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Emotion Regulation And Coping Motives: An Ema Study Of The Path Between Negative Affect And Craving

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EMOTION REGULATION AND COPING MOTIVES: AN EMA STUDY OF THE PATH BETWEEN NEGATIVE AFFECT AND CRAVING

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ABSTRACT

Negative affect (NA) is a known precipitant of cravings, and each are robust predictors of lapses, making this pathway an excellent target for lapse prevention in opioid treatment. As emotion dysregulation arises from unmitigated NA, deficits in emotion regulation (ER) contribute to cravings in part by worsening distress, although the form these deficits take remains unclear. Coping motives are relevant in the context of NA and show robust associations with ER difficulties. Further, coping motives have demonstrated a similar role in exacerbating the effect NA has on cravings. This study aimed to explore the conditional indirect effects of ER deficits (in the form high reliance on maladaptive strategies and insufficient use of adaptive strategies) on NA and craving via the conditional effects of coping motives in opioid use in a piecemeal approach.

Treatment seeking opioid users less than 90 days clean (N=57) completed dispositional measures of using motives and ER repertoires followed by a 7-day ecological momentary assessment protocol indexing ratings of NA and craving across each day. General and mixed-effects linear models were fit to test hypothesized effects. Results indicate coping, enhancement, and pain, but not social motives predict maladaptive ER and no using motives predict adaptive ER. Coping motives and within-person fluctuations in NA interactively predict craving, with simple effects suggesting high dispositional coping motives exacerbate the effect of NA on craving and individual differences explain the variability in this effect. Conditional indirect effect of ER deficits

via coping motives could not be tested due to insufficient statistical power, but the total effect of maladaptive repertoires and within-person fluctuations in NA interactively predict craving at a trend level. Simple effects suggest high maladaptive repertoires exacerbate the effect of NA on craving and individual differences explain the variability in this effect. Adaptive ER interactions were not interpretable. These finding suggest understanding using motives and reliance on maladaptive ER may help identify increased lapse risk in clinical settings.

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CHAPTER I

INTRODUCTION

On October 27th, 2017, the opioid crisis was declared a nationwide Public Health Emergency. This declaration, motivated by the opioid overdoes-related deaths that doubled 2012 to 47,600 in 2017 (National Institute on Drug Abuse, 2018), reflects an epidemic level of functionally-impairing opioid use that is estimated to affect over 2.5 million Americans annually as of 2019 (National Institute on Drug Abuse, 2019). Enshrined in the DSM-5 under the auspices of Opioid Use Disorder, such problematic patterns of use lead to clinically significant impairment or distress, and are associated with uncontrollable cravings and inability to reduce opioid use despite harmful consequences (Diagnostic and Statistical Manual of Mental Disorders: DSM-5, 2013), and are tied to a $78.5 billion annual burden in the US taking the forms of treatment, criminal justice, and healthcare expenses, as well as lost productivity (Florence et al., 2016). Further, despite improvements in behavioral healthcare over the past few decades (Kilbourne et al., 2018) Opioid Use Disorder treatment efficacy remains relatively low. In particular, around 50% of treatment seekers terminate care prematurely (Scott et al., 2005; Salamina et al., 2010), which for

many presages a return to pre-treatment opioid use levels (Zhang, Friedmann, & Gerstein, 2003).

Chemical abstinence during treatment is a key predictor of treatment retention (Sullivan, Rothenberg et al, 2006), with sobriety lapses, or a short return to substance use, prognosticating premature treatment withdrawal (Panlilio et al., 2019). Therefore, elucidating process and mechanisms that may predict sobriety lapses may be a key step to increasing treatment retention and addressing this important public health problem.

1.1 Craving in Opioid Treatment

Craving is an integral component of Opioid Use Disorder (OUD). Enshrined as a qualifying criterion for OUD in the DSM-V (American Psychiatric Association, 2013) and the ICD-10 (World Health Organization, 2016), the prevailing definition among experts describes craving as a subjective experience of wanting to use a drug (Tiffany & Wray, 2011). However, craving has been conceptualized in various ways. For instance, some neuroscience informed models posit craving as perseverative, anxiogenic cognitive process that is temporarily alleviated by substance use (Anton, 2000; Rosenberg, 2009), while others employ approach-avoidance paradigms to characterize conflicting desires to use but avoid repercussions of using said substance (Rosenberg, 2009). Other multidimensional models suggest the need to consider craving's intensity, duration, and frequency (Flannery et al, 1999; Rosenberg, 2009), and incorporate motivational states in the construct's formulation (Rosenberg, 2009).

In this study, I use the prevailing definition of craving as it was deemed a valid clinical criterion by the National Institute on Drug Abuse (Tiffany & Wray, 2011). Indeed, studies employing Ecological Momentary Assessment (EMA) paradigms show

robust links between craving and sobriety lapses in outpatient samples (Fatseas et al., 2018; McHugh et al., 2014; Moore et al., 2014; Panlilio et al., 2019) and treatment dropout (Panlilio et al., 2019). For instance, elevated cravings were linked to a 14-fold increase in risk for a sobriety lapse across subsequent EMAs in a mixed substance use treatment sample (Moore et al., 2014), and with a 17% increase in risk for opioid use per unit of craving in the Prescription Opioid Addiction Treatment Study (McHugh et al., 2014). Importantly, the relationship between cravings and sobriety lapses remain when psychiatric comorbidities are statistically controlled (Fatseas et al., 2018). As sobriety lapses are a robust prognosticator of early treatment termination (Panlilio et al., 2019) and a substance use relapse (Raj et al., 2000), elucidating mechanisms for increased craving intensity may improve treatment retention and the likelihood of sustaining abstinence and the recovery process.

1.2 Craving and Negative Affect

Substance-related cravings have strong affective ties (Tiffany, 2010), and are believed by some to have emotional substrates (Baker, Morse, & Sherman, 1987; Franken, 2003). For example, insofar as emotions reflect motivational states (Frijda, 1986), craving, or the desire for a substance, reflects an affective approach action-tendency to seek said substance (Baker et al., 2004). Though linked with both hedonic and dysphoric states (Baker et al., 2004), a large body of work points to emotional distress, spanning fear, anxiety, hostility, scorn, loneliness, and sadness (Negative Affect, NA) (Watson, Clark, & Tellegen, 1988) as a precipitant of opioid misuse (Martel et al., 2014) and relapse following drug abstinence (Marlatt, 2005). For instance, negative affect predicted increased craving levels, that, in turn, were linked to opioid misuse tendencies

within a sample of chronic pain patients (Martel et al., 2014, but see Wasan et al, 2012 for negative findings). In a similar vein, Bradley and colleagues showed that negative mood states were one of the greatest risk factors for lapses, in addition to cognitions and environmental triggers, among recently discharged inpatient-heroin users (Bradley et al., 1989), and was reported as an antecedent to recent use among those seeking treatment (Schonfeld et al., 1989). In consort, results from the experimental literature show robust associations between induced negative mood states and craving for tobacco, alcohol, and cocaine (Bresin et al., 2018; Conklin & Perkins, 2005; Maude-Griffin & Tiffany, 1996; Perkins & Grobe, 1992; Tiffany & Drobes, 1990; Sinha et al., 2000; Sinha et al., 2006), as well as opioids (Childress et al., 1994). Namely, hypnotically induced dysphoria, anxiety, and anger triggered elevated cravings for opioids among detoxified opioid-abuse patients (Childress et al., 1994). Along similar lines, experimental designs employing noxious stimuli (e.g., shock) showed heroin-seeking behavior reinstatement in the presence of heroin cues within animal studies (e.g., Shaham, Rajabi, & Stewart, 1996), and among humans when aversive interpersonal conditions were employed (Back et al., 2015; Saraiya et al., 2021). As with animal studies, participants with Opioid Use Disorder reported increased cravings for opioids following aversive interpersonal conditions (Trier Social Stress Test) within an opioid-cue paradigm that significantly predicted a reduced time-course to opioid use (Saraiya et al., 2021; Back et al., 2015).

Correlational survey designs that test relationships naturalistically as they unfold in daily life through experience sampling methodologies (Ecological Momentary Assessment, EMA) also support the distress-craving association. One EMA study examined affect and craving in a prescription opioid-dependent sample, in which main

effects between negative affect and craving were significant at both the person- and day-level. This means participants experiencing high negative affect throughout the study reported higher craving overall relative to peers with low negative affect (person-level), as well as further increase in their cravings on days where their distress exceeded their usual levels across the twelve-day monitoring period (day-level) (Huhn et al., 2016). These findings were independently replicated across an eight-to-ten-day monitoring period within an inpatient-treatment sample (Jenkins et al., 2021). Likewise, within an opioid-dependent sample, negative mood (distress) and craving preceded abstinence lapses (Preston et al, 2018).

