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The Role of Emotion Dysregulation in the Relationship between Anhedonia and Opioid Craving

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by

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ABSTRACT

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Research on factors that predict opioid cravings is lacking. Anhedonia may be a predictor of cravings and particularly relevant to cravings when people struggle to regulate emotions but has yet to be examined among justice-involved populations. This study aimed to examine the relationship between anhedonia, opioid cravings, and emotion dysregulation (ED) in this population. Participants completed several measures. The results showed that anhedonia and opioid cravings were significantly related at the bivariate level, but not in moderation models. The DERS-36 total score and 'DERS Impulse' subscale had a significant, positive effect on cravings in moderation models. In a higher severity sample of people who used heroin, there was a significant interaction wherein the relationship between anhedonia and cravings was positive at high levels of difficulty controlling behaviors when distressed. These findings indicate the need to understand how anhedonia and ED influence opioid cravings among justice-involved people with severe heroin use.

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Chapter 1. Introduction

Rates of opioid use among justice-involved populations are markedly higher compared to those in the general population. More than 7% of individuals in prison and 12% of individuals in jail reported using heroin/opiates in the month before their arrest, compared to 2.4% in the general population that reported using heroin/opiates in the past month (Bronson et al., 2017). Additionally, opioid use is uniquely problematic for justice-involved populations. Reduced tolerance to opioids during incarceration contributes to heightened overdose risk post-release (Binswanger et al., 2007; Merrall et al., 2010; National Institute of Drug Abuse [NIDA], 2019). In fact, opioid-related overdose is the leading cause of death among people being released back into the community from incarceration (Joudrey et al., 2019). Opioid use disorder (OUD) is difficult to treat, and justice-involved individuals often experience relapse and poor substance use treatment outcomes (Brady & Sonne, 1999; Ferri et al., 2014; Hunter-Reel et al., 2009; Witkiewitz & Marlatt, 2004), which increases risk for re-arrest. One factor that is known to contribute to opioid relapse is craving (McHugh et al., 2014), but little is understood about who is most likely to struggle with cravings while receiving treatment for OUD, especially among justice-involved populations. People experiencing anhedonia, a decreased ability to experience pleasure, may be particularly vulnerable to opioid cravings according to a recent review (Kiluk et al., 2019). This study will examine the impact that anhedonia has on opioid cravings in an attempt to identify factors relevant to opioid treatment outcomes among justice-involved populations.

Opioid Craving

The experience of *craving* is defined as the strong desire or urge to use (American Psychiatric Association [APA], 2013; Kleykamp et al., 2019a). Craving is one of 11 possible criteria needed to qualify for an OUD diagnosis (APA, 2013) and is present among at least 29%

of those that meet criteria for OUD (APA, 2013; Peer et al., 2013). Several researchers have explored the presence and impact of opioid cravings in treatment settings (e.g., Garland et al., 2019; Klein & Seppala, 2019; Scott et al., 2018). In a population of treatment-seeking individuals that met criteria for a DSM-IV diagnosis of prescription opioid dependence, experiencing cravings for opioids predicted using opioids again in the future, with an increased likelihood of opioid use in the first week of treatment (McHugh et al., 2014). Studies examining the prevalence of opioid cravings in OUD treatment have shown that cravings were strongest when the patient started treatment, and decreased as treatment continued (Garland et al., 2019; Klein & Seppala, 2019), indicating that cravings are the strongest predictor of relapse at the beginning of abstinence (Serre et al., 2015). Although opioid cravings are common among people with OUD, not all people experience them (Peer et al., 2013). Currently, research tends to focus on craving as a predictor of opioid use outcomes or as an outcome of medication assisted treatment (e.g., Fatseas et al., 2015; Lee et al., 2018; Preston et al., 2018; Scott et al., 2018; Tsui et al., 2014), and little is known about who is most likely to experience cravings (Kleykamp et al., 2019b). This is especially true among justice-involved populations. Although research has found that frequency of illegal drug use, less substance use treatment experience, and increases in daily stressors (e.g., finances, arguments) predict more severe drug cravings among people in the criminal justice system (Neupert et al., 2017), research on *opioid* cravings in this population is absent.

The Role of Anhedonia in Opioid Craving

Mental health symptoms (e.g., anxiety sensitivity, personality disorder symptoms, psychiatric disorders, depression) are key predictors of substance use treatment dropout among general (Amodeo et al., 2008; Brorson et al., 2013; Lejuez et al., 2008) and justice-involved

(Hiller et al., 1999; Yang et al., 2019) populations, including those in OUD treatment (Mancino et al., 2010; Panlilio et al., 2019). Importantly, mental health symptoms may exacerbate opioid use, including cravings (Fatseas et al., 2018; Sullivan et al., 2006; Winkelman et al., 2018), and research suggests certain mental health problems may be more relevant to cravings than others. For example, there is an established positive relationship in the literature between mood/anxiety disorders and substance use cravings (Fatseas et al., 2018); however, research supports that anhedonia in particular should be examined in relation to cravings (Garfield et al., 2014).

Anhedonia, defined as the failure to experience pleasure (Snaith, 1993), is a transdiagnostic symptom that is a part of several mental health disorders (e.g., Major Depressive Disorder, Posttraumatic Stress Disorder, Schizophrenia; APA, 2013; Kessler et al., 2005; Trøstheim et al., 2020). Studies of the brain reward circuit, the endogenous opioid system, and dopaminergic system with non-human animals and humans support a strong neuropsychological basis for the relationship between anhedonia and cravings for opioids (Kiluk et al., 2019), alcohol, cocaine, and food (Hatzigiakoumis et al., 2011; Koob & Volkow, 2016). There is also an established relationship between anhedonia and nicotine cravings (e.g., Cook et al., 2004). One systematic review and one narrative review compiled the existing literature on the relationship between anhedonia and substance use, concluding that substances may be used when an individual is anhedonic and experiencing cravings in order to feel pleasure (Destoop et al., 2019; Garfield et al., 2014).

