants ($N = 82$) was 60.1 (Table 3).

A *t* test for equality of means found that the difference between white non-Hispanics and black non-Hispanics in the SWCT score was statistically significant (p = .000). The 10 Hispanic participants had a mean score of 53.2. Because there were so few Hispanics in the sample, they were excluded from the between-groups analysis (Table 3).

Table 3

Means and T-Tests for Participants' Summary Score on the Stroop Word Color test by Gender and by Race/Ethnicity

Gender	n	Mean	SD
Male	61	54.11	18.657
Female	125	53.06	19.288
Overall	186	53.4	19.039

T-Test, p = .723

Race/Ethnicity	n	Mean	SD
White non-Hispanic	82	48.27	15.927
Black non-Hispanic	82	60.12	20.847
Hispanic--white or black	10	53.2	16.109
Overall	174	54.14	19.212

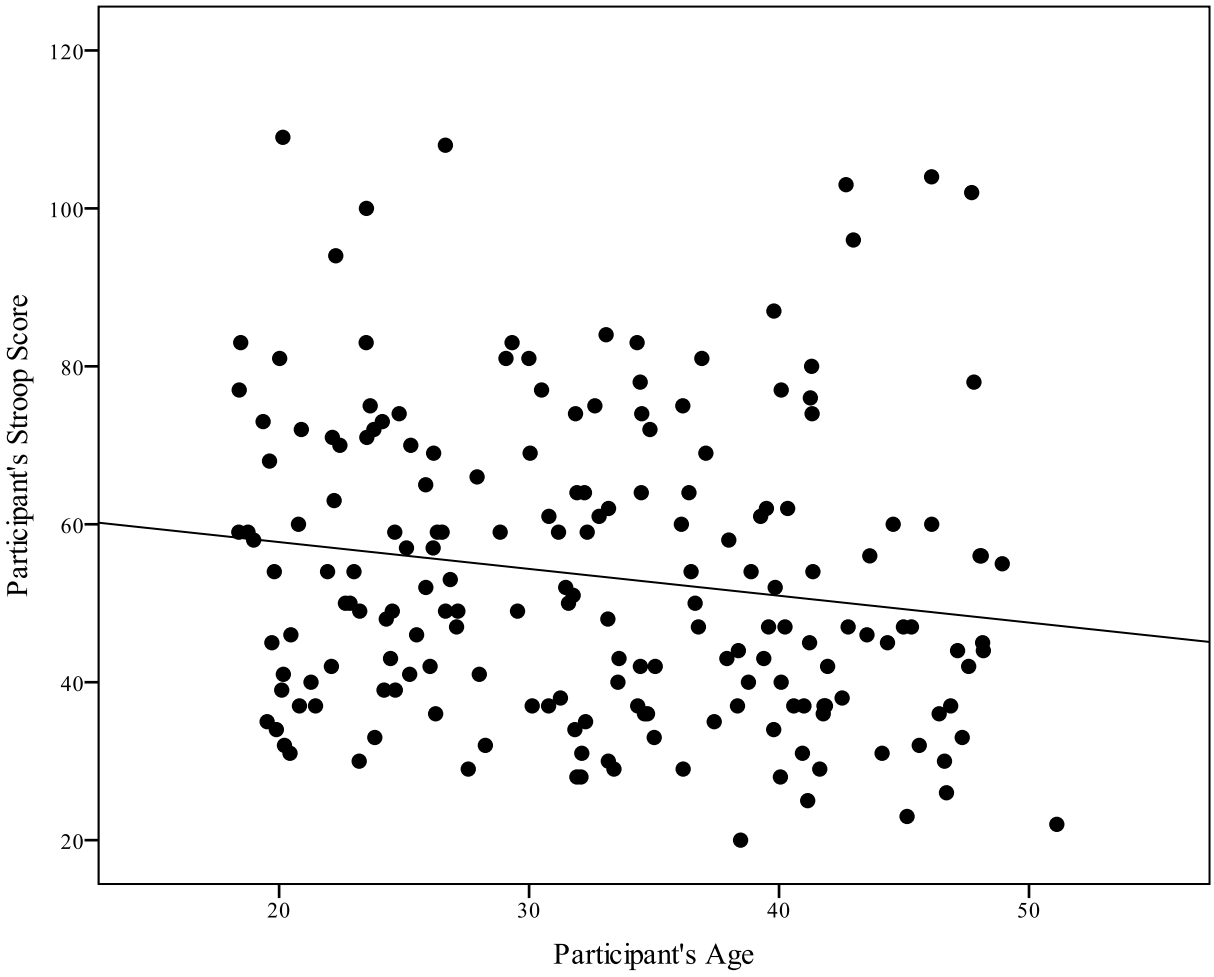
Note: Missing=12

T-Test between white non-Hispanic and black non-Hispanic, p = .000.

As for the age variable, a Pearson correlation coefficient analysis and an accompanying scatterplot (Figure 1) showed a statistically significant inverse relationship between age and SWCT score ($r(185) = -.158$, $p = .032$). That result means older participants tended to have a lower (or better) SWCT score than did younger participants.

Figure 1.

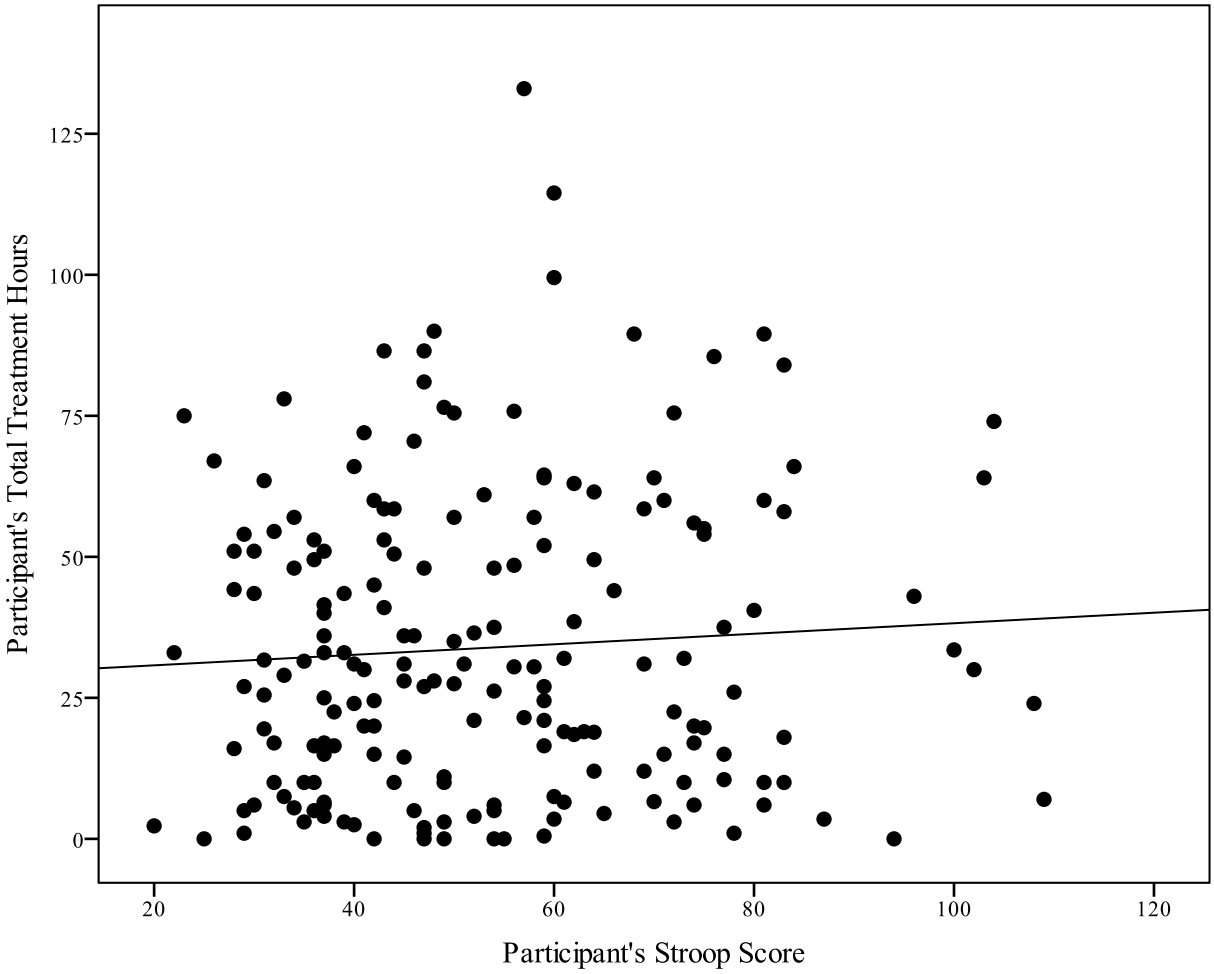
Relationship Between Participant's Age and Participant's SWCT Score



A Pearson correlation coefficient analysis and an accompanying scatterplot (Figure 2) showed a slight positive relationship between a participant's SWCT score and the total number of hours of treatment that the participant received, but the correlation was found not to be statistically significant ($r(185) = .005$, $p = .941$).

Figure 2.

Relationship Between Participant's SWCT Score and Participant's Total Treatment Hours



The mean number of total treatment hours received by a participant was 33.9 (Table 4). The level of treatment hours received was analyzed to determine how treatment hours varied according to participants' gender, age and race/ethnicity. The mean for male participants *(N* = 61) was 26.0, and the mean for female participants

(*N* = 125) was 37.7 (Table 4). A t-test for equality of means found that the difference between men and women in total treatment hours was statistically significant (p =.004) (Table 4). The mean number of total treatment hours for white non-Hispanic participants (*N* = 82) was 32.4 and the mean score for black non-Hispanic participants (*N* = 82) was 36.5. A t-test for equality of means found that the difference between white non-Hispanics and black non-Hispanics in total treatment hours was not statistically significant (*p* = .340). The 10 Hispanic participants had a mean score of 24.2. Given the low number of Hispanics in the sample, they were excluded from the between-groups analysis (Table 4).

Table 4

Means and T-Tests for Participants' Total Treatment Hours by Gender and by Race/Ethnicity

Gender	n	Mean	SD
Male	61	25.956	28.9607
Female	125	37.745	24.6042
Overall	186	33.878	26.6191

T-Test, p = .004

Race/Ethnicity	n	Mean	SD
White non-Hispanic	82	32.404	24.8603
Black non-Hispanic	82	36.485	29.5342
Hispanic--white or black	10	24.15	19.3578
Overall	174	33.853	26.9628

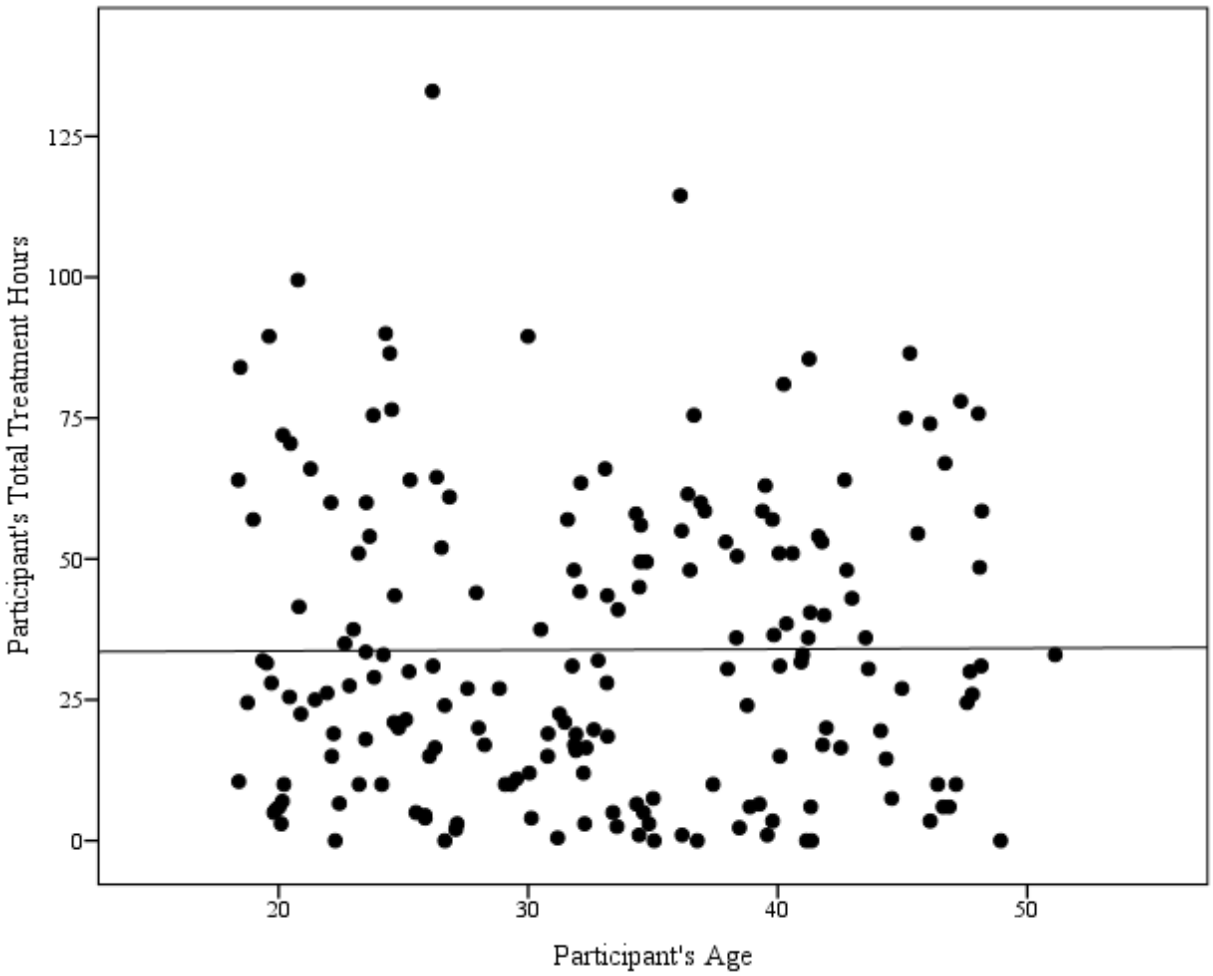
Note: Missing=12

T-Test between white non-Hispanic and black non-Hispanic, p = .340.

As for the age variable, a Pearson correlation coefficient analysis and an accompanying scatterplot (Figure 3) showed no correlation between age and total treatment hours ($r(185) = -.005$, $p = .941$).

Figure 3.

