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<https://doi.org/10.18297/etd/3259>

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OPIOID AND STIMULANT USE AMONG A SAMPLE OF CORRECTIONS-INVOLVED DRUG
USERS: SEEKING AN UNDERSTANDING OF HIGH-RISK DRUG DECISIONS WITHIN A SYSTEM
OF CONSTRAINT

By

Kirsten Elin Smith
B.S.W. University of Kentucky, 2014
M.S.W. University of Kentucky, 2015

A Dissertation
Submitted to the Faculty of the
Raymond A. Kent School of Social Work of the University
of Louisville in Partial Fulfillment of the Requirements for
the Degree of

Doctor of Philosophy in Social Work

Social Work
University of Louisville
Louisville, Kentucky

August 2019

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A Dissertation Approved on

July 16, 2019

By the following Dissertation Committee:

Adrian Archuleta, Ph.D., chair

Martin T. Hall, Ph.D.

George E. Higgins, Ph.D.

Thomas Lawson, Ph.D.

Michele Staton, Ph.D.

DEDICATION

To the many people addicted to drugs who are unquestioningly blamed for the harms that they suffer and for the harms they cause others to suffer; for those punished not once, but twice, for that which they could not help.

My family, who kept me alive through the worst of times, and in spite of myself.

My husband, Jesse, a man of infinite patience and love.

My grandfather, Randolph Onus Boring, who left the only copy of his dissertation on a bus, thus inspiring me to do otherwise.

ACKNOWLEDGMENTS

This dissertation was completed only as a result of the support and direction from many important people. Foremost, I would like to recognize the incredible guidance, insight, and energy given to me by my committee chair, Dr. Adrian Archuleta. Prior to helping curate this dissertation process, Dr. Archuleta, as an instructor, nurtured my potential as an academic. As his student, I began developing several important skills that were essential in helping complete this project. Though always earnest, forthright, and unfailing in his rapid-fire insight and wit, Dr. Archuleta was exceedingly generous with his time throughout this process. His strategic blend of encouragement and pessimism was given to me in the quality and quantity that I needed at critical points and, without which, I would have been lost. Since I have known him, Dr. Archuleta has always taken the time to nurture my strengths and help me learn how to gird my more unreasonable instincts. He continually gave of himself so that my best tendencies could be developed, and my worst tendencies could be refocused into what was useful and needed for a given task. For this, I thank him.

I would next like to thank Dr. Michele Staton, from the University of Kentucky, who has, for many years now, given me the mentorship, time, encouragement, and expertise that I needed. The opportunities that Dr. Staton provided me with changed my path in profound ways. Prior to meeting Dr. Staton, my life could have easily been one defined by several unfortunate foregone conclusions; that of another unhappy statistic. Subsequent to meeting and learning from Dr. Staton, my life was transformed into one of unquestionable redemption. An academic of purpose, poise, intelligence, and diligence, Dr. Staton is an exemplar, and a scholar whom I hope to continue to learn from as my career evolves. For all of the many doors that she opened that would have likely otherwise remained shut, I am forever grateful.

I would also like to acknowledge and express my deep gratitude to the other committee members for all of their help, time, and encouragement, both prior to and during the completion of this dissertation:

Dr. Martin T. Hall, Dr. George E. Higgins, and Dr. Thomas Lawson. Their insight and expertise during this process was instrumental; each gave me exactly what I needed in order to complete this program and this dissertation successfully. More importantly, and more enduringly, each provided me with a knowledge, insight, and opportunity for approaching challenging lessons, and learning from them, so that I could become a more capable, responsible, and thoughtful academic. These scholars provided me with a type of wisdom that transcends this dissertation, and which will undoubtedly change the tenor of my future work for the better. For this, I am truly thankful.

Dr. Riaan van Zyl, while not on this committee, had a profound influence on me when I was his student and is someone I would like to acknowledge. Dr. van Zyl imparted not only expert knowledge and skill, but also modeled a disposition and intellect that is worth emulating. My intellectual curiosity was emboldened by his instruction. Importantly, too, my belief that intellectual curiosity must be coupled with intellectual rigor and intellectual honesty, and then brought to bear on all aspects of life, found a confederate in Dr. van Zyl and reminded me, during moments when I most needed reminding, that I was not alone in this belief.

I also want to acknowledge and thank Dr. Seana Golder for her time and mentorship, and the many other professors and staff in the Kent School of Social Work who made the last few years of my academic life not only possible, but also productive and enjoyable. To them all, I owe a great deal. Thank you, as well, to the University of Kentucky's Center on Drug and Alcohol Research (CDAR) and the Kentucky Department of Corrections for allowing me to examine data collected as part of the Criminal Justice Kentucky Treatment Outcome Study (CJKTOS). In particular, I would like to thank the CJKTOS project manager, Erin Winston and CJKTOS research associate, Martha Tilson, for their assistance in the acquisition of the data and other materials used to complete this project, as well as for their support and much-appreciated good humor.

Lastly, and with great affection, I would like to acknowledge cherished mentorship from two intellectual mutants. First, Robert Walker, M.S.W., the brilliant, exact, and obstinate stoic. Robert Walker changed the way I dared to think from the first conversation forward. Though never a formal student during his professorship at the University of Kentucky, Robert Walker, over many years, taught me a new language, a language of the sort that does not interest most enough to learn. He helped me--joyfully,

painstakingly--practice speaking it each time we met, all the while suffering my many interruptions and fits. Any success I achieve is a direct result of his investment in me. Second, Dr. David Epstein, the brilliant, optimistic, and generally agreeable eccentric, and chief of the Real-world Assessment, Prediction, and Treatment Unit at the National Institute on Drug Abuse's Intramural Research Program. Dr. Epstein provided me with encouragement, expertise, and valuable insight throughout this process; always reminding me that there was a light at the end of this tunnel. He is a senior scientist whom I admire more than words can express and a mentor who I look forward to many years of creative and productive work with.

ABSTRACT

OPIOID AND STIMULANT USE AMONG A SAMPLE OF CORRECTIONS-INVOLVED DRUG USERS: SEEKING AN UNDERSTANDING OF HIGH-RISK DRUG DECISIONS WITHIN A SYSTEM OF CONSTRAINT

Kirsten Elin Smith

July 16, 2019

In the United States, high-risk drug use remains a significant social problem. Opioids and stimulants are two drug classes that have contributed to substantial recent increases in drug-related arrests, overdose, and mortality. Kentucky has been particularly devastated by high rates of opioid and stimulant use. Opioid and stimulant effects, while highly rewarding, can result in adverse consequences. Still, some people choose to use these drugs, and choose to continue using even after experiencing adverse consequences, such as incarceration. The aim of this study was to explore high-risk drug use among a sample of corrections-involved adults in Kentucky and to identify endogenous and exogenous factors with the potential to have influenced drug-related decision-making prior and subsequent to incarceration. Attention was paid to understanding concomitant opioid and stimulant use and heroin use. Survey data collected as part of an ongoing corrections-based substance use treatment program outcomes study were examined. The final sample (N=1,563) included adults released into Kentucky counties between 2012-2017. Non-parametric statistical tests and multinomial logistic regression were used to identify factors associated with opioid, stimulant, and concomitant use; binary logistic regression was used to identify factors associated with heroin use. Results indicate that opioid and stimulant use was endemic in this sample, though rates of use subsequent to incarceration were lower than pre-incarceration rates.

During the 30-day period prior to incarceration, 29.0% of participants reported concomitant use, 28.5% reported opioid use, and 18.0% reported stimulant use. During the one-year post-release period, 11.9% of participants reported concomitant use, 12.5% reported opioid use, and 8.3% reported stimulant use. During this post-release period, 10.7% reported heroin use. Concomitant and heroin use positively correlated with many factors with the potential to adversely influence cognition and constrain choice. Similar relationships between many of these factors and outcomes involving other drug or no drug use were not observed.

Behavioral economics, a molar view of choice and behavior, was used to conceptualize how factors in the lives of participants had the potential to influence and constrain decision-making in respect to high-risk drugs. Findings are discussed in light of how they may inform future research, policy, and practice.

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CHAPTER I
INTRODUCTION TO SOCIAL PROBLEM
AND CONCEPTUAL FRAMEWORK

High-risk Drug Use

Risky, or risk-taking, behavior is defined by Turner et al. (2004) as a volitional behavior with a potentially negative outcome in which the danger is recognized. Risk has been further conceptualized as outcome invariance (Real & Caraco, 1986). For instance, if two choices have equal value, the one with greater variance may be considered to have higher risk (Daly & Wilson, 2001). Use of addictive drugs is one type of volitional high-risk behavior (Bickel & Marsch, 2001). During a drug-related decision, use of high-risk drugs is one of many possible behavioral outcomes. Other potential outcomes include the substituted use of a relatively less risky but still desired drug, or no drug use, with the person otherwise engaged in behaviors unrelated to drugs (Vuchinich & Heather, 2003). The use of addictive high-risk drugs constitutes a significant economic, social, legal, and medical problem in the United States (Degenhardt et al., 2014; Schuchat, Houry, & Guy, 2017; Volkow & Collins, 2017). Although use of any drug entails some risk for the person using it, certain drugs are associated with comparatively greater risk. Opioids (e.g., heroin, non-medical prescription opioids) and psychostimulants (e.g., amphetamines, cocaine) are two drug classes that have several unique risks associated with their use, making them potentially more dangerous in both the short- and long-term, relative to other licit drugs (e.g., caffeine, nicotine, kratom, alcohol), prescription drugs (e.g., benzodiazepines), and illicit drugs (e.g., cannabis, psilocybin, LSD) (Bachi, Sierra, Volkow, Goldstein, & Alia-Klein, 2017; Chen, Storr, & Anthony, 2009; Paulozzi, 2012; Tomassoni et al., 2017). For instance, analyzing 1991-2011 National Health Interview Survey data, Walker et al. (2017) found that among a nationally representative sample, lifetime use of heroin and cocaine was significantly associated with excess mortality risk. More broadly, opioids and stimulants account for a disproportionate

number of drug overdose fatalities in the US. (Jalal et al., 2018). Examining data for drug-related overdose deaths between 1979-2016, Jalal et al. (2018) found exponential growth for all drug-related overdose fatalities, with peak mortality rates for drug classes distinguished by time, geographic region, and population characteristics (e.g., sex, race). Heroin, semisynthetic prescription opioids (e.g., oxycodone), and synthetic opioids (e.g., fentanyl) contributed to a significant portion of accidental overdose deaths, as did cocaine and amphetamine drugs. Between 2016 and 2017, opioid overdose fatalities increased approximately 30% (Vivolo-Kantor et al., 2010). Presently in the US, 130 people a day die from an opioid-related overdose, with opioid misuse comprising a nearly \$80 billion a year cost (Centers for Disease Control and Prevention [CDC]). Since, 2012, cocaine-related overdose fatalities have also resulted in significant losses, particularly among non-Hispanic Blacks (Shiels, Freedman, Thomas, & de Gonzalez 2018).

Considering this nearly 40-year exponential growth, two relevant conclusions might be made. First, the current “opioid epidemic” may be considered one of many interconnected drug epidemics, albeit a larger and possibly more insidious one, due to the continued need for analgesic drugs in the treatment of chronic pain in the US (Bowser, Fullilove, & Word, 2017; Dowell, Haegerich, & Chou, 2016). Second, both stimulants and opioids have been leading causes of drug-related overdose fatalities historically. Evidence suggests that in addition to stimulant-related overdose fatalities, stimulants may soon increase as a contributor of non-overdose drug-related fatalities, as many people who developed problematic cocaine and amphetamine use in the 1970s-1990s are growing older and are therefore more likely to start experiencing delayed consequences of use (Levandowski et al., 2016; Shiels et al., 2018; Yarnell, 2015). Taking a broader view of the problem of high-risk drug use in the US, rather than considering separable high-risk drug epidemics, it becomes clear that both opioid and stimulant use persist as leading contributors to poor outcomes for users and that both remain complicated social, economic, medical, and legal challenges to understand and address (Plunk, Grucza, & Peglow, 2018).

Opioid and Stimulant Use in the United States

Opioid Use

Opioids are defined here as any natural (i.e., derived the poppy [*Papaveraceae*] family; e.g., codeine, morphine, heroin), semi-synthetic (i.e., substances produced by chemical synthesis; e.g.,

OxyContin, Suboxone), or fully-synthetic (e.g., fentanyl, methadone) substance that acts as a partial or full agonist at one of the primary human opioid receptors (μ -opioid receptor, MOR; δ -opioid receptor, DOR; and κ -opioid receptor, KOR) and results in physiological and psychoactive effects (Feng et al., 2012; Pergolizzi, LeQuang, Berger, & Raffa, 2017; Taber, Neubert, & Rheingold, 2002). In humans, opioids produce both analgesic and euphoric effects (Webster, Johnson, Stauffer, Setnik, & Ciric, 2011). These effects are rewarding and memorable, and therefore behaviorally reinforcing, whereby people may be motivated to use again, even when it requires considerable effort or expense (Everitt & Robbins, 2005).

Adverse consequences associated with opioid use and misuse have been studied and speculated about for some time; though the full scope of possible short- and long-term consequences is still incompletely understood (Baldo, 2016; Cheng & Lee, 2016; Kreek, 1996; Laorden, Furtés, González-Cuello, & Milanés, 2000). Given the scale of opioid use and misuse in the US, adverse consequences cannot help but have an outsized effect if left insufficiently understood and addressed (Epstein, Heilig, & Shaham, 2018). In 2017, an estimated 6.0 million people in the US aged 12 and older reported past-month illicit prescription opioid use and nearly half a million of this same age group reported past-month heroin use (Substance Abuse Mental Health Services Administration [SAMHSA], 2017). Over the past two decades, rates of opioid prescribing and prescription opioid diversion increased, contributing to increases in opioid-related mortalities (Brady et al. 2015; Dart et al. 2015; Kolodny et al. 2015; Oquendo & Volkow, 2018). In 2012 the annual prescribing rate for opioids peaked at 81.3 per 100 persons and remains elevated at a rate of 58.5 per 100 persons as of 2017 (CDC 2019).

Wide-ranging efforts have been made over the past decade to address prescription opioid misuse. These have included the dismantling of predatory “pill mills”, increased access to treatment for opioid-dependent offenders, harsher criminal sanctions for opioid dealers, revised CDC opioid prescribing guidelines, mandated prescriber participation in drug monitoring systems, and scientific advances in abuse-deterrent opioid pill formulations (CDC, 2018; Freeman, Goodin, Troske, & Talbert, 2015; Lin et al. 2018; Makary et al. 2017; McCarthy 2017; Powell and Pacula, 2017; Worley, 2012). Despite these efforts, heroin use in the US has increased significantly since 2010 (Compton et al. 2016; Kanouse & Compton, 2015). Both prescription opioid and heroin use persist as significant public health threats. Between 1999 and 2016 the age-adjusted rate of drug overdose deaths involving natural and semisynthetic opioids (e.g., oxycodone)

increased from 1.0% to 4.4% (Hedegaard, Warner, & Miniño, 2017). Heroin and fentanyl-adulterated heroin overdose mortalities have also increased, with over 15,000 Americans dying from heroin-related overdose in 2017 alone (CDC, 2017b). Use of diverted buprenorphine (i.e., Suboxone) has also become a concerning new phenomenon within the broader opioid crisis (Molfenter et al., 2019).

Among high-risk drugs of abuse, opioids are more likely than other drugs to result in overdose and overdose-related mortalities, and also to be perceived by survivors as comparatively worse overdose experiences (Bohnert et al., 2018; Dowell, Noonan, & Houry, 2017). As the opioid-related death toll has increased in the US, no socioeconomic or demographic group has been spared and no region has been left unaffected (Alexander, Barbieri, & Kiang, 2017; Plunk et al., 2018; Shiels et al., 2018). Areas in the southeastern US, including regions within and adjacent to Central Appalachia, have been particularly impacted by prescription opioid and heroin use over the past two decades (Jonas et al. 2012; Moody, Satterwhite, & Bickel, 2017; Slavova et al. 2017; Staton et al. 2018).

One result of the dramatic uptick in opioid-related mortalities over a short period of time is that increased attention is being paid to the problem and more public resources are being devoted to addressing it (Collins, Koroshetz, & Volkow, 2018; Madras, 2017). Yet, even with increased attention and resources aimed at understanding and mitigating the current opioid epidemic, some of the most fundamental and enduring questions about the factors with the potential to influence a person's decision to use opioids despite associated risks, and to persist in use despite adverse consequences, remain insufficiently answered.

Psychostimulant Use

Psychostimulants are defined here as any natural (i.e., derived from coca [*Erythroxylaceae*] family; e.g., cocaine), natural but processed (e.g., hydrochloride salt cocaine, bicarbonate of sodium solution, a.k.a. “crack” cocaine), or synthetic (e.g., 3,4-methylenedioxymethamphetamine, pharmaceutical methamphetamine) substance that acts primarily on human dopamine and serotonin receptors and results in physiological and psychoactive effects. (Johanson & Fischman, 1989; Kalivas, 2007; Koob, 1992). Stimulants produce a range of effects, including increased alertness, euphoria, locomotor activity, endurance, and arousal (Rush & Baker, 2001; Rush, Stoops, & Sevak, 2010; Uhl, Halll, & Sora, 2002).

As of 2017 in the US, an estimated 2.2 people aged 12 or older reported past-month powder and/or crack cocaine use, while 1.8 million reported past-month prescription stimulant use, and 774,000 reported

past-month methamphetamine use (SAMHSA, 2017). Nationally, there has been an upward trend in the use of stimulant drugs. For instance, the number of people aged 12 or older who reported past-month cocaine use increased from 1.6 million in 2012 to 2.2 million in 2017, an increase of over half a million people (SAMHSA, 2012). There have been slight increases in prescription stimulant and methamphetamine use as well. For example, between 2012 and 2017, the number of people aged 12 or older reporting past-month prescription stimulant use increased from 1.2 million to 1.8 million, whereas past-month amphetamine use among people 12 or older increased between 2012 and 2017, from approximately 440,000 to 774,000, respectively (SAMHSA, 2012, 2017).

Cocaine's addictive potential has been well-documented for decades; however, increases in use in the 1970s and 1980s resulted in greater attention among researchers, medical professionals, and law enforcement (Associated Press, 1982; Fagan & Chin, 1989; Gawin, Allen, & Humblestone, 1989; Marriott, 1989). This was partially a result of a sharp increase in cocaine-related emergencies and mortalities. Rates of cocaine-related deaths increased four-fold between 1976-1981 (CDC, 1982). In 1985, the smokable derivative of cocaine, "crack", emerged as a serious drug of concern across many communities, particularly metro areas and within communities with a disproportionate number of people of color (Fryer, Levitt, & Murphy, 2013). Between the late 1980s and early 1990s, the total number of cocaine users in the US increased, in part due to new adopters of crack cocaine (Cornish & O'Brien, 1996; O'Malley, Bachman, & Johnston, 1988). This increase contributed to a rippling of adverse social, legal and health consequences (including drug-related violence) for users, their families, and their communities (Blumstein, 1995; Fagan, 1994; MacGregor et al., 1987).

Availability and use of diverted prescription stimulants, such as methamphetamine, methylphenidate (i.e., Ritalin), or dextroamphetamine (i.e., Adderall), increased in the 1990s and 2000s as these drugs became more widely used in the pharmacotherapy of attention deficit disorders (Wilens et al., 2008). In the 1990s, clandestine labs, spanning drug cartels to home kitchens, began producing "street meth" (e.g., "crystal meth", "ice", or "stove top meth") (Cunningham, Liu, & Callaghan, 2009; Maxwell & Rutkowski, 2008; Zernike, 2006). Thereafter, the availability and use of methamphetamine increased, becoming a fixture of many communities across the US, though use has often been more prevalent in smaller, mid-sized, and rural communities (Dombrowski, Crawford, Khan, & Tyler, 2016; Habecker,

Welch-Lazoritz, & Dombrowski, 2018; Lambert, Gale, & Hartley, 2008; Roussel, Holmes, & Anderson-Sprecher, 2013).

Concomitant Drug Use

Another form of high-risk drug use includes concomitant use of more than one drug (Zoorob, 2018). Polydrug use is a well-documented phenomenon among people with SUD, versus the general population, who may be more likely to use drugs recreationally, in moderation, and individually (verses concomitantly); however, less is known about controlled users, as they are seldom institutionalized and studied (Zinberg, 1984; Zinberg, Harding, & Winkeller, 1977; Waldorf, Reinerman, & Murphy, 1992). Oftentimes, people with SUD also present comorbidly with at least one other SUD (Anthony, Warner, & Kessler, 1994; Kandel, Chen, Warner, Kessler, & Grant, 1997). Polydrug use can include co-ingestion of more than one drug at the same time. For example, drinking alcohol while smoking cannabis, or injecting opioids and stimulants simultaneously (e.g., “speedballing”, “goofballing”) (Dolan, Black, Malow, & Penk, 1991; Latkin, Edwards, Davey-Rothwell, Yang, & Tobin, 2018). It can also include contemporaneous use of multiple drugs over a particular time period (Kandel, Yamaguchi, & Chen, 1992).

As opioid and stimulant use constitute high-risk forms of drug use singularly, co-use of these drugs is especially concerning. Specifically, opioids used in combination with other drugs, such as benzodiazepines and alcohol, is more likely to result in depressed respiration and possibly death (Calcaterra, Glanz, & Binswanger, 2013; Hobelmann & Clark, 2016; Jones, Mogali, & Comer, 2012). Similarly, cocaine used in combination with alcohol is known to significantly increase the likelihood of experiencing adverse health effects, including cardiac events and hyperthermia (McCance-Katz et al., 1993). When used together, opioids and stimulants demonstrate more potent effects than either drug used alone, in part by synergistically increasing euphoria and decreasing unpleasant subjective side effects produced by each drug, a result that can increase overall abuse potential and encourage continued dosing (Jasinski & Preston, 1986; Guzman & Ettenberg, 2004; Leri, Bruneau, & Stewart, 2003). The co-use of opioids and stimulants, popular among many polydrug users, is associated with increased likelihood of fatal and non-fatal overdose (Coffin et al., 2003; Kaye & Darke, 2004; Warner, Trinidad, Bastian, Miniño, & Hedegaard, 2016).

While there may be some important within-group homogeneity across substance users, there may also be some considerable heterogeneity, including among polydrug users generally and polydrug users who use opioids and stimulants specifically (Bickel, Crabbe, & Sher, 2010; Shaw, Shah, Jolly, & Wylie, 2008, Terracciano, Löckenhoff, Crum, Bienvenu, & Costa, 2008; Tetrault et al., 2008). This cautions against drawing overly broad generalizations about between- or within-group differences based on type of drug used. It is likely that people who use multiple drugs over a given time period or during a single drug-taking episode, despite any overall tendency toward versatile drug use, are influenced by a variety of factors. It is also likely that polydrug users may indicate greater preference for certain drugs, and continue to choose to use them, even as they also choose to use other, less preferred drugs (Smith & Lawson, 2017). It is important to keep in mind that concomitant drug use, and particularly concomitant use of opioids and stimulants, entails extreme risk. Such risk has increased in recent years as fentanyl and fentanyl analogues have proliferated in the illicit drug supply, and are now found as additives and adulterants in opioid and stimulant drugs alike (Dai, Abate, Smith, Kraner, & Mock, 2019; Gladden, 2016; Nolan, Shamasunder, Colon-Berezin, Kunins, & Paone, 2019; O'Donnell et al., 2017).

Purpose of Exploratory Study, and the Kentucky Context

Because of the risks associated with opioids, stimulants, and concomitant use of opioids and stimulants, it is important to work toward developing a better understanding of what factors have the potential to influence decisions to use these high-risk drugs. This includes considering not only what factors may have influenced initial drug use, but also what factors may influence continued decisions to use high-risk drugs among adults with established histories of drug use and other high-risk behaviors.

Although specific study aims will be introduced in the following chapter, the primary purpose of this study is to explore high-risk drug use among a sample of corrections-involved adults in Kentucky and to identify and discuss endogenous and exogenous factors with the potential to have influenced drug-related decision-making prior and subsequent to incarceration. This will be achieved by identifying the prevalence of opioid and stimulant use and correlates of use. Of interest is identifying what individual (endogenous) and contextual (exogenous) factors were present in the lives of participants that had the potential to influence decisions to use high-risk drugs during both time periods.

Kentucky is an ideal state for such exploration, as it has experienced high opioid prescribing and diversion rates and continues to experience historically high rates of opioid-related morbidities and mortalities, in both rural and urban areas (CDC 2017b; Faryar et al. 2017; Hall et al. 2013; Kentucky Office of Drug Control Policy 2016; Luu et al. 2018). In 2016, the number of opioid-related overdose fatalities in Kentucky increased to 33.5 per 100,000, ranking the state fifth highest in the nation (CDC 2017a). Opioid users in Kentucky are situated in an interesting ecological context, where rates of opioid prescribing are comparatively greater to other states, even as heroin use continues to increase (Slavova et al., 2017). In 2016, approximately 176,000 adults in Kentucky reported prescription opioid misuse and 17,000 reported heroin use (SAMHSA, 2017).

Reflective of the broader US, barriers to the equitable provision of comprehensive, scientifically-informed drug treatment remain in Kentucky (Epstein et al., 2018; Moody et al., 2017; Patrick et al., 2019). The availability of, and access to, medication-assisted treatment (MAT) is highly variable across the state. Although some Kentucky counties have few buprenorphine prescribers and experience challenges to implementing and delivering MAT, others have experienced significant increases in buprenorphine prescribing (Kentucky Cabinet for Health and Family Services, 2018a; Substance Abuse Mental Health Services Administration, 2018). Depending on where a person lives in the state, they may have more or less difficulty accessing MAT and, relatedly, comparatively greater or lesser access to purchasing buprenorphine illicitly. Diverted buprenorphine use remains a growing but underexplored phenomenon in the region and is important to consider, as it constitutes either a form of opioid misuse or medically unsupervised use for self-treatment, both of which are potentially dangerous (Carroll, Rich, & Green, 2018; Cicero, Ellis, & Chilcoat, 2018; Daniulaityte, Carlson, Brigham, Cameron, & Sheth, 2015; Mitchell, Gryczynski, & Schwartz, 2018; Smith et al., 2019).

In addition to opioids, stimulant use remains a problem in many Southeastern regions, including Kentucky (Courtwright, 1983; Stoops et al., 2007; Stoops, Staton-Tindall, Mateyoke-Scriver, & Leukefeld, 2005; Stover, Winstanley, Zhang, & Feinberg, 2018). As of 2016, approximately 59,000 adults in Kentucky reported cocaine use (SAMHSA, 2017), and methamphetamine use persists across urban and rural regions alike (Croft, Foppe, Huffines, & Subedi, 2018; Fernandez, Gohmann, & Pinkston, 2018).

As is the case in other states, many people in Kentucky who use opioids and stimulants become involved with the criminal justice system (Golder et al., 2014; Hall et al., 2018; Staton, Leukefeld, & Webster, 2003; Stoops, Staton-Tindall, Mateyoke-Scriver, & Leukefeld, 2005). Kentucky's high rates of opioid and stimulant use have contributed to the state's increased incarceration and community supervision rates, relative to other states. Currently, Kentucky incarcerates 948 people per 100,000, making it eighth in the world for per capita incarceration rates (Prison Policy Initiative, 2018). As of 2017, approximately 63,800 Kentucky adults were on community supervision (Bureau of Justice Statistics, 2018). These rates partially reflect the personal blame sometimes assigned to opioid and stimulant users and the moral and punitive approach historically taken to understanding and addressing drug use (Corrigan, 2000; Crisp, Gelder, Rix, Meltzer, & Rowlands, 2000; Corrigan & Wassel, 2008; Matheson et al., 2014). For medically untreated opioid users released from controlled environments, the risks of resumed use can be deadly. Considering findings from a meta-analysis conducted by Merrall et al. (2010), Epstein and colleagues (2018) concluded that "for addicts who are incarcerated, failure to provide agonist treatment can convert a short jail term to a death sentence."

Because high-risk drug use is a complex behavioral outcome, and not attributable to any one factor, it can be challenging to exculpate or explain to the general public. It may be more challenging to explain a person's continued use despite harsh drug-related consequences, such as incarceration. It is therefore important when exploring high-risk drug use among a sample of corrections-involved adults in Kentucky that endogenous and exogenous factors with the potential to influence a person's decision to use opioids or stimulants *despite known risks* are examined. However, even if it is presumed that risks associated with opioids and stimulants are completely unknown to people prior to any decision to use them (however unlikely that is), the question of what factors might influence a decision to use even in the absence of perceived risk remains an interesting and important one, as the consequences associated with use are severe, ranging from incarceration to death.

In order to help identify and understand some of the factors with the potential to influence decision-making about high-risk drugs among a sample of corrections-involved drug users in Kentucky, a behavioral economic approach will be used. Though behavioral economics is described in subsequent sections, it is briefly introduced here as an approach that characterizes the allocation of behavior within "a

system of constraint”, with particular emphasis on conditions that influence choice and the consumption of goods, including drugs (Bickel & Marsch, 2000; Bickel, Green, & Vuchinich, 1995, p. 258).

Self-reported Opioid and Stimulant Use as Decisional Outcomes

For this exploratory study, the self-reported use of high-risk drugs, such as opioids and stimulants, will be conceptualized as *decisional outcomes*, a behavior reflective of prior choice. Given the nature of choice and behavior, it is not possible to identify and measure all of the factors that influence decision-making in real-time in the real world, or to retrospectively construct accurate models of how a person came to make decisions. This may be even more difficult for illicit commodities, such as drugs. However, it is possible to discern unitary or aggregated decisions and their behaviors (i.e., decisional outcomes), along with some of the factors that potentially influenced them. This can be accomplished in several ways using available data sources, including self-report data, institutional records (e.g., hospital emergency department admissions), and publicly available statistics (e.g., Drug Enforcement Administration data on drug price, purity, and availability estimates). Decisions pertaining to opioids and stimulants can be recognized post hoc, due to the dichotomized behavioral outcome itself. In other words, use of a drug establishes that a decision about that drug was made. Opioid or stimulant use reported for a given time period indicates that a decision was made to use these drugs at some point during this time period. In the case of repeated or continued use of a given drug over a given time period, multiple decisions would have been made. A decisional outcome for a given time period that does not involve opioid or stimulant use, but rather other drug use or no use, suggests several possibilities. The first possibility is that opioids and stimulants were directly encountered by the person and that the person chose not to use them. The second possibility is that opioids and stimulants were not directly encountered by the person, but that the person still had the potential to contemplate their use (by virtue of knowing that these drugs do exist and are procurable), and that the person decided not to procure and use them.

Examples of the latter possibility abound in the real-world, even if they do not in lab conditions, where decision tasks often have mutually exclusive real or hypothetical choices presented to subjects (Cohen & Blum, 2002; Ratcliff & McKoon, 2008). For instance, chocolate cake and apple pie are two deserts that the vast majority of adults residing in the US have some awareness of. Even if an adult has never decided to eat chocolate cake or apple pie, they understand that both are available types of food.

People routinely make decisions based on information such as availability. If no stores in a person's town sold cakes or pies, then this would change how decisions about cakes and pies, as choices, are made. Some people may decide that it is simply too much effort to drive to another town to purchase these items not sold in close proximity to them. Other, more curious, people might decide that it is worth a trip. If these cakes and pies were illegal to purchase, then the nature of the decision would change still further. It would involve not only more effort, but greater risk. But in all cases, the choices of chocolate cake or apple are available to decision-makers. Similarly, knowing that opioids and stimulants are potentially procurable is a type of information that drug users and would-be users have.

Decisions to use opioids and stimulants does not suggest that decisions to use other licit, or comparatively less risky illicit drugs could not also have been made during a given time period. Use of drugs with well-known risks and use of drugs known to have comparatively less risk are not mutually exclusive. In examining self-reported drug use prior and subsequent to incarceration, use of drugs other than opioids and stimulants might also be identified. Additionally, concomitant use of opioids and stimulants may also be identified. Accordingly, part of this study includes exploring the problem of high-risk drug use by identifying more than one possible drug use outcome. These outcomes include opioid use, stimulant use, concomitant opioid and stimulant use, other drug use that excludes opioids and stimulants, and no drug use. The latter two outcomes can be considered as comparatively less risky, as will be discussed further below.

In practice, each decision to use drugs brings with it an increased probability of experiencing acute adverse events (e.g., injury, overdose, arrest, drug deal "gone bad", blackout, driving under the influence, etc.), delayed economic and health consequences (e.g., more money spent on more drugs, damage to vital organs, dependence), and myriad opportunity costs. Therefore, it is important not only to identify if high-risk drugs were used, and to identify some of the endogenous and exogenous factors with the potential to influence decisions to use, but also to assess participants' overall drug use. As will be subsequently discussed, any solitary instance of use indicates a decision to use, but it may be that many decisions were made to use the same drugs during a given time period. The difference between deciding to use heroin once and deciding to use it 100 times is important (Herrnstein & Prelec, 1991; Heyman, 2003). The degree of drug exposure, taken to be the frequency and regularity with which drugs were used, may itself come to

reflect not just the behavioral referent of a decision, or many decisions, but also an additional influence on subsequent drug-related decision-making. In other words, regarded episodically, a drug-related decision and its behavioral outcome of “use” may be treated as a dependent variable, but when there are numerous decisions and many instances of use (particularly for the same class of drugs) over a given time period, a question is then raised about how the history of drug use comes to influence contemporaneous or future drug-related decisions.

Selection and Description of Conceptual Framework

There are roughly two broad approaches used to guide the study and treatment of drug use and to situate the phenomenon within a larger conceptual paradigm. The first can be approximately summarized as the “brain disease model of addiction” (BDMA), whereby neurobiological changes that develop from continued drug-taking are believed to contribute to a person’s development of and persistence in problematic use despite adverse consequences, due to the intrinsically rewarding effects of drugs (Volkow & Koob, 2015). The second can be approximately summarized as the “disorder of choice” approach, whereby a person may choose to use drugs, and to continue to choose to use drugs despite adverse consequences, due to endogenous and exogenous factors that influence and constrain decision-making capacity and choice (Bickel et al., 2014; Heyman, 2009, 2013b; Hyman, 2005, 2007). In this approach, the intrinsically rewarding effects of drugs are but one among many factors of with the potential to influence use. Despite ongoing debates and important differences in what both approaches emphasize, the two approaches have much conceptual overlap and are often in empirical, if not philosophical, agreement about some important aspects of drug use and addiction (Berridge, 2017; Bickel et al., 2014; Fenton & Wiers, 2017; Hyman 2007; Leshner, 2001; Lewis, 2017; Shaffer et al., 2004; Szalavitz, 2017). Though both provide useful methods for understanding addiction, the “disorder of choice” approach, under which behavioral economics is subsumed, may provide additional explanatory power. This is because behavioral economics seeks to explain both drug use *and* addiction, whereas the BDMA focuses on pathology without equal focus on non-pathological use, and because the behavioral economic approach emphasizes the importance of considering how dynamic conditions can influence drug-related decision-making and drug use at one time point and across time (Bickel, 2014; Higgins, Silverman, & Heil, 2008; Heyman, 2009; Müller & Schumann, 2011). By utilizing a behavioral economic approach, the neurobiological changes that

result from continued drug use (that some refer to as “disease”) are not overlooked, as this approach understands the same phenomenon as a reinforcer pathology that can be influenced by many additional factors of a person’s life (Bickel et al., 2014, 2016; Heyman, 2009; MacKillop, 2016).

What Exactly is Behavioral Economics, and Why is it Relevant?

Broadly, behavioral economics conceives that people’s available choices, cognition, decision-making, and behaviors are influenced and constrained by a variety of factors and across time, and that many of these influences may be beyond a person’s complete awareness or control (Chaloupka, Emery, & Liang, 2003; McClure, Laibson, Loewenstein, & Cohen, 2004; Newell & Shanks, 2014; Tomer, 2007). Fundamentally, and in relation to decisions involving drugs, behavioral economics is concerned with how a person’s history, environment, cognitive capacities, psychology, preferences, and available choices shape drug-related decisions (and drug use) in light of rewards and costs associated with all available choices (Camerer & Loewenstein, 2004; Vuchinich & Heather, 2003). In other words, high-risk drug use and addiction can be, among other things (e.g., habituated responding), described as one type of goal-directed behavior resulting from a goal-directed decision-making process (Brown & Madsen, 2018; de Wit, 2018). As Vuchinich & Heather (2003) explain, behavioral economics is:

A system of specific concepts that applies general principles of relativism and molarity to understanding the use of psychoactive substances. In general, the value of substance use, and the extent to which it is preferred, can be viewed as a function of the benefit/cost ratio of substance consumption in relation to the benefit/cost ratios of other available activities (p. 5).

This molar view of choice simply means that activities, such as drug use, can involve local behaviors as well as behaviors extended in time, and that all behavior constitutes choice (Baum, 2004). The latter premise rests on the idea that in all situations, even the most constrained or restricted ones, more than one behavioral option is available (Baum, 1974). “In the molar view, behavior is a choice and choice a behavior. Whether local or extended, a relative response rate constitutes an allocation of behavior among alternatives and is a primary feature of behavior” (Baum, 2004, p. 355). Activities are considered here to be comprised of other activities and, in kind, to potentially comprise other activities. Activities have three properties: First, each part of an activity stands in relation, as a part, to its whole; second, parts cohere to function as a whole (toward some end); third, activities are subject to scaling (i.e., procuring heroin, fixing

heroin into a syringe, injecting the heroin; then, done with enough frequency, transitioning from someone who has injected heroin to someone addicted to heroin). Because activities are extended in time, measuring or otherwise making sense of a behavior involves considering what other behaviors precede and follow it and what else stands in relation to it. Again, a person who uses cocaine once differs from a person who uses cocaine every hour or every day. A person who studies for school once a week differs from someone who studies for school each day. The frequency of behavioral allocation provides information about activities which are comprised of many choices/behaviors. Importantly, decisions to use drugs are not made in a vacuum. In addition to many other potentially influential factors, constraints on drug availability, access to non-drug alternatives (e.g., satisfying relationships), and perceived or real likelihood of cost (e.g., parole revocation, overdose), all stand to influence drug-related decisions, at one time point and over time (Bickel et al., 2014; Caprioli et al., 2009; Greenwald & Hursh, 2006; Klapproth, 2012).

In his overview of behavioral economics, Tomer (2007) states that:

The word, strand, is the right one for thinking about [behavioral economics]. A strand is a part that is bound together (as in a rope) to form a whole. Behavioral economics consists of quite a few strands as well as individual practitioners whose work does not fit neatly into any one of these strands. Because there is enough commonality in these strands, they do form a whole (p. 469).

More recently, Bickel et al. (2014) referred to behavioral economics as “a discipline that hybridizes economics and psychology... that can be considered as the application of economic concepts and approaches to the molar study of individuals’ choices and decisions” (p. 643). Although behavioral economics began its departure from classical and neoclassical economics many decades ago, the pace of departure has accelerated in the last decade as behavioral economic researchers increasingly incorporate insights and methods from non-economic disciplines (e.g., psychology, neuroscience) (Becker, 2013; Thaler & Ganser, 2015; Tomer, 2007). Behavioral economics, and its extension neuroeconomics, continue to reconsider and refine fundamental assumptions of economics, in order to establish a more realistic understanding of decision-making and behavior, including drug use (Heshmat, 2015; Kahneman, 2003; Melrose & Monterosso, 2015; Thaler & Ganser, 2015). With increased knowledge about cognitive systems underlying information processing and decision-making (e.g., dual-process theories) and improved appreciation for how context can greatly influence decision-making, behavioral economics has

reconceptualized certain assumptions about how people make decisions involving drugs and other commodities (Evans & Stanovich, 2013; Kahneman, 2011). The application of behavioral economics to drug use and addiction has proliferated over the past decade and is increasingly used to help explain people's persistence in drug use despite risk and cost (Vuchinich & Heather, 2003).

Specific Rationale for Utilizing a Behavioral Economic Approach

Accordingly, a behavioral economic approach is helpful for organizing an exploration of high-risk drug use among corrections-involved adults, both in terms of how it may help explain some findings and in terms of its potential to contextualize high-risk drug use, something often left undone when discussing and researching drug use. A more thorough contextualization of decision-making in relation to high-risk drug use may accomplish several things. For one, it may call into question the degree to which a person can be regarded as culpable or blameworthy for their use. Further, it may do this without necessarily calling into question a person's agency, responsibility, and inherent dignity, which has important philosophical, policy, and clinical implications, several of which will be discussed in Chapter 5 (Heyman, 1996; Pickard, 2017).

A behavioral economic approach was chosen to help conceptualize the phenomenon of high-risk drug use, formulate exploratory study aims, and interpret findings for roughly three reasons. First, this approach can help to scrutinize and explain different types of high-risk drug use. For instance, particular opioid or stimulant drugs may differ in their relative availability and value to corrections-involved people in Kentucky and may be more or less accessible at different times and regions within the state. This approach can help explain why decision-making about particular drugs might differ between people and potentially change over time.

Second, this approach permits conceptualization of opioid and stimulant use as “decisional outcomes”. These can be understood as the behavioral referents of drug-related decisions (the other discernable behavioral referents of the decision being “no use”, or the use of non-opioid and non-stimulant drugs). This means that a dichotomized outcome (e.g., “use” versus “no use”) for particular drug can be examined and discussed in terms of what factors may have influenced the decision to use during a given time period, rather than merely influenced the probability that use would be observed without also acknowledging the role of a decision-making agent. This proximate step prior to use, the decision, is ultimately what all antecedents are influencing. By placing increased attention on decision-making and by

emphasizing its importance as the penultimate act of interest, interventions may be better developed to help people improve their decision-making capacities in both local and global ways (e.g., improving cognitive functioning, affect regulation, mindfulness, interoceptive awareness, inhibition, etc.) and policies can be developed to help “nudge” people into making more adaptive decisions (Aharonovich et al., 2006; Ahn et al., 2014; Chetty, 2015; Dunn et al., 2010; Naqvi & Bechara, 2010). By highlighting the capacity for some aspects of drug users’ decision-making and behavior to change under the right conditions (rather than suggesting that drug users have an incurable, chronic brain disease), self-efficacy may be better nurtured.

Third, this approach understands that opioid and stimulant use can reflect trade-offs between short-term rewards of use and long-term benefits that develop from not using. In this study, at least two long-term rewards can be discerned (i.e., not incurring morbidities or mortalities related to these drugs; not becoming incarcerated for using these drugs) (Brinkley-Rubinstein et al., 2017; Dublin & Von Korff, 2018; Merrall et al., 2010). People in the US are disincentivized from using opioids and stimulants, yet, many people in this sample made a decision to use these drugs despite disincentives. Behavioral economics can help make sense of a person’s pursuit of reward in situations involving uncertainty and risk due to the fact that this approach considers what endogenous and exogenous factors may have contributed to how drug and non-options were framed, valued, and assessed (Bickel & Marsch, 2001; Heshmat, 2015; Kahneman, 2001, 2011). That the context within which people make drug-related decisions is emphasized in this approach is also helpful, given that opioid and stimulant use cannot be divorced from the complex lives of people and the uniquely complex set of circumstances related to choice that corrections-involved people often find themselves in.

To date, a behavioral economic approach for understanding decision-making and behavior has not been used as a conceptual lens by social science researchers concerned with examining opioid, stimulant, and other drug use among corrections-involved people using secondary data sources. Many controlled human and non-human animal studies have helped to advance behavioral economic and neuroeconomic understandings of drug use. Such lab-based experiments are essential for helping describe and elucidate discrete drug-related choice and behavior. They are nonetheless limited, oftentimes unable to sufficiently model the factors that shape choice, influence decision-making, and reinforce behavior among people in their everyday lives (e.g., threat of incarceration, social status, isolation and loneliness, desire to regain

child custody, fear of contracting HIV, poverty, chronic back pain, etc.) (Heilig, Epstein, Nader, & Shaham, 2016; Venirro, et al., 2018). The vast majority of people who use opioids and stimulants make a decision to do so within the complicated and changing conditions of their life, not within a controlled study or under hypothetical (or otherwise artificial) conditions.

While it is crucial to continue studying drug-related decision-making and drug use using pre-clinical animal models, even if they cannot fully account for real-world decision-making conditions, it is also crucial that in parallel to such lab-based work researchers outside of the basic sciences and economic disciplines increasingly seek to understand high-risk drug use by conceptualizing the phenomenon in a manner that takes into fuller account the inherent complexity of drug use. Part of this complexity requires more direct acknowledgement and study of the fact that the drug *use* is only ever a byproduct of the drug *decision*, and that both occur within broader conditions.

Necessary, but not Sufficient

Therefore, instead of asking what factors are associated with observing an outcome of opioid use during a given time, it may be helpful for social science researchers to begin asking what factors have the potential to influence a person's decision to use opioids during a given time, as this helps to situate the problem with greater coherence and provides a way to achieve greater clarity by acknowledging the fact that the problem of high-risk drug use isn't necessarily the primary problem. Rather, it is the person's decision to use high-risk drugs and the conditions that give rise to the decision. It is coherent in the sense that unless drugs are forcibly given to someone, a person does indeed choose them. The drug use behavior does not exist without the prior decision. The decision does not exist without the conditions. If high-risk drug use is a problem, it is only secondary to decisions to use high-risk drugs. That drug use can assume the character of compulsion, but also may not ever have assume this character for many, may confuse how it should be conceptualized in relation to choice. However, if the decision to use drugs is also recognized as more or less voluntary (verses compelled), then it becomes possible to talk about constraint across levels (i.e., a person was compelled to decide to purchase and inject heroin despite a desire to not use heroin, or despite a desire to not make such a decision). The possibility is suggested here that the behavior of "use" cannot be performed without prior decision, however constrained and compelled the decision was. Put differently, there may be no "freedom of will" at any level, not just at the level of

observable behavior of use. Here, desires, intentions, choice, and behavior would all be constrained, but decision would still precede action.

This idea, that decision precedes action, is intuitive, yet, it is not always considered and is less frequently identified as an object of investigation, particularly among social scientists. This is the case for a variety of important problems. For example, the problem of hepatitis C infection that results from injecting drugs and sharing drug equipment is secondary to the injection itself. The observed outcome of disease is clear and measurable, and the sufficient conditions that actualize it (i.e., injecting drugs, sharing injecting equipment) are not typically confused with it. It is understood that one precedes the other, and that reducing new IDU-related hepatitis C infection rates means reducing IDU or syringe sharing. Since decisions are made prior to injecting drugs and sharing syringes, one legitimate focus might be on the factors that influence these high-risk decisions. In other words, to consider what factors are present so as to influence the decision to inject with a used syringe.

To date, myriad “risk factors” have been identified as positively correlated with drug use and misuse, often considered as contributors to observed drug use outcomes (Dube et al., 2003; Kreek, Nielsen, Butelman, & LaForge, 2005; Nation & Heflinger, 2006). Although the presence of these risk factors may be *sufficient* contributors to the development of drug use and misuse, none of them are *necessary* (Newcomb, Maddahian, & Bentler, 1986). It is the decision to use drugs that is necessary for use to occur. Additional necessary, but not sufficient, conditions include the capacity to act and the actual existence of drugs as commodities.¹ In other words, even if it may require considerable effort to procure a high-risk drug, they do (and must) exist as procurable commodities in order to be used. Many other factors with the potential to influence drug-related decision-making are also only ever sufficient, but not necessary. Indeed, there is a vast array of possible influences on decision-making. The same factors may not reliably influence decision-making across people uniformly, or across the same person over time. Still, it may be that some conditions do influence high-risk decision-making involving opioids and stimulants among more people more of the time. Of course, the presence or absence of these factors could still be conceptualized in terms

¹ By “capacitary to act”, it is meant that not merely agency, in the most general sense, is implied, but that also, more specifically, the requisite capability for particular forms of high-risk drug use are accounted for. For example, swallowing a prescription opioid requires less procedural knowledge than preparing the same pill for intravenous injection. A person must, at a minimum, be capable of drug self-administration.

of “risk” or “protection”, though they need not be. In some cases, in which the factors influencing decision-making are more proximate (i.e., milliseconds) it may be better not to think in terms of “risk”, but rather in terms of “constraint”. Irrespective of how endogenous and exogenous factors with the potential to influence drug-related decision-making are termed, they are worth considering. And, it is possible to do so using existing research on cognition, decision-making, and drug use.

Shifting the focus of the discussion toward factors with the potential to influence drug-related decision-making--instead of remaining focused on factors with the potential to influence its behavioral referent (“use”) unmoored to the decisions themselves-- gets closer to the actual phenomenon of interest. As discussed in Chapter 5, such investigatory refocus may have the potential to help inform interventions that might attenuate high-risk drug use at its more proximate and potentially extricable roots.

Coarse-grained Approach

Exploring opioid and stimulant use by identifying endogenous and exogenous factors with the potential to influence drug-related decision-making can be accomplished to the extent that available data sources are able to discern and indicate, however indirectly, the presence or absence of such factors. It is important to emphasize that attempting to identify endogenous and exogenous factors with the potential to influence drug-related decision-making constitutes a “coarse-grained” approach, whereby conceptual expanse is gained at the expense of measurement detail and specificity. In the case of a secondary data analyses of survey data, such measurement detail is already largely absent. Coarse-grained models are sometimes used in science to simplify otherwise inscrutably complex systems (Marrink, Risselada, Yefimov, Tieleman, & De Vries, 2007; Noid et al., 2008). People can be conceptualized as stochastic, self-organized complex systems, even if they cannot yet be measured or modeled as such (Bak, 2013; Bullmore & Sporns, 2009; Wagenmakers, van der Maas, & Farrell, 2012; Rubinov, Sporns, Thivierge, & Breakspear, 2011). For this reason, the general study of dynamic human decision-making and behavior will, for the foreseeable future, remain coarse-grained and even somewhat philosophical, irrespective of the degree to which measurement error is present or absent. It is also for this reason that it may be reasonable to assume a coarse-grained approach when exploring high-risk drug use among a sample of corrections-involved adults.

For the exploratory study proposed here, many lines of rapidly-developing research can be brought to bear in helping understand and think about the endogenous and exogenous factors in people’s everyday

lives with the potential to influence high-risk drug-related decisions. Using behavioral economics as a conceptual approach can help orient the study and its findings to this body of literature. Because data examined in this exploratory study were collected as part of an ongoing outcomes evaluation, the objective was not to pursue empirical validation of specific behavioral economic concepts. Rather, this study sought to apply ideas central to behavioral economics and the molar view of choice to the available data, and to use existing literature to help think about possible ways that endogenous and exogenous factors may have influenced decision-making about opioids and stimulants among participants across time periods. Many of these factors will be discussed in Chapter 2. As discussed below, the risk associated with these drugs is significant. This significant risk means that a decision to use opioids and stimulants is nothing less than puzzling, unless it is situated within the broader context of a people's lives.

The High-Risk Nature of Opioid and Stimulant Use

Other Drug Use

Before describing some of the specific risks associated with opioids and stimulants, it is worth briefly considering some of the risks associated with other commonly used drugs. Alcohol use, for instance, constitutes one of the greatest financial and social burdens on society. It results in more morbidities and mortalities in the U.S. than illicit drugs, due to the sheer volume of alcohol consumers (CDC, 2019; Jinjuvadia & Liangpunsakul, 2015). Excluding accidents, most alcohol-related morbidities and mortalities develop gradually (CDC, 2019). Alcohol poisoning can result in death; however, this accounted for only 1.9% of annual alcohol related fatalities in the U.S. between 2006-2010 (CDC, 2019).

Many potential social, psychological, educational, and occupational consequences can result from alcohol use; but these too may manifest gradually, suggesting many potential points for prevention or attenuation (Lee, Geisner, Patrick, & Neighbors, 2010; Patton et al., 2013; Schulenberg & Maggs, 2002). Some of the delayed adverse consequences of alcohol use can be attributed to the fact that alcohol is licit and socially normed, meaning that the criminalization, stigmatization, and social exclusion of alcohol users and people with alcohol use disorder (AUD) occurs to a lesser degree compared to people who use opioids or stimulants, or who have respective use disorders for these drugs (Janulis, Ferrari, & Fowler, 2013; MacArthur, Jacob, Pound, Hickman, & Campbell, 2017; Pachankis et al., 2017). The availability and price of alcohol is also such that many people who use or misuse it may not need to resort to serious criminal

offending or extreme measures to obtain the drug, even if there are fluctuations in alcohol prices that may nevertheless influence consumption (Felson & Staff, 2017; Mericle, Karriker-Jaffe, Gupta, Sheridan, & Polcin, 2016; Ornstein & Levy, 1983; Shortt, Rhynas, & Holloway, 2017). For instance, someone wanting to consume alcohol need not meet a drug dealer. Since the repeal of the 18th amendment, which prohibited non-medical sale of alcohol, people in the US over the age 21 may drink without direct threat of legal consequences (Okrent, 2010).

Lastly, with the exception of homemade spirits (e.g., “moonshine”), alcohol products sold in the US are held to strict regulatory guidelines and are subject to government monitoring to ensure that the package contents are concordant with labeling, advertising, etc. (Alcohol and Tobacco Tax and Trade Bureau, 2019; Holstege, Ferguson, Wolf, Baer, & Poklis, 2004). This means that consumers have access to information which may help them assess at least some risk. While information about opioids and stimulants is informally available to users within illicit drug markets and online, it may be unreliable and, given the nature of illicit drug markets, subject to change rapidly (Duxbury, 2018; Orsolini, Papanti, Corkery, & Schifano, 2017; Treloar & Abelson, 2005; Rönkä & Katainen, 2017). Further, information may only be available about specific illicit drug products via specific mediums (e.g., word-of-mouth, online, etc.) or about specific products sold by specific distributors (e.g., heroin advertised as “fentanyl-free” on the Deep Web and verified by customer reviews) (Becker, 2017; Quintana Mathé, 2017). In other words, illicit drug information is not reliable or durable, nor is it equally accessible to all would-be consumers. Taken together, the choice to use alcohol is one that entails serious risk, but it is one that, when compared to opioids and stimulants, has less relative risk.

Other illicit drugs, such as psychedelics, benzodiazepines, barbiturates, and cannabis, are also used by people in the general population recreationally, experimentally, or for the self-treatment of health symptoms, in addition to being used by people with SUDs (Andersson, Persson, & Kjellgren, 2017; Jeffers et al., 2015; Ogborne, Smart, Weber, & Birchmore-Timney, 2000). Though these drugs may pose health and legal risks for users, they tend to have, overall, fewer social and medical consequences compared to opioids and stimulants, including being comparatively less stigmatized (Brown, 2015; Hall, 2015; Meurk, Carter, Partridge, Lucke, & Hall, 2014; Pachankis et al., 2017; Patorno, Glynn, Levin, Lee, & Huybrechts, 2017; U.S. Department of Justice, 2015). Novel psychoactive substances (NPSs), such as synthetic

cathinones or cannabinoids, are used far less frequently than opioids and traditional psychostimulants, but are increasingly associated with adverse side effects and remain high-risk drugs of concern (Cohen & Weinstein, 2018). However, recent evidence suggests that, compared to traditional drugs, their availability and use is gradually declining and that they are not preferred over traditional drugs (Blackman & Bradley, 2017; Smith & Staton, 2018; Smith & Stoops, 2019). Thus, while NPS use is high-risk, prevalence rates currently remain far lower than other drugs (Mathews, Jeffries, Hsieh, Jones, & Buckne, 2019; Palamar, Rutherford, & Keyes, 2019). This, coupled with their relative lack of appeal to many users, means that NPSs may be considered as concerning primarily among a narrow subpopulation of drug users, compared to opioids and stimulants, which are more popular and which have over a century of documented associated risks (Chaldecott, 1907; Scheltema, 1910; Wood, 1904).

Indeterminate (but Potentially Perceived) Risks of Opioids and Stimulants

The problem of high-risk drug use in the US has recently received increased local and national attention, as rates of drug-related mortalities have come to surpass mortalities attributed to firearms, car accidents, and HIV/AIDS at their respective peaks (Blackford, 2018; Katz, 2017). Among the general public and drug-using populations, opioid and stimulant use is known to have potential for health and legal consequences (Draus & Carlson, 2009; McGovern & McGovern, 2011; Norden et al., 2009; Small, Rhodes, Wood, & Kerr, 2007). In order to procure these drugs without prescription or by chance, one must first become aware that they are available for purchase through black markets and informal peer networks (Jonas et al., 2012)². This means that potential legal consequences, even if underestimated or only vaguely perceived, are still known. As for potential health consequences, public health messaging around opioid and stimulant use has increased significantly in the past decade (Hernandez, Meyers-Ohki, Farkas, & Rotrosen, 2018; Parker, Strunk, & Fiellin, 2018).

Although all drugs have been generically profiled in public awareness and prevention campaigns for decades (e.g., DARE program), cocaine/crack cocaine and methamphetamines have been presented to US citizens via graphic and disturbing images by the Drug Enforcement Administration and the Partnership

² “By chance” alludes to the fact that people may inadvertently come across prescription drugs and illicit drugs without meaning to. For instance, discovering them in a parent’s medicine cabinet or among a sibling’s possessions, etc.

for Drug-Free America (Buchanan & Wallack, 1998; Linnemann & Wall, 2013; Marsh, Copes, & Linnemann, 2017; West & O’Neal, 2004). News media and politicians have also drawn attention to the devastation that cocaine/crack cocaine and methamphetamine use can contribute to, though with a noticeably different tenor than that used in recent profiles of opioid use, and white opioid users in particular (Netherland & Hansen, 2016). For crack cocaine specifically, US media helped facilitate the creation of caricatured social constructs that developed around both real and tragic realities, as well as exaggerated myths and misinformation (Brownstein, 1996; Hartman & Golub, 1999; Reinerman & Levine, 2017). Images and catch-phrases advertising the risk of crack cocaine use became commonplace, with many depreciatory and cautionary phrases persisting in the cultural lexicon (e.g., “crack babies”, “crack whores”, “crack mothers”) (Lyons & Rittner, 1998; Meyers, 2004). In addition to crack cocaine, methamphetamine use has been profiled in stark, graphic, and derogatory terms (Marsh et al., 2017; Peterson, Gubrium, Fiddian-Green, 2018). The media and politicians have portrayed methamphetamine use as a public menace rather than public health crisis, with methamphetamine use frequently associated with “white trash” (Hartigan, 2013; Jenkins, 1994; Weidner, 2009). Film and TV have also portrayed some of the risks associated with opioids and stimulants, even as they have simultaneously glamorized their use (Allen & Alberici, 2018; Cape, 2003; Garriott, 2016).

It should be noted that while both opioid and stimulant users have been blamed, caricatured, maligned, and punished (as well as pejoratively labeled as “junkies”, “crack-heads”, “tweakers”, etc.), the public health messaging that predominates the current opioid epidemic was not as pronounced during the crack cocaine epidemics of the 1980s and 1990s. Despite that crack use was deemed a “plague” during this era, public safety, in the form of deterrence and retributive justice, was given greater priority than public health (Furst, Johnson, Dunlap, & Curtis, 1999; Lloyd, 2013; Mauer, 2004; Reinerman & Levine, 1997). Jail and prison terms, including mandatory minimum sentences, were given to crack cocaine users and sellers more frequently than treatment referrals (Graham, 2010; Kautt & Spohn, 2002). Beginning in the early 2000s, the same became true for many methamphetamine users who began receiving jail and prison terms, including mandatory minimum sentences, for methamphetamine-related offenses (Graham, 2010). Currently, people who sell opioids, irrespective of any personal use, are receiving harsh federal

punishments, including life without the possibility of parole; again, based on mandatory minimum statutes (Duncan, 2013; Mack, 2016; Offices of the United States Attorneys, 2017). However, in addition to punitive measures, public health measures are also being promoted in earnest, with the hopes of mitigating the opioid crisis (Collins et al., 2018).

Beyond legal consequences advertising the risk of opioid and stimulant use, additional types of knowledge about the risks of use are available. These include information provided by drug-using peers and first-hand observations, as many people who come to use opioids or stimulants have also witnessed use of these drugs in their own families or communities (Alexander, Piazza, Mekos, & Valente, 2001; Barnard & McKeganey, 2004; Mohler-Kuo, Lee, & Wechsler, 2003). More directly, people can form experiential knowledge after initial or continued use. Should users experience adverse effects, they will have observed some potential consequences of use. In 2017, a majority of people in the US aged 12 or older (71.3% - 94.5%) believed that trying cocaine or heroin even occasionally was associated with “great risk” (SAMHSA, 2017). Thus, it may be concluded that, irrespective of the validity or quality of available information about opioids and stimulants, most US citizens associate opioids and stimulants with some measure of danger. For people who have encountered institutions or treatment facilities, the risks associated with these drugs may be known with even greater specificity. Although most people may not be able to articulate the specific risks associated with opioid or stimulant use, it is still reasonable to suggest that there is some indeterminate degree of understanding that opioid and stimulant use is not “risk-free”, in that there is considerable uncertainty associated with use.

Some potential risks of opioid and stimulant use that may be discerned to varying degrees by people in the US include: 1) The potential to develop dependence or addiction, due to the high abuse liability of opioids and stimulants (Epstein, Preston, & Jasinski, 2006; Higgins, 1997; Koob & Volkow, 2010); 2) The potential to develop problems in occupational, social, and daily functioning as a result of misuse or dependence (Cunha, Bechara, de Andrade, & Nicastrì, 2011; Henry, Minassian, & Perry, 2010; Hoffmann & Larison, 1999; Leshner, 1999); 3) This can be extended to potential discord in relationships, in that it is likely that not all of the people in one’s life will be supportive of opioid and stimulant use, even if some are. In other words, smoking meth may upset a spouse or injecting heroin may result in rebuke from one’s mother. Some social censure might be expected (Amato & Rogers, 1997; Orford, Copello,

Velleman, & Templeton, 2010); 4) Here, social consequences of opioid and stimulant use may include stigmatization, social exclusion, rejection, and discrimination (Brown, 2015; Kennedy-Hendricks et al, 2017; Pachankis et al., 2017). Stigmatization is public, persistent over generations, and consequential; it is why many users do not publicly disclose their drug-using identity voluntarily (Chalmers, Lancaster, & Hughes, 2016; Pachankis, 2007;

Quinn & Chaudoir, 2009; Ross et al., 2007); 5) Potential short- and long-term financial problems associated with opioid and stimulant use. This can include consequences from money spent on drugs, as well as from potentially poorer lifetime employment and earning trajectories. (Mark, Woody, Juday, & Kleber, 2001; Simon et al., 2001); 6) The potential to incur injury or health conditions related to use (e.g., infectious diseases or abscesses), including the potential for drug overdose and death (Binswanger, Kral, Bluthenthal, Rybold, & Edlin, 2000; Cornish & O'Brien, 1996; O'Donnell, Gladden, & Seth, 2017; Zibbell et al., 2018); 7) Lastly, the purchase, possession, and use of opioids and stimulants is illegal, meaning that a person is aware of the increased likelihood of coming into contact with law enforcement and becoming involved in the criminal justice system (Mumola & Karberg, 2006; Webster, Dickson, Mannan, & Staton, 2018). Moreover, opioid and stimulant use is expensive and often necessitates extralegal income-generating endeavors, including criminal ones (Biernacki, 1979; Schwartz et al., 2008).

In Kentucky, between 2015-2016, approximately 76.5% of adults reported perceiving some risk from using cocaine at least once a month (SAMHSA, 2017). For this same period, approximately 89.1% of adults in Kentucky perceived some risk from “trying heroin once or twice” (SAMHSA, 2017). This means that within this region a majority of adults associated risk with at least one opioid and/or stimulant drug. Given the wide-ranging scope and severity of the aforementioned risks associated with opioids and stimulants, and the fact that most people are aware of these risks, it is unclear what factors could sufficiently influence a person to willingly use, or to continue to use, opioid or stimulant drugs.

Why Might a Person Decide to Use, then?

As noted earlier, it is likely that a variety of endogenous and exogenous factors increase the likelihood that a person decides to use opioids or stimulants, whereby short-term reward is pursued despite possible future costs. It is important to remember, though, that the nature of risk is that it exposes one to, but does not guarantee, unfavorable outcomes (Daly & Wilson, 2001). One commonality among many of

the risks described above is that their actualization, wherein the *risk* of harm becomes *experienced* harm, can be delayed. This is important for several reasons. First, because unlike a person touching their hand to a hot stove, the association between opioids or stimulants and harm (i.e., punishment learning) is often indirect (Skinner, 1938, 1953). Opioids and stimulants, however, have directly reinforcing effects (Bickel et al., 2014; van Ree, Gerrits, & Vanderschuren, 1999; Woolverton & Johnson, 1992). In other words, the reward of using them is not only salient, but directly associated, making learning rapid and the encoding of memories about these pleasurable drug experiences instantiated in key brain areas for “quick retrieval” in the future (Baler & Volkow, 2006; Stewart, de Wit, & Eikelboom, 1984). Conversely, larger future rewards (or punishments) are abstract and more difficult to envisioned clearly (e.g., episodic future thinking, episodic counterfactual thinking) or with the same salience as proximate rewards or punishments, particularly those for which there are episodic memories (i.e., associated conditioning), which serve to influence decision-making and behavior (O'Donnell, Daniel, & Epstein, 2017; Schacter, Benoit, De Brigard, & Szpunar, 2015).

Second, many risks associated with high-risk drug use and many benefits associated with not using high-risk drugs are realized in the future, meaning that consequences or contingencies are not perceived in the same way as immediate “sure things” (Platt & Huettel, 2008). This decision-making under uncertainty means that a person may be less able to accurately assess and value information about high-risk choices and may experience less motivation to make decisions in the present that help achieve or avoid particular future outcomes, which are only ever contingent (Kahneman & Tversky, 2013).

A decision to use opioids or stimulants constitutes an intertemporal choice, whereby people make a decision at one time point with awareness that this decision influences the availability of other possibilities in the future (Berns, Laibson, & Loewenstein, 2007; Kable & Glimcher, 2007). Utility, which can be thought of as the value (e.g., enjoyment, usefulness, pleasure satisfaction, etc.) associated with a given choice, may not always be maximized in the long-term by people (Herrnstein & Prelec, 1992; Machina, 1989). Oftentimes, future rewards and punishments associated with choices cannot be fully anticipated or accurately assessed, even if some risk/benefit is discernable (e.g., anticipated, remembered, inferred) (Broome, 1991; Loewenstein & Elster, 1992; Zauberman, Ratner, & Kim, 2008). Intertemporal choice poses problems for people in instances where choosing the option with the greatest local utility (i.e.,

immediate value/reward) decreases overall utility (i.e., value/reward over time) (Herrnstein & Prelec, 1992). This mismatched utility is not always the case for addictive drugs, but often can be. By choosing to use drugs repeatedly, drugs can become overvalued, and non-drugs undervalued. This can be considered as reinforcer pathology (Bickel et al., 2001). Thus, the risk, but not certainty, of future punishments and rewards associated with opioids and stimulants, coupled with their immediate or local appeal, for which the outcome expectancies of reward are often clear, makes high-risk decisions about drugs as challenging as they are consequential. Importantly, intertemporal choice, particularly between immediately rewarding (but risky) local outcomes and future contingencies, demands significant cognitive effort and flexibility to navigate (e.g., self-control, reframing, inhibition, working memory, metacognition, etc.) (Baumeister & Vohs, 2007; Heatherton & Wagner, 2011; Nichols & Wilson, 2015; Westbrook & Braver, 2015; Yeung & Summerfield, 2012). As will be discussed, many factors can influence and impair needed cognitive capacities.

The dynamic between immediate versus future, certain versus uncertain, poses a challenge for people, in that they must evaluate choices that cannot help but be weighted differently based on past history (and how past experiences are remembered during decision-making), present states and context, and beliefs about themselves, their abilities, and their future (i.e., prospection, self-projection, self-efficacy) (Buckner & Carroll, 2007; Kahneman, 2003; Kahneman & Tversky, 2013; Krueger & Dickson, 1994). Because the utility of opioids or stimulants is also relative and changing, it is important to consider not only what factors influence decision-making generally, but also what factors might reinforce use or no use of particular opioid and stimulant drugs. This could include considering what additional drugs might be available to people as substitutes (i.e., comparable replacements) or compliments (e.g., i.e., commonly co-used drugs), as well as what rewarding non-drug alternatives (e.g., relationships, opportunity, jobs) are accessible (Bickel, Madden, & Petry, 1998; Etten, Higgins, Budney, & Badger, 1998; Morral, Iguchi, & Belding, 1999; Quick, Pyszczynski, Colston, & Shahan, 2011; Rogers et al., 2008; Waldorf et al., 1992; Yates, Bardo, & Beckmann, 2019). Given the multitude of influences on decision-making and behavior, it is likely that many factors constrain people's choices and ability to choose in ways that maximize well-being over time.

Even holding conditions constant, the starting point for making a decision between a smaller, immediate reward and a potentially larger, later reward is an uphill battle. This is because people and other animals evolved in states of uncertainty and scarcity to develop greater bias toward immediate consumption of rewarding things (e.g., food) over rewards situated in the future and rewards associated with greater trade-offs, uncertainty, or effort (Bickel, 2014; Kagel, Green, & Caraco, 1986; Rosati, 2017). It is also an uphill battle because some types of cognition are automatic, unconscious, and heavily influenced by factors that may not be readily perceived by the person (e.g., physiology, affect, surroundings) (Bubier & Drabick, 2008; Evans, 2008; Kahneman & Egan, 2011). This type of cognition can be fast and useful, but comes at a cost; it can make information processing (e.g., assessment, valuation, prediction, etc.) and decisions prone to inaccuracies, bias, and error (Kahneman & Egan, 2011; Lee, 2013). Cognitive processes that are slower, more deliberative, and concerned with intertemporal or abstract reasoning rely more heavily on higher-level cognition (e.g., attention, working memory and executive function) (Ash & Wiley, 2006; Evans & Stanovich, 2013). This type of cognition is both more effortful, but also necessary for the coordination of goal-directed behavior that is not habituated (Kahneman, 2011; Koechlin & Hyafil, 2007; Engle & Kane, 2004; McCabe, Roediger, McDaniel, Balota, & Hambrick, 2010). In addition to being more laborious, this type of cognition is also influenced by a wide-range of endogenous and exogenous factors that can contribute to decision-making error. These two cognitive systems are believed to work in concert, but the latter system is crucial for deliberation and for inhibition.

Since decision-making relies on a person's cognitive capacities (e.g., cognitive flexibility, inhibitory control, prospection), their cognitive repertoire, and the factors with the potential to influence it during decision-making, are of interest (Stanovich & West, 2000). As will be discussed in subsequent chapters, many traits and states can bias people toward greater impulsiveness or poorer self-regulation, making an already difficult job of weighing benefit/risk during a decision even more difficult (Baumeister, 2014; Frederick, 2005; Vohs & Baumeister, 2016). For instance, people with fewer resources who live amidst or routinely experience highly stressful circumstances may be ill equipped to engage in attentional control, impulse inhibition, and deliberative decision-making, and may be more likely to prefer immediately rewarding choices, rather than choices with delayed reward (Mani, Mullainathan, Shafir, & Zhao, 2013; Shah, Mullainathan, & Shafir, 2012; Shah, Shafir, & Mullainathan, 2015; Spears, 2011).

Ultimately, some people may have or experience more factors that bias them toward a decision to use drugs than others. Yet, even considering only populations that may be statistically more likely to touch a hot stove in the first place, and to repeat touching it despite adverse consequences, there remains the question of what factors influence people within this group to use opioids or stimulants specifically. After all, highly rewarding effects can be produced from other drugs. It may be that there are important endogenous and exogenous factors that are implicated as influences on decisions to use opioids or stimulants, compared decisions to use other drugs or to not use drugs at all.

The Road to Hell is Paved with Good Intentions

Monterosso & Lou (2010) and others (Rachlin, 1995) articulate that, “goal-directed behavior can be conceived on a continuum from the molecular (e.g., trying to hit a nail with a hammer) to the molar (e.g., trying to build a house)”. For instance, a person may want and plan to inject heroin at a particular moment (molecular) but prefers and plans not to become addicted to heroin and not to incur costs associated with heroin addiction (molar).

Ultimately, a person’s drug use involves choices and behaviors with the potential to reach across a lifetime. A person may have an immediate goal (to use heroin), that conflicts with other long-term goals (to stay out of prison indefinitely). Melrose et al., (2015) suggest that high-risk drug use and addiction is “a function of the individual’s overall set of motivations”, meaning that a person has multiple motivations for behavior and that these motivations can be at odds in one moment (ambivalence), or between selves over time. For instance, a person in the present may be conflicted about using or not using (this is called a “synchronic model of conflict”), or a person may value smoking crack cocaine more in the present, even if their future self would value it less, and instead value health and family more (this is called a “diachronic model of conflict”) (Melrose et al., 2015). In other words, for people who use high-risk drugs, there can be inconsistencies between what a person values or conceives of as being in their best interest (at least some of the time) and their decisions and behaviors, which are discordant with such valuation and conception.

The melioration, or “primrose path”, behavioral economic model of drug use (Herrnstein & Prelec, 1992) is in keeping with this understanding of inconsistent or conflicting preferences, and helps explain how a person who is motivated to avoid drug-related problems, or gain benefits that develop from not using, can still act in a manner (i.e., using high-risk drugs) so as to increase the likelihood that such

problems will materialize. In this model, people choose the option with the highest local reinforcement; that is, the highest local or immediate utility. Here, the choice selected among available options is the one perceived as the most immediately desirable or satisfying. Particularly for people who are drug dependent, drugs often have the highest local reinforcement value compared to other choices.

As is often the case with decisions, people make them repeatedly. On a daily basis, people decide what to eat for dinner, how to use their leisure time, what route to take to work, etc. Decisions such as these can be repeated for many years. In the case of choosing to use a high-risk drug or choosing not to, and to instead pursue some non-drug alternative (e.g., jogging, work, watch TV, spend time with friends), if using the drug has the highest perceived local utility, then that is what will be chosen--again and again. Over some finite time (a month, a year, a lifetime), the overall or average utility associated with the choice to use a drug inevitably decreases, due to the nearly unavoidable negative long-term consequences of drug use and/or due to physiological changes that render the drug less rewarding (e.g., tolerance) or even punishing (e.g., hyperalgesia) (Li, Depoortere, & Emmett-Oglesby, White, 2004). It is important to note three points. First, the *local* utility of a drug will always be higher than other choices, so long as the drug is most preferred in the immediate (which is often the case for regular drug users). Second, the *overall* utility of using the drug decreases with repeated decisions over time. Third, in the case of addictive drugs, preference and enjoyment can become decoupled, meaning that a person can come to prefer what they no longer enjoy (Robinson & Berridge, 1993). Along this “primrose path”, a person is always one who is myopic or “meliorating”, always choosing the option with the highest local utility (immediate reward), even though repeatedly making this choice decreases the overall utility as a result. In order to maximize overall utility, a person would need to repeatedly, over time, choose the option with the lower local utility (doing something other than use, that isn’t worse than using). This model illustrates that immediate and long-term motivators may conflict and may require people to choose an option with less local utility in order to maximize overall utility. As Heyman (2003) notes:

Because one cigarette does not cause cancer and one shot of heroin does not condemn a user to a ‘junkie life style’, a person can quite correctly reason that since it’s ‘just for one last time,’ the drug is the best choice. However, a series of ‘one-last times’ turns into a relapse (p. 99).

It is easy to see, then, how people who use drugs may end up experiencing severe, even ruinous consequences from use even as they did not truly intend to achieve such ends. On this path, some people may be better able to reverse their course once the overall utility of using a particular drug has decreased. A person would then need to repeatedly choose a non-drug option, even if it had a lower local utility relative to the drug. In order to do this, a person would need to, among other things reduce present-bias and increase inhibition. Though all people may have time-inconsistent preferences, people with greater present bias may demonstrate greater inconsistency, wherein the value of the immediate reward is weighted more heavily than a future reward (O'Donoghue & Rabin, 1999; Takeuchi, 2011). In order to develop more time-consistent preferences, a person would need to cognitively reframe the relative local utilities. Doing so may promote decisions that maximize overall utility. As will be discussed, many factors can influence a person's cognition, their drug and non-drug choices, and their decision-making. It is not so simple for some people to "reframe" choices. Certain endogenous and exogenous factors can make it far more difficult for a person to become less present-biased and more future-oriented. These factors can also make it more difficult for a person to choose the option with less local, but overall greater, utility.

An example to help illustrate is to consider someone who prefers eating sugary foods over other, non-sugary foods. In this model, the sugary foods would always have the greatest local reinforcement for the person, and therefore the highest local utility. However, over time, the person may grow lethargic, gain weight, develop diabetes, or experience some other decrease in their overall well-being related to the consumption of sugary foods. The person may then come to understand that the overall utility of sugary foods has decreased, even as the local utility of sugary foods remains constant (i.e., no less appealing in the immediate). At whatever point the overall utility of sugary foods clearly decreases, motivation to make different choices can develop and may potentially be nurtured, even if the relative appeal of sugary foods remains unchanged. Yet, motivation to change course after a decrease in overall utility is realized is still bound within the context of the person's history and everyday circumstances. Consider in this example how decision-making might be influenced and constrained by several factors. These factors could include living in a home or community with a high density of sugary foods, or where other potentially rewarding alternatives to sugary foods are lacking. They could also include not having the capacity to adequately plan alternative strategies for acquiring non-sugary foods, due to lack of resources and constraints on cognition

brought about by stress or scarcity. Many additional factors might also be identified that make self-regulation more or less difficult. Several such endogenous and exogenous factors with the potential to influence decision-making are discussed in Chapter 2.