Given its ties to sobriety lapses, the negative affect-craving relationship has implications for treatment retention and outcomes. Indeed, some postulate that substance use is for some a means to alleviate negative affect (Khantzian, 1985 & 1997; Conger, 1956; Sher & Levenson, 1982; Marlatt, 1987; Sher, 1987), thereby suggesting that cravings serve as a maladaptive coping cue that is maintained through negative reinforcement (Koob & Le Moal, 2008). The following sections explore the role of Emotion Regulation (ER), a construct closely tied to coping, in connection between negative affect and coping.

1.3 Emotion Regulation & Craving in Opioid Use

Emotion regulation (ER) refers to automatic and volitional processes that modulate the temporal course, intensity, and phenomenology of emotional experience across both positive and negative valences (Thompson, 1994; Gross, 2001). ER responses span the cognitive, behavioral, and interpersonal domains (Wenzlaff & Luxtion, 2003; Chapman, Dixon-Gordon, & Walters, 2011) and are considered maladaptive when their

intent serves short-term at the cost of long-term regulatory goals. Conversely, adaptive responses are those that serve short- and long-term goals, as appropriate to context (Kovacs, Rottenberg, & George, 2009). As example, some adaptive ER strategies include exercise (behavioral), humor (cognitive), and talking to friends (interpersonal) and maladaptive strategies include drug use (behavioral), rumination (cognitive), and isolation (interpersonal) (Kovacs et al., 2009).

ER deficits take the form of an excessive reliance on maladaptive strategies and the infrequent or ineffective deployment of adaptive responses. ER deficits are a transdiagnostic risk factor, involved in the development and maintenance of many psychiatric conditions, including depression, borderline personality disorder, eating disorders, somatoform disorders, and substance use disorders (SUDs) (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Gross & Munoz, 1995; Berking et al., 2014; Carpenter & Trull, 2013; Glenn & Klonsky, 2009; Svaldi et al., 2012; Prefit et al., 2019; Waller & Scheidt, 2006; Kober, 2014).

Concerning SUDs, ER deficits may be involved in at least two ways: 1) substance use is a maladaptive ER strategy (Kovacs et al., 2009) and 2) ER deficits maintain and exacerbate distress, thereby increasing substance-related cravings (Cicchetti et al., 1995). As a maladaptive ER response, acute drug intoxication is an effective means to down-regulate negative affect and up-regulate positive affect, as well as decrease cravings (Kober, 2014), which is in line with Khantzian's Self-Medication Hypothesis (1985). Irrespective of the regulatory motive (enhance positive affect or cope with negative affect), substance use is considered a maladaptive ER strategy as the behavior often compounds problems long term, leading to negative substance-related outcomes (Peraza et al., 2019).

Concerning their role as a substance use risk-factor, emotion regulation deficits are linked to intense, enduring negative emotional states that lead to disruptive or self-destructive behavioral responses (emotion dysregulation, ED). ED is more prevalent among those with substance use problems than in the general population (Kober, 2014), and is positively associated with substance use frequency and severity (Garke et al., 2021), and an increased risk of opioid misuse among chronic pain patients (Lutz, Gross, & Vargovich, 2019). In a similar vein, ER deficits from which ED arises predict a rapid return to regular substance use following treatment (Hyman et al., 2009; Ottonello et al., 2019). Following a 28-day rehabilitation program, those who evidence an early relapse exhibited more ER difficulties (specifically with "emotional clarity") relative to those still abstinent one month after discharge (Ottonello et al., 2019).

Craving is a likely pathway by which ER deficits and ED confer risk for substance use (Evenden, 1999; Fox, Bergquist, Hong & Sinha, 2007; Fox, Hong, Sinha, 2008). Opioid-dependent patients report deploying adaptive ER responses less frequently than healthy controls (Hyman et al., 2009), with similar deficits linked to emotional distress and craving among chronic pain patients at risk for misusing prescription opioids (Garland et al., 2018). On the other hand, deploying such maladaptive ER responses as thought suppression has been associated with opioid cravings (Garland et al., 2016). Similar negative and positive associations between adaptive and maladaptive ER responses and cravings have been shown by others within mixed substance-dependent samples (Basharpoor, 2014; Ottonello et al., 2019), among those with problematic marijuana use (Asiaban, Imani, & Shokri, 2020), alcohol problems (Khosravani et al., 2019), and heroin-dependence (Ghorbani et al., 2019), respectively.

As ED arises from unmitigated negative affect, ER deficits likely contribute to opioid cravings in part by worsening distress (Evenden, 1999; Fox, Bergquist, Hong & Sinha, 2007; Fox, Hong, Sinha, 2008). This implies that ER deficits moderate the association between negative affect and opioid craving. Indirect evidence for the possibility arises from studies showing a reduced association between negative affect and craving among cigarette smokers as a function of ER (Yuan et al., 2018), and the reduction in craving as a function of improved ER among a mixed-substance-dependent sample (Choopan et al., 2016) and those with opioid dependence (Garland & Howard, 2013). In the context of literature that links ER deficits with negative affect (Cicchetti et al., 1995), the therapeutic benefits of ER training on substance-related cravings indirectly support ER in a buffering role between negative affect and craving. However, it remains unclear whether the link between negative affect and craving is strengthened by sparse adaptive ER response repertoires, over-reliance on maladaptive responses, or both.

1.4 Motives for Opioid Use & Emotion Regulation

Although opioid use problems arise from the habitual use of the drug, the motivations for such use are varied, with some endorsing pain management, social-related, positive affect enhancement, negative affect reduction as reasons for their problematic opioid use (Jones et al., 2014). The construct of substance use motives originated in the work of Cox and Klinger (1988). They created a motivational model for alcohol use, which posits that people decide to drink or not drink on the basis of whether the positive affective consequence they expect to achieve by drinking outweighs the consequences of not drinking. This hypothesis combines literatures on emotion and motivational theory to explain alcohol use. It is the bedrock from which motivational

counseling for alcoholism is built on. Also emanating from Cox and Klinger's Incentive Motivation Model was a measure for drinking motives in adolescents (Cooper, 1992). Cooper's measure was revised a couple years later identifying a fourth motive, but testing these questionnaires served to bring validity to the conceptual model (Cooper, 1994). The four drinking motives include: 1) social- to bond with others or facilitate social interactions, 2) coping- to avoid or escape distressing or negative emotions, 3) enhancement- to enhance physical or emotional pleasure or create excitement, and 4) conformity- to gain social approval or avoid disapproval. Validation of the four-motive structure of the Drinking Motives Questionnaire (DMQ) was later replicated in a Swiss sample of adolescents (Kuntche et al., 2006). With the DMQ eventually becoming the gold-standard for substance use motives questionnaires, the basic factor structure was extended to and modified for substances other than alcohol. These questionnaires include the Marijuana Motives Measure (MMM), which added an 'expansion' motive, the Opioid Prescription Medication Motives Questionnaire (OPMMQ), and the Opioid Motives Scale (OMS) (Simons et al., 1998; Jones et al., 2014). These measures of opioid use motives follow a similar factor structure to what Cooper initially identified; however, the conformity motive of the DMQ is supplanted by the motivation to use to relieve pain as pain management is a more frequently cited motive in opioid use (Barth et al., 2013).

Motivations for substance use has received increasing attention as potential intervening variables between ER deficits and substance use-related outcomes; enhancement and coping motives have received particular attention due to their ER regulatory roles. Most work on the relationship between substance use-related motives come from the alcohol (Aurora & Klanecky, 2015; Messman-Moore & Ward, 2014;

Paulus et al., 2021; Simons et al, 2017; Veilleux et al., 2014) and marijuana use literatures (Bonn-Miller, Vujanovic, Boden, & Gross, 2011; Bonn-Miller, Vujanovic, & Zvolensky, 2008; Buckner et al., 2017). For instance, one study showed robust associations between ED and coping motives within a methadone-maintenance sample (Gold et al., 2020). In support, similar links have been observed among young adult marijuana smokers (Bonn-Miller et al., 2008). Indeed, ER difficulties were shown to mediate the relationship between PTSD symptoms and using marijuana to cope; those with elevated PTSD symptoms evidenced ineffective ER skills, that, in turn, predicted their reliance on marijuana to manage distress (Bonn-Miller et al., 2011). Similar mediating role of ER deficits were observed between anxiety and marijuana use within a treatment sample (Buckner et al., 2017), and between ED and problematic marijuana and alcohol use within a college sample (Lucke et al., 2021).