Relationship Between Participant's Age and Participant's Total Treatment Hours

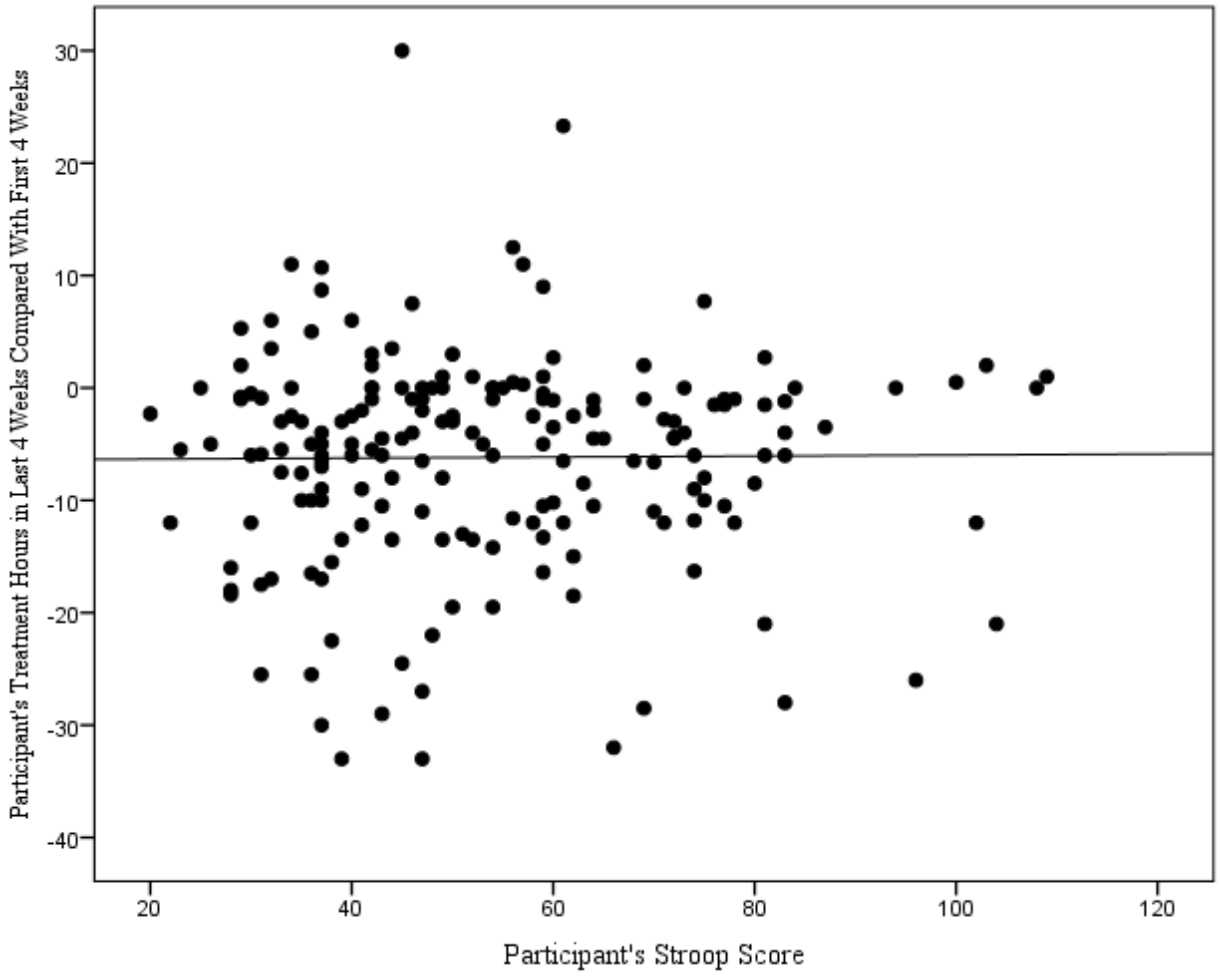


A Pearson correlation coefficient analysis and an accompanying scatterplot (Figure 4) showed no correlation between a participant's SWCT score and the extent of

attrition in treatment. The extent of attrition was calculated by subtracting the number of hours of treatment received during the last four weeks of the program from the number of hours of treatment received during the first four weeks of the program ($r(185) = -.009$, $p = .902$).

Figure 4

SWCT Score and the Extent of Attrition in Treatment



The mean number of treatment hours that participants received in the last half of the program compared with the first half was - 6.2 hours (Table 5). The differential in treatment hours between the last half and the first half was analyzed to determine how attrition varied according to participants' gender, age, and race/ethnicity. The mean for male participants (N = 61) was - 3.3 hours, and the mean for female participants (N = 125) was -7.6 hours (Table 5). A t-test for equality of means found that the difference between men and women in the extent of attrition was statistically significant (p = .004) (Table 5). That result means that as the treatment program progressed, women reduced their participation more than men. The mean number of treatment hours that participants received in the last half of the program compared with the first half was -7.1 for white non-Hispanic participants (N = 82) and 6.1 for black non-Hispanic participants (N = 82) (Table 5). A t-test for equality of means found that the difference between white non-Hispanics and black non-Hispanics in attrition was not statistically significant (p = .486) (Table 5). The 10 Hispanic participants had a mean of -0.3 hours on the attrition measure. Because there were so few Hispanics in the sample, they were excluded from the between-groups analysis.

Table 5

Means and T-Tests for Participants' Treatment Hours in the Last 4 Weeks Minus Treatment Hours in the First 4 Weeks by Gender and by Race/Ethnicity

Gender	n	Mean	SD
Male	61	-3.344	6.4023
Female	125	-7.574	10.5433
Overall	186	-6.187	9.5794

T-Test, p = .004

Race/Ethnicity	n	Mean	SD
White non-Hispanic	82	-7.09	9.0095
Black non-Hispanic	82	-6.118	8.815
Hispanic--white or black	10	-0.28	12.2414
Overall	174	-6.241	9.197

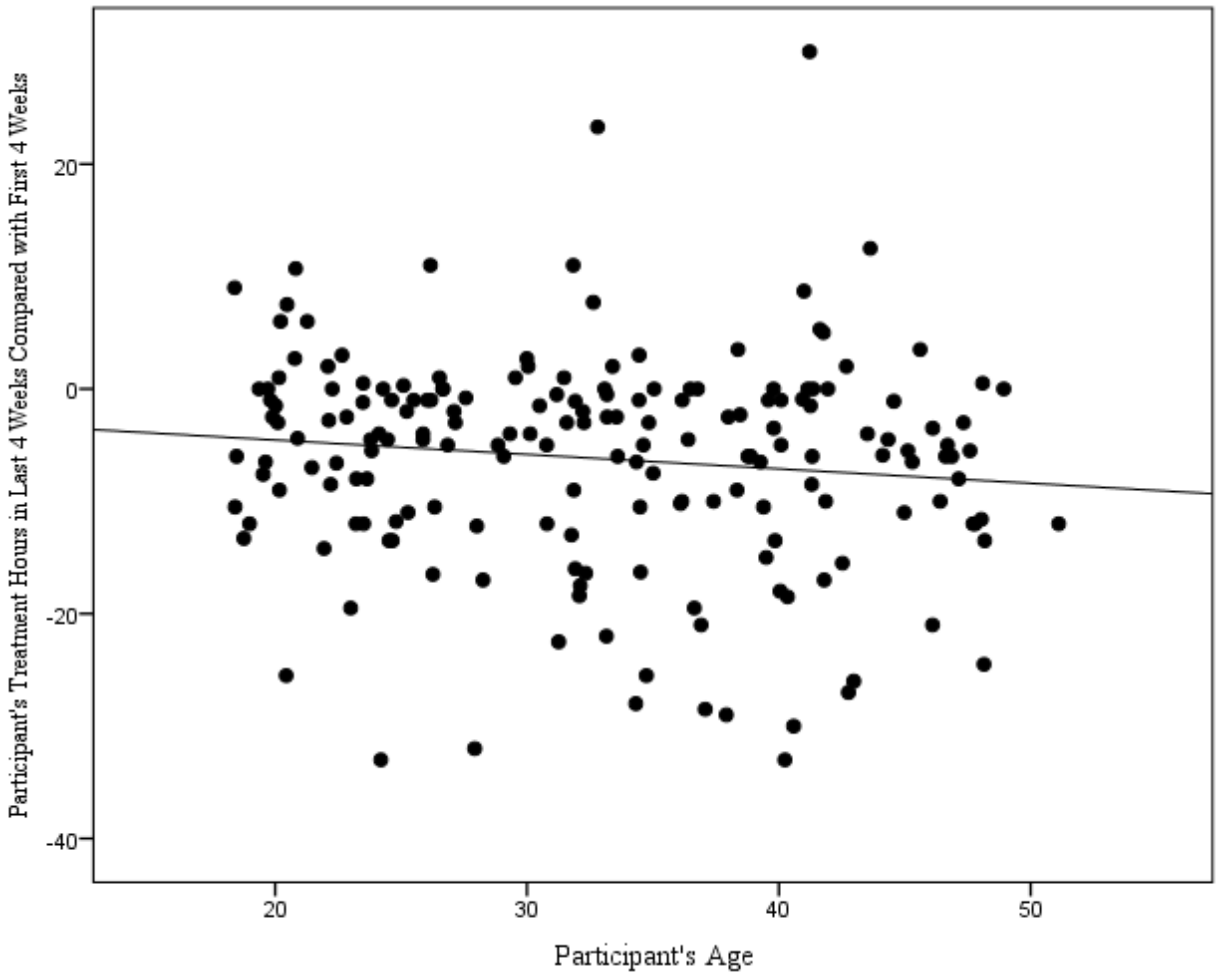
Note: Missing=12

T-Test between white non-Hispanic and black non-Hispanic, p = .486.

As for the age variable, a Pearson correlation coefficient analysis and an accompanying scatterplot (Figure 5) showed that older participants reduced their participation more than younger participants, but the correlation was found not to be statistically significant ($r(185) = -.118$, $p = .108$).

Figure 5.

Relationship Between Participant's Age and the Extent of Attrition in Treatment



Variables Used in Regression Analysis

This study addressed eight hypotheses, using multiple regression analysis to test four of the hypotheses and another multiple regression analysis to test the other four hypotheses. The same four independent variables are used in each multiple regression: the participant's SWCT score, the participant's gender, the participant's age, and the

participant's race/ethnicity. Dummy variables were constructed to permit use of the nominal-level variables of gender and race/ethnicity. In one multiple regression, the dependent variable is the participant's total number of treatment hours received. In the other multiple regression, the dependent variable is the number of treatment hours that a participant received in the last half of the program minus the number of hours received in the first half. In each regression, the independent variables were entered into the model simultaneously. Thus, all four hypotheses addressed in a regression were tested simultaneously.

Assumptions for Regression Analysis

The data collected for this study satisfy all eight assumptions required for the use of multiple regression analysis. The first assumption is that a regression has one dependent variable and that the dependent variable is continuous measure. In this study, two regressions were performed. The dependent variable in the first regression was the number of hours of treatment received during the eight-week period. The dependent variable in the second regression was the difference between the number of hours of treatment received during the first four weeks and the number of hours of treatment received during the last four weeks. The second assumption is that a multiple regression has at least two independent variables. In each of the regressions used in this study, four independent variables were used: the participant's score on the SWCT, the participant's gender, the participant's age, and the participant's race/ethnicity.

The SWCT score and the participant's age are continuous-measure variables. Dummy variables were created to represent gender and race/ethnicity. The third

assumption is that there is no multicollinearity among the independent variables used in the regression. The correlation matrix in Table 6 shows that there is little correlation between the independent variables.

Table 6

Pearson Product-Moment Correlation Coefficients Between Independent Variables Used in the Two Regression Analyses

Variable	Stroop	Age	Gender	Race
Stroop score	--	-.158	-.026	-.289
Age	-.158	--	.200	.253
Gender	-.026	.200	--	.152
Race	-.289	.253	.152	--

The fourth assumption is that there is independence of residuals. Testing that assumption was accomplished by (a) performing a regression procedure that yielded unstandardized predicted values, studentized residuals, studentized deleted residuals, Cook's Distance values, and leverage values, and (b) using the Durbin-Watson Statistic. For the total-treatment-hours variable, the Durbin-Watson level was 2.040, indicating independence of residuals. For the variable measuring attrition, the Durbin-Watson level was 2.016, indicating independence of residuals (Table 7).

Table 7

Summary of Durbin-Watson Statistics

Variable	Durbin-Watson Statistic
Total treatment hours	2.040
Difference between hours for weeks 1-4 and hours for weeks 5-8	2.016

The fifth assumption, linearity, was tested by producing partial regression plots addressing the relationship between the dependent variable and each of the continuous-measure independent variables in the two regression analyses. The partial regression plots demonstrated linear relationships (Figures 6a, 6b, 7a, and 7b).

Figure 6a.

Partial regression plot of total treatment hours with Stroop test score

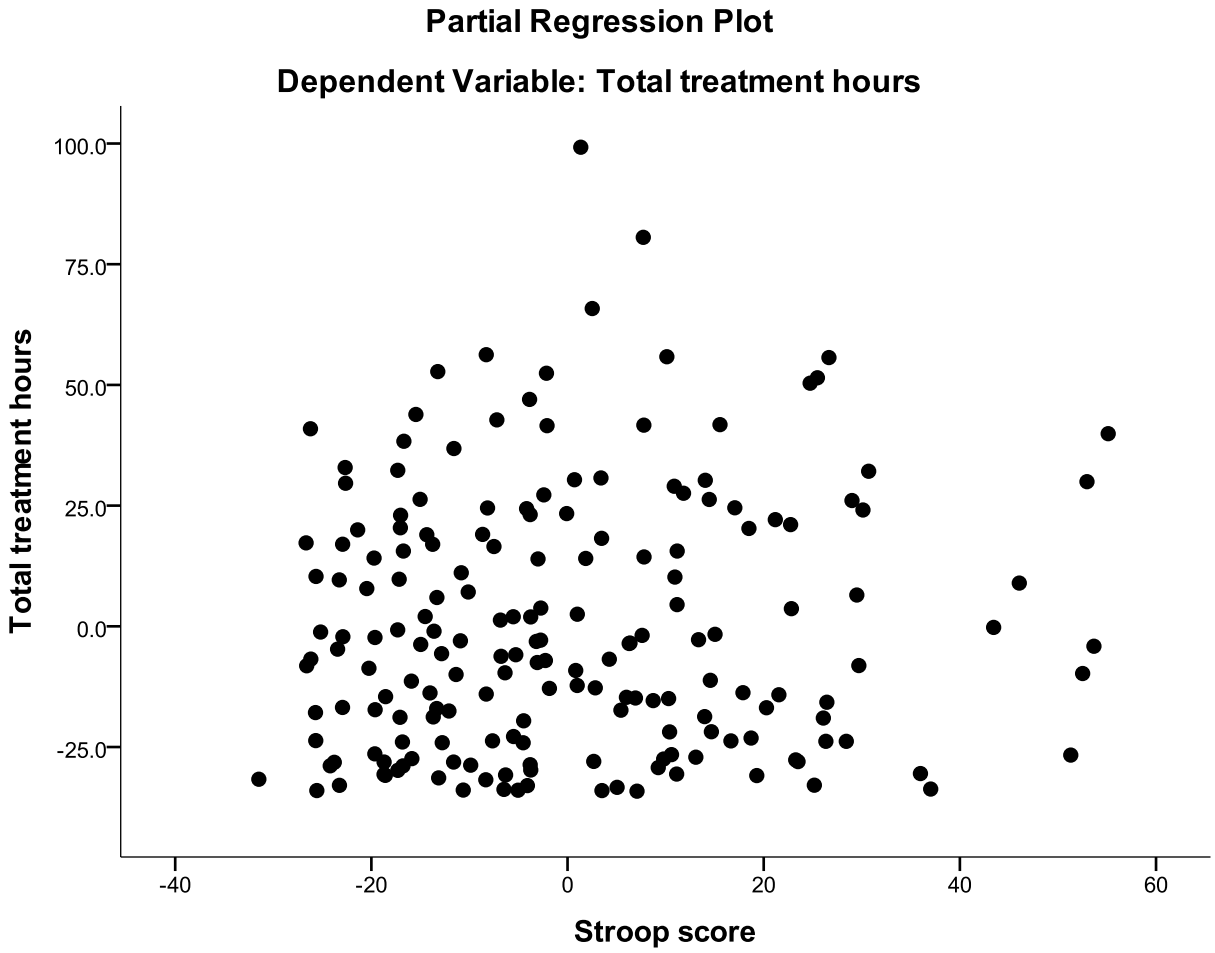


Figure 6b.