This “primrose path” model is a simplified way to understand several general points, which will be helpful to remember as decisional outcomes involving opioids and stimulants among corrections-involved adults are explored. First, is that the options and outcomes in the immediate are distinct, whereas options and outcomes in the future are indistinct and contingent. For example, the proximate rewarding effects of methamphetamines are almost certain, but all else is speculation that requires cognitive effort to envision and become behaviorally motivated by. Second, the local utility of a drug is only appreciable in the greater context of a person’s life. Decision-making about specific drugs during a particular time period is not dissociable from prior and contemporaneous circumstances, such as other available choices, or from a person’s prospects for or beliefs about the future. Third, not all people are myopic or meliorating, or at least not in respect opioids or stimulants. Some people would never find themselves on such a path. Fourth, there is reason to believe that people who do end up on this path in relation to opioids or stimulants may be less able to reverse their course due to some endogenous and exogenous factors that impair decision-making capacities more generally. Some of these factors may have predated drug use, while other may have developed as a result of use. Finally, this “primrose path” is not one that a person traverses due to immorality, willful defiance, or self-sabotage. Rather, it can be seen as a series of intertemporal decision errors pertaining to drugs that arise, in part, from time-inconsistent preferences (Kim & Lee, 2011). After all, most people do not desire or intend to become addicts. Rachlin (2003) reflects on such conflicting intertemporal preferences and some of the possible unintended consequences thusly:

The alcoholic does not choose to be an alcoholic. He prefers not to be one. His preference ordering is: 1) Not being an alcoholic, 2) Drinking tonight, 3) Not drinking tonight. He just chooses to drink tonight, and tonight, and tonight—and ends up as an alcoholic without ever having chosen to be one (147).

The lifestyle and future fate of an opioid or stimulant user may not be what is preferred and then chosen from a menu of options, but may nevertheless be what is received through solitary decisions over time. There is value in emphasizing the possibility that people who end up with drug-related consequences

did not choose this less rewarding path. Such emphasis has moral implications for how society addresses high-risk drug users, including how policies and interventions are developed and delivered.

Exploratory Study Relevance

Insufficient consideration of the many factors that can influence decision-making may lead to inaccurate conclusions about decision-making agents. Among correction-involved adults with a history of drug use, some will make decisions to use opioids and stimulants. Some will continue to use these drugs, despite the serious risks associated with use and despite experiencing significant consequences. Failing to consider the breadth of conditions with the potential to influence decisions to use high-risk drugs may contribute to the perpetuation of inaccurate attributions of corrections-involved people's overall motives or intentions, whereby they may be viewed as more culpable, blameworthy, and morally responsible for their drug use and drug-related offenses (Corrigan, 2000, 2005; Lacey & Pickard, 2012; Meurk et al., 2014).

Inaccurate intentions or attributions assigned to corrections-involved opioid and stimulant users can result in less pragmatic, humane, and effective interpersonal and systemic responses. For instance, evidence suggests that sanctions, rather than treatment, are more likely to be administered for drug use that is perceived as a willful act of "abuse" (Kelly & Westerhoff, 2010). That drug users and corrections-involved people are often stigmatized and socially devalued means that they are potentially more likely to be blamed for using, while the mitigating endogenous and exogenous factors that influence decisions to use are less likely to be fully considered (Barry, McGinty, Pescosolido, & Goldman, 2014; Crawford, 2012; Earnshaw, 2013; van Boekel, 2015). Such blame and stigmatization can contribute to increased anxiety, shame, social withdrawal, and maladaptive forms of coping--including continued opioid or stimulant use (Ahern, Stuber, & Galea, 2007; Birtel, Wood, & Kempa, 2017; Luoma, O'Hair, Kohlenberg, Hayes, & Fletcher 2010; Ritsher, Otilingam, & Grajales, 2003; Schomerus et al., 2011).

Ultimately, there are many limitations to a coarse-grained exploration of high-risk drug use among corrections-involved people using the methods proposed for this study. These are important and are discussed in Chapter 5. Challenges and limitations notwithstanding, examination of self-report data has the potential to be used as a means for fostering thoughtful discussions about decision-making and for forming critical questions about the appropriateness of attributing blameworthiness to corrections-involved drug users, who are often punished and stigmatized for their use and criminal offending (Maruna & King, 2009;

McCorkle, 1993; Phillips & Shaw, 2013; Pickard, 2011, 2017). Historically, the morality, decency, and worth of people who use drugs, or who become corrections-involved, has been doubted, and their actions treated as willful defiance and public threat; little consideration was given to their welfare (Foucault, 2012). For centuries, the collective instinct when responding to drug use, criminal offending, and other “deviant” behavior has been to punish for its own sake, or to punish in order to absolve or cure (De Tocqueville, 2003; Foucault, 2003; 2012). Given this long-standing collective instinct, it is important to draw attention the fact that there are many factors with the potential to influence and constrain a person such that they would choose to use high-risk drugs and choose to continue to use at nearly all costs. By articulating the potential range and omnipresence of such influence and constraint in this preliminary study, it may be possible in future work to also consider how responsibility and culpability for high-risk drug use, and attendant criminal offending, may be more readily dissociated (Pickard, 2017).

CHAPTER II

SOME INFLUENCES ON DRUG-RELATED DECISION-MAKING AND BEHAVIOR

In the previous chapter, the risks associated with opioids and stimulants were described along with how decisions involving drugs constitute intertemporal choice. Intertemporal choice involving opioids and stimulants inevitably differs across people and time periods, given that the circumstances of people's lives are wide-ranging and dynamic. This variance and potential for change means that, during drug-related decision-making, people will have many drug and non-drug options to evaluate, each choice differing in its probability of risk and reward in the immediate and the long-term. In short, decision-making about high-risk drugs, such as opioids or stimulants, for which the range of outcomes is never completely certain, requires that many cognitive and affective capacities be brought to bear.

Recall that self-reported use of a drug for a given time period indicates that a decision about using this drug was made during this time period. In this chapter some factors with the potential to influence a person's ability to make decisions that involve risk and trade-offs between current and future rewards will be explored, along with how the options and opportunities available to people can constrain the overall set of drug and non-drug choices. In thinking about some of the factors that might be present prior or contemporaneous to high-risk decision-making so as to influence the likelihood that opioids or stimulants would be used, several factors specific to the person, their history, and the greater context within they live might be identified. Several such factors will be explored in this chapter in at least one of two ways. The first way includes identifying factors that might increase the likelihood of risky decision-making generally. These are factors that might diminish cognitive control, limit a person's set of choices, and otherwise influence intertemporal choice such that a person makes decisions that do not maximize well-being over time. Such poorer decision-making could include choosing to use, or to continue to use, high-risk drugs. It

could also include choosing any option with high local but lower overall utility. These are factors that can influence cognitive capacities and decision-making more generally. The second way includes identifying factors that might increase the likelihood that opioids or stimulants specifically might be chosen, as opposed to choosing drugs with less relative risk, or choosing not to use drugs.

Always Today, Never Tomorrow

As noted earlier, because the future is uncertain, and therefore also less salient than the present, people may discount the utility of future rewards, typically referred to as delay or temporal discounting, where the perceived utility of a choice is reduced as time increases (Ainslie, 1992; Bickel et al., 2007; Rachlin, 2006). Temporal discounting can include discounting future rewards and punishments alike. While some economists understand a person's discount rate to be time-consistent and exponential, behavioral economists consider instead that people's discounting, and drug users' discounting in particular, can be hyperbolic (or quasi-hyperbolic) and time-inconsistent (O'Donoghue & Rabin, 1999, 2002; Rachlin, 2006). When discounting is hyperbolic, people weight the "time until reward" as received as cost, and will choose a smaller, immediate reward over a larger delayed reward (e.g., \$20 today versus \$40 in three days) (Ainslie, 1992). As the delay in the second option increases, there is a decrease in preference for this delayed outcome, even as remote outcomes still do retain some small value. A person might also choose an option in the present for which there is larger later cost (e.g., \$20 today that must be repaid two-fold the following week). In other words, people can be inconsistent in their preferences as a function of time. This can be detected, in part, by preference reversal if the choice is between two outcomes in the future; in this case, the person will select the larger amount (e.g., \$20 in one year or \$40 in one year and three days). Typically, though, the future self prefers the larger, later amount, while the present self prefers the smaller, sooner amount (O'Donoghue & Rabin, 1999). This dynamic inconsistency indicates that the value assigned to choices varies in proportion to how far away the person is from receiving the outcome associated with a given choice (Ainslie & Haslam, 1992; Green, Myerson, Lichtman, Rosen, & Fry, 1996; Loewenstein & Elster, 1992). The rewarding effects of drugs, of course, can be swift. Although many costs associated with drug use can be realized immediately (e.g., overdose, adverse side effects), others are realized only in the future (e.g., parole violation, liver failure, divorce), including ones that develop as a result of repeated solitary decisions over time (e.g., dependence, addiction).

The “primrose path” model described in the previous chapter, in which people shift decisions and behaviors to choices with the highest local utility, and without the ability to always adequately assess the utility of their distributed choices, can also be applied to decisions pertaining to other phenomena that are less destructive than addictive drugs. Distributed choice may still be suboptimal for these other decisions; but it may not be life-ruining and lethal. As Herrnstein & Prelec (1991) note, “In its most egregious form, the slippery slope of distributed choice leads to addiction, which is to say, a devastating level of overindulgence in some commodity or activity” (p.149).

People who have steeper discount rates can be considered as more present-biased or “temporally myopic”, and therefore more likely to be meliorating consumers, in which they choose the option with the highest unitary return, thus propelling them further down this unintended trajectory (Bickel & Marsch, 2001). Present-bias and steeper discounting are more common among current and remitted drug users, including opioid and stimulant users (Heil, Johnson, Higgins, & Bickel, 2006; Kirby & Petry, 2004; Kirby, Petry, & Bickel, 1999; Petry, 2001; Petry, Bickel, & Arnett, 1998; Reynolds, 2006). Petry et al. (2002) observed not only poorer decision-making performance among a sample of heroin users, evidenced by higher rates of choosing options with high immediate, but low overall reward, but also found that heroin users were less future oriented, including less capable of predicting events in the distant future and coherently organizing future events. It is important to note that while some people may evidence greater present-bias and steeper delay discounting rates for certain intertemporal decisions, they may not do similarly for others. Relatedly, a person may exercise greater self-regulation in one domain than in another. Thus, although a person may have some global propensity toward present-bias and delay discounting, and less ability to self-regulate or inhibit impulses, there can also be differences that depend on the choices themselves, other cognitive capacities, and the context in which learning and decision-making occurs (Mishel, 1973; Mischel, Ebbesen, & Raskoff-Zeiss, 1972; Mishel et al., 2010).

However, evidence suggests that some people are simply more prone toward impulsivity and present-bias, such that irrespective of the nature of reward, they will more often tend to choose the option with highest immediate or local utility, as future rewards and costs are weighted differently than immediate or near-term outcomes (Madden & Bickel, 2010; Petry, 2001). Increasing evidence suggests not only a strong positive correlation between impulsivity, delay discounting, and drug use (de Wit, 2009; Madden &

Bickel, 2010; Verdejo-García, Lawrence, & Clark, 2008), but also a likely causal relationship (in some cases mediated by poorer executive function, including working memory), evidenced by steep discounting observed prior to drug use initiation (Anokhin, Golosheykin, Grant, & Heath, 2011; Audrain-McGovern et al., 2009; Khurana et al., 2013; MacKillop et al., 2001). Although some groups may be more prone to temporal discounting, certain endogenous and exogenous factors can also contribute to this tendency.

Drug-related Influences on Decision-making

When exploring factors with the potential to influence opioid and stimulant use among a sample of corrections-involved adults with a history of drug use—who by virtue of belonging to this group may already be estimated to have a propensity toward greater present bias and delay discounting-- it is important to consider additional factors that may have been present prior to or contemporaneous with time periods when decisions about opioids and stimulants were made. Prior drug use, including prior use of opioids or stimulants, is one such factor.

Early Drug Use Initiation

Early drug use initiation is defined here as psychoactive drug intoxication at or prior to age 14. Age 14 is consistent in the literature as a critical developmental juncture, in that there is less frontocortical density and less neural integration or “coupling” of brain areas prior and during this time (Gogtay et al., 2004; Shaw et al., 2008). Early drug use initiation has been associated with a greater likelihood of developing drug-related problems and more severe use in later adolescence and adulthood, including dependence, SUD, and IDU (Anthony & Petronis, 1995; Chen et al., 2009; McCabe, West, Morales, Cranford, & Boyd, 2007; Trenz et al., 2012). It is therefore necessary to consider some of the possible implications of early drug use initiation on cognition and drug-related decision-making during adulthood.

Initial drug use can be considered as a form of experimentation and exploration. As such, it signals some proclivity toward curiosity. While curiosity is a universal human characteristic, it is particularly pronounced in youth (Piaget, 2005). Beyond age-typical curiosity, early drug use suggests the presence of pre-morbid traits known to correlate with steeper discounting and risk-taking, such as impulsivity, sensation-seeking, and novelty-seeking (Cloninger, 1987; Cloninger et al., 1988; Ebstein & Belmaker, 2002; Ersche et al., 2010; Lejuez et al., 2010; MacPherson, Magidson, Reynolds, Kahler, & Lejuez, 2010; Wingo et al., 2016). In addition to being associated with early drug use initiation, these

characteristics have been implicated, singularly or in a synergistic manner, in the development and perpetuation of problematic drug use and addiction to a variety of drugs, including opioids and stimulants (Belin, Mar, Dalley, Robbins, & Everitt, 2008; Dawe & Loxton, 2004; MacPherson et al., 2010; Madden et al., 1999; Vuchinich & Simpson, 1998).

Early drug exposure also indicates that neurophysiological and epigenetic changes transpired during critical phases of rapid neurocognitive development (Albertson, Schmidt, Kapatos, & Bannon, 2006; Andersen & Navalta, 2004; Cadet, 2016; de Wit, 2009; Guerri & Pascual, 2010; Stanwood & Levitt, 2004). This is important, in that during adolescence a person's brain evidences greater plasticity and is not yet fully developed, meaning that some neural, genetic, cognitive, and behavioral changes may have enduring impacts on later functioning if not addressed and ameliorated; particularly when other factors (e.g., stress, deviant peer influence, parental SUD) or morbidities are present (Chambers, Taylor, & Potenza, 2003; Champagne, 2010; Fagiolini, Jensen, & Champagne, 2009; Post, 2016; Mistry, Bawor, Desai, Marsh, & Samaan, 2014; Tarter, Kirisci, Habeych, Reynolds, & Vanyukov, 2004; Vaughn, Beaver, DeLisi, Perron, & Schelbe, 2009; Witt, 2010). Incorporated within this latter point is the fact that opioids and stimulants are highly rewarding, meaning that they might lead to extreme "wanting" or craving among those that use them (i.e., sensitization of incentive salience; Robinson & Berridge, 2000), which includes dramatically altering learning and behavior (stimulus-response habituation; Robbins & Everitt, 1999), in either case, biasing a person toward continued use. Consequently, a decision not to use drugs one was previously exposed to becomes more difficult make.

The degree or frequency of drug use subsequent to initiation is important. Consider how a person who uses cocaine once at age 14 may differ from someone who used cocaine intermittently at age 14 and again in young adulthood, and how this person would differ still further from a person who used cocaine at age 14 and regularly throughout adolescence and later adulthood. Moreover, someone who used cocaine prior to age 14 might be expected to experience an overall poorer SUD trajectory in later adolescence and adulthood, in part due to a longer exposure window (Anthony & Petronis, 1995; Grant & Dawson, 1998; Gruber, DiClemente, Anderson, & Lodico, 1996; Tapert & Brown, 1999).

The commonality here is that early age of drug use initiation indicates a greater likelihood of observing other traits associated with increased risk-taking and less adaptive decision-making in adulthood.

Regardless of whether early age of initiation indicates the pre-morbid presence of traits (e.g., cognitive, personality, genetic) associated with poorer executive control, propensity toward use, and greater likelihood for developing SUD, or that early use casually contributes to the development of these things, the implications of early age of initiation (e.g., greater impulsivity, poorer drug-related decision-making in adulthood) are similar. This is particularly true in regard to impulsivity and lack of self-regulatory capacity (King & Chassin, 2007; Tarter et al., 2003), as evidence suggests that impulsivity can be considered marker for SUD development and other addictive behaviors (Petry, 2001; Verdejo-García, Lawrence, & Clark, 2008).

Impulsivity involves several components. These include action with less forethought; immediate gain at risk of larger, future loss; and “disposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of reactions” (Ainslie, 1974; Dickman, 1993; Moeller et al., 2001). DeYoung & Rueter (2016) consolidate the definition into two necessary parts: 1) The impulse, urge, motivation, or desire to act, and 2) A lack of inhibition, restraint, or control of the impulse (e.g., failure of self-regulation). Impulsivity is central to consider when discussing high-risk decision-making, in that people with higher impulsivity/poorer self-regulation are typically more likely to demonstrate other executive dysfunction (e.g., poorer working memory), have steeper discount rates, and exhibit greater risk propensity/neurodisinhibition (Hinson, Jameson, Whitney, 2003; Nichols & Wilson, 2015; Semple, Zians, Grant, & Patterson, 2005; Tarter et al., 2003). These have obvious implications for decision-making and risk-taking in relation to opioids and stimulants. Further, there is support for the idea that people who evidence greater impulsivity may perceive time differently than people with greater capacity for self-regulation/impulse control, wherein the former group *overestimate* the duration of time intervals and commensurately devalue delayed rewards at steeper rates (Berlin & Rolls, 2004; Rubia, Halari, Christakou, & Taylor, 2009; Wittmann & Paulus, 2007, 2009). In other words, for these people, the future may feel like an eternity away and potential future states may resonate less intensely. Impulsivity, which involves premature decision and behavior, thus makes sense as a correlate of delay discounting, particularly in relation to drug use, where potent effects are gained in real-time (Paasche, Weibel, Wittmann, & Lalanne, 2018).

Because early age of drug use initiation often positively correlates with other high-risk behaviors (e.g., smoking, unprotected sex, driving under the influence) and with disorders which positively correlate with SUD and diminished self-regulatory control (e.g., attention deficit hyperactivity disorder [ADHD]), people who began using earlier in life may be considered potentially more impulsive and less capable of self-regulation during decision-making in adulthood than people who began using later in life (Barkley, Edwards, Laneri, Fletcher, & Metevia, 2001; Eslami-Shahrbabaki, Fekrat, & Mazhari, 2015; Stueve & O'donnell, 2005; McGue et al., 2001; Vaughn et al., 2009).

Considering early drug use initiation as a marker or proxy for impulsivity and poorer self-regulation is not without limitations. Wittmann & Paulus (2007) offer a reminder that “impulsivity is determined by a complex set of processes and consists of multiple components,... [but that] nevertheless, impulsivity can be conceptualized as a pattern of behavior for which the potential of negative consequences has limited influence on the planning of actions”. Among a sample of corrections-involved people, early drug use initiation can be considered as one of many indicators of such a behavioral pattern.

Drug Preferences, Drug Use, and Severity of Use

A person's drug preferences, drug-related decisions, and drug behaviors can change over time. For instance, a person might use heroin or cocaine heavily for several years and then later moderate or discontinue use (Lewis, 2015; Robins, Helzer, & Davis, 1975; Waldorf et al., 1992). However, when exploring factors with the potential to influence decision-making about opioids and stimulants during a particular time period, it is important to identify people's prior and contemporaneous use of these drugs, the severity of their use, and their drug preferences.

Reinforcer Pathology and Drug Preference

People who exhibit greater present bias, impulsivity, delay discounting, and poorer self-regulation may be more likely to initiate drug use and persist in use. Despite these tendencies, it is important to consider that consumption of certain commodities may not ever lead to problems. In other words, the utility associated with unitary choices and their distribution (aggregation) may not appreciably differ. It is important to keep in mind that in addition to endogenous and exogenous factors that influence decisions to use opioids and stimulants, the drugs themselves comprise a unique form of consumption. Bickel et al. (2011) describe how the consumption of highly rewarding commodities, such as drugs, can result in

reinforcer pathology, defined as a “1) the persistently high valuation of a reinforcer, broadly defined to include tangible commodities and experiences; and/or 2) the excessive preference for the immediate acquisition or consumption of a commodity despite long-term negative outcomes” (p.407). In simplest terms, a reinforcer can be understood as the presence or absence of a stimulus that results in associative learning, and subsequent increases or decreases in particular behavioral responses (Sutton & Barto, 2018; Thorndike, 1998).

People who misuse drugs, and persist in use despite costs, come to overvalue drugs in the extreme and demonstrate preference for immediate receipt of drugs. Thus, while certain factors, such as impulsivity and poorer executive control, may influence a person’s overall cognitive repertoire and decision-making capacities, the rewarding characteristics of the drugs themselves must be considered in relation to these other factors (Bickel et al., 2007, 2011; Bickel, Mueller, Jarmolowicz, 2011; Jentsch & Taylor, 1999; Monterosso et al., 2007; Stafford, LeSage, & Glowa., 1998; Xu et al., 2009). For some people, opioids and stimulants may produce rewarding effects that are greater relative to other drugs, therefore intensely motivating behavior toward the use of these, but not necessarily all other drugs with abuse liability (Bickel, Marsch, & Carroll, 2000; Kreek, Bart, Lilly, Laforge, & Nielsen, 2005; Kreek et al., 2012).

As highlighted in Chapter 1, many drug users can best be considered as polydrug users. For instance, someone who used prescription opioids frequently during the past-year may have also used heroin during the same period with even greater frequency, but may have used buprenorphine with less frequency. They may also have used MDMA, inhalants, alcohol, and a variety of other drugs (Daniulaityte, Falck, Wang, & Carlson, 2009; Leri et al., 2003). Despite this polydrug use, it is likely that this person has a preferred drug of choice (O’Connor & Berry, 1990). As will be discussed, exposure to or accessibility of a particular drug, while important, is not the only potential influence on drug-related decision-making. Preference is also important to consider, as drug choices stand in relation to one another and vary in their utility and reinforcing effects.

Although it might be measured in many ways, drug preference can be understood as the drug associated with the greatest behavioral response, which, for people, might be characterized as the drug used with greatest frequency or the drug that people spend more resources to acquire when other drug choices are also available (Katz, 1990). However, because many factors can constrain people’s choices during a

given time period, and therefore decrease use (e.g., not due to lack of preference but to decreased supply), it is also important to determine what drug a person would rate as their preferred drug of choice. Although stated preferences can diverge from choice and behavior, there is often strong correlation (Smith & Staton, 2018). Consider how a person who prefers chocolate ice cream might always choose chocolate ice cream when it is available, but might eat vanilla or strawberry ice cream if chocolate is unavailable. This same person, however, would not eat pistachio ice cream, even if it was the only flavor of ice cream available. Indeed, because preference is in many ways conceptually similar, if not interchangeable, with utility (Bentham, 1996), a person's preferred drug necessarily implies that it has a higher local utility compared to other drugs. Although such a preference doesn't suggest that this drug is preferred to *non*-drug choices, it does suggest that this preference will influence drug-related decision-making. If a person prefers heroin, then this preference influences their decision to use heroin. For instance, it would be less likely that, given a choice between heroin and a substitute for heroin, which could include a drug with similar pharmacology (e.g., prescription opioids, buprenorphine) or a drug with dissimilar pharmacology that still produced rewarding effects, a person would *not* choose heroin.

Prior Drug Use and Frequency of Use

When exploring factors with the potential to influence decision-making about opioids and stimulants for a particular time period, prior and contemporaneous use of opioids and stimulants may serve as possible influences. For example, a person may have used prescription opioids every month for the past-year or every day for the past month. Or, they could have used them seldomly, perhaps one month out of the past year and three days out of the past month. Clearly, there are differences between the two. Prior or contemporaneous use of prescription opioids influences current and future decisions about prescription opioids. At a minimum, any use of this drug indicates a willingness to use prescription opioids.

Frequent and regular use indicates the possibility that prescription opioid use may have, to some degree, become habituated over time (Nelson & Killcross, 2006; Robbins & Everitt, 1999). By habituation, it is meant that certain behaviors, in this case the acquisition and use of prescription opioids, have been established as a result of stimulus-response learning, thus making future similar behaviors easier to perform and dissimilar future behaviors (in relation to prescription opioids) more difficult to preform (Gardner, 2015). To help illustrate, consider how many common behaviors become habituated: Eating the same meal

for breakfast; putting contact lenses in after brushing teeth, beginning with the right eye; watching Netflix, eating chocolate, and drinking pinot noir every night after putting the children to bed; taking the same route home from work; using Apple operating software instead of Microsoft; ordering pizza every Friday night from the same restaurant (Aarts, Verplanken, & Van Knippenberg, 1998; Graybiel, 2008; Ouellette & Wood, 1998; Polites & Karahanna, 2012). Habits are efficient and certainly not always pathological (Desrochers, Jin, Goodman, & Graybiel, 2010). In the absence of habits, significant cognitive energy would be wasted processing previously encountered information, deliberating, forming goals, making decisions, and re-learning behaviors; indeed, maintaining habits requires less cognitive effort than inhibiting or “overriding” them, with habits strengthening over time (Gardner, 2015; Graybiel, 2008; Wood & R nger, 2016). When prescription opioid use becomes habituated, however, decision-making about this drug can be considered as significantly biased toward continued use and no longer necessarily associated with goal-directed behavior; it may even be considered compulsive (de Wit, 2018). In relation to prescription opioids, cognition and behavior would be more implicit, automated, and reflexive, and less explicit and deliberative (Bechara, Noel, & Crone, 2006). Habits may still be consonant with goals or intentions, but they may also interfere with goal-directed behavior (Wood & Neal, 2007; see also Chapter 5 for further discussion).

Additionally, more frequent and regular use of a drug (i.e., greater exposure) is associated with decreased capacity to regulate attention, affect, and make deliberative decisions about that drug (Bechara, 2005; Naqvi & Bechara, 2010). This does not suggest that habituated behaviors, including drug taking, occur involuntarily or without an agent (e.g., a person with capacity to act), or without agency, defined as the exercise or manifestation of the capacity to act (Bandura 2006; Stanford Encyclopedia of Philosophy, 2015; Wood & R nger, 2016). Rather, it implies that the cognitive effort or self-regulation needed to “do otherwise” is much greater, and much more difficult to come by, given that habituation is shaped and constrained from inputs at multiple levels (Zimmerman, 2013).

Thus, someone who has used prescription opioids frequently over the past-year or month, and who currently prefers prescription opioids to other choices, would require more cognitive energy and time when making a decision to *not* use prescription opioids following this time period; particularly if the general circumstances or context of their past use had not also changed (Lally, Van Jaarsveld, Potts, & Wardle, 2010; Wood & Neal, 2007). Ultimately, this recent prior exposure to prescription opioids would serve as an

influence on decision-making, such that the person would be more likely to choose to use prescription opioids rather than a novel or infrequently used drug. This doesn't mean that the person would *always* choose the same drug or self-administer drugs in the same manner, as habits and patterns of use can change and reform over a person's life (Des Jarlais et al., 2007; Neaigus et al., 2001). Certainly, though, the presence of other factors will enable or frustrate both goal-directed and habituated behavior. For instance, in order for a person to make other decisions and act on them, there would have to be alternative choices to opioids with presumably greater perceived local utility (e.g., other drugs, other activities), or the overall utility of prescription opioids would have to be recognized by the person as lowered as a result of continued use (e.g., tolerance). In order to discern, reflect, and act upon this information, however, the person would need higher-level cognitive capacities (e.g., attentional control, prospection, counterfactual and abstract reasoning, self-regulation, etc.), both to identify the discrepancy between the local and overall utility of prescription opioids, but also to help enable decisions and enact behaviors discordant with habituated action. In other words, greater capacity to inhibit or "override" the habituated behavior and choose the option with greater overall utility.

Severity of Drug Use

Drug exposure, or frequency of use, is not synonymous with drug use severity. Indeed, some people may use drugs frequently or with regularity over days, months, or years, but in a moderated or otherwise controlled manner (Parker, Williams, & Aldridge, 2002; Waldorf et al., 1992; Zinberg, Jacobson, & Harding, 1975; Zinberg, 1984). Severity of use can be defined in several ways. DSM-V diagnostic criteria for SUD, indicators such as craving, persistence in use despite a desire or attempts to quit, and withdrawal are used to help diagnose both the presence and severity of the disorder (APA, 2013). The severity of a person's drug use is relevant in that greater severity may indicate transition from goal-directed to habituated behavior in relation to drugs, as described above (Nelson & Killcross, 2006; Zapata, Minney, & Shippenberg, 2010). More frequent use and greater severity of use correlate with considerable neurobiological changes known to impair areas of the brain associated with capacities crucial for decision-making (e.g., risk assessment, valuation, emotional regulation, self-regulation, attention, memory information-gathering) (Blanchard, Hayden, & Bromberg-Martin, 2015; Koob & Volkow, 2010; Strait, Sleezer, & Hayden, 2015). Therefore, the qualities of drug use severity (e.g., craving, unsuccessful attempts

to quit) occurring prior to or contemporaneous with drug-related decisions indicates the presence of significant influences on decision-making capacity, whereby a person becomes more biased toward use even if a multitude of other possible choices are available and even if the subjective feeling of choice or phenomenological sense of ability to choose freely is present (Lau, Hiemisch, & Baumeister, 2015). Here, a person with greater using severity might be considered to have fewer degrees of freedom for volitional action compared to a person with less severity (Dennett, 2015; O'Connor, 2009).

Ultimately, greater drug use severity would likely influence a person to continue to make unitary (local) decisions over global ones that, in the aggregate, decrease overall utility, whereas someone with less severity might have greater purchase on the cognitive capacities needed to reframe choices, inhibit habituated behaviors, and choose another option with less local, but greater overall, utility (Heyman & Dunn, 2002).

Craving and Utility

One specific quality of drug use severity worth highlighting is craving (i.e., drug wanting), in part because it often correlates with use (Robinson & Berridge, 1993; Tsui, Anderson, Strong, & Stein, Sayette, 2016). Throughout this discussion, utility has been used primarily to mean “decision utility”, the choice with the highest preference assigned to it; however, “experienced utility” (which is closely related to decision utility, but less frequently considered; see Kahneman, Wakker, & Sarin, 1997), may also be relevant, in that it reflects the choice that brings about the greatest satisfaction experientially. In other words, the utility for a decision based on one’s preference is separable from one’s actual experience of that choice. What is preferred or desired is not always synonymous with what is enjoyable or satisfying. These differences in utility are consonant with the well-known idea that “wanting” and “liking” can become cognitively decoupled among drug users (Berridge, Robinson, & Aldridge, 2009). “Remembered utility” refers to the satisfaction one gets after having made a choice and experienced it (Kahneman et al., 1997). Generally, after having made choices and experienced their outcomes, a person forms memories that enable them to make predictions about similar choices when making decisions in the future.

Berridge & O’Doherty (2014) consider that, typically, “wanting” or “desire” would be informed by memories, would coherently map on to experiences, and that, “for such cognitive desires, decision utility=predicted utility, and predicted utility=remembered utility” (p.342) . However, incentive salience,

which is a cognitive process of wanting or craving that develops with repeated drug use (informed by both current physiology/neurobiological states and learned cue-induced stimulus response), is a reliable and potent behavioral motivator (Robinson & Berridge, 1993). For drug users, “situations exist where cue-triggered decision utility > remembered utility from the past, and similarly decision utility > predicted utility for future reward value (Berridge & Aldridge, 2008). In other words, it is possible to ‘want’ (and choose) what is not expected to be liked, nor remembered to be liked, as well as what is not actually liked when obtained” (Berridge & O’Doherty, 2014, p. 324).

Again, craving is understood as a state of incentive salience. It is cognitive and visceral, it influences the perception of time, the relative value assigned to a drug, and potentiates behavioral responses (Bechara, Dolan, & Hinds, 2002; Grant et al., 2000; Loewenstein, 2000; Sayette, 2005; Volkow et al., 1991; Wang et al., 2012). It has been proposed by Redish et al., (2015) as reflecting a possible interaction between systems of valuation characteristic of deliberation and Pavlovian conditioning. For people with extensive or pathological drug use, craving is one state that can influence decision-making by essentially cognitively decoupling a unitary choice from both past and future (e.g., cue-triggered decision utility > remembered utility from the past; decision utility > predicted utility for future reward value). Of course, for some, there may still be a desire for drugs in which incentive salience is not a component (e.g., decision utility = predicted utility, and predicted utility = remembered utility).

For polydrug users, the person’s preferred drug and drugs most frequently used in the past would serve, along with severity of use (e.g., craving, attempts to quit), as influences on decisions about drugs. Again, preference may become separable from experience, but greater prior use of a drug and craving for that drug are likely to be associated. For example, incentive salience for a person who used alcohol every day, but used cocaine only every five months, would likely correspond to different alcohol versus cocaine wanting, assuming no prior cocaine dependence at an earlier time. In this way, a person would have greater or fewer degrees of freedom when making a decision about particular drugs based, in part, on their prior exposure to these drugs. A person who exhibited this same alcohol and cocaine use behavior over a year would more likely come to “want” cocaine in the traditional sense, but “want” alcohol in the pathological, behavior-inducing sense.

Taken together, it is reasonable to believe that drug-related decision-making is likely influenced by incentive salience and other drug-related factors described above if, during a given time period, a person reports experiencing greater severity of use (e.g., craving, failed attempts to quit using following a period of regular drug use, withdrawal, etc.) and also reports ongoing drug use during this period.

Sorites Paradox

Recall that on the “primrose path”, where decisions can be considered both unitarily as well as in the aggregate (i.e., many choices distributed over a time period), it is possible for a person to reverse course by choosing options with lower local, but higher overall utility through cognitive reframing and other efforts (e.g., seeking treatment, forming new non-drug habits, etc.) after the costs associated with continued use become apparent (Herrnstein & Prelec, 1992; Heyman, 2003, 2013). However, such cognitive reframing and behavioral change might be more or less difficult depending on how many unitary choices have been made to use thus far. As Heyman (2003) articulates:

[A]lcoholism and abstinence (or controlled drinking) are states that reflect the cumulative effects of many smaller decisions ...[where] no one decision is decisive. This could be considered, among other ways, in terms of severity of use and exposure (Heyman & Dunn, 2002) (p. 103).

In other words, greater drug exposure and severity of use *develop*. “Frequent” use doesn’t begin as “frequent” and “severe” doesn’t begin as “severe”. These states or properties are acquired and therefore have the capacity to intensify or dissolve. Although earlier discussion considered how these states can influence decision-making, it failed to reconcile when these states change into something else. Similar irreconcilability exists for the idea of solitary versus aggregated decisions and local versus overall utility: There is the injection of heroin, and then there is the heroin addiction. It is therefore important to note that when exploring factors with the potential to influence opioid and stimulant use in real-world conditions, it is not possible to know the juncture at which a person--as necessarily both a *state* and a *verb*, as both the *decision-maker* and the *embodied aggregate of his decisions*--becomes precisely defined and influenced by prior drug use or using severity, or where the person is relative to past and future decisions. Instead, the parameters can only be drawn so as to define the field, or time period, of interest (which can still be arbitrary) during which solitary decisions are being made and in which their distributed effects are bounded (e.g., a day, a year, etc.), and to then identify what else stands in relation to those decisions. This doesn’t

suggest that with access to perfect information, or the acquisition of enough data points over time, decisions could not be plotted. In theory, they could. In practice, they seldom are outside of experimental conditions (and even within) due to obvious data collection limitations. Even here, choice is constrained to levels that are inconsistent with choice in the real-world.

Therefore, important conceptual and measurement limitations remain, in that any cut-off point between “many unitary decisions to use heroin” and their distributed effect of “becoming a heroin addict” is still only ever obliquely, and rather inadequately, discernable. This is due, in part, to insufficient information, diagnostic and measurement limitations, lingering disagreement about what addiction is best defined as, and the fact that observable symptoms or indicators of pathologies such as “heroin addiction” may also be attributable to other pathologies. Some “heroin addiction” indicators may be attributable to other sources, including to unitary decisions having nothing to do with heroin. Put differently, the observed effects of distributed choice to use heroin (i.e., heroin addiction or OUD) present with features that are similar to other pathologies with distinct etiologies and neural correlates (Brooks, Lochner, Shoptaw, & Stein, 2017; Cuthbert, 2015; Kwako, Momenan, Litten, Koob, & Goldman). This is noted not to disparage any particular diagnostic method or detract from behavioral economic accounts of drug use and addiction, which have tremendous parsimony and empirical support, but rather to note, as others have, some of the unavoidable tension between theory and data (Bickel, Jarmolowicz, Mueller, & Gatchalian, 2011). Because this study is exploratory, it is important to emphasize the fact that much of what is worth discussing about the social problem of high-risk drug use approach cannot yet be sufficiently modeled or explicated in terms of real-world conditions. Limitations will be considered further in Chapter 5.

Possible Constraints on Decision-making Capacity Among Opioid and Stimulant Users: *Do the Differences Matter?*

Prior drug exposure, drug use severity, and preference may also be influential in ways that vary according to drug type. Unsurprisingly, pharmacological differences between drugs have the potential to influence a drug user’s neurocognitive capacities differentially. As decisions and behaviors only occur as a result of brains, the underlying neurobiology of drug use is recognized as relevant among researchers studying choice and behavior (Bickel et al., 2007). A person who frequently uses and prefers alcohol will experience different neurobiological changes than a person who frequently uses and prefers opioids or

stimulants. For instance, a person who frequently uses opioids or stimulants, but infrequently uses alcohol, would not develop Wernicke-Korsakoff syndrome (Dodge, Jacobson, & Jacobson, 2016).

Even within opioid and stimulant drug classes, between-drug differences might be observed. For example, methamphetamine-dependent people have been found to have impaired risk-related processing due to alterations in brain areas necessary for higher-level cognitive functioning (e.g., working memory, self-regulation, attention, planning), interoception, and time perception compared to non-users and other drug users (including opioid users), and to evidence greater impulsivity and uncertainty salience (Ersch et al., 2005; Gonzalez, Bechara, & Martin, 2007; Gowin et al., 2013; Leland, Arce, Feinstein, & Paulus, 2006; Leland & Paulus, 2005; Pollatos, Laubroc, & Wittmann, 2014; Semple et al., 2005). One meta-analysis found that people with active and remitted methamphetamine use disorder exhibited moderate cognitive impairment across multiple domains, with the largest deficits observed for impulsivity/reward processing and social cognition (Potvin et al., 2018). Further, some evidence indicates that people with greater impulsivity and sensation-seeking report stronger rewarding effects from amphetamines (e.g., greater liking, wanting, and euphoria) (Kelly et al., 2006). Among MDMA users, attentional control, long-term memory, and sensory gating (i.e., ability to filter out non-relevant distractions and sensory information) were also found to be impaired, with deficits persisting over time (Lundqvist, 2005).

Compared to healthy controls and other drug users (e.g. cannabis, opioids), cocaine dependent people have performed worse on decision-tasks (e.g., making less advantageous choices, commission errors) that require information acquisition, working memory, prediction, and attention (Cunha, Bechara, de Andrade, & Nicastrri, 2011; Kjome et al., 2010; Mejía-Cruz, Green, Myerson, Morales-Chainé, & Nieto, 2016). When compared to non-users and cannabis users, cocaine users performed worse on decision tasks, even after a short period of abstinence (Verdejo-Garcia et al., 2007). Among a clinical sample, crack cocaine users scored higher on measures of impulsivity and risk-taking compared to heroin users (Bornovalova, et al., 2005). However, some evidence also suggests that cocaine users' performance can improve over time when valued contingencies (e.g., money) are introduced (Vadhan, Hart, Haney, van Gorp, & Foltin, 2009).

More generally, stimulant users (cocaine, amphetamines) have demonstrated less adaptive and dynamic cognitive functioning (i.e., no increased shift toward frontocortical processing), and poorer

decision-making and behavioral performance during tasks that require learning, prediction, and cognitive flexibility, resulting in less adaptive error responding (Paulus, 2002; Paulus, Lovero, Wittman, & Leland, 2008; Simon et al., 2001). Evidence remains mixed, though, for the degree to which cognitive functioning, impulsivity, working memory, and decision-making remains impaired or improves over time after stimulant use is reduced or discontinued, and whether cognitive, self-regulatory, and decision-making deficits are a contributor to or consequence of stimulant use (Frazer, Richards, & Keith, 2018; Hulka et al., 2015; Kalechstein, Newton, & Green, 2003; McCann et al., 2008; Potvin, Stavro, Rizkallah, & Pelletier, 2014; Potvin et al., 2018; Salo et al., 2009; Stewart et al., 2013; Wang et al., 2013).

Chronic opioid use can alter and impair neurophysiology and neuroanatomy in areas associated with emotion, self-regulation, risk-taking, and goal-directed behavior (Baldacchino, Balfour, Passetti, Humphris, & Matthews, 2012; Pandria, Kovatsi, Vivas, & Bamidis, 2018). Among a sample of opioid users, poor performance on decision tasks measured at treatment admission predicted post-treatment relapse (Passetti, Clark, Mehta, Joyce, & King, 2008). In another study, patients receiving treatment for OUD made riskier decisions compared to controls and exhibited decisional deficits associated with impaired executive function (Brand, Roth-Bauer, Driessen, & Markowitsch, 2008). Additionally, current and former opioid users, including people maintained on agonist therapies, have evidenced steeper discount rates and less adaptive decision-making (Biernacki et al., 2018; Wollman et al., 2017), including discounting delayed heroin at higher rates than money (Madden, Petry, Badger, & Bickel, 1997). Heroin users have also shown to persist in poorer strategic task performance where learning and error correction would be expected (Ornstein et al. 2000). One study examining impulsivity and strategic decision-making, found that active heroin users performed worse compared to healthy controls, people who take prescription opioids licitly (and do not have OUD), and abstinent heroin users receiving MMT (Baldacchino, Balfour, & Matthews, 2015). In another study, current and abstinent (1 year) opioid users and stimulant users performed worse than controls in terms of risk on decision tasks, but did not significantly differ by drug-use group, meaning that both groups may be considered to have increased likelihood for some cognitive impairment, even after use is discontinued (Ersche et al., 2005).

Taken collectively, though, findings provide support for the idea that both former and current opioid users have impairments in decision-making, working memory, attention, and inhibition/self-

regulation, but with arguably greater variance across samples than across samples of stimulant users (Li et al., 2013; Yan, et al., 2014; Zheng et al., 2013). Specifically, evidence points to potentially worse cognitive effects for amphetamine (including “street meth”) users, compared to cocaine and opioid users, which may be partially attributable to greater exposure to synthetic compounds that produce greater neurotoxic effects (McConnell et al., 2015; Nordahl, Salo, & Leamon, 2003; Potvin et al., 2018). Badiani et al. (2011) considered the possibility that despite the fact that cognitive impairments (e.g., memory, cognitive flexibility, decision-making) are observed in both opioid and stimulant users, and share common neurobiological substrates (Bechara, 2005; Fernandez-Serrano, Pérez-García, M., Schmidt Río-Valle, & Verdejo-Garcia, 2010; Fu et al., 2008; McNamara, Dalley, Robbins, Everitt, & Belin, 2010; Muriach et al., 2010; Orrstein et al. 2000; Tramullas, Martínez-Cué, & Hurlé, 2008), there are nevertheless noteworthy differences in the degree of neuroanatomical difference and neurocognitive impairment between opioid and stimulant users, particularly for impulsivity and cognitive flexibility. The authors note that the preponderance of (albeit limited) evidence suggests that the latter group may exhibit significant and potentially longer-lasting deficits (Ersche et al., 2005; Ersche, Clark, London et al., 2005; London, Robbins, & Sahakian, 2006; Ersche, Roiser, Robbins, & Sahakian, 2008). Further, discontinuation of stimulants is associated with increased deficits in inhibition, whereas impulsivity did not increase with opioid discontinuation (Liu, Heitz, & Bradberry, 2009; Liu et al., 2011; McNamara et al., 2010). It may therefore be reasonable to believe that frequent stimulant use, more so than frequent opioid use, would adversely influence a person’s decision making and ability to self-regulate, even after periods of abstinence.

When examining opioid and stimulant use during particular time periods, prior and contemporaneous exposure to these drugs might be considered then, not only in terms of potential influences described in previous sections (e.g., preference, habituation, craving), but also in terms of how use of these high-risk drugs may beget further high-risk decision-making in general.

A limitation to some of the research described above is that opioid and stimulant users may also co-use other drugs. However, when concomitant use of opioids and/or stimulants was examined, people using opioids and/or stimulants still performed worse than alcohol and other drug users, including other polydrug users who did not use opioids or stimulants (Nixon, Paul, & Phillips, 1998). Additionally, some

findings indicate that dependence on multiple drugs is not associated with increased delay discounting (Businelle, McVay, Kendzor, & Copeland, 2010) and that cognitive effects from other drugs may not necessarily be additive to opioids or stimulants. For instance, one study examining cognitive abilities found alcohol users performed better than stimulant-only users and alcohol/stimulant co-users, but that stimulant-only users performed worse than both the alcohol-only group and the alcohol/stimulant co-use group (Lawton-Craddock, Nixon, & Tivis, 2003). However, as findings cannot definitively clarify if cognitive deficits associated with opioid and stimulant use pre-dated drug use initiation, resulted from, or were exacerbated by prolonged exposure to these drugs, opioid and stimulant use may be considered as a generic and approximated potential indicator of cognitive deficits. Irrespective of whether these deficits pre-dated or developed from use, evidence suggests a strong association between opioid and stimulant use and executive dysfunction, such that prior exposure to these drugs indicates that important decision-making deficits may be present.

Demographic Characteristics with Potential to Influence Decision-making

Age and Sex

There are two demographic characteristics, younger age and male sex, that are commonly associated with risk-taking behavior generally and greater likelihood to use illicit drugs specifically (APA, 2013; Blazer & Wu, 2009; Gullone, Moore, Moss, & Boyd, 2000; Miller, Naimi, Brewer, & Jones, 2007).

Younger age is positively correlated with greater impulsivity, sensation-seeking, novelty-seeking, and risk-taking (Reimers, Maylor, Stewart, & Chater, 2009; Spear, 2000; Steinberg et al., 2004, 2008). Evidence suggests that while some younger people may underestimate risk, others may perceive it and their own vulnerability to unfavorable outcomes, yet, may still often pursue risky action (Bentlin, Slovic, & Severson, 1993; Cohn, Macfarlane, Yanez, & Imai, 1995; Gardner & Steinberg, 2005). Evidence also suggests that reward salience is greater in youth, and that younger people may be more reward-sensitive and punishment-insensitive compared to older adults (Doremus-Fitzwater, Varlinskaya, & Spear, 2010; Spear, 2000). Further, younger people have less crystallized intelligence that is needed, along with fluid intelligence, to assess risk and make decisions (Li, Baldassi, Johnson, & Weber, 2013). Younger people have also simply made fewer decisions, including decisions involving uncertainty and risk, than older adults, indicating a general inexperience. Additionally, younger people also tend to be more present-biased

and to have steeper delay discounting rates on the same task compared to older individuals (Green, Myerson, & O’Staszewski, 1999; Meier & Sprenger, 2010; Steinberg et al., 2009). This means that younger age may be an indicator of poorer decision-making capacity, greater risk-taking, and present-bias.

Many of these age-related differences are partially attributable to the related fact that, unlike adults over the age of 26, people in the first two and a half decades of their life do not yet have a fully matured prefrontal cortex, the region of the brain instrumental in higher-level cognition (Gogtay et al., 2004; Spear, 2007). Younger people are generally more likely to experiment with drugs, including opioids and stimulants, and to persist in use despite adverse effects (Gfroerer & Brodsky, 1992). This is one reason why rates of dependence are far lower among people aged 50 and older in the US (Blazer & Wu, 2009). However, as “baby boomer” cohorts age, rates of SUD among older persons is expected to increase due to the larger number of young people who initiated use in the 1960s (Han, Gfroerer, Coliver, & Penne, 2009; Wu & Blazer, 2011). There remains, too, the phenomenon of late-adopters to illicit drug use and the development of opioid and stimulant use disorders later in life (Arndt, Clayton, & Schultz, 2011; Lofwall, Schuster, & Strain, 2008). Meaning that there are exceptions to general trends.

Male sex, both before and after puberty, is frequently and strongly correlated with greater impulsivity/self-regulatory failure, steeper discount rates, and risk-taking behavior, including drug use (Byrnes, Miller, & Schafer, 1999; Cottle, Lee, & Heilburn, 2001; Hosseini-Kamkar & Morton, 2014; Myerson, Green, van den Berk-Clark, & Grucza, 2015; Gershon & Gershon, 2002). Taken together, evidence suggests that younger age and male sex may be factors with the potential to influence decision-making about high-risk drugs like opioids and stimulants.

Some Additional Indirect Indicators of Cognitive Functioning

As noted above, how a person makes intertemporal decisions depends in part on a person’s ability to engage deliberative and higher-level cognition. In addition to age- and sex-related influences on decision-making capacities and neurocognitive deficits that developed subsequent to drug exposure, a person may have additional attributes that influence cognition, risk-taking, self-control, and decision-making (Verdejo-García et al., 2008).

Deficits in neurocognitive functioning and executive control could have developed as a result of a number of factors (e.g., early childhood exposure to pre- or perinatal environmental neurotoxins, trauma,

injury, abuse etc.) (Coles et al., 1997; Kim et al., 2013; Meehan & Mannix, 2010; Perry, Pollard, Blakley, Baker, & Vigilante, 1995). For instance, lead and other neurotoxin exposure is a large but overlooked problem in the US, despite the fact that lead exposure is associated with a cascade of neurocognitive and affective problems that include disinhibition, intellectual disabilities, behavioral problems, attentional deficits, and poor self-regulation (Cecil et al., 2008; Goodlad, Marcus, & Fulton, 2013). Such exposure is believed to have a causal contribution to conduct disorders, drug use, and to violent and non-violent crime (Boutwell et al. 2016; Farrington, 2018). This example highlights a few possibilities. First, there can be a wide-range of cognitive function and dysfunction among people generally and among corrections-involved drug users in particular. Second, not all cognitive dysfunction is necessarily attributable to drug use. Third, such dysfunction is still nevertheless relevant to consider as a potential influence on risk-taking and decision-making using available indicators. Oftentimes, the causal contributors to neurological deficits remain unknown and only indirect indicators of impairment are observed and assessed.

Learning Disability and Poor Educational Performance

Irrespective of what ultimately contributed to the development of cognitive deficits, many young people who experience deficits in cognition, impulse control, attention, and memory experience greater challenges in school, including conduct problems, poor performance on standardized tests, and unfavorable teacher evaluations (Mattison, Hooper, & Carlson, 2006). Increasingly, per state and federal mandates, children who consistently underperform against normative standards are assessed for learning disabilities (LDs) (Bowen & Rude, 2006). LDs, defined as “a neurobiological disorder of cognitive and/or language processing caused by atypical neurocognitive functioning”, have been associated with less adaptive cognitive functioning and poorer academic performance compared to controls (Mayes, Calhoun, & Crowell, 2000; Rubinsten, 2009; Silver et al., 2008). There is also a high rate of co-occurrence for LDs, ADD/ADHD, and externalizing disorders (DuPaul & Volpe, 2009; Semrud-Clikeman et al., 1992). Further, some research has found that young adult and adult participants who self-report having a LD and/or ADHD perform worse on neurocognitive tests and evidence greater stress and psychiatric symptoms (Elbin et al., 2013; Wilson, Deri-Armstrong, Furrie, & Walcot, 2009; Zuckerman, Lee, Odom, Solomon, & Sills, 2013). Children with LDs or ADD/ADHD are sometimes enrolled into special education (SE) curriculum (Turnbull, 1995). SE services may be provided to students for a number of reasons, ranging from

intellectual and developmental disabilities, including LDs, to poor academic performance (Freeman & Alkin, 2000; Turnbull, 1995).

Having been diagnosed with a LD or having been enrolled in SE may indicate the presence of some deficits in executive functioning, including inhibitory control, as there are high rates of co-occurrence for LDs and ADD/ADHD (Barkley et al., 2001; Biederman et al., 2004). LDs, ADD/ADHD, and SE enrollment are vastly overrepresented among both corrections-involved people and drug users (Allison et al., 1999; APA, 2013; Blanton & Dagenais, 2007; Bryan, Freer, & Furlong, 2007; Cottle et al., 2001; Kavanagh, Rowe, Hersch, Barnett, & Reznik, 2010). It is important to note that this association between LD diagnosis, SE enrollment, and high-risk behavior in adulthood may be partially attributable to neurocognitive deficits, but may also be due to a variety of other psychosocial and economic factors (Coles et al., 1997; Raine et al., 2005; Spencer et al., 2005). Indeed, while LD and SE enrollment *may* provide an indirect indicator of mild intellectual impairments or deficits in cognitive functioning (e.g., working memory, self-regulation) which can impede decision-making, they may also indicate other things, such as race-based structural and systemic inequities, teacher bias, and childhood poverty (Altarac & Saroha, 2007; Artiles & Trent, 1994; Skiba et al., 2008). There is the further possibility that the effects of being diagnosed with a LD and the effects of enrollment into SE curricula may contribute to, rather than necessarily reflect, cognitive challenges or developmental delays. For instance, being diagnosed with a stigmatized condition or state, such as LD diagnosis or SE enrollment, can increase stress, negative affect, which can hinder learning (Bender, Rosenkrans, & Crane, 1999; Kistner, Haskett, White, & Robbins, 1987; Mishna, 2003; Shifrer, 2013; Tabassam & Grainger, 2002). Students with intellectual disabilities often fare worse in SE than in integrated classrooms (Freeman & Alkin, 2000). In this way, irrespective of cognitive difficulties prior to LD diagnosis or SE enrollment, the diagnosis and enrollment may themselves contribute to important developmental delays that can have a lasting impact on cognition and decision-making.

Difficulties with Comprehension, Concentration, and Memory

In addition to using LD diagnosis or SE enrollment as an indirect indicator of cognitive deficits with the potential to influence decision-making capacities, there are some specific markers of poorer cognitive functioning that might be discerned through the self-report. For instance, self-reported difficulties in concentration, comprehension, and memory during the same time periods that drugs were used may

indicate that a person was experiencing important constraints on their cognitive abilities (Bechara & Martin, 2004; Dreer, DeVivo, Novack, Krzywanski, & Marson, 2008). This may be particularly true if the person does not attribute these difficulties to acute drug intoxication.

During intertemporal choice, it is necessary to weigh benefits against risks across a range of options and probabilities, and to consider one's preferences over time. Impairments in executive control, including deficits in comprehension, concentration, and memory can all adversely influence a person's capacity to do this. For example, concentration, which is the attentional process that involves focusing on a particular task while also gating non-relevant inputs, is implicated in working memory capacity, defined as the coordination of multiple short-term memory systems' negotiation of attentional control to maintain information in a dynamic, readily retrievable fashion (Baddeley, 1992; Engle, 2002). Working memory is crucial for decision-making, particularly decision-making that involves risk and uncertainty (Paulus et al., 2001). Memory impairments self-reported by a person may implicate impairments in multiple other cognitive areas, as some of the same networks within the brain concerned with memory are also implicated in related functions, such as prospection, autobiographical memories, and counterfactual simulation of events, all which can influence a person's tendency toward present-bias and delay discounting, and their ability to make intertemporal choices (Abraham & Bubic, 2015; Schacter, Benoit, De Brigard, & Szpunar, 2015; Spreng, Mar, & Kim, 2009).

Incidence of Head Injury

In addition to these indicators, a history of traumatic brain injury (TBI) or mild traumatic brain injury (mTBI) may be an indicator of poorer cognitive function in areas necessary for impulse control, emotional regulation, and decision-making (Bechara & Van Der Linden, 2005; Bogod, Mateer, & Macdonald, 2003; Dockree et al., 2006; Fellows, 2006; Kim, 2002). While people with mTBI evidence affective and cognitive dysregulation contemporaneous to injury, symptoms often resolve within 3-6 months (Belanger, Vanderploeg, Curtiss, & Warden 2007; Mayer, Mannell, Ling, Gasparovic, & Yeo, 2011). However, people with a history of multiple head injuries may exhibit progressive neurocognitive degeneration (McKee et al., 2009). Longer-lasting deficits in cognition and behavior related to head injury may be expressed in terms of poorer self-regulation, concentration, and decision-making and may, in some cases, co-occur with anxiety and depressive symptoms (Arciniegas, Topkoff, & Silver, 2000; Greve et al.,

2001; Newcombe et al., 2011; Walker, Hiller, Staton, & Leukefeld, 2003). Self-regulation is increasingly understood as a causal mechanism in successful intertemporal choice (e.g., not selecting the smaller, sooner reward over the larger, future reward), and is associated with frontocortical areas that are especially sensitive to head trauma (Figner et al., 2010). Head injuries are also overrepresented among corrections-involved populations and drug users (Miller et al., 1992; Hestad, Updife, Seines, & Royall, 1995; Walker, Staton, & Leukefeld, 2003). Among younger corrections-involved people, higher self-reported rates of repeated TBI/mTBI positively correlated with higher rates of repeat offending (Williams, Cordan, Mewse, Tonks, & Burgess, 2010). When assessing the effects of drug use on decision-making, self-reported history of head injury has been controlled for as a possible confounding variable (Ersche et al., 2005).

It is possible that people may self-report a history of multiple head injuries in addition to LD diagnosis and/or SE enrollment. In assessing TBI/mTBI, LDs and ADD/ADHD are increasingly recommended as factors to consider as potential confounders in the assessment process (Elbin et al., 2013; McCroy et al., 2009). Similarly, in assessing neurocognitive impairment, LD and ADD/ADHD in young people, self-reported mTBI/TBI may be controlled for among other factors (e.g., abuse), underscoring its potential impact on cognitive functioning, including memory and concentration (Cicerone, 1996; Raine et al., 2005; Walker et al., 2003). It may be that a greater number of these indicators suggests that there are multiple factors present with the potential to influence a person's ability to make decisions involving opioids and stimulants. It also suggests that people with more of these indicators may be less enabled to deliberate and engage in the types of higher-level cognition needed to minimize risk and make decisions that maximize well-being over time, rather than choosing more immediate rewards.

Vague and Distal, but Potentially Relevant

Sophisticated, but still coarse-grained, conceptualizations of how multiple distal and proximate factors can influence decision-making and behavior are increasingly articulated, even as perfect information needed for fine-grained, more precise modeling of human behavior remains inaccessible. However, many potential coarse-grained inferences may be made using information about a person's history. Such history can provide indirect clues as to what factors may have influenced cognition, decision-making, and behavior during particular time periods. Although there are limitations to exploring self-reported accounts of a person's life and to examining indirect indicators with the potential to influence

decision-making (such as head injury, LD diagnosis, SE enrollment), there is also some merit. The Adverse Childhood Events Questionnaire (Felitti et al., 1998) is one example of how the dichotomized presence or absence of a set of conditions during childhood can be used to make directional hypotheses about, and to help understand, behavioral outcomes in adulthood (Baglivio et al., 2015; Dube et al., 2003; Julian et al., 2018). Just as the self-reported presence of sexual abuse during childhood increases the odds of observing drug use problems in adulthood, so too might self-reported incidence of head injury or SE enrollment be used to consider the greater likelihood of observing impaired or high-risk decision-making in adulthood. The centrality of such distal, and sometimes imprecise, factors is increasingly made explicit during pre-sentence investigations and death penalty mitigation defenses (Haney, 2007). Abuse, family interactions, mTBI, lead exposure, LD, and poor educational performance in early life are all considered as potentially mitigating factors in a person's later commission of crime (Freedman, 2007; Haney, 1994, 2007). Given this precedent, head injury, LD diagnosis, and SE enrollment may be justifiably explored as potential influences on decision-making about high-risk drugs, though understood to be limited in what they have capacity to approximate and indicate.

Economic and Social Influences

Scarcity and Economic Hardship

Some researchers have proposed that scarcity is a state that changes the way people think and behave, including how they prioritize and solve problems, perceive choices, and make decisions (Mani, Mullainathan, Shafir, & Zhao, 2013; Shah, Mullainathan, & Shafir, 2012; Shah, Shafir, & Mullainathan, 2015; Spears, 2011). For people who experience scarcity, problems may appear larger, more urgent, and may often require greater attention, emotion, and energy to address--all of which can influence attentional control, perception of time, and the ability to make intertemporal decisions that maximize long-term well-being (Jabs and Devine, 2006; Kahneman, 1973; Karlan, McConnell, Mullainathan, & Zinman, 2016; Shah et al., 2012; Zhu & Ratner, 2015). In other words, there is a quality of present-bias among people who are resource-scarce. Problems encountered by people who experience scarcity also require greater cognitive effort to address, in that trade-offs among limited resources necessitates careful deliberation that is not required to the same degree for people with abundant resources (Shah et al., 2012). Deprivation and scarcity can also increase cognitive load (e.g., "effort" involved in information processing), which can

further constrain a person's capacity to engage in deliberative thinking during decision-making--a process that necessarily involves conceptualizing rewards/costs, weighing uncertainty, and considering preferences between a person's current and future self (Hinson et al., 2003; Kurth-Nelson, Bickel, & Redish, 2012; Ward & Mann, 2000; Vinoo, Ly, & Soman, 2016). Increased cognitive load has been associated with subsequently reduced cognitive capacity, or "bandwidth", for self-regulation and with the ability to exercise "willpower", both of which can hinder a person's capacity to make decisions that will maximize overall utility, instead of choosing options with the highest local utility (Baumesiter, 2002a; Hofmann, Schmeichel, & Baddeley, 2012; Mani et al., 2013; Mullainathan & Shafir 2013; Schilbach, Schofield, & Mullainathan, 2016).

For a person who may already be attempting to self-regulate their drug use, by moderating or abstaining, ego depletion might also occur, in which sustained efforts at self-control can become partially and temporarily depleted (Baumeister, 2014). This temporary depletion in self-control can contribute to an increased desire for drugs and a failure to self-regulate when willpower is expended (Baumeister, 2014). For instance, a drug user who achieved abstinence in a controlled environment and subsequently reenters the community hoping to maintain abstinence, would need to exert considerable planning and self-regulation. For some, it may be that continued efforts to not use drugs exacerbate the very ability needed to not use. When a current or former drug user is living in scarcity, they may experience increased ego depletion and cognitive load daily and across a variety of domains (e.g., not buying the sunglasses they want because they are too expensive and not shoplifting them due to the potential consequences; inhibiting desire to approach the dealer on the block near their house; deciding between buying groceries and paying the gas bill; deciding which household member will get to use the car today and who will take public transportation; saying "no" to old using friends who want to come over). For someone who is resource scarce, all of these seemingly small deliberations and inhibitions can exert a greater cognitive toll, making already difficult decision-making more taxing.

Experiencing poverty and acute economic hardship both include aspects of scarcity. Lower earnings and transient periods of economic distress or hardship are associated with greater choice polarization, stress response, impaired cognitive functioning, and poorer self-regulation (Bernheim, Ray, & Yeltekin, 2015; Fry, Langley, & Shelton, 2017; Hackmam & Farah, 2009; Hunt, 2010; Loibl, 2017; Mani

et al., 2013; Nobel, McCandliss, & Farah, 2007; Zhu & Ratner, 2015). Across studies, low-income and poverty are associated with increased stress, negative affect, anxiety, depressive symptoms, and diminished cognitive capacity and control during decision-making (Green, Myerson, Lichtman, Rosen, & Fry, 1996; Santiago, Wadsworth, & Stump, 2011; Haushofer & Fehr, 2014; Spears, 2001; Weich & Lewis; 1998). Evidence suggests that it is the state of scarcity that results in suboptimal decision-making and cognition, not necessarily the converse (Mullainathan & Shafir, 2013; Shah et al., 2012; Sheehy-Skeffington, 2018). One result is that choices with higher local utility, but lower overall utility, are more likely to be made, thus potentially reinforcing some sources of scarcity and poverty (e.g., borrowing from a payday lender, purchasing lottery tickets, putting off a doctor's visit, delaying minor repairs that become major repairs over time, spending on smaller essential and non-essential goods in the immediate instead of saving) (Bair, 2005; Clotfelter, Cook, Edell, & Moore, 1999; Mullainathan & Shafir, 2009). Among heroin users, decisions have been shown to become more risk-prone as a function of deprivation (Bickel, Giordano, & Badger, 2004). Although all people tend to temporally discount, the consequences of this can be disproportionately greater among people with fewer resources (Bertrand, Mullainathan, & Shafir, 2004). Greater temporal discount rates have also been observed in conditions where people experience acute financial hardship or loss (Haushofer, Schunk, & Fehr, 2013).

Mani et al. (2013) conducted two complementary experiments that help elucidate how low-income and financial hardship could potentially influence cognition and inhibitory control. In the first study, the authors found that lower-income participants (e.g., \$20,000 annual income) and higher-income participants (e.g., \$70,000 annual income) performed similarly on measures of fluid intelligence and cognitive control (inhibition) when randomized to an "easy condition", in which they were primed by making hypothetical financial decisions involving smaller, less significant sums of money. However, when randomized to a "hard condition", in which participants were primed by making hypothetical financial decisions involving larger, more consequential sums of money, low-income participants performed worse than high-income participants. Specifically, an interaction was observed for low-income + hard condition, whereby lower-income participants making challenging economic decisions performed poorer than all other groups. This study, which controlled for test/math anxiety among other things, was repeated using incentives for correct responses and similar findings were observed, with effect sizes for the low-income + hard condition robust

across experiments (Cohen's d 0.88-0.94). In other words, when making high-risk/high-consequence decisions, those with the least performed the worst.

In the second experiment, Mani et al. (2013) found that farmers in India experienced greater financial hardship pre-harvest, compared to post-harvest, and that, after controlling for stress, farmer, and month fixed effects, there were significant differences between periods of economic hardship (pre-harvest) and economic stability/prosperity (post-harvest) on measures of fluid intelligence and cognitive control. In a study by Carvalho et al. (2016), a similar "liquidity constraint" on decision-making was found, whereby greater present-bias was observed for low-income households tested before payday, rather than after. Unsurprisingly, spending was also higher after payday. This finding is consonant with the notion that changes in liquidity constraints can account for changes in self-control. It also does not exclude the possibility that scarcity itself influences self-control and decision-making, highlighting the need for more research in this area.

Still, taken collectively, there is support for the idea that being low-income is associated with poorer cognitive functioning under decision-making conditions, and that transient periods of economic hardship and distress are associated with declines in cognitive functioning. Having more unmet needs may conceptually correspond to a decision-making pattern referred to as "satisficing", in which a person tends to seek out options with the potential to meet immediate needs (e.g., an available choice with high local utility), rather than maximizing utility by seeking out optimal long-term outcomes (Mishra & Lalumière, 2010; Schwartz et al., 2002; Simon, 1956; Todd & Gigerenzer, 2000). For low-income people, or people experiencing financial difficulties, this satisficing tendency may be rational and helpful in the short-term, in that it minimizes labor expenditures and, prioritizes "good enough" options over "best solutions". This makes existential sense, of course. Interestingly, satisficing, compared to maximizing, has been found to correlate with greater perceived happiness and satisfaction (Schwartz et al., 2002). A related finding suggests that while there is a ceiling on the "money equals happiness" correlation (\$75,000 annually), perceived life satisfaction increases exponentially with income (Khaneman & Deaton, 2010). The implication is that people earning less (<\$75,000) may be both less happy and less satisfied with their life and, as discussed earlier, may experience scarcity mindsets and satisficing tendencies.

One decision-making aspect related to income that is of additional interest here is that for opioid and stimulant users, increased spending power or relief from transitory economic distress may actually increase purchase and use of drugs (Bretteville-Jensen & Sutton, 1996; Petry, 2000; Greenwald & Steinmiller, 2014; Roddy & Grenwald, 2009; Roddy, Steinmiller, & Greenwald, 2011; Shaner et al., 1995). This is due to the fact that demand for opioids and stimulants, among regular users of these drugs, can be income elastic, meaning that purchases will increase at rates higher than rates of income increase, with people demonstrating greater income elastic demand for drugs they prefer, are dependent on, or believe to be of higher quality (Goudie, Sumnall, Field, Clayton, & Cole, 2007; Petry & Bickel, 1998).

Many drug users and corrections-involved people experience forms of scarcity, including low-income and economic hardship (Garland, Wodahl, & Mayfield, 2011; Mulia, Schmidt, Bond, Jacobs, & Korcha). Further, because using a drug can serve an immediate need, and may assume a form of satisficing, but because the distributed choice of repeated drug use can be suboptimal or devastating, a scarcity mindset or satisficing tendency may be problematic. It is therefore important to consider how factors in a person's life, such as income and economic distress, might be understood in terms of scarcity, but also how they may function to influence drug-related decision making in other ways, such as providing greater or lesser drug purchasing power.

Community-wide Scarcity and Harsh Environments

Scarcity of flexible resources and socioeconomic disparities may also be observed at the level of neighborhood, community, county, or region. For instance, some areas enjoy greater economic prosperity than others, whereby there are more households with higher earnings and fewer households living in poverty (Brown & Hirschl, 1995; Thorne, Tickamyer, & Thorne, 2004). Regional poverty and regional economic inequality are both associated with regional crime, violence, social mistrust, poorer self-rated health, and higher rates of non-natural and premature morbidities and mortalities, including higher infant mortality rates (Blakely, Lochner, & Kawachi, 2002; Graif, Gladfelter, & Matthews, 2014; James & Cossman, 2006; Hsieh & Pugh, 1993; Patterson, 1991; Santiago et al., 2011; Sparks, McLaughlin, & Stokes, 2009; Wilkinson & Pickett, 2009; Yen & Kaplan, 1999). Such environments are defined as “harsh” by Frankenhuis et al. (2016), who suggest that people living within such harsh places cannot develop a

sense of certainty about their lives or futures, and that such uncertainty changes their cognition.

Frankenhuis et al. (2016) note that:

In such conditions, present-orientation may be adaptive. This orientation can psychologically manifest in: first, vigilance used to detect threats and opportunities, second, impulsive reactions (little deliberation) in order to respond quickly; and third, steep future discounting to motivate the capture of immediate benefits, as future rewards are less likely to be cashed in” (pg.77).³

In other words, growing up or living in high-stress, high-mortality, low-resource, and uncertain conditions may contribute to a person being more present-biased, in which they will discount the future at higher rates, and potentially take more risks when it comes to securing immediate rewards (e.g., sex, food, drugs) or avoiding perceived harms (Griskevicius et al., 2013; Griskevicius, Tybur, Delton, & Robertson, 2011).

Evidence has shown that both lower-income areas (e.g., neighborhoods, counties, regions) and areas with greater economic inequality have high associated rates of morbidities and mortalities, meaning that such counties can be considered as “harsh”, using criteria proposed by Frankenhuis and colleagues (2016) (Cheng & Kindig, 2012; Franzini, Ribble, & Spears, 2001; Huynh, Parker, Harper, Pamuk, & Schoendorf, 2005; McLaughlin & Stokes, 2002; Muramatsu, 2003). The implication is that people living within those areas would be expected to be more present-biased and risk-taking.

Subjective Socioeconomic Comparison and Stress

Scarcity, however, is not limited to economic circumstances. People may experience scarcity across flexible resources, which are resources that are dynamic, valuable, and applicable across situations (Phelan, Link, & Tehranifar, 2010). In addition to money, these resources might include time, knowledge, education, and status, closely associated with power, defined here as “asymmetric control over valued outcomes and resources” (Joshi & Fast, 2014; Phelan et al., 2010). People who have fewer of these resources and, more importantly, who *perceive* themselves as having fewer of these resources in relation to others in society, often experience greater subjective stress, poorer physical and psychological health, and

³ Vis-à-vis evolution; in terms of biological fitness, not in terms of more adaptive health or well-being. Indeed, health and well-being, in the immediate and long-term, may actually decrease in order to better ensure transmission of genes under such conditions.

greater impulsiveness/decreased self-regulation (Adler, Epel, Castellazzo, & Ickovics, 2000; Kessler & Cleary, 1980; Marmot, 2004; Singh-Manoux, Marmot, & Adler, 2005).

Lower subjective social status, experiencing social isolation as a result of lower status, and encountering others that one feels subordinate to, particularly when the socially dominant other is encountered in a domain that they control (i.e., social defeat; e.g., the boss at work, a wealthy customer's home, probation/parole officer), may all result in increased stress response, defined as the body's physiological reaction to a real or perceived stressor that has the potential to influence health, cognition, and behavior (Adler, Epel, Castellazzo, & Ickovics, 2000; Abbott et al, 2003; Cole, Logan, & Walker, 2011; Covington & Miczek, 2005; De Kloet, Joëls, & Holsboer, 2005; Koob, 2009; McEwen & Gianaros, 2010; Sapolsky, Alberts, and Altmann, 1997; Selye, 1975, 1998). Conversely, people who have, or perceive themselves to have, more relative power, resources, and status have been shown to have better health and to exhibit heightened executive functioning, abstract reasoning, and increased goal-directed focus (Overbeck & Park, 2006; Smith, Dijksterhuis, & Wigboldus, 2008; Smith & Trope, 2006; Wilkinson & Marmot, 2003).

Among non-human animals, higher social rank and social dominance have been associated with less alcohol, cocaine, and opioid consumption, whereas lower and/or marginalized social status is associated with increased drug-taking (Heilig, Epstein, Nader, Shaham, 2016; Kuhar, 2002; McKenzie-Quirk & Miczek, 2008; Nader et al., 2012; Wolffgramm & Heyne, 1995). Pre-clinical models examining hierarchical status, social defeat, and drug use have found that cocaine serves as a behavioral reinforcer in subordinate, but not higher-ranking primates (Covington & Miczek, 2005; Morgan et al., 2002; Nader et al., 2006), that rats increase alcohol, cocaine, and cocaine + heroin self-administration following social defeat or exposure to social stress (Caldwell & Riccio, 2010; Cruz, Quadros, Hogenelst, Planeta, & Miczek, 2011), and that morphine- and cocaine-induced place preference is reinstated following exposure to various stressors, including social stressors (Do Couto et al., 2006; Do Couto, Aguilar, Lluch, Rodríguez-Arias, & Miñarro, 2009). Among non-human primates, holding a lower rank in the social hierarchy is also associated with higher stress (at resting levels, as measured by glucocorticoids), whereas higher rank, particularly in stable social hierarchies, is associated with the converse, and with greater cortical integration and coupling

(Gesquiere et al., 2011; Noonan et al., 2014; Sapolsky, 2017; Sallet et al., 2011)⁴. Increasingly, addiction researchers are emphasizing the importance of modeling social stressors, including low social status, in terms of how they may influence drug-taking (Heilig et al., 2016).

Relative to decision-making, the importance of real or perceived higher social status is summarized in part by Joshi & Fast (2014) who state that, “Power activates a high-level construal orientation (Magee, Milliken, & Lurie, 2010; Smith, Dijksterhuis, & Wigboldus, 2008; Smith & Trope, 2006). High-level construal expands temporal horizons (Troupe & Liberman, 2010), which results in the perception of the distant future as being closer and imminent and induces a sense of connection with the future self (Kantan, 2011)”. One implication is that people who have a lower perceived social rank are more likely to be present-biased, and therefore potentially more likely to temporally discount future rewards for smaller, immediate ones. Another implication is that people with real and perceived lower rank are, in general and without acute provocation, more physiologically aroused and “stressed” than higher ranking, more powerful people. This, as noted before, impairs cognitive ability. Corrections-involved drug users may subjectively perceive themselves as having an equal status to others in society. However, this should not be assumed, due to the fact that drug users and corrections-involved people are highly stigmatized and socially devalued in the US (Barry et al., 2014).

In sum, experiencing forms of resource scarcity, such as economic distress or having a lower subjective social rank, along with living in a “harsh” region that fosters a sense of uncertainty about the future, all have the potential to influence cognition and high-risk decision-making. This is because all of these factors are associated with increases in stress response and temporal discounting, and with decreases in capacities needed for future-orientation, self-regulation, and other higher-level cognition (Bartels & Rips, 2010; Ersner-Hershfield, Garton, Ballard, Samanez-Larkin, & Knutson, 2009; Frederick et al., 2002).

⁴ Cortical integration or coupling is relevant to note due to the fact that it indicates what might be considered a “healthy brain”. That is, a brain better equipped for cognitive flexibility and higher-level cognition, including working memory, attention, emotional regulation, abstract thinking, impulse control, valuation, etc.

Stress, Psychiatric Symptoms, Pain, and Misregulation

Stress-related Health Effects

Although stress response can be immediately adaptive, in terms of increasing a person's capacity to respond to threats and facilitating memory consolidation of specific threats, it disrupts homeostatic functioning and increases allostatic load, which has significant deleterious short- and long-term effects including impaired memory and cognition, fatigue, pain, lowered immunological function, affective dysregulation, elevated blood pressure, and premature mortality (Arnsten, 2000; Boyce, 2004; Chattarji, Tomar, Suvrathan, Ghosh, & Rahman, 2015; De Kloet et al., 2005; Goymann & Wingfield, 2004; Juster, McEwen, & Lupien, 2010; Lupien, Maheu, Fiocco, & Schramek, 2007; Lupien, McEwen, Gunnar, & Heim, 2009; McEwen, 1998, 2009; Sapolsky, 2004, 2005; Sapolsky, Alberts, & Altmann, 1997). In a variety of human and non-human studies, chronic stress, acute stress exposure, self-reported stress, and greater stress reactivity, have been associated with craving, addiction, and relapse to drugs, including opioids and stimulants (Back et al., 2010; Garland, Franken, & Howard, 2012; Kennedy et al., 2015; Leri et al., 2004; Preston et al., 2017; 2018; Sinha, 2001, 2008; Sinha & Jastreboff, 2013; Sorge, Rajabi, & Stewart, 2005). Taken together, these findings suggest that people who experience stress (if only ever physiologically and not psychologically) may be influenced to use drugs, use them at higher rates, and resume use (e.g., lapse, relapse) during periods of greater stress.