Opioids bring pleasure and discontinuing opioid use creates an absence of pleasure, which may then increase one's desire to experience pleasure and alleviate mental health symptoms, thereby increasing opioid cravings. This cycle can be explained by the self-medication hypothesis (Khantzian, 1997) and reward deficiency syndrome (Blum et al., 1996),

which argues that deficits in hedonic capacity decrease one's ability to cope with stress, which increases the likelihood of using illicit substances. For heroin specifically, anhedonia motivates drug-seeking behavior (Hogarth et al., 2017) because of the desire to relieve feelings of negative affect (Moustafa et al., 2020), and heroin can initially alleviate anhedonic states and negative mood (Koob, 2013; Turner et al., 2018). This improvement in mood positively reinforces continuous substance use and turns anhedonia into a cue for drug use (Koob & Volkow, 2016; Moustafa et al., 2020). The shift from sporadic use of opioids to chronic use results in a motivation to use opioids to achieve allostasis related to hedonic capacity (Koob & Le Moal, 1997). Thus, opioid use is negatively reinforced by removing withdrawal symptoms, such as irritability, emotional pain, stress, and loss of motivation for natural rewards (Koob & Le Moal, 2008; Koob & Volkow, 2010; Koob et al., 2014; Loganathan & Ho, 2021). Dackis and Gold (1983) summarized this phenomenon; opioids relieve depressive symptoms and precipitate them, further reinforcing illicit substance use and the development of addiction. Neurological evidence for the relationship between cravings and the relief of negative mood states includes changes in the nucleus accumbens, mesolimbic pathway, and the role of key neurotransmitters (e.g., dopamine, enkephalins, glutamate, CRT, norepinephrine; Koob & Volkow, 2016; Moustafa et al., 2020). Thus, anhedonia theoretically prompts opioid craving through two pathways. During early opioid use, when coupled with anhedonia, craving is initiated by the urge to decrease negative mood; whereas for individuals with OUD, craving is driven by the desire to remove withdrawal symptoms (e.g., anhedonia).

A recent review by Kiluk and colleagues (2019) made a call to action, specifically highlighting the role that anhedonia in particular may have in opioid use and treatment. They argue that if previous research has determined that anhedonia increases substance use cravings,

then the same relationship should occur in opioid-dependent samples. Kiluk et al. (2019) reviewed 11 studies which measured anhedonia and opioid use. Two studies found a significant association between anhedonia and opioid cravings in abstinent opioid-dependent samples (Janiri et al., 2005; Martinotti et al., 2008). Janiri and colleagues (2005) collected a sample of 70 participants who met criteria for a previous DSM-IV diagnosis of alcohol dependence, opiate dependence, or dependence on multiple substances. A third of the sample had a previous diagnosis of opiate dependence. The researchers concluded that anhedonia was significantly correlated with cravings for all three groups (Janiri et al., 2005). The second study, by Martinotti and colleagues (2008), recruited participants who either had a previous DSM-IV diagnosis of alcohol dependence (n = 25) or opiate dependence (n = 25). They found for the participants who were abstinent from opiates, that cravings were significantly, positively correlated with anhedonia (Martinotti et al., 2008). Both studies used a 10cm visual analogue scale (VAS) to measure opioid craving (Janiri et al., 2005; Martinotti et al., 2008). Neither of these studies were conducted in the United States or utilized a justice-involved population, and both of them had relatively small samples of about 25 participants who had a previous diagnosis of opioid dependence and were abstinent at the time of data collection.

Moderators of the Anhedonia to Opioid Craving Relationship

It is important to consider factors that may moderate the relationship between anhedonia and cravings in order to identify who is most vulnerable. One factor that may be important in the relationship between anhedonia and opioid craving is emotion dysregulation. The link between anhedonia and cravings may be especially strong for people with high levels of emotion dysregulation, which is characterized by managing emotions maladaptively, including a) lack of awareness/clarity about emotional responses, b) nonacceptance of emotions when pursuing

goals, c) inability to control impulses or pursue goals during emotional distress, and d) lack of access to emotion regulation strategies (Gratz & Roemer, 2004; Gratz et al., 2006). Although both constructs involve emotion experiences, anhedonia focuses on the capacity to experience a specific emotion (i.e., pleasure); whereas emotion dysregulation is about differentiating and responding to various emotions (Gross, 2002; Tull & Aldao, 2015). Emotion dysregulation and anhedonia also have different brain circuitry within the model of addiction. Particularly, emotion dysregulation engages a specific neurochemical system outside of the reward system when the reward system is activated during substance use (Koob & Bloom, 1988; Koob & Volkow, 2016).

Emotion dysregulation may intensify the impact of anhedonia on opioid cravings. Studies with non-clinical samples have shown that people experiencing anhedonia are likely to report diminished levels of affect intensity, attention to emotion, and clarity of emotion (Berenbaum et al., 2012), as well as using maladaptive cognitive emotion regulation strategies (e.g., self-blame, rumination, and catastrophizing) and fewer adaptative strategies (e.g., acceptance, positive refocusing, positive reappraisal; Domaradzka & Fajkowska, 2018). Relatedly, studies with individuals reporting substance use cravings found a relationship between constructs similar to emotion dysregulation (e.g., novelty-seeking, acting with awareness) and anhedonia (Martinotti et al., 2008; Enkema et al., 2020). Furthermore, the relationship between negative mood states (e.g., depression, anxiety) and substance use has been explained by emotion dysregulation (e.g., Bakhshaie et al., 2019; Collado et al., 2020; Witkiewitz & Bowen, 2010), and studies have found a positive relationship between emotion dysregulation and cravings (Aaron et al., 2020; Kober, 2014). More recently, studies have shown that emotion regulation strategies (e.g., reappraisal, suppression) can modulate a person's experience of reward (both drug-related and natural rewards) to impact cravings (Garland et al., 2019; Garland, 2021), further supporting a

complementary relationship between these constructs. People experiencing anhedonia as well as greater difficulty modulating their emotional experiences may be most likely to experience cravings.