Partial regression plot of total treatment hours with age of participant

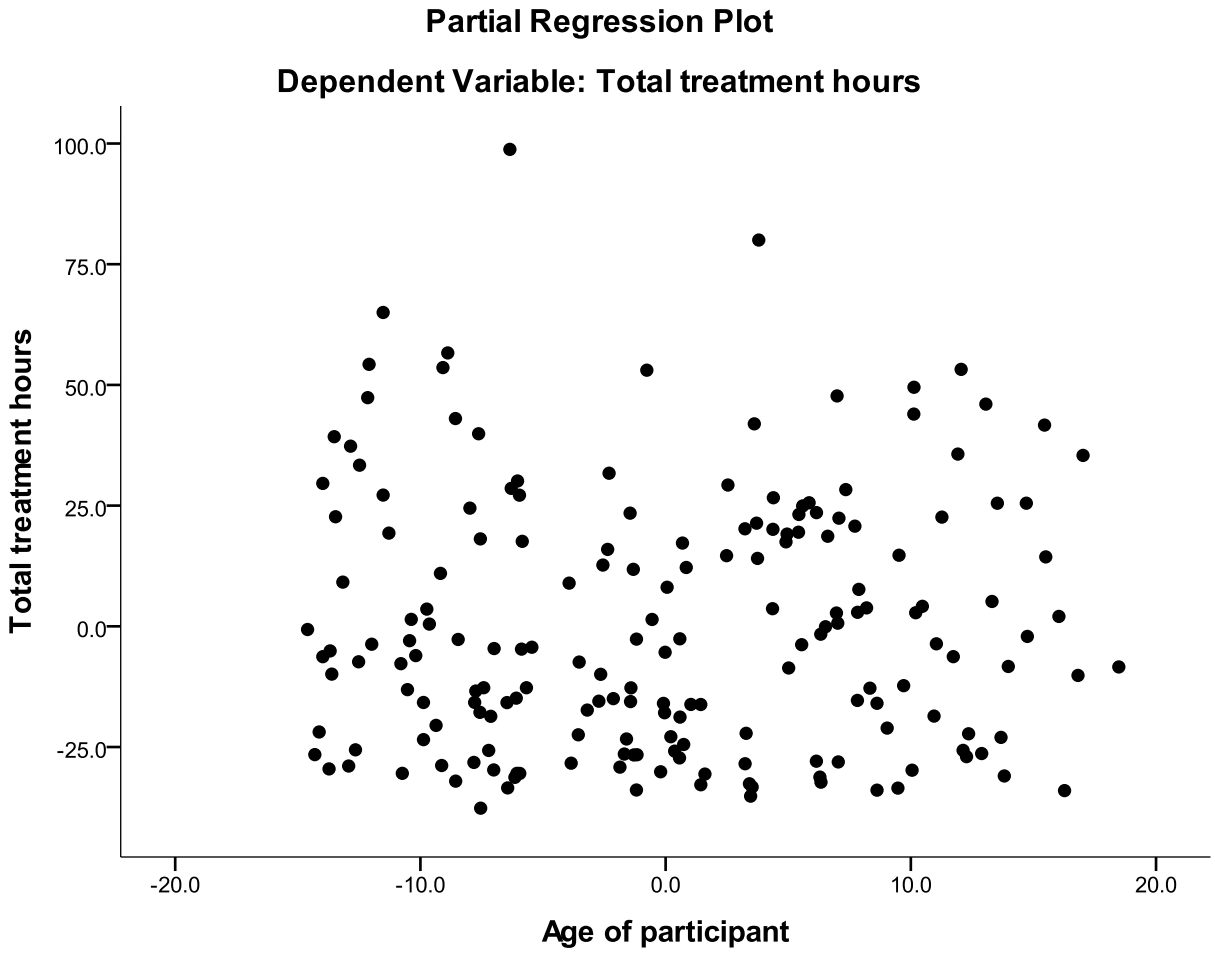


Figure 7a.

Partial regression plot of change in treatment hours with Stroop test score

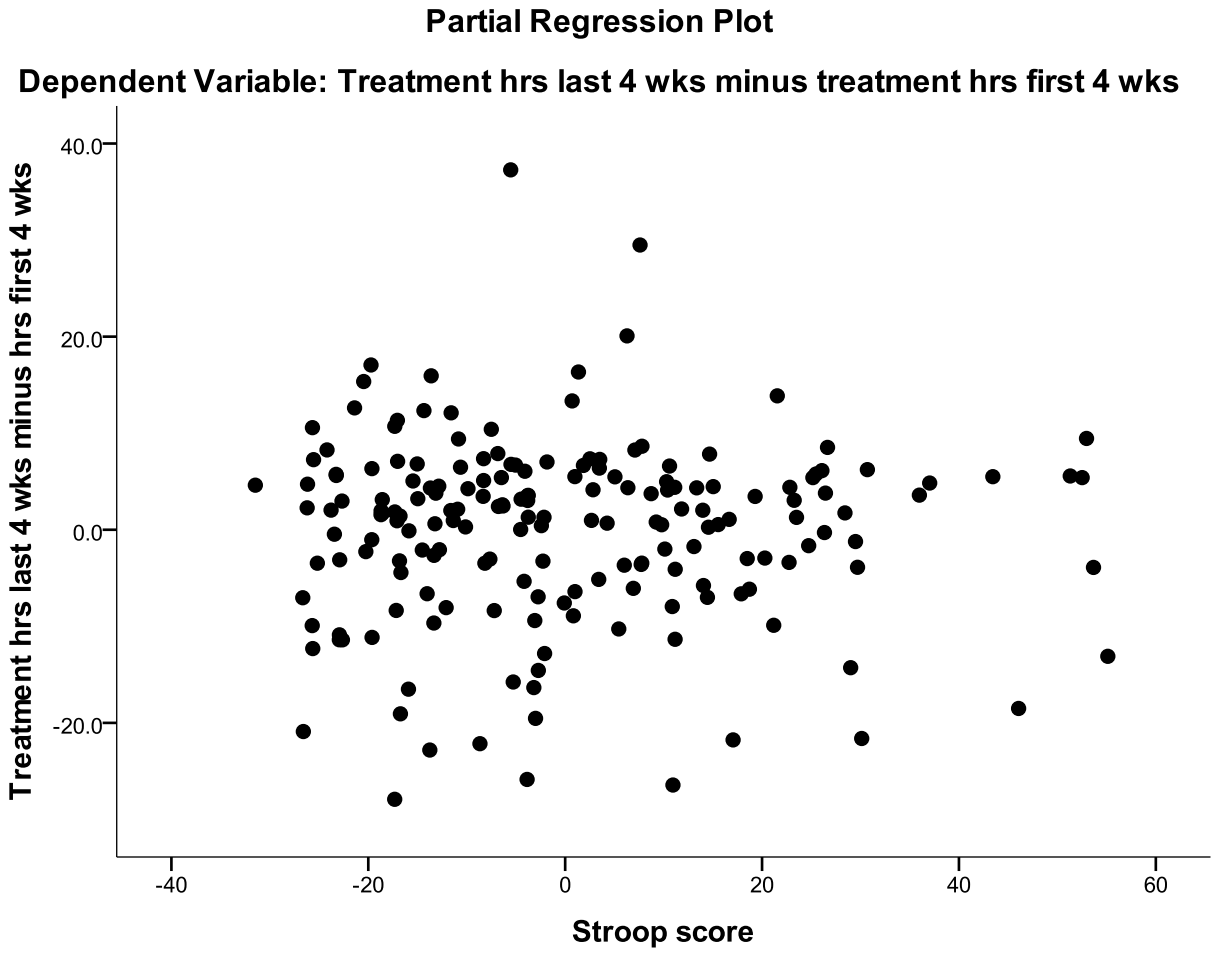
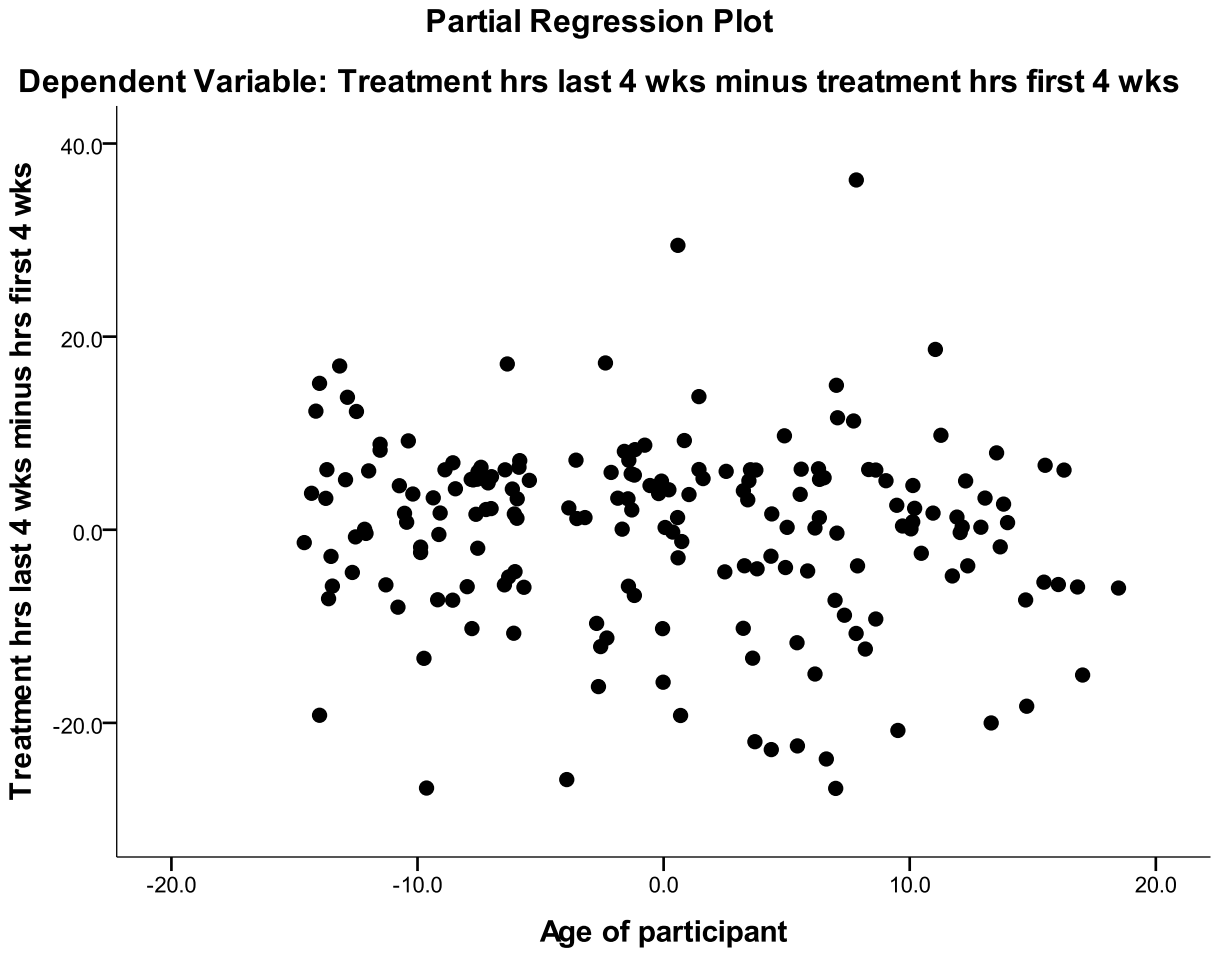


Figure 7b.

Partial regression plot of change in treatment hours with age of participant



The sixth assumption, homoscedasticity, was tested through the plotting of studentized residuals against the unstandardized predicted values in the two regression analyses. The shape of the residuals observed in the plots confirms homoscedasticity (Figures 8 and 9).

Figure 8.