Of the various motives that drive opioid use, the literature suggests analysis of coping motives may hold particular value in identifying and treating problematic using patterns (Vest & Tragesser, 2019; Menon & Kandasamy, 2018; Baker et al., 2004). Coping motivated intoxication is itself a maladaptive means of regulating emotions, which has been linked to other problems in regulating emotion. As ER deficits are considered a risk factor for opioid use and relapse, coping motives are also emerging to play a similar role (Paulus et al., 2021; Buckner et al., 2017).

1.5 Coping Motives in Opioid Use & Craving

Craving reduction is a target for opioid treatment, it is therefore of interest whether coping motives also predict cravings in addition to problematic substance use. However, only two studies to this author's knowledge have examined the role of coping

motives and craving, with mixed results. In their study of opioid misusers in residential treatment, Scamaldo and colleagues showed that coping motives predicted opioid cravings independent of other substance-related motives and psychopathology (Scamaldo, Tull, & Gratz, 2021). However, these results were not replicated in a laboratory study; opioid user's coping motives did not significantly predict drug craving in response to negative affect inductions (Stathopoulou, Pollack, & Otto, 2018).

While few studies have specifically examined coping motives in relation to negative affect in an opioid sample, there is evidence that coping motives are frequently endorsed in response to negative affect in relation to other substances (Kuntsche et al., 2005; Labhart, Kuntsche, Wicki, & Gmel, 2017; Anderson, Briggs, & White, 2013; Read, Wood, Kahler, Maddock, & Palfai, 2003). For instance, coping motives were linked to alcohol craving among those experimentally induced into a negative mood state (Hogarth et al., 2018), and outside of the laboratory among college students who reported at least one heavy drinking episode (Lindgren et al., 2015). Likewise, coping motives mediate the association between poor distress tolerance and cannabis craving severity (Farris et al., 2016; Peraza et al., 2019). In the only study to date to examine substance-related coping motives and substance use, Waddell and colleagues tested the relationships between affective states, substance-related motives, and negative affect on alcohol craving and use via EMA (Waddel, Sher, & Piasecki, 2021). Their results showed that participants' elevations in negative affect at the time of EMA prompt relative to average levels predicted increased alcohol cravings, and this effect was more prominent among drinkers with higher dispositional coping motives. This means for regular drinkers, the tendency to drink to cope exacerbates the effect negative affect has on initiating cravings.

As ER deficits are linked to substance-related coping motives (Aurora & Klanecky, 2015; Bonn-Miller, Vujanovic, & Zvolensky, 2008; Gold et al., 2020), and also magnify the association between negative affect and craving (Childress et al., 1994; Huhn et al., 2016; Jenkins et al., 2021), it is feasible that some moderation effects of ER deficits may come by indirectly via substance-related coping motives. This possibility is well-aligned with the Self-Medication Hypothesis, which substance use as a coping response to difficult emotions (Khantzian, 1985), and a reliance on such a response is likely due to broader ER deficits. Further, this possible relationship would help explain why emotion regulation skills training reduces cravings, and its empirical examination may provide insight into novel opioid treatment approaches (Choopan et al., 2016; Garland & Howard, 2013).

1.6 Measurement of Dynamic Constructs

Research on substance abuse treatment (and most psychological research in general) has long relied on questionnaires to measure constructs. However, one limitation of this design is that sampling is cross-sectional, meaning constructs are only measured once at single point in time. Yet, many psychological constructs, particularly those related to emotions, are known to fluctuate over time. It is only in the last couple decades that this methodological issue has been addressed. To improve our measurement and accuracy of scientific findings, experience sampling has increasingly been integrated into research designs. Measurement methods such as EMA (i.e. electronic diaries) have served to both increase ecological validity as well as move past the constraints of cross-sectional designs by incorporating repeated measures.

At present, these limitations remain to a degree in the literature regarding negative affect and craving. The studies utilizing mood inductions often cite a lack of ecological validity in their limitations as laboratory settings may not elicit the same responses that are observed in naturalistic settings. Correlational research often measures negative affect and craving via self-report questionnaires (ie. PANAS, Penn Alcohol Craving Scale, Obsessive Compulsive Drinking Scale, Substance Craving Questionnaire). One inherent flaw in this measurement method is recall bias as responses could be affected by poor memory and cognitive distortions that occur in the interim period between the event in question and its assessment (Hammersley, 1994; Sayette, 2000). Real-time assessments may reduce the effects of recall bias. Lastly, questionnaires measuring craving and negative affect are essentially treating these constructs as stable factors as is implied by the use of cross-sectional sampling. As a body of work suggests negative affect and craving are dynamic constructs, we are tasked with how to correctly interpret such findings from questionnaires (Shiffman, 2009; Drummond et al., 2000).

Saul Shiffman's use of real-time assessments has demonstrated the dynamic nature of craving, showing momentary ratings to vacillate over the course of a day (Shiffman et al., 1996). He went on to author an article proposing the suitability of EMA in substance use research (Shiffman, 2009). The main argument behind the suitability of EMA is that substance use is episodic and believed to be related to mood and context, which EMA captures well. As repeated measure designs have the capacity to detect fluctuations in craving and affect over the course of the day, repeated EMAs additionally examine participants in naturalistic settings, yielding high ecological validity. Lastly, utilizing repeated measures to index dynamic constructs such as negative affect and

craving over time allows researchers to address within-subject variability (in addition to between-subjects variability, which is measured cross-sectionally). This study sought to refine the measurement of negative affect and craving by incorporating EMA so that the effects of negative affect on craving while influenced by other study variables could be analyzed both between and within participants.

CHAPTER II

CURRENT STUDY AIMS

The present study sought to identify underlying processes along the pathway to relapse for those in treatment for opioid problems. Elucidation of these factors may enable clinicians to reduce client cravings, therefore mitigating the risk of lapses during treatment. As negative affect is known to initiate cravings, ER skills are likely at play as regulatory deficits may produce negative affect. Deficits in ER were expected to moderate the association between negative affect and opioid craving. As the research on ER has not yet clarified the roles repertoire make-up plays in promoting cravings, this study should grant that clarity by testing both putatively adaptive and maladaptive ER repertoires in moderator roles. Further, coping motives in substance use have received increasing attention as a potential mediator between ER deficits and risk for recurrent use with only one study sampling opioid-dependent users. As coping motives are endorsed in response to negative affect and predict craving and lapses, coping motives were also expected to moderate the association between negative affect and craving although no study had yet tested coping motives in this role in opioid use. While serving to elucidate the form ER deficits take, whether these be robust maladaptive or limited adaptive

repertoires, this study aimed to test the conditional effects of coping motives as mechanistic of the conditional effects of ER deficits.

In addition to these gaps in the literature the project addressed, the methodological approaches employed also improve our understanding of the relationships being tested. Given the limitations of questionnaires, EMA has been recommended in the context of substance use research. This study followed that recommendation, improving the ecological validity of negative affect and craving ratings. Incorporating a repeated measures design via EMA to index these dynamic constructs also enabled the detection fluctuations, improving the precision of effect estimates. Negative affect and craving were indexed at a state level, varying over time, whereas opioid use motives and ER were measured at a trait level, invariant over time.

In all, the effects of coping motives and indirect effects of ER were simultaneously tested as enhancers of contemporaneous drug craving and negative affect in daily life. As craving is a reliable marker of relapse and early treatment termination, identifying the roles of craving precipitants amongst themselves begins to elucidate the processes that govern craving. Analytically, this study allowed the effect of negative affect on craving and craving baselines to vary from person to person, with cross-level interactions used to potentially explain this variability. An understanding of how individual differences in tendencies and skillsets impact lapse risk holds clinical value. Findings may help clinicians identify OUD clients at higher lapse risk and serve to guide ER skills training with the aim of reducing cravings, highlighting the importance of ER based therapies during the early stages of opioid-dependence treatment.

2.1 Hypotheses

Hypothesis 1. High reliance on maladaptive emotion regulation strategies and infrequent use of adaptive emotion regulation strategies will significantly predict tendencies to use opioids to cope.

Hypothesis 2a. Tendencies to use opioids to cope will exacerbate the person varying relationship between negative affect and craving in daily life across the course of a week.