Chronic exposure to stress is also associated with insensitivities to changes in outcomes and with behaviors that are more habituated and rigid (and therefore less goal-directed) (Dias-Ferreira et al., 2009; Liston et al., 2006; Schwabe & Wolf, 2009, 2011; Soares et al., 2012). This is problematic, in that decisions involve contingencies. Imagining and deliberating various contingencies requires higher-level cognitive functioning and flexibility, including the capacity to utilize available information, generate abstractions, and initiate behavioral change in response to outcome change. For example, if someone was informed that instead of their next positive drug screen resulting in a one-week jail sanction it resulted in a 4-year prison term, a person would need to be able to attend to, understand, and envision these possibilities. They would also need to have the requisite cognitive flexibility for modifying decision-making patterns and behavior in light of this information. When decisions involve uncertainty, which is often the case during intertemporal

choice involving drugs, stress and stress-related health effects can increase, potentially further hindering the decision-making process (Morgado, Sousa, & Cerqueira, 2015; Peters, McEwen, & Friston, 2017). If a person's life is characterized by uncertainty, as many corrections-involved drug users' lives are, then stress may generally be higher.

Interestingly, for some drug users, and for some people with subclinical psychopathy, *underactivation* rather than *overactivation* of visceral states (e.g., such as increased heart rate, stomach upset, perspiration) or “somatic markers” can adversely impair decision-making, in that the “cues” needed to help anticipate reward and punishment are inadequate or absent (Bechara & Damasio, 2002; van Honk, Hermans, Putman, Montagne, & Schutter, 2002). Thus, there is no reason to believe that there is complete homogeneity across drug users who are resource-scarce or who have been exposed to stressors in terms of how they are cognitively or behaviorally influenced by these states. Identifying the presence of health-related stress symptoms, that include somatic as well as psychological indicators, during a given time period may be one way to discern if cognitive states are being adversely influenced by stress response.

Psychiatric Symptoms

In addition to the slower, deliberative, and higher-level cognition necessary for decision-making discussed earlier, faster, automatic cognition also facilitates adaptive decision-making (Evans, 2008). Emotions, or feeling states, can help a person intuit, reason, and make decisions, in part through viscera or somatic signals that steer them away from danger and risk (Bechara & Damasio, 2002; Damasio, 1994, 2012). The somatic marker hypothesis posits that while decision-making is a process that often requires conscious, deliberative cognition, it is also a process facilitated by unconscious physiological states and their emotional referents (Bechara & Damasio, 2005).

As with stress, feeling states--spanning affect, mood, and somatization---including those characteristic of anxiety and depressive disorders--can impair neurocognitive function, including working memory, attention, interoceptive accuracy, time perception, and risk assessment, thus influencing decision-making processes (Darke, 1988; Dias-Ferreira et al., 2009; Furman et al., 2013; Gohier et al., 2009; Harvey et al., 2004; Marazziti, Consoli, Picchetti, Carlini, & Faravelli, 2010; Nebes et al., 2000; Schulz & Vögele, 2015; Schwabe & Wolf, 2013; Scott et al., 2015; Shackman et al., 2006; Wittmann & Paulus, 2008). For instance, heightened emotional arousal corresponds to affective, rather than deliberative, decision-making,

which is associated with faster, simplified decision-making, risk-taking, and delay discounting (Figner, Mackinlay, Wilkening, & Weber, 2009; Figner & Weber, 2011). This makes some sense, in that affective, automatic/associative cognition is less effortful and demanding than deliberative reasoning and behavioral inhibition (Sanfey & Chang, 2008). But it is important to note that emotional states are not, as a rule, *unhelpful* during decision-making, given that the ability to make decisions relies heavily on emotion (Bechara & Damasio, 2005). Rather, it is important to understand that emotional states and psychological disorders have the capacity to alter cognition and decision-making processes.

For instance, time perception can be influenced by affective states. During depressive episodes, people can experience time passing more slowly, whereas people in manic or anxious states may perceive time passing more quickly; all of which can influence attention, present-bias, and delay discounting, thereby increasing the probability of suboptimal decision-making (Bschor et al., 2004; Murphey et al., 2001; Zauberman, Kim, Malkoc, & Bettman, 2009). Although investigations have examined how emotions common to psychiatric disorders, such as anxiety and depression, influence decision-making, the evidence is mixed (Paulus & Yu, 2012; Seymour & Dolan, 2008). For instance, some data suggest that anxiety-prone individuals are more risk averse and demonstrate biased attention to possible threats (Dugas, Gagnon, Ladouceur, & Freeston, 1998; MacLeod & Mathews, 1988; Maner et al., 2007). Although Rounds et al. (2007) found impulsive choice increased following increased exposure to social anxiety, this finding was not replicated (Jenks & Lawyer, 2015).

People with depression have been shown to be less biased toward and responsive to reward, to be less accurate in evaluating outcome probabilities, and to experience more conflict during decision-making (Cella, Dymond, & Cooper, 2010; Elliott et al., 1996; Han et al., 2014; Harlé, Allen, & Sanfey, 2010; Lempert & Pizzagalli, 2010; Murphy et al., 2001; Pizzagalli, Bogdan, Ratner, & Jahn, 2007; Rubinsztein, Michael, Underwood, Tempest, & Sahakian, 2006; Smoski, et al., 2008; van Randenborgh, de Jong-Meyer, & Hüffmeier, 2010). People with depressive symptoms are believed to have enhanced somatic markers for negative, but not positive stimuli, making punishment learning potentially more rapid and biasing them toward risk aversive decisions (Smoski, et al., 2008). However, during experimentally induced emotional states, Raghunathan & Pham (1999) found that people in the “sad” condition were biased toward high-risk/high-reward decisions, whereas people in the “anxious” condition were biased toward low-risk/low

reward options. Further, among a sample of people with major depressive disorder (MDD), participants with MDD discounted rewards at steeper rates and were insensitive to increases in reward changes (Pulcu et al., 2013), which is in keeping with the finding of higher discount rates among depressed participants with and without suicidal ideation and previous suicide attempts observed by Dombrovski et al. (2011). Feelings of hopelessness and detachment from one's future have been proposed as possibly contributing to temporal discounting (Pulcu et al., 2013). In other words, for a person without resonant connection to their future self, it may be easier to discount their future self's preferences.

Paulus & Yu (2012) conclude that, overall, findings suggest both trait-like (i.e., related to psychiatric disorder) and state-like (i.e., internal state and mood) decision-making dysfunction in relation to anxiety and depression. This means that both transient affective or mood states, as well as more enduring or reoccurring psychiatric disorders (which can, of course, still include these states), have the potential to influence decision-making. Anxiety and depressive symptoms are highly prevalent among both opioid and stimulant users (Grant et al., 2004; Merikangas et al., 1998). Given that drug use can impair brain areas associated with emotional processing and self-regulation, and given that abstinence can induce anxiety and depressive symptoms, it is possible that both active and abstinent drug users may experience affective and mood states that influence decision-making (Fernández-Serrano, Lozano, Pérez-García, & Verdejo-García, 2010; Verdejo-García, Rivas-Pérez, Vilar-López, & Pérez-García, 2007). However, because findings are preliminary and inconclusive, more work is needed to understand the associations between anxiety and depressive disorder symptoms and high-risk decision-making and behavior, including the use of opioids or stimulants. Nevertheless, symptoms related to anxiety and depression might still be explored as possible influences on decisions to use high-risk drugs, as the presence of negatively valenced states may influence decision-making in other ways, as will be discussed subsequently.

Chronic Pain

Chronic pain is defined here as a condition in which “signals triggered by aversive stimuli and/or damaged tissue persist over time, beyond their normal duration” (Yoris et al., 2018). Typically, pain that persists for three or more months may be considered as chronic (Cleeland & Ryan, 1994). Chronic pain conditions, which often have high prevalence rates among people who are older, have fewer resources, SUD history, and corrections-involvement, can also potentially influence decision-making (Dunn, Brooner,

& Clark, 2014; Dunn, Finan, Tompkins, Fingerhood, & Strain, 2015; Johannes, Le., Zhou, Johnston, & Dworkin, 2010; Reingle-Gonzalez, Walters, Lerch, & Taxman, 2015; Rosenblum et al., 2003; Sapolsky, 2004, Kristenson et al., 2004; Mallik-Kane & Visher, 2008; Smith et al., 2019). People who experience chronic pain have been shown to have impaired cognitive function and impaired decision-making, as indicated by poorer performance on decision-making simulations compared to healthy controls (Apkarian et al., 2004; Elvemo, Nilsen, Landrø, Borchgrevink, & Håberg, 2017; Landrø et al., 2013; Walteros et al., 2011).

Ordinarily, a multitude of physiological reactions occur prior to and during decision-making, both automatically and unconsciously, as well as consciously in the form of emotions or feeling states which, as noted earlier, can help guide learning, decision-making, and behavior (Bechara & Damasio, 2005; Berridge, 2007; Van den Bergh, Zacharioudakis, & Petersen, 2018). Recall that, as explained by dual process models of cognition, decision-making relies on more than one type of cognition (i.e., a variety of automatic, more visceral signals, and deliberative, higher-level cognitive functions), and that choice involving uncertainty is more cognitively demanding than choice with certainty and choice associated with habituation (Damasio, 1994; Evans, 2008). During complex tasks, such as intertemporal choice, cognitive systems may work together, rather than in explicit “competition” (Monterosso & Luo, 2010). Recall, too, that physiology and “feeling states” guide decision-making so as to improve adaptation and performance amidst uncertainty, ambiguity, and change (Bechara & Damasio, 2005; Damasio, 1994). Consider, for instance, the usefulness of disgust as an emotional state in the avoidance of spoiled food or refuse (Curtis, De Barra, & Aunger, 2001; Nesse, 1994). Consider, too, the usefulness of fear. When faced with perceived threat, pupils dilate to improve sight and to signal arousal, heart rate increases to pump needed blood to the body’s muscles for movement, and glucocorticoid production increases, readying the body for swift action and the consolidation of memory around threat (Clinchy, Sheriff, & Zanette, 2013; Leuchs, Schneider, Czisch, & Spoormaker, 2017; Mobbs et al., 2009; Nesse, 1994; Perry et al., 1995; Schaefer, Larson, Davidson, & Coan, 2014; Sapolsky, 2003; Schulkin, Morgan, & Rosen, 2005). This state may indeed become interpreted as fear and associated with anxiety; however, the phenomenology of such states could also be appraised as excitement and associated with pleasure (Garfinkel & Critchley, 2016). Thus, a

person's ability to accurately sense, detect, identify and appraise somatic states is important to decision-making and behavior (e.g., one may "avoid" due to fear and "approach" due to excitement).

Skin conductance response (SCRs), or electrodermal response, is one type of physiological reaction or "somatic marker" that occurs quickly and in response to arousing endogenous or exogenous stimuli (Dawson, Schell, & Courtney, 2011; Lykken & Venables, 1971). SCRs can help guide and optimize decision-making via anticipatory signaling, as evidenced by the graded relationship between SCR and other somatic marker signaling prior to choice, wherein people with weak or no signaling are more likely to make the riskiest choices (Crone, Somsen, Beek, & Van Der Molen, 2004). Evidence indicates that people with chronic pain are impaired in anticipatory SCR generation before making unfavorable outcomes (Elvemo et al., 2014). People who experience chronic pain have also been found to have less cortical volume in areas related to decision-making, emotion, and reward compared to healthy controls (Elvemo et al., 2014; Smallwood et al., 2013). Apkarian et al. (2004) propose that "chronic pain should be considered a 'cognitive state'[that] may be competing with other cognitive abilities", including emotional regulation, risk-assessment, inhibition, and decision-making, due to the preferential recruitment of the prefrontal cortex in chronic pain (Apkarian et al., 2001a-c; Apkarian et al., 2002). Still, such findings should be interpreted with caution, due not only to their correlational nature, but also due to the fact that differences in some neural areas associated with chronic pain vary by sex and potentially other factors as well (Gupta et al., 2016).

More generally, though, a variety of chronic pain conditions are associated with reductions in interoceptive *sensibility*, the ability to consciously detect and "make sense of" physiological changes, and with interoceptive *accuracy*, the ability to reliably detect interoceptive signals, with an inverse correlation observed between pain symptom severity and interoceptive accuracy (Borg et al., Di Lernia et al., 2016; Duschek, Montoror, & Reyes del Paso, 2015; Farb & Logie, 2018; Mehling et al., Pallatos et al., 2011). Findings cautiously interpreted from preliminary work suggest the possibility that people who experience chronic pain may also encounter disruptions in cognition, emotional regulation, and decision-making as a result of disruptions in interoceptive sensibility and accuracy (Dunn et al., 2010; Füstös, Gramann, Herbert, & Pollatos, 2012).

Of additional interest here is that some burgeoning research suggests that stimulant dependent people may have increased or hyperinteroceptive accuracy (de la Fuente et al., 2019). It may be, too, that other drug use is associated with hyperinteroceptive accuracy, or with *hypo*interoceptive accuracy. Ultimately, interoceptive signaling that helps inform decision-making may become disrupted from drug use (Bechara & Damasio, 2002). However, some findings suggest that while opioid users evidence poorer decision-making, it may not be due to lower SCRs. For instance, Biernacki et al., (2018) found no differences in SCR between opioid users and non-users. Contrary to other findings, opioid users who evidenced emotional reactivity on par with healthy controls, and who were found to have *higher* anticipatory SCR than controls, still made significantly riskier decisions (Biernacki et al., 2018). This suggests that even when somatic markers are present, drug users may have deficits in interoceptive *awareness* (i.e., the metacognitive awareness of accurately detecting somatic states) needed to clarify feeling states, consider their significance, and use them to guide choice (Craig, 2002). In other words, the signal is there, but not being adaptively “picked up” or interpreted.

Considering how chronic pain may influence decision-making, as a result of altered somatic marker signaling or impaired interoception is just one of several ways that chronic pain might influence decision-making in relation to high-risk drugs, particularly opioids. Unsurprisingly, chronic pain is associated with increased odds of illicit opioid and other drug use, including use among corrections-involved people (Alford et al., 2016; Cole & Logan, 2010; Hall et al., 2016; Prater, Zylstra, & Miller, 2002; Vowles et al., 2015). In addition to chronic pain potentially influencing risk-taking and decision-making, via impaired somatic markers as described above, chronic pain may influence the perceived utility of opioids due to their analgesic properties and may increase the likelihood that a person might choose to use of these drugs despite associated risks (Volkow & McLellan, 2016). In other words, being in a state of pain can motivate behaviors believed to mitigate pain or increase pleasure (Leknes & Tracey, 2008).

People with pain conditions who also have a history of SUD and/or who are receiving MAT are often undertreated for their pain, meaning that illicit use of opioids may become an appealing option (Baldacchino, Gilchrist, Fleming, & Bannister, 2010; Dunn et al., 2014; Hines, Theodorou, Williamson, Fong, & Curry, 2008; Jamison, Kauffman, & Katz, 2000; Karasz et al., 2004; Rosenblum et al., 2003). Motivation to use opioids to alleviate pain does not suggest that people who choose to take opioids to

address pain, licitly or illicitly, would not also be influenced by other factors, such as negative affective states or craving (Butler, Fernandez, Benoit, Budman, & Jamison, 2008; Garland, Brown, & Howard, 2016; Havens et al., 2009; Martel, Dolman, Edwards, Jamison, & Wasan, 2014; Martel, Jamison, Wasan, & Edwards, 2014; Tsui et al., 2016). Though some evidence suggests that pain severity does not necessarily correlate with opioid craving (Martel et al., 2016). Put differently, the local utility, or relative value, of opioids could increase due in part to a person's chronic pain, but chronic pain may not be the only factor influencing how opioids are valued.

Misregulation

As noted earlier, neurobiological changes from drug use can make people potentially less able to engage in the kind of self-regulation and higher-level cognition (e.g., prospection, deliberation, inhibition, cognitive reappraisal, mindfulness) needed to mitigate or “reframe” negatively valenced states (Baldacchino et al., 2012; Bechara, 2003; Buhle et al., 2014; Bush, Luu, & Posner, 2000; Hoffman & Vohs, 2016; Schoenbaum, Roesch, & Stalnaker, 2006). However, not all decisions to use high-risk drugs can be considered as a failure to cognitively reframe or self-regulate, or as a temporary deficit in willpower (e.g., ego depletion). People may choose to use drugs in what they may perceive to be pragmatic ways. These could include using as means to improve mood, cope with stress, anxiety, or depression, reduce pain, mitigate drug-related harms, lose weight, or to increase endurance and performance (Alford et al., 2016; Assanangkornchai, Muekthong, Sam-Angsri, & Pattanasattayawong, 2007; Baumeister et al., 1994; Conklin & Perkins, 2005; Daniulaityte, Carlson, & Kenne, 2006; Greely et al., 2008; Levine et al., 2010; Kopetz, Woerner, & Briskin, 2018; O'Connor & Berry, 1990; Smith & Lawson, 2017; Tice, Bratslavsky, & Baumeister, 2001). Such choices, when they have a high local but potentially low overall utility, can be conceptualized as misregulation, a self-regulation failure that includes attempted control or regulation, but in a way that fails to achieve the desired longer-term outcome (Baumeister et al., 1994; Baumeister & Heatherton, 1996). For instance, a person may intend to moderate or discontinue their drug use, but may still use, “lapsing” or “relapsing”, not due to a self-regulatory failure, but rather due to choosing to use drugs to cope with negatively valenced states. As noted throughout this discussion, states and contexts can influence a person's cognition and decision-making capacities. They can also influence the relative value of opioids and stimulants, with value attributable to potentially multiple factors (e.g., taking opioids to

simultaneously achieve a feeling of euphoria, to cope with stress, and to blunt lower back pain so as to be able to function at work and remain employed) (Redish, Schulheiss, & Carter, 2015). Misregulation is in harmony with the concept of satisficing and is also consonant with the idea that drug use may have a high local utility and may be rational for someone experiencing stressful or painful states, even as overall utility still decreases (Kopetz et al., 2018; Rachlin, 1997). In exploring high-risk drug use, it is important to understand if people making decisions to use drugs are doing so in part to reduce unpleasant states. Identifying such influence on decision-making has some practical implications, insofar as tendencies toward misregulation may be more amenable to intervention compared to other influences.

Access to Drug Markets and the Costs of Using

As discussed earlier, the area that a person lives in can influence a person's perception of risk and their decision-making capacities. Importantly, it can also determine what drugs are available or more readily accessible, along with some of the costs associated with acquiring them. Costs can be measured in terms of money, time, effort, and opportunity cost (e.g., money spent on heroin cannot also be money spent on rent, time spent obtaining heroin is not time spent with children) (Bickel et al., 2014; Caulkins & Reuter, 2004). Indeed, regions can sometimes differ considerably in terms of drug availability (e.g., drug type, number of different suppliers, time required to acquire drug), all of which can influence demand and consumption (Roddy & Greenwald, 2009; Taylor et al., 2011). This can include differences in accessibility of alcohol (e.g. "dry" versus "wet" counties), illicit drugs, and drugs that can be obtained via prescription (Cicero, Surratt, Inciardi, & Munoz, 2007; Cox, Motheral, Henderson, & Mage, 2003; Furst, Herrmann, Leung, Galea, & Hunt, 2004; Rigg & Monnat, 2015; Webster, Pimentel, & Clark, 2008).

Differences in drug availability and cost may be attributable to features of a geographic location that impact drug distribution networks and the burden of drug acquisition (e.g., proximity to metro areas, highway systems, "pill mills", pain clinics, MAT providers, etc.), but may also be attributable to variability in the demographic and health characteristics of a region's population (Coleman, 2012; Furst, 2004; Paterline, 2013; Inciardi, Surratt, Cicero, & Beard, 2009; Inciardi, Surratt, Kurtz, & Burke, 2006). For example, areas densely populated with older, disabled, or chronically ill people may provide more opportunities for diversion of prescription drugs into illicit markets (Green et al., 2013; Inciardi et al., 2009; Rigg, Kurtz, & Surratt, 2012). Appalachian and rural areas in Kentucky have had historically high rates of

disability, cancer, and chronic health conditions, as well as rates of opioid prescribing and diversion that rank among the highest in the nation (Inciardi, Surratt, Lugo, & Cicero, 2007; Luu et al., 2018; Social Security Administration, 2016; Wilson, Ryerson, Singh, & King, 2016). Since greater exposure to drugs is positively correlated with increased likelihood for misuse, the ambient level of a given drug in accessible markets, including licit prescription drugs, is important to consider as a possible influence on drug-related decisions (Cicero et al., 2007; Daniulaityte et al., 2006). Indeed, prescription drugs provide considerable opportunity for diversion and use for a variety of drug classes, including stimulants (McCabe, Teter, & Boyd, 2006). In one study Daniulaityte et al. (2009) found that prescription tranquilizer and prescription stimulant use were the strongest predictors of prescription opioid use. Steep increases in drug prescribing in the 1990s and 2000s contributed to subsequent increases in prescription drug diversion and misuse (Inciardi & Cicero, 2009).

For categorically illicit drugs, if a person lives in a place where there is a decreased availability of, say, cocaine, but an abundance of methamphetamine, then not only would the price of cocaine be expected to be higher and the price of methamphetamine lower, but additional costs associated with the acquisition of cocaine, in terms of labor and opportunity costs, would also be expected to increase (Kleiman, 1992). Drug preferences and the rewarding effects of drugs are important to consider here. Numerous pre-clinical studies have documented that the rewarding effect of a drug is positively correlated with learned behavioral responses, indicating increased willingness to work to obtain the drug (Everitt & Robbins, 2005). This means that people will be likely to spend more money and work harder for drugs associated with greater reward (and less punishment), or which are preferred relative to other drug choices (Herrstein, 1961, 1970; Katz, 1990).

It is also consonant with the idea of own-price elasticity of demand, which is the variation in demand to a commodity in response to variation in price (Bickel et al., 1992)⁵. Demand may be elastic, wherein increases in price significantly decrease consumption (e.g., a 35% price increase for OxyContin pills results in a 70% reduction in OxyContin pill purchases), or demand may be inelastic, wherein increases in price may only result in marginal decreases (e.g., a 35% price increase of OxyContin pills results in a 9% reduction in purchases). Heroin and cocaine are two specific drugs with price inelastic

⁵ Understood to be holding other factors constant.

demand, though demand and consumption is still responsive to fluctuations in price (e.g., at some cost they would be unattainable) (Bretteville-Jensen & Sutton, 1996; Bretteville-Jensen & Bjørn, 2003; Gallet, 2014; Olmstead, Alessi, Kline, Pacula, & Petry, 2015; Roddy & Greenwald, 2009; Saffer & Chaloupka, 1999). If cocaine was a person's preferred drug, then demand for cocaine for this person would be expected to be more inelastic. The person would be more likely to expend greater effort and resources to obtain cocaine should costs increase, with only very extreme or prohibitive costs modifying consumption. For some people with strong drug preferences, decisions to use their preferred drug may persist over time, irrespective of broader drug trends and fluctuations in price or availability (Brecht, Huang, Evans, & Hser, 2008; Falck, Wang, & Carlson, 2007). In addition to paying higher prices in local drug markets to acquire a preferred drug, a person might expend more effort (e.g., driving greater distances to purchase it), or might try accessing the drug on burgeoning avenues such as the Internet and Deep Web (Gilbert & Dasgupta, 2017; Kassab & Rosen, 2019; Quintana Mathé et al., 2017).

However, a person who prefers cocaine might also choose to substitute it with other drugs. These could include drugs with stimulant properties (e.g., amphetamines, cathinones), but could also include drugs with dissimilar pharmacology, but for which the associated costs are less than that of cocaine. In other words, changes in costs associated with one drug affect the consumption of others (i.e., cross-price elasticity of demand) (Bickel et al., 1995). For instance, following increased restriction of methamphetamine precursors in the US, methamphetamine cost temporarily rose, purity declined, and rates of methamphetamine-related service utilization and arrests decreased, while rates of cocaine use increased in some, but not all local drug markets (Borders et al., 2008; Cunningham, & Liu, 2003, 2005, 2008; Dobkin, & Nicosia, 2009; McKetin, Sutherland, Bright, & Norberg, 2011).

For people who prefer or frequently use heroin and cocaine concomitantly, (e.g., "speedballing"), it is conceivable that as demand for cocaine decreases due to increased price that heroin demand would also decrease (Ball & Ross, 1991; Leri, Bruneau, & Stewart, 2003). For this group, heroin and cocaine could be considered as compliments rather than substitutes, meaning that they are co-used with regularity and can be considered concurrent reinforcers (Bickel, DeGrandpre, & Higgins, 1995). For instance, alcohol and cocaine and nicotine and caffeine have been considered as compliments, demonstrating concurrently reinforcing effects and negative cross-price elasticity of demand (Bickel, Hughes, De Grandpre, Higgins, &

Rizzuto, 1992; Carrol, Rousaville, & Bryant, 1993; McCance-Katz et al., 1993). Again, it may be that cocaine is simply substituted for another stimulant, such as methamphetamine (e.g., “goofballing”), or that demand for heroin is independent, with changes in cocaine prices not resulting in commiserate changes in heroin demand and consumption. Research has demonstrated, though, that polydrug users are willing to substitute drugs across drug classes, even as drugs such as heroin and cocaine have demonstrated inelastic demand among regular users (Olmstead et al., 2015; Petry, 2001; Sumnall, Tyler, Wagstaff, & Cole, 2004).

Over the last decade, drug substitution has occurred en masse. Many prescription opioid users began purchasing heroin as prescription opioid supply decreased, prices increased, and abuse-deterrent pill formulations proliferated (Evans et al., 2018; Compton et al., 2016; Mallatt, 2017; Mars et al., 2014; Peavy et al., 2012; Rutkow et al., 2015). One result has been increased heroin demand, greater availability, lower prices, and increased consumption (Cicero, Ellis, Surratt, & Kurtz, 2014; Kanouse & Compton, 2015; Kilmer et al., 2014). Additionally, the supply of fentanyl and fentanyl analogues have proliferated, due in part to fentanyl’s potency and low distribution burden (Armenian, Vo, Barr-Walker, & Lynch, 2018; Ciccarone, 2017; Misailidi et al., 2018). However, the use of prescription opioids remains higher than heroin in some areas, particularly rural areas, even as rates of heroin use in suburban and rural areas continue to steadily increase (Borders & Wen, 2018; Cicero, Ellis, Surratt, & Kurtz, 2014; Day, Conroy, Lowe, Page, & Dolan, 2006; Havens et al., 2009; Wunsch, Nakamoto, Behonick, & Massello, 2009). The use of stimulant drugs differs across metro and non-metro areas and geographic regions, with cocaine often more available in metro areas, but methamphetamine increasingly available across localities (Brownstein, Mulcahy, Fernandes-Huessy, Taylor, & Woods, 2012; Gfroerer, Larson, & Colliver, 2007; Stover, Winstanley, Zhang, & Feinberg, 2018). It is important to emphasize, though, that cocaine has, to varying degrees, remained accessible in rural areas (Booth, Leukefeld, Falck Wang, & Carlson, 2006; Borders, Booth., Stewart, Cheney, & Curran, 2015).

It is also worth noting, that not all people who have used prescription opioids or who have access to heroin would choose to substitute the latter for the former, as heroin may be perceived to have higher relative risk (Daniulaityte, Falck, & Carlson, 2012; Inciardi et al., 2009; Inciardi & Cicero). Additionally, some drug users, including polydrug users, may have developed drug preferences and patterns of use over time that make them less likely to substitute their preferred drug for other drugs with similar psychoactive

effects and more likely to persist in the use of their primary drug. Evidence suggests that long-time cocaine and crack cocaine users may be less likely to use other stimulant drugs, and that co-use of cocaine and other stimulants is low among groups with greater cocaine use severity or longer use history (Booth et al., 2006; Borders et al., 2008; Falck et al. 2007; Wu et al., 2009). Further, drug users for whom cocaine is their primary drug, have persisted in cocaine use over time (>10 years), whereas primary users of methamphetamine and heroin showed gradual decline in respective use for the same duration of time (Brecht et al., 2008).

Lastly, it is important to consider that preference and decisions to use can be shaped by perceived drug quality and cost, with people reversing preferences for drugs based on increases or decreases in price and effort needed to obtain the drug (Caulkins, 1995; Goudie et al., 2007; Jacobs & Bickel, 1999). Preference for drugs may develop around a variety of factors beyond subjective effects. Conversely, some people may simply be less discriminant in their drug choice and therefore more willing to substitute preferred drugs with less preferred, but more accessible and affordable, drugs despite differences in subjective effects, quality, and known risk (e.g., substituting with fentanyl, synthetic cathinones, etc.) (Mars, Rosenblum, & Ciccarone, 2018; Smith & Staton, 2018).

In sum, drug accessibility and cost comprise part of the larger “system of constraint” within which people make decisions and allocate resources, as options in accessible drug markets provide choices with differing values, risks, and costs--all of which can motivate behavior differentially (Bickel, Mueller, MacKillop, & Yi, 2016). Although the region that a person lives in puts them in proximity to different markets, and therefore different drug choices, this proximity is just one factor that shapes drug-related decision-making and drug use. It is therefore also important to also consider the non-drug choices available to people.

Non-drug Alternative Reinforcers

As noted throughout this discussion, numerous aspects of a person’s history and everyday life have the potential to influence cognition and choice, and the potential to reinforce behavior. Recall that opioids and stimulants are potent reinforcers that can result in reinforcer pathology. This is due to the rewarding drug effects that can contribute to repeated use and/or habituated use that persists despite adverse consequences, including criminal justice involvement (Bickel, et al., 2011; Everitt & Robbins, 2005).

Aspects of a person's life apart from drugs may also be considered in terms of how they reinforce behavior. The importance of considering the role of non-drug alternative reinforcers using behavioral economics can be summarized by Bickel et al. (2014) thusly:

[The] behavioral economics perspective gives equal weight to the larger environmental context within which addictive behavior takes place and, more specifically, the alternative reinforcers to which a person has access....A behavioral economics perspective is a molar account of addiction, focusing on aggregates of behavior, not instances, and both the endogenous conditions of the organism and exogenous characteristics of their environment. Put simply, a person's internal motivational state and the alternative reinforcers available in the environmental context are theorized to jointly determine the decision to use or not to use a drug. From this perspective, the yin and yang of addiction are high levels of endogenous factors (high [drug] demand and impulsive discounting) and low levels of exogenous factors (alternative reinforcers). Furthermore, a recursive etiological process is proposed to be operative for alternative reinforcers over the course of the development of a substance use disorder. For example, an individual may begin drinking recreationally and as part of a diverse repertoire of positively and negatively reinforcing behaviors. But, as use escalates and negative consequences mount (e.g., dissolution of a relationship, loss of a job, legal difficulties), the availability of these alternative reinforcers diminish, which commensurately increases the reinforcing effects of alcohol (Rachlin, 1997). This recursive etiological feedforward loop illustrates the classic vicious cycle of addiction (e.g., the primrose path model of addiction formulated by Herrnstein & Prelec, 1992) (p.654).

Many preclinical models have demonstrated that non-drug alternative reinforcers (e.g., saccharin, food, water, access to conspecifics/social interaction) are chosen over drugs such as cocaine or morphine, depending on the dose and effort associated with choice (Ahmed, 2010; Tarou & Bashaw, 2007; Cantin et al., 2010; Lenoir, Sere, Cantin, Ahmed, 2007; Venniro, Zhang, Shaham, & Caprioli, 2017; Zernig, Kummer, & Prast, 2013). Among humans, non-drug reinforcers could include a wide-range of things. Non-drug alternatives might include exercise, money, work, school, close relationships with family or friends, hobbies, educational participation, or group membership (e.g., church, civic organizations, or mutual aid/12-Step groups) (Comer et al., 1998; Donlin, Knealing, & Silverman, 2008; Etten, Higgins, Budney, &

Badger, 1998; Greenwald & Steinmiller, 2009; Higgins, Bickel, & Hughes, 1994; Morral, Iguchi, & Belding, 1999; Petry, Tedford, J., & Martin, 2001; Quick, Pyszczynski, Colston, & Shahan, 2011; Rogers et al., 2008; Waldorf et al., 1992; Zlebnik, & Carroll, 2015). Although the possible number of non-drug alternative reinforcers that people could encounter is almost limitless, and could conceivably include abstractions (e.g., religious belief, life meaning, values), one type of non-drug alternative that may serve as a particularly effective behavioral reinforcer is social interactions and close connection with others (Laudet & White, 2008; Ostafin & Feyel, 2019). Although social interaction and close relationships are often associated with enhanced health and well-being, choice of relationships over drugs is not a given when the two are placed in direct competition. This is reflected indirectly by high divorce rates and low rates of sustained family reunification among active or recently remitted drug users (Brook & McDonald, 2009; Brook, McDonald, Gregoire, Press, & Hindman, 2010; Collins, Ellickson, & Klein, 2007; Lloyd & Akin, 2014).

Still, prosocial interactions and relationships may constitute one of the most potent non-drug alternatives a person could gain access to, given that social interaction, play, and bonding are intrinsically rewarding within and across sexes and species, and have demonstrated potential to attenuate drug use ⁶ (Fritz et al., 2011; Heilig et al., 2016; Kohtz, Lin, Smith, & Aston-Jones, 2018; Peirce, Frone, Russell, Cooper, & Mudar, 2000; Smith, 2012; Strickland & Smith, 2014; Vanderschuren, Achterberg, & Trezza, 2016; Zernig, Kummer, & Prast, 2013; Venniro et al., 2018).

Ultimately, non-drug alternatives help define the range of choices available to people, but also have the potential to be rewarding in the short- and long-term (e.g., relationships, school, hobbies) (Herrnstein & Prelec, 1991). There is the possibility, then, that certain non-drug alternatives can have both a high local and overall utility (Herrnstein & Prelec, 1991). This is important in terms of their potential to influence decisions at one time point and across time, as well as in terms of providing satisfying, but durable, alternatives to drug use. Additionally, non-drug alternatives may reinforce behavior in terms of opportunity cost, wherein the opportunity cost for a given choice is defined as equal to the best alternative

⁶ It is worth mentioning that, for people, studies have consistently found money to also be a potent behavioral reinforcer as well (see Higgins et al., 2008). Money, somewhat depressingly, was also ranked by Americans as one of the things that “gives their life meaning”, with money outranking family and other activities for some respondents (Pew Research Center, 2018).

not selected (Bickel et al., 1993, 2014). When drugs are in direct competition with a set of potentially rewarding alternatives, the opportunity cost of drug use increases and may motivate decisions not to use drugs; for instance, if food and a drug were in direct competition, the opportunity cost of choosing the drug would be not eating and, over time, eventual starvation (Caprioli, Zeric, Thorndike, & Venniro, 2015).

For corrections-involved people, community supervision and drug court (which includes drug monitoring and sanctions) have the capability to serve as additional behavioral reinforcers (Marlowe & Wong, 2008; Petry et al., 2006). Here, some abstinence-promoting behaviors may be reinforced by threat of unfavorable consequences. For someone who uses heroin while on probation, the opportunity costs associated with use and subsequent punishment may be extreme, such as incarceration.

In real-world circumstances, it is not always clear when a decision to use drugs is in direct competition with alternatives. For instance, a person could choose to use hydrocodone while simultaneously engaging in other rewarding activities (Vanderschuren, Spruijt, Hol, Niesink, & Van Ree, 1995). In other words, taking hydrocodone and pursuing non-drug choices are not necessarily mutually exclusive. Often, instead of direct competition between drugs and non-drug alternatives, there are contingencies that a person must navigate when making decisions. For example, a man's romantic partner threatens to divorce him if he continues to smoke crack cocaine each weekend. Because smoking crack and being married are not necessarily mutually exclusive, it is possible for him to do both, until the point where they do become mutually exclusive (e.g., the partner leaves, with reunification explicitly contingent on abstinence from crack cocaine). Additionally, the credibility and likelihood of the partner's threat coming true will influence its reinforcing effects, with less credible threats (e.g., divorce) or rewards (e.g., staying married) being discounted in terms of probability (Rachlin et al., 1991).

In this scenario the man loves his partner and does not want her to leave. He discontinues his crack cocaine use. Here, the presence of the man's partner in his life is rewarding and her stipulations, that in order for her to stay he must stop smoking crack, are sufficiently reinforcing. This rewarding non-drug alternative that has been put in direct competition with drugs has resulted in a decision to not use crack. Considering this same scenario between drugs and a relationship with another person, but where the relationship is not characterized as close or where the quality of it has deteriorated, suggests that the non-drug alternative may not have a similarly reinforcing effect (Homish, Leonard, Kozlowski, & Cornelius,

2009). To put this in perspective, consider the effort a person might undertake for their child, but not for an acquaintance or co-worker. Consider, too, the difference in magnitude of reward received interacting with a partner, child, or close friend compared to that received from interactions with strangers or acquaintances.

Take another example of a man who smokes crack cocaine on the weekends. In this scenario, however, the man is on probation and subject to drug monitoring. The man knows the date he will see his probation officer next month, but does not know for certain if he will be drug tested on this next visit. He also knows that his probation officer could make an unannounced visit to randomly drug test him. He has been told that if he has another positive drug test, his probation will be officially “violated” and a judge will determine his sentence. He could receive a minimum of one year and a possible maximum of six years in prison. Here, there are clear potential losses, but the probability of those consequences occurring is unclear. Further, the certain risk involved in meeting with the probation officer is one month away. The reinforcing effect of the probation officer and drug testing is real, but it is in the future, and the results of the interaction uncertain. This non-drug alternative reinforcer is thus influenced by the steepness of the man’s temporal and probability discounting which, as discussed earlier, may be influenced by many other factors. For this man on probation, there is a certainty that he will be drug tested in the future and that a negative drug screen will not result in arrest. There is no certainty of when the drug screening will occur or what the exact consequences of a positive drug screen would be. Here, the magnitude of the reinforcer may vary as a function of time (e.g., the closer to the next appointment with his officer the less likely he is to smoke crack cocaine).

Both examples illustrate how the uncertainty associated with a behavioral reinforcer for which the effects are delayed makes decision-making more complicated, and also implies that people may be biased toward choosing drugs due to the fact the drug effects are nearly immediate and approximately certain.⁷ Importantly, the *risk* of choosing drugs in both examples is clear, due to the uncertainty and severity of potential outcomes. In both examples, there are potential rewards (e.g., intact relationship, intimacy, companionship, not having probation violated, remaining free) and losses (e.g., divorce, incarceration) that

⁷ By “approximately certain” it is meant that there is an outcome expectancy for drug reward or effect in a generic sense; it is, of course, inevitable that the potency of drug effects vary across doses due to changes in drug quality, as well as physiological states and contexts (e.g., possibility of have been sold ineffectual drugs, hormonal fluctuations, etc.) (Kepler, Kest, Kiefel, Cooper, & Bodnar, 1989).

must be considered, in addition to the reinforcing effects of crack cocaine. In other words, smoking crack cocaine each weekend does not occur in a vacuum. In both examples, the opportunity cost of choosing not to smoke crack cocaine would simply be not getting to smoke crack cocaine⁸. For some, such an opportunity cost may be perceived as too great due to the overvaluation of the drug in the immediate, the undervaluation of non-drug alternatives.

Restricted Opportunity for Accessing Non-Drug Alternatives

Ultimately, it is the presence or absence, and the potential for variation, of these non-drug alternative reinforcers that defines the choices available to a person and serves to influence what decisions are made. One way to think about the role of alternative reinforcers is to consider that the more that a person has, or the more they have the opportunity to access, the greater the potential opportunity costs. Another way to think about them is to consider that in the absence of rewarding alternatives, drugs may retain a high local and conceivably, under extreme conditions, even a higher overall utility; in such extreme circumstances the overall utility, in the traditional sense, becomes irrelevant or nonsensical. Without, or with far fewer, non-drug choices the rewarding effects from drugs may be greater, potentially contributing to reinforcer pathology (Ahmed, Lenoir, & Guillem, 2013; Bickel et al., 2011). A person who does not have friends or family would not be able to choose these relationships over drugs. If a person does not have a romantic partner to enjoy the company of, then there is no reward to be had and no partner-loss to incur in its absence. It simply does not exist as a non-drug alternative and thus cannot motivate decision-making and behavior in relation to drugs.

This idea may be extended to more broadly consider how the absence of abundant opportunity for accessing non-drug alternatives might influence decision-making. As noted in the first chapter, in order to influence decision-making, people need only know that certain options exist and that there is opportunity and ability to access them in order to motivate behavior (recall the chocolate cakes and apple pies). Thus, while a person may not currently have non-drug alternatives such as close friends, employment, group affiliation, or educational participation, they still have *potential* to acquire these things. However, for

⁸ It is conceivable that there are also some other hidden opportunity costs under particular circumstances and for particular drugs. If a person is using opioids so as not to go into withdrawal or not to be crippled by pain so that they can go to work and keep their job, then there would be a string of related opportunity costs. In this example of irregular crack cocaine use, this would be less likely.

people with less proximity to opportunities for such acquisition, non-drug alternatives may remain limited, constraining choice proportionately. In line with some of the findings discussed earlier related to the detrimental effects of social isolation, studies have demonstrated that, compared to impoverished environments, enriched environments with greater access to rewarding non-drug alternatives (e.g., social interaction, food, activities) can attenuate drug-taking (Bardo, Neisewander, & Kelly, 2013; Imperio et al., 2018; Marlatt, Baer, Donovan, & Kivlahan, 1988; Nader & Banks, 2014; Panebianco, Gallupe, Carrington, & Colozzi, 2016; Strickland & Smith, 2015; Solinas, Chauvet, Thiriet, El Rawas, & Jaber, 2008; Venniro et al., 2018). Yates et al. (2017) found that in enriched environments, demand elasticity for cocaine increased. Similarly, Hofford et al. (2017) found that value and reinforcer strength for remifentanyl was lower among rats housed in enriched environments.

People who live in resource scarce, economically distressed, or otherwise “harsh” regions (e.g., higher poverty, greater prevalence of violence, disability, mortality, fewer treatment providers, etc.), or in areas with less social cohesion and fewer opportunities for prosocial connection, may be considered to live in impoverished (verses enriched) areas, in that they have comparatively less accessibility to non-drug alternatives (e.g., relationships, education, employment, money, school, group affiliation, entertainment) (Dew, Elifson, & Dozier, 2007; Erickson, VanLooy, von Schrader, & Bruyère, 2018; Monnat, 2018; Zoorob & Salemi, 2017). Highly urban or highly rural areas, including those within central Appalachia, may be considered “harsh” environments, wherein some opportunities for accessing rewarding non-drug alternatives are restricted, despite the fact that close social, cultural, and spiritual connections can be found in both locales (Case & Deaton, 2017; Diddle & Denham, 2010; Donnermeyer, Jobes, & Barclay, 2006; Eller, 2008; Lee, Maume, & Ousey, 2003; Meit, Heffernan, Tanenbaum, & Hoffmann, 2017; Oser, Harp, O'Connell, Martin, & Leukefeld, 2012; Snell-Rood & Carpenter-Song, 2018; Tonkiss, 2005; Williams, Palar, & Derose, 2011). It is perhaps unsurprising that rates of SUD, and rates of opioid and stimulant use in particular, are high in these areas (Moody, Satterwhite, & Bickel, 2017). Sadly, prolific drug use within a region may come to further qualify it as “harsh”, insofar as drug use can initiate and perpetuate a cascade of loss and breakdown in social cohesion (Mack, Jones, & Ballesteros, 2017; Monnat, 2018; Orsi, Yuma-Guerrero, Sergi, Pena, & Shillington, 2018; Oser et al., 2011; Zoorob & Salemi, 2017). This means that

drug use can potentially be understood as both cause and consequence of harsh environments. Bleakness begetting bleakness.

As noted earlier, living in “harsh” conditions can foster a sense of uncertainty about one’s future, influencing cognition and decision-making. In the last two decades, many rural and urban regions have experienced rapid changes due to globalization, deindustrialization, shifting demographics, and technological innovation, meaning that some areas that may have already engendered feelings of uncertainty about the future, had an increased potential to do so (Case & Deaton, 2017; McLean, 2016). In the presence of such existential uncertainty, and in the absence of opportunity for accessing rewarding non-drug alternatives, opioids and stimulants, despite their deadly risk, may still hold value. This is not to say that suburban communities necessarily guarantee access to opportunity or ensure protection from conditions which might create a scarcity mentality (Allard, 2017). Therefore, when identifying how the region a person lives in might shape their decision-making, it is important to avoid overgeneralizations and to consider possible gradations in “harshness” between regions.

The counter to all this is that people may have few non-drug alternatives, have only very weakly reinforcing non-drug alternatives, or may live in areas with fewer opportunities for accessing rewarding non-drug alternatives, but may still choose to not ever use opioids or stimulants, to moderate their use, or to discontinue use without prospects changing; and that people with abundant access to non-drug reinforcers may still choose to use opioids and stimulants (Bozarth, Murray, & Wise, 1989); Davis, 2014; Grant, 2007; Premac, 2017; Miller, 2004). Indeed, there are ultimately many factors with the potential to influence decisions to use and decisions not to use. The importance of considering alternative reinforcers, however, is articulated in research showing that the presence or absence of certain conditions reliably influences behavior (Dayan & Balleine, 2002). It is also articulated by the possibility that the presence of rewarding non-drug alternatives, like a job, relationships, group participation,--and the sense of belonging, responsibility, and meaning that can come with these things (Laudet & White, 2008; Petry et al., 2001; Pew Research Center, 2018)-- has the capacity to make people more vested in their lives, helping to produce what Waldorf et al. (1992) refer to as “a stake in the conventional life”. This concept is important, because implicit in it is a connection between a person’s current *and* future self. For people who have a stake in the conventional life, who are truly vested in their everyday roles and in their future, the breadth of opportunity

costs from using high-risk drugs has the potential to be nothing less than heartbreaking. For people who continue to use high-risk drugs without access to the types of rewarding alternatives that might foster a stake in the conventional life, the unrealized human potential is no less heartbreaking.

Study Aims Overview

Having discussed how a behavioral economic approach considers that both endogenous and exogenous factors influence drug-related decision-making and behavior, and having detailed several factors with the potential to exert such influence in relation to opioids and stimulants, it is important to reiterate that these factors can vary across people, and that people's lives are always in a state of flux. The same factors that may have contributed to a decision to use opioids or stimulants at one time may not be present at a later time. For corrections-involved people with a history of drug use, decision-making about opioids and stimulants may change subsequent to losses incurred as a result of their use, such as incarceration.

Given the high-risk nature of opioid and stimulant use, and the many constraints on decision-making and behavior, it is important to identify, explore, and describe what factors with the potential to influence drug-related decision-making and behavior are associated with opioid and stimulant use among corrections-involved adults residing in a state that continues to experience high rates of opioid and stimulant use, and where the risks associated with use are well-known (Havens et al., 2011; SAMHSA, 2016). Kentucky is an ideal state for such exploration. Many corrections-involved adults in Kentucky with a history of drug use have likely experienced or observed adverse consequences related to high-risk drugs first-hand. As noted earlier, the region that a person lives in can influence cognition, behavior, and drug choices. Regional differences in Kentucky can be stark, meaning that the area that a person resides in has the potential to shape both choice and behavior. People who reside in Central Appalachia, the Easternmost part of the state, may be considered to live in a "harsh" region compared to people who live in Central and Western parts of Kentucky outside of Central Appalachia. Given the insular nature of Central Appalachia, the persistently high rates of morbidities and disabilities, and the region's greater rurality, it is likely that drug markets within this area of Kentucky also influence drug-related decision-making and behavior.

Using behavioral economics as a molar framework for exploring high-risk drug use among corrections-involved adults in Kentucky prior and subsequent to incarceration, several questions can be addressed: What endogenous and exogenous factors with the potential to influence decision-making about

high risk drugs prior and subsequent to incarceration can be identified using available data sources? What differences are observed between groups who use different types of high-risk drugs during these periods, including the geographic areas in which they reside? What factors are associated with an increased likelihood of observing high-risk drug use during these periods?

Specific Study Aims

The primary aim of this study is to explore high-risk drug use among a sample of corrections-involved adults in Kentucky and to identify and discuss endogenous and exogenous factors with the potential to have influenced drug-related decision-making prior and subsequent to incarceration. This will be accomplished with three specific study aims.

Aim One

Provide a descriptive profile of a sample of adults in Kentucky with a history of drug use prior and subsequent to incarceration using self-report data collected during intake into a corrections-based drug treatment program and self-report data collected during the one-year period subsequent to incarceration for years 2012-2017. Determine the prevalence of concomitant opioid/stimulant use, opioid use, stimulant use, and other and/or no drug use that occurred during the 30-day period prior to incarceration and the one-year period subsequent to incarceration. Provide a description of these drug use groups and identify between-group differences. This includes identifying differences in the use of specific opioid and stimulant drugs by participant residence across an urban-rural continuum, as well as differences in the use of specific opioid and stimulant drugs by participant residence within or outside of Central Appalachia.

Aim Two

Identify factors associated with a change in likelihood of observing concomitant use, opioid use, and stimulant use during the 30-day period prior to incarceration and the one-year period subsequent to incarceration, compared to an outcome with less risk, such as the use of other drugs and/or no drug use.

Aim Three

Because heroin was the drug associated with the highest risk in the US during the one-year post-release period for participants in this sample (2012-2017), it is of interest to also determine the prevalence of heroin use that occurred during the one-year period subsequent to incarceration, the between-group

differences among those who did and did not report heroin use, and to identify factors associated with an increased likelihood of heroin use.

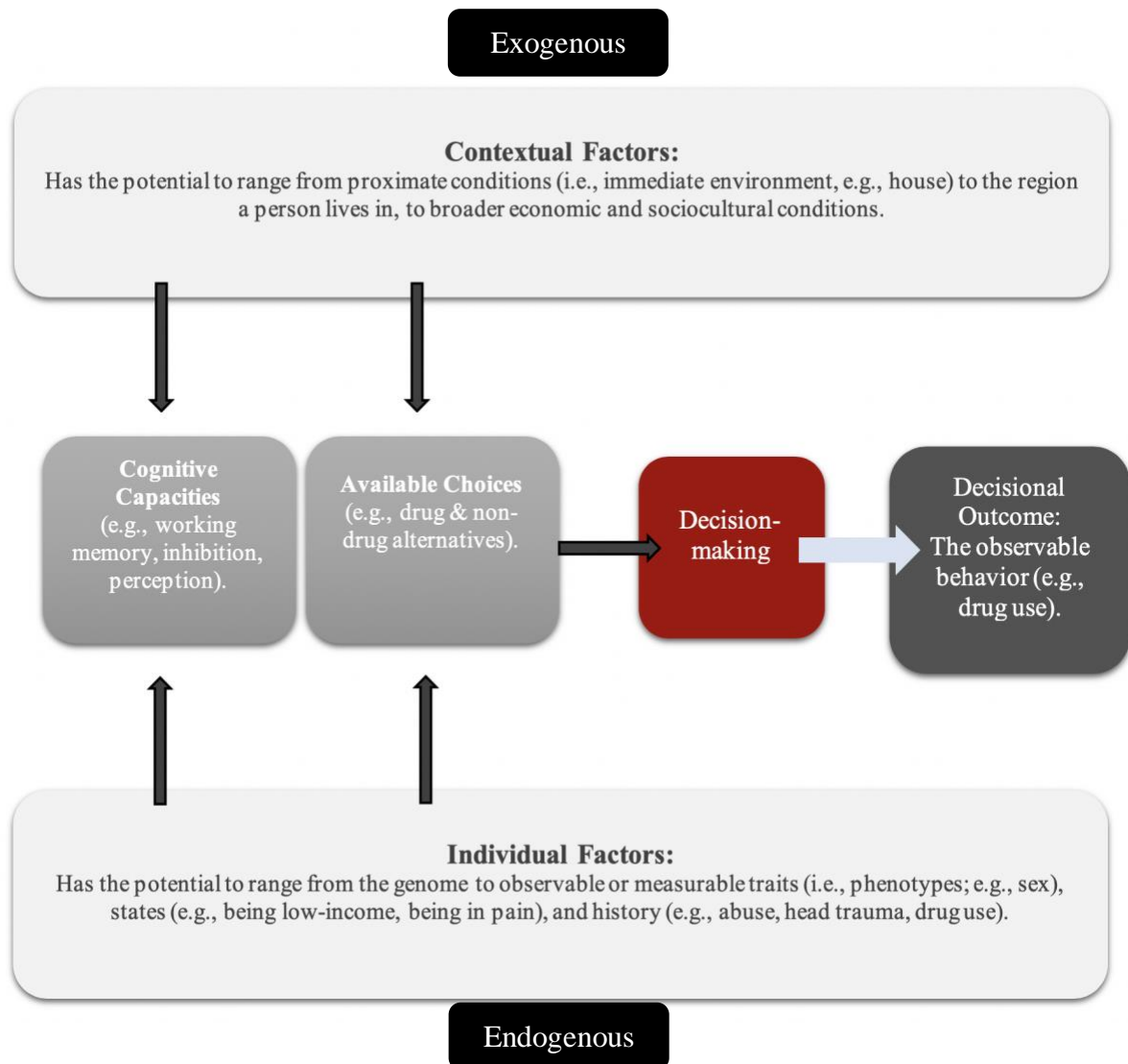
CHAPTER III

METHOD

Chapter 1 provided an overview of some of the well-known risks associated with opioids and stimulants. It also introduced behavioral economics as a conceptual approach for understanding drug-related decision-making. In Chapter 2, many endogenous and exogenous factors with the potential to influence drug-related decision-making were discussed and situated within a molar view of choice and behavior. For instance, scarcity might contribute to a person to becoming more present-biased, more prone to discount the future, and more likely to evidence poorer decision-making. Stress and living in a harsh environment can contribute to greater reliance on more automatic, habituated, lower-level cognitive systems, rather than higher-level, deliberative cognitive systems. Prior opioid use can increase the likelihood of continued opioid use. Residing in an area that is more rural, may restrict access to a wider variety of drugs, compared to urban drug markets.

A simplified way to think about the previously discussed factors (and others not discussed here), is to consider that they have the potential to influence decision-making in roughly one of two ways: 1) Influencing a person's cognitive capacity to make decisions that maximize overall utility (versus choosing immediately rewarding options with higher local, but lower overall utility); and/or 2) Influencing the set of drug and non-drug choices available or accessible to people. This simplified conceptual model of how endogenous and exogenous factors have the potential to influence drug-related decision-making and drug use is displayed in Figure 1.

Figure 1. Concept model of endogenous and exogenous factors with potential to influence drug-related decision-making by constraining cognitive capacities and by constraining choice.



Importantly, both types of influence can occur at the level of the person or at the level of the person’s context or environment. When Bickel et al. (2014) describes the “yin and yang of addiction” as high levels of endogenous factors and low level of exogenous factors, this is, in part, what they are referring to. Behavioral economics understands that endogenous factors can also be influenced by exogenous factors so as to influence cognition, affect, and decision-making. This general idea, that organisms are influenced by their environment, spans many disciplines. That context can influence decision-making and behavior was hopefully made apparent in literature reviewed in the previous chapter.

Ideally, that overview also made more apparent that the “system of constraint” in which people make decisions is not unidimensional (Bickel & Marsch, 2000; Bickel et al., 1995). Rather, people are constrained across levels. People are constrained by their capacities (traits and states), by their contexts, and by the choices for behavior available to them. The specific configuration of endogenous and exogenous factors that constrain people’s decision-making in relation to opioids and stimulants differs by person. At the group level, some endogenous and exogenous factors with demonstrated potential to influence decision-making may be observed for given time periods. In this chapter, methods are proposed for identifying some of these factors among a sample of drug users prior and contemporaneous to incarceration and participation in corrections-based treatment. Discussion of findings and their implications will be considered in subsequent chapters.

Data Sources and Sample

Data Sources

In order to address the aims of this exploratory study, secondary data analyses were conducted using individual-level and county-level data. All individual-level data were collected as part of the Criminal Justice Kentucky Treatment Outcome Study (CJKTOS). CJKTOS is ongoing evaluation of the KY DOC Substance Abuse Treatment Program (SAP). CJKTOS was initiated in April 2005 with the primary objectives of better understanding the population served by SAP and assessing the effectiveness of SAP in reducing drug use and recidivism. CJKTOS is conducted by the University of Kentucky’s Center on Drug and Alcohol Research (CDAR) and is funded on an annual basis through a contract with the KY DOC. SAP is available to adults involved with the KY DOC who have a history drug use or who are currently KY DOC-involved due to a drug-related offense. People may voluntarily enroll in SAP and SAP aftercare, or may be mandated by a judge or parole board. While the majority of SAP participants are mandated (approximately 75%), even those who volunteer are incentivized, in that SAP participation may be regarded favorably by the parole board. Moreover, all SAP participants who successfully complete the program receive a 90-day sentence reduction. SAP is delivered by trained clinicians in Kentucky jails, prisons, or in secure DOC-affiliated community residential facilities that constitute controlled environments and correctional custody.

SAP lasts approximately six months. During this time, it is expected that participants will indicate therapeutic progress in a variety of ways. Progress indicators include demonstrating a willingness to change, completing recovery-related assignments, engaging in group activities, adhering to institutional and SAP regulations, and holding themselves and other SAP participants accountable for attitudes and behaviors considered antithetical to the broad therapeutic goals of SAP. These goals include reducing or extinguishing drug use through cognitive, spiritual, and behavioral modification. Although there is variability across correctional institutions in terms of how SAP is delivered (e.g., amount of individual time with a counselor versus time spent in groups), all programs are styled as a residential therapeutic community grounded in 12-Step principles and cognitive behavioral modalities, and each uses structured materials (e.g., workbooks, readings) to facilitate treatment.

Subsequent to release, SAP participants who still reside in Kentucky are either paroled onto community supervision or are released having “served out” their time, such that they are not mandated to community supervision. On any given year, a majority of CJKTOS participants are on community supervision subsequent to release. Some of the terms of community supervision include abstaining from alcohol and drug use, not associating with known felons, monthly reporting to a parole officer, random drug monitoring (e.g., urine analyses, breathalyzer), and mandated participation in recommended services (e.g., aftercare) and/or completion of reentry tasks (e.g., obtaining employment, driver’s license, etc.).

CJKTOS data includes data collected by CDAR research staff, data collected by SAP clinicians, and institutional data provided by the KY DOC and community supervision officers. Parole officers, KY DOC officials, and social service clinicians enter information about offenders (e.g., supervision notes, program referrals, drug screen results, parole violation reports, reincarceration dates, institution location etc.) electronically into the web-based Kentucky Offender Management System (KOMS).

Individual-level CJKTOS data include several different types of information (e.g., age, employment status) and also include the counties that participants resided in prior and subsequent to incarceration. County-level self-report data was used to determine the relative rurality of participants’ county of residence by examining urban influence designations, as well as the proportion of participants who resided in one of fifty-four counties in Kentucky that fall within Central Appalachia. In addition to CJKTOS data, publicly available data measured at the county-level were obtained for this study from state

and federal entities for all 120 Kentucky counties. These entities include: Alcohol Beverage Control, Appalachian Regional Commission, the Federal Communications Commission, the Kentucky Cabinet for Health and Human Services, the Social Security Administration, and the U.S. Census Bureau. Using participants' counties of residence prior and subsequent to incarceration allowed for the possibility of matching individual cases with corresponding county data, thus potentially providing an additional level of measurement.

Individual-level and county-level data have been successfully integrated and analyzed by many researchers, and are included among investigations examining county or regional influence on a variety of outcomes. Such outcomes include drug use, drug-related health outcomes, depression, recidivism, obesity, self-rated health, quality of life, and mortality (Blakely, Lochner, & Kawachi, 2002; Goodman, Huang, Wade, & Kahn, 2003; Jia, Moriarty, & Kanarek, 2009; Kim, Subramanian, Gortmaker, & Kawachi, 2006; Lochner, Pamuk, Makuc, Kennedy, & Kawachi, 2001; Muramatsu, 2003; Orrick et al., 2011; Patrick et al., 2019; Subramanian, Kawachi, & Kennedy, 2001). The growth of social epidemiological methodology and the expanded awareness of multi-level social determinants of health have increased the availability of publications describing how the integration and analysis of multiple data sources and types can be accomplished, and how data may be examined within and across levels (Blakely & Woodward, 1999; Diez-Roux, 2000; Duncan, Jones, & Moon, 1996; Galea, Hall, & Kaplan, 2009; Jia, Muennig, & Borawski, 2004; Soobader, Cubbin, Gee, Rosenbaum, & Laurenson, 2006; Macintyre, Ellaway, & Cummins, 2002; Pickett & Peral, 2001).

Data Collection

In implementing CJKTOS, the KY DOC and CDAR worked to develop a baseline instrument that functions as a psychosocial assessment of incoming SAP participants as well as a data collection tool. Information self-reported by participants is used by SAP clinicians to help evaluate participants' psychosocial and drug use histories. All SAP baseline data are de-identified, aggregated, and analyzed as part of CJKTOS (e.g., outcome evaluation reports). Every SAP participant completes a baseline survey "assessment" as part of the standard enrollment process into the treatment program.

Baseline Data Collection

Baseline data are collected after a person has been referred to SAP, but prior to treatment initiation. Baseline data collection is conducted by a trained SAP provider at their respective location (e.g., jail, prison, community-based DOC facility). Baseline surveys are completed in one of two ways: 1) A trained SAP provider administers the survey by reading items aloud to participants and then recording responses into the secure, university-operated web-based Client Information System (CIS); 2) Participants self-administer the baseline survey electronically into the CIS online survey platform, seeking assistance from the SAP provider as necessary. The total number of baseline survey questions varies between years, and between participants within years, given that certain responses may prompt automatic follow-up questions, thereby increasing the number of questions asked. Across years 2012-2017, the maximum number of possible individual baseline survey items ranged from approximately 232-261, though this is likely far more questions than participants typically respond to. The baseline survey takes approximately 1 hour to complete.

Follow-up Data Collection

Follow-up data are collected approximately 12 months subsequent to a participant's release. To be eligible for follow-up, the person must have participated in SAP, consented to participate in the CJKTOS follow-up portion of the study, and have a release date from a KY DOC institution following SAP participation that is verified using KOMS. Consent for study participation is typically over half of all SAP participants. For instance, between 2010-2018, 57.3% of people who completed a CJKTOS baseline survey as part of their SAP assessment (N=43,390) consented to be contacted in the one-year post-release period as part of the CJKTOS follow-up study. CJKTOS uses randomized proportionate sampling, whereby SAP participants who consented to be contacted for follow-up interviews are randomly selected for inclusion into a given FY's follow-up sample. This method is utilized to help ensure that each FY the follow-up sample reflects the entire SAP population released for the same FY period for characteristics such as gender, race, SAP program type (e.g., jail, prison, community-based), so that findings from the follow-up sample can be generalized (Shadish et al., 2002). The final FY follow-up sample is thus an approximate representation of the total state population of SAP participants (Lavrakas, 2008b). Participants included in the follow-up pool become eligible for contact and data collection 10 months from their release date. The

follow-up window closes 14 months from participants' release date. The CJKTOS follow-up rate for FYs 2013-2017 is as follows: FY13=82.0%, FY14=81.0%, FY15=80.0%, FY16=83.0%, FY17=84.0%. This means that of the total follow-up sample pool, 16-20% of participants for which contact attempts were made did not complete interviews, either because contact attempts were unsuccessful, or because the participant chose not to complete the interview. Follow-up refusal rates for FYs 2013-17 range from 4%-7%.

During the follow-up data collection window, trained CDAR research staff use information provided by participants at baseline, in conjunction with more current contact information obtained from KOMS, to facilitate contact. KOMS also provides contact information for relatives and associates of participants (e.g., mother, fiancé, children) and information about the known location of participants who are on community supervision or who have been reincarcerated. Facebook and VINELink, an online inmate search tool, are also used to search for participants who cannot be readily located using self-reported contact information or KOMS. The use of social media, including Facebook, for locating and contacting research participants is increasingly common and well supported, particularly among rural, drug-using, transient, or otherwise difficult-to-reach populations (Bolanos et al., 2012; Dickson et al., 2017; Staton et al., 2018).

Research staff make repeated attempts to contact participants via telephone, direct mail, and social media until successful contact is made, or until the 14-month follow-up contact window closes. When making contact through these means, the study is referred to as a "UK Health Study" so that sensitive information related to correctional involvement and drug use is not inadvertently disclosed. Participants must verify their date of birth prior to study specifics being disclosed. At follow-up, participants are reminded of the voluntary nature of the study and asked if they would like to participate in the follow-up interview, which is conducted via telephone at their convenience. Approximately 30-35% of CJKTOS follow-up interviews are conducted with participants who are currently in jail or prison, meaning that subsequent to release they either violated the terms of their community supervision or were arrested for a new offense. Prison and jail interviews are also conducted via telephone and are scheduled by coordinating with correctional facility staff.

Before beginning any follow-up interview, the identity of participants is verified using birthdate, release date, and the SAP institution of record. Research staff read questions from the follow-up instrument aloud and enter participant responses into CIS. The number of follow-up survey items also varies between FYs and between participants within FYs based on response patterns. Between 2012-2017, the maximum possible number of unique follow-up survey items ranged from approximately 201-232. Again, it is unlikely that all questions would be asked. The follow-up interview takes approximately 30 minutes to complete. Compensation, in the form of a \$20 check, is provided via direct mail only to participants who complete both baseline and follow-up surveys. Some information self-reported by participants (e.g., release or rearrest dates, program completion, recidivism, parole status) is cross-referenced and verified by CDAR research staff using KOMS and KY DOC records.

Study Inclusion Criteria

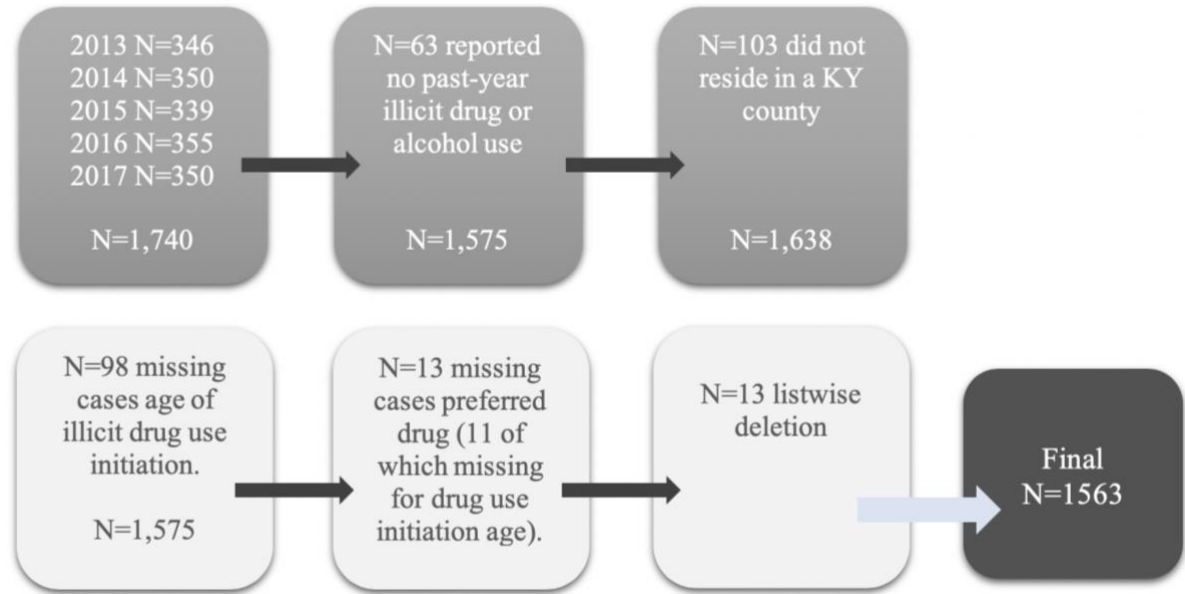
Cases were included in the sample if they met the following four criteria: 1) Verified SAP participation; 2) Completed CJKTOS baseline interview; 3) Completed CJKTOS follow-up interview for 2012-2017; 4) Reported residing in a Kentucky county for the majority of months (>6) out of the one-year period prior and subsequent to incarceration. Kentucky residency for participants who became reincarcerated after release was determined using the county that participants self-reported that they would be residing in if not incarcerated, versus designating the county of incarceration as the county of residence; 5) Reported alcohol or illicit drug use for the one-year period prior to incarceration. The latter criterion was included due to the fact that some SAP participants are enrolled in SAP due to drug-related charges (e.g., drug trafficking), but not necessarily due to drug use. As lifetime history of drug use is not assessed as part of CJKTOS, but rather only past-year and past 30-day use, no satisfactory determination could be reached as to what the nature of participants' drug use history entailed. Such ambiguity would hinder conceptualization of the sample and interpretation of findings. Further, even for cases where some history of drug use could be discerned using the variable of "age of illicit drug use initiation", the inclusion of such cases into the sample was still untenable due to the numerous drug-related variables that were missing for the time periods of interest.

Final Sample and Missing Data

The sample is comprised of men and women age >18 with a history of drug use who participated in KY DOC SAP between 2012-2017. As displayed in Figure 2, a total of 1,740 CJKTOS participants completed follow-up interviews for FYs 2013-2017. It was determined that the first three study inclusion criteria (i.e., SAP participation, completion of both baseline and follow-up surveys) were met for all cases. Using zip code or county residence self-reported by participants, a total of 102 cases were identified as residing in a county outside of Kentucky for the majority of months (>6) of the one-year period prior and subsequent to incarceration. Removing these cases resulted in a sample size of N=1,638. Cases were then examined to see if the last inclusion criterion of past-year alcohol and/or illicit drug use was met. This was accomplished by examining responses for the baseline survey item “I did *not* use *any* illegal drugs in the 12 months prior to incarceration” (0=“no” vs. 1=“yes”), in conjunction with the dichotomized responses for the baseline survey item “During the 12 months before you were incarcerated, how many months did you use any alcohol?” (0= “no alcohol use” vs. 1-12= “alcohol use”). A total of 148 participants reported no past-year illicit drug use. Of these, 63 also reported no past-year alcohol use. These 63 cases with no past-year illicit drug use *and* no past-year alcohol use were removed, resulting in a sample size of N=1,575.

Two variables were identified as having missing data for unexplained reasons, as these variables appeared in all FY 2013-17 instruments. These included “age of illicit drug use” and “preferred drug of choice” for the past-year period prior to incarceration. Ninety-eight cases were missing values for “age of illicit drug use initiation”. This variable was analyzed to rule out the possibility of data missing completely at random (MCAR; Little, 1988). Tests indicated that data were not MCAR ($p < .001$). Upon further inspection, it was determined that missing values may have been due to the fact that these participants only had a history of alcohol use, not alcohol and/or illicit drug use. However, examining past-year and past 30-day use rates indicated that some, but not all, of these participants had used illicit drugs. In order to partially address this issue, the variable, “age of drug use initiation” was created to reflect the estimated age at which participants began using any psychoactive drug (see “Independent Variables” subsection, pg. 149).

Figure 2. CJKTOS sample size for FYs 2013-2017, removal of cases, and final sample size.



For this variable, missing values for age of illicit drug use initiation were imputed with age of alcohol use initiation. Then, the lowest age for either alcohol or drug use initiation was used in creating the final variable. This combined variable allows for approximation of the age that participants first used a psychoactive drug. One limitation of the method is that the missing value for age of illicit drug use initiation could be significantly lower than age of alcohol use initiation. However, evidence suggests that alcohol use often predates use of illicit drugs (Beman, 1995; McGue, Iacono, Legrand, Malone, & Elkins, 2001). Still, there are exceptions (Mackesy-Amiti, Fendrich, & Goldstein, 1997). Therefore, this variable has some limitations, but still adequately represents the underlying phenomenon of interest (e.g., approximate age of psychoactive drug use initiation).

Even after combining alcohol and illicit drug use into a single variable, 11 cases remained that had missing values for “preferred drug of choice”, which was missing for 13 total cases. When analyzed, “preferred drug of choice” MCAR could not be ruled out ($p < .001$). Examining the merged data set, and copies of original baseline datasets, the reason for missingness could not be determined. All cases for which this variable were missing had affirmative responses for some past-year drug use, meaning that this question should have been applicable to them. As there is a meaningful difference between “preferred drug

of choice” and past-year use of a drug (even if it is frequent use), missing values for this variable were not imputed with the drug most frequently used during this time period, even though this single imputation method was considered.

Several methods for handling missing data, (e.g., single imputation, multiple imputation, or pairwise deletion) were considered; however, it was determined that listwise deletion would be the most reasonable method, because missingness accounted for less than 1.0% of cases and because deleting these cases would result in the least disturbance to the data integrity, by not manipulating the raw data (Kang, Rowe, Barreira, Robinson, & Mahar, 2009; McKnight & McNight, 2011; McKnight, McKnight, Sidani, & Figueredo, 2007; Rubin, 2004; Schafer, 1999; Schafer & Graham, 2002). Mean substitution was considered for age of illicit drug use, but for the same reasons, was not performed. Removing the 13 cases that were missing data for past-year drug preference resulted in a complete dataset with 1,563 intact cases (shown in Figure 2).

This exploratory study was approved by the University of Louisville Institutional Review Board (IRB) and the University of Kentucky IRB via an Institutional Authorization Agreement between the two university IRBs under the study name “Criminal Justice Treatment Outcome Study” (see Appendix A). The University of Kentucky served as the IRB of record. Permission to analyze CJKTOS data and disseminate findings was granted by the KY DOC.

Measures

Many CJKTOS survey questions, including those used as part of dependent variable measurement described below, were adapted for use by CDAR from the *Addiction Severity Index (ASI)* (5th edition) “Alcohol/Drugs” (McLellan et al., 1992). The ASI is a public domain clinical and research instrument that assesses drug use, drug treatment history, and drug-related problems across life domains (e.g., employment, criminal justice involvement) (McLellan et al., 1985). The ASI has been used as a data collection tool for a variety of drug-using populations, including corrections-involved drug users (Haas & Peters, 2000; Jaffe, Du, Huang, & Hser, 2012; Wahler, 2015; Zanis, McLellan, & Corse, 1997). The “Alcohol/Drugs” section of the ASI was adapted for use in CJKTOS instruments due to the fact that this section has demonstrated adequate criterion validity, convergent validity, and discriminant validity, as well as adequate internal consistency and test-retest reliability (Calsyn et al., 2004; Chermack et al., 2000; Mäkelä, 2004; McLellan

et al., 1985; Wertz et al., 1995; Zanis, McLellan, & Randall, 1994). ASI questions were adapted by CDAR for use as part of the CJKTOS surveys to serve as a standardized question format. Due to slight modifications, they are not utilized by CDAR, or in this study, as a validated measure, or as a measure based on calculating ASI substance use scores or perceived severity ratings; the latter of which is subjective and intended for clinical use. Use of the ASI as part of the CJKTOS surveys is noted so as to make clear the standardized formatting of drug-related questions across baseline and follow-up surveys and across FYs. Other adaptations of standardized instruments for inclusion into the CJKTOS surveys will be subsequently discussed.

Dependent Variables

Three dependent variables were examined in this study: Drug use outcomes that occurred during the 30-day period *prior* to incarceration, drug use outcomes that occurred during the one-year period subsequent to incarceration, and heroin use that occurred during the one-year period subsequent to incarceration.

Detailed measures of these dependent variables are described in the following subsections. First, it should be noted that dependent variables were created using ASI “Alcohol/Drugs” section items that comprise part of the larger CJKTOS surveys. These include responses provided for past-year and past 30-day drug use. Past-year drug use and past 30-day drug use was self-reported by participants at baseline and follow-up. At baseline, participants were asked to list the total number of months out of the past 12 (0-12), and number of days out of the past 30 (0-30), that they used alcohol or an illicit drug (e.g., “During the past 12 months before you were incarcerated, how many months did you use marijuana/hashish, pot?”; “During the past 30 days before you were incarcerated, how many days did you use marijuana/hashish, pot?”). Including alcohol, participants reported use for a total of 13 drugs/drug classes. At follow-up, participants were asked to self-report drug use for these same drugs, with use pertaining to the one-year post-release period (e.g., “During the past 12 months, how many months did you use cocaine/crack?”) in an identical manner.

Drug Use Outcomes *Prior* to Incarceration

For the 30-day period prior to incarceration, drug use outcomes were measured using of a categorical variable comprised of four mutually exclusive categories: *past 30-day*: 1) *concomitant use of*

both opioids and stimulants, 2) opioid, but not stimulant use, 3), stimulant, but not opioid, use, and 4) other drug use, that excludes opioid and stimulant use. As discussed earlier, opioids and stimulants can be considered as high-risk drugs. Concomitant use of these drugs may increase risk further. Use of opioids, stimulants, and concomitant use of both during the 30 days prior to incarceration represent decisional outcomes involving high-risk drugs for this period. Use of other drugs, while still entailing risk, can be considered to have comparatively less risk in many, but certainly not all, circumstances. Therefore, the drug outcome of “other drug use”, that excludes opioid and stimulant use, can be conceptualized as less risky relative to the other drug use outcomes examined. Because uncertainty is greatest, and the probability of adverse outcomes higher with opioid use, any outcome involving opioids can be considered as entailing greater risk than outcomes not involving opioids. Additional considerations in conceptualizing risk will be discussed in Chapter 5.

The past 30-day period prior to incarceration was chosen for examination (versus past-year), because it provided a narrower time frame and because it could facilitate examination of outcomes in relation to other measures reflecting time periods prior to or contemporaneous with the 30-day period (e.g., past-year, past 30-day, and 7-days). For instance, it is logical to suggest that endogenous and exogenous factors of a person’s life in the past-year had the potential to influence past 30-day outcomes, but not the reverse.