Homoscedasticity plot for total treatment hours

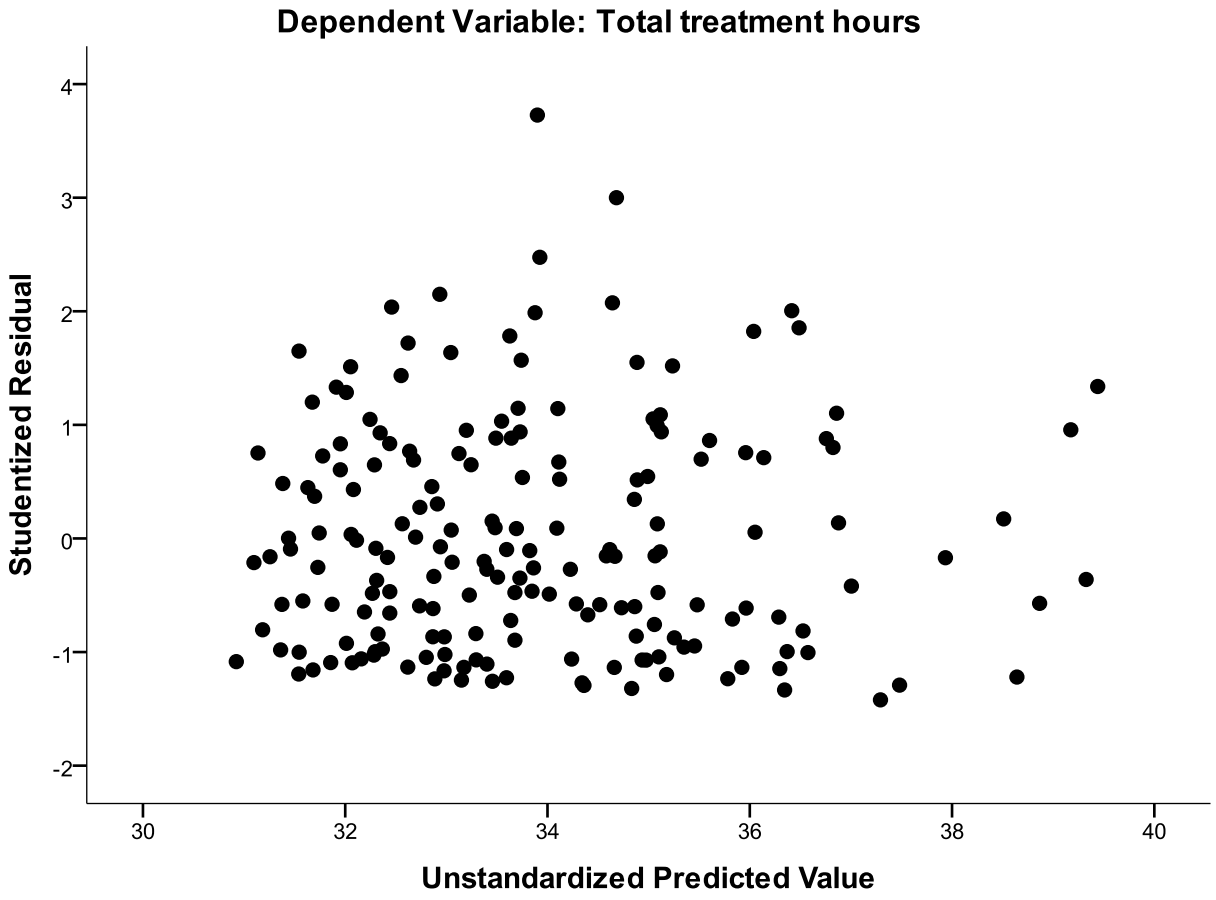
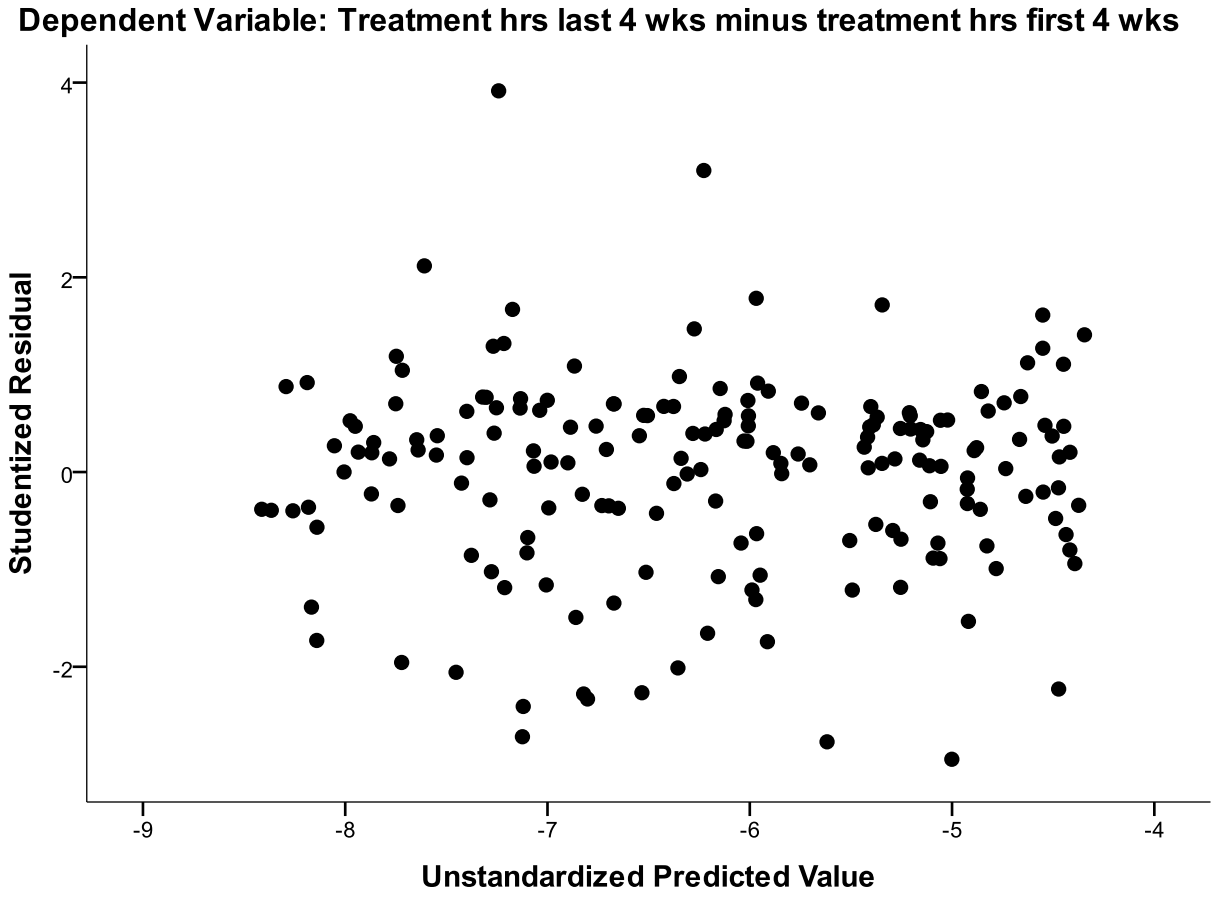


Figure 9.

Homoscedasticity plot for change in treatment hours



The seventh assumption is that no significant outlier values exist in the data set. Standardized residuals were calculated for each case for each regression, as were values for leverage and Cook's Distance. No troublesome outliers were found. The eighth assumption is that the residuals are normally distributed. Histograms and P-P Plots indicate that the standardized residuals for each regression are approximately normally distributed (Figures 10a, 10b, 11a and 11b).

Figure 10a.

Frequency distribution of the regression standardized residual for total treatment hours.

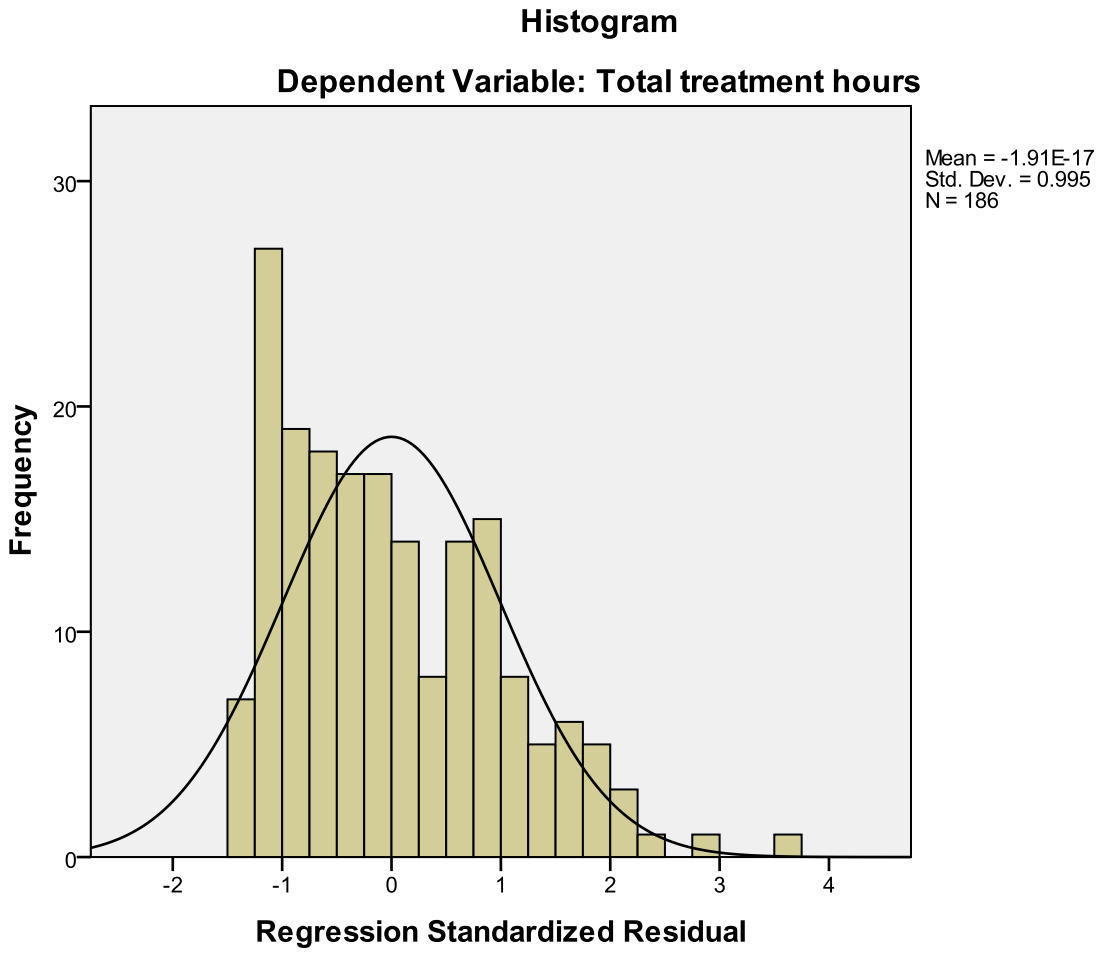


Figure 10b.

Frequency distribution of the regression standardized residual for change in treatment hours.

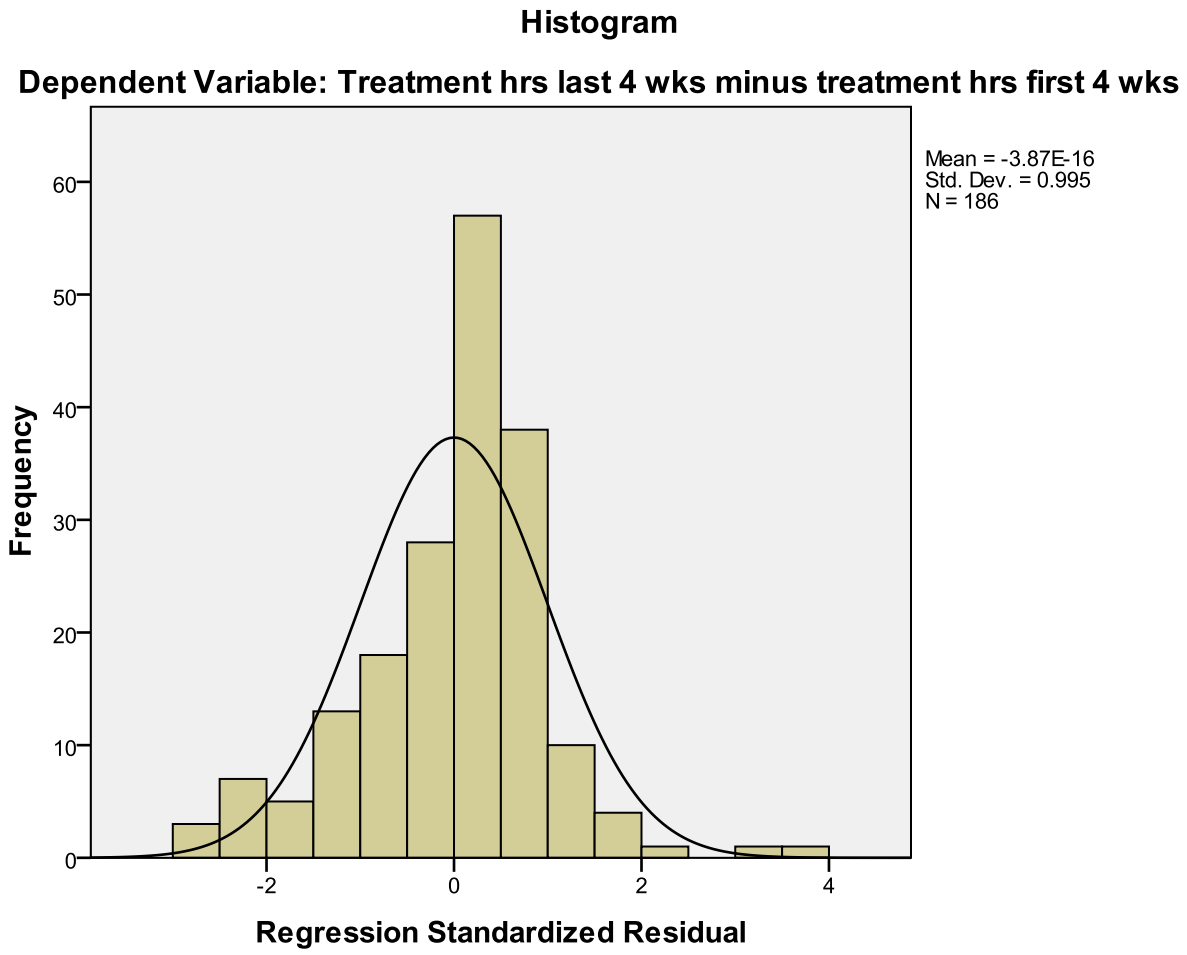


Figure 11a.

Normal P-P Plot of the regression standardized residual for total treatment hours.