Hypothesis 2b. Tendencies to use opioid to cope will exacerbate the relationship between the time-invariant components of negative affect and craving in daily life.

Hypothesis 3a. Infrequent use of adaptive emotion regulation strategies will indirectly exacerbate the person varying relationship between negative affect and craving in daily life across the course of a week through coping motivated opioid use.

Hypothesis 3b. High reliance on maladaptive emotion regulation strategies will indirectly exacerbate the person varying relationship between negative affect and craving in daily life across the course of a week through coping motivated opioid use.

Hypothesis 4a. Infrequent use of adaptive emotion regulation strategies will indirectly exacerbate the relationship between the time-invariant components of negative affect and craving in daily life through coping motivated opioid use.

Hypothesis 4b. High reliance on maladaptive emotion regulation strategies will indirectly exacerbate the relationship between the time-invariant components of negative affect and craving in daily life through coping motivated opioid use.

CHAPTER III

METHOD

3.1 Participants

The sample was comprised of fifty-seven adult participants self-identifying as seeking rehabilitation from opioid dependency by means of mutual help group involvement. The sample was 42% female (n=24) relative to males with ages ranging from 18 years to 63 years, at an average age of 34.76 years old. Eligibility was defined as within ninety days of the most recent sobriety lapse and having regular access to a smart cellular phone.

3.2 Recruitment

Participants were recruited via advertisements posted in major cities across the nation on Craigslist.com. Those who express interest were contacted via telephone and screened to assess their merits regarding inclusion criteria. Participants were compensated up to $25 for their time, disaggregating to $10 for completing the one-hour battery of questionnaires and $15 for completing at least 80% of EMA surveys (28/35). Those who completed less than 80% of EMA surveys were still compensated $5 for their effort in completing the EMA protocol. Nightly emails were sent updating participants on

their EMA survey completion percentage progress. Payments were made by either money order or electronic transfer via PayPal, Cash App, and Venmo.

3.3 Measures

3.3.1 General measures.

Demographic questionnaire. An 11-item measure collecting personal information including age, gender, education level, race, country of origin, number of years and generations family has been in the U.S., sexual orientation, gender orientation, number of days sober, and mutual help group program affiliation.

Opioid motives scale (OMS). The opioid motives scale is a 27-item self-report questionnaire used to assess participants' rationale for using opioids. Each item corresponds with one of four motives for using opioids: enhancement, coping, social, and pain. Participants endorse items based on the frequency they've used for the corresponding reason. Items are assessed on a 6-point scale: Never (0), Very Rarely (1), Rarely (2), Occasionally (3), Frequently (4), and Very Frequently (5). This measure is a product of motivational theory, from which the Drinking Motives Questionnaire is derived (Cox & Klinger, 1988; Cooper, 1994). Multiple scales have been adapted to assess using motives in substances other than alcohol. The OMS is a version of the validated Opioid Prescription Medication Motives Questionnaire (OPMMQ), which identified a four-factor model for the primary reasons opioids are used (Jones et al., 2014). To develop the OMS, the OPMMQ was adapted to include non-prescription opioid use by simply removing the item "How often have you used opioids… because it is safer than street drugs." The OPMMQ demonstrated excellent internal consistency in the enhancement ($\alpha = 0.96$), coping ($\alpha = 0.93$), social ($\alpha = 0.92$), and pain ($\alpha = 0.91$)

subscales (Jones et al., 2014). Akin to the OPMMQ, items of the OMS are aggregated into four distinct scales reflecting the same cardinal motives to use opioids. In this sample, the OMS demonstrated acceptable reliability in the enhancement ($\alpha = 0.84$), coping ($\alpha = 0.81$), social ($\alpha = 0.93$), and pain ($\alpha = 0.78$) subscales.

Feelings and me- adult version (FAM-A). The FAM-Adult is a 56-item self-report questionnaire measuring dispositional tendencies to deploy emotion regulation strategies in response to sadness across cognitive (e.g., re-evaluation), behavioral (e.g., planned action), and interpersonal (e.g., engaging with other to relieve one's distress) domains. Each item begins with "When I feel sad or down, I…" followed by either an adaptive response (e.g., "I try to find something constructive to do") or a maladaptive emotion regulation response (e.g., "I think about how badly I feel; I use drugs"). Participants respond on a 3-point scale for each item: Not true of me (0), Sometimes true of me (1), or Many times true of me (2). In creating this questionnaire, a panel of judges consisting of seven clinical psychologist researchers classified each item as either an adaptive or maladaptive emotion regulation response, requiring agreement by at least five out of seven judges. In respect to scoring, 32 of these items are classified as adaptive, while 24 are classified as maladaptive. This measure can be broken into two subscales: a subtotal score of the items reflecting putatively maladaptive ER repertoires and another subtotal reflecting putatively adaptive ER repertoires. The FAM-A maladaptive and adaptive subscales have been shown to demonstrate good psychometric properties in the form of high internal consistency among healthy individuals ($\alpha = 0.80$ & $\alpha = 0.89$, respectively) and those with a history of depression ($\alpha = 0.91$ & $\alpha = 0.88$, respectively)

(Kovacs, Rottenberg, & George, 2009). In this sample, the FAM-A demonstrated good reliability in its maladaptive ER ($\alpha = 0.90$) and adaptive ER ($\alpha = 0.93$) subscales.

3.3.2 Ecological momentary assessment measures.

Negative affect. Negative affect was measured at both moments of peak distress ("Rate how you were feeling when you felt the worst/ most negative…" or "Rate how you were feeling right before you used…") since responding to their most recent EMA prompt and current moments ("Rate how you feel at this moment…") while responding to the survey. An index score was aggregated with items taken from the Positive and Negative Affect Schedule, reflecting feeling sad, angry, upset, frustrated, and stressed (Watson et al., 1988). Each of the five items was assessed on a 5-point Likert scale: very slightly/ not at all (1), a little (2), moderately (3), quite a bit (4), and extremely (5).

Craving. Craving was measured at both moments of peak distress ("How strongly did you crave substances when you felt the worst/ most negative?" or "How strongly did you crave substances before you used?") since responding to their most recent EMA prompt and current moments ("How strongly do you crave substances at this moment?") while responding to the survey. Craving was assessed on a slider scale of 0-100: not at all (0) and extremely (100).

3.4 Procedures

3.4.1 Online questionnaires.

The study was carried out remotely by means of telephone and email. An initial telephone call served as an orientation to the study. Eligible participants were given an identification number and emailed a website link containing the informed consent document followed by online questionnaires. Upon consenting to participate following

the phone call, participants privately completed a battery of online questionnaires (~60 minutes). This battery included measures of demographic characteristics, emotion regulation (FAM-A), and motives for opioid use (OMS).

3.4.2 Ecological momentary assessment.

Upon completion of the online questionnaires, EMA sampling was conducted for a period of 7-consecutive days, commencing the following morning. Brief (~3 minute) surveys were sent to participants' cell phones via text message or email operating through SurveyHub (Ghose, 2017). Prompts were fixed for random delivery five times each day (spaced at least 2 hours apart) between the hours of 6am and 10pm, although accommodations were made to fit participants' schedules in order to encourage higher response rates. Participants were given a 30-minute window to complete each survey before the link became inactive. In accordance with best practices (Shiffman, Stone, & Hufford, 2008), participants were sent a reminder prompt 15 minutes after receiving the initial prompt.

3.5 Analytic Approach

SPSS v. 28 was used to examine descriptive statistics and bivariate correlations among study variables. Regression assumptions were then examined including normality, linearity, homoscedasticity, independence of errors, and multicollinearity. Multivariate multiple regression was conducted using the multivariate general linear model command in SPSS v. 28. Multilevel regression was employed via the mixed model command in the same version of SPSS. Fitting a multilevel model accounted for nesting in the EMA data, a violation of the independence of errors assumption in single-level regression. This study aimed to assess mediation following the joint significance approach (see figure 1).