Present Study

Opioid craving, and the factors that predict it, are especially important to consider in post-release treatment settings, wherein the risks of relapse and treatment failure are high. The present study will examine the relationship between anhedonia and opioid cravings among people who are court-mandated to substance use treatment after release from incarceration. The aim of this study is to investigate whether the relationship between anhedonia and opioid cravings is present in a larger, opioid-abstinent sample of justice-involved individuals. Additionally, there is very little research identifying moderators of the anhedonia-craving relationship. This study will determine whether emotion dysregulation moderates the relationship between anhedonia and opioid cravings.

The research questions for this study are as follows:

1. Is anhedonia associated with opioid cravings among people with opioid misuse receiving court-mandated substance use treatment?
2. Does emotion dysregulation moderate the relationship between anhedonia and opioid cravings?

We hypothesized that anhedonia would be positively associated with opioid cravings, and that emotion dysregulation would strengthen this relationship. In other words, we expected that participants who experience anhedonia and who have high levels of emotion dysregulation would be the most likely to experience opioid cravings. Likewise, if participants experience anhedonia and better regulation of their emotions, they would be less likely to experience opioid

cravings. A range of relevant covariates were assessed including demographic variables, polysubstance use (i.e., frequency of using other substances), and opioid use severity.

Chapter 2. Methods

Participants

Participants included adult males and females currently enrolled in court-mandated substance use treatment at a community corrections facility in the Midwest (N = 167). The residential treatment program offers individual counseling and evidence-based cognitive-behavioral groups focused on relapse prevention, skills building (e.g., social skills, parenting), and mental health. Patients of the treatment program are required to remain abstinent from alcohol and drugs and receive regular urine drug screens. There are three phases of treatment in this program. About 50% of this sample was in Phase 1, 35.8% in Phase 2, and 12.6% in Phase 3 at the time of data collection. The sample analyzed in this study consisted only of individuals who reported using heroin and/or prescription opioids at least one time in the past year (n = 97). About 58% of the overall sample reported using heroin (n = 85), prescription opioids (n = 31), or both (n = 19). The majority of this sample identified as male (55.7%), white/Caucasian (81.4%), and were 20-56 years old (M = 31.1, SD = 7.3). Additional information about the demographics of this sample is presented in Table 1.

Table 1

Demographics of Participants (n = 97)

	***n* (%)**	**Mean (SD)**	**Actual Range**
Age		31.1 (7.3)	20-56
Gender (Man)	54 (55.7%)		
Race/Ethnicity			
White	79 (81.4%)		
Racial/Ethnic Minority	18 (18.6%)		
Education Level [a]		3.9 (1.7)	1-8
Eighth grade or less	2 (2.1%)		
Some high school	23 (23.7%)		
GED	20 (20.6%)		
High school graduate	22 (22.7%)		
Business/technical training	4 (4.1%)		
Some college	21 (21.6%)		
College graduate	3 (3.1%)		
Some graduate or professional school	2 (2.1%)		
Household Income [b]		2.8 (2.5)	1-10
Less than $9,999	38 (39.2%)		
$10,000-$29,999	39 (40.2%)		
$30,000-$49,999	4 (4.1%)		
$50,000-$69,999	9 (9.3%)		
$70,000-$99,999	6 (6.2%)		
$100,000 or more	1 (1%)		
Currently in Phase 1 of Treatment	49 (51.6%)		
Opioid Use Severity (within the past year) [c]		3.5 (1.7)	1-5
One time	24 (24.7%)		
Monthly or less	5 (5.2%)		
2-4 times a month	10 (10.3%)		
2-3 times a week	12 (12.4%)		
4 or more times a week	46 (47.4%)		
Polysubstance Use		21.3 (10.8)	1-65

Note.

[a] Ordered response ranging from 1 “Eighth grade or less” to 8 “Some graduate or professional school.”

[b] Ordered response ranging from 1 “< $9,999” to 10 “$100,000 or more.”

[c] Ordered response ranging from 1 “One time” to 5 “4 or more times a week.”

Measures

Demographics

Age, sex, race, level of education (i.e., eighth grade or less, some high school, GED, high school graduate, business/technical training, some college, college graduate, some graduate or professional school, Master's degree, Doctoral degree), and income (i.e., less than $9,999, $10,000-19,999, $20,000-29,999…$90,000-99,999, $100,000 or more) were self-reported as part of the study questionnaire.

Anhedonia

Three questions from The Posttraumatic Stress Disorder (PTSD) Checklist for Diagnostic and Statistical Manual of Mental Disorders-5 (PCL-5; Blevins et al., 2015; Weathers et al., 2013) were used to assess anhedonia; "*loss of interest in activities that you used to enjoy?*", "*feeling distant or cut off from other people?*", and "*trouble experiencing positive feelings (for example, being unable to feel happiness or have loving feelings for people close to you)?*." The PCL-5 is a 20-item self-report questionnaire based on DSM-5 criteria for PTSD that assesses for trauma symptoms experienced in the past month. Participants are instructed to consider the most stressful event they reported experiencing on the Life Events Checklist-5 (LEC-5; Blake et al., 1995) when answering the PCL items, though items do not directly reference trauma. The PCL-5 uses a five-point Likert scale (0 = not at all, 1 = a little bit, 2 = moderately, 3 = quite a bit, 4 = extremely). Other studies (Erwin et al., 2017) have used questions from the PCL-5 to assess the association between anhedonia and alcohol consumption, with the rationale being that anhedonia is best conceptualized as a transdiagnostic symptom that spans multiple disorders, and the PCL-5 item wording is consistent with other measures of anhedonia that are not specific to trauma (e.g.,

Brief Symptom Inventory; Carroll et al., 2018). These three questions exhibited strong internal consistency ($\alpha = .93$) in this sample.