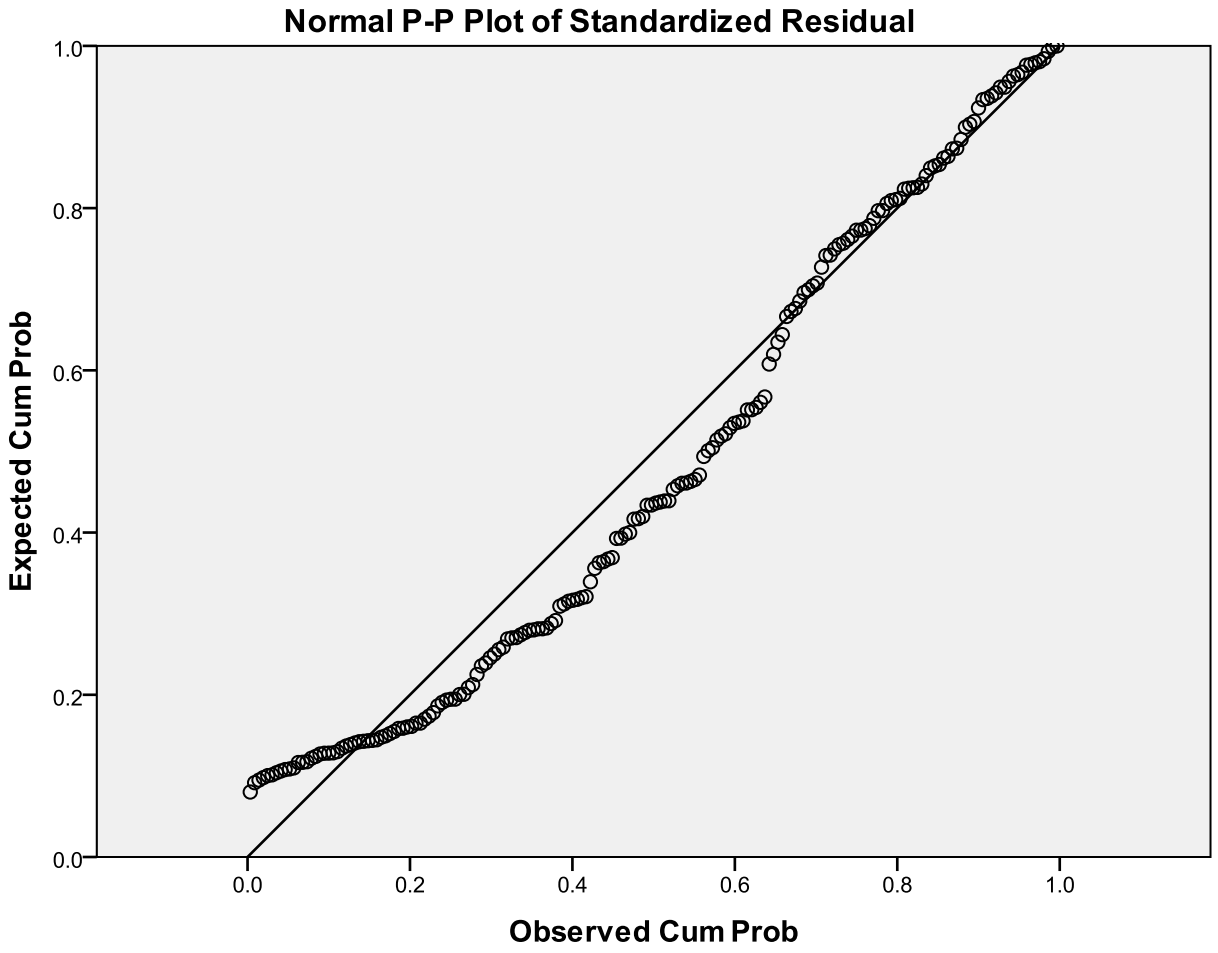
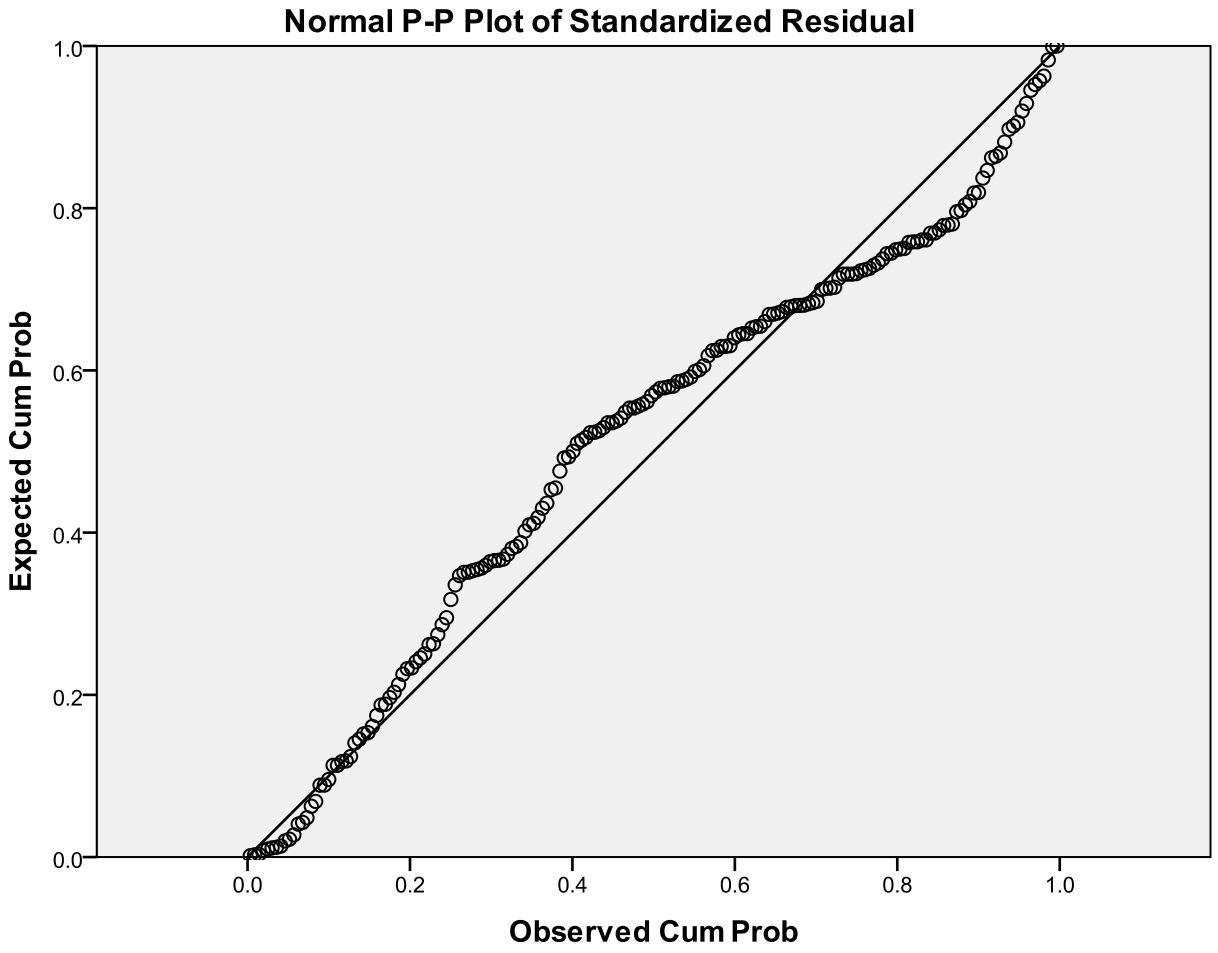


Figure 11b.

Normal P-P Plot of the regression standardized residual for change in treatment hours.



Results of Regression Analysis

The first four hypotheses tested were:

1. The SWCT predicts the level of attendance when controlling for all other variables.
2. Gender predicts the level of attendance when controlling for all other variables.
3. Age predicts the level of attendance when controlling for all other variables.
4. Race/ethnicity predicts the level of attendance when controlling for all other variables.

The regression output displayed in Table 8 shows that gender is a statistically significant predictor of participation (Adjusted R^2 = .029, $F(4, 169)=2.292$, $p<.01$), thus providing support for Hypothesis 2. Although gender is a statistically significant predictor, it still explains only 2.9% of the variation in level of attendance. The unstandardized beta coefficient for the dummy variable "female" is positive (12.420), indicating that a female participant would tend to receive more treatment hours than would a male participant. The regression analysis found that none of the other independent variables improved the ability to predict the level of attendance. Therefore Hypotheses 1, 3 and 4 were not supported.

Table 8

Summary of Multiple Regression Analysis for Participants' Total Hours of Treatment

	B	*SE B*	*β*	*t*	*p*
Intercept	27.109	10.503	--	2.581	.011
Participant is female	12.420	4.352	.220	2.854	.005**
Participant is white	-3.311	4.353	-.061	-0.761	.448
Participant's age	-0.107	0.238	-.035	-0.448	.655
Participant's Stroop score	.067	.110	.048	.610	.543

Note 1: ***p* <.01.
Note 2: *B* =unstandardized regression coefficient; *SE B* =standard error of the coefficient; *β* =standardized coefficient; *t* =values.

The final four hypotheses tested were:

5. The SWCT predicts the level of attrition in participation when controlling for all other variables.
6. Gender predicts the level of attrition in participation when controlling for all other variables.
7. Age predicts the level of attrition in participation when controlling for all other variables.
8. Race/ethnicity predicts the level of attrition in participation when controlling for all other variables.

The regression output displayed in Table 9 shows that gender is a statistically significant predictor of attrition in drug treatment participation (Adjusted R^2 = .039, F(4, 169) = 2.737, p<.01), thus providing support for Hypothesis 6.

Although gender is a statistically significant predictor, it still explains only 3.9% of the variation in participation attrition. The unstandardized beta coefficient for the dummy variable "female" is negative (-3.997), indicating that a female participant would tend to experience more of a drop-off in participation than would a male participant. The regression analysis found that none of the other independent variables improved the ability to predict the level of attendance, thus Hypotheses 5, 7 and 8 were not supported.

Table 9

Summary of Multiple Regression Analysis for Participants' Attrition in Treatment

	B	*SE B*	*β*	*t*	*p*
Intercept	-.068	3.565	--	-0.019	.985
Participant is female	-3.997	1.477	-.207	-2.706	.008**
Participant is white	.782	1.477	-.043	-0.529	.597
Participant's age	-.080	.081	-.078	-0.994	.322
Participant's Stroop score	-.010	.037	-.022	-.280	.780

Note 1: **p<.01.
Note 2: *B* =unstandardized regression coefficient; *SE B* =standard error of the coefficient; *β* =standardized coefficient; *t* =values.
Note 3: A negative coefficient indicates attrition.

Summary

In Chapter 4, I analyzed data using an archival drug treatment program study that included the demographic characteristics of 186 adults who participated in an eight-week treatment program for cocaine and MA addiction. My study also included an analysis of participants' performance on the Stroop Word Color Task completed before beginning treatment. Next, I reported the number of hours of treatment that participants received,

broken down by number of hours in the first four weeks of the program and number of hours in the final four weeks. In addition, I described results of an analysis examining the relationship between (a) the participants' treatment program participation, and (b) the participants' demographic characteristics and SWCT test performance. The analysis found that in the eight-week treatment program women tended to participate more than men but that the level of attendance in the program did not vary significantly by age, race/ethnicity, or SWCT score. The analysis also found that women tended to experience more of a participation drop-off than men as the treatment program progressed, but that participants' attrition did not vary significantly by age, race/ethnicity, or SWCT score.

Chapter 5: Discussion

Neuropsychological studies of neurocognitive deficits related to cocaine and MA abuse have demonstrated that addiction vulnerabilities, treatment, and relapse differ by sex (Becker, McClellan, & Reed, 2017; Ramackers et al., 2016). Contemporary drug addiction theories are heavily based in classical and operant conditioning paradigms (Becker et al., 2017). These theories underscore two significant factors of drug addiction: (a) brain-based behaviors in addiction are contingent upon rewards systems associated with positive or negative reinforcement, and (b) that neurocognitive behaviors in addiction conditioning can differ by sex (Mitchell & Potenza, 2015).

This quantitative, correlational study was designed to examine whether the level of attendance and level of attrition of cocaine and MA-addicted adult males and females in a drug treatment program is associated with a participant's demographic characteristics. In addition, I explored the association between levels of treatment attendance and performance on a test of neurocognitive function. The dependent variables in this study were the total number of hours of treatment a participant received during an eight-week drug treatment period, the difference between the number of hours of treatment received during the first four weeks, and the number of hours during the last four weeks. The second measure (differential number of hours between first four and last four weeks) was included to address the issue of participant attrition.

Participants in this study were randomly selected from an archival study involving drug treatment community sites across the United States (NIDA, 2013). All participants met the archival study requirements. All study participants were active cocaine and

methamphetamine-addicted individuals. All participants were at least 18 years of age at the time of the archival study. All study participants had completed a series of tests of neurocognitive function including the Stroop Word Color Task (SWCT).

I conducted a multiple regression analysis to determine whether a participant's gender, age, race/ethnicity, and performance on the SWCT was related to hours and weeks spent in a specific drug treatment program, and non-completion hours while enrolled in treatment. In terms of demographic characteristics, gender was a statistically significant predictor of number of hours spent in a drug treatment program. In addition, gender was statistically significant in measuring completion of the eight-week treatment program.

I found that while women typically participated more than men in the first four weeks of a drug treatment program, women were more likely to have higher non-completion (or attrition rates) than did men in the last four weeks. The findings in this study concerning gender differences in levels of treatment attendance are supported by previous research involving environmental, social, and psychological factors that often hinder successful drug treatment participation (CBHSQ, 2015; Hartwell, 2016).

In addition, neuropsychological researchers reported that complications of female cocaine and MA addiction involve multiple brain pathways that serve to interrupt, modify and severely damage cognition and executive functions (Simpson et al., 2016). Studies of treatment attrition and relapse substantiate that females exhibit greater enhancement of dopamine systems during initial drug exposure than men. This effect on the dopamine

system is expected to impact a woman's ability to maintain drug abstinence after treatment (Shrestha et al., 2015).

In this study I found that older participants tended to have a lower (or better) score on the SWCT than did younger participants. In addition, I found no significant differences in terms of age, race/ethnicity, or SWCT score of a participant.

Interpretation of the Findings

Data specific to participants' age and race/ethnicity were extracted from the general demographic questionnaire section of CTN-0031A. Any specific identifiers including names, location, incarcerations and other personal identifiers were eliminated from the CTN-0031 and CTN-0031A dataset files. The SWCT is one of the most reliable and widely used neuropsychological tests of executive function involving selective attention, cognitive control and flexibility, goal-oriented behavior, and impulsivity (Kiyonaga & Enger, 2014). In addition, the SWCT has been deemed very useful in detecting cognitive impairments due to chemical changes in the brain related to substance abuse. In this study, it was expected that participants would demonstrate greater cognitive interference in response time performance of executive function based on comparable studies that employed SWCT testing.

Although other neuropsychological were tests administered in the archival study, the documented reliability and validity of the SWCT was considered most relevant for this research. Participants who completed the SWCT did so voluntarily and met rigorous APA regulations and policy regarding ethics and standards in testing substance abusing populations. Testing bias and undue influence in using the SWCT were resolved in the

archival study. Despite these circumstances, this does not diminish the need for continued drug addiction intervention especially among these largely underserved groups (Burlew, 2018).

Regarding the relationship between performance on the SWCT and the level of attendance when controlling for all other variables, the results indicate no significant relationship between these two variables. Regarding the relationship between performance on the SWCT and the level of attrition when controlling for other variables, the results indicate no correlation between a participant's score and extent of attrition in treatment.

In terms of the relationship between age and the SWCT score, the results showed an inverse relationship, meaning that older participants tended to have lower (better) SWCT scores than did younger participants. Over two-thirds of the participants in this study were between the ages of 18 and 39 years old, the remaining participants were age forty or older. In this study, eleven percent of participants were between the ages of eighteen and twenty years old. Although this study did not take as a focus drug addiction experiences of young adults (ages eighteen to twenty-one), addiction among this group presents special challenges (Reynolds. Basso, Miller, Whiteside, & Combs, 2019).

Among these complications are problems in coping with social and emotional traumas including physical or sexual abuse in childhood, a history of parental abuse of alcohol or drugs, depression and anxiety, and social isolation (Reynolds et al., 2019). The diversity of social circumstances of young adults who become addicted often leads to

negative consequences including higher school drop-out rates, lower employment, homelessness, and incarceration. Santa Maria, Narendorf, & Matthew (2018) revealed that substance abuse in general among young adults often involved a disproportionate number of homeless and incarcerated youth. In their study they concluded that substance abuse was correlated with race/ethnicity, gender, sexual identity, shelter status, stress and trauma.

In this type of research, these results are not atypical in that drug addiction studies related to SWCT performance demonstrated that those who fall into the young adult age group are more likely to experience problems with interference control and inhibition in neurocognitive tests than older participants (Dahlgren et al., 2016; Portugal et al., 2018). Regarding the relationship between the number of treatment hours and gender, the results indicate that the difference between men and women in total treatment hours was statistically significant. In viewing race/ethnicity and total treatment hours, the results indicate that the difference between white non-Hispanics and black Non-Hispanics was not statistically significant. In my study, the number of white and black participants were evenly split, and the numbers of Hispanic and other participants were low (less than 10%). Although the archival study sites were in urban areas, with higher percentages of Latina and other ethnic minorities, the absence of these groups in drug addiction studies are not uncommon. Based on current drug addiction studies, while the incidence of drug use and substance abuse are endemic in many of these communities; cultural differences, a general lack of distrust of substance abuse professionals, current legal or citizenship

status, and fear of retribution often contribute to a lack of participation in drug abuse treatment programs (Burlew, 2018; Greenfield, Roos, Hagler, Stein, Bowen & Witkiewitz, 2018). I want to stress that these factors should not deter comprehensive and informed outreach for future addiction research and treatment program services for these groups.