Past 30-day opioid use prior to incarceration was measured using data collected at baseline and was defined as use of any opioid agonist drug. These include *heroin, prescription opioids* (e.g., Oxycontin, Lortab, Demerol), *methadone*, and *buprenorphine*. For opioid drugs that might have been used licitly by prescription, participants were asked to affirm only illicit use (e.g., “In the 30 days prior to this incarceration, have you used methadone not prescribed for you?”). Use of any opioid drug for the this time period was summed in order to create a dichotomized variable (e.g., 0=“no use” vs. 1=“use”).

Past 30-day stimulant use prior to incarceration was measured using data collected at baseline and was defined as use of any psychostimulant drug, which included *powder cocaine, crack cocaine, amphetamines* (e.g., Adderall, Dexedrine), *MDMA*, and *methamphetamines*. For stimulant drugs that might have been used licitly by prescription, participants were asked to affirm only illicit use (e.g., “In the 30 days prior to this incarceration, have you used stimulants (e.g., Adderall, Dexedrine, Ritalin, etc.) not

prescribed for you?”). Use of any stimulant drug for the this time period was summed in order to create a dichotomized variable (e.g., 0=“no use” vs. 2=“use”).

Past 30-day concomitant use of opioids and stimulants prior to incarceration was measured by summing the two dichotomized variables for past 30-day opioid and stimulant use in order to create a categorical variable that consisted of four categories (e.g., 0=“no opioid/stimulant use”, 1=“opioid but not stimulant use”, 2=“stimulant, but not opioid use”, and 3=“concomitant opioid and stimulant use”).

Concomitant use of both opioids and stimulants was coded so as to include only cases for which both opioid and stimulant drugs were used within the same 30-day period prior to incarceration.

Past 30-day other drug use is defined as use of any non-opioid/non-stimulant drugs (e.g., alcohol, cannabis, hallucinogens, sedatives, etc.) during this time period. For drugs that might have been used licitly by prescription, participants were asked during the baseline interview to affirm only illicit use (e.g., “In the 30 days prior to this incarceration, have you used benzodiazepines (e.g., Xanax, Valium, etc.) not prescribed for you?”). Drugs excluding opioids and stimulants were summed and then a dichotomous variable was created by recoding all non-zero values equal to 4 (e.g., 0=“no other drug use” vs. 4=“other drug use”).

This variable was then combined with the prior categorical variable described above. The result was a single polytomous dependent variable, reflecting the four decisional outcomes of interest for the 30-day period prior to incarceration (e.g., 1=“opioid, but not stimulant use”, 2=“stimulant, but not opioid use”, 3=“concomitant opioid and stimulant use”, 4=“other drug use”).

Drug Use Outcomes *Subsequent to Incarceration*

Subsequent to incarceration, drug use outcomes were examined for the one-year post-release period. This was done for four reasons. First, rates of drug use are significantly lower for the one-year and past 30-day periods subsequent to incarceration, compared to these respective periods prior to incarceration, and past-year use subsequent to incarceration is typically higher than past 30-day use subsequent to incarceration. Second, examining outcomes for the one-year post-release period broadens the timeframe during which a drug use occurred, permitting examination of drug use contemporaneous with other reported states (e.g., depression, cognitive difficulties) that were measured for the entire year. Many of the measures used in the CJKTOS follow-up interview pertain to the past year, rather than the past 30-days or past 7-days. Third, looking at this longer period permits some discussion about the possibility that

reentry, as a process, influenced participants' drug-related decision-making. Finally, examining this longer time period allowed the community supervision status (e.g., parole) of participants to be examined as a potential influence on decision-making (e.g., behavioral reinforcer). Some participants who reentered the community on probation/parole, and who may have been under supervision for the majority of the year, may not have still be on parole in the 30-day period prior to the follow-up interview. Therefore, for the purposes of this study, it was more important to examine the past-year period subsequent to incarceration rather than the 30-day period prior to follow-up interview completion.

For this one-year post-release period, drug use outcomes were measured using of a categorical variable comprised of four mutually exclusive categories: *past year*: 1) *concomitant use of both opioids and stimulants*, 2) *opioid, but not stimulant use*, 3), *stimulant, but not opioid, use*, 4) *other drug or/no drug use*. Questions pertaining to past-year drug use were asked at follow-up in an identical manner to how questions pertaining to past 30-day drug use were asked at baseline. The final outcome variable was summed using the same process described above for the outcome variable of “past 30-day drug use outcomes” (see above subsection “Drug Use Outcomes Prior to Incarceration”).

Past-year Heroin Use Subsequent to Incarceration

Past-year heroin use was measured at follow-up, by having participants respond to the question, “During the past 12 months, how many months did you use did you use heroin?”. Responses were then dichotomized (0=no use vs. 1=use).

A Note on Fentanyl

It is important to note that, at baseline, participants reported drug use for the one-year and 30-day periods prior to *incarceration*, not simply prior to *SAP* entry. This means that there is some variance among the time periods of use reported by some, but not most, participants. For instance, a minority of participants may have been describing drug use that occurred in the late 1990s or early 2000s, while others may have described drug use that occurred in 2014 or 2016. This is due to the fact that some participants may have been incarcerated for several years prior to entering *SAP*, due to having longer sentences, whereas other participants, with shorter sentences, may have entered into *SAP* within a matter of months following their conviction. At follow-up, however, differences in the time period reported for is no longer a concern, making it possible to examine drug use outcomes for the same time period (2012-2017). This is noteworthy

insofar as fentanyl was introduced into the US drug supply during this time period (Daniulaityte et al., 2019; O'Donnell, Halpin, Mattson, Goldberger, & Gladden, 2017; Peterson, 2016; Seth, Scholl, Rudd, & Bacon, 2018). In addition to fentanyl-adulterated heroin, stimulant products and counterfeit prescription drugs are increasingly identified as containing fentanyl analogues (Dai et al., 2019; Gladden, 2016; Green & Gilbert, 2016; Nolan et al., 2019; O'Donnell et al., 2017). It is likely that many people in this sample would not have known definitively that they were using fentanyl and that, prior to 2014, people would have been far less likely to encounter fentanyl-adulterated products. One limitation is that participants were not asked to report on use of fentanyl specifically. It may be that some participants intended to use fentanyl or were aware that they may be using fentanyl (Kenney, Anderson, Conti, Bailey, & Stein, 2018). This confounds an already challenging process of conjecture about the risks potentially known by participants and of assessing objective risk independent of user knowledge. The drugs that will be examined, (e.g., heroin, prescription opioids, buprenorphine, cocaine/crack cocaine, amphetamines) still reflect what is of interest: decisional outcomes involving high-risk drugs. Fentanyl, in some ways, may in future years become an equalizer, in the sense that greater uncertainty surrounding both opioid and stimulant use will likely only grow. The significance of fentanyl's introduction into the drug supply during the time period will be considered further in Chapter 5.

Independent Variables

Drug-related Influences

Age of drug use initiation was measured at baseline by having participants report the age at which they first used an illicit drug (e.g., "How old were you when you first began to use illicit drugs like marijuana, cocaine, heroin, tranquilizers, stimulants, sedatives, barbiturates, inhalants or prescription painkillers not prescribed for you?"). For participants who did not report any illicit drug use, *or* for which age of first illicit drug use was missing (N=54), the age of first alcohol intoxication was used (e.g., "How old were you when you had your first alcoholic drink, other than a few sips?"). In cases where there were responses for both alcohol and illicit drugs, the younger age was retained (see also, "Final Sample and Missing Data" subsection, pg. 138). Combining responses for age of first alcohol use or age of first illicit drug use and using the younger age reported, while not precise, does provide an estimate of the age that participants first used a psychoactive drug. As discussed earlier, age of drug use initiation indicates several

possibilities, any one of which, or any combination of which, has the potential to influence drug-related decision-making so as to bias a person toward further drug use. Response options were unlimited.

Past 30-day drug use prior to incarceration was measured at baseline by summing the number of days that ten specific drugs (alcohol, cannabis, prescription sedatives, hallucinogens, synthetic drugs, cocaine/crack cocaine, amphetamines, heroin, prescription opioids, and buprenorphine) were used in the 30-day period prior to incarceration (0-30). Ten dichotomous variables were then generated from these to reflect “use” or “no use” of a given drug for the 30-day period prior to incarceration. These items were examined as a possible influence on drug outcomes for the one-year period subsequent to incarceration.

Drug use severity was measured using data collected at baseline by creating a composite variable. This variable consists of three questions pertaining to past 30-day drug problems contained in the “Alcohol/Drugs” subsection of the ASI-5 (range 1-40). At baseline, participants were first asked to report the total number of days out of the past 30 prior to incarceration that they experienced drug problems, “such as craving, withdrawal, wanting to quit but being unable to”. Participants then ranked on a 5-point Likert scale how troubled or bothered they were by these drug problems and how important receiving treatment for these drug problems was to them (1=Not at all—5=Extremely). Internal consistency of this composite variable was sufficient ($\alpha=0.76$). Drug craving, withdrawal, and persistent problematic use despite a desire to moderate or abstain comprise some of the DSM-5 diagnostic criteria for SUD, meaning that this composite variable may be considered as an estimated, but inexact, indicator of drug use severity (APA, 2015). Including participants’ self-rated importance of receiving treatment for their problematic use also provides indication that the problems associated with use were significant enough so as to make them consciously registered and contemplated, rather than wholly unrecognized or dismissed (DiCemente, 2018).

Past-year drug use versatility prior to incarceration was measured by summing the number of different drugs that a participant reported using during the one-year period prior to incarceration (1-13). This was explored due to the fact that polydrug use is a high-risk form of drug use. Versatile drug use, wherein a greater number of different drugs are used during a given time period, versus fewer, may influence the likelihood that drugs such as opioids and stimulants are used concomitantly. It may also indicate the possibility the co-use of opioids and/or stimulants with other drugs (e.g., alcohol, synthetic

drugs, prescription sedatives) is occurring, which can be conceived as a higher-risk form of use (Smith & Staton, 2018). Using a greater number of drugs during a given time period may also indicate novelty-seeking and higher tolerance for risk, uncertainty, and adverse consequences.

Abstinence self-efficacy prior to treatment was measured at baseline by asking participants to respond on a 5-point Likert scale (0=very poor, 2=uncertain, 5=very good) the degree to which they believed they could refrain from alcohol and illicit drug use (e.g., “Based upon what you know about yourself and your situation, how good are the chances that you can get off and stay off of drugs/alcohol?”). Responses were recoded to reflect the presence or absence/ambivalence of abstinence self-efficacy (e.g., “moderately poor, very poor, uncertain”=0 vs. “moderately good, very good”=1).

Past-year Drug Use Subsequent to Incarceration was measured using data collected at follow-up pertaining to past-year drug use for the following drugs: Alcohol, cannabis, prescription sedatives, hallucinogens, synthetic drugs, cocaine/crack cocaine, amphetamines, heroin, prescription opioids, and buprenorphine. For each of the 10 drugs, the number of months out of the 12 months subsequent to incarceration was summed and then dichotomized to reflect past-year use (0=“no use” vs. 1=“past-year use”), resulting in ten separate drug use variables that were then dichotomized. These were used as independent variables for the outcome of past-year heroin use subsequent to incarceration.

Demographic Characteristics

Age was measured at baseline in years using participants’ dates of birth. Birthdates were confirmed for all participants at follow-up. **Sex** was measured at baseline by asking participants to select which gender they identified with (e.g., male, female, transgender). For baseline surveys prior to 2016, the “transgender” option did not include a specifier (e.g., “male to female” vs. “female to male”). However, no participants selected “transgender” for these years. In 2016, a specifier was included with the transgender option. However, because sex, rather than gender, is being considered as a potential influence on decision-making, cases for which “transgender” was selected (N=3) were recoded to reflect biological sex which was cross-referenced by examining the correctional institution in which they were housed (i.e., all-male or all-female prison). More information would have been needed in order to determine if trans male or trans female cases were appropriate for this study’s conceptualization of sex. For instance, no information was available to clarify if these participants had undergone hormone replacement therapies or other elective

procedures. As the majority of the sample was male, a dummy variable was created (“not male”=0 vs. “male”=1).

Indirect Indicators of Cognitive Functioning

To measure the presence of some potential indirect indicators of cognitive functioning, three variables were examined, these included one composite variable denoting *learning disorder diagnosis and/or prior special education involvement*, as well as two dichotomous variables, *past-year cognitive difficulties*, and *lifetime history of head trauma*.

The first variable, **learning disorder (LD) diagnosis and/or special education (SE) involvement** included summing responses for two questions asked at baseline pertaining to LD and SE enrollment. LD was measured by asking participants, “Have you ever been told that you have learning disability?”. Participants could respond “no” or “yes” for each item. SE enrollment was measured at baseline by asking participants, “Have you ever been in special education?”. Participants could respond “no” or “yes” for each item. Responses were dichotomized to reflect the presence or absence of these conditions (0=no LD diagnosis/no SE enrollment vs. 1=LD diagnosis and/or SE enrollment).

The second indicator of cognitive functioning, **past-year cognitive difficulties** was measured by identifying the presence of cognitive deficits during the one-year post-release period with the potential to influence decision-making. For this item, participants were asked to report the number of months out of the past 12 that they experienced “trouble understanding, concentrating, or remembering, not as a direct result of alcohol and drug intoxication” (0-12). Responses were summed and recoded to reflect the presence or absence of past-year cognitive difficulties (0=“none” vs. 1=“some past-year cognitive difficulties”).

The third indicator of cognitive functioning, **lifetime history of head trauma**, was measured at baseline by asking participants to self-report the number of times in their life that they experienced head trauma (e.g., “How many times have you *ever* had a head injury from being hit, having an auto accident, or another incident that resulted in being knocked out/unconscious?”). Response options were unlimited. History of head trauma was measured again at follow-up by asking participants to report any head trauma that occurred during the one-year post-release period. This response was summed with the number of head injuries reported at baseline in order to create a new head trauma variable with an updated lifetime head trauma incident total. However, this variable does not reflect head injuries sustained between a participant’s

completion of the baseline survey and their release date. For instance, head trauma could have occurred while incarcerated, meaning that the actual number of times that head trauma was sustained could be underestimated. Additionally, participants may have sustained head trauma as young children, but may be unaware of this history. Accordingly, a dichotomous variable was created for both time periods (0="no reported history of head trauma" vs. 1="reported of head trauma").

Scarcity and Social Influences

As discussed in Chapter 2, scarcity, economic hardship, and lower social status can influence cognition and decision-making. Additionally, income can influence drug purchasing behaviors. These potential influences were explored using *economic hardship*, *past-month income*, *past-year homelessness*, and *subjective socioeconomic status*.

Past-year economic hardship, defined as difficulty in meeting basic living (e.g., food, shelter) and healthcare needs (Beverly, 1999) was measured at baseline by combining two subscales in the CJKTOS survey. These subscales were adapted from the Survey of Income and Program Participation (SIPP), a longitudinal nationally representative survey of non-institutionalized adults conducted by the U.S. Census Bureau (Beverly, 2001; Iceland & Bauman, 2004; She & Livermore, 2007). The first subscale consists of five dichotomous questions ("no" vs. "yes") and measures difficulty meeting basic living needs during the one-year period prior to incarceration (e.g., "In the 12 months prior to this incarceration, did you and/or your family have difficulty paying the full amount of rent or mortgage?"). Due to the increased use and cost of cellular telephones, one SIPP question pertaining to telephone disconnection was modified by CDAR to also reflect cell phones in addition to landlines. The second subscale consists of three dichotomous questions and measures difficulty meeting basic healthcare needs during the one-year period prior to incarceration (e.g., "In the twelve months prior to this incarceration was there a time when you or someone in your household needed to see a doctor or go to the hospital but wasn't able to because of financial reasons?"). Because of the rising prescription drug costs in the U.S., a question about accessing prescription medication was included by CDAR as one of the three subscale items measuring difficulties in meeting basic healthcare needs (e.g., "In the twelve months prior to this incarceration was there a time when you or someone in your household needed to fill a prescription for medication but was unable to because of cost?"), though this item does not appear in SIPP. Among a clinical sample of drug users in

Kentucky (N=5,273) this revised economic hardship scale (range 0-8) demonstrated good internal consistency reliability ($\alpha=0.83$), as did the subscales measuring difficulties in meeting basic living needs ($\alpha=0.76$) and health care needs ($\alpha=0.83$; Cole, Logan, Miller, & Scrivner, 2016). The combined scale among the current study sample demonstrated adequate internal consistency ($\alpha=0.85$).

Past-month income was measured at follow-up using self-reported income in US dollars from all past 30-day income sources. As discussed in the previous chapter, lower-income is believed to reflect a type of scarcity and uncertainty, whereas higher income is believed to reflect a state of that enables (comparatively) enhanced cognitive functioning, greater, choice, and potentially more purchasing power for drugs (or non-drug commodities). Questions pertaining to employment and income used as part of CJKTOS surveys were adapted from the ASI-5 “Employment/Support Status” subsection. Participants were asked at follow-up to report the income received from licit work (e.g., payroll, odd jobs), illicit work (e.g., drug dealing), alternative sources (e.g., gambling winnings), public assistance and benefits (e.g., Supplemental Nutrition Assistance Program, Social Security Disability Insurance), and money received from friends and family for the past 30 days. Amounts from all sources were summed for a total past 30-day income amount.

Past-year homelessness was measured at baseline by asking participants to respond (“yes” vs. “no”) to the question, “In the 12 months prior to this incarceration, did you consider yourself to be homeless?”.

Subjective socioeconomic status was measured at baseline using an adapted version of the Subjective Socioeconomic Scale (Adler et al., 2000). This one-item measure is comprised of a 10-rung ladder, displayed vertically in the form of a drawing, that participants used to help respond to the accompanying question: “Overall, on a scale of 1 to 10, with 1 representing the people who are worst off, those who have the least money, least education, and worst jobs or no job, and 10 representing the people who are best off, have the most money, most education and best jobs, how would you rate yourself on that scale?”. Here, the ladder was used to help visualize the lowest status (e.g., 1) versus highest status (e.g., 10). Due to instrument changes, the ladder only accompanied the question for 3 out of the 5 baseline years examined as part of this study. However, the wording of the question remained consistent across years. Lower scores for this item (range, 1-10) indicate lower perceived social and economic status.

Community-wide Scarcity and Inequality

As discussed earlier, regional and household poverty, scarcity, and inequality can influence decision making and high-risk drug use in several ways. To examine this potential influence, *county-level poverty and county-level wealth inequality* were considered for examination.

County-level poverty was measured at the county-level using Small Area Income and Poverty Estimates (SAIPE) for years 2013-2017 by using the median value for the proportion of households per county considered by the U.S. Department of Health and Human (HHS) to be living at or below the poverty threshold, which is calculated using household size and income (U.S. Census Bureau, 2018). For example, in 2019, a household size of one is considered to be living in poverty if annual income does not exceed \$12,490, whereas a household size of five is considered to be living in poverty if annual income does not exceed \$30,170 (HHS, 2019). Although median household income for counties provides an indicator of typical income, examining the proportion of households per county living in poverty provides an indication of how thinly spread annual income may be per household.

County-level wealth inequality was operationalized using the GINI coefficient, a measure of income and wealth distribution that indicates financial resource inequality, whereby a value of 0 reflects perfect equality and a value of 1 reflects the maximum value of inequality (Atkinson, 1970; U.S. Census Bureau, 2019a). Using ACS data for years 2013-2017, GINI coefficients for each Kentucky county were considered for examination. As there are not significant fluctuations between years, the median coefficient value for the five-year period was selected for possible use.

Psychiatric Symptoms, Stress, Pain and Misregulation

As noted earlier, mood, affect, and symptoms related to psychiatric conditions, such as depression or anxiety, can influence drug-related decision-making and behavior. The potential influence of psychiatric symptoms was considered by examining *past-year depressive symptoms*, *past-year suicidal ideation*, and *past-year anxiety symptoms*.

Past-year depressive symptoms was measured at baseline using items adapted from the 9-item Patient Health Questionnaire-9 (PHQ-9), an instrument that measures depression symptom severity using DSM-IV major depressive disorder (MDD) diagnostic criteria (Kroenke, Spitzer, Williams, 2001). Participants responded (“no/absent” versus “yes/present”) to questions pertaining to any two-week period

in the past-year prior to incarceration (e.g., “In the 12 months prior to incarceration, did you have two weeks in a row when you were consistently down or depressed most of the day, nearly every day?”). Overall, the PHQ-9 has demonstrated good criterion and convergent validity, with strong positive correlations observed between higher PHQ-9 scores and lower scores on measures of mental health, social functioning, overall functioning, and role functioning (Kroenke et al., 2001; Kroenke, Spitzer, Williams, & Löwe, 2010). Here, PHQ-9 items were adapted for use on the CJKTOS baseline survey by CDAR by dichotomizing response options, instead of using Likert scales (0-3), thus resulting in a range of 0-9 rather than the 0-27 PHQ-9 range. Good internal consistency reliability for this adapted PHQ-9 was found in a clinical sample of drug users in Kentucky (N=5,273; $\alpha = 0.95$; Cole et al., 2016), as well as in the current sample ($\alpha = 0.94$). A dichotomous variable was created using a cutoff point between those evidencing symptoms of MDD and those not, whereby participants were classified as having MDD symptoms if they responded “yes” to 5 out of 9 questions. At follow-up, the presence of past-year depressive symptoms was measured by asking participants to report the number of months out of the past 12 that any depressive symptoms were experienced (e.g., “In the past 12 months how many months have you experienced serious depression, that was not a direct result of drug/alcohol use?”). Responses can range from 0-12. Responses were dichotomized (e.g., zero months=0 vs. >1 month=1) so as to reflect the presence or absence of depressive symptoms for this period.

Past-year suicidal ideation was measured at baseline by asking participants to respond (“yes” vs. “no”) to the question, “During the 12 months prior to this incarceration, did you have thoughts about ending your life or committing suicide?”. At follow-up, suicidal ideation was measured by asking participants to respond the question, “In the past 12 months how many months have you experienced serious thoughts of suicide that was not a direct result of drug/alcohol use?” for which they could report 0-12 range. Responses were recoded to reflect the presence or absence of past-year suicidal ideation (“no suicidal ideation”=0 vs. “suicidal ideation”=1).

Past-year anxiety symptoms was measured at baseline using an adapted version of the Generalized Anxiety Disorder scale (GAD-7), a 7-item measure designed to identify and assess symptoms of GAD using DSM-IV diagnostic criteria (Spitzer, Kroenke, Williams, & Löwe, 2006). The GAD-7 has demonstrated adequate convergent and criterion validity as well as good internal consistency (Delgado et

al., 2012; Löwe et al., 2008; Spitzer et al., 2006). Items were adapted by CDAR researchers by dichotomizing response options (“no/absent” versus “yes/present”), instead of using 4-point Likert scales to measure frequency of symptoms, resulting in a 0-7 range. Among a clinical sample of drug users in Kentucky, good internal consistency was found ($N=5273$; $\alpha = 0.98$; Cole et al., 2016). In this sample, good internal consistency was also observed using this modified version of the GAD-7 ($\alpha = 0.92$). A cutoff point between those evidencing symptoms of GAD and those not was created whereby participants were classified as having GAD symptoms if they responded “yes” to 4 out of 7 questions, including the screener question: “In the 12 months before you were incarcerated, did you have a time period lasting 6 months or longer where you worried excessively or were anxious about multiple things on more days than not for all 6 months?”. At follow-up, the presence of past-year anxiety symptoms were measured by asking participants to report the number of months out of the past 12 that any symptoms associated with anxiety were experienced (e.g., “In the past 12 months how many months have you experienced serious anxiety or tension that was not a direct result of drug/alcohol use?”). Responses can range from 0-12. Responses were dichotomized (e.g., zero months=0 vs. >1 month=1) so as to reflect the presence or absence of anxiety symptoms for this period.

As noted earlier, increased stress response can impair decision-making in a variety of ways. Accordingly, **past-week stress-related health effects** was measured with data collected at baseline using 11 items contained on the 15-item *Stress-related Health Consequences Scale (HCS)*, developed to measure past-week stress indicators and stress-related health consequences (Logan & Walker, 2010). Participants were asked to respond using a 4-point Likert scale (1=None of the time – 4=All of the time) the degree to which they experienced indicators of stress in the seven days prior to incarceration (e.g., “In 7 days prior to incarceration, have you experienced anxiety and/or panic attacks?”; “In 7 days prior to incarceration, have you felt stressed out?”). For a total scale score, all 15 scale items are summed, with higher scores indicating a greater degree of physical and psychological stress (15-60). Among a clinical sample of drug users ($N=5,273$), the scale demonstrated good internal consistency reliability ($\alpha = 0.90$; Cole et al., 2016). The initial consistency for all 15 items was acceptable in this sample ($\alpha = 0.88$).

However, because the content of the HCS is a multidimensional construct, seeking to measure states and experiences that are somatic or physiological (e.g., “experienced unexplained aches and pains”,

“increased heart rate”), psychological (e.g., “experienced stress, anxiety, worry, or fear”), and behavioral (e.g., “used illicit drugs to reduce stress, anxiety, worry, or fear”) principal component analysis (PCA) was used to examine scale items in order to further scrutinize item correlations and to determine if subscales could be formed. Three components were extracted ($KMO=0.93$; $X^2=9410.79$, $df=105$, $p<.001$). Component one, comprised of seven items pertaining to affect, sleep, fatigue, and changes in eating patterns, accounted for 40.2% of the total variance; component two, comprised of five items pertaining to somatic disruptions and the re-experiencing of trauma, accounted for 8.8% of the variance; component three, comprised of the three items pertaining to drug-related stress coping behaviors, explained 7.7% of the variance.

Upon closer examination, one of the items comprising component two was identified as potentially invalid in this sample due to self-report limitations, as it asked participants to rate the degree to which they experienced high blood pressure, a physiological state that is not always subjectively felt or consciously recognized as high blood pressure (Greenstadt, Shapiro, & Whitehead, 1986; Kollenbaum, Dahme, & Kirchner, 1996; Koroboki, 2010). For younger participants, high blood pressure, both conceptually and phenomenologically, may be less understood, even as interoceptive capacity may be greater in younger individuals (Khalsa, Rudrauf, & Tranel, 2009). Removing this item did not reduce the internal consistency ($\alpha=0.88$).

The three items pertaining to drug-related stress coping *behaviors*, that comprised component three were removed and retained for use as a composite variable indicating misregulation. Removing these component three items, along with the HBP item, resulted in a final 11-item measure (range, 11-44) of recent stress-related health effects with good internal consistency ($\alpha=0.89$).

Chronic pain, defined as pain lasting three months or longer (Treede et al., 2015), was measured by asking participants at baseline and follow-up to report (“no” vs. “yes”) any chronic pain experienced (e.g., “Do you have any chronic physical pain, that is, pain that has lasted three or more months?”) so as to reflect the presence or absence of chronic pain experienced during each period.

Misregulation, defined as exerting control over one’s actions in a manner that achieves a short-term end (e.g., reducing stress) at the expense of a long-term end via instrumental coping (Baumeister, Heatherton, & Tice, 1994; Tice, Bratslavsky, & Baumeister, 2018), was measured using the three

behavioral items contained on the HCS (e.g., “In 7 days prior to incarceration, have you used alcohol to reduce stress, anxiety, worry or fear?”). This question was asked in reference to alcohol, prescription drugs, and illicit drugs. Participants could respond using a 5-point Likert scale (0=None of the time-5=All of the time). Although these items differ in kind (i.e., drinking alcohol to cope with stress versus using illicit drugs) and, when grouped, did not demonstrate robust internal consistency ($\alpha=0.64$), these behaviors all nevertheless indicate some propensity toward misregulation in that a non-zero response to any of these questions means that the participant has engaged in instrumental coping by using a psychoactive drug as an attempt to reduce stress. Responses were dichotomized where values of >1 were coded as 1= “misregulation occurred” and values of 0=“no misregulation occurred”. One limitation in using this variable is that participants who did not report any of the three behaviors indicative of misregulation during this 7-day period, either due to the fact they did not experience “stress, anxiety, worry, or fear” during this time or because they did not use drugs in this time (even as they used drugs within the larger 30-day period), may still have some proclivity toward misregulation, despite the fact that it was not captured for the week in question. As such, this variable should be considered as an approximation of misregulation that occurred contemporaneous to past 30-day drug use, indicating some propensity toward misregulation or “self-medication” during this time period.

Access to Drug Markets

As discussed earlier, the area that a person lives in and the access they have to drug markets can influence drug-related decision making and high-risk drug use by restricting the range of choices and/or influencing the cost and difficulty with which some drugs may be acquired. To examine potential influences, *county Internet connectivity, county disability rates, county opioid and buprenorphine prescribing rates, and county alcohol availability* were considered for examination.

Internet connectivity was measured using the percentage the households per Kentucky county with internet access, 25 minimum broadband speed (i.e., the slowest speed option) for 2017 (Federal Communications Commission, 2018). This was examined due to the fact that Kentucky counties vary in their internet access, with some counties far more connected than others. Since the Internet is increasingly used as an avenue for accessing drug markets, the ease or difficulty for accessing these online markets is important to consider.

County disability rates were measured by creating a five-year average for the proportion of residents per Kentucky county receiving Social Security Disability Insurance benefits for years 2013-17 (Social Security Administration, 2019). As noted earlier, areas with a higher density of people who are ill and/or are receiving prescription medications may influence local drug markets in terms of access to diverted medications.

County opioid prescribing rates were measured using data collected from the Kentucky All Schedule Prescription Electronic Reporting (KASPER) surveillance program, which consists of an online database used to document and monitor the prescription and distribution of all Schedule II-V Controlled Substances in Kentucky (Kentucky Cabinet for Health and Family Services [CHFS], 2019). Prescribing medical professionals and pharmacists are mandated to enter data into KASPER and may utilize the system to generate reports and make clinical decisions. KASPER is also utilized by state government and law enforcement to monitor prescribing trends and to investigate potential prescription drug diversion (CHFS, 2019). County opioid prescribing rates were measured by first summing all individual opioid prescriptions (e.g., Oxycontin, Hydrocodone, Methadone, and Tramadol) written and filled per county, creating five-year averages for years 2013-17, and then by calculating per 1,000 prescribing rates based on the 2013-17 five-year county adult population ASC averages (U.S. Census Bureau, 2019b). **County buprenorphine prescribing rates** were calculated similarly, but instead by summing all Suboxone/Subutex prescriptions written and filled.

Non-drug Alternative Reinforce

As noted previously, many non-drug alternatives can reinforce behavior. Some of these are important to consider as possible influences on drug-related decision-making prior and subsequent to incarceration. Here, they were measured using *close relationships, social interaction, perceived value of social interaction, social worth, leisure time, educational and vocational involvement, and post-release correctional status*.

Close relationships were measured using data collected at baseline and follow-up. Participants were asked to indicate from a 5-item list important people, such as family, romantic partners, with whom they had a relationship with (e.g., “Would you say you have had a close, long-lasting relationship with your children?”). Participants then had the opportunity to report (“yes” vs. “no”) if they had other people with

whom they had a close, long-lasting relationship with that were not already listed. Lastly, participants were asked “How many close friends do you have?”, for which there was an unlimited response option. The final number of close relationships was calculated by summing the dichotomous close relationship responses (0-6) and then summing this total with the number of close friends, resulting in a variable with unrestricted range.

Social interaction was measured at baseline and follow-up by asking participants to select one of three response options to the following question “In the past 12 months, with whom did you spend most of your free time?”. Participants could select “Friends”, “Family”, or “Alone.” Responses were recoded to reflect the absence (0= “alone”) or presence (1=“friends, family”) of past-year social interaction.

Perceived value of social interaction was also considered. To assess if social interaction was rewarding, participants were asked to rate their satisfaction with how their free time was spent (e.g., “Were you satisfied spending your time this way?”). Participants could respond “No”, “Yes”, “Indifferent”. Responses were recoded into a dichotomous variable reflecting the presence or absence of reward (0=“no/indifferent” vs. 1=“satisfied”).

Some of the rewarding aspects of non-drug alternatives that are social in nature, such as close relationships, extend beyond the experiential pleasure that can come from being with others. One aspect is that, when relating to others, a person not only comes to value other people, but comes to be valued and supported *by* other people. A sense of worth and support can be experientially pleasurable and directly rewarding, which has the potential to reinforce behavior accordingly; but it can also, under the right conditions, buffer stress response, pain, and other negatively valenced states, which also has the potential to reinforce behavior (Cutrona & Russell, 1987; Hagerty & Williams, 1999; Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003; Langford, Bowsher, Maloney, & Lillis, 1997; Yoshida et al., 2009). Further, social worth and support may also be in keeping with the idea of “having a stake in the conventional life”, insofar as a person may be more likely to invest in people and activities for which their presence matters, and is encouraged through supportive gestures. In other words, reciprocity of rewarding prosocial patterns might be established (Cropanzano & Mitchell, 2005). **Social worth** was measured at follow-up by asking participants to rate on a 5-point Likert scale (1=not at all—5=Extremely) the degree to which they felt valued and supported by others (e.g., “How much do you feel cared about or supported by the important

people in your life?”). Responses were recoded to reflect the presence or absence of feeling valued (0=“did not feel cared about/supported” vs. 1=“felt cared about and supported”).

Leisure time was measured at baseline by asking participants to report the average number of days per week that they could pursue activities of personal interest (e.g., “In the 12 months prior to this incarceration, how many days per week, on average, were you involved in hobbies or activities that you liked to do?”). This item was considered because it indicates the presence of the flexible resource of time which is often needed to pursue potentially rewarding activities of interest.

Past-year educational and vocational involvement was measured using data collected at baseline and follow-up. To first assess vocational involvement, participants choose from a list the employment designation that best reflected their status for the majority of months (>6) out of the 12-months prior and subsequent to incarceration (e.g., unemployed, retired, disabled, working part-time, working, full-time, seasonal/irregular work, retired, student, etc.). Responses were dichotomized to reflect the presence or absence of regular vocational involvement (e.g., 0=“unemployed, retired, disabled, irregular employment” vs. 1=“full- or part-time employment”). For people who reported being unemployed, they could also specify that they were a student, thus indicating educational involvement even in the absence of vocational involvement (2=student). In a separate question, participants were also asked at baseline and follow-up to report any involvement in educational/vocational training, irrespective of employment (0=no training vs. 1=educational training). These two variables were summed and then recoded into a dichotomized variable to reflect the presence or absence of educational and/or vocational involvement (0=no educational/vocational involvement vs. 1=educational/vocational involvement) in the one-year period prior and subsequent to incarceration.

Post-release correctional status was measured at follow-up by asking participants to self-report if they were on community supervision (i.e., probation, parole) at any point since their release. Post-release correctional status is considered as an additional behavioral reinforcer.

Central Appalachia

As described earlier, residing in a harsh region can have a profound impact decision-making and behavior. It can accomplish this by influencing cognition and one’s beliefs about their future, but also by narrowing choices and opportunities for pursuing rewarding non-drug alternatives. For people in Eastern

Kentucky, the portion of the state that falls within Central Appalachia, opportunities for accessing rewarding non-drug alternatives are more limited. Historically and presently, Central Appalachia is a region in which there are excess morbidities---including high rates of disability and psychiatric health disorders--premature death, resource scarcity, and economic insecurity. Relative to other areas in the state, Central Appalachia portion of Kentucky may be considered as a harsh environment, even other regions in the state may have smaller, concentrated areas that might also be considered harsh. To explore this possible influence of residing in a “harsh” region, **Central Appalachia** was measured at baseline and follow-up using the zip code and/or county of residence that participants reported residing in for the majority of months (>6) out of the past 12, prior and subsequent to incarceration. At baseline, U.S. postal zip codes were converted into counties and coded as either “Central Appalachia” or “non-Appalachian” using Appalachian Regional Commission (ARC) designations (ARC, 2019). At follow-up, participants reported the county in which they resided in and similar codes were created. For participants reincarcerated at follow-up, the county of residence, rather than county of incarceration, was used to code responses.

Control Variables

In addition to the independent variables described above, which are believed to influence decision-making in respect to opioids and stimulants, several additional participant characteristics with the potential to influence the outcomes of interest were also measured.

High school diploma (HSD)/General Equivalence Degree (GED) was measured using data collected at baseline. Participants were asked to select from a list the highest level of education they completed. Categories ranged from “1=never attended” to “21=doctoral degree”. Responses were summed and a cut-off point reflecting the attainment of HSD/GED was used to create a dichotomized variable (e.g., 0=no high school diploma/GED vs. 1=high school diploma/GED or greater).

Race/ethnicity was measured using data collected at baseline. Participants were asked to select from a list the race/ethnicity with which they identified themselves as (e.g., African American, Alaskan, Hispanic-Mexican, Hispanic-Cuban, Native American, White, etc.) or to write-in “other” for categories not already provided. Responses were dummy coded into a dichotomized variable (e.g., “non-white”=0 vs. “white”=1). This was done due to the small group sizes for all race/ethnic groups other than African American and White. State-wide, both Kentucky’s non-institutionalized population and KY DOC

population are majority White, making this category as a dummy variable an appropriate choice.

Limitations for dummy coding race/ethnicity will be discussed in Chapter 6.

Lifetime drug treatment episodes were measured using data collected at baseline by summing the number of times that participants reported having ever received any of the following substance use services: Medical detox, outpatient treatment, inpatient/residential treatment, for which the response range was unlimited.

Ever IDU was measured at baseline by asking participants to respond to the question “Before this incarceration, did you ever inject any drugs?” for which they could respond “no” or “yes”.

Nights spent in a controlled environment was measured at baseline for the 30-day period prior to incarceration (0-30). At follow-up, the nights spent in a controlled environment was measured for the entire one-year post-release period (i.e., the time period beginning the date of participants’ release and concluding the date of follow-up interview completion) (0-365).

Mandated to SAP was measured using KOMS data (which comprises the broader CJKTOS datasets). Cases were coded 0=“voluntary participation” vs. 1=“mandated participation”.

SAP completion was also measured using KOMS data, which provides a documented date of SAP graduation or termination. Participants who were terminated from SAP were coded as 0=“terminated” and participants who completed SAP were coded as 1=“graduated”.

Descriptive Variables

In addition to the independent and control variables described above, the below variables were also examined in order to provide a fuller description of the entire study sample and as well as richer descriptions of all drug use outcome groups, including how characteristics that differed between groups.

Marital status was measured using data collected at baseline. Participants were asked to select from five categories (e.g., “married”, “widowed”, “separated”, “divorced”, and “never married”), the status that best reflected their marital situation.

In addition to exploring *past-year* drug use versatility as an independent variable, ***past 30-day drug use versatility prior to incarceration*** was included for descriptive purposes. This item was measured by summing the number of different drugs that a participant reported using during the 30-day period prior to incarceration (1-13).

In addition to examining the dichotomized variable of past 30-day drug use prior to incarceration as an independent variable, **past 30-day drug use prior to incarceration and past 30-day drug use frequency prior to incarceration** are presented for descriptive purposes for all drug use outcomes. These items were measured at baseline by summing the number of days that ten specific drugs (alcohol, cannabis, prescription sedatives, hallucinogens, synthetic drugs, cocaine/crack cocaine, amphetamines, heroin, prescription opioids, and buprenorphine) were used in the 30-day period prior to incarceration (0-30). Responses were then dichotomized so that proportions for “use” versus “no use” of specific drugs could also be presented.

Past-year drug use prior to incarceration and past-year drug use frequency prior to incarceration were measured using data collected at baseline pertaining to past-year drug use for the following drugs: Alcohol, cannabis, prescription sedatives, hallucinogens, synthetic drugs, cocaine/crack cocaine, amphetamines, heroin, prescription opioids, and buprenorphine. For each of the 10 drugs, the number of months out of the 12 months prior to incarceration was summed, resulting in ten separate drug use frequency variables (range 0-12). New variables were generated from these to produce an additional dichotomous variable of past-year use (0=no use vs. 1=past-year use).

Past-year drug use subsequent to incarceration and past-year drug use frequency subsequent to incarceration were measured using data collected at follow-up in a manner identical to past-year drug use prior to incarceration, with the only difference being the time period (range 0-12). Although the 10 “past-year drug use subsequent to incarceration variables” are considered as independent variables for the outcome of past-year heroin use subsequent to incarceration, they are also presented as means and proportions to help describe the sample and drug use groups during the one-year period subsequent to incarceration.

Past-year preferred drug of choice was measured at baseline by asking participants to select from a list of 13 drugs the one which they most preferred using during the year prior to incarceration (e.g., “In the 12 months prior to this incarceration, what was your primary substance of choice?”). Responses were recoded into 9 categories for the most commonly reported drugs: alcohol, marijuana, cocaine/crack cocaine, amphetamine-based stimulants, heroin, prescription opioids, buprenorphine, prescription sedatives/barbiturates, and inhalants/hallucinogens/synthetic drugs.

Urban proximity was measured using the 2013 Urban Influence Codes, a 12-part classification scheme that categorizes counties by metropolitan (i.e., counties in metro areas with 20,000 to >1 million residents) and non-metropolitan (i.e., counties adjacent/not adjacent to metro areas, but not in metro areas) status into two metro and ten nonmetro designations (U.S. Department of Agriculture, 2013). Metropolitan counties are differentiated by population size of their metro area and nonmetropolitan counties are differentiated by size of largest city and proximity to metro and micropolitan areas (U.S. Department of Agriculture, 2013). Counties designations range from 1 (e.g., “Large-in a metro area with at least \geq 1 million residents”) to 12 (e.g., “Noncore-not adjacent to a metro/micro area and <2,500 population (Department of Agriculture, 2013).

Unrestricted alcohol sales was measured using data obtained from the Kentucky Alcohol Beverage Control (KY ABC) (KY ABC, 2017). A dichotomous variable was created that coded counties as either 1=“restricted” (i.e., alcohol is significantly restricted or completely prohibited) or 0=“unrestricted” (i.e., alcohol sales are unrestricted county-wide). Because alcohol is widely consumed, may be used as a substitute for or compliment to various illicit drugs, and because its use more difficult to detect among people on community supervision, it is important to consider how access to this licit, and overall less risky, drug may influence drug use outcomes.

Days until post-release alcohol and/or illicit drug use was measured at follow-up by asking participants who reported alcohol use subsequent to incarceration to respond to the following question, “In 12 months since your release, how many days were you on the street before you first used alcohol?”. For participants who reported illicit drug use subsequent to incarceration the same question was asked (range 0-365).

Intoxicated during offense was measured at baseline by asking participants to respond (“yes” vs. “no”) to the question, “Were you under the influence of alcohol and/or drugs when you committed the offense that led to your current incarceration?”.

In addition to the independent variable of “chronic pain” described above, a description of **chronic pain severity**, for participants who reported experiencing chronic prior to incarceration, was measured by creating a composite variable composed of three scale items adapted from the Brief Pain Inventory (BPI; Cleeland & Ryan, 1994), a widely used instrument for assessing clinical pain caused by a variety of health

conditions that has demonstrated good validity and reliability (Cleeland, 2009). Participants were asked to rate the intensity of their chronic pain when the pain is at its “least”, “average”, and “worst” using a 10-point Likert scale (e.g., “Please rate the intensity your chronic at its worst in the 30 days prior to this incarceration”). Higher composite scores indicated overall greater pain severity (3-30; $\alpha=0.95$).

Analytic Plan Overview

Data Handling and Preparation

A total of ten datasets were obtained from CDAR along with four codebooks and all original survey instruments. Datasets included five baseline survey datasets and five follow-up data survey datasets for FYs 2013-17. Methods proposed by MacInnes (2017) for handling and preparing (e.g., inspecting, cleaning, merging) data obtained from secondary sources for preliminary examination and analyses were followed, along with other sources, as needed (Kiecolt & Nathan, 1985; Trzesniewski, Donnellan, & Lucas, 2011). Variables and variable names were reviewed prior to merging datasets, as were all codebooks.

Small instrument changes between FYs resulted in some survey versions containing slightly more or fewer questions. Although instrument changes were not extensive, they nevertheless resulted in some variables only being collected for one or two FYs. To include variables that were only collected for one or two years would have resulted in significant non-random missing data for many cases (>900). Rather than deleting a significant percentage of cases and drastically reducing the sample size, a decision was made to exclude variables that were not measured across all FYs, particularly if the same the same construct could be represented using a different variable or combination of variables, or if it was not relevant to the current study (e.g., military history, criminal offenses) (Cook & Campbell, 1979; MacInnes, 2017; Trzesniewski et al., 2011). Variables of interest to this study were renamed such that all variable names across datasets were uniform. Codebooks were annotated and dated with each change. Variables that were not of possible interest were not renamed and not included during merging. The final merged baseline and follow-up CJKTOS dataset contained 696 variables.

In addition to visually inspecting the data, preliminary analyses such as frequency distributions and descriptive statistics were produced in order to preliminarily identify any potential data entry or merging errors, improperly coded variables, and missing data that was not expected (e.g., if participants

responded “no” to lifetime incidence of head trauma, then there should be no value for “number of times” that head trauma was experienced).

Statistical Software

Data cleaning, merging, and preliminary analyses were conducted using IBM-SPSS version 27 (IBM Corp., 2018). All subsequent analyses were conducted using Stata/SE version 15 (StataCorp LLC, 2017).

Analytic Plan Development

One of the conceptual assumptions underlying this study is that people and their decision-making cannot be divorced from the contexts in which they live. In this sense, they can be conceptualized as nested within and across contextual layers. In acknowledging that people are nested within larger contexts and conditions, it cannot be assumed that observations observed at the individual-level are truly independent. This is important, in that it violates assumptions for many families of statistical tests, including ordinarily least squares (OLS) regression (Robson & Pevalin, 2016). This can result in incorrect inference and inflated statistical significance based on too many degrees of freedom that are not truly independent (Tabachnick & Fidell, 2013). To help illustrate, a commonly used example is to consider outcome measures for students. Outcomes for a population of students who live in the same city, but who reside in different neighborhoods and attend different schools may vary not only due to student-level differences, but also due to contextual factors that influence learning and development. Here, variance might be observed at more one than one level. Student performance may differ as a result not only of student-level differences (e.g., measures of general intelligence), but also due to broader conditions, such the different classrooms they learn in, schools they attend, and neighborhoods they live in. In other words, observed effects or outcomes may vary as a function of individual characteristics and shared group characteristics identifiable at other levels. Even if study aims were not concerned with exploring possible contextual influences on drug use, the nature of the data used in this study (i.e., cases clustered at higher levels, such as counties) may violate the assumption of independence of errors, potentially contributing to incorrect estimations of the standard errors (Robinson & Pevalin, 2016; Tabachnick & Fidell, 2013).

Because of this possibility, mixed-effects (random-intercept) multilevel regression models (MLMs) was explored first, prior to developing the final analytic plan, using the exploratory strategy

proposed by Hox (2002). Mixed-effect MLMs include fixed and random effects, needed to “nest” one subset of data in another. MLMs are an extension of OLS regression and can be highly versatile and customizable (Hox, Moerbeek, & Van de Schoot, 2017). As noted above, in some instances, individual-level outcomes examined without taking into account the hierarchical structure of the data can produce inaccurate estimates. MLM addresses such an issue by permitting intercepts (means) and slopes (IV-DV relationship) to vary between levels (Hox et al., 2017). For example, the relationship between cocaine use and, say, misregulation would be allowed to vary between different second-level groups (Tabachnick & Fidell, 2013). Stata enables MLM model building and customization, with many available commands and online resources that can be utilized as models are built (Acock, 2016; Robson & Pevalin, 2016; StataCorp LLC, 2017).

Power analysis

Because MLM uses maximum likelihood estimation (MLE) and because there are numerous variables of interest in this study, it was important to determine that the final sample size of 1,563 would provide adequate statistical power (Maas & Hox, 2005). Although Long (1997) notes that >500 cases are likely sufficient to be able to obtain reliable estimates of variance, that does not necessarily take into consideration the number of covariates across levels, of which there are several in this study, nor the power needed to detect smaller effect sizes (Acock, 2016; Hox, et al., 2017).

In areas of exploratory, non-critical research, a power of 0.80 may be minimally adequate (Jones, Carley, & Harrison, 2003). Even though the current study is exploratory and heavily conceptual in nature, ideally it is desired that there will be sufficient power for accurately detecting a small effect size in terms of explained variance ($f^2=0.02$; $R^2=0.02$). However, it would be acceptable for the purposes of this study if power is sufficient for accurately detecting a medium effect size ($f^2=0.15$; $R^2=0.13$). A priori estimates of the required sample size, conducted using the software G*Power (Faul, Erdfelder, Buchner, & Lang, 2009), determined that for a small effect size $f^2=0.02$, $\alpha=0.05$, $\text{power}=0.85$, tested predictors=40, a sample size $N=1,545$ was required⁹. Setting the $\text{power}=0.90$ or 0.95 would have necessitated increasing the sample size to $N=1,726$ and $2,005$, respectively. In order to be able to accurately detect a medium effect size $f^2=0.15$ at

⁹ Note that 40 variables was used to err on the side of caution. While there were many IVs proposed for examination, not all of them were included into the models, as some did not demonstrate any correlation to outcome variables and others were not included in order to avoid overfitting the model.

alpha=0.05, power=0.85, tested predictors=40, a sample size of N=232 would be required. Increasing this to power=0.90 or 0.95 would have necessitated increasing the sample size to N=256 or N=293, respectively. Preliminary analyses using the current study sample size (N=1,564) with $f^2=0.02$, alpha=0.05, tested predictors=40, calculated achieved power=0.86.

However, with MLM, needed sample size varies between levels. Although level-one had sufficient power at N=1,643, the overall power needed for each MLM varies based on the groupings and sample sizes for groupings across levels (Hox & Maas, 2002). Typically, MLE methods, which produce parameter estimates and asymptotic standard errors, is used in MLM as well as logistic and multinomial regression, in which only fixed effects are modeled (Hox et al., 2017). MLE is used to test the significance of specific parameters and to establish confidence intervals (CI). This means that there are assumptions of normal distribution of error, not just at level-1, but at level-2 and so on. (Maas & Hox, 2004). Small sample sizes (<50) for groups at higher levels can lead to biased estimates; specifically, the random effects at the second level may be inaccurate due to distribution assumptions at the second-level (or third-level, etc.) not being satisfied (Maas & Hox, 2004). It has been suggested that the number of level-2 or level-3 groups is generally more important than the number of observations within each grouping (Hox et al., 2017).

In this study, variables measured at the level of the county were spread over >100 county groupings (N=119), meaning that there was sufficient sample size of counties to produce reliable error estimates (see Maas & Hox, 2005). Although the recommended sample size for groups varies from to 20-30, the general consensus is that power increases as the number of groups increase (Duncan, 1998; Maas & Hox, 2005; Mox, 1995; Snijders, 2005). As noted above, the number of higher-level clusters is typically considered more important for conducting MLM than the number of observations within each cluster, with a recommendation of 20 clusters minimum (Hox et al., 2017). There is growing consensus that as the number of clusters increases the number of observations needed per cluster may decrease without biasing estimates (Hox, 1998, 2010; McNeish & Stapleton, 2014; Snijders & Bosker, 2012). For instance, 50 clusters with 20 observations or 100 clusters with 10 observations may produce a stable MLM (Hox 1998, 2010). Dedrick et al. (2009) have proposed a “30/30” guideline based on a review of MLMs in which they found that just over 20% of reviewed studies did not have adequate clusters and observations per cluster to perform MLM or MLM that produced unbiased estimates.

Exploratory MLM Building Results

With this recommendation in mind, the distribution of participant counties was examined to determine if the number of observations per group within the county-level cluster would permit MLM of county-level variables (e.g., household poverty, Internet access, etc.). When baseline data were collected participants reported living in 118 counties; at the time follow-up data were collected, participants reported living in 119 counties (out of a possible 120 counties). Although there were >100 groups at the county-level, there were >10 observations for only 33.1% of the counties for the period prior to incarceration and for only 32.6% of the counties for the period subsequent to incarceration. Prior to incarceration, observations were identified as primarily clustered within Jefferson (N=228, 14.6%), Fayette (N=71, 4.5%), Kenton (N=56, 3.6%), Hardin (N=54, 3.5%), and Daviess (N=51, 3.3%) counties. Subsequent to incarceration, observations were identified as still primarily clustered within Jefferson (N=259, 16.6%), Fayette (N=82, 5.2%), Kenton (N=53, 3.4%), Daviess (N=53, 3.4%), and Hardin (N=48, 3.1%). In Appendix B, Figures 3.0 and 3.1 display frequencies of all counties with <10 observations per county. Frequencies for all counties with >10 observations are presented in Figures 4.0 and 4.1 in Appendix B.

In order to demonstrate that MLM could not be pursued due to insufficient observations at the level-two grouping variable, models were built following the general sequence outlined by Hox (2002), which involved several steps. The first step included analyzing the intercept-only (null) model and examining the interclass correlation (ICC), (i.e., ratio of the variance between groups at higher levels and variance within groups at these levels), with high values indicating that the assumption of independence of errors had been violated. This was done for five drug outcomes. These included heroin (ICC=0.055, random intercept=0.0723; between-subject SD=0.2986, $\chi^2=59.6$, $p<.001$), prescription opioids (ICC=0.003, random intercept=0.0194, between-subjects SD=0.3492, $\chi^2=0.24$, $p=.313$), buprenorphine (ICC=0.0142, random intercept=0.0348; between-subject SD=0.2900, $\chi^2=1.74$, $p=.094$), cocaine/crack cocaine (ICC=0.000, random intercept=0.0348; between-subject SD=0.2610, $\chi^2=0.0$, $p=1.00$), amphetamines (ICC=0.0476, random intercept=0.0785; between-subject SD=0.3513, $\chi^2=21.6$, $p<.001$). Additionally, counties were ranked in order of random intercepts on outcomes to create confidence intervals (CIs) around the estimates of the random intercepts. Standard error bar charts were then used to graph the relative random intercept values. Tabachnick & Fidell (2013) note that if the ICC is sufficiently

small that a single-level regression analysis is appropriate. Still, as Robson & Pevalin (2016) note, it is not always clear when a non-zero ICC indicates a clear cut-off point.

Second, models were analyzed using all level-1 IVs fixed, assessing contribution of each IV and model differences. IVs were selected for inclusion based on bivariate statistics indicating statistically significant correlation between an IV and outcome variables. Next, a MLM for heroin was built, using “county” as the higher-level group. This outcome was chosen because it had the largest ICC value. Here, the slope for each IV was permitted to be random, adding county-level IVs individually. Though the model converged after 10 iterations, SEs and CIs were not produced, indicating that the Hessian calculation had become unstable. Further, when comparing the saved fixed- and random-effects estimates, output reported that levels were “not nested”. It was therefore concluded there were insufficient cases for MLM in general and that, for some of the other drug outcomes explored in preliminary analyses, there was insufficient variance at the individual-level explained by the county-level to justify the use of MLM. Ultimately, due to insufficient cases, MLM was excluded as a means for examining drug use outcomes of interest. A revised analytic plan was created and is outlined below.

Final Analytic Plan

Aim One

To address this aim, (described on pg. 126) descriptive statistics, such as means and proportions, were generated for the entire sample and for all four drug use groups (e.g., concomitant use, opioid use, stimulant use, other drug use and other drug/no drug use) using data collected at baseline and follow-up. Chi-square test of independence and the Kruskal-Wallis analysis of variance by ranks were used to determine if groups were statistically significantly different ($p < .05$) (Everitt, 1977; Meyers et al., 2013; Siegel & Castellan, 1988).

Aim Two

To address this aim (described on pg 126), multinomial logistic regression was used to examine the association between independent variables and concomitant, opioid, and stimulant use for each time period. Independent and control variables that differed significantly ($p < .05$) across drug use outcome groups in non-parametric tests were chosen for inclusion into regression models. Multinomial logistic regression was selected due to the polytomous outcome variable (Luke, 2004; Skrondal & Rabe-Hesketh,

2003). For the 30-day period prior to incarceration, the drug use outcome group of “other drug use” was used as the reference category, meaning that the coefficients for all other drug use outcome groups describe how the IVs are related to the probability of being in one of the drug use outcome groups, versus the reference group of other drug use. Because all participants reported some drug use in the 30-day period prior to incarceration, “no drug use” was not also used to define that group, but rather only “other drug use”. For the one-year post-release period, the drug use group of “other/no drug use” was used as the reference category. This is because, during the one-year post-release period, some participants reported using drugs other than opioids and stimulants while other participants reported not using any drugs, unlike the 30-day period prior to incarceration, in which all participants reported some drug use. These drug use outcome groups of “other drug use” and “other/no drug use” were selected to serve as the reference categories because they reflect decisions with the less relative risk compared to decisions involving opioids and stimulants.

Aim Three

To address this aim, (described on pg. 127) descriptive statistics, chi-square, and t-test were used to describe and examine differences between participants who reported heroin use during the one-year post-release period and those who did not. Binary logistic regression was used to examine the relationship between independent variables and heroin use during the one-year post-release period. Independent variables that differed significantly ($p < .05$) between the heroin-use group and the non-heroin use group in bivariate analyses were selected for inclusion into regression model.

CHAPTER IV

RESULTS

Aim One Results

Drug Outcomes During the 30-day Period Prior to Incarceration

Table 1 displays means and proportions for the final sample (N=1,563) and for each drug use group for the period prior to incarceration. For the *30-day period* prior to incarceration, 29.0% of participants reported concomitant use of opioid and stimulants, 28.5% reported opioid, but not stimulant, use; 18.0% reported stimulant, but not opioid use; and 24.4% reported use of drugs other than opioids and stimulants.

The majority of the sample was White (81.5%), with the remainder African American (17.1%), Hispanic (0.8%), and other (e.g., Asian, American Indian, Middle Eastern; 0.6%). There was a higher proportion of White participants among those who reported past 30-day opioid (93.9%) and concomitant use (90.1%), compared to past 30-day stimulant (70.6%) and other drug use (64.7%, $X^2=161.71$, $df=3$, $p<.001$). Approximately 71% of the sample had earned a high school diploma (HSD)/GED. The proportion of participants with a HSD/GED were equivalent across groups ($X^2=2.27$, $df=3$, $p=.519$), with rates highest among participants who reported past 30-day concomitant use (73.3%) and lowest among participants who reported past 30-day opioid use (68.8%). Twenty percent of the sample was married and 47.6% reported never having been married, with the remainder widowed (1.6%), separated (7.5%), or divorced (23.3%). Marital status was similar across groups ($X^2=14.13$, $df=12$, $p=.292$). Participants who reported past 30-day opioid use had slightly higher rates of

being currently married (22.0%) as well as divorced (25.8%). Participants who reported past 30-day other drug use had the highest rates of never being married (52.6%).

Although the mean number of nights spent in a controlled environment out of the 30-day period prior to incarceration was low sample-wide ($\bar{x} = 1.3$, $SD=3.5$), participants who reported past 30-day other drug use were incarcerated for 1.6 nights, whereas those who reported past 30-day stimulant use were incarcerated <1 night (0.9) ($p=.011$). For the entire sample, the mean number of lifetime drug treatment episodes was 2.2 ($SD=3.8$, range 0-62). Past 30-day concomitant use was associated with a greater average number of lifetime treatment episodes (2.8) compared to use of opioids (2.1), stimulants (2.2), and other drugs (1.8) ($p<.001$). Participants who reported past 30-day concomitant use had a higher rate of IDU history (64.2%; $X^2=238.35$, $df=3$, $p<.001$), whereas history of IDU for the entire sample was 42.9%. Participants who reported past 30-day opioid use also had a higher rate of IDU history (53.1%) compared to participants who reported past 30-day stimulant (29.1%) and other drug use (16.0%).

Table 1
Sample Characteristics and Drug Use Group Means, Proportions, and Between-group Differences Prior to Incarceration

	Sample	Concomitant	Opioid	Stimulant	Other	p value
N=	1,563	453	446	282	382	
%		29.0	28.5	18.0	24.4	
<i>Race/ethnicity</i>						
White	81.5%	90.1%	93.9%	70.6%	64.7%	.001
African American	17.1%	7.9%	4.9%	27.7%	34.6%	
Hispanic	0.8%	1.3%	0.9%	0.7%	0.3%	
Other	0.6%	0.7%	0.2%	1.1%	0.5%	
HSD/GED	71.3%	73.3%	68.8%	72.0%	71.2%	.519
<i>Marital status</i>						
Married	20.0%	19.4%	22.0%	20.9%	17.8%	.292
Widowed	1.6%	2.0%	1.1%	0.7%	2.1%	
Separated	7.5%	8.4%	8.3%	5.7%	6.8%	
Divorced	23.3%	23.0%	25.8%	23.4%	20.7%	
Never married	47.6%	47.0%	42.8%	49.3%	52.6%	
Nights in controlled environment	1.3	1.4	1.3	0.9	1.6	.011
Lifetime drug treatment episodes	2.2	2.8	2.1	2.2	1.8	.001
Ever IDU	42.9%	64.2%	53.1%	29.1%	16.0%	.001
Age	33.9	32.2	34.0	36.9	33.8	.001
Male	80.9%	77.3%	76.5%	85.8%	86.9%	.001
LD diagnosis/SE enrollment	28.6%	29.4%	28.0%	28.7%	28.3%	.974
Head trauma	41.9%	47.1%	44.2%	37.9%	36.4%	.007
Mean head injuries (N=655)	2.5	2.3	2.5	2.8	2.7	.009
Anxiety symptoms	44.5%	57.0%	44.6%	41.1%	32.2%	.001
Depressive symptoms	46.2%	59.6%	49.1%	42.2%	29.8%	.001
Suicidality	11.6%	15.7%	12.1%	11.7%	6.3%	.001
Chronic pain	24.8%	27.6%	28.7%	20.6%	19.9%	.004
Chronic pain severity (N=387; 3-30)	15.6	15.6	16.2	15.1	15.2	.003
Stress-related health effects (11-44)	23.5	26.3	23.6	22.7	20.1	.001
Economic hardship (0-8)	1.6	2.2	1.7	1.4	1.1	.001
Homelessness	14.8%	19.4%	16.1%	12.1%	9.9%	.001
Subjective socioeconomic status (1-10)	5.0	4.7	4.8	5.3	5.3	.001
Misregulation	83.1%	91.4%	86.8%	83.7%	68.8%	.001
Close relationships	7.1	6.7	6.5	7.3	7.9	.010
Social interaction	88.9%	88.1%	89.2%	86.5%	91.4%	.228
Social satisfaction	70.8%	61.8%	71.3%	73.4%	79.8%	.001

	Sample	Concomitant	Opioid	Stimulant	Other	p value
N=	1,563	453	446	282	382	
%		29.0	28.5	18.0	24.4	
Table 1 (continued)						
Leisure time (0-7)	2.5	2.0	2.2	2.5	3.3	.001
Educational/vocational involvement	65.8%	66.2%	62.8%	70.2%	65.7%	.232
Age of drug use initiation	14.7	13.7	15.5	15.3	14.5	.001
Severity of drug use, past 30-days (0-40)	23.2	30.0	27.3	22.3	11.2	.001
Intoxicated during offense	78.2%	89.0%	81.8%	79.4%	60.2%	.001
Past-year drug use versatility	3.8	6.1	3.6	2.6	2.1	.001
Past 30-day drug use versatility	3.0	5.3	2.9	2.3	1.1	.001
<i>Past-year drug prior to incarceration</i>						
Alcohol	63.5%	68.7%	54.0%	63.1%	68.8%	.001
Cannabis	61.4%	72.0%	52.0%	56.0%	63.6%	.001
Sedatives	39.0%	66.9%	42.6%	14.2%	19.9%	.001
Hallucinogens	6.1%	13.0%	3.1%	5.0%	2.1%	.001
Synthetics	10.1%	19.6%	7.0%	7.8%	4.2%	.001
Cocaine/crack cocaine	33.5%	63.8%	12.1%	47.5%	12.3%	.001
Amphetamines	36.7%	72.0%	7.4%	62.4%	10.2%	.001
Heroin	21.8%	40.0%	30.9%	0.4%	5.5%	.001
Prescription opioids	55.8%	91.4%	86.5%	4.6%	15.4%	.001
Buprenorphine	24.9%	44.4%	35.9%	1.8%	6.0%	.001
<i>Past 30-day drug use prior to incarceration</i>						
Alcohol	7.3	8.4	4.7	8.1	8.3	.001
Cannabis	11.2	14.9	9.1	11.1	10.1	.001
Sedatives	5.2	9.9	6.1	1.1	1.6	.001
Hallucinogens	0.3	0.5	0.1	0.4	0.0	.001
Synthetic drugs	1.1	2.2	0.5	1.0	0.6	.001
Cocaine/crack cocaine	3.3	7.4	0.0	6.6	0.0	-
Amphetamines	6.2	12.9	0.0	13.6	0.0	-
Heroin	3.7	6.6	6.1	0.0	0.0	-
Prescription opioids	10.4	18.1	18.2	0.0	0.0	-
Buprenorphine	2.7	5.1	4.2	0.0	0.0	-
<i>Past-year preferred drug of choice</i>						
Alcohol	13.1%	5.5%	7.2%	11.3%	30.4%	.001
Cannabis	21.3%	9.7%	14.1%	19.9%	44.5%	
Sedatives	2.9%	2.0%	3.8%	1.8%	3.9%	
Hallucinogens/synthetics	1.3%	2.2%	0.4%	1.4%	1.0%	
Cocaine/crack cocaine	8.7%	11.0%	0.4%	25.2%	3.4%	
Amphetamines	15.2%	23.4%	0.7%	38.7%	5.0%	

	Sample	Concomitant	Opioid	Stimulant	Other	p value
N=	1,563	453	446	282	382	
%		29.0	28.5	18.0	24.4	
Table 1 (continued)						
Heroin	9.8%	13.9%	17.3%	0.0%	3.4%	
Prescription opioids	25.2%	29.8%	50.7%	1.8%	7.1%	
Buprenorphine	2.6%	2.4%	5.4%	0.0%	1.3%	
Central Appalachia	31.8%	35.3%	43.9%	18.4%	23.3%	.001
Urban influence	4.6	4.7	5.1	4.3	4.0	.001

Age and Sex

Participants were 33.9 years old on average ($SD=9.0$, range=18-74) prior to entering SAP.

Participants who reported past 30-day stimulant use were relatively older (36.9; $p<.001$) compared to participants who reported past 30-day opioid (34.0), concomitant (32.2), and other drug use (33.8). While the sample was majority male (80.9%), the proportion of males was highest among participants who reported past 30-day other drug (86.9%) and stimulant use (85.8%), whereas the proportion of males among participants reporting past 30-day opioid and concomitant use was lower, and more similar, at 76.5% and 77.3%, respectively ($X^2=22.95$, $df=3$, $p<.001$).

LD diagnosis, SE enrollment and History of Head Trauma

Over a quarter of participants (28.6%) reported a history of LD diagnosis and/or SE enrollment.

The proportion of participants reporting LD diagnosis and/or SE enrollment was similar across groups, with rates ranging from 28.3% among participants who reported using other drugs to 29.4% among participants who reported concomitant use ($X^2=0.22$, $df=3$, $p=.974$). Nearly 42.0% of participants reported lifetime history of head trauma. Among those who did ($N=655$), the average number of head injuries reported was 2.5 ($SD=3.3$, range=1-40, $p=.009$). Rates for any history of head trauma were highest among participants reporting past 30-day concomitant use and lowest among participants who reported past 30-day other drug use ($X^2=11.99$, $df=3$, 47.1% vs 36.4%; $p=.007$).

Psychiatric Symptoms

During the year prior to incarceration, 44.5% of participants met or surpassed the GAD cutoff point, meaning that they experienced ≥ 4 anxiety symptoms during the one-year period prior to incarceration at a level of clinical significance. Approximately 46.0% of participants met or surpassed the

MDD cutoff point, meaning that they experienced ≥ 5 symptoms associated with major depressive disorder during the year prior to incarceration at a level of clinical significance. Groups significantly differed in terms of the proportion of participants who met these thresholds for anxiety ($X^2=53.14$, $df=3$, $p<.001$) and depressive symptoms during this pre-incarceration time period ($X^2=77.19$, $df=3$, $p<.001$). Rates of past-year anxiety and depressive symptoms were highest among participants who reported past 30-day concomitant use, with 57.0% reporting anxiety symptoms and 59.0% reporting depressive symptoms. Rates of anxiety symptoms were lower among participants reporting past 30-day opioid (44.6%) and stimulant use (41.1%), as were rates of depressive symptoms, with 49.1% of participants who reported past 30-day opioid use and 42.2% of participants who reported past 30-day stimulant use reporting depressive symptoms. Participants who reported past 30-day other drug use had the lowest rates of both depressive and anxiety symptoms, 32.2% and 29.8%, respectively. Suicidal ideation for this same time period was reported by 11.6% of the sample. For participants who reported past 30-day concomitant use, however, 15.7% reported past-year suicidal ideation, the highest among all groups ($X^2=17.92$, $df=3$, $p<.001$). Approximately 12% of participants who reported past 30-day opioid and stimulant use also reported past-year suicidal ideation, still relatively high at nearly double the rates of those who reported past 30-day other drug use (6.3%).

Chronic Pain

Just under a quarter of the sample reported experiencing chronic pain in the one-year period prior to incarceration (24.8%). Of those who experienced chronic pain ($N=387$), the mean BPI chronic pain severity score was 15.6 out of a possible 30 ($SD=5.5$, $range=3-30$, $p=.003$). For subscales (0-10), pain “at its worst” was ranked 7.0, pain “on average” was ranked 4.8, and pain “at its least” was ranked 3.8, meaning that pain severity ranged from approximately 4-7 on a 10-point scale. Participants who reported past 30-day opioid and concomitant use evidenced the highest rates of chronic pain, 28.7% and 27.6%, respectively, whereas rates of chronic pain among participants who reported past 30-day stimulant and other drug use were slightly lower, 20.6% and 19.9%, respectively ($X^2=13.82$, $df=3$, $p=.004$).

Stress-related Health Effects

In terms of past-week stress-related health effects reported for the 7-day period prior to incarceration, the mean score on the revised HCS was 23.5 ($SD=8.1$, $range=11-44$), indicating that, on average, moderate stress-related health effects were experienced during this time period by the majority of

participants (93.0% reported at least one stress-related health effect). Participants who reported past 30-day concomitant use scored the highest on the HCS, whereas participants who reported past 30-day other drug use scored the lowest (26.3 vs. 20.1; $p < .001$). Participants who reported past 30-day opioid and stimulant use had similar HCS scores, at 23.6 and 22.7, respectively.

Economic Hardship, Homelessness, and Subjective Socioeconomic Status

The mean economic hardship score for the entire sample during the one-year period prior to incarceration was 1.6 ($SD=2.2$, range=0-8), meaning that, on average, participants experienced fewer than 2 episodes of economic hardship during the year prior to their incarceration. Measures of past-year economic hardship were highest among participants reporting past 30-day opioid (1.7) and concomitant use (2.2), the latter approximately double that of participants who reported other drug use (1.1) ($p < .001$). A total of 14.8% of participants reported experiencing homelessness during this same time period. Experiencing past-year homelessness was highest among participants who reported past 30-day concomitant use (19.4%), nearly double that of participants who reported past 30-day other drug use (9.9%, $X^2=17.01$, $df=3$, $p < .001$). Participants who reported past 30-day opioid use also reported relatively higher rates of past-year homelessness (16.1%).

The average subjective social comparison rating was 5.0 ($SD=2.0$, range 1-10). This means that perceived socioeconomic status for the sample was, on average, one in which participants' subjective social comparison equated to being "worse off" than approximately one-half of people in US society in terms of social and economic status (or "better off", depending on how one wishes to interpret this). Among participants who reported past 30-day opioid and concomitant use, the average rank of perceived socioeconomic status was just under the sample mean of 5.0, at 4.8 and 4.7 respectively, differing from participants who reported past 30-day stimulant and other drug use, which had the same mean rank of 5.3 ($p < .001$).

Misregulation

In the 7-day period prior to incarceration, 83.1% of participants reported using drugs (e.g., alcohol, prescription drugs, illicit drugs) to reduce stress, anxiety, worry or fear. This means that not only did a majority of participants report experiencing stress, anxiety, worry, or fear for a portion of the 30-day period prior to incarceration, but also that a majority sought out drugs as a means of coping with these states.

Using a psychoactive drug to ameliorate fear, stress, worry, or anxiety in the week prior to incarceration was highest among participants who reported past 30-day concomitant use and lowest among participants reporting other drug use (91.4% vs. 68.8%, $X^2= 82.05$, $df=3$, $p<.001$). Nearly 87.0% of participants who reported past 30-day opioid use also engaged in this form of coping or “self-medication”, as did slightly fewer, but still a majority (83.7%), of participants who reported past 30-day stimulant use.

Non-drug Alternative Reinforcers

On average, participants reported having fewer than 10 close relationships ($\bar{x} =7.1$) with people such as family members, friends, children, intimate partners, and other people with whom they felt close ($SD=5.2$, $range=0-56$). Participants who reported past 30-day concomitant and opioid use reported having fewer close relationships on average during the one-year year period prior to incarceration (6.7 and 6.5, respectively), compared to participants who reported past 30-day stimulant use (7.3). Participants who reported past 30-day other drug use had the highest average number of close relationships 7.9 ($p=.010$).

Compared to spending the majority of time alone, 88.9% of the sample reported some social interaction (i.e., spending time friends or family) during the one-year period prior to incarceration. Participants who reported past 30-day other drug use had the highest rates of social interaction, though groups did not differ significantly overall ($X^2=4.33$, $df=3$, $p=.228$). Specifically, 91.4% of participants who reported past 30-day other drug use reported spending time with friends or family, versus alone, whereas rates of spending time with friends or family were lowest among participants who reported past 30-day stimulant use (86.5%). Participants who reported opioid and concomitant use had similar rates at 88.1% and 89.2%, respectively. Compared to being indifferent to or not enjoying spending their time this way, 70.8% of the sample reported that they received satisfaction from these social interactions. Participants who reported past 30-day concomitant use had the lowest rates of receiving satisfaction from past-year social interaction, whereas participants who reported past 30-day other drug use had the highest (61.8% vs. 79.8%; $X^2=31.30$, $df=3$, $p<.001$). Rates of satisfaction were similar among participants who reported past 30-day opioid (71.3%) and stimulant use (73.4%).

In the year prior to incarceration, the average number of leisure days per week, in which hobbies or enjoyable activities could be freely pursued, was 2.5 for the entire sample ($SD=2.4$, $range=0-7$). The mean number of leisure days was highest among participants who reported past 30-day other drug use

(3.3), but slightly lower among participants who reported past 30-day stimulant (2.5), opioid (2.2), and concomitant use (2.0, $p=.002$).

Approximately 66% of participants reported being involved in educational and/or vocational pursuits in the one-year period prior to incarceration. Past-year educational/vocational involvement did not differ between groups ($X^2=4.29$, $df=3$, $p=.232$), but was highest among participants who reported past 30-day stimulant use (70.2%), followed by concomitant (66.2%), other drug (65.7%), and opioid use (62.8%).

Age of Drug Use Initiation

The mean age of drug use initiation for the entire sample was just over 14 years old ($\bar{x}=14.7$, $SD=4.9$, $range=4-56$). Participants who reported past 30-day opioid and stimulant use were similar in terms of the average age at which drug use was initiated, at just over 15 years of age; however, age of first drug use occurred at a younger age among participants who reported other drug (14.5) and concomitant use (13.7; $p<.001$).

Drug Use Severity

In the 30-day period prior to incarceration, the mean drug use severity score was 23.2 ($SD=15.8$, $range=2-40$). Severity scores, which indicate higher degree of being bothered by drug-related problems and more frequent instances of craving, withdrawal, and/or unsuccessful attempts to quit, were highest among participants who reported past 30-day concomitant (30.0) and opioid use (27.3). Participants who reported past 30-day stimulant use had lower scores at 22.3, though even this was still approximately double that of the average severity score for participants who reported past 30-day other drug use (11.2; $p<.001$).

Similarly, a greater proportion of participants who reported past 30-day concomitant use also reported being intoxicated at the time that they committed their offense, compared to participants who reported past 30-day other drug use (89.0% vs. 60.2%, $X^2=106.96$, $df=3$, $p<.001$).

Drug Use Versatility

Across the entire sample, the average number of drugs used during the *one-year* period prior to incarceration was 3.8 ($SD=2.3$, $range=1-13$). However, among participants who reported past 30-day concomitant use, the average was 6.1, higher than participants who reported past 30-day opioid (3.6) and stimulant use (2.6), and nearly three times more than participants who reported past 30-day other drug use (2.1; $p<.001$). Sample-wide, the average number of drugs used during the *30-day* period prior to

incarceration was 3.0 ($SD=2.1$, range=0-13). However, among participants who reported past 30-day concomitant use, the average was 5.3, higher than participants who reported past 30-day opioid (2.9) and stimulant use (2.3), and nearly three times more than participants who reported past 30-day other drug use (1.1; $p<.001$).

Past-year Drug Use Prior to Incarceration

Among non-opioid and non-stimulant drugs, alcohol was used in the one-year period prior to incarceration by 63.5% of the sample, with rates similar among participants who reported past 30-day concomitant and other drug use, approximately 68%. Rates were lowest among participants who reported past 30-day opioid use (54.0%, $X^2=27.2$, $df=3$, $p<.001$). Just over 60% of the sample reported past-year cannabis use. Participants who reported past 30-day concomitant use had the highest rates of past-year cannabis use (72.0%), followed by participants who reported past 30-day other drug use (63.6%). This differed from participants who reported past 30-day opioid and stimulant use, among whom just over half reported past-year cannabis use ($X^2=42.10$, $df=3$, $p<.001$). Thirty-nine percent of the sample reported past-year prescription sedative use, but only 14.2% of participants who reported past 30-day stimulant use and 19.9% of participants who reported past 30-day other drug use reported past-year prescription sedative use; rates were highest among participants who reported past 30-day concomitant use (66.9%, $X^2=282.28$, $df=3$, $p<.001$). Past-year hallucinogen use was relatively low sample-wide (6.1%), with rates among groups lowest among participants who reported past 30-day other drug use (2.1%) and highest among those who reported past 30-day concomitant use (13.0%, $X^2=26.27$, $df=3$, $p<.001$). Synthetic drugs were also not widely used across the sample during the year prior to incarceration (10.1%), but similar to past-year hallucinogen use, rates were lowest among participants reporting past 30-day other drug use (4.2%) and highest among those reporting past 30-day concomitant use (19.6%, $X^2=66.63$, $df=3$, $p<.001$). Still, between 7-8% of participants who reported past 30-day opioid and stimulant use reported past-year synthetic drug use.