Cravings

The Penn Alcohol Craving Scale (PACS; Flannery et al., 2006) was modified to measure opioid (e.g., heroin, prescription drugs) cravings, becoming The Penn Opioid Craving Scale (POCS; Tsui et al., 2014). The PACS has been adapted for other substances (Costello et al., 2020), gambling (de Castro et al., 2007), and the POCS has been administered in other opioid-dependent samples (Tsui et al., 2014). The POCS, similar to the PACS, is a five-item self-report questionnaire assessing the frequency, intensity, and duration of opioid craving over the past week (e.g., "during the past week how often have you thought about using opioids or about how good using opioids would make you feel?"). Responses are rated on a seven-point (0 to 6) Likert-type scale and summed to create a total score (Costello et al., 2020; de Castro et al., 2007; Flannery et al., 2006). The PACS has been shown to have high internal consistency, predictive, construct, and discriminant validity in a sample of individuals participating in a 9-month combined naltrexone/psychotherapy trial (Flannery et al., 2006). In other opioid-dependent samples, the POCS has exhibited strong internal consistency, good convergent validity, and predictive validity (Tsui et al., 2014). The POCS exhibited strong internal consistency ($\alpha = .91$) in this sample, as well.

Emotion Dysregulation

The Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) was used to measure emotion dysregulation. The DERS is a 36-item self-report questionnaire with a five-point Likert scale (1 = almost never [0-10%], 2 = sometimes [11-35%], 3 = about half the time [36-65%], 4 = most of the time [66-90%], 5 = almost always [91-100%]). The measure has six

subscales which describe different aspects of emotion dysregulation: nonacceptance of emotion responses, difficulties engaging in goal-directed behavior, impulse control difficulties, lack of emotional awareness, limited access to emotion regulation strategies, and lack of emotional clarity. A higher score represents more emotion dysregulation. The DERS demonstrates strong validity in both clinical and non-clinical samples (Gratz & Roemer, 2004; Gratz & Tull, 2010), along with high internal consistency among people with substances use disorders (Gratz & Tull, 2010). There is good internal consistency for the overall measure ($\alpha = .93$) and within the subscales (i.e., α ranges from .76 to .86) in the current sample.

Covariates

The Drug Use Questionnaire (DUQ; Hien & First, 1991) was used to measure polysubstance use and severity of opioid use (including heroin and prescription opioids). The DUQ is a self-report questionnaire that is consistent with the Structured Clinical Interview for DSM-IV (SCID-IV; First & Gibbon, 2004). Participants were asked to choose the option that best describes their frequency of use of cannabis, alcohol, cocaine, ecstasy, stimulants, sedatives, heroin, hallucinogens, PCP, inhalants, nicotine, prescription drugs, and crystal meth in *the past year*. Responses were rated on a six-point Likert-type scale (0 = never, 1 = one time, 2 = monthly or less, 3 = 2-4 times a month, 4 = 2-3 times a week, 5 = 4 or more times a week) and were summed to create an overall score representing the frequency of substances that were used concurrently in the past year. Also, responses to the questions on frequency of heroin use and prescription opioid use were combined to create the 'severity of opioid use' variable. The DUQ demonstrates good reliability and validity, as well as convergence with the SCID-IV substance use disorder diagnoses in prior studies (Lejuez et al., 2007; Tull et al., 2013).

Procedures

This data collection was part of a larger study that was approved by the University of Toledo Institutional Review Board (IRB). To be eligible for participation in the larger study, participants had to be: 1) over the age of 18 and 2) able to speak and understand English. They could be at any stage of treatment at the community-based correctional facility. Participants eligible for the study were recruited by treatment staff and then approached by research personnel to receive more information about the study. Once they expressed interest in being a part of the study, informed consent was obtained, and they completed all questionnaires using either a paper-and-pencil or a computer (depending on whether a computer was available). Participants were given a candy bar after completing the study (this incentive was recommended by the staff at the treatment center).

Data Analysis Plan

The data were analyzed using Statistical Packages for the Social Sciences (SPSS), Version 26. Missing data were determined to be missing at random (i.e., missing data is not related to the variables being studied) and managed using listwise deletion. Bivariate correlations were run for all study variables; demographics or substance use variables that were significantly associated with opioid cravings were analyzed as covariates in the final models. Model 1 from the PROCESS macro in SPSS with a confidence interval of 95% and 5000 bootstrap samples was used for seven separate moderation models, one for the total DERS-36 score and one for each of the six subscale scores.

These models examined the main effects of anhedonia and emotion dysregulation on opioid cravings as well as the interaction of anhedonia and emotion dysregulation on opioid cravings. Predictor and moderator variables are continuous and linear, and simple slopes analysis

was used to probe significant interactions. Scores on the anhedonia scale and the DERS-36 total score and subscales were mean-centered for moderation analyses.

Chapter 3. Results

Data were screened prior to univariate and multivariate analyses. Normality plots, skewness, and kurtosis were examined for the anhedonia scale, POCS, DERS-36 total score, DERS-36 subscale scores, and the DUQ total score (Table 2). A cutoff score of +/-3 on skewness and +/-10 on kurtosis was used to determine normality. Observation of these plots and skewness and kurtosis values indicated that each of these variables were normally distributed and homoscedastic, and not influenced by extreme values. With the assumptions of a linear regression met, univariate and multivariate analyses were pursued. Means and standard deviations of participant demographics, the anhedonia scale, POCS, DERS-36 total score, and the DERS-36 subscale scores can be found in Table 2. The mean total score on the POCS was 7.0 (SD = 6.7), on a scale from 0 to 30.