The mean number of treatment hours between the first half and the last half was analyzed to determine how attrition varied according to the participants' gender, age, race and ethnicity. The results indicate that the difference between addicted men and addicted women in the extent of attrition was statistically significant. The result indicates that as the treatment program progressed, women reduced their participation more than men.

There was no statistically significant difference between white non-Hispanics and black non-Hispanics in attrition, that is the mean number of treatment hours that participants received in the last half of the program compared with the first half. As for the age variable, the results indicate that older participants reduced their participation more than younger participants, but the correlation was not found to be statistically significant.

Limitations of the Study

The type of correlational design for this study does not offer strong internal validity for several reasons: (a) the sample size of 186 participants was quite modest, (b) the representation of 61 males was smaller than number of female participants, and (c) participants were active cocaine and/or methamphetamine addicts. These factors presented certain challenges in my ability to generalize findings to other substance

addicted groups in the general population. These data were extracted from previous research that focused on treatment attendance and attrition among active cocaine and methamphetamine-addicted men and women. Given that the dataset was archival, participant selection, drug history, personal profiles, and any number of social and psychological factors that might have influenced their participation in the selected drug treatment program are beyond the control of this researcher. In addition, the reliability of testing actively addicted cocaine and MA-addicted men and women presents special challenges in terms of validity and reliability of collected self-reports and actual test performance.

Protection of participants' rights, and privacy prevented access to any identifying information that might have shed light on previous drug treatment enrollment, performance on prior neuropsychological tests and a participant's environmental dynamics. Any combination of these factors might have influenced a participant's success or attrition in a drug treatment program. In the archival study, six psychometric tests were administered, whereas in this study scores from only the SWCT were used, leaving open the possibility that one or more tests (not included in my study) might have demonstrated an association between a participant's test performance and treatment attendance.

Recommendations

Clinical psychology literature strongly supports therapeutic drug treatment programs in alleviating substance dependence; however, it is reported that fewer than half of participants complete recommended programs (Worhunsky et al., 2013). Female

participants with low attendance or high incompletion rates during active drug treatment are more likely to return to substance abuse than program completers (Fernandez-Montalvo et al., 2017). Neuropsychological studies contend that although there are commonalities in the neural pathways to drug addiction regardless of sex, there are significant differences in the attributes of social environment, physical, and physiological elements between males and females. Psychological models of addiction based on classical learning theories assert that female addicts experience addiction differently in terms of persistence of use and rationale for continuing substance abuse despite the very serious, and dangerous consequences to themselves and others.

The realities of the persistence of drug addiction offer plentiful opportunities to further examine the lived experiences of women who abuse cocaine, methamphetamine, and other illicit drugs (Imtiaz, Wells, & McDonald, 2016). Researchers and practitioners must continue to focus on the complexities of substance abuse that affect the participation of women in drug treatment programs, and on the need to more accurately assess environmental, physical, and psychological limitations that are often placed on female addicts before, during and after treatment. Researchers must also find ways to expand the relevance of gender-based studies in neurocognition and substance use research. Removing biased language, providing a means of safety and greater inclusiveness of women in addiction studies are important factors in eliminating societal stigmas for addicted women.

Implications

Substance-abusing women are a unique group in that they are often difficult to identify, locate and evaluate for drug treatment. Drug treatment programs and posttreatment recovery must include strategies that are cognizant of past and present life circumstances, and other special issues that are likely to hinder seeking treatment and successful drug recovery. Treatment protocols must include evaluation and assessment of life circumstances that include social, physical and psychosocial events that encourages women to seek treatment, and to continue participation in treatment programs. While health risks, social dysfunction, and incarcerations rates are increasing for many addicted women, the availability of appropriate treatment programs, peer support and mentoring, and financial assistance have not kept pace (Lorvick, Browne, Lambdin, & Comfort, 2018).

To become a drug addict is seldom the outcome that any woman desires for her life regardless of the circumstance of her addiction; likewise, addiction recovery (if even possible) is often fragile and temporary even under the best conditions. To be clear, it is erroneous to conclude that substance abusing women fit any particular social category, they do not; nor do all addicted women share similar life experiences. The diversity of these experiences including their roles and statuses in society, whether prominent or obscure, can also present special challenges for cocaine and MA-addicted females. Some of these challenges involve availability and access to needed resources including financial and medical assistance, and on-going social support networks. Additional psychological research on female addiction and recovery must be supported in terms of

greater access to study populations and general outreach. Researchers should actively engage as change agents in terms of working with other professionals to promote awareness, provide early intervention, and secure the tools required for recovery and restorative health for at-risk and drug addicted women.

Conclusion

Neurocognitive studies involving tests of executive function reveal that while cocaine and MA-addicted males and females exhibit similar problems in working memory and decision-making tasks, stark differences between addicted males and females emerge in tests of impulsivity (Moeller, 2014). In executive function tests, females were more likely to demonstrate highly impulsive behaviors in responding to drug use events compared with males. These impulsivity responses are also related to the likelihood of how females respond to drug treatment participation and completion (Balconi et al., 2015; Jaskina et al., 2014). In developing addiction treatment plans, the importance of neurocognitive behaviors related to decision-making, impulsivity, risk taking and inhibitory mechanisms in females must be made relevant in terms of rehabilitative strategies.

Conducting pertinent psychological tests to assess executive function performance can provide further insight in predicting treatment participation and treatment attrition of substance-abusing females. One such test is the SWCT, a neuropsychological test used extensively in evaluating cognitive interference related to executive function in drug addiction (Scarpina & Tagini, 2017). This study endeavors to add to existing knowledge by: (a) comparing how cocaine and MA-addicted people differ by gender in their level of

participation in a treatment program; and (b) whether a person's degree of executive-function impairment is correlated with the person's level of participation in a treatment program.

It is anticipated that this study will encourage neuropsychological researchers to more rigorously explore how specific brain-based behaviors among female addicts shapes their ability to successfully participate in drug treatment programs. Increasing the participation of adult female addicts (including incarcerated populations) in female inclusive studies is critical in understanding the challenges of addiction and plausible solutions. The implication in this study for positive social change includes disrupting gendered stigmas and life-threatening vulnerabilities that impede help for drug-addicted women (Keane, 2017).

References

Adinoff, B., Devous, B., Williams, M., Best, Harris, S., Minhajuddin, A., Zielinski, T., & Cullum, M. (2010). Altered neurocholinergic receptor systems in cocaine and methamphetamine-addicted subjects. *Neuropsychopharmacology, 35,* 1485-1499. doi:10.1038/npp.2010.18

Althubaiti, A. (2016). Information bias in health research: definition, pitfalls, and adjustment methods. *Journal of Multidisciplinary Healthcare, 9,* 211-217. doi: 10.2147/JMDH.S104807

America's opioid epidemic is worsening. *(2017, March). Economist.* Retrieved from https://www.economist.com/blogs/graphicdetail/2017/03/daily-chart-3

American Psychiatric Association (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Washington, DC: Author.

Andersen, M., Sawyer, E., & Howell, L. (2012). Contributions of neuroimaging to understanding sex differences in cocaine and methamphetamine abuse. *Experimental and Clinical Psychopharmacology, 20,* 2-15. doi:10.1037/a002521

Anker, J.J., & Carroll, M.E. (2011). Females are more vulnerable to drug abuse than males: Evidence from pre-clinical studies and ovarian hormones. *Current Topics in Behavioral Neuroscience, 8,* 73-96. doi:10.1007/7854_2010_93

Badiani, A., Belin, D., Epstein, D., Calu, D., & Shaham, Y. (2013). Opiate versus psychostimulant addiction: Differences do matter. *Nature Reviews Neuroscience, 12,* 685-700. doi:10.1038/nrn3104.

Baicy, K., & London, E. (2007). Corticolimbic dysregulation and chronic methamphetamine abuse. *Addiction, 102,* 5-15. doi:10.1111/j.1360-0443.2006.01777.x

Balconi, M., & Finocchiaro, R. (2015). Decisional impairments in cocaine addiction, reward bias, and cortical oscillation "unbalance." *Neuropsychiatric Disease and Treatment, 11,* 77-786. doi:10.2147/NDT.S79696

Ballard, M., Weafer, J., Gallo, D., & de Wit, H. (2015). Effects of acute methamphetamine on emotional memory formation in humans: Encoding vs. consolidation. *PlosOne.* doi:10.1371/journal.pone.0117062

Barry, D., & Petry, N. (2008). Predictors of decision-making on the Iowa Gambling Task: Independent effects of lifetime history of substance use disorders and performance in the Trail Making Test. *Brain and Cognition, 66,* 243-252. doi: 10.1016/j.bandc.2007.09.001

Barratt, M., Lenton, S., Maddox, A., & Allen, M. (2016). *"What if you live on top of a bakery and you like cakes?"* Drug use and harm trajectories before, during and after the emergence of Silk Road. *Drug Policy, 35,* 50-57. doi: https://doi.org/10.1016/j.drugpo.2016.04.006

Bell, R., Garavan, H., & Foxe, J. (2014). Neural correlates of craving and impulsivity in abstinent former cocaine and methamphetamine users: Toward biomarkers of relapse risk. *Neuropharmacology, 85,* 461-470. doi:10.1016/neuropharm.2014.05.011

Becker, J., McClellan, M., & Reed, B. (2017). Sex differences, gender and addiction. *Journal of Neuroscience Research, 95,* 136-147. doi: 10.1002/jnr.23963.PMID:27870394

Becker, J., Perry, A., & Westenbroek, C. (2012). Sex differences in the neural mechanisms mediating addiction: A new synthesis and hypothesis. *Biological Sex Differences, 3,* 1-53. doi:10.1186/2042-6410-3-14

Bersoff, D.N. (2008). *Ethical Conflicts in Psychology*. Washington, D.C. American Psychological Association

Bickel, W., Landes, R., Hill, P., & Baxter, C. (2011). Remember the future: Working memory training decreases delay discounting among stimulant addicts. *Biological Psychiatry,* 69, 260-265.doi:http://doi.org/10.1016/j.biopsych.2010.08.017

Bingham, N., & J. Fry (2010). *Regression: Linear Models in Statistics.* New York, NY: Springer

Bisagno, V., & Cadet, J.L., (2014). Stress, gender, and addiction: potential roles of CRF, oxytocin and arginine-vasopressin. *Behavioral Pharmacology, 25,* 445-457. doi:10.1097/FBP.0000000000000049.

Bhuvansewar, C.H., Chang, G., Epstein, A., & Stern, T. (2008). Cocaine and opioid use during pregnancy: Prevalence and management. *Primary Care Companion to the Journal of Clinical Psychiatry, 10,* 59-65. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2249829/

Bobzean, S., Denobrega, A., & Perotti, L. (2014). Sex differences in the neurobiology of drug addiction. *Journal of Experimental Neurology, 259,* 64-74. doi: 10.1016/jexperneurol.2014.01.022

Burlew, K. (2018). The case for considering rather than ignoring race/ethnicity in substance abuse research. *Journal of Ethnicity in Substance Abuse, 17,* 91-93. doi: https://doi.org/10.1080/15332640.2018.1424070

Brogly, S., Link, K., & A. Newman (2018). Barriers to treatment for substance use disorders among women with children. *Canadian Journal of Addiction, 9,* 18-22. doi:10.1097/CXA.0000000000000025

Buck, J., & Seigel, J. (2015). The effects of adolescent methamphetamine exposure. *Frontiers in Neuroscience, 9,* doi:10.3389/fnins.2015.00151

Carson, E.A. & Anderson, E. (2016 December). *"Prisoners in 2015"* US Department of Justice Statistics. Washington, D.C. Retrieved from https://www.bjs.gov/index.cfm?...

Carey, R., Carrera, M., & Damianopoulos, E. (2014). A new proposal for drug conditioning with implications for drug addiction: The Pavlovian two-step from delay to trace conditioning. *Behavioral Brain Research, 275,* 105-156. doi: https://doi.org/10.1016/j.bbr.2014.08.053

Center for Behavioral Health Statistics and Quality. (2015). *Behavioral Health Trends in the United States: Results from the 2014 National Survey on Drug Use and Health*. (HHS Publication No. SMA 15-4927, NSDUH Series H-50). Retrieved from www.samhsa.gov

Centers for Disease Control. (2010). *Unintentional drug poisoning in the United States*. Retrieved from www.cdc.gov/homeandrecreational safety/pdf /poison-issue-brief.pdf

Choy, L.T. (2014). The strengths and weaknesses of research methodologies: Comparison and complimentary between qualitative and quantitative approaches. *IOSR Journal of Humanities and Social Science, 19,* 99-104.

Clingan, S., Fisher, D., Pendersen, W., Reynolds, G., & Xandre, P. (2016). Impulsiveness, and trait displaced aggression among drug using female sex traders. *Addictive Behaviors, 60,* 24-31. doi: doi.org/10.1016/jaddbeh.2016.03.027

Colzato, L., & Hommel, B. (2009). Recreational use of cocaine eliminates inhibition of return. *Neuropsychology, 1,* 125-129. doi:10.1037/a0013821

Cockroft, J., Adams, S., Bonnet, K., Matlock, D., & Schlundt, D. (2019). "A scarlet letter": Stigma and other factors affecting trust in the healthcare system for women seeking substance abuse treatment in a community setting. *Journal of Substance Abuse, 40,* 170-177. doi:https://doi.org//10.1080/08897077.2018.1544184

Covington, S. (2008). Women and addiction: A trauma-informed approach. *Journal of Psychoactive Drugs, 4,* 377-385. doi:10.1080/02791072.2008.104006

Crane, N., Schuster, R., & Gonzalez, R. (2013). Preliminary evidence for sex-specific relationship between amount of cannabis use and neurocognitive performance in young adult cannabis users. *Journal of the International Neuropsychological Society, 19,* 1009-1015. doi:10.1017/S1355617713000088X.