Although the rates of past-year use of stimulant and opioid drugs would necessarily differ as a function of past 30-day use of opioids and stimulants, it was important to determine differences for particular types of drugs used during the one-year period prior to incarceration, as it may be that

participants who reported past 30-day stimulant use used cocaine/crack cocaine, but not amphetamines and vice versa. Here, the proportions of use for a specific drug are more informative than the test statistic itself.

For stimulant drugs, 33.5% of the sample reported using cocaine/crack cocaine during the one-year prior to incarceration. Rates of cocaine/crack cocaine use were highest among participants who reported past 30-day concomitant use (63.8%), followed by past 30-day stimulant use (47.5%, $X^2=380.04$, $df=3$, $p<.001$). Participants who reported past 30-day opioid and other drug use had similar rates, at just over 12.0%. Nearly 37.0% of the sample reported past-year amphetamine use. Rates were highest among participants who reported past 30-day concomitant (72.0%) and stimulant use (62.5%) and lowest among participants who reported past 30-day other drug (10.2%) and opioid use (7.4%, $X^2=602.79$, $df=3$, $p<.001$).

For opioid drugs, 21.8% of the sample reported using heroin during the one-year period prior to incarceration. Rates were highest among participants who reported past 30-day concomitant use (40.0%), followed by participants who reported past 30-day opioid use (30.9%). Only 5.5% of participants who reported past 30-day other drug use and only 0.4% of participants who reported past 30-day stimulant use reported past-year heroin use prior to incarceration ($X^2=244.95$, $df=3$, $p<.001$). Compared to heroin, a greater proportion of the sample reported past-year prescription opioid use (55.8%). Participants who reported past 30-day concomitant use had the highest rates of past-year prescription opioid use (91.4%), followed by participants reporting past 30-day opioid use (86.5%). These rates differed from those who reported past 30-day other drug (15.4%) and stimulant use (4.6%, $X^2=955.41$, $df=3$, $p<.001$). Sample-wide, past-year use of buprenorphine was also higher, albeit slightly, compared with heroin, with 24.9% reporting use. While only 1.8% of participants who reported past 30-day stimulant use reported past-year buprenorphine use, 44.4% of participants who reported past 30-day concomitant use and 35.9% of participants who reported past 30-day opioid use reported past-year buprenorphine use; only 6.0% of participants who reported past 30-day other drug use reported past-year buprenorphine use ($X^2=274.12$, $df=3$, $p<.001$).

Past-year Drug Use Frequency Prior to Incarceration

Frequency, measured in months (results not shown in table), that a particular drug was used during the one-year period prior to incarceration, varied from an average of 0.2 month to 6.2 months. Included among non-opioid and non-stimulant drugs was alcohol, used an average of 4.6 months, cannabis, used an

average of 5.1 months, prescription sedatives, used an average of 2.7 months, hallucinogens, used an average of 0.2 months, and synthetic drugs, used an average of 0.5 months. The average number of months out of the one-year period prior to incarceration that alcohol was used was fairly uniform across groups, ranging from 3.4 months among participants who reported past 30-day opioid use and 5.1 months among participants who reported past 30-day other drug use ($p=.306$). The average number of months that cannabis was used was highest among participants who reported past 30-day concomitant use (6.1), followed by participants who reported other drug use (5.2), though groups did not differ overall ($p=.938$). For prescription sedatives, the average number of months that these were used was highest among participants who reported past 30-day concomitant (4.8) and opioid use (3.2) compared to other groups ($p<.001$). Hallucinogens, which were less frequently used sample-wide, were used a greater number of months on average among participants who reported past 30-day concomitant use (1.1), whereas all other groups used hallucinogens $1 <$ month on average (range= 0.2-0.4; $p<.001$). Synthetic drugs, also less frequently used, were used a greater number of months among participants who reported past 30-day concomitant use (2.2), compared to participants who reported past 30-day opioid (0.5), stimulant (0.9) and other drug use (0.6; $p<.001$).

For stimulant drugs, amphetamines were used on average 6.2 months, making it the most frequently used drug for this time period as measured in months. Cocaine/crack cocaine was used an average of 1.8 months. Unsurprisingly, the average number of months that cocaine/crack cocaine was used was highest among participants who reported past 30-day stimulant and concomitant use, 3.2 and 3.5, respectively ($p<.001$). Participants who reported past 30-day opioid use used cocaine/crack cocaine on average $1 <$ month (0.3), as did participants who reported past 30-day other drug use (0.5). Similarly, amphetamine use was highest among participants who reported past 30-day stimulant and concomitant use, 5.3 and 5.4, respectively ($p<.001$). Participants who reported past 30-day opioid use also used amphetamines on average <1 month (0.2) out of the one-year period prior to incarceration, as did participants who reported past 30-day other drug use (0.4).

For opioid drugs, heroin was used for 1.4 months on average, prescription opioids 4.8 months, and buprenorphine 1.4 months. The average number of months that heroin was used was similar across participants who reported past 30-day opioid and concomitant use, at 2.2 and 2.4 months, respectively;

however, no participants who reported past 30-day stimulant use reported heroin use, and among participants who reported past 30-day other drug use, the average number of months heroin was used was <1 (0.2; $p<.001$). Prescription opioids were used an average of 7.9 months among participants who reported both past 30-day opioid use as well as past 30-day concomitant use. Among participants who reported past 30-day stimulant use, the average number of months that prescription opioids were used was <1 (0.1), and among participants who reported past 30-day other drug use, was 0.7 ($p=.206$). The average number of months that buprenorphine was used was highest among participants who reported past 30-day concomitant (2.5) and opioid use (2.0). The average number of months that buprenorphine was used among participants who reported past 30-day stimulant or other drug use was <1 month, 0.4 and 0.2, respectively ($p<.001$).

Past 30-day Drug Use Frequency Prior to Incarceration

Frequency of drug use that occurred during the 30-day period prior to incarceration also varied significantly from an average of 0.3 days to 11.2 days. Included among non-opioid and non-stimulant drugs was alcohol, used an average of 7.3 days, cannabis, used an average of 11.2 days, prescription sedatives, used an average of 5.2 days, hallucinogens, used an average of 0.3 days, and synthetic drugs, used an average of 1.1 days.

Alcohol was used, on average, for approximately the same number of days out of the 30-day period prior to incarceration among participants who reported past 30-day stimulant (8.1), concomitant (8.4), and other drug use (8.3), whereas participants who reported past 30-day opioid use used alcohol for approximately 4.7 days ($p<.001$). The average number of days that cannabis was used during the 30-day period prior to incarceration was highest among participants who reported past 30-day concomitant use (14.9), followed by stimulant (11.1), other drug (10.1), and opioid use (9.1; $p<.001$). Prescription sedatives were used nearly 10 days on average by participants who reported past 30-day concomitant use, far higher than participants who reported past 30-day opioid (6.1), stimulant (1.1), and other drug use (1.6; $p<.001$). Hallucinogens were used <1 day on average across groups (range=0-0.5), with participants who reported past 30-day other drug use reporting zero days of hallucinogen use for this time period ($p<.001$). Synthetic drugs were used 2.2 days on average among participants who reported past 30-day concomitant use and approximately 1.0 day among participants who reported past 30-day stimulant use, still significantly more often than participants who reported past 30-day opioid and other drug use ($p<.001$).

Among stimulant drugs, amphetamines were used an average 6.4 days and cocaine/crack cocaine was used an average of 1.8 days. Between the two groups who reported past 30-day use of stimulants (i.e., stimulants and concomitant use), cocaine/crack cocaine was used for more days on average among participants who reported past 30-day concomitant use compared to stimulant use (7.4 vs. 6.6). Amphetamine use among these same groups was slightly more frequent among participants who reported past 30-day stimulant versus concomitant use (13.6 vs. 12.9).

Among opioid drugs, heroin was used for 3.7 days on average, prescription opioids 10.4 days, and buprenorphine 2.7 days. Between the two groups who reported past 30-day use of opioids (i.e., opioids and concomitant use), heroin was used approximately the same number of days on average among participants who reported past 30-day opioid (6.1) and concomitant use (6.6). The frequency of prescription opioid use among these same groups was nearly equal, an average of 18 days out of the 30 days prior to incarceration. Among these two groups, buprenorphine was used slightly more days on average by participants who reported past 30-day concomitant use (5.1), compared to participants who reported past 30-day opioid use (4.2).

Past-year Preferred Drug of Choice

The most commonly preferred drugs across the sample were prescription opioids (25.2%), cannabis (21.3%), and amphetamines (15.2%). Heroin was preferred by 9.8%, and buprenorphine was preferred by 2.6% of participants. Cocaine was preferred at a comparable rate to heroin at 8.7%. Additional non-opioid and non-stimulant drugs included alcohol, preferred by 13.1% of participants, prescription sedatives, preferred by 2.9%, and less frequently used drugs such as inhalants, hallucinogens, and synthetic drugs, preferred by 1.3% collectively. Unsurprisingly, groups differed in terms of their preferred drug of choice for the one-year period prior to incarceration ($X^2=945.73$, $df=24$, $p<.001$). Among participants who reported past 30-day concomitant use, prescription opioids (29.8%), heroin (13.9%), amphetamines (14.1%), and cocaine (11.0%) were the most preferred drugs. Among participants who reported past 30-day opioid use, prescription opioids (50.7%), heroin (17.3%), cannabis (14.1%) and alcohol (7.2%) were the most preferred drugs. Among participants who reported past 30-day stimulant use, amphetamines (38.7%), cocaine/crack cocaine (25.5%), cannabis (19.9%) and alcohol (11.3%) were the most preferred drugs.

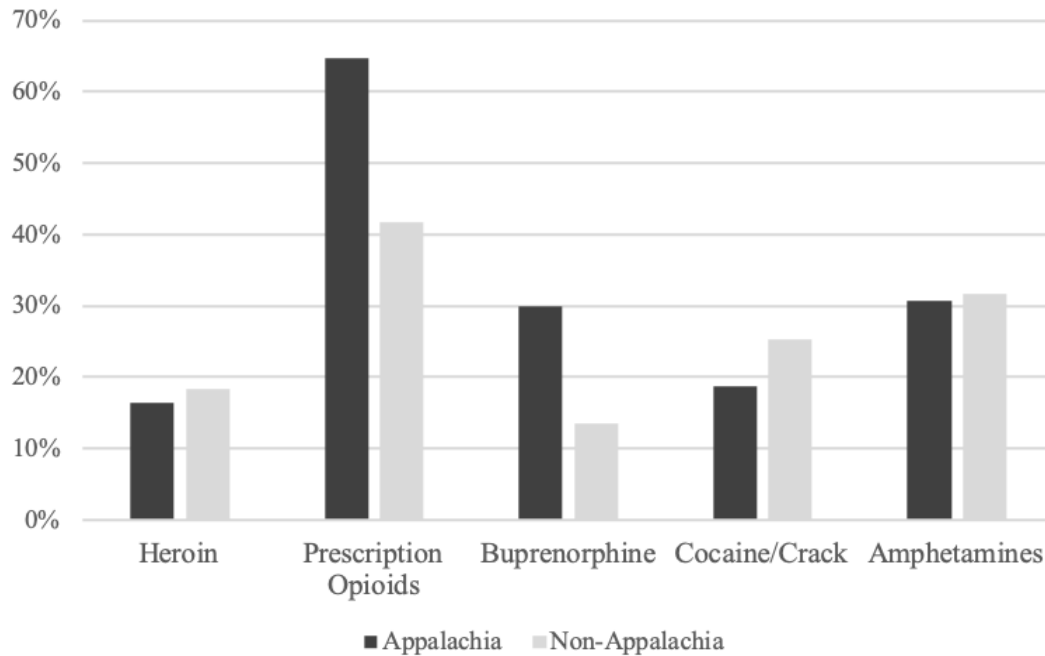
Lastly, among participants who reported past 30-day other drug use, cannabis (50.7%), alcohol (44.5%), prescription opioids, (7.1%), and amphetamines (5.0%) were the most preferred drugs.

Central Appalachia

Approximately one-third of participants (31.8%) reported residing within Central Appalachian, the Easternmost region of Kentucky, for the majority of the one-year period prior to incarceration. A greater proportion of participants who reported past 30-day opioid use resided in Central Appalachia (43.9%), followed by participants who reported concomitant use (35.3%). These rates differed from the 18.4% of participants who reported past 30-day stimulant use and the 23.3% of participants who reported past 30-day other drug use ($X^2=68.90$, $df=3$, $p<.001$).

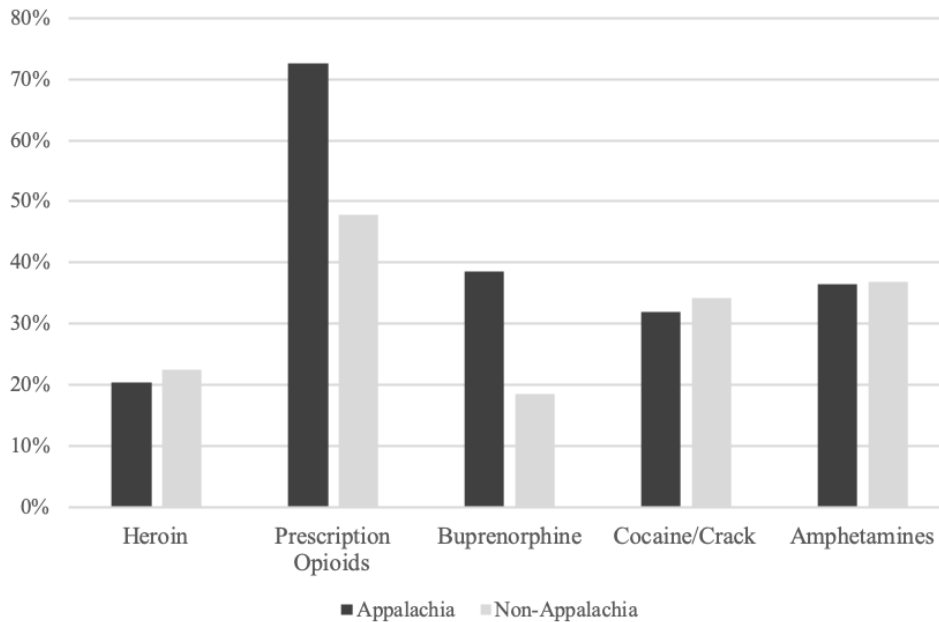
Specific opioid and stimulant drug use by region was also examined (chi-square results not shown in-table). Proportions of past 30-day opioid and stimulant drug use by region (Central Appalachia vs. non-Appalachia) are displayed in Figure 5. For past 30-day heroin use, rates were slightly lower among participants who resided in Central Appalachia compared to those who resided outside of Central Appalachia (16.3% vs. 18.4%, $X^2=0.88$, $df=1$, $p=.314$). Groups by region differed, however, for rates of past 30-day prescription opioid (64.8% vs. 41.8%, $X^2=71.44$, $df=1$, $p<.001$) and buprenorphine (30.0% vs. 13.4%, $X^2=61.23$, $df=1$, $p<.001$) use, with a higher proportion of participants residing in Central Appalachia for both groups. A greater proportion of participants who resided outside of Central Appalachia reported past 30-day cocaine/crack cocaine use

Figure 5. Opioid and stimulant use during the 30-day pre-incarceration period by Appalachia and Non-Appalachia Residence.



(18.7% vs. 25.3%, $X^2=8.31$, $df=1$, $p=.005$), though no difference was observed for past 30-day amphetamine use (30.6% vs. 31.6%, $X^2=0.18$, $df=1$, $p=.726$). In addition to these drugs, past 30-day use of alcohol (41.2% vs. 53.4%, $X^2=19.47$, $df=1$, $p<.001$) cannabis (45.9% vs. 55.6%, $X^2, 12.54$, $df=1$, $p<.001$) occurred at higher rates for participants residing outside of Appalachia. Past 30-day prescription sedative use also differed by region, with a slightly greater proportion of users residing within Appalachia (36.8% vs. 30.2%, $X^2=6.78$, $df=1$, $p=.011$). Because past 30-day use does not necessarily reflect use over a longer time period, use of specific opioid and stimulant drugs for the one-year period prior to incarceration was also examined. Proportions are displayed in Figure 6.

Figure 6. Opioid and stimulant use during the one-year pre-incarceration period by Appalachia and Non-Appalachia Residence.



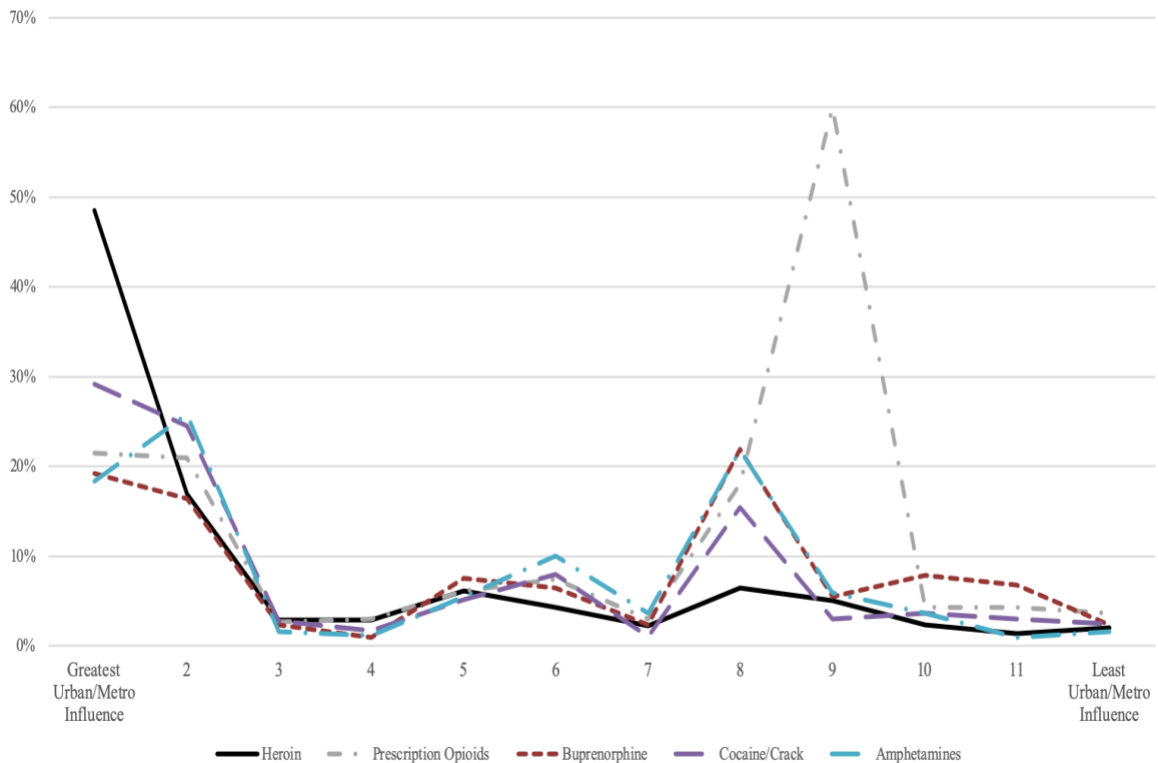
Among participants who reported past-year heroin use, 20.5% resided in Central Appalachia and 22.4 % resided outside of Central Appalachia ($X^2=0.72$, $df=1$, $p=.435$). For the one-year period prior to incarceration, differences were observed for past-year prescription opioid (72.6% vs. 47.9%, $X^2=82.84$, $df=1$, $p<.001$) and buprenorphine (38.6% vs. 18.5%, $X^2=72.56$, $df=1$, $p<.001$) use, with a higher proportion of participants residing in Central Appalachia. Groups by region did not differ significantly for past-year cocaine/crack cocaine use (32.0% vs. 34.2%, $X^2=0.67$, $df=1$, $p=.413$) or past-year amphetamine use (36.4% vs 36.9%, $X^2=0.29$, $p=.864$).

Urban Influence

In keeping with this finding, the mean urban influence for the entire sample, with 1 denoting the greatest urban influence and 12 denoting the least (i.e., more rural, less populated), was 4.6, indicating that the past-year residence of the sample was skewed toward metropolitan and urban areas, rather than toward rural, non-metropolitan areas. The average urban influence designation was higher among participants who reported past 30-day opioid (5.1) and concomitant use (4.7), and lower among participants who reported past 30-day other drug (4.0) and stimulant use (4.3; $p<.001$). Figure 7 displays the proportion past 30-day drug use prior to incarceration for specific opioid and stimulant drugs by urban influence designation.

Although higher proportions for all drugs were associated with greater urban and metro influence, the highest rate of use by urban influence designation for any specific drug was prescription opioids (60.0%), and this was associated with greater rurality. Apart from the two designations indicating greatest urban influence (1 and 2), the next two urban influence designations with the largest proportion of concentrated use were found among designations 8 and 9 (more rural, less populated areas), as evidenced by the modest uptick for all drugs other than heroin, which increased within these designations only slightly. Between designations of 7 and 10 is where rates of prescription opioid use, as noted before, substantially increase. Overall, higher rates of heroin and cocaine use were more likely to be found in designations indicating greater urban influence, whereas prescription opioid, buprenorphine, and amphetamine use showed greater overall dispersion across designations.

Figure 7. Opioid and stimulant use during the 30-day pre-incarceration period by urban influence designation.



Drug Outcomes During the One-year Period *Subsequent* to Incarceration

Table 2 displays means and proportions for the entire sample and for each drug use group for the one-year period subsequent to incarceration. For this post-release period, 11.9% of participants reported concomitant use of opioid and stimulants, 12.5% reported opioid, but not stimulant, use; 8.3% reported stimulant, but not opioid use; 22.9% reported use of drugs other than opioids and stimulants, and 44.4% reported no past-year use, a total of 67.3% for the other/no drugs outcome group.

During the one-year post-release period, the largest proportion of White participants were found among those who reported past-year concomitant (95.2%) and opioid use (91.5%), compared to participants who reported past-year stimulant (77.7%) and other/no drug use (77.8%, $X^2=56.46$, $df=3$, $p<.001$). The proportion of participants with a HSD/GED were equivalent across groups ($X^2=1.67$, $df=3$, $p=.643$), with the highest proportion of HSD/GED among participants who reported past-year opioid use (74.4%), and the lowest among participants reporting past-year stimulant use (68.5%). Seventy-three percent of the sample was mandated (i.e., parole board ordered) to complete SAP, and 78.3% completed SAP. Participants who reported past-year opioid use had slightly higher rates of mandated SAP participation (76.4%), whereas participants who reported past-year stimulant use had the lowest (66.2%); though groups did not significantly differ overall ($X^2=5.10$, $df=3$, $p=.164$). Rates of SAP completion did not differ between groups either ($X^2=3.35$, $df=3$, $p=.341$).

During the one-year post-release period, the mean number of nights spent in a controlled environment was 43.6 ($SD=77.6$, range=0-351), however, participants who reported past-year other/no drug use reported fewer nights in a controlled environment on average, particularly compared to participants who reported past-year concomitant use (31.7 vs. 78.2; $p<.001$). Compared to the sample-wide rate of 42.9%, approximately 65.0% of participants who reported past-year opioid and concomitant use had a history of IDU, nearly double that of participants who reported past-year stimulant (35.4%) and other/no drug use (36.0%, $X^2=96.29$, $df=3$, $p<.001$).

Table 2
Sample Characteristics and Drug Use Group Means, Proportions, and Between-group Differences Subsequent to Incarceration

	Sample	Concomitant	Opioids	Stimulants	Other /none	p value
N=	1,563	186	195	130	1,052	
%		11.9	12.5	8.3	67.3	
White	81.5%	95.2%	91.5%	77.7%	77.8%	.001
HSD/GED	71.2%	72.6%	74.4%	68.5%	70.8%	.643
Mandated to SAP	73.0%	70.4%	76.4%	66.2%	73.7%	.164
SAP completion	78.3%	73.7%	81.0%	77.7%	78.7%	.341
Nights in a controlled environment, past-year	43.6	78.2	54.4	75.1	31.7	.001
Lifetime drug treatment episodes	2.2	3.1	3.2	2.7	1.9	.001
Ever IDU	42.9%	64.5%	64.6%	35.4%	36.0%	.001
Age	34.6	31.6	32.1	35.6	35.3	.001
Male	80.9%	79.0%	81.0%	88.5%	80.3%	.141
Past-year cognitive difficulties	26.4%	38.8%	25.6%	32.3%	23.7%	.001
Lifetime history of head trauma	43.5%	49.5%	41.0%	41.5%	43.0%	.321
Past-year anxiety symptoms	40.7%	58.1%	43.1%	50.0%	36.1%	.001
Past-year depressive symptoms	32.7%	52.2%	35.4%	45.5%	27.3%	.001
Past-year suicidal ideation	4.5%	11.3%	5.6%	6.9%	2.8%	.001
Chronic pain	32.5%	39.8%	32.8%	31.5%	31.4%	.160
Past-month income	\$1,290	\$1,056	\$1,311	\$1,227	\$1,336	.001
Close relationships	6.1	5.5	5.8	6.2	6.4	.001
Social interaction	88.4%	86.6%	88.2%	89.2%	88.7%	.851
Social satisfaction	88.9%	75.1%	84.6%	79.2%	93.3%	.001
Perceived social worth	92.3%	87.5%	90.3%	90.0%	93.7%	.013
Past-year educational/vocational involvement	67.1%	60.8%	65.6%	57.7%	69.6%	.008
On community supervision	87.0%	92.5%	84.1%	92.3%	85.9%	.014
Age of drug use initiation	14.7	13.6	14.3	13.7	15.3	.001
<i>Past 30-day drug use prior to incarceration</i>						
Alcohol	49.5%	50.5%	39.0%	51.4%	51.0%	.019
Cannabis	52.5%	55.4%	53.3%	61.5%	50.8%	.102
Sedatives	32.3%	52.2%	40.5%	24.6%	28.2%	.001
Hallucinogens	3.2%	7.0 %	3.1%	3.1%	2.6%	.001
Synthetics	7.7%	11.8%	8.7%	10.8%	6.4%	.001
Cocaine/crack cocaine	23.2%	32.8%	17.9%	30.0%	21.7%	.001
Amphetamines	31.3%	48.4%	22.6%	50.0%	27.6%	.001
Heroin	17.7%	27.4%	35.4%	3.8%	14.4%	.001

	Sample	Concomitant	Opioids	Stimulants	Other /none	p value
N=	1,563	186	195	130	1,052	
%		11.9	12.5	8.3	67.3	
Table 2 (continued)						
Prescription opioids	50.7%	68.8%	70.8%	36.2%	45.5%	.001
Buprenorphine	18.7%	26.9%	30.8%	11.5%	15.9%	.001
<i>Abstinence self-efficacy</i>						
Prior to treatment	81.5%	73.7%	77.4%	75.4%	84.4%	.001
Subsequent to treatment	85.0%	60.2%	82.6%	78.5%	90.7%	.001
<i>Past-year drug use post-release (N=869)</i>						
Alcohol	56.7%	53.8%	37.9%	45.4%	72.6%	.001
Cannabis	45.8%	57.7%	34.4%	47.7%	45.3%	.001
Sedatives	14.4%	32.8%	19.0%	6.2%	5.3%	.001
Hallucinogens	2.1%	5.9%	1.5%	3.1%	0.0%	.001
Synthetic drugs	12.7%	17.2%	7.7%	17.7%	11.2%	.009
Cocaine/crack cocaine	13.2%	37.6%	0.0%	34.6%	0.0%	-
Amphetamines	27.4%	80.1%	0.0%	68.5%	0.0%	-
Heroin	19.3%	47.8%	40.5%	0.0%	0.0%	-
Prescription opioids	25.7%	60.2%	56.9%	0.0%	0.0%	-
Buprenorphine	16.9%	55.8%	33.3%	0.0%	0.0%	-
Drug use versatility, past year (N=869)	2.4	4.5	2.4	2.3	1.4	.001
<i>Days until post-release use (N=869)</i>						
Alcohol use	86.0	66.3	87.5	68.3	97.6	.001
Illicit drug use	87.1	60.9	94.0	96.8	99.0	
Central Appalachia	30.3%	27.4%	42.6%	21.5%	29.7%	.001
Urban influence	4.5	4.4	5.0	4.3	4.5	.072
Unrestricted alcohol sales	56.6%	58.6%	52.3%	49.2%	57.9%	.148

Age and Sex

During the one-year post-release period, the sample was 34.5 years old ($SD=9.1$, range=19-75) on average. Participants who reported past-year stimulant and other drug/no drug use were relatively older, 35.6 and 35.3, respectfully, compared to participants who reported past-year opioid (32.1) and concomitant use (31.6; $p<.001$). The proportion of males did not differ by group ($X^2=6.07$, $df=3$, $p=.141$), but was highest among participants who reported past-year stimulant use and lowest among participants reporting past-year concomitant use (88.5% vs. 79.0%).

Past-year Cognitive Difficulties and History of Head Trauma

For the one-year post-release period, 26.4% of participants reported experiencing past-year cognitive difficulties (i.e., trouble understanding, concentrating, or remembering). Rates of past-year cognitive difficulties varied by group. Participants who reported past-year concomitant use had the highest rates (38.8%), followed by participants who reported past-year stimulant (32.3%), opioid (25.6%), and other/no drug use (23.7%; $X^2=20.92$, $df=3$, $p<.001$). Subsequent to incarceration, approximately 44% of participants reported a history of head trauma. Rates of head trauma history were highest among participants who reported concomitant use and lowest among participants who reported other/no drug use (49.5% vs 43.0%), though groups did not differ significantly overall ($X^2=3.50$, $df=3$, $p=.321$).

Psychiatric Symptoms

Anxiety and depressive symptoms during the one-year post-release period were experienced by 40.7% and 32.7% of participants, respectively. Groups differed in the proportion of participants who reported experiencing past-year depressive symptoms ($X^2=56.10$, $df=3$, $p<.001$) as well as past-year anxiety symptoms ($X^2=37.47$, $df=3$, $p<.001$). Experiencing past-year anxiety symptoms was more common among participants who reported past-year concomitant use and less common among participants who reported past-year other/no drug use (58.1% vs. 36.1%). Over half of participants who reported past-year concomitant use reported past-year depressive symptoms (52.2%), nearly double that of participants who reported past-year other drug/no drug use (27.3%). However, over one-third of participants who reported past-year opioid and stimulant use also reported depressive symptoms, 35.4% and 45.5%, respectively. Past-year suicidal ideation was reported by 4.5% of the sample during the one-year post-release period. Past-year suicidal ideation was highest among participants who reported past-year concomitant use

(11.3%), followed by participants who reported past-year stimulant use (6.9%). Participants who reported past-year other/no drug use had the lowest rates (2.8%), followed by those who reported past-year opioid use (5.6%; $X^2=29.91$, $df=3$, $p<.001$).

Chronic Pain

During the one-year post-release period, 32.5% of the sample reported experiencing chronic pain. Groups were similar for rates of chronic pain ($X^2=5.17$, $df=3$, $p=.160$), with rates highest among participants who reported past-year concomitant use (39.8%). Among participants who reported past-year opioid use, 32.8% reported experiencing chronic pain.

Past-month Income

During the one-year post-release period, the average past-month income from all income sources (e.g., disability benefits, earned income, money received from friends and family) among participants was \$1,290, meaning that all groups might be considered as low-income, when not taking into account the potential contributions of other household members' income (which was not asked as part of this question). Participants who reported past-year other/no drug use had a higher average past-month income, whereas participants who reported past-year concomitant use had the lowest (\$1,336 vs. \$1,056, $p<.001$), a modest practical difference.

Non-drug Alternative Reinforcers

During the one-year post-release period, the mean number of close relationships that participants reported having was 6.1 ($SD=5.5$, $range=0-78$). The average number of close relationships ranged from 5.5-6.4 across groups. Participants who reported past-year stimulant and other/no drug use reported more close relationships on average, 6.2 and 6.4, respectively. Participants who reported past-year concomitant use reported having the fewest close relationships (5.5, $p<.001$).

Compared to spending the majority of time alone, 88.4% of the sample reported some social interaction with friends or family during the one-year post-release period. Groups were similar in terms of reported social interaction ($X^2=0.80$, $df=3$, $p=.851$), with >85.0% of all groups reporting some social interaction. Compared to being indifferent to or not enjoying spending their time in this way, 88.9% of participants reported that they received satisfaction from these social interactions. Groups differed, however, in terms of the social satisfaction they received from this past-year social interaction ($X^2=72.22$,

df=3, $p < .001$). Specifically, 75.1% of participants who reported past-year concomitant use received satisfaction from past-year social interaction, whereas 79.2% of participants who reported past-year stimulant use, and 84.6% of participants who reported past-year opioid use, reported receiving satisfaction from past-year social interaction. Among participants who reported past-year other drug/no drug use, 93.3% reported receiving satisfaction from past-year social interaction, the highest rate of all groups.

The majority of the sample (92.3%) reported feeling as though they had some social worth, meaning that they reported feeling cared about and supported by people in their lives. Rates were highest, however, among participants who reported past-year other/no drug use and lowest among those who reported past-year concomitant use (93.7% vs. 87.5%, $X^2=10.79$, $df=3$, $p=.013$). Participants who reported past-year opioid and stimulant use had similar rates of approximately 90.0%.

Approximately 67% of the sample reported being involved in either educational or vocational pursuits during the one-year post-release period, though such involvement was lowest among participants who reported past-year stimulant (57.7%) and concomitant use (60.8%), and highest among participants who reported past-year other drug/no drug use (69.6%, $X^2=11.72$, $df=3$, $p=.008$).

Finally, while the majority of participants across all groups (87.0%) were on community supervision at some point during the one-year post-release period, rates were highest for participants who reported past-year concomitant (92.5%) and stimulant use (92.3%), and lowest among participants who reported past-year opioid (84.1%) and other/no drug use (85.9%; $X^2=10.68$, $df=3$; $p=.014$).

Age of Drug Use Initiation

The mean age of drug use initiation was 14.7 ($SD=4.9$, range=4-56). Drug use groups for the one-year period subsequent to incarceration differed, though, with older drug use initiation observed among participants who reported past-year other/no drug use (15.3), followed by participants who reported past-year opioid use (14.3; $p < .001$). Age of drug use initiation was <14 for participants who reported past-year stimulant and concomitant use, 13.7 and 13.6 years of old, respectively.

Past 30-day Drug Use and Drug Use Frequency Prior to Incarceration

During the one-year post-release period, groups differed for both rates of use during the 30-day period *prior* to incarceration as well as frequency of use (frequency of use not shown in table), measured in days, for this same pre-incarceration time period.

For non-opioid and non-stimulant drugs used during the 30-day period prior to incarceration, rates of pre-incarceration alcohol use were similar across all groups examined (approximately 50.0%), except among those who reported past-year opioid use (39.0%, $X^2=9.94$; $df=3$, $p=.019$). Pre-incarceration alcohol use was more frequent among participants who reported past-year other drug/non-drug (7.7) and stimulant use (7.6), whereas participants who reported past-year opioid use drank alcohol an average of only 5.5 days for this same time period ($p<.001$). Rates of pre-incarceration cannabis use did not differ between groups ($X^2=6.21$, $df=3$, $p=.102$), however, cannabis was used prior to incarceration most often among participants who reported past-year stimulant use (13.9), whereas all other groups reported cannabis use for approximately 11 days prior to incarceration ($p<.001$). Participants who reported past-year concomitant and opioid use reported higher rates of pre-incarceration prescription sedative use, 52.2% and 40.5%, respectively ($X^2=51.1$, $df=3$, $p<.001$). These groups used prescription sedatives an average of 7.5 and 6.9 days, respectively ($p<.001$). Hallucinogens were used <1 day on average prior to incarceration across groups, though the average number of days was highest among participants who reported past-year concomitant use (0.6, $p=.019$); this group also had the highest rate of use (7.0%, $X^2=10.1$, $df=3$, $p<.001$). Participants who reported past-year concomitant use also reported using synthetic drugs prior to incarceration at higher rates (11.8%) followed by participants who reported past-year stimulant use (10.8%, $X^2=9.12$, $df=3$, $p<.001$).

For stimulant drugs, rates of cocaine/crack cocaine use prior to incarceration were highest among participants who reported past-year concomitant (32.8%) and stimulant use (30.0%), though 17.9% of participants who reported past-year opioid use and 21.7% of participants who reported past-year other/no drug use also reported pre-incarceration cocaine/crack cocaine use ($X^2=17.37$, $df=3$, $p<.001$). The average number of days that cocaine/crack cocaine was used prior to incarceration was greatest among participants who reported past-year stimulant (5.3) and concomitant use (5.0), differing from participants who reported past-year opioid (2.2) and past-year other drug/no drug use (3.0; $p<.001$). Groups also differed for rates ($X^2=60.15$, $df=3$, $p<.001$) and average number of days ($p<.001$) of pre-incarceration amphetamine use. Fifty percent of participants who reported past-year stimulant use reported using amphetamines prior to incarceration, for 11.6 days on average. Nearly the same proportion of participants who reported past-year concomitant use (48.4%) also reported pre-incarceration amphetamine use, for 8.5 days on average. Still,

approximately a quarter of participants who reported past-year opioid and other/no drug use also reported pre-incarceration amphetamine use, using 3.9 and 5.6 days, respectively.

For opioid drugs, rates of pre-incarceration heroin use were highest among participants who reported past-year opioid (35.4%) and concomitant use (27.4%, $X^2=78.61$, $df=3$, $p<.001$). These groups also reported using heroin a greater number of days prior to incarceration, 8.4 and 5.4, respectively, compared to participants who reported past-year stimulant (0.9) and other/no drug use (2.8; $p<.001$). Similarly, participants who reported past-year opioid (70.8%) and concomitant use (68.8%) reported higher rates of pre-incarceration prescription opioid use compared to participants who reported past-year stimulant (36.2%) and other/no drug use (45.5%, $X^2=70.09$, $df=3$, $p<.001$). Participants who reported past-year opioid and concomitant use reported using prescription opioids more days on average prior to incarceration, 16.2 and 14.9, respectively, compared to participants who reported past-year other/no drug (9.8) and stimulant use (5.3; $p<.001$). Buprenorphine was used prior to incarceration by all groups, though rates were higher among participants who reported past-year opioid (30.8%) and concomitant use (26.9%, $X^2=36.81$, $df=3$, $p<.001$). These groups also reported using buprenorphine more days on average (4.8 and 3.8, respectively), followed by participants who reported past-year other/no drug (2.2) and stimulant use (1.4, $p<.001$).

Abstinence Self-efficacy Prior and Subsequent to Treatment

Prior to entering SAP, 81.5% of the sample reported that they perceived their ability to abstain from alcohol and other drugs as “moderately good” or “very good”. Participants who reported past-year other/no drug use had the highest rates of pre-treatment abstinence self-efficacy (84.4%), compared to participants who reported concomitant (73.7%), stimulant (75.4%), and opioid use (77.4%; $X^2=18.87$, $p<.001$). Interestingly, this was also the case for abstinence self-efficacy reported during the one-year post-release period. At this time, participants who reported past-year other/no drug use had the highest rates of abstinence self-efficacy (90.7%) and participants who reported concomitant use had the lowest (60.2%; $X^2=121.5$, $p<.001$).

Past-year Drug Use Subsequent to Incarceration

Among participants who reported any drug use during the one-year post-release period (N=869), non-opioid and non-stimulant drug use varied. Alcohol was used during the one-year post-release period at a fairly high rate sample-wide (56.7%), with rates of use higher among participants who reported past-year

other drug (72.6%) and concomitant use (53.8%, $X^2=72.36$, $df=3$, $p<.001$). Participants who reported past-year opioid use had the lowest rates of past-year alcohol use (37.9%). Rates of past-year cannabis use were highest among participants who reported past-year concomitant use (57.7%), followed by participants who reported past-year stimulant (47.7%) and other drug use (45.3%, $X^2=20.82$, $df=3$, $p<.001$). For this time period, prescription sedatives were used at higher rates among participants who reported past-year concomitant use, with rates lowest among participants who reported past-year other drug use (32.8% vs. 5.3%, $X^2=85.34$, $df=3$, $p<.001$), though nearly one-fifth of participants who reported past-year opioid use also reported past-year prescription sedative use. Hallucinogens were used by <10% of all groups, but were used at higher rates among participants who reported past-year concomitant use (5.9%, $X^2=22.03$, $df=3$, $p<.001$). Synthetic drug use was approximately equivalent between participants who reported past-year stimulant and concomitant use, at just above 17%. This differed from participants who reported past-year opioid (7.7%) and other drug use (11.2%, $X^2=11.52$, $df=3$, $p=.009$).

Among this subsample that reported any drug use during the one-year post-release period, 13.2% reported past-year cocaine/crack cocaine use. This was divided among participants who reported past-year concomitant and stimulant use, with 37.6% of participants who reported past-year concomitant use and 34.6% who reported past-year stimulant use reporting cocaine/crack cocaine use specifically. Nearly 28% of this subsample reported past-year amphetamine use, with 80.1% of participants who reported past-year concomitant use and 68.5% who reported past-year stimulant use reporting amphetamine use specifically. Heroin was used by 19.3% of this subsample, with 47.8% of participants who reported past-year concomitant use and 40.5% of participants who reported past-year opioid use reporting heroin use specifically. Prescription opioids were used by 25.7% of this subsample, with 60.2% of participants who reported past-year concomitant use and 56.9% of participants who reported past-year opioid use reporting prescription opioid use specifically. Buprenorphine was used by 16.9% of this subsample, with 55.8% of participants who reported past-year concomitant use and 33.3% who reported past-year opioid use reporting buprenorphine use specifically.

Among this subsample who reported drug use for the one-year post-incarceration period, the average number of different drugs used was 2.4. The highest rates were among participants who reported

past-year concomitant use (4.5). This differed from participants who reported past-year opioid and stimulant use, who used approximately 2.3 different drugs on average ($p < .001$).

Days Until Post-Release Use

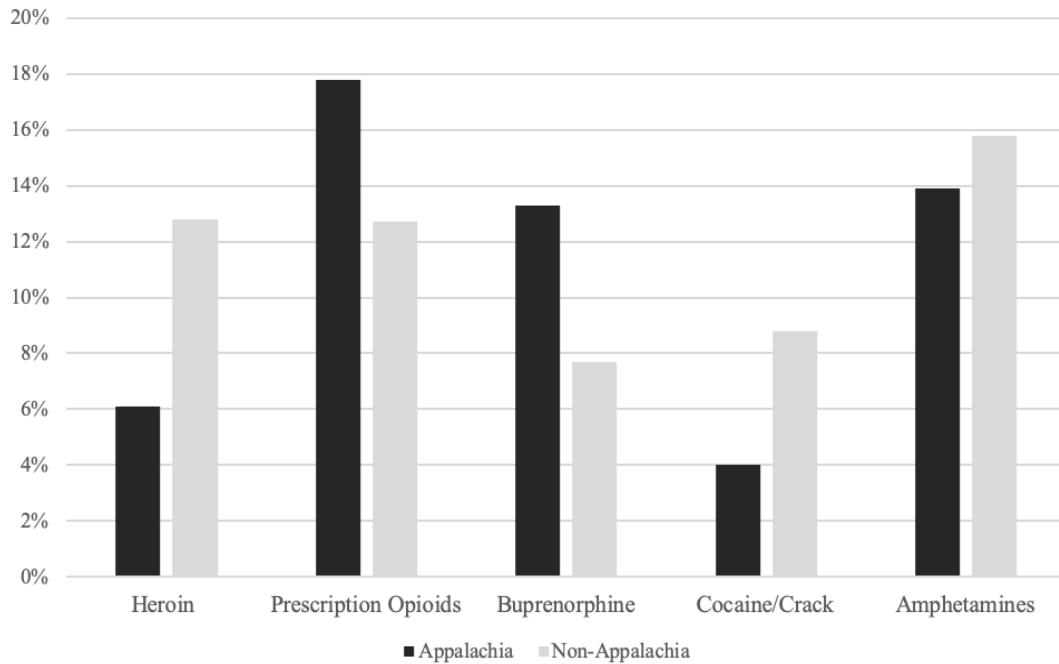
Among this subsample, the number of days between participants' release date and their first incidence of alcohol or other drug use was approximately the same, with 86.0 days out before the first incidence of alcohol use and 86.7 days out before the first incidence of illicit drug use. Participants who reported past-year concomitant use used alcohol and drugs earlier than participants in all other groups, with use occurring between 60-70 days on average subsequent to release. Participants who reported past-year other drug use went approximately 97-98 days subsequent to release before using alcohol or other drugs, the longest for all groups. This was followed by participants who reported past-year opioid use, who did not report using alcohol until nearly 88 days after their release and who did not report using illicit drugs until 94 days after their release.

Central Appalachia

During the one-year post-release period, 30.3% of participants reported residing in Central Appalachia for the majority of time. A greater proportion of participants who reported past-year opioid resided in Central Appalachia (42.6%, $X^2=19.41$, $df=3$, $p < .001$). This was followed by participants who reported past-year other/no drug (29.7%), concomitant (27.4%), and stimulant (22.0%). Specific opioid and stimulant drug use by region were also examined. Proportions of past-year specific opioid and stimulant drug use by region (Central Appalachia vs. non-Appalachia) are displayed in Figure 8.

For past-year heroin use, rates were lower among participants who resided in Central Appalachia compared to those who resided outside of Appalachia (6.1% vs. 12.8%, $X^2=15.20$, $df=1$, $p < .001$). Groups by region also differed for rates of past-year prescription opioid (17.9% vs. 12.7%, $X^2=7.47$, $df=1$, $p=.008$) and buprenorphine (13.3% vs. 7.7%, $X^2=12.06$, $df=1$, $p < .001$) use, with a higher proportion of participants residing in Central Appalachia. Groups by region differed for rates of past-year cocaine/crack

Figure 8. Opioid and stimulant use during the one-year post-release period by Appalachia and Non-Appalachia residence.



cocaine use (4.0 % vs. 8.8%, $X^2=11.20$, $df=1$, $p<.001$), but not past-year amphetamine use (13.9% vs. 15.8%, $X^2=0.90$, $p=.385$). In addition to these drugs, past-year alcohol (23.8% vs. 34.9%, $X^2=18.69$, $df=1$, $p<.001$) and synthetic drug use (4.2% vs. 8.3%, $X^2=8.26$, $df=1$, $p=.006$) also differed by region.

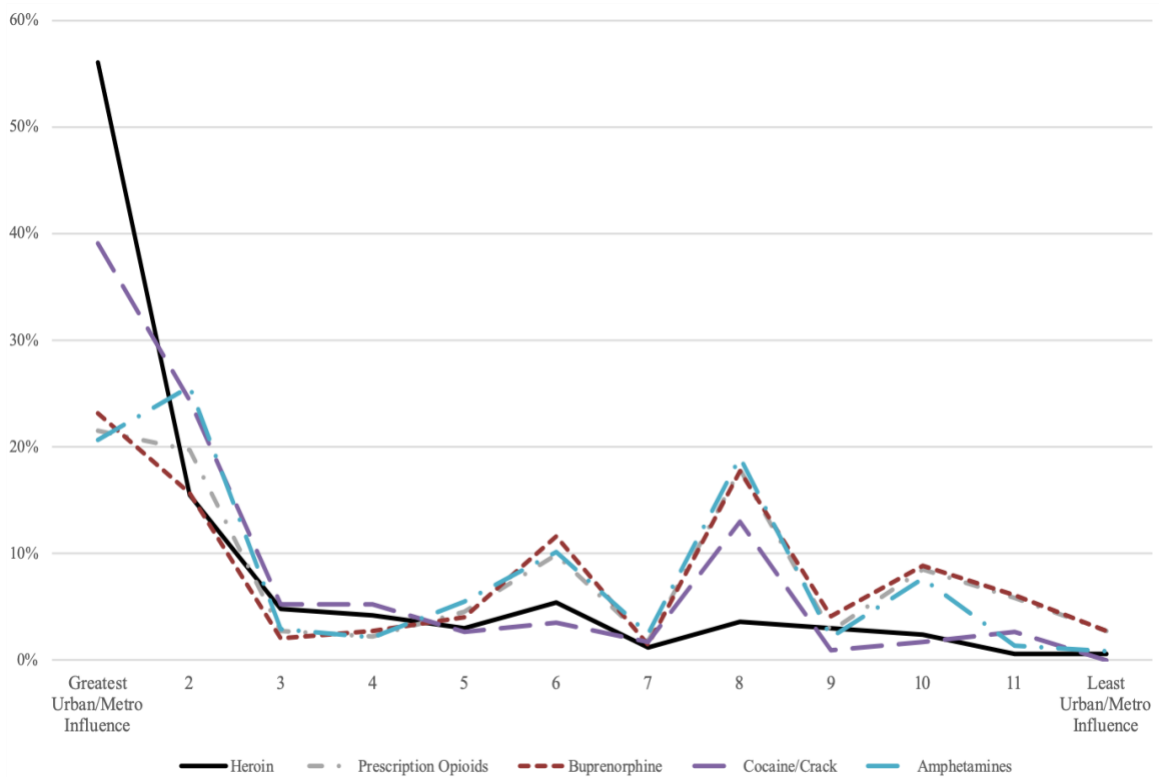
Urban Influence

The mean urban influence for the sample during the one-year period subsequent to incarceration ($\bar{x} = 4.5$) indicated that, similar to participant residence reported for the one-year period prior to incarceration, the sample was comprised of a greater proportion of people living in a metro or urban area. As displayed in Table 2, the average urban influence designation was higher among participants who reported past-year opioid (5.0) and other drug/no drug use (4.5), indicating greater rurality and less population density, but was slightly lower among participants who reported past-year stimulant (4.3) and concomitant use (4.4; $p<.001$), indicating greater population and urban influence.

Similar to drug use prior to incarceration, higher proportions for all drugs were associated with greater urban and metro influence. However, instead of prescription opioids showing the highest use rates

in association with less urban influence, the highest rate of use for any drug by urban influence designation during the one-year period subsequent to incarceration was heroin, which was associated with the designation indicating greatest urban influence (56.0%). Apart from the two designations indicating greatest urban influence (1 and 2), the next two urban influence designations with the largest proportion of concentrated use were found in 6 and 8. Overall, only prescription opioids, buprenorphine, and amphetamines had rates of use across more rural areas that, while still significantly less than those found in areas with greater urban influence, approached something comparable. As shown in Figure 10, cocaine/crack cocaine and heroin use in designations 1 and 2 are over four- and five-fold compared to other designations.

Figure 9. Opioid and stimulant use during the one-year post-release period by urban influence designation.



Access to Alcohol

During the one-year post-release period, 56.6% of participants resided in a county with unrestricted alcohol sales for the majority of time. Groups were similar in the proportion of participants who resided in a county with unrestricted alcohol sales ($X^2=5.35$, $df=3$, $p=.148$), with participants who reported past-year concomitant use having the highest rate (58.6%) and participants who reported past-year stimulant use having the lowest rate (49.2%).

Aim Two Results

Multinomial Logistic Regression Results for Drug Outcomes Prior to Incarceration

Table 3 displays the results of the multinomial logistic regression examining opioid and stimulant outcomes for the *30-day period prior to incarceration*, with “other drug use” as the reference group. Independent and control variables (as opposed to variables used for description purposes only; see Measures subsection “Descriptive Variables” pg. 171) which differed significantly by group when examined using nonparametric tests were included into the regression model. The only exception was the variable measuring past-year depressive symptoms, which was omitted due to collinearity with the variable “stress-related health effects”. Collinearity was assessed via variance inflation factor (VIF) and $1/VIF$ (1 minus the R^2 obtained with IV regressed on the set of other IVs); an approximate $VIF < 1.5$ or $1/VIF > 0.85$ was considered acceptable (Hair, Anderson, Tatham, & Black, 1995). VIFs for different models were calculated using different variable configurations (i.e., singularly removing or adding past-year depressive symptoms, stress-related health effects, suicidal ideation, and past-year anxiety symptoms to the model). A decision was made to remove the variable of past-year depressive symptoms, rather than the stress-related health effects variable. This decision was made for three reasons. First, stress-related health effects (measured for the 7-day period prior to incarceration) may have served as a potentially more proximate influence on past 30-day drug-related decision-making and is important in this regard. Second, depressive symptoms were considered as a stress-related health effect, as measured by one question contained in the revised HCS, meaning that by using the variable of stress-related health effects, depression is not entirely ruled out as still possibly exerting some, albeit less discernable, influence on drug use for this time period. That depression and, to a lesser extent, anxiety, were both positively correlated with stress-related health effects (i.e., revised HCS scores) may actually provide some oblique and partial support for the modified

scale’s construct validity. Lastly, past-year suicidality was retained as an independent variable. Though suicidality is not synonymous with depression, it is positively correlated with and conceptually related to it such that it may provide an indirect indicator of past-year depression even with the variable of past-year depressive symptoms removed. Model fit statistics, displayed at the bottom of Table 3, indicated acceptable model fit.

In the first column of Table 3, robust standard errors are displayed. These were calculated to address the fact that some cases were clustered by county and to help establish a more “model-agnostic” model. The specific correction-method that produces robust errors (versus asymptotic standard errors) used was the Huber/White robust estimator of variance (Huber, 1967; Gutierrez & Drukker, 2019; White, 1982). The Huber/White estimator for obtaining robust variance estimates is available as a command in Stata, and has been utilized to address clustered or nested data, such as cases clustered by county or some other grouping (Froot, 1989; Gutierrez & Drukker, 2019; Rogers, 1993; Williams, 2000; Wooldridge, 2002). In the second column, corresponding confidence intervals are displayed. The third column displays regression coefficients calculated as relative risk ratios (RRR), which can be conceptualized as increases or decreases in log odds of being in one of the opioid or stimulant outcome groups (i.e., the ratio of the probability of one of the three outcome groups being chosen over the probability of the reference group of “other drug use” being chosen). By specifying that linear equations be exponentiated, regression coefficients that are the relative risk ratio for a unit change in the independent variables can be produced and displayed. This can be termed as relative risk, or odds. In column four, p values are displayed.

Table 3
Results of Multinomial Logistic Regression Examining Opioid and Stimulant Use During the 30-day Pre-incarceration Period

	Robust SE	95% CI	RRR	p value
Concomitant				
White	0.304	0.68-1.92	1.15	.607
Controlled environment, past 30-days	0.262	0.89-0.99	0.94	.893
Lifetime drug treatment episodes	0.300	0.94-1.05	0.99	.865
Ever IDU	0.879	2.43-5.88	3.81	.001
Age	0.012	1.00-1.05	1.03	.015
Male	0.383	0.74-2.32	1.31	.363
Lifetime history of head trauma	0.208	0.66-1.50	0.99	.996
Past-year economic hardship	0.057	0.95-1.17	1.06	.286
Past-year homelessness	0.196	0.32-1.11	0.64	.122
Subjective socioeconomic status	0.056	0.93-1.14	1.03	.588
Past-week stress related health effects	0.016	0.97-1.03	1.00	.929
Past-year anxiety symptoms	0.219	0.57-1.46	0.92	.716

Table 3 (continued)

Past-year suicidal ideation	0.365	0.54-2.08	1.06	.858
Chronic pain	0.261	0.64-1.70	1.04	.874
Misregulation	0.524	0.94-3.12	1.72	.077
Close relationships	0.017	0.97-1.03	1.00	.953
Social satisfaction	0.195	0.52-1.31	0.82	.422
Leisure time, in days	0.038	0.86-1.01	0.93	.084
Age of drug use initiation	0.024	1.03-1.12	1.08	.001
Severity of use	0.007	1.04-1.07	1.06	.001
Drug use versatility, past-year	0.310	2.59-3.84	3.15	.001
Central Appalachia	0.284	0.79-1.94	1.24	.344
Opioids				
White	0.941	2.19-6.01	3.64	.001
Controlled environment, past 30-days	0.022	0.92-1.00	0.96	.065
Lifetime drug treatment episodes	0.027	0.93-1.03	0.98	.509
Ever IDU	0.569	1.90-4.08	2.81	.001
Age	0.010	0.99-1.03	1.01	.177
Male	0.308	0.75-1.90	1.23	.425
Lifetime history of head trauma	0.204	0.81-1.61	1.14	.465
Past-year economic hardship	0.050	0.91-1.10	1.00	.959
Past-year homelessness	0.277	0.51-1.62	0.91	.744
Subjective socioeconomic status	0.048	0.91-1.10	1.00	.917
Past-week stress related health effects	0.013	0.96-1.00	0.98	.193
Past-year anxiety symptoms	0.189	0.60-1.35	0.90	.618
Past-year suicidal ideation	0.361	0.66-2.14	1.19	.574
Chronic pain	0.282	0.85-1.97	1.30	.236
Misregulation	0.427	1.21-2.90	1.89	.005
Close relationships	0.015	0.94-0.99	0.97	.040
Social satisfaction	0.244	0.80-1.78	1.19	.399
Leisure time, in days	0.033	0.86-0.96	0.92	.019
Age of drug use initiation	0.021	1.05-1.13	1.09	.001
Severity of use	0.006	1.04-1.07	1.06	.001
Drug use versatility, past-year	0.161	1.51-2.14	1.80	.001
Central Appalachia	0.316	1.13-2.39	1.64	.010
Stimulants				
White	0.209	0.72-1.55	1.06	.774
Controlled environment, past 30-days	0.023	0.89-0.98	0.94	.014
Lifetime drug treatment episodes	0.030	0.93-1.03	1.00	.947
Ever IDU	0.869	1.09-2.56	1.68	.019
Age	0.012	1.03-1.06	1.05	.001
Male	.0383	0.78-2.34	1.35	.279
Lifetime history of head trauma	0.208	0.73-1.48	1.04	.834
Past-year economic hardship	0.057	0.91-1.10	1.00	.930
Past-year homelessness	0.285	0.51-1.62	0.94	.842
Subjective socioeconomic status	0.047	0.97-1.15	1.06	.179
Past-week stress-related health effects	0.013	0.97-1.01	0.99	.657
Past-year anxiety symptoms	0.198	0.60-1.35	0.98	.923
Past-year suicidal ideation	0.466	0.79-2.74	1.48	.217
Chronic pain	0.172	0.50-1.18	0.76	.234
Misregulation	0.376	1.14-2.65	1.74	.010
Close relationships	0.012	0.97-1.01	0.99	.452
Social satisfaction	0.202	0.65-1.46	0.98	.921

Table 3 (continued)

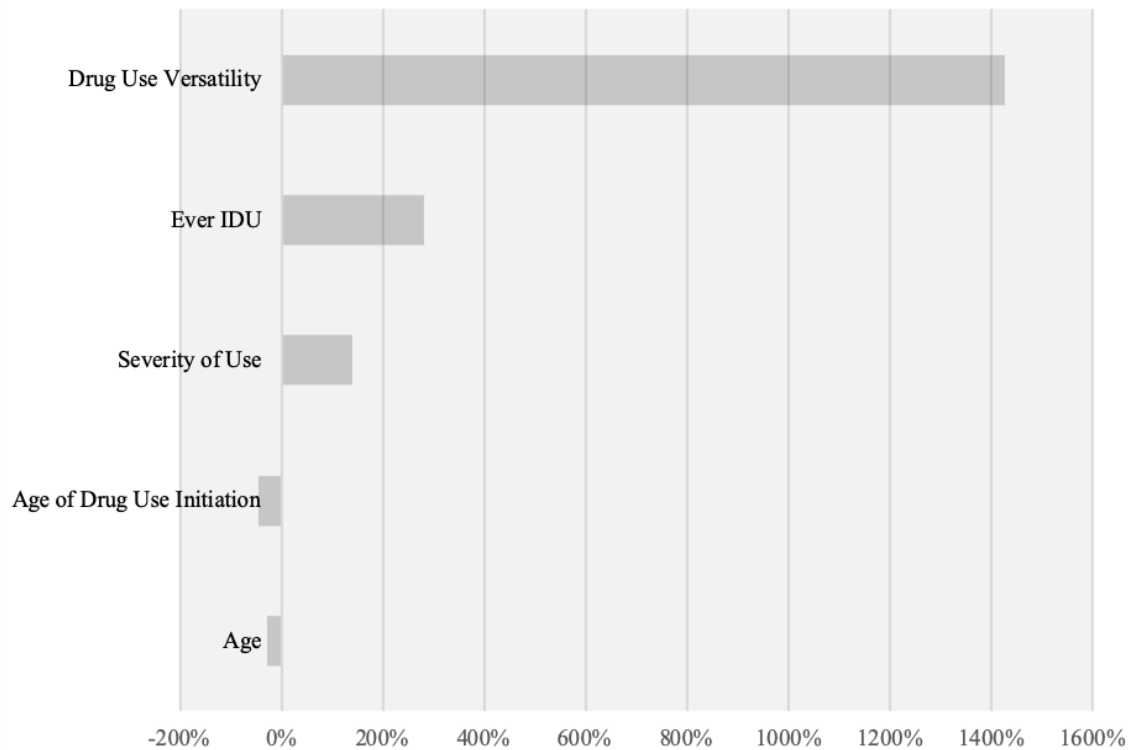
Leisure time, in days	0.033	0.86-0.99	0.92	.025
Age of drug use initiation	0.020	1.00-1.08	1.04	.034
Severity of use	0.007	1.03-1.06	1.05	.001
Drug use versatility, past-year	0.109	1.13-1.56	1.33	.002
Central Appalachia	0.135	1.13-2.39	0.63	.032
Intercept-only: -2141.458 Model: -1522.240	Pseudo R ² =0.289			
Wald Chi2 (df=66) =630.810, p<.001	Cox-Snell/ML=0.547			
	Cragg-Uhler/Nagelkerke=0.585			

Past 30-day Concomitant Use Prior to Incarceration

Among participants who reported past 30-day concomitant use, having a history of IDU was associated with the greatest increased odds for observing the outcome of past 30-day concomitant use (RRR=3.81, p<.001). Younger age (RRR=1.03, p=0.15) was also associated with increased likelihood of concomitant use for this period. Younger age of drug use initiation (RRR=1.08, p<.001), greater severity of use (RRR=1.06, p<.001), and greater past-year drug use versatility, indicated by a greater number of drugs used (RRR=3.15, p<.001), were all associated with an increased likelihood of past 30-day concomitant use. Residing in Central Appalachia for the one-year period prior to incarceration was not associated with a statistically significant increase in likelihood of past 30-day concomitant use (RRR=1.24, p=.344). For the entire model, the overall effect of residing in Central Appalachia was significant ($X^2=25.01$, p<.001). The effect of residing in Central Appalachia on predicting the probability of past 30-day concomitant did not differ from the effect of residing in Central Appalachia on predicting the probability of past 30-day opioid use ($X^2=2.84$, p=.0918), but did differ modestly from past 30-day stimulant use ($X^2=9.37$, p=.022).

Figure 10 displays the percent change in odds for a one unit increase among binary independent variables and the percent change in odds for a one standard deviation increase among continuous or ranked independent variables (Long & Freese, 2005, 2014). Only independent variables significantly associated with changes in the likelihood of observing concomitant use for the 30-day period prior to incarceration are presented.

Figure 10. Percent change in odds of past 30-day concomitant use prior to incarceration.



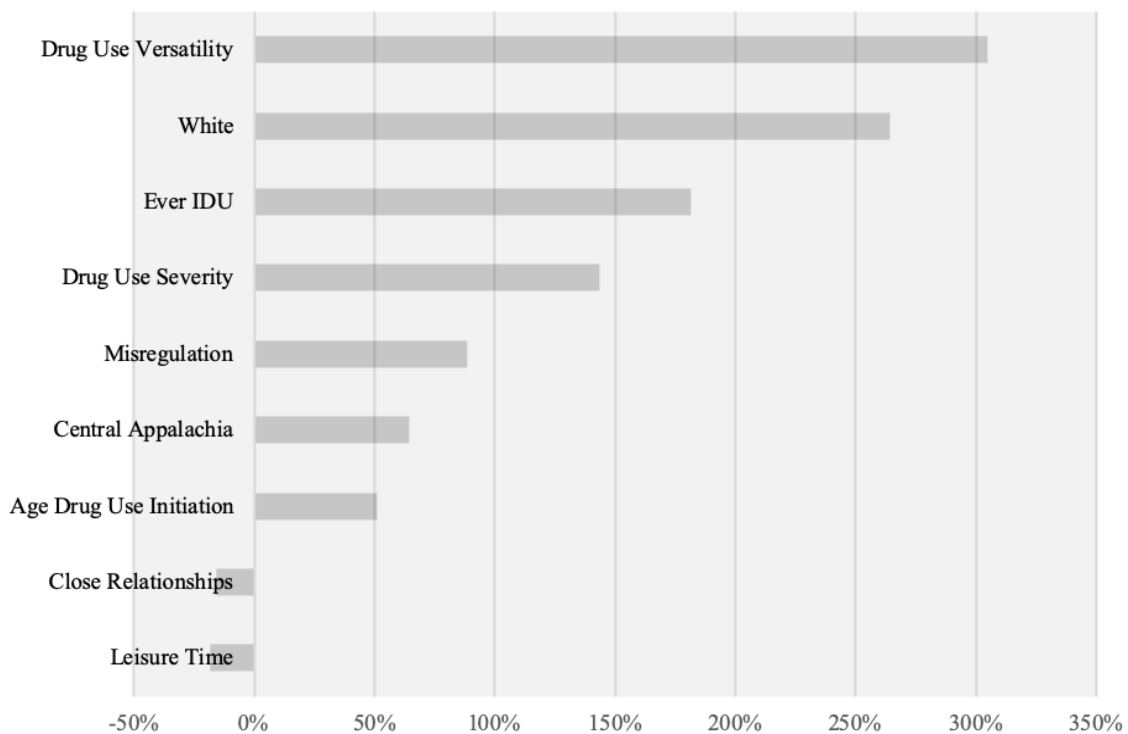
Drug use versatility (i.e., the number of drugs used in the year prior to incarceration) increased the odds of observing past 30-day concomitant use the most, with the likelihood of past 30-day concomitant use increasing 1,426.7% for every SD increase ($SD=2.4$); an approximate 215.2% increase in odds for every 1 additional drug used. The likelihood of observing past 30-day concomitant use increased by 281.1% when history of IDU was also reported. For every SD increase in severity of use ($SD=15.8$), past 30-day concomitant use was 140.2% more likely (i.e., a 5.7% increase for every one-digit severity score increase). Observing past 30-day concomitant use was 44.7% less likely for every SD increase in age of drug use initiation ($SD=5.0$); an approximate 7.7% decrease for every one-year increase. Odds decreased 29.6% for every SD increase in age ($SD=9.0$); an approximate 2.9% decrease for every year.

Past 30-day Opioid Use Prior to Incarceration

Being White ($RRR=3.64$, $p<.001$) and having a history of IDU ($RRR=2.81$, $p<.001$) were both associated with an increased likelihood of using opioids during the 30-day period prior to incarceration. Misregulation was also associated with an increased likelihood of using opioids for this time period

(RRR=1.89, $p<.005$). Having fewer close relationships (RRR=0.97, $p=.040$) and fewer number of leisure days per week (RRR=0.92, $p=.019$) also increased the likelihood of past 30-day opioid use. Older age of drug use initiation (RRR=1.09, $p<.001$), greater severity of use (RRR=1.06, $p<.001$), and greater drug use versatility during the one-year period prior to incarceration (RRR=1.80, $p<.001$), were all associated with an increased likelihood that opioids would be used during the 30-day period prior to incarceration. Finally, residing the majority of the year prior to incarceration in Central Appalachia also increased the likelihood that past 30-day opioid use would be observed, with participants who resided in this region 1.64 times more likely to report past 30-day opioid use ($p=.010$). Figure 11 displays the percent change in odds for independent variables significantly associated with changes in the likelihood of observing past 30-day opioid use prior to incarceration.

Figure 11. Percent change in odds of past 30-day opioid use prior to incarceration.



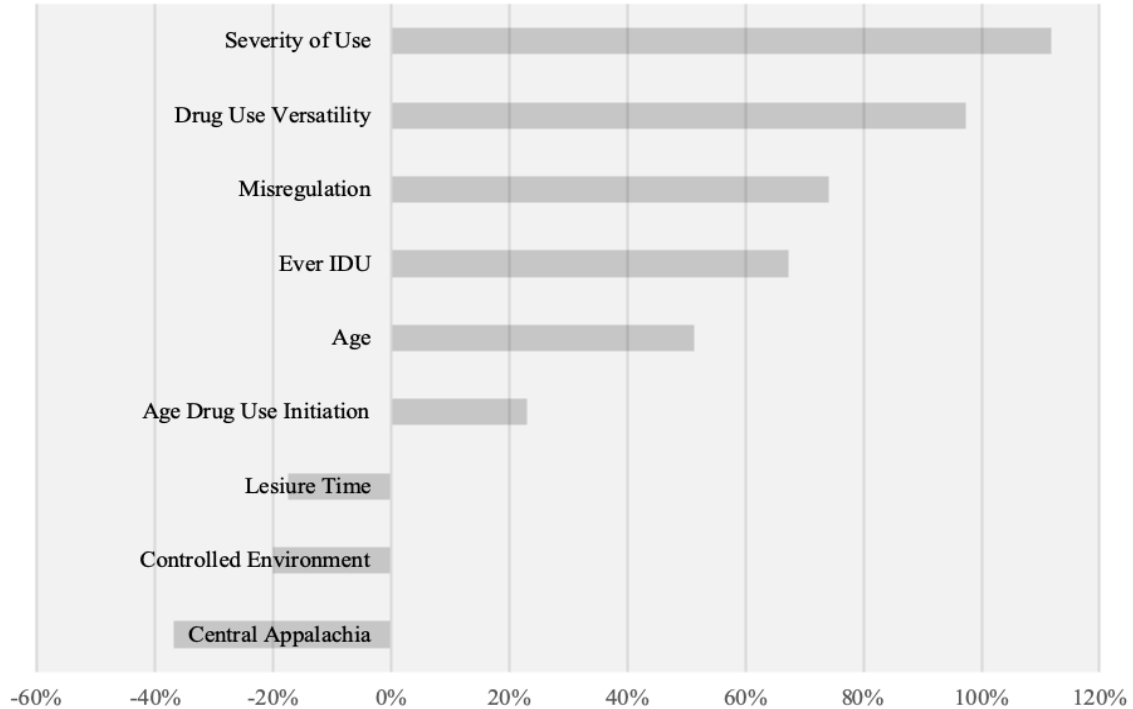
Drug use versatility increased the odds of observing past 30-day opioid use by 305.0% for every SD increase ($SD=2.4$); an approximate increase of 80.3% for every 1 drug used. The likelihood of observing past 30-day opioid use increased by 264.1% when the person was also White and by 181% if

history of IDU was reported. For every SD increase in severity of use ($SD=15.8$) the likelihood of observing past 30-day opioid use increased by 143.6% (i.e., a 5.8% increase for every one-digit severity score increase). Past-week misregulation increased the likelihood of observing past 30-day opioid use by 88.6%. Residing in Central Appalachia during the one-year period prior to incarceration increased the odds of observing past 30-day opioid use by 64.2%. Past 30-day opioid use was 51.0% more likely for every SD increase in age of drug use initiation ($SD=5.0$); an approximate 8.6% increase for every year. Close relationships modestly decreased the likelihood of observing past 30-day opioid use by 15.6% for every SD increase ($SD=4.1$); an approximate decrease of 3.3% in odds per relationship. Finally, for every SD increase in leisure days ($SD=2.4$), the odds of observing past 30-day opioid use decreased by 18.1%, about an 8.1% decrease for per day.

Past 30-day Stimulant Use Prior to Incarceration

Fewer number of nights spent in a controlled environment during the 30-day period prior to incarceration was associated with an increased likelihood of stimulant use for the 30-day period prior to incarceration ($RRR=0.94$, $p=.014$). History of IDU was also associated with an increased likelihood of past 30-day stimulant use ($RRR=1.68$, $p=.019$), as was older age ($RRR=1.05$, $p<.001$). Similar to past 30-day opioid use prior to incarceration, misregulation was associated with increased likelihood of past 30-day stimulant use ($RRR=1.74$, $p=.010$). The likelihood of past 30-day stimulant use also decreased in association with an increase in the number of leisure days per week ($RRR=0.92$, $p=.025$). Older age of drug use initiation ($RRR=1.04$, $p=0.34$), greater severity of use ($RRR=1.05$, $p<.001$), and greater number of drugs use versatility prior to incarceration ($RRR=1.33$, $p<.002$), were all associated with an increased likelihood that stimulants would be used during the 30-day period prior to incarceration. Unlike past 30-day opioid use, residing in Central Appalachia for the majority of time out of the year prior to incarceration slightly decreased the likelihood of stimulant use ($RRR=0.63$, $p=0.32$). The effect of residing in Central Appalachia on predicting the probability of past 30-day use differed between participants who reported past 30-day opioid and past 30-day stimulant use ($X^2=24.24$, $p<.001$). Figure 12 displays the percent change in odds for independent variables significantly associated with changes in the likelihood of observing past 30-day stimulant use prior to incarceration.

Figure 12. Percent change in odds of past 30-day stimulant use prior to incarceration.



For every SD increase in drug use severity ($SD=15.8$), the likelihood of observing past 30-day stimulant use increased by 111.8% (i.e., a 4.9% increase for every one-digit severity score increase), and for every SD increase in drug use versatility ($SD=2.4$) the likelihood increased 97.4%; an approximate 33.2% increase for every one drug used. Past-week misregulation was associated with a 74.1% increase in the likelihood of observing past 30-day stimulant use. The odds of observing past 30-day stimulant use increased by 67.3% if history of IDU was reported and by 51.3% for every SD increase in age ($SD=9.0$), an approximate increase of 4.7% for each year. The likelihood of observing past 30-day stimulant use increased modestly by 22.9% for every SD increase for age of drug use initiation ($SD=5.0$); an approximate increase of 4.2% for each year. For every SD increase in leisure days ($SD=2.4$), the odds of observing past 30-day stimulant use decreased by 17.4%, about a 7.7% decrease for per day. The likelihood of observing past 30-day stimulant use decreased by 20.0% for every SD increase in nights spent in a controlled environment ($SD=3.6$); an approximate 6.0% decrease for each night. Lastly, residing in Central Appalachia was associated with a 36.9% decrease in the likelihood of observing stimulant use for the 30-day period prior to incarceration.

Multinomial Logistic Regression Results for Drug Outcomes Subsequent to Incarceration

Tables 5.0 and 5.1 display the results of the multinomial logistic regression models examining opioid and stimulant outcomes for the one-year period subsequent to incarceration, with “other/no drug use” as the reference group. Variables considered as control variables and independent variables (as opposed to variables used for description only) which differed significantly by group when examined using nonparametric tests were included into the regression models.

Due to the overall number of independent variables which differed significantly by group in non-parametric analyses, two separate models were built to avoid model overfitting, as the events (i.e., taken to be the smaller number of cases reporting the outcome of interest, versus the number of cases for which the outcome was not reported; e.g., past-year opioid use rather than no use) for each outcome variable were smaller for the one-year post-release period compared to the 30-day pre-incarceration period. Specifically, N=186 for past-year concomitant use, N=195 for past-year opioid use, and N=130 for past-year stimulant use). The events per variable (EPV), the number of events divided by the number of independent variables, thus translates to approximately 19, 20, and 13, covariates respectively. A decision was made to examine the relationship between pre-incarceration drug use and opioid and stimulant outcomes that occurred during the one-year post-release period in a separate model. As prior drug use was not included in the multinomial regression model examining opioid and stimulant use outcomes for the 30-day period prior to incarceration, this decision allowed for some continuity between sets of analyses and related discussion. Examining the relationship between pre-incarceration drug use on opioid and stimulant outcomes subsequent to incarceration also permitted a narrower examination of premise discussed in earlier chapters that prior exposure to, or use of, drugs can significantly influence and constrain future decision-making about drugs, and therefore future drug behaviors, independent of other factors. Prior to examining the relationship between pre-incarceration use of specific drugs and opioid and stimulant outcomes for the one-year period subsequent to incarceration, it was expected (both for conceptual reasons as well as due to non-parametric test results) that specific opioid and stimulant drugs (e.g., heroin, buprenorphine, cocaine, etc.) used during the 30-day period prior to incarceration would demonstrate a positive correlation with drug outcomes for the one-year post-release period by drug class (e.g., opioids, stimulants) or combination of classes (e.g., concomitant) of which they are constituents. It was unclear, however, if all specific drugs for each drug

class would demonstrate a positive and statistically significant relationship with expected outcomes, or if instead, only certain drugs would. Further, it was uncertain what, if any drugs, might be associated with a decreased likelihood of observing a given outcome.

For the first model examining opioid and stimulant outcomes during the one-year period subsequent to incarceration, VIF indicated that collinearity was not an issue for either model. Model fit statistics for the first model, displayed at the bottom of Table 4.0, indicated acceptable model fit.