Path 'a' would have regressed coping motives onto adaptive and maladaptive ER repertoires via OLS multiple regression. Path 'b' would have tested same-level and cross-level interactions between coping motives and negative affect in predicting craving. Simple slopes would have then been plotted to graphically determine the nature of interactions. Path 'a' and each simple slope in path 'b' would have then been used to calculate indirect effects by the Monte Carlo Method for Assessing Mediation, a bootstrapping method estimated with 5,000 samples at bias-corrected 95% confidence intervals (Selig & Preacher, 2008). Unfortunately, recruitment fell below the stated goals, reducing statistical power. As a result, there was not enough statistical power to detect the indirect effects that would have tested hypotheses 3a – 4b. Instead, in a piecemeal approach, both coping motives alone and with the other three opioid use motives were each regressed onto adaptive and maladaptive ER repertoires in multiple regression and multivariate multiple regression, respectively. Then, coping motives were examined as a moderator of negative affect and craving in same- (level 2 x level 2) and cross-level (level 2 x level 1) interactions in a multilevel model, including first-order effects in the model. Lastly, the piecemeal approach included examining the moderating effects of adaptive and maladaptive ER repertoires on negative affect and craving in consideration of the total effect (path 'c') in the proposed mediation model. Per best practices, negative affect (collected via EMA) was disaggregated into its time-varying (level 1) and time-invariant (level 2) in all multilevel analyses (see Enders & Tofighi, 2007). To index time-invariant negative affect, negative affect ratings for the week were aggregated to an average rating for each participant. In all multilevel analyses, the effect of negative affect on craving was free to vary (random slope) as guided by indices in the model building

process. Level 2 predictors were grand mean centered and level 1 predictors were group mean centered (Enders & Tofighi, 2007). The effects of participants' age and sex were controlled for in all models.

3.5.1 Power analysis.

A priori power analyses were conducted to identify the required sample size for detecting the hypothesized effects. As path 'a' examines constructs on the same level (level 2), G*Power (Faul & Erdfelder, 1992) is a sufficient tool for calculating the statistical power of this path. At an alpha level of .05 (two-tailed), and a moderate effect size (f^2=.15; Cohen, 1988) for three variables (coping motives, adaptive ER repertoires, maladaptive ER repertoires), 55 participants would be required to achieve statistical power of .80. Path 'b' sought to examine relationships among variables at multiple levels, therefore, calculation of statistical power required software for multilevel analysis; Optimal Design (Raudenbush et al., 2011) was utilized for this task. In calculating required sample size for the interaction at level 2 between coping motives and time-invariant negative affect in predicting craving, including first-order effects (path 'b'), 83 participants were required when the alpha level was set at .05, the effect size was moderate (d=.5; Cohen, 1988), and the ICC was .593 to achieve statistical power of .80. The sample size for a cross-level interaction between coping motives and time-varying negative affect in predicting craving, including first-order effects (path 'b') required 12 participants with the alpha level set at .05, the effect size moderate (d=.5; Cohen, 1988), and level 1 variance at .20 (since the slope of negative affect was random) to achieve power of .80. These multilevel power calculations were based on cluster sizes of 49 observations per participant; previous study records have guided this estimation as

individuals of this population completed ~70% of EMA surveys. Recruitment of 83 participants would have rendered the ability to detect effects across levels, however, only 57 participants were recruited.

CHAPTER IV

RESULTS

4.1 Descriptive Analyses

Bivariate correlations among all study variables were examined using Pearson correlation (see Table 1). Gender was not significantly correlated with other study variables, and age evidenced a non-significant trend correlation with negative affect and pain management motives in opioid use (*rs*=-.17-.21, *ps*=.068-.087). Though not associated with variables of interest, gender and age were both included as covariates in all final analyses based on prior work (Back et al., 2011; Moran et al., 2018). Craving was highly correlated with negative affect and maladaptive ER, and moderately correlated with coping motives in opioid use (*rs*=.27-.48, *ps*=<.001-.03). Craving also weakly correlated at a trend level with pain management motives in opioid use at a trend level (*r*=.22, *p*=.088). Average EMA-based negative affect was also highly correlated with maladaptive ER (*r*=.49, *p*<.001). Lastly, maladaptive ER also correlated with enhancement, pain, and coping motives in opioid use but not social motives (*rs*=.27-.33, *ps*=.008-.03) and adaptive ER did not correlate with any opioid use motives.

4.2 Hypothesis Testing

4.2.1 H1. High reliance on maladaptive emotion regulation strategies and infrequent use of adaptive emotion regulation strategies will significantly predict tendencies to use opioids to cope.

To support other investigations into opioid use motives and emotion regulation, a preliminary analysis was run to consider the effects of ER strategies on each of the four opioid use motives, while controlling for demographic characteristics. Coping, enhancement, pain, and social motives for opioid use (OMS) were simultaneously regressed onto maladaptive and adaptive ER repertoires (FAM-A) in multivariate multiple regression.

Independent of the effects of adaptive ER and demographic characteristics, maladaptive ER significantly predicted coping (b=.12, p=.013), enhancement (b=.14, p=.042), and pain (b=.20, p=.009), but not social motives for using opioids (b=.10, p=.187). Independent of the effects maladaptive ER and demographic characteristics (see Table 2), adaptive ER failed to predict any of the four opioid use motives (coping b=.01, p=.887; enhancement b=.00, p=.997; pain b=-.02, p=.782; social b=.01, p=.878). A post-hoc analysis was performed to evaluate whether the three significant effects of maladaptive ER on the three motive variables (coping, enhancement, and pain) are comparable in magnitude or significantly differ from one another. Results indicated these magnitudes (maladaptive ER on coping, enhancement, and pain motives) do not significantly differ from each other (Wald Chi Square (2) = 2.13, p=.344).

The broader model (see Figure 1) sought to test the conditional indirect effects of adaptive and maladaptive ER repertoires with negative affect on craving via the

conditional effects of coping motives with negative affect using a series of regression analyses. This analysis would have constituted path a of the overall model; however, the indirect effects could not be tested due to a small sample size (underpowered).

4.2.2 H2a. Tendencies to use opioids to cope will exacerbate the person varying relationship between negative affect and craving in daily life across the course of a week.

To test hypotheses 2a and 2b, a multilevel model was fit to examine the moderating effect of trait level coping motives (OMS) on state level negative affect and craving in participants' daily lives (ascertained via EMA). The model included age, gender, coping motives (all level 2), negative affect (at both level 2 and level 1), and the same- (level 2 x level 2) and cross-level (level 2 x level 1) interaction between and coping motives and negative affect as predictors of craving (level 1 dependent variable). Negative affect (collected via EMA) was disaggregated into its time-varying (deviation around each participant's average affect rating- level 1) and time-invariant components (average affect rating per participant- level 2). Due to nesting within subjects, the intercept (participants' baseline craving rating) was free to vary across participants as per the variance partitioning coefficient (ICC= .593). The effect (slope) of negative affect (at level 1) on craving (level 1) was also set as random in the final analysis, per fit indices while building the model. The initial plan to test hypothesis 2 involved including the first-order and moderating effects of both ER deficits and coping motives to control for the effects of ER deficits in assessing mediation. However, given the small sample, the effects of adaptive and maladaptive ER repertoires (FAM-A- level 2), as well as each's

same- and cross-level interaction effects with negative affect (at both levels) were unloaded from the model to avoid potential type II error.

As expected, participants' average negative affect (b=2.93, p<.001) as well as the deviation around that average (b=1.34, p<.001) significantly predicted craving. The first-order effects of coping motives also accounted for a significant amount of the variance in craving (b=1.66, p=.047). The cross-level interaction between coping motives (level 2) and time-varying negative affect (level 1) predicting craving tested this hypothesis. In line with expectations, this interaction significantly predicted craving in daily life when the effect of negative affect on craving was random (b=.12, p=.045), independent of the effects of demographic characteristics and the first-order effects of coping motives and negative affect (at both levels) (see Table 3). The interaction was then probed graphically to examine the simple effects of negative affect on craving in those who tended to use opioids to cope and those who tended to not use opioids to cope (see Figure 2). Graphical interpretations suggested those who tended not to use opioids to cope experienced a lower baseline of cravings, although cravings increased as negative affect increased. (b=.89, p=.008). Those who did tend to use opioids to cope experienced higher baseline of cravings and the effect negative affect had on cravings increased (b=1.78, p<.001). The tendency to use opioids to cope exacerbated the relationship between negative affect and craving in daily life.

4.2.3 H2b. Tendencies to use opioid to cope will exacerbate the relationship between the time-invariant component of negative affect and craving in daily life.

The same random intercept-random slope model that tested the previous hypothesis was used to also test the present hypothesis. The interaction between coping

motives (level 2) and time-invariant negative affect (level 2) in predicting craving tested this hypothesis. Contrary to expectations, this interaction did not significantly predict craving in daily life (b=.22, p=.320), independent of the effects of demographic characteristics and the first-order effects of coping motives and negative affect (at both levels) (see Table 3). Because the interaction was not significant at level 2, the simple slopes were not explored graphically as they would not be interpretable.