Table 2

Univariate Statistics of Variables

Variables	*n*	Mean (SD)	Skew	Kurtosis	Possible Range	Actual Range
Anhedonia	94	4.5 (3.9)	.28	-1.22	0-12	0-12
Opioid Cravings	88	7.0 (6.7)	.78	.23	0-30	0-30
Emotion Dysregulation						
DERS Total Score	96	84.7 (22.6)	.33	-.67	30-150	46-136
DERS Nonacceptance	96	12.0 (4.5)	.46	-.58	5-25	6-22
DERS Goal	96	13.5 (4.2)	.06	-.47	5-25	5-23
DERS Impulse	96	13.6 (5.2)	.63	.02	6-30	6-28
DERS Awareness	96	16.9 (5.0)	.16	-.41	6-30	7-30
DERS Strategies	96	17.3 (6.1)	.84	.47	8-40	8-37
DERS Clarity	96	11.5 (4.6)	.61	-.48	5-25	5-23
Polysubstance Use	97	21.3 (10.8)	.97	1.87	0-65	1-65

Bivariate correlations between model variables and participant characteristics are displayed in Tables 3 and 4. Participant demographics (i.e., age, sex, education level, household income, race, treatment phase) were largely unrelated to model variables (Table 3). Polysubstance use was significantly correlated with opioid cravings (r = .45, p<.001), the DERS-36 total score (r = .40, p<.001), and each DERS subscale (Table 3), and thus was retained as a covariate in all models. Anhedonia and opioid cravings were significantly related (r = .32, p=.003). Additionally, the DERS-36 total score and subscale scores were significantly, positively related to both anhedonia and opioid cravings (Table 4).

Table 3

Bivariate Correlations Between Participant Demographics and Model Variables

	Age	Sex	Education Level	Household Income	Race	Treatment Phase	Poly Use
Anhedonia	-.01	.07	.05	-.03	.04	-.17	.19
Opioid Cravings	-.15	.11	-.03	-.06	.01	.03	.45***
Emotion Dysregulation							
DERS Total Score	-.17	.05	-.14	-.05	.11	-.05	.40***
DERS Nonacceptance	-.23*	.05	-.11	-.04	.09	.01	.23*
DERS Goal	-.19	-.13	-.12	.02	.14	.01	.42***
DERS Impulse	-.11	-.01	-.11	-.05	.11	-.02	.35***
DERS Awareness	-.08	.10	-.16	-.11	.00	-.03	.24*
DERS Strategies	-.16	.07	-.08	-.03	.16	-.03	.35***
DERS Clarity	-.03	.15	-.07	-.01	-.02	-.16	.26*

Note. *p<.05, **p<.01, ***p<.001

Table 4

Bivariate Correlations Between Anhedonia, Opioid Cravings, and Emotion Dysregulation

	Anh	Craving	DERS Total	DERS Non	DERS Goal	DERS Imp	DERS Aware	DERS Strat	DERS Clar
Anhedonia	1								
Opioid Cravings	.32**	1							
DERS Total	.63***	.49***	1						
DERS Nonaccept	.45***	.31**	.78***	1					
DERS Goal	.45***	.44***	.69***	.55***	1				
DERS Impulse	.46***	.54***	.83***	.59***	.65***	1			
DERS Awareness	.40***	.27*	.64***	.34**	.14	.36***	1		
DERS Strategies	.57***	.43***	.88***	.64***	.64***	.76***	.38***	1	
DERS Clarity	.52***	.24*	.73***	.49***	.22*	.38***	.69***	.54***	1

Note. *p<.05, **p<.01, ***p<.001

Moderation Analyses

The first moderation model, which included polysubstance use, anhedonia, the DERS-36 total score, and the interaction between anhedonia and the DERS-36 total score as predictors, accounted for 30.9% of the variance in cravings. There was a significant main effect of polysubstance use on opioid cravings, b=.18, t(85)=2.63, p=.01, with opioid cravings increasing as the frequency and severity of polysubstance use increased. There was also a significant main effect of emotion dysregulation on opioid cravings, b=.09, t(85)=2.54, p=.01, with opioid cravings increasing as emotion dysregulation increased. There was no main effect of anhedonia on cravings b=.06, t(85)=.30, p=.76, and there was no significant interaction between anhedonia and emotion dysregulation on cravings, F(1, 80)=.92, p=.34.

The DERS subscale models (i.e., nonacceptance of emotion responses, difficulties engaging in goal-directed behavior, impulse control difficulties, lack of emotional awareness, limited access to emotion regulation strategies, and lack of emotional clarity) accounted for between 24.9% and 37.6% of the variance in opioid cravings. Polysubstance use was accounted for as a covariate and had a significant main effect on opioid cravings in each model (see Table 5), with opioid cravings increasing as the frequency and severity of polysubstance use increased. Overall, there were no significant interactions within any of the DERS subscale moderation models (see Table 5). In the model examining anhedonia and lack of emotional clarity as well as their interaction, there was a significant main effect of anhedonia on opioid cravings, b=.41, t(85)=2.15, p=.03, with opioid cravings increasing as anhedonia increased. In the model examining anhedonia and difficulties controlling behaviors when distressed (i.e., impulse control difficulties subscale), there was a significant main effect of difficulties controlling behaviors when distressed on opioid cravings, b=.45, t(85)=3.30, p=.002, with opioid cravings increasing as difficulties controlling behaviors increased.