Creswell, J. (2009). *Research Design: Qualitative, Quantitative and Mixed Method Approaches.* Thousand Oaks, CA: Sage

Dahlgren, M., Sagar, K., Racine, M., Dreman, M., & Gruber, S. (2016). Marijuana use predicts cognitive performance on tasks of executive function. *Journal of Studies on Alcohol and Drug Addiction, 77,* 298-308. doi: https://doi.org/10.15288/jsad.2016.77.298.2016

Dalla, C. & Shors, T. (2009). Sex differences in learning processes of classical and operant conditioning. *Physiology and Behavior, 97,* 229-238. Retrieved from https://doi.org./10/1016/jphysbeh2009.02.35

Dean, A. Groman, S., Morales, A., & London, E. (2013). An evaluation of the evidence that methamphetamine abuse causes cognitive decline in humans. *Neuropsychopharmacology, 38,* 259-274. doi:10.1038/npp.2012.17

Department of Justice [DOJ] (2015). Bureau of Justice Statistics: *Women and the drug war.* Retrieved from http://www.drugwarfacts.org/cms/Women#sthash.Bk1J3URY.dpb

DeVito, E., Worhunsky, P., Carroll, K., Kober, H., & Potenza, M. (2012). A preliminary study of the neural effects of therapy for substance use disorders. *Drug & Alcohol Dependence, 12,* 228-235. doi: https://doi.org./10.1016/j.drugalcdep.2011.10002

Dragisic, T., Dickov, A., Dickov, V., & Mitjatovic, V. (2015). Drug addiction as risk for suicide attempts. *MateriaSocioMedica, 27,* 188-191. doi:10.5455/msm.2015.27.188-191

Du, J., Huang, D., Zhao, M., & Hser, Y. (2013). Drug-abusing offenders with co-morbid mental disorders: Gender differences in problem severity, treatment participation, and recidivism. *Biomedical and Environmental Sciences, 26,* 32-39. doi: 10.3967/0895-3988.2013.01.004

Eisinger, T., Larson, K., Boulware, E., Thomas, M. & Mermelstein. P. (2018). Membrane estrogen receptor signaling impacts the reward circuitry in the female brain to influenced motivated behaviors. *Steroids, 133,* 53-59.doi https//doi.org/10.1016/j.steroids.2017.11.013

Ersche, K.D., Clark, L., London, M., Robbins, T., & Sahakian, B. (2006). Profile of executive and memory function associated with amphetamine and opiate dependence. *Neuropsychology, 31,* 1036-1047. doi:10.1038/sj.npp.1300889

European Monitoring Centre for Drugs and Addiction (2016). *Analysis: Cocaine trafficking to Europe.* Retrieved from http://www.emcdda.europa.eu/topics /pods/cocaine-trafficking-to-europe

Everitt, B. (2014). Neural and psychological mechanisms underlying compulsive drug-seeking habits and drug memories-indications for novel treatment of addiction. *European Journal of Neuroscience, 40,* 2163-2182. doi:10.111/ejn.12644

Fattore, L. (2015). Reward processing and drug addiction: does sex matter? Frontiers in Neuroscience, 9, 329. Doi:10.3389/fins.2015.00329 Retrieved from https://www.frontiersin.org/articles/10.3389/fnins.2015.00329/full

Fattore, L., Melis, M., Fadda, P., & Fratta, W. (2014). Sex differences in addictive disorders. *Frontiers in Neuroendocrinology, 35,* 272-84. doi: 10.1016/j.frne.2014.04.003

Fernandez-Montalvo, J., Lopez-Goni, J., Azana, P., Arteaga, P., & Cacho, R. (2017). Gender differences in treatment of drug-addicted patients. *Women and Health, 57,* 358-376. doi:10.1080/03630242.2016.1160967

Flagel, S., Akil, H., & Robinson, T. (2009). Individual differences in the attribution of incentive salience to reward-related cues: Implications for addiction. *Neuropharmacology, 56,* 139-148. doi: https://doi.org.10.1016/j. neuropharm .2008.06.027

Fox, H., Morgan, P., & Sinha, R. (2014). Sex differences in guanfacine effects on drug craving and stress arousal in cocaine dependent individuals. *Neuropsychopharmacology, 36,* 1527-1537. doi: 10.1038/npp2014 Epub 2014 Jan7

Fridberg, D., Gerst, K., & Finn, P. (2013). Effects of working memory load, a history of conduct disorder and sex on decision-making in substance dependent individuals. *Journal of Drug and Alcohol Dependence, 133,* 654-60. doi: 10.1016/j.drugalcdep.2013.08.014

Gallop, R.J., Crits-Christoph, P., Ten Have, T., Barber, J., Frank, A., Thase, M., & Griffin, M. (2007). Differential transitions between cocaine use and abstinence for men and women. *Journal of Consulting and Clinical Psychology, 75,* 95-103. doi:10.1037/0022-006X.75.1.95

Garavan, H., Kaufman, J., & Hester, R. (2008). Acute effects of cocaine on the neurobiology of cognitive control. *Philosophical Transactions of the Royal Society, 363,* 3267-3276. doi:10.1098/rstb.2008.0106

Garcia-Perez, M. (2012). Statistical conclusion validity: some common threats and remedies. *Frontiers in Psychology, 3,* 325 doi:10.3389/fpsyg.2012.00325

Glasner-Edwards, S. & Rawson, R. (2010). Evidence-based practices in addiction treatment: Review and recommendations for public policy. *Health Policy, 97,* 93-104. doi: 10.1016/j.healthpol 2010.05.013

Goddard, B., Son Hing, L., & Leri, F. (2013). An exploration of responses to drug-conditioned stimuli during treatment for substance dependence. *Journal of Addiction, 2013,* 1-11. doi:10.1155/2013/394064

Goldstein, R., & Volkow, N. (2011). Dysfunction of the prefrontal cortex in addiction: neuroimaging findings and clinical implications. *Nature Reviews Neuroscience, 11,* 652-69. doi:10.1038/nrn3119

Gould, T. (2010). Addiction and Cognition. *Addiction Science and Clinical Practice, 5*(2),4-14. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3120118/

Green, M. L., Locker, L., Boyer, T. & Sturz, B. (2016). Stroop like interference in a match-to-sample task: Further evidence of semantic competition? *Learning and Motivation, 56,* 53-64, doi: http:/doi.org/10.1016/jlmot.2016.09.003

Greenfield, B., Roos, C., Hagler. K., Stein, E., Bowen, S., & Witkiewitz, K. (2018). Race/ethnicity and racial group composition moderates the effectiveness of mindfulness-based relapse prevention for substance use disorder. *Addictive Behaviors, 81,* 96-103. doi: 10.1016/j.addbeh.2018.02.010

Greenfield, S., Back, S., Lawson, K., & Brady, K. (2010). Substance abuse in women. *Psychiatric Clinicians North America, 33,* 339-355. doi: 10.1016/j.psc.2010.01.004

Gregory R. (2011). Psychological Testing: History, principles and applications. 6th Ed. Boston, MA: Allyn & Bacon.

Hagen, E., Erga, A., Hagen, K., Nesvag, K., McKay. J., Lundervold, A., & Walderhaug, E. (2016). Assessment of executive function in patients with substance abuse use disorder: A comparison of inventory ad performance-based assessment. *Journal of Substance Abuse Treatment, 66,* 1-8. doi:dx.doi.org/10.1016/jsat.2016.02.010

Hegarty, S., Sullivan, A., & O'Keefe, G. (2013). Midbrain dopaminergic neurons: A review of the molecular circuitry that regulates development. *Developmental Biology, 379,* 123-138. doi:10.1016/j.ydbio.2013.04.014

Herbeck, D., & Brecht, M.L. (2013). Substance use and mental health characteristics associated with cognitive functioning among adults who use methamphetamine. *Journal of Addiction, 32,* 11-25. doi:10.1080/10550887.2012.75987

Hess, A.R., Menezes, C., & Martins de Almeida, R. (2018). Inhibitory control and impulsivity levels in women crack users. *Substance Use and Misuse, 53*, 972-979. doi: https://doi.org.10.1080/10826084.2017.1387568

Hartwell, E., Moallem, N., Courtney, K., Glasner-Edwards, S., & Ray, L. (2016*).* Gender differences in the association between internalizing symptoms and craving in methamphetamine users. *Journal of Addiction Medicine, 10,* 395-401.doi: 10.1097/ADM 000000000000250

Homack, S., & Riccio, C. (2004). A meta-analysis of the sensitivity and specificity of the Stroop Color and Word Task with children. *Archives of Clinical Neuropsychology, 19,* 725-743. doi: 10.1016/j.acn.2003.09.003

Ide, J., Zhang, S., Hu, S., Mazure, C., & Li, C. (2014). Cerebral gray matter volumes and low-frequency fluctuation of BOLD signals in cocaine dependence: Duration of use and gender difference. *Drug and Alcohol Dependency, 1,* 51-62. doi: 10.1016/j.drugalcdep.2013.09.004

Imtiaz, S., Wells, S., & McDonald, S. (2016). Sex differences among treatment clients with cocaine-related problems. *Journal of Substance Use, 21,* 22-28. doi: 10.3109/14659891.2014.949315

Jasinska, A. J., Stein, E., Kaiser, J., Naumer, M., & Yalachov, Y. (2014). Factors modulating neural reactivity to drug cues in addiction: A survey of human neuroimaging studies. *Neuroscience and Biobehavioral Reviews, 38,* 1-6. doi: 10.1016/jneurobiorev.2013.1013.10.10.013

Jonkman, S., & Kenney, P. J. (2013). Molecular, cellular, and structural mechanisms of cocaine addiction: A key role for MicroRNA's. *Neuropsychopharmacology, 38,* 198-211. doi: 10.1037/npp.2012.120

Keane, H. (2017). Female vulnerabilities and susceptible brains: Gendered discourse in addiction. *The Social History of Alcohol and Drugs, 31,* 126-139. doi: https://doi.org/10.1086/SHAD31010126

Kennedy, A., Epstein, D. Phillips, K., & Preston, K. (2013). Sex differences in cocaine and methamphetamine/heroin users: drug-use triggers and craving in daily life. *Drug and Alcohol Dependency, 2,* 29-37. doi:10.1016/j.drugalcdep.2012.12.025

Kerstetter, K., Zu-in, S., Ettenberg, A., & Kippin, T. (2013). Sex and estrous cycle differences in cocaine and methamphetamine-induced approach-avoidance conflict. *Addiction Biology, 18,* 222-229. doi:10.1111/j.1369-100.2010. 00292.x

Kiluk, B., Nich, C., & Carroll, K. (2011). Relationship of cognitive function and the acquisition of coping skills in computer-assisted treatment for substance use disorders. *Drug and Alcohol Dependence, 114,* 169-176. doi:10: 1016/j.drugalcdep.2010.09.019

King, G., Alicata, D., Cloak, C., & Chang, L. (2010). Neuropsychological deficits in adolescent methamphetamine abusers. *Psychopharmacology, 212,* 243-249. doi:10.1007/s00213-010-1949-x.

Kiyonaga, A., & Egner, T. (2014). The working memory Stroop Effect: When internal representations clash with external stimuli. *Psychological Science, 25,* 1619-1629. doi: https://doi.org./10.1177/0956797614536739

Koob G., & Volkow, N. (2010). Neurocircuitry of addiction. *Neuropsychology, 35,* 217-238. doi:10.1038/npp.2009.110

Kober, H., Lacadie, C., Wexler, B., Malinson, R., Sinha, R., & Potenza, M. (2016). Brain activity during cocaine craving and gambling urges: an fMRI study. *Neuropsychopharmacology, 44,* 628-637. doi:10.1038/npp.2015.193

Lejuez, C., Bornovalova, M., Reynolds, E., Daughters, S., & Cronin, J. (2007). Risk factors in the relationship between gender and crack/cocaine and methamphetamine. *Experimental and Clinical Psychopharmacology, 15,* 165-175. doi:10.1037/1064-1297.15.2.165

Lester, B., & Lagasse, L. (2010). Children of addicted women. *Journal of Addictive Diseases, 29,* 259-276. doi:10.1080/10550881003684921

Levandowski, M., Tractenberg, S., de Azeredo, L., De Nardi, T., Rovaris, D., Bau, C., Rizzo, L., Maurya, P., Grassi-Oliveira, R. (2016). Crack cocaine addiction, early life stress and accelerated aging among women. *Progress in Neuropsychopharmacology and Biological Psychiatry, 71,* 83-89.

LoBue, C., Cullum, C., Braud, J., Walker, R., Winhusen, T, Suderain., P., & Adinoff, B. (2014). *American Journal of Drug and Alcohol Abuse, 40,* 455-462. doi: 10.3109/00952990.2014.939752

Lorvick, J., Browne, E., Lambdin, B.H., & Comfort, M. (2018). Polydrug use patterns, risk behavior and unmet healthcare need in a community-based sample of women who use cocaine, heroin or methamphetamine. *Addictive Behaviors, 85,* 94-99. doi: https://doi.org/10.1016/j.addbeh.2018.05.013

Luo, X., Zhang, S., Hu, S., Bednarski, S., Erdman, E., Farr, O., Singha, R., & Li, C. (2013). Error processing and gender-shared and specific neural predictors of relapse in cocaine and methamphetamine dependence. *Brain, 4,* 1231-1244. doi:101093/brain/aw1040

MacLeod, C. (2015). The Stroop Effect. *Encyclopedia of Color Science and Technology* doi:10.1007/978-3-642-27851-8-1

Marceau, E., Kelly, P. & Solowij, N. (2018). The relationship between executive functions and emotion regulation in females attending therapeutic community treatment for substance use disorders. *Drug Alcohol Dependence, 182,* 58-66. doi: 10.1016/j.drugalcdep.2017.10.008. Epub 2017 Nov12

Mahoney, J., Hawkina, R., De LaGarza, R., Kalechstein, A., & Newton, T. (2010). Relationship between gender and psychotic symptoms in cocaine and methamphetamine-dependent addicts. *Gender Medicine Journal,* 7, 414-421. doi: 10.1016/j.genm.2010.09.003

Malek, A. (2012). Effects of prenatal cocaine exposure on human pregnancy and postpartum. *Pharmaceutica Analytica Acta, 3,* 2153-2435. doi:10.4172/2153-2435.100019

McHugh, K., Votaw, V., Sugarman, D., & Greenfield, S. (2017). Sex and gender differences in substance use disorders. *Clinical Psychology Review, 66,* 12-23. doi:https:/doi.org/10.1016/j.cpr.2017.10.012

Mehrjerdi, Z., Tasnin, F. & Farahami, L. (2010). Emotion-Cognition Interactions: A study of coping responses of methamphetamine-dependent women. *Neurocognitive Laboratory of Iranian National Center for Addiction Studies (INCAS).* Retrieved from http://bcn.iums.ac.ir/files/site1/user_files _c424bc /godadmin-A-10-2-19-7151291.pdf

Milton, A., & Everitt, B. (2012). The persistence of maladaptive memory: Addiction, drug memories and anti-drug relapse treatments. *Neuroscience and Biobehavioral Reviews*, 36, 1119-1139. doi:10.1016/j.neurobiorev.2012.01.002

Mitchell, M., Balodis, I., DeVito, E., Lacadie, C., Yeston, J., Constable R.T., Carroll, K., & Potenza, M. (2013). A preliminary investigation of Stroop related intrinsic connectivity in cocaine dependence*:* Associations with treatment outcomes. *American Journal of Drug and Alcohol Abuse, 39*, 392-402. doi:10.3109/00952990.2013.841711

Mitchell, M. R., & Potenza, M.N. (2015). Importance of sex differences in impulse control and addictions. *Frontiers in Psychiatry, 6,* 1-4. doi:10.3389/fsyt.2015.00024

Moeller, S., Konova, A., Parvaz, M., Tomasi, D., Lane, R., Fort, C., & Goldstein, R. (2014). Functional, structural, and emotional correlates of impaired insight into cocaine addiction. *JAMA Psychiatry, 71,* 61-70. doi:10.1001/jamapsychiatry.2013.2833

Moeller, S., Maloney, T., Parvaz, M., Alia-Klein, N., Woicik, P., Telang, F., Goldstein, R. (2010). Impaired insight in cocaine addiction: Laboratory evidence and effects of cocaine-seeking behavior. *Brain, 133,* 1484-1493. doi:10.1093/brain/awq06

Moreno-Lopez, L., Stamatakis, E., Fernandez-Serrano, M., Gomez-Rio, M., Rodriguez-Fernandez, A., Perez-Garcia, A. Verdejo-Garcia, A. (2012). Neural correlates of hot and cold executive functions in polysubstance addiction: Association between neuropsychological performance and resting brain metabolism as measured by positron emission tomography. *Psychiatry Residence, 3,* 214-221. doi: 10.1016/j.psychresna.2012.01.006

Morie, K., De Sanctis, P., Garavan, H., & Foxe, J. (2014). Executive dysfunction and reward dysregulation: A high density electrical mapping study in cocaine abusers. *Neuropharmacology, 85,* 397-407. doi:10.1016/j.neuropharmacology.2014.05.016

Najavits, L., & Lester, K. (2008). Gender differences in cocaine and methamphetamine dependence. *Drug and Alcohol Dependence, 97,* 190-194. doi:10.1016/drugalcdep.2008.04.012

National Institute on Drug Abuse (2013). An evaluation of neurocognitive function, oxidative damage, and their association with treatment outcomes in methamphetamine and cocaine abusers. Retrieved from http://ctndisseminationlibrary.org/protocols/0031A1.pdf

National Institute on Drug Abuse (2013a). *Scope of cocaine and methamphetamine use in the United States.* Retrieved from https://www.drugabuse.gov/publications/ research-reports/cocaine/what-scope-cocaine-use-in-united-states

National Institute on Drug Abuse (2013b, September 19). Methamphetamine. Retrieved from https://www.drugabuse.gov/publicationsreports/methamphetamine on 2018, May 26.