Table 4
Results of Multinomial Logistic Regression Examining Opioid and Stimulant Use During the One-year Post-release Period

	Robust SE	95% CI	RRR	p value
Concomitant				
White	1.730	2.15-10.07	4.67	.001
Nights controlled environment, past-year	0.011	1.00-1.08	1.01	.001
Lifetime drug treatment episodes	0.022	1.00-1.09	1.05	.016
Ever IDU	0.440	1.61-3.37	2.32	.001
Age	0.010	0.93-0.97	0.95	.001
Past-month income	0.007	0.99-1.01	1.00	.188
Past-year cognitive difficulties	0.316	1.00-2.26	1.50	.058
Past-year anxiety symptoms	0.251	0.73-1.74	1.13	.583
Past-year depressive symptoms	0.473	1.33-3.25	2.09	.001
Past-year suicidal ideation	0.898	1.23-5.05	2.49	.011
Close relationships	0.017	0.97-1.03	1.00	.846
Social satisfaction	0.085	0.22-0.55	0.36	.001
Perceived social worth	0.266	0.46-1.57	0.86	.627
Past-year educational/vocational involvement	0.327	1.00-2.31	1.53	.046
On community supervision	0.610	1.01-3.55	1.89	.049
Age of drug use initiation	0.024	0.95-1.03	0.99	.556
Abstinence self-efficacy prior to treatment	0.142	0.45-1.02	0.68	.066
Central Appalachia	0.163	0.58-1.23	0.84	.376
Opioids				
White	0.594	1.08-3.33	1.90	.026
Nights controlled environment, past-year	0.001	1.00-1.01	1.00	.001
Lifetime drug treatment episodes	0.020	1.02-1.10	1.07	.001
Ever IDU	0.450	1.69-3.42	2.42	.001
Age	0.011	0.94-0.98	0.96	.001
Income, past-month	0.005	0.99-1.00	1.00	.834
Past-year cognitive difficulties	0.209	0.70-1.54	1.04	.847
Past-year anxiety symptoms	0.181	0.62-1.33	0.91	.618
Past-year depressive symptoms	0.281	0.87-2.00	1.32	.187
Past-year suicidal ideation	0.677	0.82-3.73	1.75	.154
Close relationships	0.021	0.95-1.03	0.99	.640
Social satisfaction	0.117	0.27-0.75	0.45	.002
Perceived social worth	0.232	0.44-1.40	0.78	.405
Past-year educational/vocational involvement	0.255	0.83-1.81	1.25	.289

Table 4 (continued)

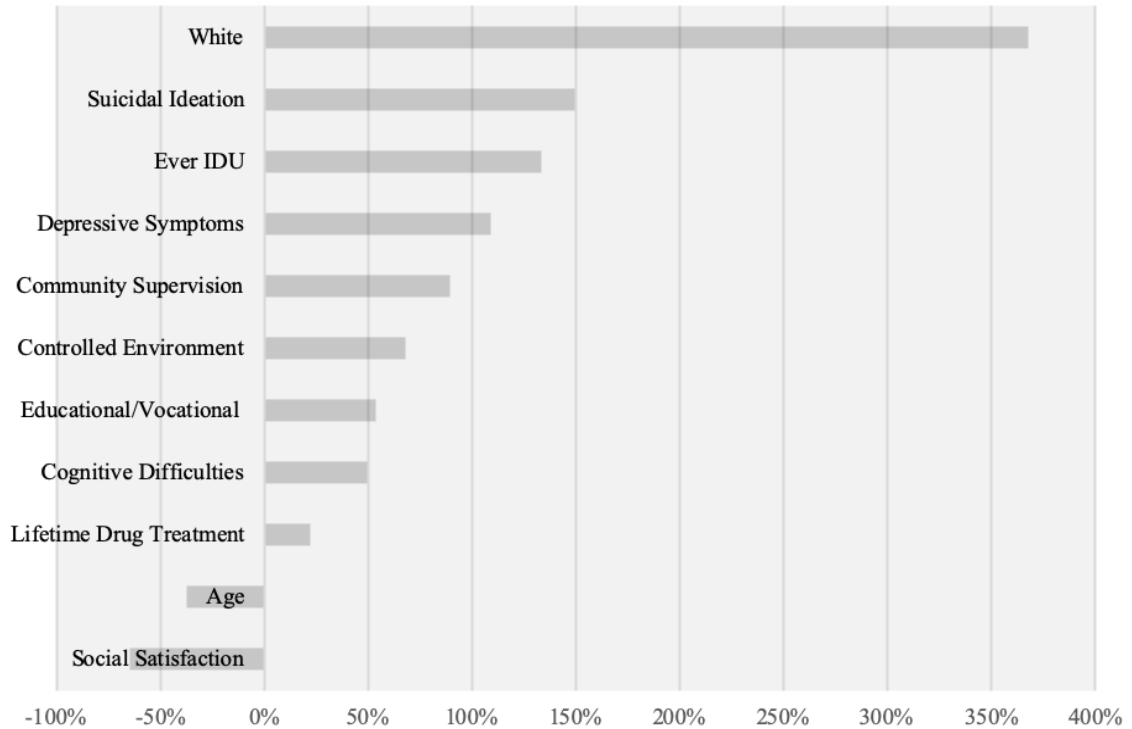
On community supervision	0.176	0.51-1.23	0.80	.304
Age of drug use initiation	0.019	0.96-1.02	1.00	.855
Abstinence self-efficacy prior to treatment	0.169	0.55-1.22	0.82	.334
Central Appalachia	0.279	1.12-2.24	1.60	.008
Stimulants				
White	0.303	0.72-1.95	1.18	.520
Nights controlled environment, past-year	0.001	1.00-1.01	1.06	.001
Lifetime drug treatment episodes	0.025	1.00-1.10	1.05	.055
Ever IDU	0.183	0.55-1.28	0.84	.420
Age	0.011	0.99-1.03	1.01	.163
Income, past-month	0.006	0.99-1.00	1.00	.650
Experienced cognitive difficulties	0.259	0.66-1.71	1.07	.796
Past-year anxiety symptoms	0.271	0.69-1.80	1.13	.635
Past-year depressive symptoms	0.460	1.11-2.98	1.82	.018
Past-year suicidal ideation	0.666	0.66-3.46	1.54	.310
Close relationships	0.016	0.98-1.04	1.01	.360
Social satisfaction	0.111	0.23-0.69	0.40	.001
Perceived social worth	0.383	0.53-2.16	1.01	.844
Past-year educational/vocational involvement	0.246	0.66-1.66	1.05	.852
On community supervision	0.652	0.93-3.62	1.86	.078
Age of drug use initiation	0.027	0.90-1.00	0.95	.072
Abstinence self-efficacy prior to treatment	0.140	0.38-0.94	0.59	.027
Central Appalachia	0.179	0.45-1.17	0.74	.206
Intercept-only: -1538.692/Model: -1342.738	Pseudo R ² =0.127			
Wald Chi2 (df=54)=300.538, p<.001	Cox-Snell/ML=0.222			
	Cragg-Uhler/Nagelkerke=0.25			

Past-year Concomitant Use Subsequent to Incarceration

Being White was significantly associated with past-year concomitant use (RRR=4.68, p<.001). Greater number of nights spent in a controlled environment during the one-year post-release period (RRR=1.01, p<.001), greater number of lifetime drug treatment episodes (RRR=1.05, p=0.16), and history of IDU (RRR=2.32, p<.001) were all associated with an increased likelihood of observing past-year concomitant use. While experiencing past-year cognitive difficulties approached statistical significance (RRR=1.50, p=.053), experiencing past-year depressive symptoms (RRR=2.09, p<.001) and past-year suicidal ideation (RRR=2.49, p=.011) were both associated with an increased likelihood of past-year concomitant use. Receiving satisfaction from past-year social interaction, as opposed to being indifferent to or not receiving satisfaction, decreased the likelihood of past-year concomitant use (RRR=0.37, p<.001). Past-year concomitant use was also significantly associated with educational and/or vocational involvement (RRR=1.53, p=.046), as well as being on community supervision during the one-year post-release period

(RRR=1.89, p=.049). Residing in Central Appalachia during the one-year post-release period was not associated with changes in the likelihood of observing past-year concomitant use (RRR=0.84, p=3.76). The overall effect of residing in Central Appalachia for the entire model was significant ($X^2=11.52$ p=.0092). The effect of residing in Central Appalachia on predicting the probability of past-year concomitant use differed from the effect on predicting the probability of past-year opioid use ($X^2=7.73$, p=.0051), but not past-year stimulant use ($X^2=0.23$, p=.6352). Figure 13 displays the percent change in odds for independent variables significantly associated with changes in the likelihood of observing concomitant use during the one-year period subsequent to incarceration.

Figure 13. Percent change in odds of concomitant use during one-year post-release period.



Being White increased the likelihood that concomitant use during the one-year post-release period would be observed by 367.4%. The likelihood of observing past-year concomitant use increased by 149.3% with past-year suicidal ideation. History of IDU increased the likelihood of observing past-year concomitant use by 133.0%, whereas past-year depressive symptoms increased the likelihood by 109.0%.

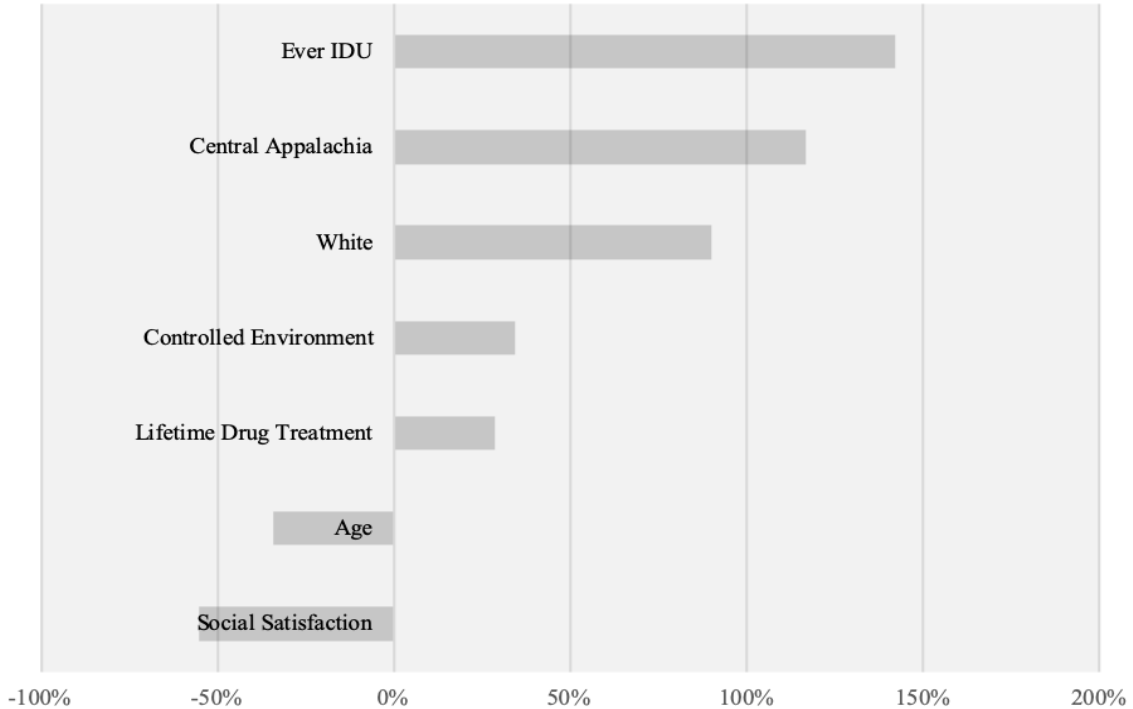
Being on community supervision for this same time period increased odds by 89.0%. For every SD increase in nights spent in a controlled environment during the past year ($SD=77.7$), the odds of observing past-year concomitant use increased by 67.6%; an approximate increase of 0.8% per night. Past-year educational/vocational involvement was associated increased 53.2% increased odds of observing past-year concomitant use. Past-year cognitive difficulties were associated with a 49.3% increase in odds of observing past-year concomitant use. The likelihood of observing concomitant use also increased by 22.0% for each SD increase in lifetime drug treatment episodes ($SD=3.9$); an approximate increase of 5.6% per treatment episode. For age, the likelihood of observing past-year concomitant use decreased by 37.3% for every SD increase ($SD=9.1$); an approximate 5% decrease for every 1 year. Lastly, receiving satisfaction from past-year social interaction decreased the odds of observing past-year concomitant use by 64.8%.

Past-year Opioid Use Subsequent to Incarceration

As with past-year concomitant use, being White ($RRR=1.90$, $p=.026$) was associated with increased odds of past-year opioid use. Greater number of nights spent in a controlled environment during the one-year post-release period ($RRR=1.00$, $p<.001$), greater number of lifetime drug treatment episodes ($RRR=1.07$, $p<.001$), and history of IDU ($RRR=2.42$, $p<.001$) were all associated with an increased likelihood of observing past-year opioid use. Participants who reported past-year opioid use were also more likely to be younger ($RRR=0.96$, $p<.001$). Receiving satisfaction from past-year social interaction was associated with decreased odds of past-year opioid use ($RRR=0.46$, $p=.002$). Finally, residing in Central Appalachia for the majority of the year subsequent to incarceration was associated with an increased likelihood of past-year opioid use ($RRR=1.60$, $p=.008$). The effect of residing in Central Appalachia for the one-year post-release period on predicting the probability of past-year opioid use differed from the effect on predicting the probability of past-year stimulant use ($X^2=7.57$, $p=.0051$) as well as concomitant use ($X^2=7.73$, $p=.0058$).

Figure 14 displays the percent change in odds for independent variables significantly associated with changes in the likelihood of observing opioid use during the one-year subsequent to incarceration.

Figure 14. Percent change in odds of opioid use during one-year post-release period.



History of IDU increased the odds of observing past-year opioid use by 142.2%. Residing in Central Appalachia for the majority of time out of the past year increased the odds of observing past-year opioid use by 116.8%. Being White increased the likelihood of observing past-year opioid use by 90.1%. For every SD increase in nights spent in a controlled environment during the past year ($SD=77.7$), the odds of observing past-year opioid use increased by 34.3%, just 0.4% for each night. For each SD increase ($SD=3.9$) in lifetime drug treatment episodes, there was a 28.8% increase in the likelihood of observing past-year opioid use; an approximate 6.7% increase for each treatment episode. For every SD increase in age ($SD=9.0$), the likelihood of past-year opioid use decreased by 34.2%; an approximate 4.5% decrease for every 1 year. Lastly, receiving satisfaction from past-year social interaction decreased the odds of observing past-year opioid use by 55.1%.

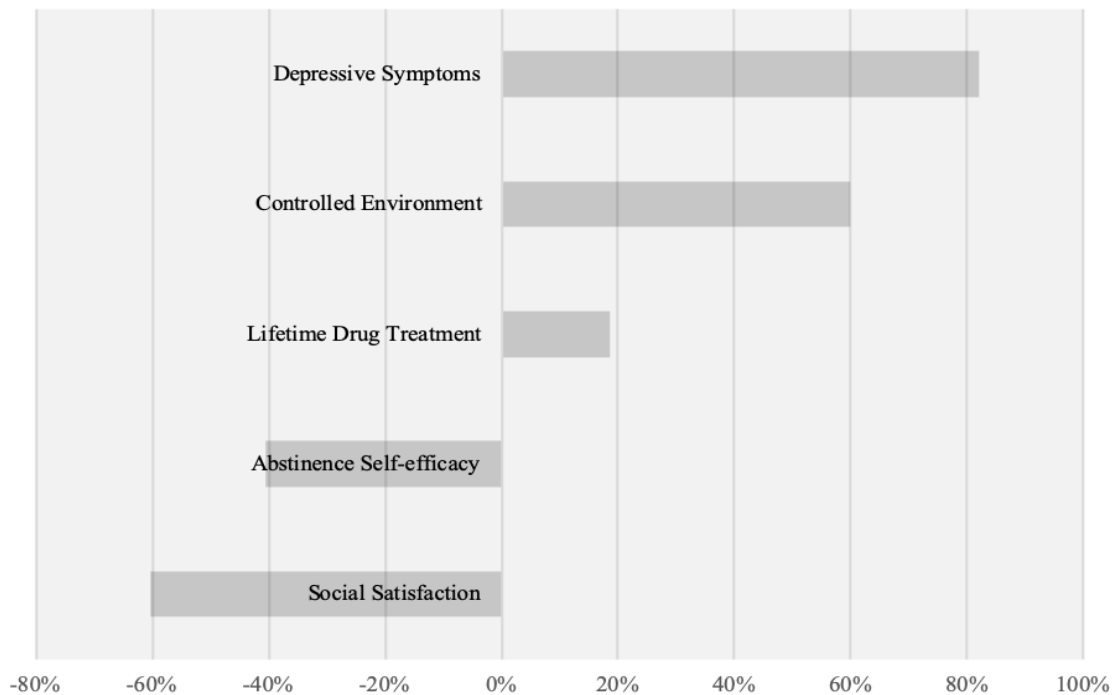
Past-year Stimulant Use Subsequent to Incarceration

Unlike concomitant and opioid use for the one-year post-release period, being White did not increase the likelihood that past-year stimulant use would be observed ($RRR=1.18$, $p=.520$). Similar to past-year concomitant and opioid use, though, greater number of nights spent in a controlled environment

in the year following release was associated with an increased likelihood of past-year stimulant use (RRR=1.06, $p<.001$). Greater number of prior drug treatment episodes (RRR=1.05, $p=.055$) approached statistical significance. Experiencing past-year depressive symptoms was associated with an increased likelihood of past-year stimulant use (RRR=1.82, $p=.018$), whereas receiving satisfaction from social interaction was associated with decreased likelihood (RRR=0.40, $p<.001$). Reporting “moderately good” or “very good” abstinence self-efficacy prior to treatment was associated with decreased odds of past-year stimulant (RRR=0.59, $p=.027$). Residing in Central Appalachia for the majority of the one-year post-release period was not associated with a change in odds of stimulant use for this same time period (RRR=0.74, $p=.206$).

Figure 15 displays the percent change in odds for independent variables significantly associated with changes in the likelihood of observing stimulant use during the one-year period subsequent to incarceration.

Figure 15. Percent change in odds of stimulant use during one-year post-release period.



The likelihood of observing past-year stimulant use increased 82.1% when past-year depressive symptoms were also reported. For every SD increase in nights spent in a controlled environment during the

year subsequent to incarceration ($SD=77.7$), the odds of observing past-year stimulant use increased by 59.9%, just 0.6% for each night. Lifetime drug treatment was associated with a 18.7% increase in the likelihood of observing past-year stimulant use for each SD increase ($SD=3.9$); an approximate 4.5% increase for each treatment episode. Having reported “moderately good” or “very good” abstinence self-efficacy prior to treatment was associated with a 40.5% decrease in odds of observing stimulant use during the one-year post-release period. Lastly, receiving satisfaction from social interaction was associated with a 60.5% decrease in the odds of observing stimulant use for this time period, similar to the percentage change in odds observed for past-year concomitant and opioid use.

For the second model examining the relationship between specific drug use that occurred during the 30-day period prior to incarceration and opioid and stimulant outcomes that occurred during the one-year post-release period, collinearity was not an issue and model fit statistics, displayed at the bottom of Table 4.1., indicated acceptable fit.

For concomitant use during the one-year period subsequent to incarceration, drugs used during the 30-day period prior to incarceration that were significantly associated with an increased likelihood of past-year concomitant use included prescription sedatives ($RRR=1.69$, $p=.006$), heroin ($RRR=1.52$, $p=.043$), prescription opioids ($RRR=1.74$, $p=.006$) and amphetamines ($RRR=1.97$, $p<.001$). For opioid use during the one-year period subsequent to incarceration, drugs used during the 30-day period prior to incarceration that were significantly associated with an increased likelihood of past-year opioid use included heroin ($RRR=2.55$, $p<.001$) and prescription opioids ($RRR=2.19$, $p<.001$). Alcohol ($RRR=0.64$, $p=.009$), cocaine/crack cocaine ($RRR=0.63$, $p=.034$), and amphetamine use ($RRR=0.62$, $p=.022$) during the 30-day period prior to incarceration were all associated with a decreased likelihood of opioid use during the one-year period subsequent to incarceration. For stimulant use during the one-year period subsequent

Table 4.1 Results of Multinomial Logistic Regression Examining Past 30-day Pre-incarceration Drug Use and Past-year Post-release Drug Use

	Robust SE	95% CI	RRR	p value
Concomitant				
Alcohol	0.141	0.60-1.16	0.83	.241
Sedatives	0.330	1.18-2.50	1.69	.006
Hallucinogens	0.583	0.72-3.22	1.49	.291
Synthetic drugs	0.306	0.58-1.84	1.01	.954
Cocaine/crack cocaine	0.260	1.01-2.44	1.37	.101
Amphetamines	0.343	0.95-2.00	1.97	.001
Heroin	0.312	1.02-2.27	1.52	.043
Prescription opioids	0.489	1.18-2.57	1.74	.006
Buprenorphine	0.229	0.70-1.62	1.07	.757
Opioids				
Alcohol	0.106	0.46-0.88	0.64	.009
Sedatives	0.237	0.84-1.80	1.25	.241
Hallucinogens	0.572	0.42-3.01	1.16	.763
Synthetic drugs	0.375	0.64-2.20	1.19	.554
Cocaine/crack cocaine	0.137	0.40-0.95	0.63	.034
Amphetamines	0.127	0.41-0.93	0.62	.022
Heroin	0.495	1.74-3.72	2.55	.001
Prescription opioids	0.423	1.51-3.01	2.19	.001
Buprenorphine	0.293	0.98-2.15	1.45	.066
Stimulants				
Alcohol	0.171	0.61-1.29	0.92	.704
Sedatives	0.209	1.99-1.30	0.87	.570
Hallucinogens	0.471	0.80-3.03	0.79	.726
Synthetic drugs	0.531	0.81-3.03	1.65	.144
Cocaine/crack cocaine	0.420	1.19-2.89	1.92	.004
Amphetamines	0.574	1.98-4.23	3.0	.001
Heroin	0.107	0.09-0.57	0.23	.002
Prescription opioids	0.152	0.44-1.06	0.68	.082
Buprenorphine	0.255	0.40-1.46	0.77	.438
Intercept-only: -1541.577/Model: -1423.094 Pseudo R ² =.078				
Wald Chi2 (df=27) =214.211, p<.001 Cox-Snell/ML=0.143				
Cragg-Uhler/Nagelkerke=0.166				

to incarceration, the only two drugs used in the 30-day period prior to incarceration significantly associated with an increased likelihood of past-year stimulant use during the one-year period subsequent to incarceration included cocaine/crack cocaine (RRR=1.92, p=.004) and amphetamines (RRR=3.0, p<.001). Heroin use during the 30-day period prior to incarceration was associated with a decreased likelihood of stimulant use during the one-year period subsequent to incarceration (RRR=0.23, p=.002). Buprenorphine was the only opioid drug used during the 30-day period prior to incarceration not associated with statistically significant change in odds for any of the outcomes of interest.

Figures 16, 17, and 18 display the percent change in odds for independent variables significantly associated with changes in the likelihood of observing concomitant, opioid, and stimulant use during the one-year period subsequent to incarceration, respectively.

Figure 16. Percent change in odds of concomitant use during one-year post-release period by pre-incarceration drug use.

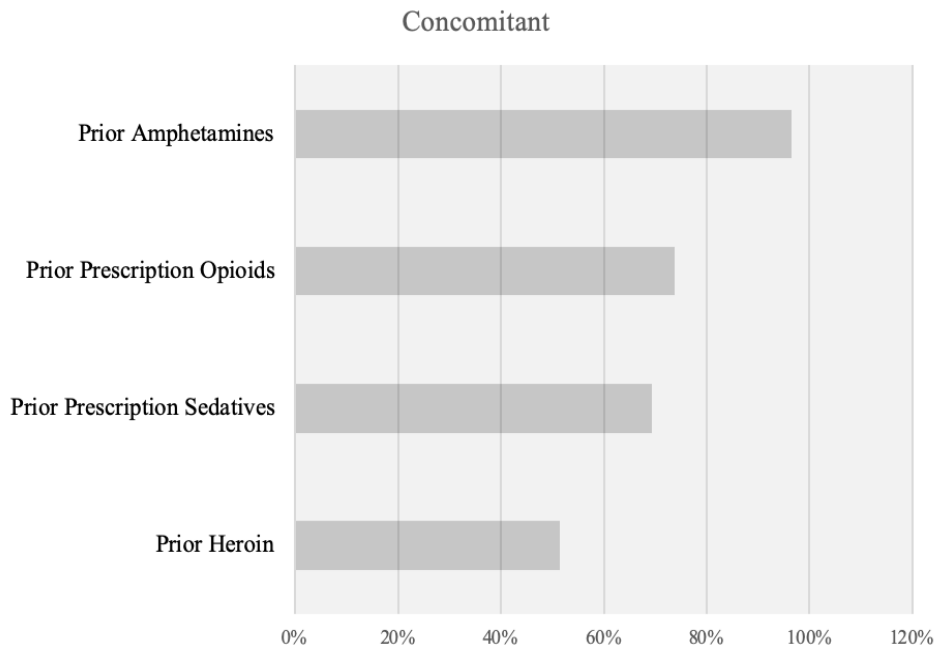


Figure 17. Percent change in odds of opioid use during one-year post-release period by pre-incarceration drug use.

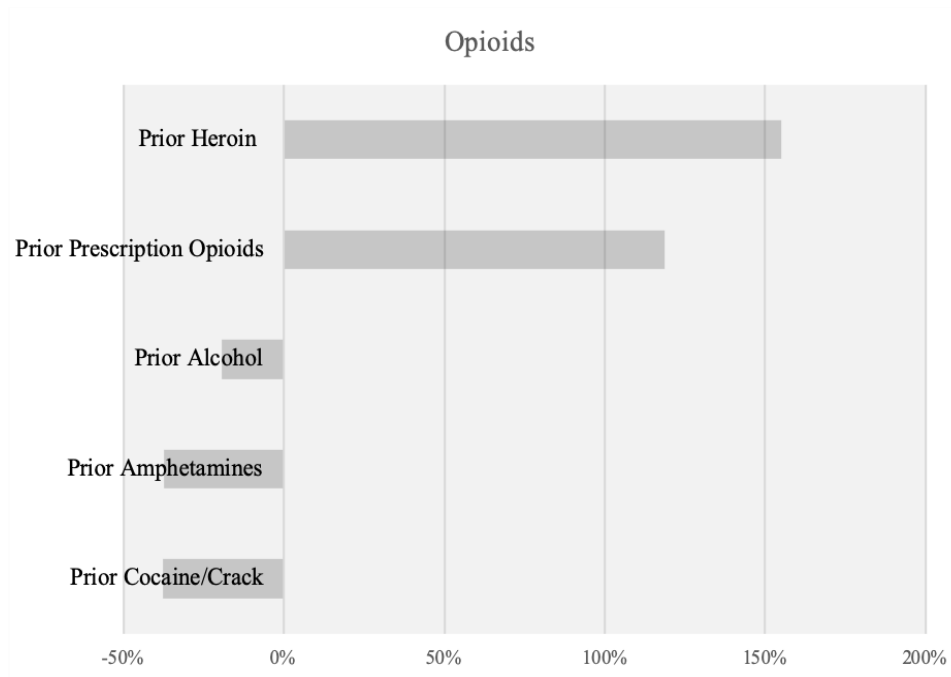
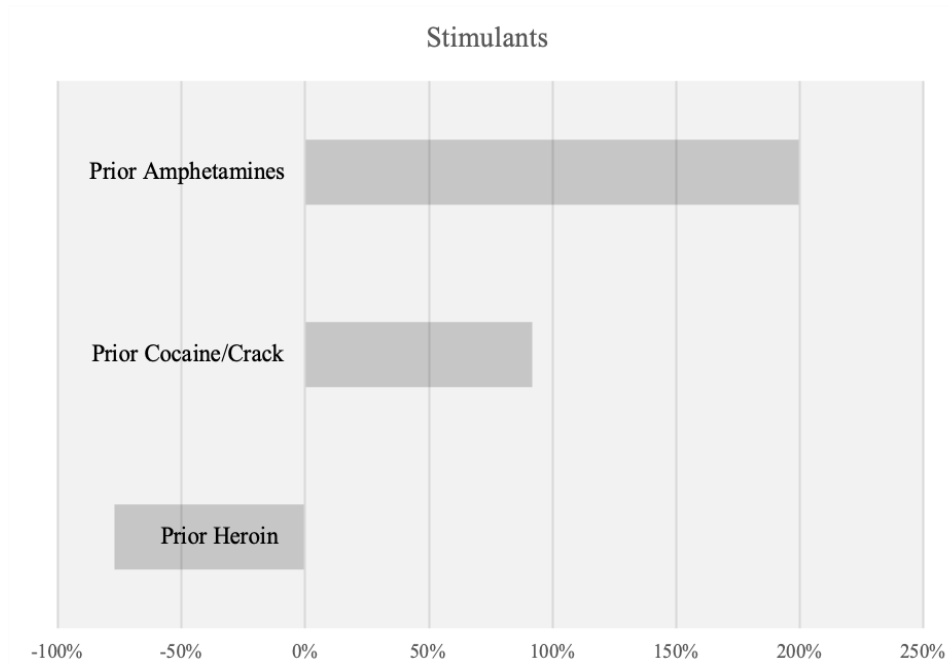


Figure 18. Percent change in odds of stimulant use during one-year post-release period by pre-incarceration drug use.



Amphetamine use during the 30-day period prior to incarceration was associated with the largest increase in odds for past-year concomitant use, with participants who reported using amphetamines during

the 30-day period prior to incarceration 96.5% more likely to have reported concomitant use subsequent to incarceration. This was followed by past 30-day prescription opioid (73.8), prescription sedative (69.3%), and heroin use (51.4%), which all increased the likelihood that concomitant use would be observed for the one-year period subsequent to incarceration.

Heroin and prescription opioid use during the 30-day period prior to incarceration were associated with the largest increase in odds for past-year opioid use, with participants who reported past 30-day heroin use prior to incarceration 155.1% more likely to have reported past-year opioid use subsequent to incarceration and participants who reported past 30-day prescription opioid use 118.8% more likely. Past 30-day use of alcohol, cocaine/crack cocaine, and amphetamines prior to incarceration decreased the odds of observing past-year opioid use subsequent to incarceration by approximately 20-40%.

Amphetamine use during the 30-day period prior to incarceration was associated with the largest increase in odds for observing past-year stimulant use for the one-year period subsequent to incarceration, with participants who reported using amphetamines just prior to incarceration 199.6% more likely to have reported stimulant use subsequent to incarceration. This was followed by past 30-day cocaine/crack cocaine use prior to incarceration, which increased odds by 91.7%. Past 30-day heroin use decreased odds by 77.1%.

Aim Three Results

Table 5 displays means and proportions of participants who reported using heroin during the one-year period subsequent to incarceration. For this time period, 10.7% (N=168) of the sample reported past-year heroin use. Only 2.1% of the entire sample reported heroin use within the 30-day period prior to follow-up data collection (approximately 10-14 months subsequent to release).

Compared to the non-use group, the majority of the heroin-use group was White (96.4%, $X^2=26.86$, $df=1$, $p<.001$). Groups were similar in terms of rates for HSD/GED (76.2% vs. 70.6%, $X^2=2.21$, $df=1$, $p=.161$), mandated SAP participation (67.9% vs. 73.6%, $X^2=2.24$, $df=1$, $p=.133$), and SAP completion (73.8% vs. 78.9%, $X^2=1.96$, $df=1$, $p=.160$). However, during the one-year period subsequent to incarceration, the heroin-use group spent more nights on average in a controlled environment (68.7, $SD=78.0$ vs. 40.6, $SD=77.0$, $t=-4.40$, $p<.001$). This group also reported a higher number of lifetime drug

treatment episodes on average (3.3, $SD=4.8$ vs. 2.1, $SD=3.7$, $t=-3.10$, $p=.002$) and higher rates for IDU history compared to the non-use group (66.1% vs. 39.9%, $X^2=41.12$, $df=1$, $p<.001$).

Age and Sex

The heroin-use group was slightly younger than the non-use group (31.5, $SD=7.3$ vs. 34.9, $SD=9.1$, $t=5.4$, $p<.001$), though did not differ significantly from the non-use group in the proportion of males (76.8% vs. 81.4%, $X^2=1.81$, $df=1$, $p=.179$).

Past-year Cognitive Difficulties and History of Head Trauma

Approximately 30% of the heroin-use group reported experiencing past-year cognitive difficulties, not significantly higher than the non-use group (29.8% vs. 26.0%, $X^2=0.89$, $df=1$, $p=.341$). Rates for lifetime incidence of trauma history were essentially identical across groups, at approximately 43.0% ($X^2=0.00$, $df=1$, $p=1.00$).

Table 5
Group Means, Proportions, and Between-group Differences Among Heroin and Non-heroin users for One-year Post-release Period

	Sample	Heroin	No heroin	p value
N=	1,563	168	1,395	
%		10.7	89.3	
White	81.5%	96.4%	79.7%	.001
High School Diploma/GED	71.2%	76.2%	70.6%	.161
Mandated SAP	73.0%	67.9%	73.6%	.133
Graduated SAP	78.3%	73.8%	78.9%	.160
Nights controlled environment, past-year	43.6	68.7	40.6	.001
Lifetime drug treatment episodes	2.2	3.3	2.1	.002
Ever IDU	42.9%	66.1%	39.9%	.001
Age	33.9	31.5	34.9	.001
Male	80.9%	76.8%	81.4%	.179
Cognitive difficulties, past-year	26.4%	29.8%	26.0%	.341
History of head injury	43.4%	43.5%	43.4%	1.00
Past-month income	\$1,290	\$1,128	\$1,310	.144
Anxiety symptoms	40.7%	45.8	40.1	.180
Depressive symptoms	32.7%	45.2	31.2	.001
Suicidal ideation	4.5%	9.5%	3.9%	.002
Chronic pain	32.5%	31.5%	32.7%	.838
Close relationships	6.1	5.8	6.2	.379
Social interaction	88.4%	84.5%	88.9%	.122

	Sample	Heroin	No heroin	p value
N=	1,563	168	1,395	
%		10.7	89.3	
Table 5 (continued)				
Social satisfaction	88.9%	76.2%	90.5%	.001
Educational/vocational involvement	67.1%	65.5%	67.3%	.705
Perceived social worth	92.3%	86.3%	93.0%	.004
On community supervision	87.0%	88.1%	86.8%	.732
Age of drug use initiation	14.7	13.6	14.8	.010
Abstinence self-efficacy prior to treatment	81.5%	73.2%	82.5%	.005
<i>Past 30-day drug use prior to incarceration</i>				
Alcohol	49.5%	44.6%	50.1%	.209
Cannabis	52.5%	50.6%	52.8%	.653
Sedatives	32.3%	45.2%	30.8%	.001
Hallucinogens	3.2%	5.4%	2.9%	.147
Synthetics	7.7%	10.1%	7.4%	.269
Cocaine/crack cocaine	23.2%	32.1%	22.2%	.005
Amphetamines	31.3%	31.0%	31.3%	.992
Heroin	17.7%	54.2%	13.3%	.001
Prescription opioids	50.7%	71.4%	48.2%	.001
Buprenorphine	18.7%	25.0%	17.9%	.034
Past-year drug use, post-release				
Alcohol	31.5%	42.3%	30.3%	.002
Cannabis	25.5%	45.8%	23.0%	.001
Sedatives	8.0%	25.6%	5.9%	.001
Hallucinogens	1.2%	5.4%	0.6%	.001
Synthetic drugs	7.0%	8.9%	6.8%	.393
Cocaine/crack cocaine	7.4%	28.6%	4.8%	.001
Amphetamines	15.2%	37.5%	12.5%	.001
Prescription opioids	14.3%	38.7%	11.3%	.001
Buprenorphine	9.4%	33.3%	6.5%	.001
Central Appalachia	30.3%	17.3%	31.9%	.001
Urban proximity	4.5	2.7	4.7	.001
Unrestricted alcohol sales	56.6%	74.4%	54.4%	.001

Psychiatric Symptoms and Chronic Pain

Just under half of the heroin-use group reported experiencing past-year anxiety symptoms, similar to the rates among the non-use group (45.8% vs. 40.1%, $X^2=1.78$, $df=1$, $p=.180$). Groups differed, though, in rates at which past-year depressive symptoms were experienced (45.2% vs 31.2%, $X^2=12.68$, $df=1$, $p<.001$). Past-year suicidal ideation was nearly three-times higher among the heroin-use group (9.5% vs.

3.1%, $X^2=9.92$, $df=1$, $p=.002$). Because of the high rates of past year suicidal ideation, the relationship between past 30-day heroin use and suicidal ideation was also explored (results not displayed). Among participants who reported heroin use during the 30-day period prior to follow-up data collection ($N=33$), 24.1% also reported past-year suicidal ideation, compared to 4.1% of participants who did not report heroin use during this same time period ($X^2=26.3$, $df=1$, $p<.001$). For rates of chronic pain, groups were nearly identical (31.5% vs. 32.7%, $X^2=0.45$, $df=1$, $p=.838$).

Past-month Income

Past-month income did not differ between groups. Reflecting the generally low past-month income for the entire sample, both groups reported past-month income $< \$1,500$. The heroin use group reported an average past-month income of \$1,128, whereas the non-use group reported an average past-month income of \$1,320 ($t=1.5$, $p=.144$).

Non-drug Alternative Reinforcers

Groups were similar in terms of the average number of close relationships reported (5.8, $SD=6.6$ vs. 6.2, $SD=5.3$, $t=0.87$, $p=.379$), rates of past-year social interaction (84.5% vs. 88.9%, $X^2=2.30$, $df=1$, $p=.122$), past-year educational/vocational involvement (65.5% vs. 67.3%, $X^2=0.14$, $df=1$, $p=.705$), and being on community supervision (88.1% vs. 86.8%, $X^2=0.11$, $df=1$, $p=.732$). However, groups differed for rates of receiving satisfaction from their past-year social interactions as well as for rates of perceived social worth, as measured by feelings of being cared about and supported by others. Specifically, the heroin-use group had far lower rates of receiving satisfaction for past-year social interaction, with 76.2% of the heroin-use group reporting satisfaction compared to 90.5% of the non-use group ($X^2=29.61$, $df=1$, $p<.001$). Likewise, 86.3% of the heroin-use group reported feeling cared about and supported by others, compared to 93.0% of the non-use group ($X^2=8.42$, $df=1$, $p=.004$).

Age of Drug Use Initiation and Abstinence Self-efficacy Prior to Treatment

On average, the heroin-use group was younger at the time they first used alcohol or illicit drugs compared to the non-use group (13.5, $SD=4.1$ vs. 14.8, $SD=5.1$, $t=2.6$, $p=.010$). This group also had lower rates of “moderately good” or “very good” abstinence self-efficacy prior to treatment (73.2% vs. 82.5%, $X^2=79.9$, $df=1$, $p=.005$).

Past 30-day Drug Use and Drug Use Frequency Prior to Incarceration

Groups differed for both pre-incarceration drug use rates as well as frequency of use, as measured in days, for the 30-day period prior to incarceration.

For non-opioid and non-stimulant drugs used during the 30-day period prior to incarceration, rates of pre-incarceration alcohol use were similar across groups, with 44.6% of the heroin-use group and 50.1% of the non-use group reporting use ($X^2=1.58$, $df=1$, $p=.209$). The number of days that alcohol was used also differed slightly from an average of 5.7 ($SD=9.6$) for the heroin-use group and 7.5 ($SD=11.0$) for the non-use group ($t=1.9$, $p=.034$). Rates of pre-incarceration cannabis use did not differ between groups ($X^2=0.20$, $df=1$, $p=.653$), with approximately half of both groups reporting use, nor did frequency of days used, with each group reporting 10-11 days of use on average ($SD=13.0$ for both groups) ($t=1.1$, $p=.261$). The heroin-use group did report higher rates of prescription sedative use prior to incarceration (45.2% vs. 30.8%, $X^2=13.73$, $df=1$, $p<.001$), reporting an average of 6.6 ($SD=10$) days of use, compared to 5.0 ($SD=9$) days for the non-use group ($t=-1.9$, $p<.001$). Hallucinogens were used <1 day on average prior to incarceration for both groups ($t=-1.2$, $p=.346$), with rates of use higher among the heroin-use group (5.4% vs. 2.9%, $X^2=2.10$, $df=1$, $p=.147$). Similarly, the heroin-use group reported using synthetic drugs prior to incarceration at slightly higher rates (10.1% vs. 7.4%), though groups did not differ significantly ($X^2=1.22$, $df=1$, $p=.269$). Both groups used synthetic drugs <2 days on average ($t=-0.9$, $p=.385$).

For stimulant drugs, rates of past 30-day cocaine/crack cocaine use prior to incarceration were higher among the heroin-use group (32.1% vs. 22.2%, $X^2=7.85$, $df=1$, $p=.005$). The average number of days that cocaine/crack cocaine was used prior to incarceration was also slightly greater among the heroin-use group (4.9, $SD=9.6$ vs. 3.2, $SD=8.1$, $t=2.1$, $p=.013$). For past 30-day amphetamine use prior to incarceration, rates between groups were nearly equivalent, approximately 31.0% ($X^2=0.10$, $df=1$, $p=.922$). However, the non-use group reported using amphetamines for slightly more days on average (6.4, $SD=11.3$ vs. 4.6, $SD=10.1$, $t=2.2$, $p=.032$).

For opioid drugs, rates of past 30-day heroin use prior to incarceration were, as anticipated, higher among the heroin-use group (54.2% vs. 13.3%, $X^2=168.67$, $df=1$, $p<.001$), as was the average number of days that heroin was used (13.0, $SD=14.0$ vs. 2.5, $SD=7.9$, $t=-9.4$, $p<.001$). Similarly, the heroin-use group reported using prescription opioids at a higher rate (71.4% vs. 48.2%, $X^2=31.52$, $df=1$, $p<.001$) and, again,

for a greater number of days on average (15.3, $SD=13.4$ vs. 10.3, $SD=13.0$, $t=-4.6$, $p<.001$). For past 30-day buprenorphine use prior to incarceration, the heroin use group reported higher rates than the non-use group, but by a narrower margin (25.0% vs. 17.9%, $X^2=4.49$, $df=1$, $p=.034$) compared to the other opioid drugs examined. The heroin-use group did report using buprenorphine for slightly more days on average (3.3, $SD=8.2$ vs. 2.6, $SD=7.4$, $t=-1.2$, $p=.245$).

Past-year Drug Use Subsequent to Incarceration

During the one-year period subsequent to incarceration, the heroin-use group reported higher rates of use for all drugs, used 3.8 drugs on average, and went 71.7 days from the date of their release to the date that they first used illicit drugs.

Among non-opioid and non-stimulant drugs, alcohol was most commonly used sample-wide (31.5%). Just over 40% of the heroin-use group reported past-year alcohol use compared to 30.3% of the non-use group ($X^2=9.47$, $df=1$, $p=.002$). Cannabis was the next most commonly used drug during the post-release period (25.5%). The heroin-use group had higher rates of cannabis use compared to the non-use group (45.8% vs. 23.0%, $X^2=39.96$, $df=1$, $p<.001$). For this time period, prescription sedatives, used by 8.0% of the entire sample, were used at higher rates among the heroin-use group ($X^2=76.57$, $df=1$, 25.6% vs. 5.9%, $p<.001$). Hallucinogens and synthetic drugs were used by <10% of both groups. Higher rates of use were reported by the heroin-use group for both hallucinogens (5.4% vs. 0.6%, $X^2=25.25$, $df=1$, $p<.001$) and synthetic drugs (8.9% vs. 6.8%), though groups did not significantly differ for the latter ($X^2=0.73$, $df=1$, $p=.393$).

For stimulant drugs, cocaine/crack cocaine, used by 7.4% of the entire sample, was used during the one-year post-release period at a far higher rate by the heroin-use group (28.6% vs. 4.5%, $X^2=120.81$, $df=1$, $p<.001$), as were amphetamines (37.5% vs. 12.5%, $X^2=70.42$, $df=1$, $p<.001$), which were used by 15.2% of the entire sample. For opioid drugs, prescription opioids, used by 14.3% of the entire sample, were used by the heroin-use group during the one-year post-release period at a rate similar to that of amphetamines (38.7%), whereas 11.3% of the non-use group reported prescription opioid use during this time period ($X^2=89.57$, $df=1$, $p<.001$). Sample-wide, buprenorphine was used during the one-year post-release period by 9.4% of participants, nearly the same proportion that reported heroin use for this same

time period. Among the heroin-use group, however, 33.3% reported past-year buprenorphine use, nearly five times that of the non-use group (6.5%, $X^2=123.36$, $df=1$, $p<.001$).

Central Appalachia, Urban Influence, and Access to Alcohol

The heroin-use group had a smaller proportion of participants who resided in Central Appalachia for the majority of time during the one-year period subsequent to incarceration (17.3% vs. 31.9%, $X^2=15.21$, $df=1$, $p<.001$). Accordingly, the mean urban influence designation for the heroin-use group was lower, indicating greater urban and metro area influence, compared to the non-use group (2.7 vs. 4.7, $p<.001$). Accordingly, the heroin-use group had a higher proportion of participants residing in a county with unrestricted alcohol sales (74.4% vs. 54.4%, $X^2=23.6$, $df=1$, $p<.001$), as urban and metro areas have overall fewer alcohol prohibitions.

Binary Logistic Regression Results for Heroin Use Subsequent to Incarceration

Tables 7.0 and 7.1 display the results of the binary logistic regression models examining heroin use (versus “other/no drug use”) for one-year period subsequent to incarceration. Variables considered as control variables and independent variables (as opposed to variables used for description only) which differed significantly by group in bivariate analyses were included into the regression models. Due to the overall number of variables which differed significantly by group, two separate models were used to examine the outcome, so as to avoid model overfitting. The first model examined factors correlated with heroin use that occurred during the one-year post-release period along with drug use that occurred during the 30-day period prior to incarceration. A second model examined the relationship between heroin and other drugs used during the one-year post-release period in order to identify what other drugs were significantly associated with a change in the probability that heroin use would be observed.

As displayed in Table 6.0, participants who reported heroin use for the one-year period subsequent to incarceration were more likely to be White (AOR=4.84, $p<.001$). They were also more likely to have spent a greater number of nights in a controlled environment since their release (AOR=1.00, $p=.005$) and to be younger (AOR=0.96, $p=.002$). Though past-year depressive symptoms were not associated with increased odds of observing past-year heroin use (AOR=1.42, $p=.089$), past-year suicidal ideation was (AOR=2.55, $p=.017$). Receiving satisfaction from past-year social interaction was also associated with a slight, but significant, decreased likelihood of past-year heroin use (AOR=0.42, $p<.001$). Among drugs

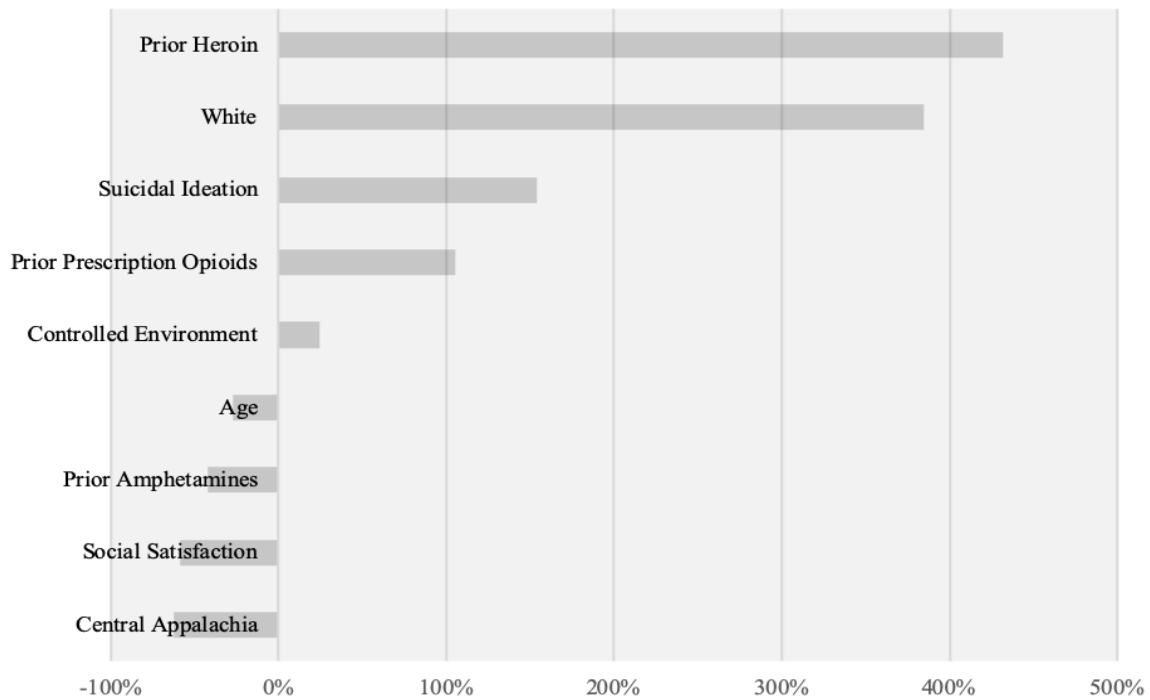
used during the 30-day period prior to incarceration, amphetamines (AOR=0.58, p=.008), heroin (AOR=5.32, p<.001), and prescription opioids (AOR=2.05, p=.002) were all associated with an increased likelihood that heroin use would be observed for the one-year period subsequent to incarceration, whereas use of prescription sedatives (AOR=0.95, p=.812), cocaine/crack cocaine (AOR=1.43, p=0.80), and buprenorphine (AOR=0.72, p=.154) prior to incarceration were not. Residing in Central Appalachia for the majority of time during the one-year post-release period was associated with a decreased likelihood of past-year heroin use (AOR=0.38, p<.001).

Table 6.0
Results from Binary Logistic Regression Examining Heroin Use for the One-year Post-release Period

	Robust SE	95% CI	AOR	p value
White	2.177	2.00-11.06	4.84	.001
Nights spent in controlled environment	0.001	1.00-1.01	1.00	.005
Lifetime drug treatment episodes	0.022	0.98-1.06	1.02	.285
Ever IDU	0.296	0.87-2.07	1.34	.180
Age	0.011	0.94-0.99	0.96	.002
Past-year depressive symptoms	0.290	0.95-2.11	1.42	.089
Past-year suicidal ideation	0.996	1.17-5.42	2.55	.017
Social satisfaction	0.101	0.25-0.67	0.42	.001
Perceived social worth	0.175	0.36-1.08	0.62	.096
Age of drug use initiation	0.022	0.95-1.04	0.99	.903
Abstinence self-efficacy prior to treatment	0.192	0.60-1.37	0.90	.654
<i>30-day drug use prior to incarceration</i>				
Prescription sedatives	0.203	0.62-1.44	0.95	.812
Cocaine/crack cocaine	0.297	0.96-2.15	1.43	.080
Amphetamines	0.121	0.38-0.87	0.58	.008
Heroin	1.191	3.54-8.25	5.32	.001
Prescription opioids	0.468	1.31-3.21	2.05	.002
Buprenorphine	0.168	0.46-1.13	0.72	.154
Central Appalachia	0.091	0.24-0.60	0.38	.001
Intercept-only: -533.336/Model: -405.742	Pseudo R ² = 0.239			
Wald Chi2 (df=18) 220.306	Cox-Snell/ML= 0.151			
Hosmer-Lemeshow Chi2=2.39, p=0.966	Cragg-Uhler/Nagelkerke=0.305			

Figure 19 displays the percent change in odds for independent variables significantly associated with changes in the likelihood of observing heroin use during the one-year period subsequent to incarceration.

Figure 19. Percent change in odds for heroin use during the one-year post-release period.



Heroin use during the 30-day period prior to incarceration increased the odds of observing past-year heroin use for the one-year period subsequent to incarceration by 432.1%. Being White increased the likelihood of past-year heroin use by 384.4%. Past-year suicidal ideation increased the odds of observing past-year heroin use by 154.2%. Use of prescription opioids prior to incarceration increased the odds of past-year heroin use subsequent to incarceration by 105.3%. For every SD increase for nights spent in a controlled environment ($SD=77.7$) the odds of observing past-year heroin use increased by 24.2%, just 0.4% for each night. The likelihood of observing past-year heroin use decreased by 27.0% for every SD increase in age ($SD=9.1$); an approximate 3.4% decrease for every year increase. Amphetamine use during the 30-day period prior to incarceration decreased the likelihood of observing heroin-use subsequent to incarceration by 42.4%. Receiving satisfaction from past-year social interaction decreased the likelihood by 58.7%. Finally, residing in Central Appalachia for the majority of the one-year period subsequent to incarceration decreased the likelihood of heroin use by 62.2%.

Results of the second model are displayed in Table 6.1. Prescription sedatives (AOR=1.82, $p=.043$), cocaine/crack cocaine (AOR=5.70, $p<.001$), amphetamines (AOR=1.71, $p=.029$), prescription

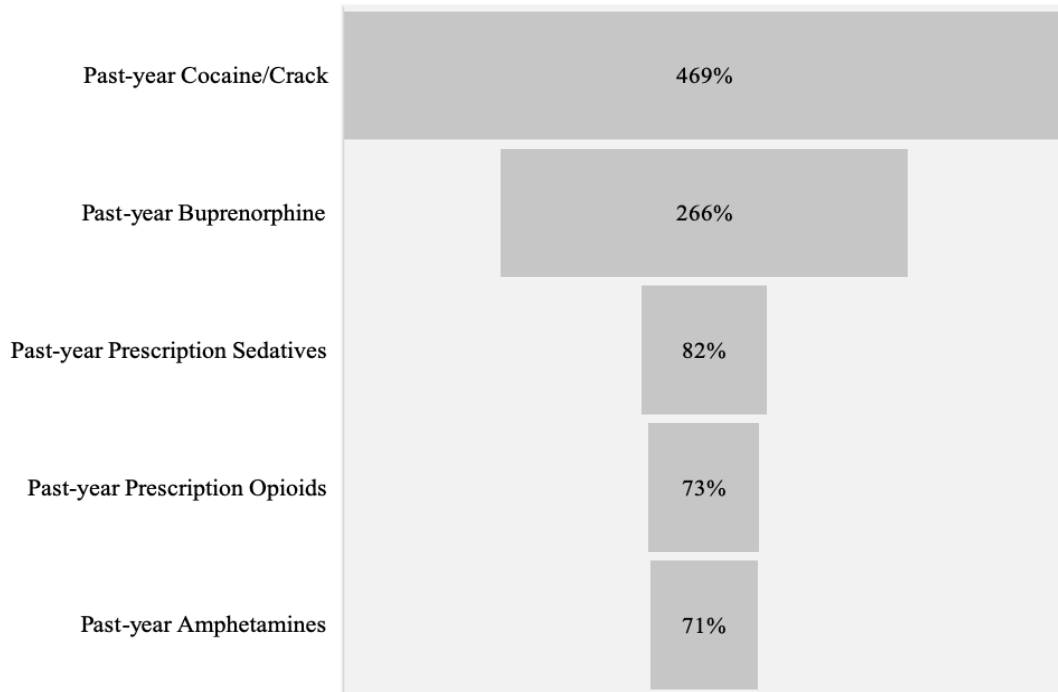
opioids (AOR=1.72, p=.030), and buprenorphine (AOR=3.66, p<.001) used during the one-year period subsequent to incarceration were all associated with an increased likelihood of heroin use for this same time period. Alcohol (AOR=0.85, p=.446), cannabis (AOR=1.40, p=.119), and hallucinogens (AOR=1.61, p=.397) used during the one-year period prior to incarceration did not significantly influence the likelihood of past-year heroin use.

Table 6.1
Results of Binary Logistic Regression Examining Past-year Other Drug use and Past-year Heroin Use During One-year Post-release Period

	Robust SE	95% CI	AOR	p value
Alcohol	0.179	0.56-1.28	0.85	.446
Cannabis	0.302	0.92-2.13	1.40	.119
Prescription sedatives	0.540	1.01-3.22	1.82	.043
Hallucinogens	0.908	0.53-4.66	1.61	.397
Cocaine/crack cocaine	1.44	3.48-9.34	5.70	.001
Amphetamines	0.421	1.06-2.76	1.71	.029
Prescription opioids	0.431	1.06-2.81	1.72	.030
Buprenorphine	0.907	2.25-5.91	3.66	.001
Intercept-only: -533.336/Model: -436.689		Pseudo R ² = 0.181		
Wald Chi2 (df=8) 189.581		Cox-Snell/ML= 0.116		
Hosmer-Lemeshow Chi2=15.56, p=0.082		Cragg-Uhler/Nagelkerke=0.235		

Figure 20 displays the percent change in odds for drugs used during the one-year period subsequent to incarceration significantly associated with changes in the likelihood of observing heroin use during the same time period.

Figure 20. Percent change in odds for heroin use during the one-year post-release period by co-used drug.



For all drugs used during the one-year period subsequent to incarceration associated with a change in odds for past-year heroin use, past-year cocaine/crack cocaine use showed the most influence, increasing the odds that heroin use would be observed by 469.1%. This was followed by past-year buprenorphine use, associated with 265.9% increased odds of observing past-year heroin use. Past-year prescription sedative use increased the likelihood of observing past-year heroin use by 82.3%, whereas past-year prescription opioid use increased the likelihood by of 72.9% and past-year amphetamine use increased the likelihood by 70.9%.

CHAPTER V

DISCUSSION

The use of high-risk drugs, such as opioids and stimulants, constitutes a significant economic, social, legal, and medical problem in the US (Degenhardt et al., 2014; Schuchat, Houry, & Guy, 2017; Volkow & Collins, 2017). Kentucky is a state that continues to experience high rates of opioid and stimulant use and related problems, and is also a state that incarcerates a disproportionate number of people who use opioids and stimulants (CDC 2017a, CDCb; Faryar et al. 2017; Prison Policy Initiative, 2018). It is important to better understand decisions to use high-risk drugs among corrections-involved people in Kentucky, in part because the adverse consequences of continued use for this population can be extreme (e.g., becoming reincarcerated, increased odds of overdose following release from correctional custody) (Merrall et al. 2010).

Accordingly, this study's primary aim was to explore the social problem of high-risk drug use among a sample of corrections-involved adults in Kentucky and to identify and discuss endogenous and exogenous factors with the potential to have influenced drug-related decision-making prior and subsequent to incarceration. This was accomplished with three specific study aims. First, using self-report data, a descriptive profile of a sample of corrections-involved adults in Kentucky with a history of drug use was provided. The prevalence of concomitant opioid/stimulant use, opioid use, stimulant use, and other and/or no drug use during the 30-day period prior to incarceration and the one-year period subsequent to incarceration was determined. A description of these drug use outcome groups was presented, and differences between groups was determined. Differences in the use of specific opioid and stimulant drugs (e.g., heroin, prescription opioids, buprenorphine, cocaine/crack cocaine, and amphetamines) by participant

residence across an urban-rural continuum and by participant residence within or outside of Central Appalachia were also established. Second, factors associated with a change in likelihood of observing concomitant use, opioid use, and stimulant use during the 30-day period prior to incarceration and the one-year period subsequent to incarceration, compared to an outcome with less risk (e.g., other/no drug use), were identified. Third, the prevalence of heroin use that occurred during the one-year period subsequent to incarceration was determined and the between-group differences among participants who reported heroin use and those who did not were identified. Factors associated with a change in the likelihood that heroin use would be observed were also identified.

Behavioral economics, a molar view of human choice and behavior, was used in earlier chapters to first conceptualize the problem of high-risk drug use and then to help situate and better understand the problem in relation to a large and growing body of empirical research. While only a small portion of research relevant to understanding how people's decision-making and behavior can be influenced was reviewed in Chapter 2, the overview hopefully demonstrated the important point that many endogenous and exogenous factors have the ability to influence decision-making and behavior, not only in respect to high-risk drug use, but in respect to all choice and action. It also hopefully articulated the idea that while many of these factors are not always knowable, observable, or readily modeled, they are nonetheless recognizable (and worth recognizing) using a molar paradigm.

Because of the vast number of possible endogenous and exogenous factors exerting influence on human behavior, it is important to at times seek a broad understanding of specific behaviors, such as high-risk drug use, as an expansive view acknowledges the inherent complexity and dynamic nature of choice and action (Sapolsky, 2017). Opioid and stimulant use specifically are important to understand, as use of these drugs constitutes a threat to both the people using them as well as to those around them. That opioid and stimulant use simultaneously represents the potential for pleasure and pain, and that only a small fraction of people will ever in their lifetimes pursue such risky choice, suggests the possibility that certain unique factors present among high-risk drug users, and among corrections-involved drug users in particular, are influencing decision-making and behavior. Why and how people choose to do something that they know is potentially detrimental, and then continue to choose it even after experiencing adverse outcomes, are important empirical questions generally. It is necessary, though, to explore this phenomenon

both conceptually and empirically; the latter helping to guide empirical exploration, and the former helping to refine conceptualizations of choice and behavior within a system of constraint. This chapter seeks to achieve limited accomplishment of this in respect to study findings in several ways.

First, by revisiting the puzzling phenomenon of high-risk drug use, with attention paid to how participants might continue to choose to use opioids and stimulants even after problems related to using have become apparent. In earlier chapters, the conflict that can arise between a person during intertemporal choice was discussed along with the idea that people can have time-inconsistent preferences (Shane, Loewenstein, & O'Donoghue, 2002). Also discussed was how a person can want, and choose, what they don't actually like, and which does not produce experienced utility (Berreidge & O'Doherty 2014). People can also prefer a particular outcome, but then act in a discordant manner by choosing to undertake a behavior that will bring about its opposite. Recall that while drugs have a high local utility, their repeated use over time decreases their overall utility (Herrnstein & Prelec, 1992). A person might prefer to not get arrested, overdose, or become dependent on heroin, yet may still repeatedly decide to use heroin due to its high local utility, thus increasing the probability that such unwelcome outcomes will occur. These ideas will be briefly revisited using information self-reported by participants as an example. This will be followed by considering how drug-related decision-making prior and subsequent to incarceration may differ. Not all people who use opioids and stimulants experience adverse outcomes, and certainly do not all experience an outcome as extreme or adverse as incarceration; however, many in this sample did. This makes the phenomenon of incarceration itself a point of interest. Among participants in this sample, it reflects time spent in a controlled environment between two periods of decision-making for which self-report information was available for examination.

Second, several key study findings will be discussed, giving attention to some of the ways that they relate to a behavioral economic account of choice and behavior. Of the many findings presented in Chapter 4, those most illustrative of the concepts described in earlier chapters will be discussed. It will hopefully be made clear by the nature of the discussion that all findings, that is, all factors identified and explored in this study as having the potential to influence drug-related decision-making and high-risk drug use, are important--as are many other factors not explored as part of this study. An omission of a particular study finding is not meant to suggest its irrelevance or unimportance. As this is an exploratory study,

priority will be given to highlighting broad take-aways from study findings. In the examples that follow, it will be apparent that all factors with the potential to influence decision-making and the complex behavior of high-risk drug use are potentially relevant, even if it is impractical to enumerate, and impossible to measure, all such influences. Referring back to Figure 1 provides the “big picture” view that is of interest and which is applicable to study findings. For findings not specifically discussed, or not discussed at a length equal to others, the idea of choice and behavior as operating within a system of constraint can still be applied. The broader take-away when this conceptual framework is applied to any or all findings is unchanged; a testimony to its parsimony and flexibility. A summary of future directions, limitations, and concluding thoughts will be presented at the chapter’s end.

Some Potential Differences in Drug-related Decision-making Prior and Subsequent to Incarceration

As described earlier, the many endogenous and exogenous factors of a person’s life comprise part of the system of constraint within which they make decisions and behave (Bickel et al., 2014; 2016). These factors influence people’s cognition, choice, and capacity for action. Better recognition of these factors can help make sense of decisions to use opioids and stimulants despite known risks, and decisions to continue using despite adverse consequences. It can also be extended to help make sense of why use could continue despite a person’s desire or intention to stop. People who choose to undertake the steps necessary to acquire and self-administer drugs with the potential to kill them are an extreme example of how choice and behavior can be influenced in profound and counterintuitive ways. This is most poignant when a person at one moment desires to use opioids and then undertakes the actions required to use them, while a moment before desired not to use opioids and may have even resolved not to use them, indicating that people, their preferences, and their intentions are not necessarily consistent over time, or even within the same moment of time (Ainslie, 2001; Bratmann, 1999; Mann, 2004; Melrose et al., 2015; Monterosso & Lou, 2010; O’Donoghue & Rabin, 1999). In part, self-control conflict involves tension between preference at different scales, the molecular (e.g., desire for crack cocaine right now) and the molar (e.g., desire not to be addicted to crack cocaine) (Rachlin, 1995).

This idea may be applicable to some participants in this sample and indirectly reflected among some survey responses. For instance, some participants made a decision to use opioids or stimulants subsequent to incarceration, but may have, during their incarceration, contemplated doing otherwise.

Examination of some of the constituent elements of the “drug use severity” variable used in this study may be illustrative. Some of its specific qualities are considered here for the purposes of thinking about how discrepancies in utility, or preference, can occur between a person’s current and future self. For instance, the majority of participants who reported using opioids (74.2%) and stimulants (70.3%) during the one-year period subsequent to incarceration also reported being “moderately, considerably, or extremely troubled or bothered” by their drug use during the 30-day period prior to incarceration.

Further, a majority of participants who reported using opioids (95.8%) and stimulants (94.9%) during the one-year period subsequent to incarceration also reported believing that receiving drug treatment for their drug problems was “moderately, considerably, or extremely important to them” at the time of treatment intake, which occurred weeks, months, and in some cases, years after their arrest. This means that participants had some time since their last period of regular using to possibly consider whether receiving drug treatment was a low or high priority. When answering this question, participants were presumably not intoxicated, nor were they presumably at their drug-using nadir--in a state of withdrawal or acute crisis common among regular opioid and stimulant users. In other words, a response to this question was likely provided during a period of relative stability. If responses are considered valid, it means that >70% participants who later used opioids and stimulants felt at these earlier times not only bothered by their drug problems, but also felt that receiving drug treatment was important in helping them address these problems. For the latter, rates were significantly higher among participants who reported opioid and stimulant use subsequent to incarceration, compared to those who reported other drug or no drug use ($p < .05$; results not displayed). Thus, despite acknowledgment of drug problems, despite an articulated belief that drug treatment was important, and despite receiving severe consequences as a result of drug use, opioid and stimulant use continued.

That people who once used opioids and stimulants experienced adverse consequences as a result of use, expressed some interest in treatment, participated in treatment, and then subsequently chose to use opioids and stimulants, is not shocking. Rates of lapses and relapses subsequent to a variety of drug interventions or after periods of abstinence are well documented (Dodge, Sindelar, & Sinha, 2005; McLellan, Lewis, O'Brien, & Kleber, 2000; Sinha, 2001). Indeed, the conceptualization of drug addiction as a chronic condition or “disease” relies in part on the fact that many people who once misused opioids and

stimulants go on to use them again even after intervention of periods of abstinence (Denis & Scott, 2007; McLellan, et al., 2000).

There is, of course, no way to know whether participants who used opioids and stimulants both prior and subsequent to incarceration at any point developed in the interim a desire or intention to not use these drugs, but it is possible that many at some point did. It is possible for two reasons. First, participants who used opioids and stimulants during the one-year period subsequent to incarceration experienced 16 days of drug-related problems on average during the 30-day period prior to incarceration. These problems included craving, withdrawal, and a *desire* but inability to quit using. It is possible that during this time period in which some very frustrating and painful symptoms were frequently occurring that an intention to modulate or discontinue use was formed by at least some portion of participants; though there are insufficient data to clearly support this proposition. This possibility is nonetheless noted to raise the point that people are capable of deciding to engage in a behavior that they previously indicated was problematic for them and after experiencing significant consequences, reflective of time-inconsistent preferences and the diachronic model of conflict (DiClemente, 2018; Melrose et al., 2015). Second, this 30-day period when frequent drug-related problems occurred climaxed with incarceration, which is itself comprised of multiple humiliations and punishments and involved, for participants in this sample, a period of confinement lasting many months or longer. This means that there were many occasions for these participants to possibly consider some of the benefits of not using opioids and stimulants upon release and, possibly, of developing some desire or intention not to use following release. Yet, many still used. Trying to better understand desire and intention related to high-risk drug use among people with history of high-risk drug use will be important to explore in future work concerned with drug-related decision-making.

Incarceration and Community Supervision

The possibility that cognition and behavior in respect to opioids and stimulants was influenced by incarceration and treatment makes exploring high-risk drug use among this sample interesting, as there is a demarcation (pre- and post-incarceration) between two periods of decision-making. These periods are distinctive in several ways. For example, participants could have been influenced to use or not use following a period of incarceration by a variety of factors that could have materialized as part of the incarceration experience itself. On the one hand, these might include generally stabilizing experiences, such

as rebuilding relationships with family members, receiving treatment, engaging in spiritual, religious, or mutual-aid programs, exercising, developing a routine, etc. (Buckaloo, Krug, & Nelson, 2009; Freudenberg, Wilets, Greene, & Richie, 1998; Stringer, 2009; Tasca, Mulvey, & Rodriguez, 2016). On the other hand, they could include experiences such as sexual and physical violence, social isolation, family estrangement, and overall decreased psychological health due to jail and prison conditions (Alarid, 2000; Bonner & Rich, 1990; Brinkley-Rubinstein, 2013; Kaba et al., 2014; Rokach, 1997). This study was not concerned with investigating highly personal and varied experiences that might influence a person's overall cognitive health prior to re-entry, though they warrant investigation. Rather, the idea that incarceration may have influenced later decision-making about opioids and stimulants is noted because it applies to findings for the post-incarceration period when considered using a molar paradigm, such as behavioral economics.

First, by having experienced the adverse outcome of incarceration as a direct or indirect result of use and by being under DOC supervision upon release, participants may have been influenced to modify their behavior so as to reduce the likelihood of their experiencing incarceration again. Experienced punishment and the threat of additional punishment could have influenced decision-making about opioids and stimulants subsequent to incarceration in several ways. For instance, whereas prior to incarceration the risks associated with opioid and stimulant use may have only been considered in terms of outcome uncertainty in the abstract--the known *potential* for adverse outcomes with contingent future states discounted as a function of time or probability (or both)--subsequent to incarceration, risks associated with opioid and stimulant use could have been partially reflected upon in terms of *experienced* adverse outcomes (Bickel et al., 2007; Rachlin, Raineri, & Cross, 1991; Vuchinich & Simpson, 1998). Future states would still be abstract and uncertain, and therefore have the potential to be discounted as a function of time and probability, but the salience associated with the experience of adverse outcomes from opioid and stimulant (and their memories) might have served as a behaviorally motivating influence on decision-making subsequent to incarceration for some, but certainly not all, participants (Blair, Morton, Leonard, & Blair, 2006; He, Cassaday, Howard, Khalifa, & Bonardi, 2011; Newman, 1987). Just as reward can facilitate learning and reinforce behavior, so too can punishment; fear of threat and anticipation of reward both involve memory, outcome expectations, prospection, etc. (Bohnert et al., 2018; Herry & Johansen, 2014; Sigurdsson, Doyère, Cain, & LeDoux, 2007). For example, having overdosed once or having been arrested

once, a person would develop a clearer understanding and appreciation of what the possible future outcome of overdose or arrest entail (Warner-Smith, Darke, & Day, 2002). However, people who experience adverse events related to drugs may differ in terms of how future behaviors are influenced by past experiences, as threat (of punishment) detection, fear processing, and risk-aversion may differ across people, drug use histories, and contexts (Hoppenbrouwers, Bulten, & Brazil, 2016; McGregor, Darke, Ali, & Christie, 1998; Wood & Anagnostaras, 2009). Relevant, too, is that some memories associated with drug pleasure may also be highly salient (Stacy, Ames, Wiers, & Krank, 2010). There is no way to know which may have been more influential at any given moment subsequent to incarceration: memories of drug-related pleasure or memories of drug-related pain; and, likewise, prospection about possible future drug-related reward or prospection about possible future drug-related punishment.

Community supervision following release, which includes drug monitoring and the threat of sanctions, may have served as one specific influence on decision-making and behavior (Burdon, Roll, Prendergast, & Rawson, 2001; Franken et al., 2003; Marlowe & Wong, 2008). However, while rates of being on community supervision subsequent to incarceration differed by drug use outcome group, differences were <10%; not substantial. Further, a greater proportion of participants who reported concomitant and stimulant use subsequent to incarceration were on community supervision, meaning that being on probation/parole did not necessarily influence a decision not to use or to use less dangerous drugs in all instances. This is evidenced further by the fact that being on community supervision was associated with an 89% increase in odds that concomitant use would be observed.

Experiencing incarceration and being on community supervision may partially explain why rates of opioid and stimulant use subsequent to incarceration decreased from rates of use prior to incarceration, but it does less to explain why use would continue. It is possible that participants on community supervision who chose to use may have discounted future outcomes not only as a function of time, but also probability (Rachlin, 2006; Rachlin et al., 1991). While some interaction with a probation or parole officer while on community supervision is an eventuality, the particulars of those interactions, such as the frequency of drug monitoring, are often irregular. One potential appeal of opioids and stimulants is that their metabolites are cleared from the body fairly rapidly, depending on the person's age, weight, dosing, and drug type, meaning that it is possible that a portion of participants who used these drugs while on

community supervision did so with an expectation that they would be able to avoid detection via drug monitoring (Moeller, Kissack, Atayee, & Lee, 2017). The purposeful selection of drugs while on community supervision as a means of circumnavigating drug monitoring has been documented elsewhere (Smith & Stoops, 2019, Smith & Staton, 2019).

Second, having spent time in a controlled correctional facility means that participants went from an environment where there were few restrictions to accessing drugs to a facility where access to drugs was significantly restricted. Even if it cannot be assumed that the facilities that participants resided in were 100% drug-free 100% of the time, it can be assumed that the accessibility of alcohol and illicit drugs was still significantly less than the accessibility of alcohol and illicit drugs in the free world. This means that for many in this sample opioid and stimulant use either stopped or decreased significantly during their incarceration. Even if use only became irregular, rather than ceasing entirely, it still means that the frequent and regular use of drugs, characteristic of the 30-day period prior to incarceration, was moderated. This is relevant insofar as a period of intermittent use or complete abstinence, would have permitted the opportunity for some *modest and heterogenic*, but nevertheless potentially important, neurobiological and behavioral changes (Galinato et al., 2018; Hollander & Carelli, 2005; Pitel et al., 2009; Schulte et al., 2014; Volkow et al., 2001).

There would have also likely been fewer drug-related cues in jail or prison capable of producing a conditioned-response, compared to places where participants spent time prior to incarceration, meaning that attention would be directed less frequently to drug stimuli. Even if participants' attention was still largely pre-occupied with drugs during incarceration, by virtue of just thinking about drugs, these cognitions would not have had behavioral traction in most cases due to the decreased drug availability. Thus, for this sample, drug-related decision-making subsequent to incarceration could not have been undertaken with the exact same set of endogenous factors (i.e., not the same brain) that drug-related decision-making prior to incarceration was undertaken with. However subtle and ambiguous the changes were, there was still some change. This is important, because it means that at the time of participants' release, drug-related visceral states, cognitions, and behavioral patterns would have been different than at the time of arrest. Put differently, their cognitive capacities would be, holding other factors constant, less constrained than they were prior to incarceration. Although a participant's regular cocaine use prior to incarceration would still have the

potential to bias them toward a decision to use cocaine subsequent to incarceration, this prior regular cocaine use would not necessarily be influencing decision-making subsequent to incarceration in the same manner or to the same degree as it did prior to incarceration. Consider how decision-making about cocaine might look for a person who had used cocaine every day for the past month compared to the same person who used cocaine for 30 days one year and one month ago. It is easy to envision how more or less constrained a person would be in their decision-making about cocaine between these two time periods. That prior decisions to use can still bias a person toward future use of the same drug is reflected in the findings that use of specific opioids and stimulants prior to incarceration increased the likelihood of the same, or similar, drug use subsequent to incarceration. But that many participants also did not use subsequent to incarceration reflects the possibility that they were potentially less constrained in their drug-related decision-making than they had been during the 30-day period prior to incarceration. These ideas will be described in more detail below.

Upon re-entering the community, participants would have become exposed to significantly more actionable choices than they were while incarcerated. Greater access to drugs is, unsurprisingly, associated with greater likelihood of use and continued use. The mere knowledge that opioids and stimulants are again accessible would have been another factor with the potential to influence participants' visceral, affective, and cognitive states subsequent to incarceration, including those associated with craving, which can be a profound influence on drug decision-making and behavior (Badger et al., 2007; Berridge & O'Doherty, 2014; Paliwal, Hyman, & Sinha, 2008; Robinson & Berridge, 1993; Tiffany, Warthen, & Goedeker, 2008; Tsui, et al., 2016). Although access to rewarding non-drug choices would also have increased significantly upon reentry, not all participants would have had equitable access to the same types of non-drug alternatives. Ultimately, the context into which participants were released would have had significant influence on decisions to use and to continue using (Marlatt, 1996).

Lastly, and perhaps most importantly, because reentry into the community following incarceration involves significant transition across all aspects of daily living means that it is likely that some participants experienced stress following their release (Bahr, Armstrong, Gibbs, Harris, & Fisher, 2005; Phillips & Lindsay, 2011; Shiviy et al., 2007). Stress is toxic for higher-level cognitive functioning, such as deliberative decision-making, planning, prospection, and inhibition, meaning that participants may have

been generally less capable of engaging in adaptive decision-making in relation to drugs during this period of transition and possible stress (Kosten & George, 2002; Weiss, 2005; McEwen, 2006; McEwen & Sapolsky, 1995). That reentry-related stress or other daily life challenges would have occurred contemporaneous with a significant increase in potential exposure to drug-related cues suggests that community reentry should be considered a time period of heightened risk, insofar as stress + drug-related cue exposure is associated with craving and drug use among abstinent and current drug users (Fox, Bergquist, Hong, & Sinha, 2007; Hyman, Fox, Hong, Doebrick, & Sinha, 2007; Phillips & Lindsay, 2011; Sinha, Catapano, & O'Malley, 1999). Among participants who prefer opioids, a return to opioid use following a period of decreased use or abstinence would have the potential to be life-threatening, due to diminished tolerance, meaning that risk among this group may be greatest (Davidson, Wagner, Tokar, & Scholar, 2019).