Table 5

Model Results Examining the Main Effects and Interactions of Anhedonia and Emotion Dysregulation on Opioid Cravings Controlling for Polysubstance Use (n = 85)

Moderation Model	B (SE)	t	95% CI of B	R^2-change
DERS Total Score	**.095 (.037)***	2.539	.021; .169	
Anhedonia	.062 (.206)	.302	-.347; .472	
DERS Total x Anhedonia	.007 (.007)	.961	-.007; .021	.008
Polysubstance Use	**.181 (.069)***	2.63	.044; .317	
DERS Nonacceptance	.182 (.162)	1.123	-.141; .505	
Anhedonia	.343 (.185)	1.85	-.025; .711	
DERS Nonacceptance x Anhedonia	-.022 (.038)	-.569	-.098; .054	.003
Polysubstance Use	**.239 (.067)*****	3.596	.107; .372	
DERS Goals	.350 (.178)	1.965	-.005; .705	
Anhedonia	.249 (.183)	1.362	-.115; .614	
DERS Goals x Anhedonia	.022 (.038)	.586	-.053; .097	.003
Polysubstance Use	**.204 (.070)****	2.898	.064; .343	
DERS Impulse	**.451 (.137)****	3.297	.179; .724	
Anhedonia	.117 (.168)	.696	-.217; .450	
DERS Impulse x Anhedonia	.04 (.028)	1.457	-.015; .095	.017
Polysubstance Use	**.186 (.064)****	2.899	.058; .313	
DERS Awareness	.107 (.138)	.779	-.167; .382	
Anhedonia	.350 (.179)	1.959	-.006; .705	
DERS Awareness x Anhedonia	.032 (.035)	.927	-.037; .102	.008
Polysubstance Use	**.231 (.069)****	3.367	.094; .367	
DERS Strategies	.225 (.140)	1.608	-.054; .504	
Anhedonia	.210 (.195)	1.077	-.178; .599	
DERS Strategies x Anhedonia	.018 (.026)	.707	-.033; .07	.005
Polysubstance Use	**.219 (.067)****	3.277	.086; .351	
DERS Clarity	.070 (.169)	.411	-.268; .407	
Anhedonia	**.408 (.190)***	2.154	.031; .785	
DERS Clarity x Anhedonia	-.024 (.036)	-.651	-.096; .049	.004
Polysubstance Use	**.261 (.069)*****	3.800	.125; .398	
Note. *p<.05, **p<.01, ***p<.001				

Post-hoc Analyses

To investigate whether the heterogeneity in opioid use (prescription opioids vs. heroin) and frequency (a few times vs. daily) may have impacted our ability to detect a significant

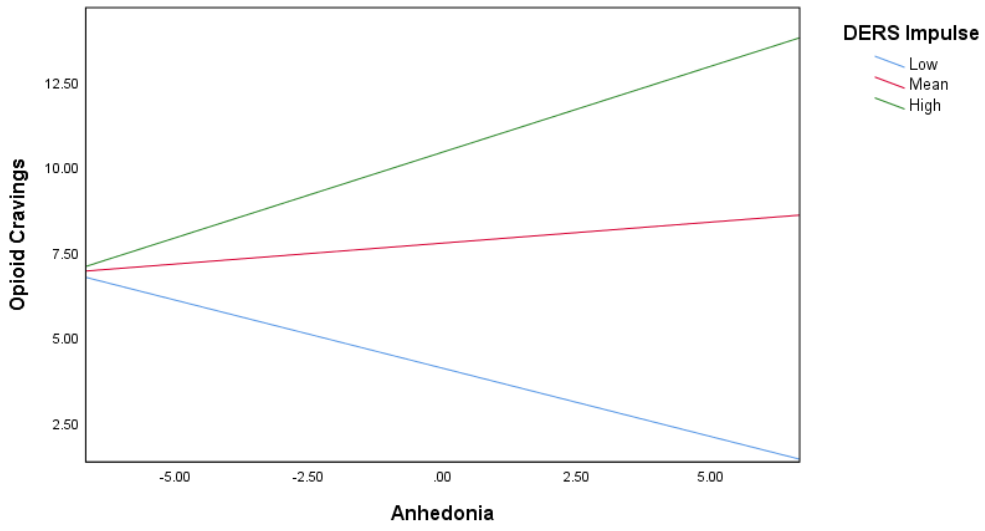
interaction between anhedonia and emotion dysregulation on cravings, we examined the proposed models among participants who had severe (compared to less severe) heroin and prescription opioid use. First, independent samples *t*-tests were examined comparing opioid craving scores for individuals who self-reported using heroin and prescription opioids one time in the past year to those who used these substances more than one time in the past year. On average, individuals who used opioids (prescription opioids or heroin) more often (n = 66) had a higher score on the opioid cravings scale (M = 7.65, SE = .82), compared to individuals who used opioids less often (n = 22; M = 5.00, SE = 1.38), although this difference was not statistically significant, $t(36.94) = 1.66$, 95% CI = [-.59, 5.90], p=.106. Then, the sample was further broken down to compare type of opioid. Individuals who used heroin more than once in the past year (n = 57) had a higher score on the opioid cravings scale (M = 8.21, SE = .88), compared to individuals who used heroin one time in the past year (n = 31; M = 4.74, SE = 1.12). This difference was statistically significant, $t(64.91) = 2.44$, 95% CI = [.63, 6.31], p=.02. Finally, individuals who used prescription opioids more often in the past year (n = 23) had a lower score on the opioid cravings scale (M = 6.39, SE = 1.27), compared to individuals who used prescription opioids less often (n = 48; M = 8.17, SE = .98), although the difference was not statistically significant, $t(47.97) = -1.11$, 95% CI = [-5.00, 1.45], p=.27.