National Institute on Drug Abuse (2014). *Drugs, brain, and behavior: The science of addiction*. Retrieved from www.drugabuse.gov/publications/drugs-brains-behavior-science-addiction/drug-abuse-addiction

National Institute on Drug Abuse (2017*). Sex and gender differences in substance use*. Retrieved from https://www.drugabuse.gov/publications/drugfacts/substance-use-in-women

Nephew, B., & Febo, M. (2012). Effects of cocaine and methamphetamine on maternal behavior and neurochemistry. *Current Neuropharmacology, 10,* 53-63. doi: 10:2174/157001570159127993622760

Nyberg, F. (2012). Cognitive impairments in drug addicts. Retrieved from *http://cdn.intechopen.com/pdfs/32690/InTechCognitive impairments_in_drug_addicts.pdf*

Pedraz, M., Araos, P., Garcia-Marchena, N., Serrano, A., Romero-Sanchez, P., Castilla-Ortega, E., Mayoral-Cleries, J.… Javier, F. (2015). Sex differences in psychiatric comorbidity and plasma biomarkers for cocaine addiction in absent cocaine-addicted subjects in outpatient settings. Retrieved from http://www.frontiersin.org/articles/10.3389/fpsyt.2015.00017/full

Peters, W., Guille, C., & Mittal, L. (2019). Substance Use Disorders in Women: In: O'Neal, M. (eds.), *Neurology and Psychiatry of Women*: Springer, Cham

Pili, R., Naidu, M., Pingali, U., Shobha, J., & Reddy, A. (2013). A computerized Stroop Test for the evaluation of psychotropic drugs in healthy participants. *Indian Journal of Psychological Medicine, 35,* 180-189. Retrieved from http://www.ijpm.info/text.asp?2013/35/2/1801/116251

Pinel, J. (2011). *Biopsychology* (8th ed.). Boston: Allyn & Bacon.

Portugal, A.C., Afonso, A.S., Caldas, A.L., Maturana, W., Mocaiber, I., & Machodo-Pinheiro, W. (2018). Inhibitory mechanisms involved in Stroop-matching and stop-signal tasks and the role of impulsivity. *Acta Psychologica, 191,* 234-243. doi:https//doi.org/10.1016/jactpsy.2018.10.003

Potenza, M., Hong, K., Lacadie, C., Fulbright, R., Tuit, K., & Singha, R. (2012). Neural correlates of stress-induced drug cravings: Influence of sex and cocaine and methamphetamine dependence. *American Journal of Psychiatry, 169,* 217-238. doi:10.1176/app.ajp.2011.11020289

Pannucci, C, J. & Wilkins, E. (2010). Identifying and Avoiding Bias in Research. *Plast Reconstr Surg. 126,* 619-625. doi:10.1097/PRS.0b013e3181de24bc.

Quinones-Jenab, V. & Jenab, S. (2012) Influence on sex differences and gonadal hormones on cocaine addiction. *ILAR Journal, 53,* 14-22. doi:10.1093/ilar.53.1.14

Ramackers, J.G., van Wel, J., Spronk, D., Franke, B., Kenis, G., Toennes, Kuypers, P., Theunissen, E....Verkes, R. (2016). Cannabis and cocaine decrease impulse control and functional corticostriatal connectivity in drug users with low DBH genotypes. *Brain Imaging and Behavior, 10,* 1254-1263. doi:10.1007/s11682-015-9488-z

Ramoa, C., Doyle, S., Naim, D., & Lynch, W. (2013). Estradiol as a mechanism for sex differences of an addicted phenotype flowing extended cocaine administration. *Neuropsychological pharmacology, 38,* 1698-1705. doi: 10.1038/npp.2013.68

Ray, S. (2013). Neurocognitive mechanisms in cocaine users. *Journal of Alcoholism and Drug Dependence, 1,* 1-2. doi:10.4172/2329-6488.1000e102

Reynolds, B., Basso, M., Whiteside, D., & Combs, D. (2019). Executive function, impulsivity, and risky behaviors in young adults. *Neuropsychology, 33,* 212-221. doi: https://doi.org/10.1037/neu0000510(/di/10.1037/neu0000510)

Robinson, T., Yager, L, Cogan, E., & Saunders, B. (2014). On the motivational properties of reward cues: individual differences. *Neuropharmacology, 76,* 450-459. doi: https//doi.org//10.1016/j.neuropharm.2013.05.040

Rothman, R.B., Blough, B.E., & Baumann, M.H. (2008). Dual dopamine/serotonin releasers: Potential treatment agents for stimulant addiction. *Experimental and Clinical Psychopharmacology*. *16,* 458-474. doi:10.1037/a0014103

Rusyniak, D. (2011). Neurologic Manifestations of chronic methamphetamine abuse. *Clinical Neurology, 29,* 641-655. doi: 10.1016/j.ncl.2011.05.004

Saddoris, M., Stamatakis, A., & Carrelli, R. (2011). Neural correlates of Pavlovian-to instrumental transfer in the nucleus accumbens shell are selectively potentiated following cocaine self-administration. *European Journal of Neuroscience, 33,* 2274-2287. doi: 10.1111/j.1460-9568.2011.07683. x.

Salo, R., Nordahl, T., Galloway, G., Moore, C. Waters, C., Leamon, M. (2009). Drug abstinence and cognitive control in methamphetamine dependent individuals. *Journal of Substance Abuse Treatment, 37,* 292-297. doi: 10.1016/j.jsat.2009.03.004

Santa Maria, D., Narendorf, S., & Matthew, B. (2018). Prevalence and correlates of substance use in homeless youth and young adults. *Journal of Addictions Nursing, 29,* 23-3. doi: 10.1097/JAN.0000000000000206

Saunders, B., Yager, L., & Robinson, T. (2013). Cue-evoked cocaine craving: role of dopamine in the accumbens core. *The Journal of Neuroscience, 23,* 13989-14000. doi:10.15234JNEUROCI0450.13.201

Scarpina, F., & Tangini, S. (2017). The Stroop Color and Word Test. *Frontiers in Psychology, 8,* 557-562. https://doi.org/10.3389/fpsyg.2017.00557

Seigel, J., Craytor, M., & Raber, J. (2010). Long-term effects of methamphetamine exposure on cognitive function and muscarina acetylcholine receptor levels in mice. *Behavioral Pharmacology, 21,* 602-614. doi:10.1097/FBP.0bo13e32833c7c44.

Shors, T.J. (2016). A trip down memory lane about sex differences in the brain. *Philosophical Transactions of the Royal Society*. doi:10.1098/rstb.2015.0124

Shrestha, R., Huedo-Medina, T., Copenhaver, M., (2015). Sex-related differences in self-reported neurocognitive impairment among high-risk cocaine and methamphetamine users in methadone maintenance treatment program. *Substance Abuse Research and Treatment, 1,* 17-24. http://doi.org/10.4317/SART.S23332.

Simpson, J., Grant, K., Daly, P., Kelley, S., Carlo, G., & Bevins, R. (2016). Psychological burden and gender differences in methamphetamine-dependent individuals in treatment. *Journal of Psychoactive Drugs, 48,* 261-269. doi: 10.1080/02791072.2016.1213470

Strauss, G., Allen, D., Jorgensen, M., & Cramer, S. (2005). Test-Retest reliability of standard and emotional Stroop Tasks. *Assessment, 12,* 330-337. https//doi.org/10.1177/1073191105276375

Streeter, C., Terhune, D., Whitfield, T., Lang, A., Pellecchia, G., Silveri, M., & Strafella, A. (2008). Performance on the Stroop predicts treatment compliance in cocaine-dependent individuals. *Neuropsychopharmacology, 33,* 827-836. doi:10: 1038/sj.npp.13014

Taylor, S., Lewis, C., & Olive, F. (2013). The neurocircuitry of illicit psychostimulant addiction: acute and chronic effects in humans. *Substance Abuse and Rehabilitation, 4,* 29-43. doi: https://doi.org/10.2147/SAR.S3968

Thakkar, K., Congdon, E., Poldrack, R., Sabb, F., London, E., Cannon, T., & Blider, R. (2014). Women are more sensitive than men to prior trial events on the Stop Signal Task. *British Journal of Psychology, 105,* 254-272. doi:10.1111/bjop.12034

Todd, T., Vubric, D., & Bouton, M. (2014). Behavioral and neurobiological mechanisms of extinction in Pavlovian and Instrument learning. *Neurobiology of Learning and Memory, 105,* 52-64. doi:10: 1016/j.nim.2013.08.012

Tolliver, B., Price, K., LaRowe, S., Simpson, A., McRae-Clark, A., Saladin, M., …Brady, K. (2012). Impaired cognitive performance in subjects with methamphetamine dependence during exposure to neutral versus methamphetamine related cues. *American Journal of Drug Abuse, 38,* 251-259. doi:10.3109/00952990.2011

Trypathy, J. P. (2013). Secondary data analysis: Ethical issues and challenges. *Iranian Journal of Public Health, 42,* 1478-1479. doi: https:www.//ijph.tums.ac.ir

Tull, M., Gratz, K., & Weiss, N. (2011). Exploring associations between borderline personality disorder, crack/cocaine and methamphetamine dependence, gender, and risky sexual behavior among substance-dependent inpatients. *Personality Disorders: Theory and Treatment, 2,* 209-219. doi:10.1007/s/10608-12-9490-3

United Nations Office on Drug and Crime (UNODC) (2016). *Illicit drug markets; Situations and trends.* Retrieved from http://www.unodc.org/doc/wdr2016/WDR_2016_Chapter_1.pdf

United Nations Office on Drug and Crime (UNODC) (2018) *World Drug Report 2018* (United Nations publication, Sales No. E.18.XI.9).

van der Plas, E., Crone, E., van den Wildenberg, P., Tranel, D., & Bechara, A. (2009). Executive control deficits in substance-dependent individuals: A comparison of alcohol, cocaine and methamphetamine of men and women. *Journal of Clinical and Experimental Neuropsychology*, *31*, 706-719. doi:10.1080/138003390802484797

Verdejo-Garcia, A., Benbrook, A., Funderburk, F., David, P., Cadet, J.L. & Bolla, K.L. (2007). The differential relationship between cocaine use and marijuana use on decision-making performance over repeat testing with the Iowa Gambling Task. *Drug and Alcohol Dependence*, *90,* 2-11. doi:10.1016/j. drugalcdep2007.02.004

Volkow, N., Fowler, Baler, R., & Goldstein, R. (2011). Addiction: Pulling at the neural threads of society. *Neuron,* 69, 599-602. doi:10.1016/j.neuron.2011.01.027

Volkow, N., Tomasi, D., Wang, G. J., Fowler, J., Telang, F., & Goldstein, R. (2011a) Reduced metabolism in brain "Control Networks" following cocaine and methamphetamine-cues exposure in female cocaine and methamphetamine abusers. *PLoSone, 2,* 1-9. doi: 10.1371/journal.pone.0016573

Volkow, N., Gene-Jack, W., Fowler, F., & Tomasci, D. (2015). Addiction circuitry in the human brain. Focus, *13,* 341-350. doi: 10.1176/appi.focus.130306

Wetherington, C. L. (2010). Sex differences and gonadal hormone influences in drug addiction and sexual behavior: Progress and possibilities. *Hormones and Behavior*, *58,* 2-7. doi: 10.1016/j.yhbeh.2010.03.004

Winhusen, T., Lewis, D., Brigham, G., Kropp, F., Donovan, D., Seamans, C., Jones, D. (2013). Impulsivity is associated with treatment non-completion in and methamphetamine-dependent patients but differs in nature as a function of stimulant dependent diagnosis. *Journal of Clinical Neurology*, *29,* 541-547. doi: 10.1016/j.jsat.2012.12.005

Winhusen, T., Walker, J., Brigham, G., Lewis, D., Somoza, E. (2013a). Preliminary evaluation of a model of stimulant use, oxidative damage, and executive dysfunction. *American Journal of Drug and Alcohol Abuse. 39,* 227-234. doi:10.3109/00952990.2013.79866

Woicik, P., Urban, C., Alia-Klein, N., Henry, A., Maloney, T., Telang, F., Gene-Jack, W., Goldstein, R. (2011). A pattern of perseveration in cocaine addiction may reveal neurocognitive processes implicit in the Wisconsin Card Sorting Test. *Neuropsychologia,* 7, 1660-1669. doi:10.1016/2011.02.037

Worhunsky, P.D., Stevens., M., Carroll, K. M., Rounsaville, B., Calhoun, V., & Potenza, M. (2013). Functional brain networks associated with cognitive control, cocaine dependence and treatment outcome. *Psychology of Addictive Behavior*, *27,* 477-488. doi:10.1037/a0029092

Yager, L.M., & Robinson, T.E. (2014). A classically conditioned cocaine cue acquires greater control over motivated behavior in rats prone to attribute incentive salience to a food cue. *Psychopharmacology, 226,* 217-228. doi:https://10.1007/s00213-012-2890-y

Yu, S., Zho, L., Shen, Q., Bai, X., & Di, X. (2015). Recent advances in methamphetamine neurotoxicity mechanisms and its molecular pathophysiology. *Behavioral Neurology*, Retrieved from https://www.hindawi.com/journals/bn/2015/103969/abs/

Zuloaga, D., Jacobskind, J., & Rhaber, J. (2015). Methamphetamine and the hypothalamic-pituitary-adrenal axis. *Frontiers in Neuroscience*, 9, 1-12. doi:10.3389/Inins.2015.00178

Appendix A

CITI CERTIFICATION

Completion Date 28-Feb-2019 Expiration Date N/A Record ID 30521287

This is to certify that:

Gwendolyn Royal-Smith

Has completed the following CITI Program course:

Student Researchers (Curriculum Group) Student Researchers (Course Learner Group) 1 - Basic Course (Stage)

Under requirements set by:

Walden University

Verify at www.citiprogram.org/verify/?w8786020b-833f-4004-ab60-233ed26916d4-30521287