4.2.4 Hypothesis 3a – Hypothesis 4b

Hypotheses 3 and 4 considered the indirect moderating effect of ER repertoires on negative affect predicting craving via the moderating effect of coping motives. Since there was not enough statistical power to detect the conditional indirect effects of ER repertoires, hypotheses 3a – 4b were not tested (avoiding potential type II error). However, exploratory analyses were still conducted to test the total effect (path c) of the proposed mediation model by examining the moderating effects of ER repertoires on negative affect and craving (excluding the effects of coping motives). A multilevel model was fit to examine the same- and cross-level interactions between adaptive ER repertoires and negative affect as well as maladaptive ER repertoires and negative affect in predicting craving. This model included age, gender, adaptive and maladaptive ER repertoires (all level 2), time-varying (level 1) and time-invariant negative affect (level 2), and the same- (level 2 x level 2) and cross-level (level 2 x level 1) interactions between adaptive ER repertoires and negative affect and maladaptive ER repertoires and negative affect as predictors of craving (level 1 dependent variable). The intercept was free to vary across participants as well as the slope of negative affect at level 1.

In line with expectations, participants' average negative affect (b=1.66, p=.006) as well as the deviation around that average (b=1.25, p<.001) significantly predicted craving. However, the first-order effects of adaptive ER repertoires did not account for a significant amount of the variance in craving (b=.19, p=.257). The interaction between adaptive ER and time-invariant negative affect at level 2 significantly predicted craving in daily life (b=.12, p=.005), however, the cross-level interaction between adaptive ER (level 2) and time-varying negative affect (level 1) did not significantly predict craving (b=-.02, p=.181), independent of the effects of demographic characteristics and first-order effects of ER repertoires and negative affect (at both levels) (see Table 4). The significant interaction at level 2 was then probed graphically to examine the simple effects of negative affect on craving in those with robust adaptive ER repertoires and those with a dearth of adaptive strategies in their ER repertoires (see Figure 3). Graphical interpretations suggested in those with robust adaptive repertoires, the effect negative affect had on cravings was relatively stronger (b=3.19, p<.001). Those who lacked adaptive strategies in their repertoire experienced a higher baseline of cravings, although the effect negative affect had on cravings was much weaker (b=.13, p=.648).

The same model that tested the effects of adaptive ER was used to test the effects of maladaptive ER. The first-order effects of maladaptive ER repertoires accounted for a significant amount of the variance in craving (b=.85, p<.001). The interaction between maladaptive ER and time-invariant negative affect at level 2 did not significantly predict craving in daily life (b=.04, p=.468), however, the cross-level interaction between maladaptive ER (level 2) and time-varying negative affect (level 1) did predict craving at a trend level (b=.03, p=.062), independent of the effects of demographic characteristics

and first-order effects of ER repertoires and negative affect (at both levels) (see Table 4). The trend level cross-level interaction was then probed graphically to examine the simple effects of negative affect on craving in those with robust maladaptive ER repertoires and those with few maladaptive strategies in their ER repertoires (see Figure 4). Graphical interpretations suggested those with few maladaptive strategies in their repertoires experienced a weaker baseline of cravings, although cravings increased as negative affect increased (b=.95, p<.001). Those with robust maladaptive repertoires experienced stronger cravings and the effect of negative affect on craving was stronger relative to those with smaller maladaptive repertoires (b=1.55, p<.001). Having ER repertoires robust with maladaptive strategies exacerbated the relationship between negative affect and craving in daily life.

CHAPTER V

DISCUSSION

The present study aimed to elucidate key underlying processes that lead to opioid lapse in naturalistic conditions. An ecologically valid understanding of such factors may be informative to the treatment of OUD. Negative affect and craving were of interest given each is a robust predictor of lapses in opioid users (Preston et al., 2018). ER deficits likely contribute to opioid cravings in part by exacerbating negative affect, although the form these deficits take hadn't yet been investigated (Evenden, 1999; Fox, Bergquist, Hong & Sinha, 2007; Fox, Hong, Sinha, 2008). Given the preliminary evidence of coping motives in substance use playing a role similar to ER deficits (Waddel, Sher, & Piasecki, 2021), this study hoped to explore coping motives as a potential mechanism. Three sets of hypotheses were developed to examine these relationships via self-report and in daily life, although the latter hypotheses examining the mechanistic role of coping motives could not be tested.

The first hypothesis examined the trait-level relationship between coping motives opioid use and ER deficits, in the form of maladaptive and adaptive repertoires. This analysis found maladaptive ER repertoires to be significantly linked to coping,

enhancement, and pain, but not social motives, although adaptive ER repertoires showed no significant ties to any motives for opioid use. These findings illustrate reasons other than socializing are why those with ER deficits use opioids. The results also suggest, in part, that having deficits in ER is predictive of using opioids to cope at a trait level, and these deficits take the form of repertoires robust with maladaptive strategies and not repertoires deficient in adaptive options. While the literature is thin on the relation between substance use motives and types of regulatory strategies, the discrepancy between adaptive and maladaptive repertoires is consistent with a meta-analytic review on emotion regulation strategies in substance-related disorders (Aldao, Nolen-Hoeksema, & Schweizer, 2010). The review found medium to large effect sizes for avoidance and rumination (maladaptive regulatory strategies) with substance use and small effect sizes for reappraisal and acceptance (adaptive regulatory strategies) with substance use. The discrepant findings suggest the relation between using motives and ER repertoires may follow suit in substance dependent populations. With regard to specific motives, results of maladaptive ER are consistent with prior work. Coping motives have shown robust associations with ER difficulties in similar cross-sectional research on problematic opioid, alcohol, and marijuana use (Gold et al., 2020; Messman-Moore & Ward, 2014; Bonn-Miller, Vujanovic, & Zvolensky, 2008). Enhancement motives have also been connected to ER difficulties in the literature on problematic alcohol use (Aurora & Klanecky, 2015). To the author's knowledge, only the link to pain motives is new to the literature on ER in SUDs, although few studies to date have explored motives in opioid use, which the pain motive is distinctive. No studies have found a significant association between social motives in substance use and ER problems. As coping motives in opioid

use have demonstrated a strong covariance with difficulties in ER (Gold et al., 2020), the present results suggest the make-up of ER repertoires may be important to consider in investigating using motives as deficits in adaptive ER were not predictive of using motives.

The next set of hypotheses examined trait-level coping motives in opioid use as a moderator of state-level negative affect and craving in daily life. The first hypothesis was supported, finding a significant cross-level interaction between coping motives (level 2) and time-varying negative affect (level 1) in predicting craving. The first-order effects of coping motives on craving were consistent with findings from a similarly designed EMA study (Scamaldo, Tull, & Gratz, 2021), but not an affect induction study (Stathopoulou, Pollack, & Otto, 2018). Regarding interaction effects, the simple slopes suggested those who tend to use opioids to cope experience a higher baseline of cravings and the tendency to use to cope exacerbates the already strong tie between negative affect and craving. In examining the second hypothesis, a significant interaction at level 2 was not found between subject's average negative affect and tendencies to use opioids to cope in predicting craving. To the author's knowledge, no other studies have tested this interaction in an opioid-dependent sample. However, these results are consistent with an EMA study on problem drinking, which revealed within-subject elevated negative affect predicted increased alcohol cravings, and this effect was more prominent among drinkers who tended to drink to cope (Waddel, Sher, & Piasecki, 2021). In the present study, the slope of negative affect on craving was random, meaning the relationship between negative affect and craving was allowed to vary from subject to subject. The results suggest individual differences in tendencies to use opioids to cope or not helps explain

the variability in the exacerbating effects of negative affect on craving, although when disregarding within-subjects variability, coping motives no longer demonstrate these moderating effects