Drug-related Influences on Decision-making

A person's ability to make decisions that maximize overall utility are, even in the best of circumstances, not superb. People are generally biased toward the present more so than the future and can have time-inconsistent preferences (Loewenstein & Prelec, 1993; Monterosso & Lou, 2010). Certain endogenous and exogenous conditions can hinder decision-making capacities further, by either influencing cognition and executive function and/or by restricting available choices and opportunities (Bickel et al., 2014). For participants in this sample with a history of opioid and stimulant use, the capacity for making decisions that maximize overall utility, instead of repeatedly selecting choices with higher local utility, but greater cost or risk, may be diminished compared to people without a history of such drug use (Badiani et al. 2011; Heil et al., 2006; Kirby & Petry, 2004; Kirby, Petry, & Bickel, 1999; Petry, 2001; Petry et al., 1998; Reynolds, 2006; Rogers et al., 1999). This may be partially due to the presence of certain factors that may have pre-dated opioid and stimulant use, and which are found disproportionately among people who elect to use opioids and stimulants, or due to characteristics and states that developed as a result of opioid and stimulant use (Badiani et al. 2011; Petry, 2001; Potvin et al., 2018; Verdejo-García, et al., 2008). In either case, there is an implication that all participants who used opioids and stimulants during their lifetime may have been less able to engage in adaptive decision-making compared to people without such history.

The rates of opioid and stimulant use during the year prior to incarceration among this sample indicate fairly regular use. Although it is possible that participants who used opioids and stimulants during the 30-day period prior to incarceration did so regularly, but in a controlled manner not suggestive of disordered use, it is not likely, given the high rates of drug use severity, IDU history, and having been intoxicated during the commission of a crime. Overall, evidence suggests that the high rates of opioid and stimulant use during the one-year period prior to incarceration, and any use prior to that, would have served to influence participants' decision-making capacities in respect to these drugs during the 30-day period prior to incarceration, insofar as neurocognitive changes associated with regular opioid and stimulant use correspond to impairments in impulse control, future-oriented cognition and behavior, metacognition, and working memory capacity, among other things (Bechara, 2005; Nichols & Wilson, 2015; Koob & Volkow, 2010). Recall that a behavioral economic account of drug use and addiction describes changes in the person as a result of drug use over time, as well as changes in available choices as a result of drug use over time, with the person's overall set of motivations informing the development and perpetuation of use (Bickel et al., 2011, 2014). While a person's brain changes as a result of regular using, so too does their economic situation, their social standing, their health, the quality of their relationships, and their priorities, preferences, and goals, etc., all of which, in turn, change their brain, cognition, and behavior still further (Adolphs, 1999; Cacioppo & Hawkley, 2009; Fiske & Taylor, 2013; Volkow, Baler, & Goldstein, 2011). These neurocognitive and social conditions, some more long-lasting than others, can have profound effects, including altering how drug and non-drug choices are perceived, valued, and acted upon (Heilig et al., 2016; Kosten & George, 2002).

During the 30-day period prior to incarceration, participants, by virtue of their prior regular use, may have already reached the point where opioids and stimulants were significantly overvalued and non-drug choices, which would have likely already declined in number and quality for many, were significantly undervalued; this imbalance would have helped to further reinforce continued decisions to use (Bickel et al., 2001). Crucially, too, the very type of cognitive capacities (e.g., flexibly, ability for abstract, counterfactual, or prospective thinking, top-down cortical control to inhibit reflexive or habituated responding) that participants would have most needed to "do otherwise" would have been either more diminished or impaired during the 30-day period prior to incarceration than at earlier times, due to the fact

that opioids and stimulants had, by that point, been used over a longer period of time and used fairly recently (Di Sclafani, Tolou-Shams, Price, & Fein, 2002; Jovanovski, Erb, Zakzanis, 2005; Potvin et al., 2018; Verdejo-García, 2011; Verdejo-García, Bechara, Recknor, & Perez-Garcia, 2006).

One possible result of regular opioid and stimulant use in the months leading up the 30-day period prior to incarceration is that degrees of freedom for the development of preference, intention, choice, and action would have decreased, rather than increased or remained in a state of equipoise, due to neurophysiological and psychosocial changes that developed as a result of continued drug taking (Bratman, 1999; Brower, Guilfooy, 2004; Dennett, 2015; Mann, 2004; O'Connor, 2009; Volkow & Li, 2004). In this way, there would have been fewer mechanisms by which participants could have overridden the many conditions biasing them toward continued decisions to use during that 30-day period. These mechanisms might be cognitive, but they may also consist of resources and other tools external to the person that became degraded after a period of regular use (e.g., decrease in the number of avenues for pursuing non-drug opportunities, decrease in amount of available help or support) (Peirce et al., 2000; Skinner, Feather, Freeman, & Roche, 2007). This means, in part, that the opportunity costs associated with continued use may have been fewer, the non-drug options slimmer, and understanding and assistance from others limited or difficult to access (Ahmed, 2013; Bickel et al., 2014).

Participants who used opioids and stimulants during the 30-day period prior to incarceration who had a history of opioid and stimulant use can be considered to have already been at a disadvantage by the time they reached this point, in that their past use was likely exerting some influence on decision-making and behavior in relation to opioids and stimulants, and through whatever conditions of their lives were shaped as a result of prior using. This would have occurred to greater or lesser degrees depending on the nature of their respective past-year or lifetime using history. Because participants' lifetime drug use history could not be examined as part of this exploratory study, due to the fact such data were not collected as part of the SAP clinical assessment and the CJKTOS evaluation, there are many limits to understanding the degree to which participants may have been influenced in their decision-making about opioids and stimulants. However, several pieces of information related to participants' drug use history were able to be examined. These may help to further contextualize decisions about opioids and stimulants that were made prior and subsequent to incarceration.

Prior Drug Use

Rates of drug use decreased between the one-year period prior to incarceration, the 30-day period prior to incarceration, and again between the 30-day period prior to incarceration and the one-year period subsequent to incarceration.¹⁰ Considered together, these basic findings convey several possibilities. For one, prior exposure to a drug does not guarantee continued use, but rather may only confer increased likelihood of use compared to people who have never previously used these drugs. This is evidenced by the fact that rates of use decreased over time, but did not decrease to zero. Some participants who used an opioid during the year prior to incarceration did not use an opioid during the 30 days prior to incarceration; fewer still used opioids and stimulants subsequent to incarceration. Thus, a history of use, while informative, is not a marker of some later fate. Other factors besides prior opioid and stimulant use may have also influenced the likelihood that participants would decide to use these drugs subsequent to incarceration, as will be discussed below in subsequent sections.

Differences were found, though, between participants who reported concomitant, opioid, and stimulant use during the 30 days prior to incarceration for the number of months out of the year prior to incarceration that specific opioid and stimulant drugs were used. For example, participants who reported past 30-day concomitant use or past 30-day opioid use reported using heroin, prescription opioids, and buprenorphine more months on average during the year prior to incarceration compared to past 30-day stimulant users, even though the latter group did report some, albeit less, opioid use during this same one-year period. Heroin was the only opioid drug that wasn't used during the one-year period prior to incarceration among participants who reported stimulant use during the 30 days prior to incarceration. As was anticipated, participants who reported past 30-day concomitant use prior to incarceration used opioids and stimulants, and several other drugs, at higher rates, and for more months on average, than the other

¹⁰ During the one-year period prior to incarceration 37.0% of participants reported concomitant use, and for the 30-day period prior to incarceration 29.0% reported concomitant use; for the one-year period subsequent to incarceration 11.9% reported concomitant use. For the one-year period prior to incarceration, 63.7% of participants reported using opioids, and for the 30-day period prior to incarceration, 28.5% used opioids; for the one-year subsequent to incarceration 12.5% reported using opioids. For the one-year period prior to incarceration 56.7% reported using stimulants, and for the 30-day period prior to incarceration 18.0% reported using stimulants; for the one-year subsequent to incarceration 8.3% reported using stimulants.

groups. The only exception was for alcohol, which was used by all groups at approximately the same rate and frequency.

During the one-year period subsequent to incarceration, a portion of participants for all drug use outcome groups reported prior use of opioids and stimulants. The post-release rates of use for opioids and stimulants disproportionately fell along pharmacological lines, though. For instance, a greater proportion of participants who reported stimulant use subsequent to incarceration reported greater stimulant use during the 30 days prior to incarceration; likewise, participants who reported opioid use subsequent to incarceration had higher rates of opioid use prior to incarceration. Between 17.9%-22.6% of participants who reported opioid use subsequent to incarceration had used cocaine or amphetamines prior incarceration, but within this same group, between 30.8%-70.8% had used heroin, prescription opioids, or buprenorphine prior to incarceration. Similarly, between 3.8%-36.2% of participants who reported stimulant use subsequent to incarceration had used heroin, prescription opioids, or buprenorphine prior incarceration, but between 30.0%-50.0% had used cocaine/crack cocaine or amphetamines prior to incarceration. In other words, groups used across drug classes, though pre-incarceration rates of use for specific opioid and stimulant drugs corresponded to participants' later use of either opioids, stimulants, or both.

Results from the regression model examining the association between drug use during the 30-day period prior to incarceration and concomitant, opioid, and stimulant use during the one-year period subsequent to incarceration further articulate these relationships. For instance, heroin use and prescription opioid use during the 30-day period prior to incarceration significantly increased the likelihood that opioids would be used subsequent to incarceration, whereas alcohol, amphetamine, and cocaine/crack cocaine use during the 30-day period prior to incarceration decreased the likelihood of later opioid use. For stimulant use during the one-year period subsequent to incarceration, the converse was observed; amphetamine and cocaine/crack cocaine use during the 30-day period prior to incarceration substantially increased the likelihood of stimulant use subsequent to incarceration, whereas heroin use during the 30-day period prior to incarceration decreased the likelihood of later stimulant use. The odds of observing concomitant use for the one-year period subsequent to incarceration did not decrease in association with prior use of any drug; rather, amphetamines, prescription opioids, heroin, and prescription sedative use during the 30-day period prior to incarceration increased the likelihood of later concomitant use. Participants who reported

concomitant use subsequent to incarceration did have the highest rates of preferring prescription sedatives prior to incarceration, even though the proportion of concomitant users with this preference was low (3.8%) compared to preferences reported for other drugs.

When examining heroin use for the one-year period subsequent to incarceration, similar findings were observed. Participants who reported heroin use subsequent to incarceration also reported having used both stimulants and opioids during the 30-day period prior to incarceration, with rates far higher for opioid drugs; the only exception being buprenorphine. For all drugs used during the 30-day period prior to incarceration, prescription opioids had the highest rates of use among participants who reported heroin use subsequent to incarceration. Heroin was the next most frequently used drug during the 30-day period prior to incarceration for this group. Approximately 11% of participants (N=158) did not report any heroin use subsequent to incarceration, but did report other opioid use. This group had lower rates of heroin, prescription opioid, and buprenorphine use during the 30-day period prior to incarceration compared to participants who used heroin subsequent to incarceration. Rates of use ranged from 13.3% for heroin, 17.9% for buprenorphine, and 48.2% for prescription opioids. This indicates that prior use of opioids did not ensure later heroin use, even as this prior use was still positively correlated with later prescription opioid or buprenorphine use.

Differences in heroin use subsequent to incarceration may be partially attributable to the frequency with which heroin and other drugs had previously been used. For instance, participants who reported using heroin subsequent to incarceration used prescription opioids 15 days on average out of the past 30 days that they were last on the street and used heroin for 13 days on average during this same time; buprenorphine was used only 3.3 days on average. Among this group, amphetamines and cocaine/crack cocaine were used at comparatively lower rates during the 30-day period prior to incarceration, but were still used at rates higher than buprenorphine. Both amphetamines and cocaine/crack cocaine were used less than a week on average during the 30-day period prior to incarceration, far less than the number of days that prescription opioids and heroin were used. Participants who did not report past-year heroin use subsequent to incarceration used prescription opioids and heroin fewer days on average during the 30-day period prior to incarceration, 10 and 2.5 days respectively. The relationship between drug use at an earlier time and later use of similar drugs was highlighted further by findings from the regression model showing that heroin use

and prescription opioid use during the 30-day period prior to incarceration significantly increased the likelihood of observing later heroin use; the relationship was strongest between heroin use prior to incarceration and heroin use subsequent to incarceration.

These findings illustrate some of the concepts discussed in earlier chapters describing how past drug use, particularly when it constituted a regular behavior, and certainly when it constituted a habituated behavior, has the capacity to influence people's ability to think and behave differently in respect to the same drugs in the future. Put simply, prior opioid and stimulant use can lead to continued or increased use (Ahmed, Walker, & Koob, 2000). While it is possible that anyone might decide to use heroin, it is far more probable that people who have previously used heroin would make such a decision. Even for drugs with extreme danger or stigma associated with them, use may become ritualized and normalized (Brown, 2015; Mars, Bourgois, Karandinos, Montero, & Ciccarone, 2014; Waldorf et al., 1992; Zinberg, 1984). That drug use subsequent to incarceration was associated with frequent use of similar drugs prior to incarceration is not surprising. Decisions and behaviors that have been previously made or preformed are easier to persist in than initiation of novel decisions and behaviors (Ronis, Yates, & Kirscht, 1989). Recall that habits can be strengthened or weakened over time, with behaviors preformed repeatedly instantiated in the brain in a manner that an infrequently preformed behavior would not be, potentially making choice and behavior cognitively "easier", particularly amidst the same or similar environmental conditions, and particularly if the behavioral outcome is highly rewarding (e.g., greater automaticity and less deliberation) (Everitt & Robbins, 2016; Gardner, 2015; Graybiel, 2008; Robbins & Everitt, 1999; Sebold et al., 2017; Wood & Runger, 2016). Conversely, decisions and behaviors that were dissimilar to previously made decisions and previously performed behaviors would require more deliberation and more effort.

Even if time spent in a controlled environment disrupted participants' ability to perform a behavior pertaining to opioids, upon release that behavior would have the potential to be resumed and would be more likely to be resumed if participants were exposed to the same or very similar environments in which they previously obtained and used opioids, and certainly more likely if they were exposed to the drugs themselves (Childress et al., 1993; Crombag, Bossert, Koya, & Shaham, 2008; de Wit, 1996). That most participants returned to the same county that they resided in prior to incarceration means that it is not only possible, but probable, that some participants were exposed to places and people which would have had the

potential to produce a conditioned-response (Childress, et al., 1993; Lee, Milton, & Everitt, 2006; Leverentz, 2010). Among participants who had regularly used opioids and stimulants, exposure to drug-related cues, both before and after incarceration, would have had the potential to influence decision-making about these drugs, in part by constraining the cognitive and behavioral repertoire with which participants might have flexibly responded (Bechara, 2005; Monti, Schoenbaum et al., 2006; Tiffany, 1999; Rohsenow, & Hutchison, 2000). Exposure to cues associated with opioids and stimulants could have influenced not only the frequency with which these drugs were thought about explicitly, meaning that greater cognitive attention is directed toward drugs, but also could have produced visceral states (e.g., craving, stress, arousal, etc.) and further biased attention to drug-related cues in the environment (Field, Munafò, & Franken, 2009; Franken, Kroon, Wiers, & Jansen, 2000; Lubman, Peters, Mogg, Bradley, & Deakin, 2000). Craving and attentional bias to drug-related cues have been shown to predict use (Franken, 2003; Marissen et al., 2005, 2006).

Visceral states, even if people are not always fully aware of their presence and are not able to articulate their exact nature or origin, may nevertheless influence mood, affect, cognition, and decision-making (Cooney, Litt, Morse, Bauer, & Gaupp, 1997; Critchley, Wiens, Rotshtein, Öhman, & Dolan, 2004; Drummond, 2001; Monteroso & Luo, 2010; Wiers, Field, & Stacy, 2016). Recall that a racing heart, sweaty palms, and queasy stomach might be as easily attributable to fear as it is to excitement or happy anticipation (Garfinkel & Critchley, 2016). Recall, too, that disruptions in somatic signaling and interoceptive awareness have been associated with drug use, meaning that it may have been difficult for some participants to have adaptively navigated somatic, affective, and cognitive states during times in which it would have been most crucial (Bechara & Damasio, 2002, de la Fuente et al., 2019; Paulus & Stewart, 2014; Sönmez, Kahyacı Kılıç, Ateş Çöl, Görgülü, & Köse, 2017). Irrespective of any disruption, interoceptive awareness, necessary for adaptive human functioning, can compel a person's attention and potentiate action, potentially exacerbating visceral sensations of craving, desire, or temptation (Naqvi, Rudrauf, Damasio, & Bechara, 2007; Turel et al. 2014; Van den Bergh et al., 2018). When interoceptive awareness is activated, top-down cognitive capacities needed for deliberation and inhibition may be weakened, while bottom-up impulses and urges may be excited, thus potentially enabling action without forethought (Noël, Brevers, & Bechara, 2013; Turel & Bechara, 2016).

In summary, opioid and stimulant drugs used with regularity prior to incarceration were associated with use of similar drugs subsequent to incarceration. During both time periods, drug-related cues in the environment, along with other stressors that may have been present, would have had the potential to influence participants' physiological, cognitive, and affective states, making higher-level cognition needed for impulse control and adaptive decision-making more challenging (Sinha et al., 2003; 2005; Snyder & Hankin, 2016; Tice et al. 2001). Some of these additional influences will be discussed further below.

Versatile Drug Use, Preference, and Drug Use Severity

Many participants in this sample can be considered as polydrug users. Drug use versatility, indicated by the total number of different drugs used during the one-year periods prior and subsequent to incarceration, was higher among participants who reported concomitant and opioid use for the 30-day period prior to incarceration and the one-year period subsequent to incarceration. Concomitant use during the 30-day period, rather than separate use of either opioids or stimulants, might lead one to intuit that the total number of drugs used for the entire one-year period prior to incarceration would be greater compared to other groups, and this was indeed the case. But this was not a foregone conclusion. Participants who reported past 30-day opioid, stimulant, or other drug use could have used alcohol, cannabis, sedatives, hallucinogens, or synthetic drugs during that year, meaning that they would have used five or more drugs. Participants who reported past 30-day concomitant use could have only used opioids and stimulants for that year, making them less versatile users by comparison. That this wasn't the case, but instead that concomitant use of two high-risk drugs was associated with overall greater drug use versatility, hints at the possibility that there is a subgroup of participants who are less discriminant in their drug selection and possibly more risk-prone.

This idea is partially supported by the finding that participants who reported concomitant use had the highest rates of drug use severity followed by participants who reported past 30-day opioid use. This means that during the 30-day period prior to incarceration, participants who co-used opioids and stimulants, or who used opioids (either alone or contemporaneously with non-stimulant drugs), more often experienced drug-related problems, craving, a desire but inability to quit using, and withdrawal. The presence of craving and withdrawal among some participants is especially significant, as these qualities indicate that

participants were possibly dependent on certain drugs, which would imply that the local utility of these drugs was high, the discount rate of future, non-drug rewards was steep, and that decision-making may have been more impulsive and less deliberative (Bickel, Koffarnus, Moody, & Wilson, 2014; Giordano et al., 2002; Mitchell, 2004; Franken, 2003).

While higher rates and greater frequency of drug use across many classes does not necessarily correspond to drug use severity in a linear way, using more drugs more often does mean that a person is exposed to the rewarding, and behaviorally reinforcing, effects of drugs with greater regularity. Participants' ability to flexibly make intertemporal decisions, particularly about higher-risk drugs, would likely be impaired with regular use of opioids, stimulants, and other drugs, but so too would their ability to make adaptive, less-risky decisions in general due to any direct effects of drug intoxication (Cromer, Cromer, Maruff, & Snyder, 2010; Gilman, Smith, Ramchandani, Momenan, & Hommer, 2012; Goldstein et al., 2009; Ramaekers et al., 2006; Rogers et al., 1999). The initial use of one drug may precipitate further drug use and, among all drugs used, those associated with the greater perceived value or preference may continue to be used at higher rates (Aharonovich et al., 2005; Greenwald, 2008). This is indirectly evidenced in this sample by the correspondence between preferred drugs and drug use outcomes, with greater preference for heroin, prescription opioids, and buprenorphine associated with opioid use, greater preference for cocaine/crack cocaine and amphetamine use associated with stimulant use, and some preference for all of these drugs associated with concomitant use. Although participants who reported other drug use during the 30-day period prior to incarceration did prefer opioid and stimulant drugs, rates were lower compared to other groups based on drug type.

Drug use versatility was greatest among the concomitant use group, both before incarceration and after. However, in the regression model examining concomitant, opioid, and stimulant use during the 30-day period prior to incarceration, the odds of observing an outcome of concomitant, opioid, or stimulant use increased across all groups as a function of drug use versatility. In other words, the more drugs that were used, the more likely it was that a participant would use opioids or stimulants, or to co-use them, during this 30-day period prior to incarceration, rather than use non-opioid and non-stimulant drugs such as alcohol, cannabis, prescription sedatives, etc. Polydrug use, and particularly use of a greater number of different drugs across drug classes, may indicate a willingness to try new drug experiences even if regular

use of all drugs is not adopted (Smith & Staton, 2019; Smith & Stoops, 2019; Sutherland et al., 2016; Wagner et al., 2014). Regular, versatile, and overall more severe drug use that was more common among participants who reported concomitant and opioid use during the 30-day period prior to incarceration may indirectly indicate the possible presence of traits and/or states that would incline a person toward more diverse experimentation, such as greater impulsivity, higher propensity for novelty- or sensation-seeking, and less risk-aversion which, as previously discussed, are all strongly associated with opioid and stimulant use specifically and less adaptive decision-making generally (Bardo, Donohew, & Harrington, 1996; Butler & Montgomery, 2004; Galizio & Stein, 1983; Jentsch et al., 2014; Kirby & Petry, 2004; Verdejo-García, Perales, & Pérez-García, 2007; Wingo et al., 2016). Being more versatile and less discriminate in respect to drug experiences would also influence decision-making about opioids or stimulants by virtue of the fact that all drug options remain open for selection, thereby increasing the probability that opioids and stimulants would be used, or used concomitantly, irrespective of overall preference.

Worth emphasizing is that drug use severity was measured so as not to pertain to any one drug. Had severity of use for each drug type been assessed, it would have likely helped to clarify drug selection among participants who reported concomitant use prior and subsequent to incarceration, though doing so would not have explicated the overall greater propensity toward versatile drug use. For instance, a person could have a higher drug use severity score, but also ever only use crack cocaine, meaning that severity itself cannot explain the phenomenon a using a more diverse range of drugs. Of additional interest is the higher average number of previous drug treatment episodes among participants who reported concomitant use for the 30-day period prior to incarceration and among participants who reported past-year concomitant and opioid use for the one-year period subsequent to incarceration, as this may further indicate drug use severity. For instance, participants in these groups may have experienced psychosocial or medical problems that precipitated or otherwise motivated treatment entry or may have engaged in problematic drug behaviors that resulted in treatment being mandated (Cacciola, Dugosh, Foltz, Leahy, & Stevens; 2005; Cosden et al., 2006; DiClemente, 2018; Hser, Grella, Chou, & Anglin, 1998).

Abstinence Self-efficacy

Interestingly, participants who reported concomitant use subsequent to incarceration also had the lowest rates of reporting moderately or very good abstinence self-efficacy prior to treatment initiation. This

group also had the lowest proportion of participants reporting “moderately” or “very good” abstinence self-efficacy approximately one-year post-release. It is important to note that the abstinence self-efficacy question (e.g., “Based on what you know about yourself and your situation, how good do you think the chances are that you can stay off drugs and alcohol?”) was phrased in a manner that may confuse interpretation of findings. Specifically, the question implies that it is the intention of participants to “stay off drugs and alcohol”. It may be that some participants had an intention to abstain from some drugs but use others in moderation and that others had no intention of trying to abstain from any drug and were uncommitted to treatment (Kelly & Greene, 2014; Laudet & Stanick, 2010). Other information obtained from the survey could not clarify this ambiguity. This limitation notwithstanding, the fact that abstinence self-efficacy at two different time periods was lowest among participants who reported concomitant use and highest among participants who used other/no drugs may indicate that one possible factor influencing later drug-related decision-making was participants’ belief that abstinence was in fact possible. Self-efficacy beliefs are considered cognitively instrumental in intention formation, decision-making, and behavioral control (Ajzen, 2002; Bandura, 1982; Bandura, 1999). Participants who believed that abstinence was both possible and likely to be achieved may have been primed and enabled to later actualize those self-efficacy beliefs. These participants may have believed that they were capable of making different decisions, controlling their behavior, or engaging in recovery or non-drug behaviors (Bandura, 1989, 1991; Marlatt, Baer, & Quigley, 1997). For participants who may not have intended to abstain from all drugs, and therefore may have been more likely to respond “uncertain”, “moderately poor”, or “very poor” to this question (as opposed to responses of “moderately good” or “very good”), findings of greater drug use among these participants would still be in keeping with the idea that earlier ambivalence about using or earlier intention to keep using would have had the potential to later influence decisions to use, rather than abstain. In other words, decisions to use could reflect both lower perceived abstinence self-efficacy or the absence of intention to quit using.

Drug Substitutes, Compliments, and Risk Amidst Changing Markets

Concomitant use of opioids and stimulants during the one-year period prior to incarceration was most common among participants who reported concomitant use during the 30-day period prior to incarceration, but was also found among participants that used opioids-only during the 30-day period prior

to incarceration. Other than participants who reported concomitant use prior and subsequent to incarceration, participants who reported using opioids during the 30-day period prior to incarceration and the one-year period subsequent to incarceration used more drugs across drug classes compared to participants who used stimulants-only for these same time periods.

Although greater drug use versatility was also associated with increased odds that stimulant-only use would be observed during the 30-day period prior to incarceration, participants who used stimulants, but not opioids, during this time period had the lowest rates of past-year opioid use, even when compared to participants who reported past 30-day other drug use. Stimulant users in this and other samples, while still predominantly polydrug users, may be less likely to use opioids as either compliments or substitutes, or to use opioids only infrequently (Harrell, Mancha, Petras, Trenez, & Latimer, 2012). Older stimulant users in this sample may have been using stimulants for a longer period of time and, as a result, may have transitioned from use to dependence, or may have simply had more well-established drug preferences and use patterns (Booth et al., 2006; Brecht et al., 2008; Lee, Vivier, & Diercks, 2009; Lopez-Quintero et al., 2011; Wu et al., 2009). Alcohol or cannabis may have been treated as compliments among stimulant users in this sample, as evidenced by past-year rates of use for these drugs that were comparable to those of other groups, unlike rates of past-year opioid use, which were far lower among participants who reported past 30-day stimulant use. Alcohol and cannabis were also preferred by a greater proportion of participants who reported past 30-day stimulant use, compared to participants who reported past 30-day concomitant or opioid use. Alcohol and cannabis have been documented as compliments to cocaine and are often co-used with cocaine (John & Wu, 2017; Lindsay, Stotts, Green, Herin, & Schmitz, 2009; Midanik, Tam, & Weisner, 2007; McCance-Katz et al., 1993; Williams & Parker, 2001).

Contemporaneous use of alcohol and cannabis is not uncommon among people who use multiple drugs, even among people who prefer drugs other than alcohol and cannabis (Barrett, Darredeau, & Pihl, 2006; Smith and Lawson, 2017; Yurasek, Aston, & Metrik, 2017). This study produced similar findings, with alcohol and cannabis not overwhelmingly preferred, but still used, by a majority of participants. This phenomenon may be due in part to the greater availability and affordability of alcohol and cannabis compared to other drugs. Cannabis is increasingly legal in some form throughout the US and has fewer social and legal risks associated with it than it did during previous decades (Carliner, Brown, Sarvet, &

Hasin, 2017; Hall & Lynskey, 2016; Hathaway, Mostaghim, Erickson, Kolar, & Osborne, 2018).

Interestingly, a slightly higher proportion of participants who reported past-year stimulant use subsequent to incarceration resided in a county with restricted alcohol sales, though differences in alcohol accessibility did not differ appreciably by drug use outcome group.

Alcohol, cannabis, prescription sedatives, cocaine/crack cocaine, and amphetamines were used at fairly high rates among participants who also used opioid drugs, which raises the possibility that these drugs may have been treated as compliments or as substitutes among participants who co-used them (Lucas et al., 2016; Petry & Bickel, 1999; Reiman, 2009; Sumnal et al., 2004). As previously discussed, cocaine/crack cocaine and amphetamines are co-used with heroin and prescription opioids at fairly high rates (e.g., “speedball”, “goofball”) among polydrug users due to their mutually reinforcing effects, meaning that for some participants they may have been more often treated as compliments (Bickel et al., 1995; Jasinski & Preston, 1986; Guzman & Ettenberg, 2004; Leri, Bruneau, & Stewart, 2003; Lorvick, Browne, Lambdin, & Comfort, 2018; Wade-Galuska, Winger, & Woods, 2007). Due to their distinct subjective psychoactive effects, it may be less likely that regular drug users, and drug users with greater preference for either opioids or stimulants, but not both, would treat drugs within these two classes as substitutes.

Heroin and...Buprenorphine

That approximately one-third of participants who reported past-year heroin use subsequent to incarceration also reported using prescription opioids and buprenorphine for this same time period raises the possibility that drug substitution within the same drug class occurred or that during this time period some participants made a decision to transition from prescription opioids to heroin (Evans et al., 2018; Monti, 2019; Peavy et al., 2012). Many people who currently use heroin in the US transitioned to heroin as a substitute for prescription opioids, and it has been shown elsewhere that opioid users are willing to substitute preferred opioids with other, less preferred opioids, such as buprenorphine (Compton et al., 2016; Kanouse & Compton, 2015; Lankenau et al., 2012; Smith et al., 2017). This was partially evidenced in this study by high rates of multiple opioid drug use among participants who reported concomitant and opioid use prior and subsequent to incarceration. It could be that at various times during the one-year post-release period that prescription opioids were substituted for heroin or vice versa, due to periods of greater or lesser

availability of either drug, increases or decreases in price, changes in drug quality, or fluctuations in participant income (Goudie, Sumnall, Field, Clayton, & Cole, 2007; Greenwald & Hursh, 2006; Chalmers et al., 2010; Petry, 2000).

While use of heroin, prescription opioids, amphetamines, and cocaine during the 30-day period prior to incarceration were all associated with changes in the likelihood of opioid, stimulant, and concomitant use during the one-year period subsequent to incarceration, buprenorphine was not significantly associated with these post-release outcomes. Similarly, buprenorphine use during the 30-day period prior to incarceration was not associated with a change in odds for observing heroin use during the one-year period subsequent to incarceration. For the 30-day period prior to incarceration, buprenorphine was used by 25.0% of participants who reported using heroin during the one-year period subsequent to incarceration. Subsequent to incarceration, however, buprenorphine use increased to 33.3% among participants who reported heroin use, far higher than rates found among participants who did not report heroin use subsequent to incarceration (only 6.5% reported buprenorphine use). Buprenorphine use during the one-year period subsequent to incarceration was associated with a 266% increase in odds of observing heroin use for this same time period, whereas use of prescription opioids was associated with a 73% increase in odds of heroin use. Although prior to incarceration buprenorphine was used at higher rates among participants who resided in rural counties, subsequent to incarceration rates of buprenorphine use were slightly higher in urban areas. Rates of heroin use both prior and subsequent to incarceration were higher among participants who resided in urban areas, increasing during the 2012-2017 post-release period. It may be that proliferation of MAT providers in urban areas provided greater access to diverted buprenorphine during a time when heroin was also becoming more ubiquitous in urban areas.

For some participants, buprenorphine could have served as a substitute and may have been chosen by heroin-using participants for purposes such as self-adopted harm-reduction or informal OUD self-treatment, as such use has been documented elsewhere (Bazazi, Yokell, Fu, Rich, & Zaller, 2011; Daniulaityte, Falck, Wang, & Carlson, 2009; Furst, 2013; Gwin-Mitchell et al., 2009; Jayadeva et al. 2017; Schuman-Olivier et al., 2010). Buprenorphine may have also been selected by some participants to achieve pleasant subjective effects, though evidence remains mixed as to whether buprenorphine should be regarded as a serious drug of abuse and as a preferred drug among polysubstance users given its ceiling

effects (Cicero, Surratt, & Inciardi, 2007; Smith et al., 2019). Because buprenorphine was preferred by only 2.6% of the entire sample, and 1.2% of participants who reported using heroin subsequent to incarceration, it may be less likely that participants decided to use buprenorphine primarily as a means of achieving states of intense euphoria or pleasure. That the survey question pertaining to buprenorphine included both Suboxone and/or Subutex, but made no distinction between them, makes speculation difficult due to the fact that these drugs differ in their effects. Buprenorphine, an agonist and/or antagonist at different opioid receptors, is found in both brand-name drugs; Suboxone also contains naloxone, an opioid antagonist, whereas Subutex contains only buprenorphine (Lobmaier, Gossop, Waal, & Bramness, 2010; Lufty & Cowan, 2004).

Although buprenorphine might not ordinarily have high local utility for many polydrug users, its perceived value might increase significantly among participants who regularly used heroin or prescription opioids, but then encountered a period of supply disruption. It may also have been more valued among participants using buprenorphine to self-treat OUD. This relationship between heroin and buprenorphine may also reflect broader changes in the illicit drug market. Over the past eight years, opioid prescribing has decreased and prescription opioid monitoring has increased, driving up the price of prescription opioids in illicit drug markets (Lebin et al., 2019; Mallatt, 2018). Conversely, buprenorphine prescribing has increased significantly in the US, with prescribing rates higher among states that adopted Medicaid expansion under the Patient Protection Affordable Care Act (ACA), Kentucky being one such state (CHFS, 2019; Clemans-Cope, Epstein, & Kenney, 2017; Wen, Hockenberry, Borders, & Druss, 2017). Prescription drug diversion is a perennial problem in the US and there is often a positive relationship between rates of drug prescribing and prescription drug diversion (Cicero et al., 2007; Daniulaityte et al., 2006; Kurtz, Buttram, Margolin, & Wogenstahl, 2019). Use of diverted buprenorphine has been found among many samples, including among other corrections-involved samples in Kentucky, (Cicero et al., 2018; Lofwall & Havens, 2012; Molfenter et al., 2019; Smith et al., 2019).

Given the high rates of any opioid use prior to incarceration, it is worth considering two related questions. First, why did so many participants decide not to use heroin subsequent to incarceration? Nearly 22% of the sample reported using heroin during the one-year period prior to incarceration, but this declined to 10.7% during the one-year period subsequent to incarceration. Participants were released during a time

when prescription opioids were becoming more expensive and heroin was becoming more ubiquitous, cheaper, and potent, making it a potentially more attractive opioid substitute. Second, why did so many participants in this sample decide to use heroin subsequent to incarceration? Participants were released during a time when heroin was becoming more adulterated, dangerous, and deadly (Jalal et al., 2018; Marshall et al., 2017; Ruhm, 2018). The penalties for selling even small quantities of heroin, which is one way that heroin users can help generate the funds needed to support their own heroin use, increased during this time (Biernaki, 1979; Duncan, 2013; Offices of the United States Attorneys, 2017). These increased sanctions, coupled with the increased risk of heroin-related overdose and death, still did not deter about 10% of participants. Heroin is a drug associated with great reward as well as great risk. That heroin was more available in Kentucky during the 2012-2017 post-release period than in any previous decade (thus including any pre-incarceration period), but that use declined among participants in this sample, suggests that, for some participants, the risks associated with use may have been perceived as too great (Ciccarone, Ondocsin, & Mars, 2017; Votaw, Wittenauer, Connery, Weiss, & McHugh, 2017).

Greatest Risk

One disquieting finding is that the use of prescription sedatives, cocaine/crack cocaine, prescription opioids, and amphetamines during the one-year period subsequent to incarceration was associated with increased likelihood of also observing heroin use for this same time. Put differently, the single most dangerous drug that could be used during this time period was significantly associated with contemporaneous use of drugs most likely to result in an acute adverse event when used with it (Clinton, Hunter, Logan, & Lapidus, 2019; Hobelmann et al., 2016; Mital, Windle, Cooper, & Crawford, 2017; Yamamoto et al., 2019). That rates of opioid and stimulant use among participants reporting past-year heroin use were higher both prior and subsequent to incarceration means that these 168 participants may be appropriately considered as polydrug users across time periods and arguably the highest-risk users of the sample. Participants who did not use heroin, but who used prescription opioids contemporaneously or concomitantly with other drugs were still engaging in high-risk form of drug use, in that co-use of opioids with stimulants, benzodiazepines, or alcohol is associated with increased likelihood of adverse outcomes, including overdose and death (Calcaterra et al., 2013; Hobelmann & Clark, 2016; Jones et al., 2012; Kaye & Darke, 2004; Warner et al., 2016).

Intravenous Administration

High-risk drug decisions can also be reflected by the route of administration. Approximately 40% of participants in this sample had some history of IDU. Participants who reported past 30-day concomitant and opioid use prior to incarceration had the highest rates of IDU history, with rates highest among participants who reported concomitant use. During the one-year period subsequent to incarceration, rates of IDU history were approximately equal between concomitant and opioid users. While history of IDU was associated with increased odds of concomitant, opioid, and stimulant use during the 30-day period prior to incarceration, it was associated only with increased likelihood of observing past-year concomitant and opioid use subsequent to incarceration. This means that opioids, either used in isolation or in combination with other drugs, were associated with history of IDU, a relationship that has been observed elsewhere for both prescription opioids and heroin (Al-Tayyib, Koester, & Riggs, 2017; Warner-Smith, Darke, Lynskey, & Hall, 2001).

Differences in history of IDU between participants who reported past-year heroin use and those who did not were stark. In separate analyses (results not displayed), among participants who reported any drug use during the one-year period subsequent to incarceration (N=869), participants who reported using heroin were significantly more likely than participants who reported other drug use to report IDU during the one-year period subsequent to incarceration (17.2% vs. 6.9%, $X^2=14.6$; $p<.001$). This may be partially attributable to preferred routes of administration that includes intravenous injection. A person who prefers this method may be influenced in their decision-making, being inclined to choose more readily injectable drugs, such as heroin, and less inclined to choose drugs that involve more preparatory steps, such as prescription opioids (Ponton & Scott, 2004).

In illicit drug markets, there has been a decrease in availability of many popular prescription opioids that were once commonly injected (e.g., original formulation OxyContin) (Alpert et al., 2018). These prescription opioids, while not eliminated from illicit drug markets, are nevertheless being increasingly replaced with tamper-resistant prescription opioid formulations intended to deter abuse, meaning that they are far more difficult to prepare for injection (Alpert, et al., 2018; Chilcoat, Coplan, Harikrishnan, & Alexander, 2016; Patrick, Fry, Jones, & Buntin, 2016). Although earlier generation prescription opioids required several steps of preparation prior to injection, and certainly more steps than

heroin, participants who may have attempted injecting formulations brought to market after 2010 would have needed peer-based instruction on how to prepare these pills for injection or would have needed to undertake extensive research and trial-and-error (Duxbury, 2018; Rönkä & Katainen, 2017; Vosburg, Haynes, Besharat, & Green, 2017). They may have also needed to acquire additional chemical compounds required for the refinement of pills into injectable form. In short, while abuse-deterrent prescription opioids might be less expensive than original formula prescription opioids (though still more expensive than heroin), they would cost more in effort and time (Lebin et al., 2019). The potential for wasted product or weaker effects, in cases where pills were not prepared properly or were unable to be injected successfully, coupled with the increased cost in time, could have made heroin, rather than prescription opioids, a more attractive drug among participants with a preference for this route of administration (Vosburg et al., 2013). For people who inject drugs, time might be considered a cost due to the fact that one of the appeals of IDU is that drug effects are extreme and felt nearly instantaneously (3-7 seconds), particularly when compared to swallowing or even insufflation (Zering et al., 2003). However, increased tolerance and variability in potency may have made heroin less desirable over the long-term among some participants (Monico & Mitchell, 2018).

Cocaine and amphetamines are also more readily injectable than other drugs, one reason why concomitant use of heroin and cocaine or heroin and amphetamine remain popular among some IV polydrug users (Al-Tayyib, Koester, Langegger, & Raville, 2017; Dolan et al., 1991; Harrell, Mancha, Petras, Trenz, & Latimer, 2012; Sanders, Lankenau, Jackson-Bloom, & Hathazi, 2008). Crack cocaine may also be injected, though requires more steps to prepare, meaning that some participants may have preferred to smoke rather than inject crack cocaine (Lankenau, Clatts, Goldsamt, & Welle, 2004; Waninger, Gotsch, Watts, & Thuahnai, 2008).

Although high-risk drug use was common across this sample, participants with a with a history of IDU may be considered as even less risk-averse compared to participants without such history. Risk-aversion may be less pronounced still among people with a history of IV heroin administration, versus IV prescription opioid administration, as IV heroin administration entails the highest risk of all for this generation of drug users. Though heroin and prescription opioids are more often associated with IV administration and, to a lesser extent, cocaine and amphetamines, IV buprenorphine use is an increasingly

well-documented phenomenon that warrants closer examination (Brecht, O'Brien, Von Mayrhauser, & Anglin, 2004; Fischer et al., 2018; Kelly et al., 2017; Novak & Kral, 2002; Yokell et al., 2011).

Additional Endogenous Factors with the Potential to Influence Decision-making

Age of Drug Use Initiation

Participants who reported concomitant use prior and subsequent to incarceration were <14 years old on average when they first used drugs. The relationship remained significant in the regression model, with younger age associated with slightly increased odds of use. Participants who reported using heroin during the one-year period subsequent to incarceration were 13.8 years-old on average when drug use was initiated, a full year younger than the average age of drug use initiation among participants who did not report heroin use, though this association did not remain significant in the regression model. Participants who reported other drug use prior to incarceration were on average 14.5 years old when they first used drugs and those who reported other/no drug use during the one-year period subsequent to incarceration were 15.3.

These average ages associated with other drug and/or no drug use, while all >14 years old, are still young. Even though age 14 is regarded as a critical neurodevelopmental juncture, with drug use and other insults to the brain prior to age 14 having more enduring effects, there does not exist any clear line; what can be considered normative development still allows for variation. It may be that, for some, the neurodevelopmental implications of drug use initiation at age 15 differs little than use which began at age 13. It may be more important to understand that, overall, a positive relationship between earlier age of drug use initiation and problems associated with drug use in later adolescence and adulthood is commonly observed (Chen et al., 2009; King & Chassin, 2007; Labouvie & White, 2002; Walters & Urban, 2014). Even this understanding should be contextualized by other factors, such as the frequency of use at young ages, social conditions (e.g., trauma, poverty, and structural inequality), or by a number of other endogenous or exogenous factors with demonstrated capacity to adversely influence neurodevelopment and impair later cognitive-behavioral functioning (Bergen, Gardner, & Kendler, 2007; Champagne, 2010; Champagne & Curley, 2005; Charach, Yeung, Climans, & Lillie, 2011; Dube et al., 2003; Perry et al., 1995; Walker et al., 2011). Information about participants' childhood and adolescence was not available for

examination in this study, meaning that some important details pertaining to early drug use initiation will need to be more fully considered in future work.

In separate analyses (results not displayed), differences in age of drug use initiation were examined by sex, history of head injury, and LD diagnosis and/or SE enrollment, as all of these factors might confer the possibility of less adaptive cognitive function, including poorer inhibitory control and working memory, and, in some cases, less risk-aversion (APA, 2013; Cottle et al., 2001; Mcallister, Flashman, Sparling, & Saykin, 2004; Van der Meere, Marzocchi, & De Meo, 2005). On average, participants who were male, had a history of head trauma, or LD diagnosis/SE enrollment initiated drug use at an earlier age. Males were 14.4 years-old on average, compared to females, who were 15.9 years-old on average ($t=4.52$, $p<.001$), reflecting possible sex-based differences in early life for impulsivity, risk-taking, and dose-dependent drug reward (Cross, Copping, Campbell, 2011; Eckel & Grossman, 2008; Hosseini-Kamkar & Morton, 2014; Vansickel, Stoops, & Rush, 2010). Participants with a history of head injury were 14.2 years-old on average when drug use was initiated, compared to those without, who were 15.1 years-old on average ($t=3.51$, $p<.001$). Participants with a history of LD diagnosis and/or SE enrollment were 14.2 years-old on average when they initiated drug use, compared to those without this history, who were 14.9 years-old on average ($t=2.22$, $p=0.27$). Thus, there is some limited evidence to suggest that participants who initiated drug use at an earlier age may have had traits and states that biased them toward riskier decision-making and/or decreased their ability to inhibit acting on the urges which precipitated these decisions. However, because temporal order cannot be established, these associations cannot be considered past the point of conjecture and are presented primarily to draw attention to the idea that any initial decision to use a drug is not made in isolation and that many factors beyond the age of initiation are important to examine with greater sophistication in future work.

That the average age of drug use initiation for the entire sample was 14.7 years, does mean that drug use occurred for most participants at a fairly young age in terms of neurolocognitive and psychosocial development (Gogtay et al., 2004; Shaw et al., 2008; Sorrells et al., 2018). Early age of drug use may indirectly indicate that some participants in this sample may be higher in trait impulsivity compared to people who either do not elect to use drugs, or who initiate use later in life (Petry, 2001; Verdejo-García, Lawrence, & Clark, 2008). Though as discussed previously, novelty-seeking, impulsiveness, risk-taking,

and poorer intertemporal decision-making are more prominent in childhood and adolescence, meaning that early drug experimentation cannot be taken as a clear indicator of the presence of traits often associated with greater risk-taking, impulsiveness, or poorer decision-making at later times. Findings should be interpreted with that in mind.

Age and Sex

Overall, younger age was most often associated with concomitant and opioid use both prior and subsequent to incarceration, including among participants who reported past-year heroin-use. That participants who reported other/no drug use subsequent to incarceration were slightly older is in keeping with previous research documenting that drug use and other high-risk behaviors are more prominent in early adulthood, decreasing or moderating with age (Gfroerer & Brodsky, 1992; Fleming, White, Catalano, 2010). It may be that slightly older participants had other factors, such as a spouse, children, and other investments in everyday life that helped establish greater stability, serving to reinforce less risky behavior; though this trend is not always uniform, with minority groups sometimes continuing to use drugs in adulthood due to inequitable access to non-drug alternatives and other stabilizing resources (Duncan, Wilkerson, & England, 2006; Sampson, Laub, & Wimer, 2006; Visher, Knight, Chalfin, & Roman, 2009; Vogt Yuan, 2010; Zapolski, Baldwin, Banks, & Stump, 2017). For participants who were younger than 27 years-old during the time periods examined, and particularly those who were younger than 23 years-old, frontocortical areas crucial for deliberative decision-making and inhibition would have been less developed, meaning that they would have had comparatively less capacity for adaptive decision-making during intertemporal choice (Gogtay et al., 2004; Spear, 2007).

Although drug use for the 30-day period prior to incarceration differed by sex, with slightly more males found among the stimulant use and other drug use groups, the proportion of males among drug use groups did not differ subsequent to incarceration, including for heroin use. That a greater proportion of females were found among the higher risk drug using groups (concomitant, opioid, and heroin), compared to stimulant and other/no drug use groups, suggests that greater propensity for risk-taking based on sex was not a meaningful influence among participants in this sample, even though elsewhere in Kentucky males have found to use a greater variety and quantity of drugs (Shannon, Havens, Mateyoke-Scriver, & Walker, 2009).

It may also be that other factors influenced the use of these generally higher risk opioid drugs among female participants. Some factors that might have influenced cognitive capacity and drug-related decision-making include higher rates of prior or ongoing sexual and physical violence, childhood adversity and trauma, physical and psychological health symptoms, chronic pain, disability, and poverty, as these characteristics have been found at high rates among corrections-involved women with a history of drug use, including samples in Kentucky (Binswanger, Krueger, & Steiner, 2009; Champagne & Curley, 2005; Bronson, Maruschak, & Berzofsky, 2015; Golder, Engstrom, Hall, Higgins, & Logan, 2015; Hall et al., 2016; Logan, Walker, Jordan, & Leukefeld, 2006; Lynch, DeHart, Belknap, & Green, 2012; Staton, Leukefeld, & Logan, 2001; Staton-Tindall et al., 2015; Smith et al., 2019). Not only have many stress-related states and conditions been shown to influence drug-taking among women differently, and in some ways disproportionately, then men, but psychological problems associated with drug use are typically greater among women than men (Fox & Sinha, 2009).

Additional analyses (results not displayed) showed that during the one-year period prior to incarceration female participants experienced higher rates of depressive (68.8% vs. 40.9%, $X^2=74.5$, $p<.001$) and anxiety symptoms (60.1% vs. 40.9%, $X^2=35.2$, $p<.001$), suicidal ideation (17.4% vs. 10.3%, $X^2=11.4$, $p<.001$), unemployment (47.3% vs. 31.1%, $X^2=31.3$, $p<.001$), chronic pain (34.2% vs. 22.5%, $X^2=17.1$, $p<.001$), and higher stress-related health symptom scores (27.1 vs. 22.6, $t=8.81$, $p<.001$). Perhaps unsurprisingly, rates of misregulation were slightly higher among women (87.9% vs. 82.0%, $X^2=5.2$, $p=0.19$). Though, fewer women than men reported LD diagnosis/SE enrollment (22.8% vs. 30.0%, $X^2=5.7$, $p=.017$). During the one-year period subsequent to incarceration, female participants experienced higher rates of depressive (38.9% vs. 31.3%, $X^2=6.02$, $p=.014$) and anxiety symptoms (56.7% vs. 37.0%, $X^2=38.0$, $p<.001$), cognitive difficulties (35.9% vs. 24.2%, $X^2=16.4$, $p<.001$), and unemployment (42.6% vs. 34.2%, $X^2=7.02$, $p=.008$), though rates of chronic pain (36.6% vs. 31.6%, $X^2=2.48$, $p=.116$) and suicidal ideation (5.0% vs. 4.3%, $X^2=0.13$, $p=.719$) did not differ significantly between men and women subsequent to incarceration. These findings may help to explain why rates of high-risk drug use were similar among male and female participants. While men tend to be less risk-averse than women, certain conditions in the lives of corrections-involved women, including greater stress, may have contributed to decisions to use drugs with high risk, either by influencing cognitive capacities needed for adaptive decision-making or by

increasing the likelihood that drugs would be used in an attempt to help reduce stress, anxiety, fear, or other unpleasant states (Logan et al., 2006; Zlotnick, Najavits, Rohsenow, & Johnson, 2003). It is important to keep in mind that responses for some survey questions (e.g., anxiety, pain, suicidal ideation) may reflect gender-based differences in self-report (Herbert et al., 1997; Sigmon et al., 2005). Ultimately, continued work is needed to better understand sex-based differences in high-risk drug-related decision-making among corrections-involved people.

Psychiatric Symptoms, Stress, Misregulation

Past-year anxiety and depressive symptoms were higher among participants who reported concomitant use during the 30-day period prior to incarceration, as were rates of suicidal ideation. Participants who reported concomitant use also had significantly higher stress-related health effects scores, whereas scores were lowest among participants who reported other drug use. Higher stress-related health effects served as an indirect measure of stress among participants prior to incarceration. Higher scores would be indicative of greater psychological stress, as well as heightened stress response, meaning that both the manifestation and phenomenology of stress would have likely varied considerably between participants.

That participants who evidenced the greatest drug use versatility and severity and higher rates of psychiatric symptoms (e.g., the concomitant group) also experienced greater stress-related health effects, but that participants who evidenced the least drug use versatility and severity and lowest rates of psychiatric symptoms (e.g., other drug use group) evidenced the fewest, may not be surprising. For one, two stress-related health effects items measured the presence or absence of anxiety and depressive symptoms, and the relationship between stress and psychiatric symptoms is well-established, meaning there should be positive relationship between these measures (Turner, Wheaton, & Lloyd, 1995). Moreover, while subjective stress, stress response, and depressive and anxiety symptoms all have the potential to contribute to drug craving, seeking, and use (though not always uniformly), they can also develop as a result of these and other drug-related conditions (e.g., withdrawal, exposure to drug-related cues) (Epstein et al., 2009; Mantsch, Baker, Funk, Lê, & Shaham, 2016; Shaham & Stewart, 1995; Sinha, Fuse, Aubin, & O'Malley, 2000; Sinha & Li, 2007). Regular drug use, and certainly addiction, can be conceptualized as a

protracted state of chronic stress (i.e., allostasis), the body working to maintain homeostasis and the person taking more drugs in response (George, Le Moal, & Koob, 2012; Koob, 2008; 2009).

Whereas rates of misregulation were lowest among participants who reported other drug use, rates were highest among participants who reported concomitant use prior to incarceration and were associated with increased odds of concomitant, opioid, and stimulant use during this same time. This suggests that among these groups, at least one decision to use drugs during the 30-day period prior to incarceration involved a specific intention of trying to mitigate negatively valenced states, as the variable “misregulation” reflected the use of drugs as an attempt to “reduce stress, anxiety, worry or fear”, possibly because participants believed these drugs would produce an ameliorating effect, despite overall risk of use (Baumeister & Heatherton, 1996; Doweiko, 1999). The association between stress, craving, and drug use, including relapse, is well documented (Mulia et al., 2008; Hyman et al., 2007; Preston & Epstein, 2011; Sinha, 2008, 2012). Decisions to use drugs as a form of “self-medication” are not uncommon and may not necessarily be considered, under the right conditions, as irrational, *per se*, even if, over time, the utility associated with a drug has the potential to decrease, the states that the drug was used to alleviate have the potential to intensify, and additional drug-related problems have the potential to develop as a result of continued “self-medication” (for differing viewpoints on this topic see Becker & Murphy 1988, Darke, 2013; Khantzian, 1997, 2013; Tomer, 2001). Because costs of drug use are often delayed and uncertain, but because unpleasant anticipatory states, such as anxiety or fear, are certain, *experienced* in the moment, means that opioids and stimulants would likely have been weighted differently compared to non-drug choices for which ameliorating or otherwise rewarding effects may not have been either immediate or certain (Bickel et al., 2007; Green, Myerson, & McFadden, 1997). For these participants experiencing negatively valenced states, the local utility of opioids and stimulants may have simply been higher than other options. With drugs selected in an attempt to reduce unpleasant states, use might be considered utilitarian rather than hedonic (O'Curry & Strahilevitz, 2001).

Subsequent to incarceration, rates of psychiatric symptoms were still most prevalent among participants who reported concomitant use, followed by participants who reported stimulant use. For both groups, depressive symptoms were associated with increased odds of use. Among participants who reported past-year heroin use specifically, rates of past-year depressive symptoms were far higher than those of

participants who did not use heroin. Suicidal ideation was still highest among those who reported concomitant use, followed by those who reported stimulant use. Interestingly, past-year suicidal ideation was over twice as high among participants who reported heroin use, with suicidal ideation associated with a 154% increase in odds of observing heroin use. Again, participants who reported other drug/no drug use subsequent to incarceration had the lowest rates for all symptoms, including lowest rates of suicidal ideation.

As noted in Chapter 2, depression and anxiety symptoms can influence cognition, present-bias, risk assessment, goal pursuit, intertemporal choice, and the degree to which outcomes are rewarding or punishing (Dias-Ferreira et al., 2009; Furman et al., 2013; Gohier et al., 2009; Harvey et al., 2004; Lerner, Li, & Weber, 2012; Marazziti et al., 2010; Nebes et al., 2000; Schulz & Vögele, 2015; Pulcu et al., 2013; Schwabe & Wolf, 2013; Scott et al., 2015; Shackman et al., 2006; Wittmann & Paulus, 2008). However, there is insufficient evidence to suggest that anxiety or depressive symptoms influenced opioid and stimulant use among participants in this sample in any definitive way. Still, one idea of interest is that depression may contribute to a person being more present-biased due to the fact that they perceive time passing more slowly, have diminished capacity to feel sufficiently attached to notions of their future self, or to believe that affective states experienced during depressive episodes will ever be other than they currently are (Bschor et al., 2004; Dombrowski et al., 2011). This unpleasant myopic orientation to the present has been described poignantly among people who have experienced depression (Soloman, 2014; Styron, 2010). That suicidal ideation was highest among participants who reported concomitant use prior and subsequent to incarceration, and who reported heroin use subsequent to incarceration, suggests that for a portion of opioid and stimulant users in this sample the idea of a future self might have been not only less salient and less behaviorally motivating during decision-making, in that delayed outcomes of use may not have been expected to be cashed in. Choosing to use drugs may in some circumstances be regarded as an act of willful destruction, in which the potential for adverse consequences in the short- and long-term is fully known; in the extreme, this may extend to self-harm and suicide (Flanagan, 2016; Pickard & Ahmed, 2016; Oquendo & Volkow, 2018). If future consequences are not only more difficult to envision, but also something that a person might not expect to be alive long enough to experience, then risk and utility beyond the present moment lose coherent meaning. For a small minority of participants, use of these high-risk drugs may have

even been considered as a possible means to an end, as intentional drug overdoses are a real, if all-too underexplored, phenomena (Austin, Proescholdbell, Creppage, & Asbun, 2017; Brådvik, Frank, Hulenvik, Medvedeo, & Berglund, 2007; Heale, Dietze, & Fry, 2003; Roxburgh et al., 2017).

Indirect Indicators of Cognitive Functioning

Just under one-third of the entire sample reported a LD diagnosis or SE enrollment history, with no observed difference between groups. Rates of self-reported cognitive difficulties (e.g., difficulties understanding, concentrating, and remembering) that occurred during the one-year period subsequent to incarceration were highest among participants who reported concomitant use and lowest among participants who reported other/no drug use. Past-year cognitive difficulties increased the likelihood of concomitant use during the one-year post-release period by approximately 50%. As neurocognitive impairments and indicators of executive dysfunction commonly associated with poorer decision-making and inhibitory control are found among people with a history of opioid and stimulant use, it is unsurprising that participants who reported concomitant use had higher rates of poorer cognitive functioning compared to participants who reported less drug use. Unfortunately, the question pertaining to past-year cognitive difficulties asked as part of the follow-up survey did not appear on the baseline survey. It is possible that participants who reported concomitant use prior to incarceration would also have had high rates of self-reported cognitive difficulties.

Participants who reported concomitant use both prior and subsequent to incarceration had the highest rates for history of head trauma as well, whereas rates were again lowest among participants who reported other drug use prior to incarceration. That both history of head trauma and past-year cognitive difficulties were represented at higher rates among participants who reported more versatile and severe drug use provides further indirect support for the idea that indicators of poorer cognitive function may correspond to greater impulsiveness and risk-taking, and decreased capacity for advantageous decision-making during intertemporal choice. However, findings cannot explicate causality, meaning that poorer cognitive functioning could have pre-dated opioid and stimulant use, or developed as a result of use.

Chronic Pain

Chronic pain rates were highest among participants who reported concomitant and opioid use prior and subsequent to incarceration. As discussed in earlier chapters, chronic pain can significantly alter and

impair cognitive functioning and contribute to less adaptive decision-making (Apkarian et al., 2004; Elvemo, et al., 2017; Landrø et al., 2013; Walteros et al., 2011). Experiencing chronic pain may also increase the perceived value of opioid drugs due to their analgesic properties (Trescot, Datta, Lee, & Hansen, 2008). Although rates of chronic pain were higher among participants who used opioids, including concomitantly with stimulants, chronic pain was, somewhat unexpectedly, not associated with increased odds of opioid or concomitant use either prior or subsequent to incarceration. No differences in chronic pain rates were observed between participants who reported heroin use subsequent to incarceration and those who did not. It is possible, then, that chronic pain may correspond to use of specific types of opioids, but not opioid use more generally. Additional examination (results not displayed) of differences in chronic pain by heroin, prescription opioid, and buprenorphine use revealed that chronic pain rates differed for prescription opioids, with slightly more participants who reported chronic pain prior (64.2% vs. 53.1%, $X^2=13.0$, $p<.001$) and subsequent to incarceration (17.7% vs. 12.7%, $X^2=6.3$, $p=.014$) reporting prescription opioid use; though no statistically significant differences were found for heroin or buprenorphine.

People who experience chronic pain experience pain symptoms that can increase or decrease in severity over a period of time, with some non-cancer chronic pain conditions having the potential to continue for years or an entire lifetime (Fine, 2011; Goldberg & McGee, 2011). Given this, it is possible that participants who reported chronic pain had previously been prescribed opioids for pain symptoms. Particularly for pain that was treated prior to revised opioid prescribing guidelines and prior to 2012, when opioid prescriptions per 100 persons peaked in the US (CDC, 2019). Subsequent analysis revealed that 4.2% of participants who reported illicit drug use prior to incarceration also reported that they were introduced to drugs by a doctor or physician, meaning that illicit opioid use, dependence, or addiction may have been iatrogenic for some participants (Ballantyne & LaForge, 2007; Keller et al., 2012). Prior exposure to prescription opioids, even if initially used as prescribed and not misused, has the potential to contribute to dependence or OUD (Cerdá, Santaella, Marshall, Kim, & Martins, 2015; Edlund et al., 2014; Volkow & McLellan, 2016). In general, people with OUD are often undertreated for their pain symptoms and routinely encounter stigma, discrimination, and other obstacles in accessing medical care (Baldacchino, et al.2010, Dunn et al., 2014; Hines et al., 2008; Karasz et al., 2004; Rosenblum et al., 2003; van Boekel, Brouwers, van Weeghel, & Garrestsen, 2013; van Boekel, van Weeghel, & Garrestsen, 2014). Under such

conditions, participants with OUD who experience chronic pain might continue to use prescription opioids illicitly to self-treat their pain symptoms in addition to other reasons (e.g., producing a euphoric effect, relieving withdrawal symptoms) (Cicero, Lynskey, Todorov, Inciardi, & Surratt, 2008; Leukefeld, Walker, Havens, 2007). The local utility of opioids for such participants would likely be extremely high, and the long-term risks of use not weighted similarly.

Scarcity and Economic Hardship

Participants who reported past 30-day concomitant and opioid use prior to incarceration experienced a greater number of economic hardships on average during the one-year period prior to incarceration, with the former reporting double that of participants who reported other drug use. Similarly, rates of having experienced past-year homelessness were twice as high among participants who reported concomitant use compared to those who reported other drug use. This association may not be surprising, insofar as homelessness is associated with psychiatric health symptoms, history of head injury, and greater drug use severity (Galea & Vlahov, 2002; Lafferty, 2010; Oddy, Moir, Fortescue, & Chadwick; 2012; Watson Crawley, & Kane, 2016). While disruption in economic stability can produce a scarcity mentality, in which cognition, valuation, and decision-making abilities become impaired, homelessness may be considered an extreme form of scarcity, as it involves protracted uncertainty and hardship in addition to having fewer tangible resources and social supports (Mani et al., 2013; Phelan, Link, Moore, & Stueve, 1997; Hwang et al., 2009; Shah et al., 2015). Homelessness is associated with a low social rank and stigmatized status, which can influence psychiatric functioning among people experiencing homelessness (Caton, Wilkins, & Anderson, 2007; Link, Struening, Rahav, Phelan, & Nuttbrock, 1997; Roschelle & Kaufman, 2004; Skosireva et al., 2014). Additionally, homelessness reflects a state in which basic needs are unmet, or under threat of not being met, and in which existential uncertainty is elevated due to greater exposure to unsafe conditions. Taken together, experiencing homelessness has similar characteristics of living in a harsh environment, and has the potential to not only produce an acute stress response, but also to keep states of arousal sustained at elevated levels over a period of time (Frankenhuis et al., 2016). Present-bias and reflexive decision-making would likely increase under these uncertain conditions, with cognition directed toward the capture of certain and immediate, versus uncertain and delayed, reward (Frankenhuis et

al., 2016; see also optimal foraging theory: Abarca & Fantino, 1982; Brown, Laundré, & Gurung, 1999; Kagel et al., 1986).

During the one-year period subsequent to incarceration, participants reported their total income (before taxes) from all sources for the 30-day period prior to completing the follow-up interview. This means that most participants would have been out of jail or prison for approximately 10-14 months when this income was reported. Past 30-day income was low sample-wide, with \$1,290 the average income before taxes; approximately \$15,480 annually. Assuming that this was taxable income, which is not the case for some types of reported income (e.g., SNAP benefits, Social Security Insurance), average monthly take-home pay was \$1,049, or approximately \$12,588 annually, just \$448 above the Federal Poverty Guideline for a household of one (U.S. Department of Health and Human Services, 2019). However, the mean number of people who were listed as being dependent on this income was 2.1 (range 0-6), meaning that some participants may have been living below the Federal Poverty line. Because participants were not asked to report income from other household members, such as a spouse or parent, a more precise estimate could not be made. It may be that other family members had high monthly earnings. What is known, is that, participant earnings were low overall and unemployment rates were high. These conditions would have had the potential to produce stress and a scarcity mentality, both of which can disrupt adaptive decision-making (Bratanova, Loughnan, Klein, Claassen, & Wood, 2016; Mani et al., 2013; Pearlin, Menaghan, Lieberman, & Mullan, 1981). Lower income subsequent to incarceration could have also influenced drug purchasing, by potentially restricting the overall flexibility with which participants could make purchasing decisions about preferred drugs and non-drug goods, as well as respond to short- and long-term changes in drug markets related to perceived drug quality, drug risk, and drug cost (Becker, Murphy, & Grossan, 2004; Carroll & Rodefer, 1993; Goudie et al., 2007; Ornstein & Levy, 1983; Petry, 2002). Though past-month income was lowest among participants who reported past-year concomitant use subsequent to incarceration and highest among those who reported other/no drug use, the low income across groups makes it difficult to discern the extent to which income may have influenced drug-related decision-making differentially across groups, given that the lower income associated with concomitant drug use was marginal.

Subjective Socioeconomic Status

The average perceived subjective socioeconomic rank that participants reported was 5.0, though for participants who reported past 30-day concomitant or opioid use prior to incarceration, it was slightly below that. Differences in rank were statistically significant, but it is unclear if there are substantive differences between groups, as lower perceived subjective socioeconomic status was not associated with changes in odds for any outcome. Considering that participants in this sample believed, on average, that they were ranked--in terms of education, money, desirable employment-- below approximately one-half of the rest of society, but above approximately another one-half, means that, similar to all people, participants' stress response and cognition likely varied dynamically as a function of context, engaging in downward or upward social comparison, increased or decreased vigilance, and arousal or ease depending on the social context (Collins, 1996; Fiske & Taylor, 2013; Kraus, Horberg, Goetz, & Keltner, 2011 Taylor & Lobel, 1989). Examining the frequencies of responses for this variable showed that 35.3% of the sample reported a rank 4<, meaning that a subgroup of participants perceived themselves as having a lower perceived socioeconomic status¹¹.

Across the life course, lower actual and perceived social and/or economic status is associated with poor physical (e.g., increased cortisol, impaired immunological function) and psychological health (e.g., anxiety), higher stress, and impairments in executive function (Abbott et al., 2003; Adler et al., 2000; Derry et al., 2013; Hackman, Farah, & Meaney, 2010; McEwen & Gianaros, 2010; Ursache, Noble, & Blair, 2015; Wilkinson & Pickett, 2003). Though differing somewhat between stable and unstable social hierarchies and populations, being and/or perceiving oneself as lower-ranking (or subordinate) in a social hierarchy is often associated with increased stress response and less adaptive neurocognitive functioning, whereas being higher ranking (or superordinate) is associated with decreased stress response and more adaptive neurocognitive functioning (Gesquiere et al., 2011; Noonan et al., 2014; Sapolsky, 2017; Sallet et al., 2011). Even a rank of 5, indicating perception of oneself as lower than half of all others in a society where higher socioeconomic status is associated with increased power, opportunity, prestige, and social worth, would have had the potential to contribute to negatively valenced states and increased stress

¹¹ A breakdown of this 35.3% of participants: 6.7% reported a rank of 1, 5.0% reported a rank of 2, 10% reported a rank of 3, and 13.6% reported a rank of 4.

response, particularly during interaction with a supraordinate, all of which could have influenced cognition and behavior related to drugs, including increased drug taking and relapse (Caldwell & Riccio, 2010; Covington et al., 2005; Covington & Miczek, 2001; Cruz, Quadros, Hogenelst, Planeta, & Miczek, 2011; Do Couto et al., 2006, 2009; Weiss, 2005).

That the entire sample is comprised of corrections-involved people with a history of drug use means that some participants may have experienced social, affective, cognitive, and physiological effects associated with lower status in respect to these stigmatized characteristics, as both groups are openly castigated and routinely experience discrimination, rejection, and marginalization (Fiske, 2005; Moore, Tangney, & Stuewig, 2016; Harris & Fiske, 2007; Major, Dovidio, & Link, 2017; Pachankis et al., 2017). It is possible that had participants been asked to rank their perceived socioeconomic status during the one-year period subsequent to incarceration that mean ranks would have decreased across groups as a result of having a stigmatized “felon” status, which was not necessarily the case for all participants prior to incarceration (Behrens, 2004; Copenhaver, Edwards-Willey, & Byers, 2007; Moore, Stuewig, & Tangney, 2013, 2016).

Non-drug Alternative Reinforcers

Social Satisfaction and Social Worth

Participants did not differ either prior or subsequent to incarceration in terms of social interaction, with >80% participants reporting spending the majority of their free time in some social capacity (e.g., with friends or family). Participants who used other drugs and stimulants during the 30-day period prior to incarceration had, on average, a greater number of close relationships and also reported receiving greater satisfaction from these relationships. It may be of some interest that stimulants, alcohol, and cannabis, used at high rates among these groups, are more often conceptualized as social or “party” drugs compared to opioids, meaning that some drug use among these groups may have been social (Freese, Miotto, & Reback, 2002; Green, Pickering, Foster, Power, & Stimson; 1994; Waldorf et al., 1992).

Reported social satisfaction was lower among participants who reported past 30-day concomitant and opioid use, with both groups also having slightly fewer close relationships on average. Although receiving satisfaction from social interaction was not associated with a change in odds of observing concomitant, opioid, or stimulant use prior to incarceration, receiving satisfaction from social interaction

was associated with a 50-60% decrease in the likelihood that concomitant, opioid, and stimulant use during the one-year post-release period would be observed. This was found when examining past-year heroin use as well; the odds of heroin use decreased by approximately 59% when social satisfaction was reported.

Sample-wide, the average number of close relationships decreased from 7.1 prior to incarceration to 6.1 subsequent to incarceration. While it is possible that fewer available non-drug choices, such as close relationships, may have contributed to drug use initiation and continued use, it is also possible that as a result of continued drug use and incarceration the real and perceived number of non-drug alternatives needed to help reinforce behavior away from continued drug use declined (Ahmed et al., 2010; Bickel et al., 2014; Lenoir & Ahmed, 2008; Staton-Tindall, Royse, & Leukfeld, 2007). As noted earlier, one possible result of continued drug use is that the number of avenues for pursuing non-drug opportunities decreases, as does the degree of support received from others. It can be challenging to be in a relationship with a person who continues to use high-risk drugs, in part due to the higher level of social dysfunction found among regular drug users (Cunha, Bechara, de Andrade, & Nicastrì, 2011). As use persists, relationships, which may in some cases have already been defined by dysfunction or discord, can become strained further, less satisfying, and possibly terminated (Collins et al., 2007; Mowen & Visser, 2015; Wallace et al., 2016). Fewer, and poorer quality, relationships would decrease some of the opportunity costs associated with continued use. This idea is partially reflected by the negative relationship observed between receiving satisfaction from social interactions and high-risk drug use that occurred during the one-year period subsequent to incarceration.

In addition to having the highest number of relationships on average subsequent to incarceration, participants who reported other/no drug use had the highest rates of social worth, meaning that a greater proportion of this group reported feeling “valued, supported, and cared about” by other people in their life compared to other groups. Conversely, participants who reported concomitant use subsequent to incarceration, who had the fewest close relationships on average, reported the lowest rates of social satisfaction. Although a majority of all groups reported feeling at least “somewhat” cared about or supported by people in their lives, the fact that rates differed by groups who reported more or less use helps to articulate the idea that family and friends may be less willing to remain invested in and supportive of people who continue to use high-risk drugs and also the idea that people who feel less cared about and

supported by others may come to believe that they have fewer reasons to moderate opioid and stimulant use and fewer avenues for accessing help. As noted earlier, positive social interaction can have a powerful influence on a person's perceived sense of well-being, psychological health, and cognitive functioning, whereas social isolation, social exclusion, withdrawal of social support, and other forms of social stress can produce cognitively damaging effects along with increases in drug craving and use (Abbott et al., 2003; Cole et al., 2011; Stein, van Honk, Ipser, Solms, & Panksepp, 2007; also see Heilig et al., 2016 for further discussion).

Education, Employment, and Leisure Time

Past-year educational and/or vocational involvement was similar across all drug use outcome groups prior and subsequent to incarceration. Although post-incarceration rates of employment are often higher than pre-incarceration rates among corrections-involved samples, educational/vocational involvement increased by only 2.0% between time periods, even though alcohol and other drug use decreased substantially, perhaps suggesting that participants' felony status made obtaining employment and entry into post-secondary education more challenging (Copenhaver et al., 2007; Duwe & Clark, 2017; Flake, 2015; Halkovic et al., 2013; Lam & Harcourt, 2003; Pager, 2003). This is a particularly compelling possibility given that the period subsequent to incarceration was after the 2007 economic crisis had stabilized, a time when the unemployment rate in Kentucky decreased annually from 8.4% in January 2012 to 4.4% in December 2017 (U.S. Bureau of Labor Statistics, 2019).

That a majority of participants who reported concomitant, opioid, and stimulant use both prior and subsequent to incarceration were employed or otherwise engaged in educational pursuits during the same time period raises the important point that drug use, licit or illicit, is not always mutually exclusive with other behaviors (Kowalski-McGraw, Green-McKenzie, Pandalai, & Schulte, 2017; Tiesman, Konda, Cimineri, & Castillo, 2019). Potentially rewarding non-drug alternatives, such as work and education, comprise activities, as does drug use, meaning that they are extended over time and are comprised of many temporally connected choices and behaviors (Baum, 2004). Many behaviors must be executed in a particular order prior to and during an activity, such as "going to work" and "being employed" or "using amphetamines" (Baum, 2004; Rachlin, 1995). Drug use, over a day or year, can be chosen or not chosen at different intervals, meaning that it can be avoided or approached in terms of trade-offs with family

obligations, employment, school, or other roles (Waldorf et al., 1992). A person may therefore choose to use amphetamines to excess, miss work or school, but then subsequently choose to put in extra hours or effort at work or school to offset this earlier decision to binge. For some participants, opioid and stimulant use might have continued to the point where the loss of a job or academic suspension from school became a credible threat or probable outcome, making them, at that point, mutually exclusive choices. That such patterns could not be discerned in this study, makes it an important avenue of investigation in future work.

Labor as Labor, and the Indignity of Work

An important possibility not to overlook is the fact that work may influence a person's willingness or desire to use opioids or stimulants. Although employment and educational involvement have been framed in terms of potentially rewarding non-drug alternatives, it may be that for some participants in this sample neither work nor school were associated with anything rewarding, and not contemplated of in terms of feeling more vested in their everyday lives and future. Instead, it may be that employment was simply an unpleasant means to achieving some meager economic end or fulfilling a stipulation of community supervision (Gurusami, 2017; Travis & Stacey, 2010). Because jobs are demanding and can be perceived, particularly by people with lower socioeconomic status, as something over which they can exert little control, means that employment can also be considered a possible source of stress (Kunz-Ebrecht, Kirschbaum, & Steptoe, 2004). That work is hard and not always rewarding should also not be overlooked. It is possible that the labor expended by participants in this sample was disproportionate to social and economic gains. Rather than contributing to participants' feeling as though they have "stake in the conventional life", disparities between effort and compensation may have, for some, produced a sense of disillusionment (Buck, 2001; Kahn, 2018; Shipler, 2005; Waldorf et al., 1992).

The histories of drug use and labor are indeed closely linked. The term "skid row" originates from logs being "skidded" toward lumber mills along stretches of road in the Pacific Northwest, where the supply of alcohol, opium, and other drugs proliferated to serve the many timber laborers who resided in the area and who routinely worked themselves to exhaustion under difficult conditions (Keniston-Longrie, 2009). Prior to incarceration, participants who reported past 30-day other drug use reported having more leisure days on average on a given week in which they could pursue hobbies or other activities of interest to them, whereas participants who reported past 30-day concomitant use had the fewest, even though the rate

of educational and/or vocational involvement between these two groups was similar. This means that having fewer leisure days was associated with overall greater drug use. Stimulant and opioid use as a form of misregulation may not be uncommon among employed people, particularly among people employed in physically and psychologically taxing, or otherwise tedious and dangerous, occupations, in which reducing pain and increasing stamina can be central to a person's ability to work or to work longer hours (Anglin, Burke, Perrochet, Stamper, & Dawud-Noursi, 2000; Dalla, Xia, & Kennedy, 2003; Gibson, Leamon, & Flynn, 2002). Indeed, some decisions to use opioids and stimulants may have been influenced by a perceived need to function or enhance performance in vocational or educational roles (Ahmad & Aziz, 2012; Arria et al., 2018; Dalla et al., 2003; Liu, Elliott, Striley, Gurka, & Cottler, 2019).