Per the results of the independent samples *t*-tests, bivariate correlations and the seven moderations models described in the Data Analysis Plan section were re-examined with the subsample of individuals who reported using heroin more than one time in the past year (n = 57). Among this subsample, anhedonia was significantly correlated with opioid cravings (r = .36, p=.01), the DERS total score (r = .64, p<.001), and each subscale of the DERS (*rs* range from .39 to .62, *p's*<.01). In the first moderation model (i.e., DERS-36 total score), there was a

significant main effect of emotion dysregulation on opioid cravings, *b*=.13, *t*(49)=2.90, *p*=.01, but no other main or interaction effects. Among the moderation models examining the DERS-36 subscales, there was a significant positive main effect of goal-directed behavior (*b*=.58, *t*(49)=2.71, *p*=.01) and difficulties controlling behaviors when distressed (*b*=.61, *t*(49)=3.79, p<.001) on opioid cravings, and a significant interaction between anhedonia and difficulties controlling behaviors when distressed, *F*(1, 49)=5.51, *p*=.02. The addition of this interaction explained significantly more variance in opioid cravings (R^2-change = .07). Among this subset of individuals with more frequent heroin use, the relationship between anhedonia and craving was strong and positive among people with high levels of difficulty controlling behaviors when distressed (*b*=.50, 95% CI = [.027, .980], *t*(49)=2.12, *p*=.039), but was nonsignificant among people with low levels of difficulty controlling behaviors when distressed (*b*= -.40, 95% CI = [-1.057, .256], *t*(49)= -1.23, *p*=.226; Figure 1).

Figure 1

Interaction Between Anhedonia and Difficulty Controlling Behaviors on Opioid Cravings Among Individuals that Use Heroin More Than One Time in the Past Year



Chapter 4. Discussion

With opioid-related overdose being the leading cause of death among people re-entering into the community from incarceration (Joudrey et al., 2019), researchers and practitioners need to better understand factors that lead to poor treatment outcomes in this group. Opioid craving in particular (McHugh et al., 2014) is not well understood among justice-involved populations. In response to a review by Kiluk and colleagues (2019), we focused on anhedonia as a predictor of opioid cravings. Furthermore, we examined whether other emotion-related constructs changed the relationship between anhedonia and opioid cravings to understand more about who is at risk of experiencing opioid cravings in mandated treatment settings. Emotion dysregulation was chosen as a moderator because it is predictive of substance use cravings (Aaron et al., 2020; Kober, 2014) and it was theorized to be a unique risk factor for opioid cravings when someone is in an anhedonic state.

Anhedonia and Opioid Cravings

It was hypothesized that anhedonia would be positively associated with opioid cravings, and that emotion dysregulation would strengthen this relationship. Our hypothesis was partially supported. Anhedonia was correlated with opioid cravings at the bivariate level, which is consistent with prior literature (Janiri et al., 2005; Martinotti et al., 2008); however, it was largely unrelated in multivariate models, including those that were limited to a subsample of people with more severe opioid use problems. This is one of the first studies to examine the association of these variables in a more conservative model in which control variables and other predictors were included. Thus, polysubstance use and emotion dysregulation appear to be more important in predicting opioid cravings than anhedonia in this population. In the overall sample, emotion dysregulation (total score) and one facet of emotion dysregulation (i.e., difficulties

controlling behaviors when distressed) predicted opioid cravings. Previous literature has interpreted using substances as a form of emotion regulation to decrease cravings (Kober, 2014) and using other, more adaptive strategies (e.g., mindfulness) to regulate cravings has been a focus of treatment (e.g., Szasz et al., 2012; Westbrook et al., 2013). However, even fewer studies have examined the association between emotion regulation and cravings for *opioids* specifically. Thus far, studies have primarily been in the context of examining a mindfulness-based treatment to target opioid cravings (Garland et al., 2014; Garland et al., 2018; Garland et al., 2019). This study highlights the importance of emotion dysregulation on opioid cravings, and future research should continue examining this link to identify novel points of intervention to improve substance use treatment outcomes. This is especially important to examine among justice-involved populations, who have high rates of treatment failure and may struggle more with impulse control than other individuals with OUD.

Severity of Use and Emotion Dysregulation

The lack of relationship between anhedonia and cravings in our overall sample, paired with the significant difference in cravings between participants who use heroin more versus less frequently, led us to examine the moderation models in a subsample of participants who self-reported using heroin more frequently in the past year. The results of these post-hoc analyses showed that anhedonia was again only associated with opioid cravings at the bivariate level in this subsample. Anhedonia was, however, related to opioid cravings at high levels of a certain emotion dysregulation facet (i.e., difficulty controlling behaviors when under emotional distress), in this subsample of people with more severe heroin use. High emotion dysregulation decreases a person's ability to find alternative, naturally reinforcing stimuli to replace opioids. For example, using maladaptive (e.g., substance use) instead of adaptive (e.g., mindfulness) emotion

regulation strategies to manage distressing situations (Aguilar de Arcos et al., 2008). When in an anhedonic state, people who use heroin specifically may experience cravings because they want to experience pleasure but lack the ability to manage emotional distress that would allow them to pursue other, non-substance-related rewards.

Studies support this finding. For example, emotion dysregulation is an explanatory variable for the relationship between negative affectivity and substance use; specifically, substance use disorder symptoms (Collado et al., 2020), self-reported addiction to prescription opioids (Bakhshaie et al., 2019), and cravings (Enkema et al., 2020). More specifically, Enkema and colleagues (2020) concluded that 'acting with awareness' (i.e., a facet of mindfulness) mediates the relationship between negative affect and substance use cravings among a partially court-mandated sample. Two studies also used the Difficulties in Emotion Regulation Scale (DERS) to measure emotion dysregulation (Bakhshaie et al., 2019; Collado et al., 2020). However, none of these studies included *opioid cravings* as an outcome variable, which is particularly important to examine in a justice-involved population.