The final two sets of hypotheses sought to examine coping motives as mechanistic of ER deficits' (adaptive and maladaptive repertoires) moderating effect on negative affect and craving. Unfortunately, recruitment fell below the stated goals and there was not sufficient statistical power to calculate the indirect effects hypotheses 3a-4b posited. Instead, the total effect (path c) in the proposed mediation model (excluding the effects of coping motives) was analyzed. Regarding adaptive ER repertoires, results indicated weak first-order effects and a significant interaction at level 2, but a non-significant cross-level interaction. While there is some evidence adaptive ER is deployed relatively infrequently by opioid users (Hyman et al., 2009), work by Aldao and Nolen-Hoeksema may shed more light on the findings concerning adaptive ER (2012). The weak first-order effect of adaptive ER on craving is generally in line with their meta-analysis of ER strategies across psychopathology, finding adaptive strategies (acceptance and appraisal) to demonstrate low predictive power in problematic substance use (Aldao, Nolen-Hoeksema, & Schweizer, 2010). In later work, the effectiveness of adaptive ER responses has been shown to be contextual as evidenced by adaptive strategies being implemented with more variability across situations than maladaptive strategies (Aldao & Nolen-Hoeksema, 2012). Flexibility is necessary in adaptive ER as strategies must be implemented that are appropriate to varying circumstances and facilitate specific goals (Aldao, Sheppes, & Gross, 2015). For instance, to regulate anger, one might need to deploy suppression when his goal is to not let others see his anger but may need the

flexibility to deploy reappraisal when his goal is to forgive someone to maintain long-term relations. When the goal is forgiveness, suppression may do a poorer job than reappraisal; the flexibility to deploy reappraisal is required to effectively achieve said goal. To assess ER flexibility and its adaptiveness with consideration to context, EMA is the recommended methodology (Aldao, Sheppes, & Gross, 2015). As the present study employed a trait ER measure, it is feasible that the non-significant cross-level interaction between adaptive ER repertoires and occasion-related NA fluctuations reflects the ER measure's inability to take context into account. In a similar vein, the counterintuitive second-level interaction between adaptive ER and average NA levels may also suggest that the adaptive nature of a given ER response is determined by context (Aldao & Nolen-Hoeksema, 2012; Aldao, Sheppes, & Gross, 2015).

Results of the total effect (path c) of maladaptive ER repertoires as a moderator of negative affect effect and craving revealed a non-significant interaction at level 2 and a trend level cross-level interaction. Given the lack of statistical power, its plausible a larger sample size would reveal a significant cross-level interaction. This may be interpreted as reliance on maladaptive strategies may help explain individual variability in the within-subjects effect negative affect has on craving, although when disregarding within-subjects variability, maladaptive repertoires no longer demonstrate moderating effects. Further analysis (simple slopes) of the cross-level interaction revealed ER repertoires robust with maladaptive strategies exacerbated the relationship between negative affect and craving in daily life. Maladaptive ER findings are consistent with some studies on negative emotion regulation and craving in alcohol and opioid misuse (Jansen et al., 2019; Hudak et al., 2022) and suggest ER deficits in part constitute heavy reliance on maladaptive strategies,

regardless of context. Importantly, the present study provides preliminary evidence that individual differences in reliance on maladaptive ER strategies explain the variability in the exacerbating effects of negative affect on craving.

Furthermore, given a) the significant path between maladaptive ER and coping motives, b) the significant interaction between coping motives and negative affect on craving, and c) the trend-level interaction between maladaptive ER and negative affect on craving, there is enough preliminary evidence to consider examining the proposed mediation model in a larger sample.

5.1 Limitations

Interpretation of this study's findings should consider the several limitations faced. The most glaring limitation is the inadequate sample size, which can affect generalizability as well as the statistical power to detect effects. Each statistical path includes many parameters (covariates, first-order and interaction effects at multiple levels, as well as random intercepts and slopes) to estimate resulting in a shortage of degrees of freedom in the full mediation model, which is why indirect effects were not calculated. Another recruitment concern relates to sampling strategy. Structured clinical interviews were not given to ensure inclusion criteria was met. Rather, participants were recruited remotely via online advertisements and screened via telephone conversation. It cannot be guaranteed that all participants have an OUD diagnosis and were less than 90 days sober at the time the study began; this study relied on the combination of an honor-system and the judgement of the screening researcher.

It is also worth noting a weakness in how negative affect was indexed. To measure negative affect, ratings of feeling sad, angry, upset, frustrated, and stressed were each

aggregated to a total score reflecting negative affect. More discrete measurement of negative affect could improve the variable's potentially weak construct validity. Lastly, with regard to construct measurement, the scales reflecting opioid use motives offer their own limitation. Recent work suggests opioid use motives are a dynamic construct, subject to fluctuations across the course of a day (Votaw & Witkiewitz, 2021). The present study assessed motives for using opioids as a more static construct reflecting dispositional tendencies. Lastly, the lack of consideration to the context adaptive ER strategies were deployed in rendered respective results difficult to interpret.

5.2 Future Directions

Future research in this area should recruit a larger sample to test the entire mediation model and avoid overfitting such a complex statistical model. It may be difficult to ascertain precise required sample size estimates for complex statistical models with currently available power analysis tools. Surpassing recruitment goals would reduce any uncertainty regarding model fit or effect significance. Next, recruiting from an addiction treatment center or including an assessment or clinical interview into the screening process could increase certainty about participants meeting inclusion criteria (diagnosis of OUD).

As this study failed to meet its stated recruitment goals, the proposed mediation model could not be tested. Future studies are encouraged to test the indirect effects of ER deficits as a moderator of negative affect and craving through coping motives, particularly the conditional indirect effects of maladaptive ER repertoires as maladaptive repertoires explained substantially more of the variance in craving scores. This study has laid the groundwork by testing all paths relevant to the proposed mediation; however, a larger sample size would be required to test indirect effects.

Regarding the measurement of opioid use motives (OMS), future research could improve on this study by incorporating the construct into an EMA protocol. Indexing opioid use motives by EMA allows motives to be measured at a state-level as opposed to a trait-level. As EMA is a repeated measures approach, this enables the researcher to capture changes in motives to use over time. Future research may find improved results by indexing adaptive ER via EMA. This would enable the deployment of adaptive ER strategies to be measured with consideration to varying contexts (Aldao, Sheppes, & Gross, 2015).

Additionally, craving makes an excellent criterion variable, however, craving is not a perfect predictor of sobriety lapses. If future research would include an additional variable into an EMA protocol measuring whether a participant lapses or staves off a craving, more could be elucidated about the roles of all study variables to better inform current treatments or even new interventions. EMA research on substance use disorders (especially that which aims to predict lapses) is relevant to the development of new brief and mobile interventions that use similar devices (i.e. smart phones).

Lastly, the data collected via EMA is self-report. While there is much overall value in EMA, the subjectivity of self-report is not ideal. Future research in this area is encouraged to integrate more objective ecological measures alongside an EMA protocol. For instance, some constructs may be indexed via "wearables" like sensor-laden wristbands that tap into psychophysiology (i.e. heart rate, stress levels, body temperature, and emotional responsiveness). Incorporating more objective measurement will improve validity, helping ground results obtained via EMA.

5.3 Strengths and Clinical Implications

The strengths of the present study can be seen in its design. Employing a repeated measures design through EMA enabled fluctuations in key dynamic constructs (negative affect and craving) to be captured for each participant, measuring these constructs at a state level. Next, the EMA design also allowed negative affect and craving to be assessed within a naturalistic setting, improving these constructs' ecological validity. Further, the use of real-time (or close to) assessments via EMA also reduces the chance of recall bias (Hammersley, 1994; Sayette, 2000). By incorporating a psychometrically sound questionnaire alongside the EMA protocol, deficits in maladaptive ER could be assessed reliably at a trait level. Furthermore, the analytic approach (MLM) allowed within-subject relationships between negative affect and craving to be tested simultaneously alongside between-subjects relationships.

Of the findings that could be ascertained, demonstrating a relationship between coping motives and ER deficits serves to bolster the literature in this area, reiterating others' work about the clinical relevancy of coping motives in opioid problems, while also discerning that these deficits take the form of robust maladaptive repertoires and not small adaptive repertoires although this may be explained by a lack of consideration to context. Next, the clinical relevancy of coping motives was further signified with finding that these motives exacerbate the effect of negative affect on craving. These results suggest the reasons clients tend to use opioids may say much about the cravings they will experience during distressing situations. Therefore, if a clinician understands clients' using rationales (ie. coping), he/she may better identify clients at higher lapse risk.

There may also be clinical value in parsing out the form ER deficits take in exacerbating the effect of negative affect on craving. While preliminary evidence suggests reliance on maladaptive strategies is a larger contributor to cravings than lacking in the use of adaptive strategies, a contextual model of emotion regulation may suggest deficient adaptive repertoires still promote cravings under various circumstances. More research is needed to fully understand the role of adaptive repertoires in exacerbating cravings.