For participants without a high school or college degree, and particularly after a felony record was established, it is possible that many of the occupations that they were engaged in were challenging, exhausting, stressful, and associated with lower prestige, compared to people with high school and college degrees and no criminal record (Bridgeland, DiIulio, & Morison, 2006; Liker, 1982). Labor exploitation (e.g., forced day labor, temporary employment, percentage cut of hourly pay) among people with criminal histories, including among people on community supervision, is not uncommon (Elcioglu, 2010; Purser, 2012) and is reflected in some routine practices among US companies (e.g., PeopleReady, LaborReady) (Capstone Law, 2019; Theirman Buck Law Firm, 2019). It is not inconceivable, then, that some participants may have found it difficult to feel a sense of reward from working at Wal-Mart, picking up garbage, or toiling in a factory, let alone to achieve the feeling of having "a stake in the conventional life", and therefore more vested in their everyday life. The idea of working at Wal-Mart for the rest of one's life, assuming that working at Wal-Mart is not a person's life ambition, may contribute to depression or anxiety, feelings of resentment and disenfranchisement from the wealth of society in which they do not equitably share despite their hard work, and feelings of estrangement from their own future (Kraus et al., 2011; Shipler, 2005). Having a job in which one knows that they are easily replaceable, as is the case with almost all menial work in the US, also has the potential to create a sense of uncertainty. A belief that a bleak present will not give way to a brighter future may have the capacity to increase decisions to use high-risk drugs in the present (Buer et al., 2016). "Deaths of despair", which include premature mortalities associated

with drugs, have increased in the US, particularly among men without college degrees in economically depressed areas with high drug accessibility (Ruhm, 2019; Stein et al., 2017).

Central Appalachia

Central Appalachia is a geographic region spanning four states, Western North Carolina, Eastern Tennessee, Eastern Kentucky, and all of West Virginia. Fifty-four of Kentucky's 120 counties comprise part of this Central Appalachian region (ARC, 2019). Central Appalachia, and Eastern Kentucky in particular, have experienced historic disadvantage compared to other areas of the US and continue to experience economic and social hardship and collective uncertainty about the future (Billings & Blee, 2000; Eller, 2008; Greenberg, 2018; Hayes, 2018; Mather, 2004). There remain significant psychological and physical health disparities between Eastern Kentucky and the rest of the state, as well as the rest of the country (Crosby, Wendel, Vanderpool, & Casey, 2012; Hendryx, 2010). These are reflected by significantly higher rates psychological, developmental, and learning disorders, SUDs (including for nicotine), chronic illness, chronic pain conditions, cancer, obesity, and disability (Herath & Brown, 2013; Lane et al., 2012; Pugh, 2014; Rodriguez, Vanderford, Huang, & Vanderpool, 2018; Schoenberg, Huang, Seshadri, & Tucker, 2015). In Eastern Kentucky counties, the life expectancy is 9-12 years younger than counties in other parts of the state; between 2014 and 2017 the average life expectancy actually decreased, despite Kentucky's adoption of Medicaid expansion under the ACA, which increased access to care for many in the region (University of Wisconsin Population Health Institute, 2019). These disparities are partially attributable to greater difficulties in accessing preventative medical services or interventions, including for SUD (Hill, Cantrell, Edwards, & Dalton Sexton, Carlson, 2016; Leukefeld, Booth, 2008; Patrick et al., 2018; Staton-Tindall et al., 2015).

However, some disparities may also be attributable to economic conditions in the region, as 37 out of the 54 Kentucky counties within Central Appalachia are economically distressed (ARC, 2018). These counties rank in the bottom 10% of all counties in the US in terms of poverty and employment (ARC, 2018). Nationally, the poverty rate between 2011-2016 was approximately 16%, whereas for Central Appalachian Kentucky counties during this same time period, it was approximately 26%; in 2015, per capita income in these counties was \$19,204, sharply lower than the national per capita income of \$39,778.

For these reasons, Appalachian Kentucky may be conceptualized as a “harsh” environment (Frankenhuis et al., 2016; Meit et al., 2017).

Carpe Diem

Beyond the fact that these conditions may contribute to a scarcity mentality, residing in a harsh environment, such as Central Appalachia, has the potential to decrease opportunities for accessing rewarding non-drug alternatives, particularly when they require more effort or cost to obtain (e.g., needing to drive long distances, but not having a vehicle). Residing in a more rural part of Central Appalachia may present unique barriers for accessing non-drug alternatives, such as higher education, employment and economic advancement, civic organizations, sports clubs, mutual aid groups, and many types of leisure activities ubiquitous in urban and suburban areas (Buck, 2001; Denk, 2019; Nelson & Smith, 1999; Petry et al., 2001). Residing in a harsh region characterized by wide-spread hardship, premature mortality, restricted opportunity, and overall greater uncertainty about the future, would have had the potential to influence participants by increasing present-bias and decreasing risk-aversion in order to facilitate the immediate capture of rewards despite risk (Frankenhuis et al., 2016; Pepper & Nettle, 2013; Smith & Tickamyer, 2011). Though the future is always uncertain, and therefore less motivating when making decisions in the present, for participants in Central Appalachia, this uncertainty may be perceived as even greater. Why wait to enjoy something that may never materialize, when relief can be found in the present? In this way, living in a harsh environment might also engender propensity toward misregulation, with opioids and stimulants a possibly appealing anesthetic to bleak conditions (Buer et al., 2016).¹²

¹² Interestingly, factors that might be expected to differ between participants who resided in Central Appalachian and those who did not (e.g., chronic pain, misregulation, depressive symptoms, suicidal ideation) evidenced very few statistically significant between-group differences when examined (results not displayed). One difference, though, included higher unemployment among participants who resided in Central Appalachia prior (41.4% vs. 30.8%, $X^2=18.0$, $p<.001$), but not subsequent to incarceration (38.7% vs. 34.6%, $X^2=2.1$, $p=.146$). Other modest differences, though not statistically significant, were reflected by the fact that past 30-day income among participants who resided in Central Appalachia was slightly lower (\$1,194 vs. \$1,332, $t=1.43$, $p=.109$) and that a greater average portion of income was received through Social Security Disability Insurance benefits (\$862 vs. \$792, $t=.671$, $p=.503$). Participants who resided in Central Appalachia reported having more close relationships subsequent to incarceration (6.7 vs. 5.9, $t=2.30$, $p=.022$), though groups were approximately equal for the year prior to incarceration (7.0 vs. 7.1, $t=1.79$, $p=.858$). While there were no between-group differences for rates of feeling cared about or supported by others, there were differences for social interaction subsequent to incarceration, with a larger proportion of participants who resided in Central Appalachia reporting that they spent more free time with others, versus alone (91.1% vs. 87.2% , $X^2=4.5$, $p=.033$). Participants who resided in Central Appalachia during this same time also reported higher rates of social satisfaction (92.8% vs. 87.0%, $X^2=9.93$, $p=.002$).

Additional analyses (results not displayed) showed that participants differed across several drug-related variables depending on whether they resided within or outside of Central Appalachia. Participants who resided in Central Appalachia were more versatile users, using a greater number of different drugs on average during the one-year periods prior (4.1 vs. 3.6, $t=2.7$, $p=.007$) and subsequent (1.5 vs. 1.2, $t=2.44$, $p=.011$) to incarceration, had higher drug use severity scores (25.2 vs. 22.3, $t= 3.4$, $p<.001$), and had higher rates of being intoxicated at the time that they committed their offense (81.5% vs. 76.6%, $X^2=4.39$, $p=.036$). Older average age of drug use initiation, however, was found among participants who resided in Central Appalachia (15.1 vs. 14.5, $t=2.31$, $p=0.20$). Participants who resided in Central Appalachia had higher rates of IDU history (56.6% vs. 37.0%, $X^2=50.6$, $p<.001$), though rates of IDU reported subsequent to incarceration were equivalent (7.2% vs. 10.8%, $X^2=2.64$, $p=.881$). Because of the difference in IDU history by Central Appalachia residence, infectious disease was also explored. Participants who resided in Central Appalachia prior to incarceration were significantly more likely to report having Hepatitis C (15.3% vs. 7.1%, $X^2=22.6$, $p<.001$), though no participants who resided in Central Appalachia reported having HIV.

As presented in Chapter 4, a greater proportion of participants who reported opioid use prior and subsequent to incarceration resided in Central Appalachia, whereas a greater proportion of participants who reported stimulant use resided outside of Central Appalachia. This relationship was evidenced further by the finding that Central Appalachian residence prior to incarceration was associated with a 64% increase in odds of past 30-day opioid use and a 37% decrease in odds of past 30-day stimulant use. Subsequent to incarceration, Central Appalachian residence was associated with a nearly 117% increase in the likelihood of past-year prescription opioid use. Heroin and cocaine/crack cocaine were used at lower rates among participants residing in Central Appalachia, potentially reflecting overall greater availability and use of these drugs in urban areas (Habecker, Welch-Lazoritz, & Dombrowski, 2018; Jalal et al., 2018). Odds of observing past-year heroin use decreased by approximately 62% subsequent to incarceration by Central Appalachian residence. At both time periods, rates of prescription opioid and buprenorphine use were higher among participants residing in Central Appalachia, potentially attributable to the significantly higher per 1,000 rates of opioid and buprenorphine prescribing found in Eastern Kentucky and wider-spread acceptability of prescription opioid use found in rural areas of Kentucky (Havens, Talbert, Robert, Cynthia, & Leukefeld, 2006; CHFS, 2019; Havens, Young, Havens, 2011). Amphetamine use did not differ

significantly between Appalachian and non-Appalachian regions, suggesting that this drug may be equally accessible, or manufacturable, across regions (Weisheit & Brownstein, 2016; Sexton, Carlson, Leukefeld, & Booth, 2006; Stoops et al., 2011). That amphetamine drugs include both “street meth” as well as prescription stimulants means that it is also possible that some amphetamine use among participants who resided in Central Appalachia was attributable to diverted prescription stimulants, though this may have only accounted for a small portion of stimulant use and may have been more common among younger participants (Cassidy et al., 2015; Kroutil et al., 2006).

Kentucky counties in Central Appalachia are predominately rural, meaning that they are not proximate to major urban drug markets, such as Louisville or Cincinnati, which borders Kentucky and continues to be a source of heroin for Northern and Central Kentucky (Stewart, Cao, Hsu, Artigiani, & Wish, 2017).¹³ Accessibility to drugs based on urban influence was highlighted by some of the findings in this study. For instance, prior to incarceration, rates of prescription opioid use were highest among participants who resided in more rural counties compared to heroin, which was used at higher rates among participants who resided in urban counties. Subsequent to incarceration, rates of heroin use were still highest among participants who resided in urban counties and prescription opioids, while still used at high rates in rural areas, decreased from pre-incarceration rates, likely reflecting decreases in opioid prescribing that began in 2012. Buprenorphine was used at higher rates in rural areas during the period prior to incarceration, but not subsequent. Heroin availability and use continues to increase in rural Appalachia, but during the time that data were collected was simply less available than prescription opioids and other drugs (Cloud, Ibragimov, Prood, Young, & Cooper, 2019; Moody, Satterwhite, & Bickel, 2017).

As noted in earlier chapters, accessibility has the potential to shape drug preferences, not only because it exposes a person to a drug more regularly, thus increasing the probability of use and later possible dependence, but also because it decreases the effort needed to obtain the drug. Driving 80 miles to buy heroin costs more in time, effort, energy, and risk for contact with law enforcement than driving 10 miles to buy prescription opioids. It may be that among participants who resided in Central Appalachia, proximity to drugs was an influence on decision-making and the development of drug preferences. This is

¹³ The mean urban influence for non-Appalachian counties was 3.1, whereas the mean urban influence for Appalachian counties was 7.7 (range=1-12).

partially reflected by the fact that rates of county-wide opioid and buprenorphine prescribing were higher in Central Appalachia during the time periods examined in this study, and that rates of prescription opioid and buprenorphine use were higher among participants who resided in these counties (CHFS, 2019). It is further reflected by the fact that prescription opioids (39.6% vs. 18.4%), buprenorphine (6.5% vs. 0.8%), and prescription sedatives (4.4% vs. 2.3%) were more often preferred among participants who resided in Central Appalachia, whereas heroin (4.8% vs. 12.1%), cocaine (5.2% vs. 10.3%), and alcohol (8.5% vs. 15.3%), were more often preferred among participants who resided outside of Central Appalachia ($X^2=164.2$, $p<.001$). Unrestricted alcohol sales did differ significantly by residence within or outside of Central Appalachia, with the latter having overall greater access to unrestricted alcohol sales (72.8% vs. 19.6%, $X^2=375.78$, $df=1$, $p<.001$). This may account for slightly lower preference for alcohol. Amphetamines were preferred approximately equally across regions (15.1% vs. 15.2%) and used at similar rates across regions.

Ambiguous Risk

It is unclear, though, the extent to which participants' decisions to use high-risk drugs meaningfully differed according to living within a harsh region, such as the Central Appalachian region of Kentucky. However, other studies have documented risky drug practices among people in Kentucky who reside in rural Appalachia and have found associations between high-risk drug use in this region and economic distress (Cloud et al., 2019; Havens, Oser, & Leukefeld, 2011; Staton-Tindall, Webster, Oser, Havens, & Leukefeld, 2015). Though Central Appalachia and other distressed rural areas continue to be associated with "deaths of despair", hardship, and widespread uncertainty, there were also other factors present among participants who resided in Central Appalachia that could have influenced drug-related decision-making (Erwin, 2017; Meit et al., 2017; Segal et al., 2017; Woolf, Schoomaker, Hill, & Orndahl, 2019). For instance, many participants who resided in Central Appalachia reported having close relationships, social interaction, and social satisfaction, which could all be considered as rewarding non-drug alternatives.

Still, drug use and involvement with family, friends, work, or other activities is not mutually exclusive, and it could be that some participants were interacting with friends, family, or intimate partners who also used high-risk drugs (Fleming et al., 2010; Havassy, Hall, & Wasserman, 1991; Mayock, Cronly,

& Clatts, 2015; McCrady, 2004; Staton et al., 2018). Family-wide drug use and greater cultural acceptance of drug misuse is not uncommon in the Central Appalachian region of Kentucky (Jonas et al., 2012; Keyes et al., 2014; Leukefeld et al., 2007; Young, Havens, & Leukefeld, 2010). In fact, some rural, drug-using women in Appalachian Kentucky have reported feeling “stuck” to the region, other people within the region, and to prescription opioids as a fixture of the region and relationships, with myriad constraints on their ability to make different drug-related decisions (Buer, Leukefeld, & Havens, 2016).

It should not be overlooked that some participants who resided outside of Central Appalachia resided in regions that, while not broadly and diffusely harsh, nevertheless may have contained concentrated harsh locales that influenced decisions to use opioids and stimulants (e.g., blocks, neighborhoods, zip codes) (Boardman, Finch, Ellison, Williams, & Jackson, 2001; Dear & Wolch, 2014; Schroeder et al., 2001; Stull et al., 2019). That participants did not differ by region for characteristics such as psychiatric symptoms, chronic pain, suicidal ideation, stress-related health effects, and financial distress may not discredit the notion that Central Appalachia constitutes a harsh region with the potential to influence cognition and choice, so much as lend support to the idea that participants who resided outside of Central Appalachia may have also resided in harsh urban and suburban areas. This is reflected by the fact that, compared to the general population, the entire sample had higher rates for many factors with the potential to unfavorably influence decision-making in relation to high-risk drugs.

Overall, findings indicate that drug use may not have been necessarily or straightforwardly riskier among participants who resided in Central Appalachia, but rather that it had a different tenor. Participants who resided in Central Appalachia did evidence overall greater drug use severity and versatility, using more drugs on average compared to participants who resided outside of Central Appalachia. These participants not only used prescription opioids with or contemporaneous to amphetamines, alcohol, prescription sedatives, buprenorphine, and to a lesser extent cocaine and heroin, but also reported significantly higher rates of IDU. That said, participants who resided outside of Central Appalachia also reported high rates of opioid and stimulant use, with heroin, perhaps the riskiest drug that could be used during the time periods explored in this study, used at higher rates. Considered together, and in combination with findings previously discussed, it may be reasonable to suggest that high-risk drug use is

endemic across the sample, even as it varied by time period, specific drug type, residence in or outside of Central Appalachia, and other factors already highlighted.

Broader Implications and Future Directions

The Road Back to Hell is Still Paved with Good Intentions

The idea that guided this exploratory study is that there are many endogenous and exogenous factors with the ability to influence and constrain drug-related decision-making and behavior. This pertains to people before they choose to take their first drug and at all points thereafter. As prior decisions to use drugs accumulate, a person's capacity to choose to do otherwise in relation to drugs becomes more, not less, difficult. In the extreme, and under the right conditions, choosing drugs over all other choices is not unthinkable, meaning that it is imperative to understand what motivates continued drug use despite great risk and great cost.

Part of the behavioral economic perspective of drug use includes an understanding that many psychological, affective, and neurophysiological states and changes occur when addictive drugs such as opioids and stimulants are used. Brain changes are, after all, endogenous to the person and can contribute to the person's pathological overvaluing of drugs and their continued use despite costs (Heyman & Mims, 2015). In this way, there is some harmony between the behavioral economic/neuroeconomic conceptualization of drug use that persists despite adverse consequences and the BDMA conceptualization, suggesting possible common ground for advancing a more nuanced understanding of the nature of the problem (Fenton & Wiers, 2017). But, in order to better make sense of and intervene on these endogenous factors, and to better understand how decisions to use high-risk drugs can continue despite adverse consequences, it may also be necessary to identify and examine people's *overall* set of available capacities and choices prior to and during a period of problematic use, along with the contexts in which drug-related decisions are being made (Bickel et al., 2014).

This study used a molar view of choice (Baum, 2004; Vuchinich & Heather, 2003) to identify and explore several factors with the potential to influence decision-making about high-risk drugs among a sample of corrections-involved adults using available survey data. In so doing, it was able to help articulate the idea that endogenous and exogenous conditions have the capacity to constrain choice and behavior.

Broadly and indirectly, some study findings helped to illustrate the important idea that influences on decision-making and behavior are not always in the direct awareness or control of people. These ideas may be extended in future work to consider how endogenous and exogenous conditions also have the capacity to influence and constrain the formation of desires and intentions, both of which are important for understanding high-risk drug use. As discussed earlier, a person's preferences may be ordered:

- 1) Not be addicted to heroin.
- 2) Inject heroin.
- 3) Do not inject heroin.

This could also be reflected as conflicting desires that constrain a person's will, in which a first-order desire constrains a second-order desire, making it impossible for a person to act on their desire (Mann, 2004)¹⁴:

- 1) Wants to inject heroin.
- 2) Does not want to inject heroin.

A better understanding of the ranked preferences and desires of people who use drugs would help to clarify choice and behavior in respect to use. There is an important clinical difference between:

- 1) Continued drug-taking despite a person's desire to stop
- 2) Continued drug-taking because of a person's desire to continue.

There is also an important clinical difference between:

- 1) Remitted drug-taking despite a person's desire to take drugs.
- 2) Remitted drug-taking because of a person's desire to not take drugs.

If facilitating a state of remission or achieving a state of abstinence is a principal goal when addressing SUD, then both cases of the latter example might be considered treatment success. But it is easy to see why the differences between the two matter. Achieving a behavioral change without also achieving a change in desire or intention, assuming it is even possible, may be missing the bigger point: most of us

¹⁴ "One has freedom of will if one is free to want what one wants to want; if, that is, there is harmony between one's first-order desires and one's second-order desires. A narcotics addict who takes drugs because he wants to has freedom of action. Nonetheless, he lacks freedom of will if his second-order desire not to have a first order-desire for narcotics is powerless over the first-order desire" (Mann, 2004, pg. 286).

would rather live in a world in which people's lives are of a quality that they no longer want to choose to take drugs with significant risks and at tremendous cost.

A person's primary and secondary intentions in relation to drugs are also of interest and warrant investigation. Future study of people's ranked intentions is a potentially useful area of exploration, insofar as intention precedes purposeful and planned behavior and insofar as intentions cannot be formed except by a broader set of conditions which, in theory, have the potential to be manipulated or improved (Bratman, 1987, 1999). For instance, a person may be able to form a primary intention to quit using drugs if sufficiently appealing services or non-drug options were offered. Even with this primary intention formed, secondary intentions (e.g., not calling the drug dealer, throwing away syringes and not buying new ones, developing non-drug routines etc.) would still need to be reinforced over time. Because the formation of intent is conditional and temporally situated, it is important that future work not only examine intentions related to drug-related choice and behavior, but also seek to understand what conditions influence their development and ability to be acted upon (Bratman, 1987, 1990). Further examination of intentions related to drugs may also help bridge some of the conceptual divide between the BDMA and behavioral economic/neuroeconomic model. While the BDMA does emphasize desire and behavior, choice and intention are de-emphasized.

Detailed study of discrepancies between desires, intentions, choice, and behavior in relation to drug use, moderation, and cessation may begin to reduce some of the assumptions made during research and practice. For instance, it cannot be assumed that any participant in this sample wanted to use opioids or wanted to stop using opioids, or that they intended to keep using cocaine subsequent to incarceration or intended to quit using cocaine subsequent to incarceration. Even though participants' drug-related decisions were implied by their behaviors, participants' desires and intentions, and the exogenous and endogenous conditions which may have influenced and constrained their development, could not be inferred from any study data. Nor could any conflict or agreement between ordered preferences, desires, and intentions be discerned, leaving many fundamental questions to be addressed in future studies. This is important to work towards, because, ultimately, rates of drug use or abstinence subsequent to any intervention lose much of their meaning if the degree of concordance or discordance between the goals of treatment and the goals of the people receiving treatment are not also known. Insofar as there is discordance between the two, policies

and practices may continue to fall short, and people who may otherwise benefit from tailored treatment or from harm-reduction intervention may not been given access to potentially beneficial services that take into account what it is that they as people want and intend.

Additional Considerations for Future Work

This study identified many factors with the potential to have influenced decisions about opioids and stimulants, but because of this broadness of scope, both conceptually and from a measurement standpoint, there was no way define what was of greatest influence on decisions to use. Because there are in reality even more factors with the potential to influence drug-related decision-making then were discussed or examined here, it will be important moving forward to develop a more parsimonious study of what remains a complex phenomenon.

This may be accomplished, in part, by significantly narrowing the scope of future investigation and improving data collection methods, but also by examining a few select aspects of drug-related decision-making from different angles. For instance, the use of ecological momentary assessment and other sophisticated data collection methods that allow for passive and active data collection, coupled with structured interviewing, would facilitate measurement of some proximate influences over a period of time, but also more nuanced exploration of participants' desires and intentions (Buckner, Crosby, Silgado, Wonderlich, & Schmidt, 2012; Epstein et al., 2009; Moore et al., 2014; Onnela & Rauch, 2016; Roth, et al., 2017; Shiffman, Stone, & Hufford, 2008). Despite some of the inherent limitations of using qualitative data, this type of information has the potential to reduce the burden of interpretation for some findings (or rather add an additional layer of data for interpretation, depending on how one wishes to view this). Had such data been available for examination in this preliminary study, they would have likely helped to provide a fuller picture of drug-related decision-making than was able to be established. In addition to EMA and structured interviewing, neuroimaging, biosensors, and biological measures could also be used in a limited capacity, helping to provide a fuller picture of how people's decision-making may be influenced during a particular period of time. Longitudinal studies (particularly those beginning during childhood and adolescence), though more challenging and costly to conduct, are particularly needed to help move this area of research forward. Aiming for data collection across multiple levels and time scales would help to establish a line of research that gives primacy to understanding endogenous and exogenous factors that can

constrain choice and behavior in real-time *and* over time, and may permit study of how people's desires and intentions can vary as a function of broader conditions.

Of particular interest would be to investigate if the conditions of incarceration, which often include enforced abstinence, change cognition in respect to drugs. People with a history of opioid and stimulant use who are on community supervision or who are participating in drug court programs would be more likely to become incarcerated than other drug-using populations. These populations might be studied over time to see how cognition, desires, and intentions change as a function of being in a controlled environment where abstinence is enforced. Confinement in jail or prison might conceivably have the potential to decrease present-bias and increase future-oriented cognition. For some, time spent in a controlled environment may help achieve, at least temporarily, greater consonance between what their current self and future self value. Presently, these possibilities are offered here as speculation. However, should a study of drug-related cognition and temporal perception among people residing for long periods of time in a controlled environment be developed, it may be able to inform how interventions for corrections-involved populations are developed. Measuring present-bias, craving intensity, attentional bias, and temporal perception, along with ranked desires and intentions, during periods of incarceration might help to explain differences in lapses and relapses following release. As noted by Epstein et al. (2006), there is an important difference between abstinence that is imposed by external circumstances and abstinence that occurs under conditions which permit volitional drug use as well as volitional abstinence. Focusing on preferences, motivations, and intentions across contexts during future research will be crucial for developing a more well-rounded understanding of drug use that occurs subsequent to people's release from controlled environments.

Future work would also benefit from more diverse sample, not just in terms of race, sex, and age, but also in terms of educational status, income, and geographic location of participant residence. Greater heterogeneity of residence would permit further exploration of the idea that residing in harsh environment might influence drug-related decision-making. Such work might be undertaken in Tennessee, West Virginia, and Kentucky to examine differences between people who reside within or outside of Central Appalachia, but might also be undertaken in highly urban areas, such as Chicago or Baltimore, based on the block, neighborhood, or zip code (Furr-Holden et al., 2010; Stockdale et al., 2007; Stull et al., 2019).

Finding Common Ground?

Regardless of whether addiction is ultimately conceptualized as a reinforcer pathology or as a brain disease, if the major approaches for understanding drug use and addiction can agree on the premise that people who use high-risk drugs do not have direct awareness or control over many of the factors that influence their ultimate behavior, and that as a result of repeated use they have fewer degrees of freedom in thought and action in respect drugs, then there may be agreement enough to move forward in collectively asking and answering the question of how intervention of high-risk drug use may be improved ethically in light of shared belief in this premise (Hyman, 2017). Presently, bioethical frameworks for clinical decision-making in SUD intervention are not well-developed and may be wholly absent within some settings, such as peer-delivered recovery services and mandated programs affiliated with 12-Step models of recovery (Bassuk, Hanson, Greene, Richard, & Laudet, 2016; Bøg, Filges, Brännström, Jørgensen, & Fredriksson, 2017; Logan, Miller, Cole, & Scrivner, 2018). This means that certain practices, such as collaborative treatment planning or obtaining informed consent that is truly informed, cannot be taken for granted (Walker, Logan, Clark, & Leukefeld, 2005).

Significant heterogeneity among SUD interventions is not necessarily a bad thing, as the factors that influence drug use differ across people. However, across mandated and voluntary SUD interventions there remain shortfalls in evidence-based practice (with some research-informed interventions unable to be implemented with fidelity to the underlying science), and continued reliance on non-professional services (Alcoholics Anonymous, 1994; Bøg et al., 2017; Butler, Chapman, Forman, & Beck, 2006; De Leon, Perfas, Joseph, & Bunt, 2015; Logan, Miller, Cole, & Scrivner, 2018; Oser, Harp, O'Connell, Martin, & Leukefeld, 2012; Walker, Godlaski, & Staton-Tindall, 2013). Beyond this, evidence-based practice constitutes a *process* that includes taking into account not only scientific findings, but also the goals, preferences, and needs of people on an individual basis (Elwyn et al., 2012; Gambrill, 2006; Sackett, 1997).

The wide-spread awareness of the BDMA and the lack of awareness about the behavioral economic/neuroeconomic model of addiction across many service providers may, however unintentionally, encourage an overly simplistic view of and morally ambiguous response to the problem of high-risk drug use (Hall, Carter, & Forlini, 2015; Hammersley, 2019 Kirby, Benishek, Dugosh, & Kerwin, 2006). This may be partially due to the BDMA's narrower scope, but also due to the language commonly associated

with this perspective that de-emphasizes the roles of intention, choice, and agency (NIDA, 2018). Because the BDMA, however unintentionally, finds itself in some rough conceptual agreement with 12-Step models of addiction (i.e., alcoholics and addicts have “an allergy” to alcohol and drugs, but continue to use despite this allergy because of spiritual estrangement), an overly simplistic, and still not quite clear, view of the problem might continue to persist among treatment providers and treatment-seekers alike (Alcoholics Anonymous, 2008; 2009, 2014; NIDA, 2018). Worryingly, the BDMA’s de-emphasis of choice, intention, and agency does not yet seem to have resulted in fundamental transformations in how people with SUD are treated socially or within systems of intervention (Carter & Hall, 2017). This is partially reflected by the continued practice of incarcerating people for using drugs, even though drug use is, by definition, part of the disease (Bureau of Justice Statistics, 2018). That addiction is considered to be a disease that is both chronic and relapsing may also inadvertently influence the degree to which the public, policy makers, clinicians, and people who use drugs believe that meaningful change is possible, even though evidence suggests it is (Heyman & Mims, 2016; Wiens & Walker, 2015).

Seeking to better understand drug use within a system of constraint, in which constraints on desire, intention, choice, and behavior are *all* more unequivocally considered, may permit, perhaps a bit paradoxically, some exoneration, while also better allowing for the person’s humanity and dignity to be present in a way that the BDMA less readily permits. By directly acknowledging and purposefully studying people’s capacities for forming desires and intentions, making decisions, and undertaking action, the lines of their personhood may become more evident and the factors which influence their decision-making about drugs more readily addressed. The degree to which investigation of and discussion about drug use involves or omits the idea of a decision-making agent is the degree to which people’s values, preferences, and goals may be neglected during intervention. Omitting some of these central ideas may incline treatment providers to aim primarily for the problem *behavior*, without also aiming to identify and better understand the conditions that make that behavior possible. It also means that, in theory, decrease in substance use might be sought as an isolated target outcome without ever treating the person who decided to use drugs and without asking them what they desire and intend, and under what conditions they believe fulfilling those desires and intentions are possible. Many SUD interventions and recovery services in the US, especially mandated ones, do not commonly take into account what the person using drugs actually wants or desires,

or how those desires may be at odds. It may be that because of the externalizing nature of SUD there is little sympathy for what the person using drugs wants or intends. Or it may be that, due to the increasingly accepted notion that drug users have a chronic and relapsing brain disease, there is a belief that drug users cannot be trusted to know what it is they want or intend, or that there is little point in asking due to the putative permanence of the condition.

It is in some ways easier to talk about, research, and moderate certain behaviors (e.g., “using” versus “not using”) than it is to talk about, research, and target cognitive states (e.g., desire, intention), even though the two are inextricably linked (Bandura, 1986; Beck & Haigh, 2014; Bratman, 1999). But it may be unwise to think that behaviors can be understood and moderated in the long-term, versus achieving a short period of remitted abstinence, without first seeking to better understand, clarify, and moderate people’s desires, intentions, cognitive capacities, and conditions prior to choice. Aiming to better understand and address people’s desires, intentions, and cognitive capacities in relation to drug-related decision-making, and aiming to improve the conditions in which these states and decisions are formed, has the potential to produce outcomes that are more expansive and enduring, as well as more faithful to the concept of person-centered care, compared to efforts that seek primarily to achieve just the behavioral outcome (e.g., remission or abstinence). It would also imply that prevention is equally if not more important than intervention.

Limitations

There were many important limitations to this exploratory study. First, because this sample was a comprised of corrections-involved participants in Kentucky, generalizability of any finding is limited. Second, using data from a survey that was not designed with the primary concern of establishing the intercorrelation of variables, or their relation to the outcomes examined in this study, poses a threat to validity in terms of temporal ambiguity (Langley, 1999; Shadish et al., 2002). Here, the temporal order of some factors and their influence on opioid and stimulant use outcomes cannot be established within or across given time periods (e.g., past-year, past 30-days, past 7-days). For instance, if someone experienced depressive symptoms during the past year, the relationship to an outcome of past 30-day use is far from direct. This is related to the fact that the CJKTOS surveys used to collect data contained measures created for other purposes and were unconcerned with theoretically-informed causal modeling. This may not be a

limitation, per se, as this study was exploratory and sought principally to identify and describe some approximate contiguity or coincidence between endogenous and exogenous factors and high-risk drug use, making it agnostic about which constructs were “crucial” for causation (Bagozzi & Yi, 2012; Hume, 2007; Shadish, 2002). This is noted simply as an acknowledgement that the measures used to collect data were not developed or implemented for purposes other than clinical use and program evaluation. This is a fact that may be applied to several other study limitations discussed in this and in previous sections.

Third, opioid and/or stimulant use (or no use) during a particular time period represents not just one decision, but many. It is likely that most in this sample did not decide to use a given drug only one time per day or month during the 30 days prior to incarceration or the one-year period subsequent to incarceration, but rather multiple times over these time periods, potentially dosing one or more drugs dozens of times per day, or even hour. For powder and crack cocaine, it is likely that the number of the decisions made to use the drug is greater than other drugs, given the pharmacological differences of cocaine relative to other drugs whose subjective psychoactive effects and half-life are relatively longer (Cone, 1995; Gawin, 1991, Jenkins, Oyler, & Cone, 1995). It should be understood, then, that *many* drug-related decisions were being made contemporaneous to each other, in relation to proximate factors with the potential to influence decision-making (e.g., anxiety symptoms, chronic pain, living in Central Appalachia), and in relation to other, more distal factors (e.g., age of drug use initiation) with the potential to influence decision-making.

Fourth, random error is an inevitable part of any measurement process, but in this study, there are potentially several sources of nonrandom error, wherein instruments do not measure what they purport to measure, either in regard to states of the world at certain time points, or in regard to abstract concepts (Althauser & Heberlein, 1970, Carmines & Zeller, 1979; Werts & Linn, 1970). For example, participant self-report in the form of discrete descriptions, that can only be one particular way or another (e.g., sex, age), or in the form of descriptions of their life during a given time period (e.g., nights spent in a controlled environment), can result in measurement error by only allowing participants to select from prefigured categories. These categories may not provide a full range of response options that accurately reflect the participant’s lived experience (Coughlan, Cronin, & Ryan, 2009). For instance, powder cocaine and crack cocaine could not be examined as separable decisional outcomes, as the CJKTOS survey combines the two

in both baseline and follow-up surveys. It is likely that different factors would influence the likelihood of observing a decisional outcome for powder cocaine versus crack cocaine (Guindalini, Vallada, Breen, & Laranjeira, 2006; Hatsukami & Fischman, 1996).

Additionally, measurement at other levels, such as the availability of alcohol within counties, was imprecise given the heterogeneity of alcohol prohibitions at the city and county-level across Kentucky. Although alcohol was considered as either “restricted” or “unrestricted”, there was inevitably some variation between restricted counties, due to within-county differences in city statutes for the conditions of permissible alcohol sales, including by type of alcohol and type of establishment in which alcohol may or may not be distributed. The question pertaining to “current marital status” did not capture current relationship status, making it impossible to know if participants were in a committed relationship outside of legal marriage.

Nonrandom error was also possible, and perhaps more probable, in the measurement of variables indirectly indicating abstract concepts (e.g., impulsiveness), variables indicating the presence or absence of psychiatric constructs (e.g., anxiety symptoms), or variables indicating severity of somatic states (e.g., chronic pain). Nonrandom error may have also been introduced by the ways survey questions were worded. For instance, participants’ response to items with ambiguous terminology (e.g., the number of close relationships participants believe they had, for which the concept of “close” is utterly subjective) and for which the surveys did not attempt to establish greater objectivity or linguistic coherence by defining terms (Searle, 2008). That the question pertaining to abstinence self-efficacy did not permit a response that clarified if participants intended to remain abstinent makes interpretation of that variable oblique at best.

Fifth, this exploratory study used single-item indicators and composite variables. Both have their limitations. Although the validity and reliability of single-item indicators have been questioned, and their use cautioned against in some instances, there is growing evidence and support for their limited use (Abdel-Khalek, 2006; Bergkvist & Rossiter, 2007; Nagy, 2002; Sarstedt & Wilczynski, 2009). Some studies have found that single-item indicators have acceptable performance for reliability and construct and criterion validity (Gardner, Cummings, Dunham, & Pierce, 1998; Elo, Leppänen, & Jahkola, 2003; Ruckert & Churchill, 1984; Wanous & Hudy, 2001; Wanous & Reichers, 1996; Youngblut & Casper, 1993). After consulting various sources, it is reasonable to state that single-item indicators--while not always preferable

and not equal to multi-item measures in predictive validity-- may still be used with caution and with understanding of their limitations. Single-item indicators can be helpful, and are sometimes necessary to bridge theoretical demands and problematic data collection methods that arise out of practical necessity (e.g., to reduce survey length, secondary data analyses; institutional and clinical considerations) (Bergkvist, 2015; Diamantopoulos, Sarstedt, Fuchs, Wilczynski, & Kaiser, 2012; Fuchs & Diamantopoulos, 2009; Loo, 2002; Wanous, Reichers, & Hudy, 1997). Use of single-item indicators in this study was therefore undertaken with appropriate caution and with an understanding for how they may have the potential to weaken conceptual claims made upon the data and hinder interpretation.

Although composite variables created for use in this study were evaluated for internal consistency reliability, there is no way to measure criterion validity, just as criterion validity could not be assessed for the single-item indicators used (Carmines & Zeller, 1979; Messick, 1975). It is also important to note that while some validated instruments, or items from validated instruments, were adapted for use as part of the CJKTOS surveys, these changes did not undergo validity or reliability testing. Other composite variables used consisted of CKTOS survey questions that were created by CDAR researchers and the KY DOC Substance Use Treatment Director during survey development. It is important to emphasize the fact that CJKTOS surveys are intended for use both clinically and as an outcome study evaluation tool. Therefore, there is no established validity for CJKTOS surveys nor survey sections, even as they are standardized in their content format during a given FY so as to minimize burden on participants (Dillman, Smyth, & Christian, 2014; Tourangeau, Couper, & Conrad, 2004).

Sixth, additional potential threats to validity due to other issues. Some of these issues include the possibility of: 1) social desirability bias or interviewer effects, 2) test fatigue/survey length, 3) instrument changes between baseline and follow-up, 4) possible participant difficulties with verbal and reading comprehension, mendacity, or poor recall, and 5) other conditions present during data collection and testing that cannot be known or accounted for (Cook & Cshadish, 1994; Davis, Couper, Janz, Caldwell, & Resnicow, 2009; Lavrakas, 2008a; Pedhazur, & Pedhazur-Schmelkin, 1991; Holbrook, Green, & Krosnick, 2003; Richman, Kiesler, Weisband, & Drasgow, 1999; Shadish, Cook, & Campbell, 2002). However, among samples of drug users, including those who are corrections-involved, self-report of drug use and drug-related behaviors has been found to be reliable (Del Boca & Darkes, 2003; Del Boca & Noll, 2000;

Denis et al., 2012; Zanis, McLellan, & Randall, 1994). In this study, the probability of nonrandom error being introduced was likely higher at baseline, as there were a greater number of different SAP clinicians collecting baseline data across multiple institutional settings, compared to the fewer number of different CDAR research staff collecting follow-up data via telephone in a non-clinical capacity (Dillman, 1978; Fink, 2015; Holbrook et al., 2003). Further, at baseline, some participants may have self-administered the survey, whereas others provided verbal responses to survey items read by SAP clinicians. This variation in survey administration and response format, within baseline data collection and between baseline and follow-up data collection, is one potential source of error (Carmines & Zeller, 1979).

Seventh, despite that this study was developed with the idea of exploring the possible influence of participant residence as an important exogenous factor with the potential to influence decision-making about high-risk drugs, it was unable to be investigated with the depth or precision needed due to insufficient sample size, and in some cases insufficient variance. Accordingly, county-level measures initially proposed for examination (e.g., wealth inequality, poverty, opioid prescribing rates) were unable to be explored. However limited, urban influence and residence in Central Appalachia did reveal some important differences in opioid and stimulant use.

Eighth, using a behavioral economic approach for thinking about drug-related decision-making and drug use was a necessarily expansive approach, as it explicates drug use from a molar perspective of choice. The potential expansiveness of behavioral economics and a molar account of choice reflects, among other things, a conceptual sensitivity to the complexities involved, including context and time. This expansiveness opens the door to narrow and broad investigation alike (Tomer, 2007). Conceptual breadth permits researchers a fair degree of empirical latitude, as well as use of a variety of methodologies and data sources, including survey data (Katona, 1951, 1975; Tomer, 2007). But with breadth and inclusiveness, comes the potential for loss of specificity of inquiry, decreased likelihood for incremental advancement of parochial subareas, and, in some cases, an inability to reproduce or replicate methods or findings. Given that this exploratory study was not designed with reproducibility or replicability in mind, but rather with conceptual breadth in mind (even at the expense of specificity), some allowances for investigating the problem of high-risk drug use in a coarse-grained manner might be made. This coarse-grained approach may be considered as a starting point for future work.

Because the outcome variables used in this study are understood from a molar view of choice as the behavioral indicator of a drug-related decision, but because participants were not asked specific questions about some of the important factors that may have influenced decision-making, such as drug price, drug availability, intent, perceived risks, etc., important gaps between conceptualization and measurement remain. Opioid and stimulant use explored in this study reflect the fact that a drug-related decision occurred prior to the behavior (e.g., heroin use during the one-year period subsequent to incarceration is the behavioral referent of a heroin-related decision that occurred during that one-year period). One limitation already noted is that the frequency of decisions could not be quantified. Another is that many other non-drug choices that would have been of interest to explore were likely made during these time periods, but were not able to be indicated with available data. Again, due to temporal ambiguity, it was not possible to discern the temporal relation between “an influence” and “that which was influenced”, but rather only possible to understand that there was co-occurrence during a given time period (30 days, one year, or a lifetime) of potential influences and decisions involving high-risk drugs.

Finally, in seeking improved understanding of choice and behavior in relation to high-risk drugs, the identification of an appropriate stopping point for data collection, statistical modeling, and discussion was not always clear. The premise underlying this exploratory study, that endogenous and exogenous factors of a participants’ lives influenced and constrained drug-related decision-making and behavior, paved the road generously toward narrow and precise investigation, as well as and broad and coarse investigation. One potential strength of this study, its broadness in conceptual scope, was also a limitation in terms of how data were selected for examination and in terms of how such broad conception could be statistically modeled. Using institutional survey data, many self-reported factors of participants’ lives were able to be explored and, to a limited extent, indirectly discerned, thus illustrating some important concepts. Doing this, though, did not encourage recognition or emphasis of what factors mattered most; nor could it have. The absence of focus on any one factor or set of factors stemmed partially from measurement limitations, but also from the fact that from this study’s outset nothing was presumed to be irrelevant. With this study’s conclusion, this presumption has not changed.

What has changed is understanding that the inherent tension between theory and measurement will need to be approached differently, and more parsimoniously, in future research, with greater emphasis

placed on streamlining study aims, questions, and data collection and scaling these differently than the conceptual model itself. The dynamic, self-organizing complexity of human cognition and behavior that is of most interest when seeking to better describe and understand high-risk use within a system of constraint is also what is least measurable by its nature, requiring appropriate use of simple mental models in places where elaborate data collection methods and statistical models are not yet developed. While a small degree of complexity was approachable in this exploratory study conceptually, it was not approachable from a measurement standpoint. This study can therefore be considered, in part, as a conceptual gesture, undertaken in the spirit and recognition of the need to move toward greater integration of information and theory, as well as more rigorous methods and more fine-grained measurement. Study methodology did permit a coarse-grained snapshot of some of the factors that may have influenced decision-making about high-risk drugs among this corrections-involved sample. Study limitations notwithstanding, findings may still have value when considered from a behavioral economic perspective, insofar as they may help facilitate a discussion about the complicated and challenging lives of people who choose to use opioids and stimulants despite associated risks and who continue to use despite adverse consequences.

Conclusion

This exploratory study provided a descriptive profile of a sample of adults in Kentucky with a history of drug use using self-report data collected prior and subsequent to incarceration and established the prevalence of opioid, stimulant, and concomitant opioid and stimulant use at both time periods. Description of and differences between groups who reported opioid, stimulant, and concomitant use was presented. Endogenous and exogenous factors that demonstrated an association with opioid and stimulant use were explored in order to further understand the relationship between these factors and outcomes involving opioids and stimulants. These factors were described in terms of their potential to influence and constrain cognition and choice related to high-risk drug use.

Overall, opioids and stimulants were used at high rates among participants in this sample and were often used contemporaneously with other drugs. While polydrug use in was a feature of this sample generally, greater drug use versatility was observed primarily among people who reported using opioids, and using them concomitantly with stimulants. This is concerning due to the fact opioids used in combination with other drugs entails significant risk. Concomitant use and heroin use, both associated with

greater drug use versatility, were positively correlated with many factors with the potential to adversely influence cognition and constrain choice. Similar relationships between many of these factors and outcomes involving other/no drug use were not observed. The primary take-away is that riskier use was associated with a greater number of factors with the potential to constrain choice and behavior, whereas other/no drug use was less frequently associated with these factors. Still, these relationships were not unambiguous and should be interpreted cautiously. More work is required to better understand when the presence of certain factors has the capacity to influence choice in respect to opioids and stimulants, including the strength of any observed effect.

Although use of specific opioid and stimulant drugs was found to vary based on participants' residence within or outside of Central Appalachia and by urban proximity, ongoing investigation of these influences is needed as drug markets continually change. For instance, it may be that heroin is now more available in Central Appalachia and rural locations than it was when follow-up data were collected. The increased presence of fentanyl in the drug supply also means that many of the drugs used by participants prior and subsequent to incarceration are possibly riskier now than when data were collected.

Despite differences in opioid and stimulant use among participants, there was some sample-wide homogeneity that may be reflective of the overall greater disadvantage found among corrections-involved people in the US. Seeking to understand high-risk drug use among a sample of corrections-involved people is in some ways synonymous with seeking to understand high-risk drug-use among a vulnerable and stigmatized population. Because of this population's marginalized and disempowered status in the US, it is of particular importance to better understand how certain conditions influence desire, intention, choice, and behavior in relation to opioids and stimulants, as the potential consequences of such high-risk use may be disproportionate among this population and less easy to reverse, compared to populations with greater access to flexible resources (Phelan et al., 2010).

Through examination of available survey data and broad review of related literature this exploratory study identified many factors with the potential to influence decision-making about high-risk drugs. It left many other factors unexplored. Given the preponderance of possible influences on drug-related decision-making, policy-makers and clinicians might better consider how they can aim for two moving targets simultaneously: advance interventions that assist people in critical moments as they decide

to use drugs or not (interventions could include decreasing craving or decreasing present-bias, pharmacotherapies, etc.), but also better develop and expand access to interventions that may help people acquire capacities and competencies across multiple life domains (e.g., mindfulness-based interventions, cognitive-behavioral interventions, working-memory training, intensive case management, memory reconsolidation, etc.), stabilizing them over time by increasing opportunities for engaging with non-drug alternative reinforcers and by helping them reduce stress while habits of daily living are strengthened (Bickel et al., 2011; Bowen et al., 2006; D’Onofrio et al., 2015; Fjorback, Arendt, Ørnboel, Fink, & Walach, 2011; Gorelick, Zangen, & George, 2014; Himelstein, Saul, & Garcia-Romeu, 2015; Jarlais et al., 2015; Laudet, 2011; Peiper et al., 2019; Tobin, Davey, & Latkin, 2005; Volkow, Frieden, Hyde, & Cha, 2014; Wheeler, Davidson, Jones, & Irwin, 2019; Witkiewitz, Marlatt, & Walker, 2005). Longer-term stabilizing forces (i.e., improved cognitive capacities, greater choice) can, in part, develop as a result of aggregated instances of inhibiting urges to use opioids and stimulants to excess. As stability increases, these critical moments of craving would become less frequent, and more cognitively and behaviorally manageable. Successful intervention would need to gain purchase on both developments, at both time scales.

Ultimately, the idea that people choose to use high-risk drugs, but that their capacities for decision-making are constrained by many endogenous and exogenous factors, is not only conceptually coherent, but also optimistic. It is coherent insofar as intention and choice precede action. It is optimistic because many of the conditions of people’s lives before, during, and after drug use have the potential to be changed. That the idea of constraint is in some way represented in both the BDMA and the behavioral economic/neuroeconomic model may be an important bit of common ground to exploit moving forward, even if, for now, there remains disagreement about what *specifically* is being constrained. This point of modest agreement, though, indicates that in seeking to change people’s use of high-risk drugs, it is also necessary to change the conditions, the constraints, that give rise to the problem. If all organisms operate within a system of constraint, then there are practical and moral reasons for investing in efforts aimed at making that system of constraint one in which people are more likely flourish and less likely to suffer as a result of the decisions that they make.

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APPENDIX A

Institutional Authorization Agreement Study Renewal Letter

DATE: October 11, 2018
TO: Kirsten E Smith
FROM: The University of Louisville Institutional Review Board
IRB NUMBER: 18.0860
STUDY TITLE: IAA- Criminal Justice Kentucky Treatment Outcome Study
REFERENCE #: 672057
DATE OF REVIEW: 10/11/2018
IRB STAFF CONTACT: Christy LaDuke 852-2541 clpepp01@louisville.edu
IRB OF RECORD: University of Kentucky (UK)

The continuation request was received by the Human Subjects Protection Program Office, reviewed by the HSPPO staff and was found to be complete.

UK IRB is the IRB of Record for this study. Thank you for submitting the updated IRB Continuation Approval letter with the new expiration listed as 9/17/2019. **Please submit the continuing review application in iRIS prior to the study expiration date.**

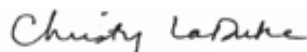
This letter will be kept on file with the Human Subjects Protection Program office. All direct correspondence with the other institution involved should be kept with the study records by the Principal Investigator.

As a reminder, the investigator is responsible for ensuring the reporting requirements to the external IRB are met.

In addition, local University of Louisville IRB reporting is required for:

- Local personnel/Investigator changes
- Submitting the Continuation Approval letter upon renewal of the study by the external IRB
- Serious Issues of Non-Compliance
- Unanticipated Problems (UPIRSTOs)
- Data Safety Monitoring Reports that indicate safety concerns (e.g. suspending treatment, placing enrollment on hold)
- Study Closure

If you have any questions, please contact the IRB analyst listed above or the Human Subjects Protection Program office at hsppofc@louisville.edu.



Christy LaDuke, MA, CCRP
Associate Director, HSPPO

APPENDIX B

Participant Counties of Residence Frequencies

Figure 3.0. Participant counties of residence prior to incarceration with ≤ 10 observations per county

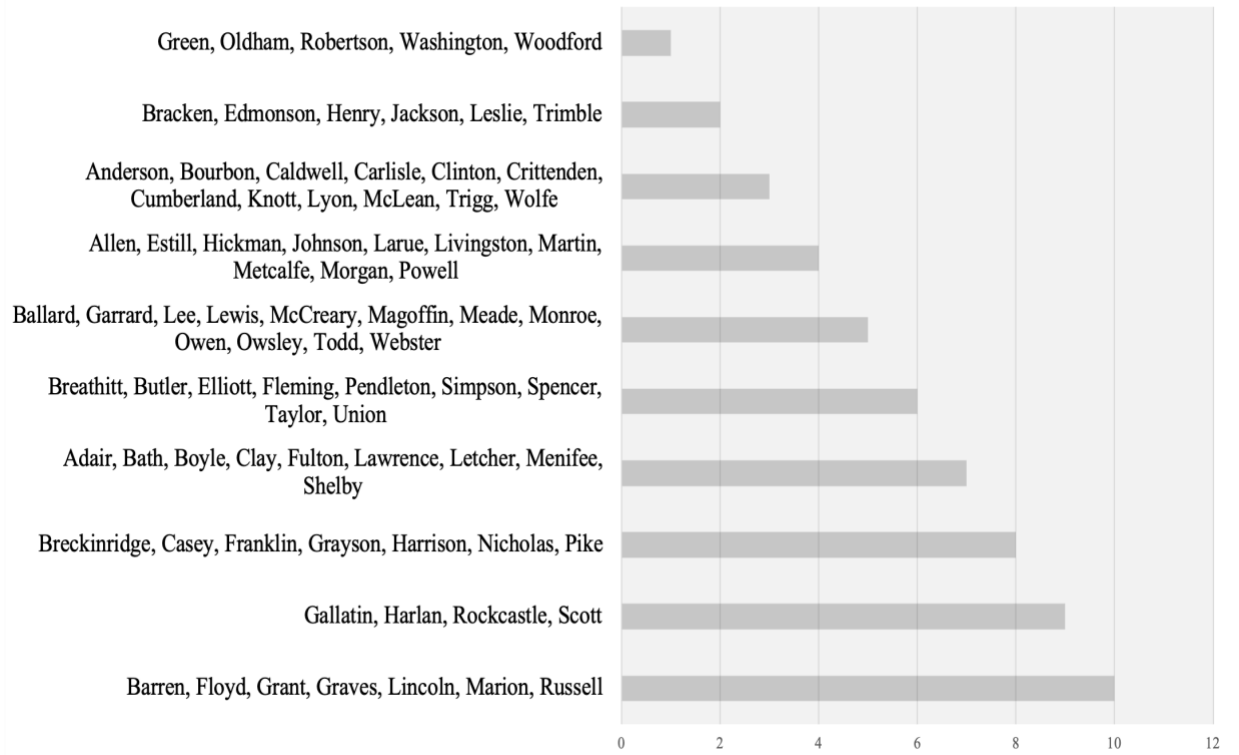


Figure 3.1. Participant counties of residence subsequent to incarceration with ≤ 10 observations per county

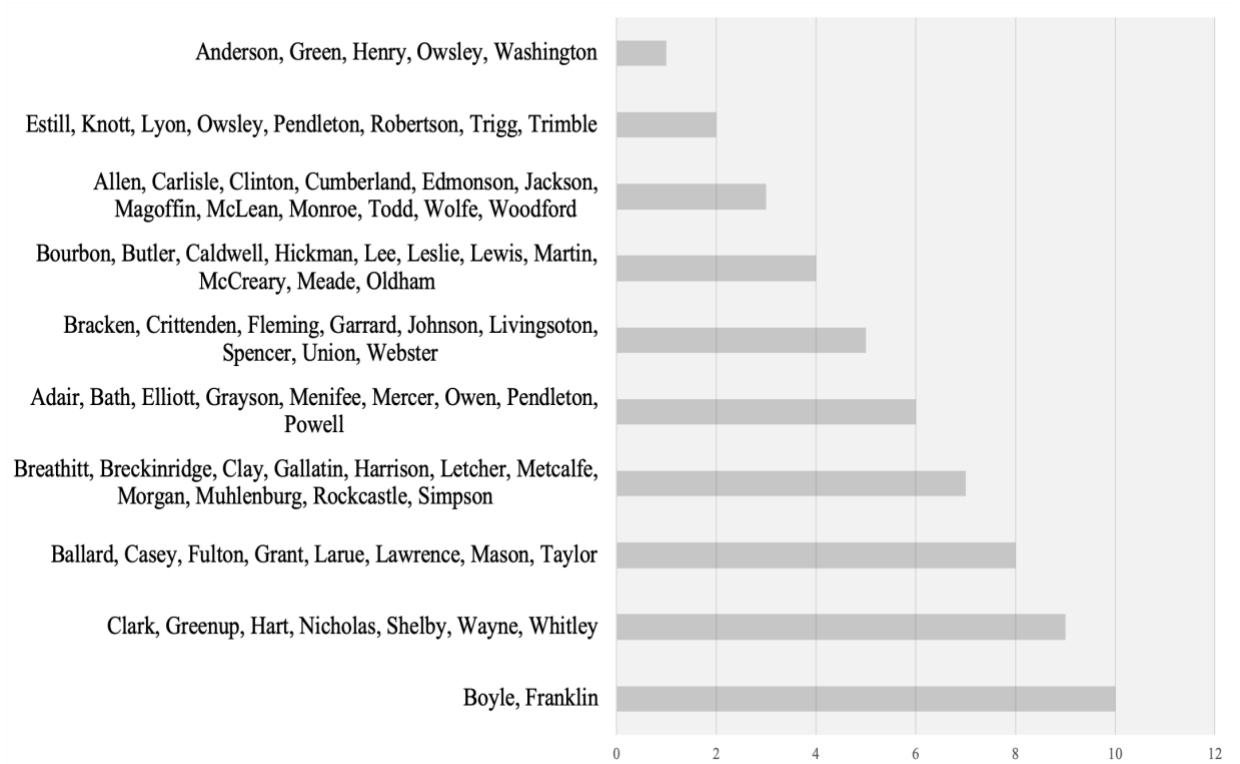


Figure 4.0

Participant counties of residence prior to incarceration with >10 observations per county

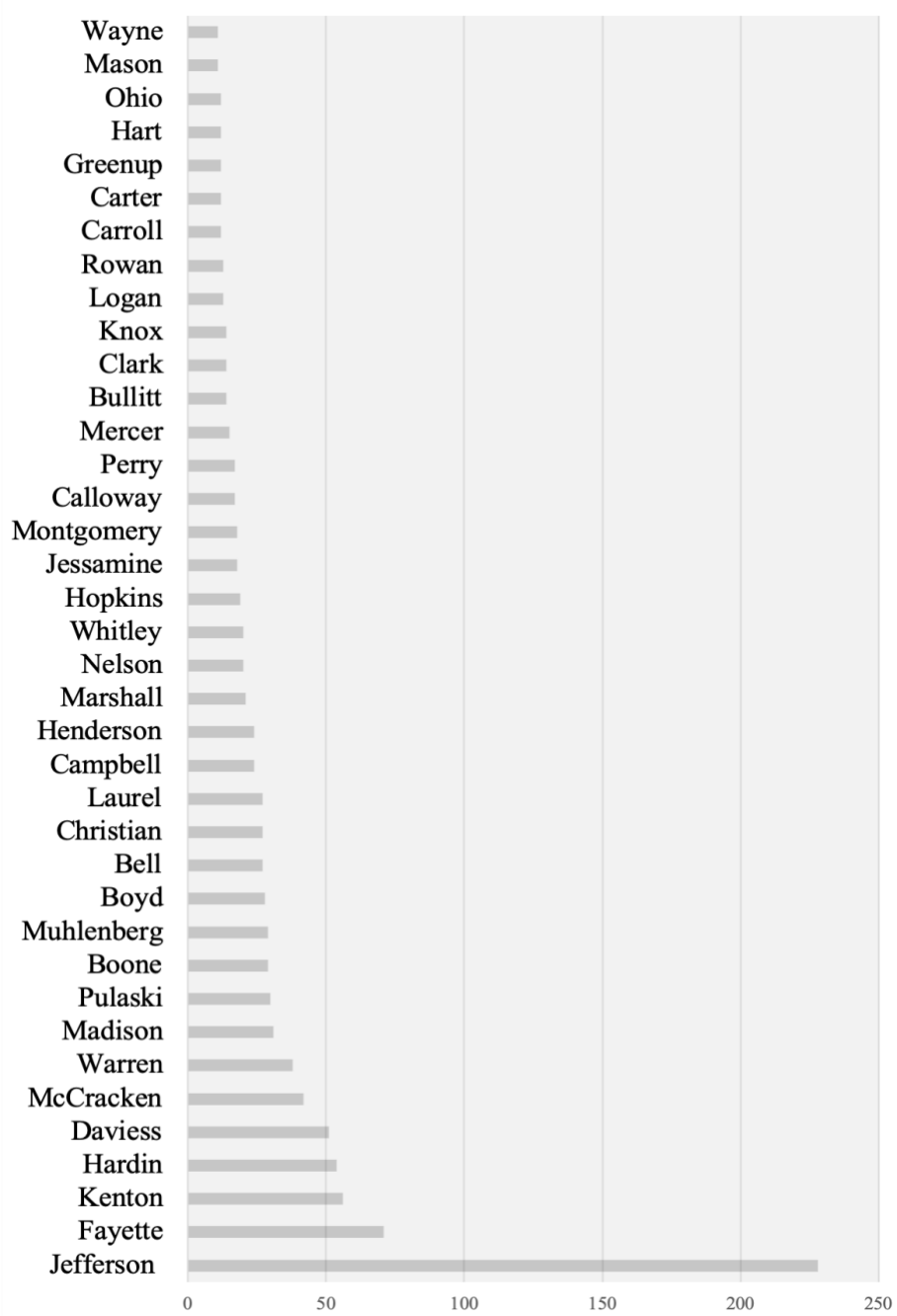
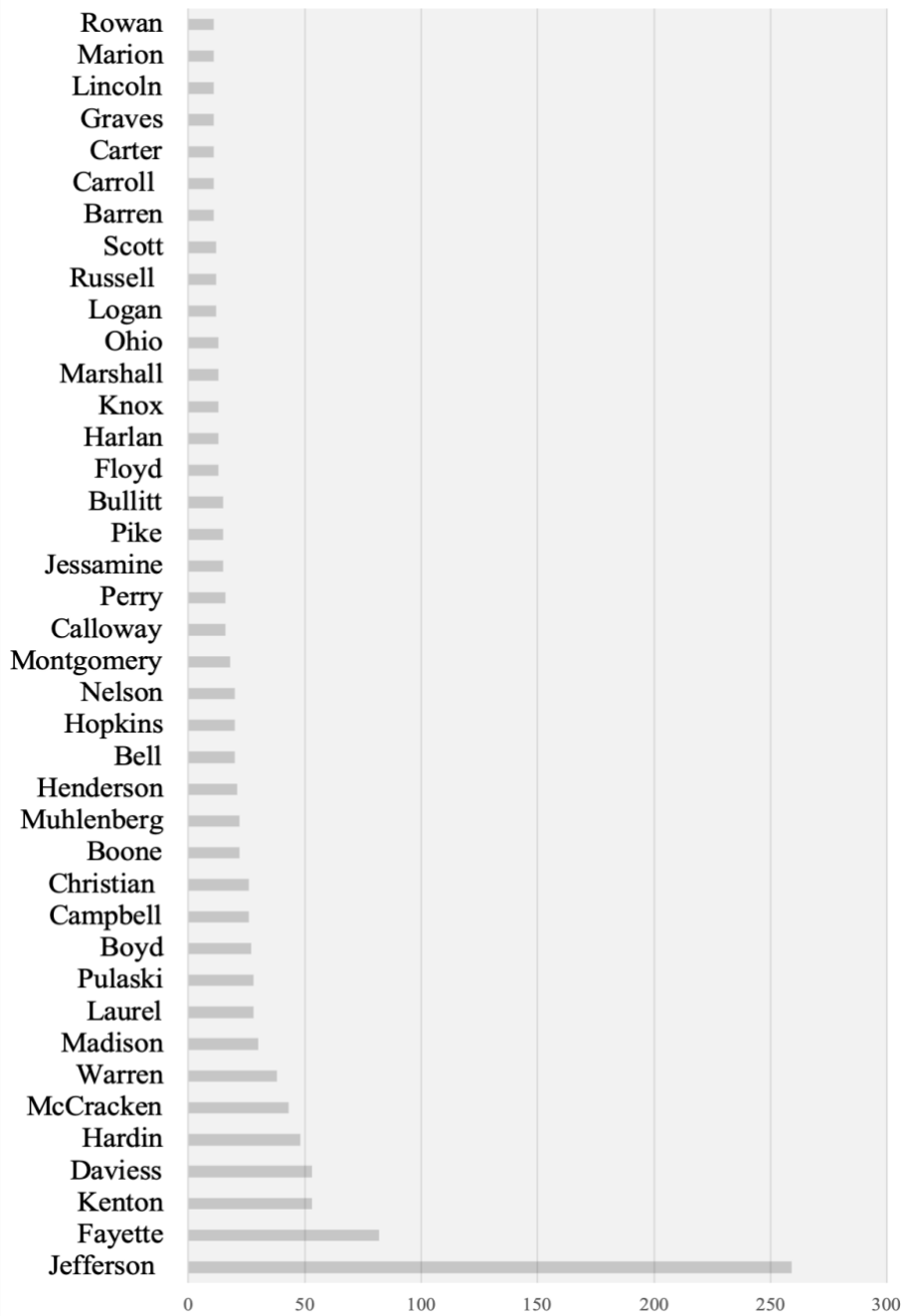


Figure 4.1. Participant counties of residence subsequent to incarceration with >10 observations per county.



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EDUCATION

Doctoral Candidate, Kent School of Social Work, University of Louisville	2016-2019
Post-Baccalaureate Independent Study, University of Kentucky Department of Behavioral Science, Lexington, Kentucky	2016
Master's Social Work, University of Kentucky Lexington, Kentucky Summa Cum Laude	2015
Bachelor's Social Work, Minor in History, University of Kentucky Lexington, Kentucky Summa Cum Laude	2014

RESEARCH

(PI) Lawson, T, **Smith, K. E.** Alternative psychoactive substances: Prevalence and emerging trends in a sample of drug-using individuals enrolled in community-based treatment (2017-2018). This study sought to examine lifetime and recent use of kratom, novel psychoactive substances, and traditional drugs of abuse (e.g., alcohol, nicotine, cocaine).

PUBLICATIONS

PUBLISHED:

Smith, K. E., Bunting, A., Walker, R., Hall, M. T., Grundmann, O., Castillo, O. (2019). Non-prescribed buprenorphine use mediates the relationship between recent heroin and kratom use among a sample of polysubstance users. *Journal of Psychoactive Drugs*.

Smith, K. E., Stoops, W. W. (2019). Synthetic cathinone use among a sample of polysubstance users: Indirect indicator of indiscriminate drug taking or preferred drug of abuse? *Journal of Drug Issues, 49*(2), 369-386.

Smith, K. E., Bunting, A. M., Golder, S., Hall, M. T., Higgins, G. E., Logan, TK. (2019). Prevalence and correlates of disability among a sample of victimized women on probation and parole. *Journal of Correctional Healthcare, 33*(3), 250-256.

Smith, K. E., Staton, M. (2018). Synthetic cannabinoid use among a sample of individuals enrolled in community-based recovery programs: Are synthetic cannabinoids actually preferred to other drugs? *Substance Abuse, 1*-10.

Smith, K. E. (2018). Prevalence and correlates of electronic cigarette use among a clinical sample of polysubstance users in Kentucky: Long live the cigarette? *Substance Use and Misuse, 54*(2), 225-235.

Smith, K. E., & Lawson, T. (2017). Prevalence and motivations for kratom use in a sample of substance users enrolled in a residential treatment program. *Drug and Alcohol Dependence, 180,* 340-348.

Dickson, M. F., Staton-Tindall, M., **Smith, K. E.,** Leukefeld, C., Webster, J. M., & Oser, C. B. (2017). A Facebook follow-up strategy for rural drug-using women. *The Journal of Rural Health, 33*(3), 250-256.

Smith, K. E., Bunting, A., Staton, M., Walker, J. R., Shalash, S., McNees, E., & Pangburn, K. (2017). Examination of synthetic cannabinoid and cathinone use in drug-using offender sample 2013-2015. *Journal of Psychoactive Drugs, 49*(5), 436-445.

SUBMITTED FOR REVIEW:

Garcia-Romeu, A., Dunn, K. E., **Smith, K. E.,** Griffiths, R. R. Kratom (*Mitragyna speciosa*): User demographics, use patterns, and implications for the opioid epidemic.
Under review: *Drug and Alcohol Dependence*.

Bath, R., Buchholz, T., Buros, A. F., Singh, D., **Smith, K. E.,** Veltri, C. A., Grundmann, O. Self-reported health diagnoses and demographic correlates with Kratom use: Results from an online survey. *Journal of Addiction Medicine*.

Pope, N. D., Baldwin, P. K., Gibson, A., **Smith, K. E.** Exploring How Young adult caregivers adopt family caregiving roles. *Journal of Intergenerational Relationships*.

Victor, G., **Smith, K. E.,** Walker, J. R., Logan, T. K, Cole, J. Residential peer-led recovery program: An exploratory examination of psychosocial outcomes.
Under review: *American Journal of Drug and Alcohol Abuse*

IN PREPARATION:

Garcia-Romeu, A., Dunn, K. E., **Smith, K. E.,** & Griffiths, R. R. An online survey of kratom (*Mitragyna speciosa*) users: Motivations for use and perceived therapeutic potentials

Smith, K. E., Tillson, M., Staton, M., & Winston, E. Diverted buprenorphine use among adults entering corrections-based treatment.

Smith, K. E. Ethical analysis: Potential harms associated with peer-led, 12-step recovery approaches for addressing opioid use disorder in the United States

PRESENTATIONS

Center for Clinical & Translational Science Spring Conference (April 2016). Lexington, KY. Poster Presentation: *Profile of synthetic drug users in corrections-based substance abuse treatment program.* **Smith, K. E.**, Shalash, S., Staton-Tindall, M., McNees, E., & Pangburn, K.

Society for Social Work Research Conference (January 2018). Washington, DC. Poster Presentation: *Prevalence and features of Social Security Disability Insurance (SSDI) utilization in a sample of women on community corrections.* **Smith, K. E.**, Bunting, A., Golder, S., Hall, M., Higgins, G. E., & Logan, T. K.

Graduate Student Regional Research Conference (March 2018). Louisville, KY. Oral Presentation: *Profile of kratom use among a sample of polysubstance users enrolled in residential drug treatment.* **Smith, K. E.**

Academic and Health Policy Conference on Correctional Health (March 2018). Houston, TX. Poster Presentation: *Prevalence and correlates of disability among a sample of women on probation and parole.* **Smith, K. E.**, Bunting, A., Golder, S., Hall, M., Higgins, G. E., & Logan, T. K.

College on Problems of Drug Dependence 2018 Annual Meeting (June 2018). San Diego, CA. Oral Presentation: *Kratom use patterns among opioid users in the United States: A novel form of harm-reduction?* **Smith, K. E.**, Bunting, A. M., Walker, R., Hall, M., Grundmann, O, Castillo, O.

College on Problems of Drug Dependence 2018 Annual Meeting (June 2018). San Diego, CA. Media Forum Oral Presentation: *Kratom use patterns among opioid users in the United States: A novel form of harm-reduction?* **Smith, K. E.**, Bunting, A. M., Walker, R., Hall, M., Grundmann, O, Castillo, O.

Appalachian Translational Research Network Summit. (September 2018). Lexington, KY. Poster Presentation: *A profile of 'diverted' buprenorphine use among treatment-seeking offenders: Implications for Appalachian Kentucky.* Tillson, M., **Smith, K. E.**, Staton, M., Winston, E.

Substance Use Research Day. (March 2019). Lexington, KY. Poster Presentation: *Chemical bedfellows: Illicit use of prescription opioids and buprenorphine associated with methamphetamine use among a sample of polydrug users in Kentucky.* **Smith, K. E.**

Academic and Health Policy Conference on Correctional Health (March 2019). Las Vegas, NV. Oral Presentation: *Prevalence and correlates of past-year non-prescribed buprenorphine use among a sample of adults entering Kentucky Department of Corrections drug treatment programs.* **Smith, K. E.**, Tillson, M., Staton, M., Winston, E.

Chaired/co-chaired sessions and panels:

Chilcoat H., & **Smith, K. E.** Oral Communications: Is there a downside? Harm reduction. College on Problems of Drug Dependence 2018 annual meeting (June 2018). San Diego, CA.

PUBLICATIONS REVIEWED & CONSULTING

Reviewer, <i>Addiction</i> [2]	2018-2019
Reviewer, <i>Drug and Alcohol Dependence</i> [1]	2018
Reviewer, <i>Journal of Psychoactive Drugs</i> [5]	2017-2019
Reviewer, <i>Journal of Ethnopharmacology</i> [2]	2017-2018
Reviewer, <i>Neuropsychiatric Disease and Treatment</i> [1]	2018
Reviewer, <i>Substance Abuse Treatment, Prevention, and Policy</i> [1]	2017-2018
Reviewer, <i>Journal of Pain Research</i> [2]	2018
The Commonwealth of Kentucky's Department of Public Advocacy: Death penalty mitigation case reviews	2016-2018

PROFESSIONAL EXPERIENCE

INTRAMURAL RESEARCH TRAINING AWARD, POST-DOCTORAL FELLOW National Institutes of Health, National Institute on Drug Abuse Real-world Assessment, Prediction, and Treatment Unit, Clinical Pharmacology and Therapeutics Research Branch Baltimore, Maryland	2019-
DATA COORDINATOR/ANALYST University of Kentucky, Center on Drug and Alcohol Research Lexington, Kentucky	2018-2019
Major Responsibilities: Conducted baseline interviews and consolidated tracking and locating efforts for post-intervention follow-up data collection among a clinical sample of substance users residing in rural Appalachia. Track and locate difficult-to-reach participants for follow-up data collection as part of the Criminal Justice Kentucky Treatment Outcome Study (CJKTOS), an ongoing study examining effectiveness of the KY Department of Correction's (DOC) Substance Abuse Treatment Program (SAP) and KY DOC-referred medication-assisted treatment pilot programs. Assisted in data management and analyses for five ongoing outcome evaluations. Prepared annual technical reports and manuscripts for academic publication.	
RESEARCH ASSISTANT Kent School of Social Work, University of Louisville Louisville, Kentucky	2016-2018
Major Responsibilities: To fulfill objectives for a SAMHSA-funded grant, conducted follow-up interviews pertaining to substance use, mental health, victimization, and perinatal/postnatal health behaviors among a sample of drug-using women exiting residential treatment. Oversaw data collection tasks of 1 Masters-level student. Assisted with statistical analyses and manuscript preparation using longitudinal Women's Health Study (NIDA R01DA027981) data which captures health behaviors of women on probation/parole with a history of victimization.	
SENIOR DATA COORDINATOR University of Kentucky, Center on Drug and Alcohol Research Lexington, Kentucky	2015-2016

Major Responsibilities: Tracked and located difficult-to-reach study participants for post-intervention data collection as part of the Criminal Justice Kentucky Treatment Outcome Study (CJKTOS), an ongoing study

examining effectiveness of the KY DOC SAP program. Conducted follow-up interviews with paroled and incarcerated individuals. Drafted annual reports for state legislators. Trained DOC clinicians to conduct baseline assessments of incarcerated SAP participants. Created a pilot assessment instrument for DOC clinical training workgroups on substance use intervention practices. Assisted in data management, analyses, and manuscript preparation.

RESEARCH ASSISTANT 2016
University of Kentucky College of Social Work, Lexington, Kentucky

Major Responsibilities: Helped prepare academic presentations and publications on issues pertaining to substance use, incarceration, health care policy, and use of social media in conducting research with hard-to-reach populations. Assisted with transcribing, coding, and rating data obtained under an ongoing project concerned with harm-reduction interventions for rural, female substance users involved with the criminal justice system (NIDA R01DA033866 & K02DA035116).

MASTER'S PRACTICUM 2014-2015
Hope Center Recovery Program for Men, Lexington, Kentucky

Major Responsibilities: Conducted strengths-based, trauma-informed biopsychosocial assessments for incoming clients. Founded and facilitated weekly process group and led classes for Phase I clients. Created curriculum for and taught a monthly psychoeducational class pertaining to the neurobiology of addiction. Established therapeutic alliances with clients and collaboratively explored issues related to reentry, relapse prevention, and strategies for improving self-efficacy.

UNDERGRADUATE PRACTICUM 2014
United Way of the Bluegrass, Lexington, Kentucky

Major Responsibilities: Worked as part of an interdisciplinary financial stability team to assist economically marginalized clients with establishing individualized development accounts (IDAs). Revised UWBG participant follow-up survey. Collected and analyzed UWBG participant data and prepared for quarterly and annual reports. Conducted client orientations, helped participants complete individualized savings plans and establish financial goals. Coordinated financial literacy and education opportunities with community partners. Participated in community outreach events and grant reviews.

UNDERGRADUATE PRACTICUM 2013
Chrysalis House, Inc. Lexington, Kentucky

Major Responsibilities: Assisted in client admission screening, intake. Conducted psychosocial and drug history assessment. Assisted with weekly home visits at off-site housing and administered urine analysis tests. Facilitated weekly cognitive behavioral therapy group. Updated electronic client files with progress notes and assessed for relapse risk. Helped prepare clients for GED testing, job-seeking, and independent living.

TEACHING 2018
Teaching Practicum
University of Louisville, Kent School of Social Work
Louisville, Kentucky
SW 662-75 Substance Use and Substance Use Disorders

ACADEMIC AND PROFESSIONAL AWARDS

Academic and Health Policy Conference on Correctional Health Travel award	2019
College on Problems of Drug Dependence Early Career Investigator travel award	2018
Society for Social Work & Research Travel award	2018
Academic and Health Policy Conference on Correctional Health Travel award	2018
University of Louisville Doctoral scholarship & Research assistantship	2016-2018
Idea Festival Scholarship award	2017
University of Kentucky Virginia Lane Award, full undergraduate scholarship	2012-2013
University of Kentucky Virginia Lane Award, full undergraduate scholarship	2013-2014
University of Kentucky Two-time recipient of the Academic Excellence Scholarship	2012-2014

FUNDING

University of Louisville Graduate Student Research Fund Grant Recipient	2017
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MEMBERSHIPS & AFFILIATIONS

College on Problems of Drug Dependence, member-in training	2018-Present
Academic Consortium on Criminal Justice Health	2017-Present
American Society of Criminology	2017-Present
Society for Social Work and Research	2017-2019
Sociologists for Women in Society	2016-Present
Students for Sensible Drug Policy, University of Kentucky	2015-2016
National Association of Social Workers	2014-2016
Center for Inquiry	2016-Present
American Humanist Association	2015-Present

SERVICE WORK

Volunteer instructor, Hope Center Women's Recovery Program	2018-2019
Bluegrass Reentry Council	2016-2018
Disability Resource Center	2016-2017
Guest lecturer, University of Kentucky College of Social Work	2014-2016
Volunteer, United Way of the Bluegrass	2014-2015
Volunteer, AIDS Volunteers of America Inc.	2013
Volunteer instructor, Hope Center Men's Recovery Program	2012-2019
Volunteer, Lexington Rescue Mission, Lexington, KY	2012