These findings can also be explained biologically. For example, increased activity in the dorsolateral and ventral prefrontal cortex (PFC) is responsible for regulating cravings and negative emotions (Kober, 2014), along with becoming activated during reappraisal tasks (Golkar et al., 2012), which is conceptually similar to emotion regulation. Also, the interaction between anhedonia and emotion regulation is controlled by the same brain pathway, the cortico-striatal pathway which includes interactions between the amygdala and PFC (Banks et al., 2007; Koob & Le Moal, 1997), and the endogenous opioid system (Koob, 2020). Thus, at high levels of emotion dysregulation, these brain regions may be activated in such a way that anhedonia more readily cues opioid craving.

The relationship between emotion dysregulation and opioid cravings may only be relevant among people who use heroin because it is inherently more risky than other opioid use. For example, people who inject heroin as their primary route of administration are at risk for a variety of medical complications, including HIV (NIDA, 2021) and are more likely to use multiple substances (Jones et al., 2015). In addition, a higher severity, heroin-abstinent sample is more likely to struggle with anhedonia due to the opponent process theory and allostasis, which proposes that during withdrawal negative emotional states worsen enough to exceed the capacity of the reward system, leading to permanent changes in reward processing, thus an anhedonic state (Shurman et al., 2010; Solomon, 1980). Research has yet to distinguish between heroin and prescription opioids when examining opioid craving, but our study suggests this may be necessary in order to understand which factors predict craving.

Limitations

This study has limitations to consider. First, it is cross-sectional rather than longitudinal, so causality between anhedonia and opioid cravings could not be determined. Future research should explore the causal relationship and/or bidirectionality between these variables using longitudinal or ecological momentary assessment (EMA) data. Second, low levels of anhedonia (M = 4.5 out of 12) and opioid cravings (M = 7 out of 30) were reported by study participants, which may have impacted the study's findings. This could be due to how anhedonia and opioid cravings were measured. There are several limitations in how the most common self-report measures of opioid cravings are assessing this construct; for example, key dimensions of opioid cravings (e.g., interfering thoughts) are missing from some of the frequently used measures (Bergeria et al., 2021). Also, the questions used to assess for anhedonia may not have been comprehensive. Future research should replicate these findings using a different, validated

measure of anhedonia (e.g., Snaith-Hamilton Pleasure Scale [SHAPS]). Third, our sample was relatively small (n = 97, n = 57 for post-hoc analyses), yet bigger than previous studies with similar research questions (Janiri et al., 2005; Martinotti et al., 2008). Finally, it is unknown if participants were given the option to take medications for opioid use disorder (MOUD) at the community corrections facility. It is possible participants were taking MOUD at the time of data collection, which could have impacted their self-reported anhedonia and craving scores.

Clinical Implications and Future Directions

Individuals with OUD report less than 50% confidence in their ability to resist using opioids in situations involving negative emotional states (Hayaki et al., 2021). This is concerning given how common it is to have a co-occurring mood and substance use disorder. Effective interventions for individuals with OUD who are experiencing negative affectivity, including anhedonia, should primarily focus on bolstering emotion dysregulation skills as well as increasing self-efficacy towards managing opioid cravings. Currently, MOUD is the gold standard treatment for reducing the frequency and severity of opioid use, along with decreasing cravings (Wakeman et al., 2020). However, MOUD does not target emotion dysregulation, and thus supplemental behavioral therapies focused on emotion regulation skills are needed.

Mindfulness-Oriented Recovery Enhancement (MORE) is a mindfulness-based treatment that encourages the *savoring* of natural rewards by reorienting one's attention to naturally pleasant stimuli and noticing the positive emotional responses to the stimuli. Specifically for cravings, MORE teaches clients to deconstruct unpleasant internal experiences (e.g., cravings) into single physiological components (e.g., heat), while noticing pleasant stimuli in one's environment. The mindful reappraisal of drug-related stimuli, an adaptive emotion regulation strategy, is also part of MORE (Garland, 2021). Through a randomized control trial (RCT) with

participants diagnosed with an OUD and chronic pain in MOUD treatment, MORE reduced participants' reactivity to drug cues while enhancing natural reward processing and reducing opioid craving (Garland et al., 2019). Other mindfulness-based treatments have small-to-large effects on reducing the intensity of cravings, (Li et al., 2017) and are preferable to reduce cravings compared to a cognitive-behavioral approach (Kober, 2014). Clinicians should consider providing **both** MORE and MOUD to reduce opioid cravings. Previous studies have shown beneficial effects of combining psychosocial treatments (e.g., contingency management, CBT) and pharmacological treatments to treat OUD (Amato et al., 2008; Dugosh et al., 2016). Additionally, research has shown that mindfulness-based programs can be successfully adapted to criminal justice settings to reduce drug cravings (Lyons et al., 2019). However, no studies have examined MORE's ability to reduce drug cravings among justice-involved populations. Thus, mindfulness-based interventions such as MORE should be administered to people with OUD receiving court-mandated treatment, particularly when individuals exhibit anhedonia and emotion dysregulation.

Conclusion

Individuals with OUD who are in court-mandated substance use treatment are at risk for poor treatment outcomes, including relapse and overdose. Results of this study showed that anhedonia and opioid cravings were significantly related, but that variables like polysubstance use and emotion dysregulation were stronger predictors of cravings. Among a subset of people who reported using heroin more than once in the past year, difficulties controlling behavior under emotion distress strengthened the relationship between anhedonia and opioid cravings. More specifically, individuals in an anhedonic state and had more difficulty controlling their behavior under distress experienced more opioid-related cravings. The researchers propose the

implementation of MORE and MOUD, combined, to target both of these risk factors in court-mandated treatment settings.

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