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APPENDIX A: Tables

Table1. *Descriptive statistics and correlations among demographic, opioid use motives, ER repertoires, negative affect, and craving.*

		M (SD)	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	Age	34.76 (10.96)	---	-.03	.08	.11	.21	.02	-.09	-.04	-.17	-.09
2.	Gender	---		---	-.05	.02	-.07	-.23	.04	-.01	-.12	.04
3.	Enhance	17.75 (4.55)			---	.70***	.48***	.72***	.03	.27*	.08	.19
4.	Coping	14.71 (3.43)				---	.52***	.32*	.08	.32**	.11	.27*
5.	Pain	17.76 (5.35)					---	.28*	.02	.33**	.21	.22
6.	Social	13.05 (4.92)						---	.01	.19	.09	.16
7.	AMR	58.26 (11.95)							---	-.06	.06	.07
8.	MMR	44.95 (9.26)								---	.49***	.46***
9.	NA	11.24 (4.17)									---	.48***
10.	Craving	27.70 (24.29)										---

***$p \leq .001$, **$p \leq .01$, *$p \leq .05$

Note. Enhance= OMS enhancement motives subscale total score; Coping= OMS coping motives subscale total score; Pain= OMS pain motives subscale total score; Social= OMS social motives subscale total score; AMR= FAM adaptive subscale total score; MMR= FAM maladaptive subscale total score; NA= participant's average negative affect rating via EMA; craving= participant's average craving rating via EMA.

Table 2. *Univariate effects of multivariate multiple regression predicting opioid use motives.*

Dependent Variable	Parameters	*B*	*SE*(B)	*t*	95% Confidence Interval	
					Lower Bound	Upper Bound
Coping Motives	Intercept	7.11*	3.30	2.15	.492	13.726
	Age	.05	.04	1.16	-.035	.131
	Gender	.20	.88	.23	-1.559	1.962
	MMR	.12**	.05	2.58	.027	.220
	AMR	.01	.04	.14	-.067	.077
Enhancement Motives	Intercept	9.41*	4.57	2.06	.247	18.572
	Age	.07	.06	1.20	-.046	.183
	Gender	-.22	1.22	-.19	-2.662	2.213
	MMR	.14*	.07	2.08	.005	.272
	AMR	.000	.05	.00	-.099	.100
Pain Motives	Intercept	5.08	4.95	1.03	-4.834	15.002
	Age	.14*	.06	2.28	.017	.265
	Gender	.03	1.32	.02	-2.607	2.670
	MMR	.19**	.07	2.71	.050	.339
	AMR	-.02	.05	-.28	-.123	.093
Social Motives	Intercept	8.19	4.89	1.68	-1.608	17.995
	Age	.04	.06	.57	-.088	.158
	Gender	-1.96	1.30	-1.51	-4.571	.645
	MMR	.10	.07	1.34	-.047	.238
	AMR	.01	.05	.16	-.098	.115

Note. Gender= 0 = male, 1 = female; Coping Motives= OMS coping motives subscale total score; Enhancement Motives= OMS enhancement motives subscale total score; Pain Motives= OMS pain motives subscale total score; Social Motives= OMS social motives subscale total score; MMR= FAM maladaptive subscale total score; AMR= FAM adaptive subscale total score.
***$p \leq .001$, **$p \leq .01$, *$p \leq .05$

Table 3. *Fixed effects and variance-covariance estimates for the mixed model interaction between coping motives (moderator) and negative affect in predicting craving.*

Parameters	*B*	*SE*(B)	*t*	*df*	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	31.37***	2.84	11.06	55.03	25.687	37.061
			Level 2			
Age	.20	.29	.68	59.01	-.389	.789
Gender	-.26	6.02	-.04	55.58	-12.328	11.811
MeanNA	2.93***	.77	3.79	55.33	1.378	4.477
Coping	1.66*	.82	2.03	54.79	.020	3.308
MeanNAxCoping	.22	.22	1.00	54.72	-.221	.666
			Level 1			
NA	1.34***	.21	6.44	50.35	.920	1.75
NAxCoping	.12*	.06	2.06	46.77	.003	.240

Random Parameters

Parameters	Variance Component	*SE*(B)	Wald Z	95% Confidence Interval	
				Lower Bound	Upper Bound
Intercept	464.75	91.08	5.10	316.518	682.391
NA	1.56	.43	3.63	.911	2.682
Residual (*e*)	318.499	8.93	35.66	301.466	336.495

Note. Gender= 0 = male, 1 = female; Coping= OMS coping motives subscale total score; MeanNA= participant's average negative affect rating via EMA; NA= deviation around participant's average negative affect rating via EMA.
***$p \leq .001$, **$p \leq .01$, *$p \leq .05$

Table 4. *Fixed effects and variance-covariance estimates for the mixed model interaction between ER deficits (moderators) and negative affect in predicting craving.*

Parameters	*B*	*SE*(B)	*t*	*df*	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	23.78***	2.21	10.74	97.60	19.390	28.178
			Level 2			
Age	.06	.18	.32	99.36	-.301	.416
Gender	5.74	3.98	1.44	97.55	-2.16	13.63
MeanNA	1.66**	.60	2.78	101.00	.478	2.848
AMR	.19	.16	1.14	97.36	-.137	.508
MMR	.85***	.24	3.53	96.52	.370	1.323
MeanNAxAMR	.12**	.04	2.86	99.42	.038	.210
MeanNAxMMR	.04	.06	.73	97.17	-.073	.159
			Level 1			
NA	1.25***	.15	8.09	93.07	.941	1.554
NAxAMR	-.02	.01	-1.35	88.99	-.043	.008
NAxMMR	.03†	.02	1.89	86.26	-.002	.063

Random Parameters

Parameters	Variance Component	*SE*(B)	Wald Z	95% Confidence Interval	
				Lower Bound	Upper Bound
Intercept	371.97	55.49	6.70	277.376	498.010
NA	1.43	.30	4.85	.957	2.149
Residual (*e*)	283.971	6.09	46.65	272.287	296.158

Note. Gender= 0 = male, 1 = female; AMR= FAM adaptive subscale total score; MMR= FAM maladaptive subscale total score; MeanNA= participant's average negative affect rating via EMA; NA= deviation around participant's average negative affect rating via EMA.

***$p \leq .001$, **$p \leq .01$, *$p \leq .05$

APPENDIX B: Figures

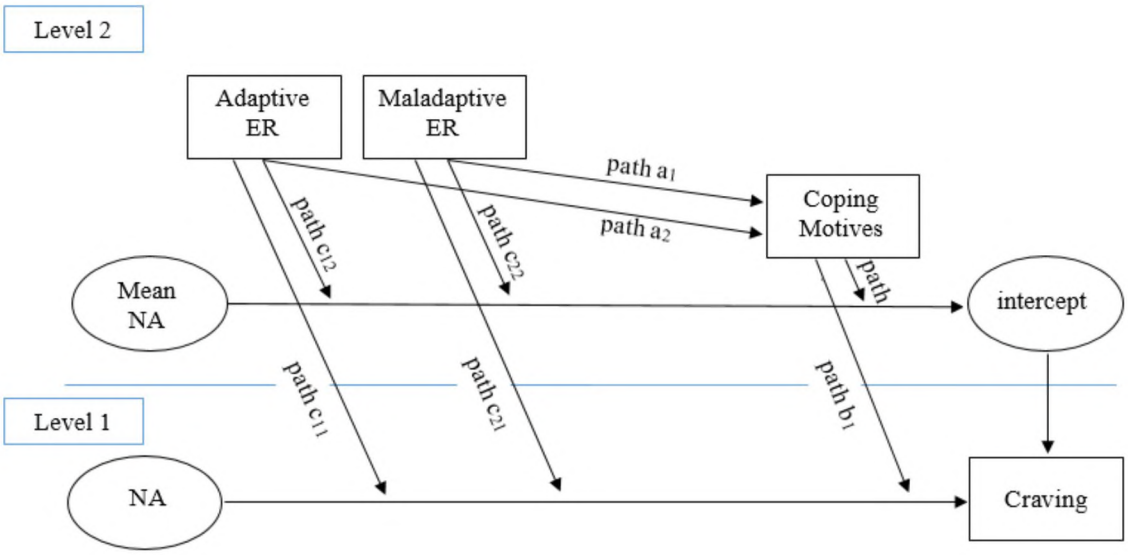

Figure 1. Adaptive ER= FAM adaptive subscale total score; Maladaptive ER= FAM maladaptive subscale total score; Coping Motives= OMS coping subscale total score; Mean NA= participant's average negative affect rating via EMA; NA= deviation around participant's average negative affect rating via EMA.

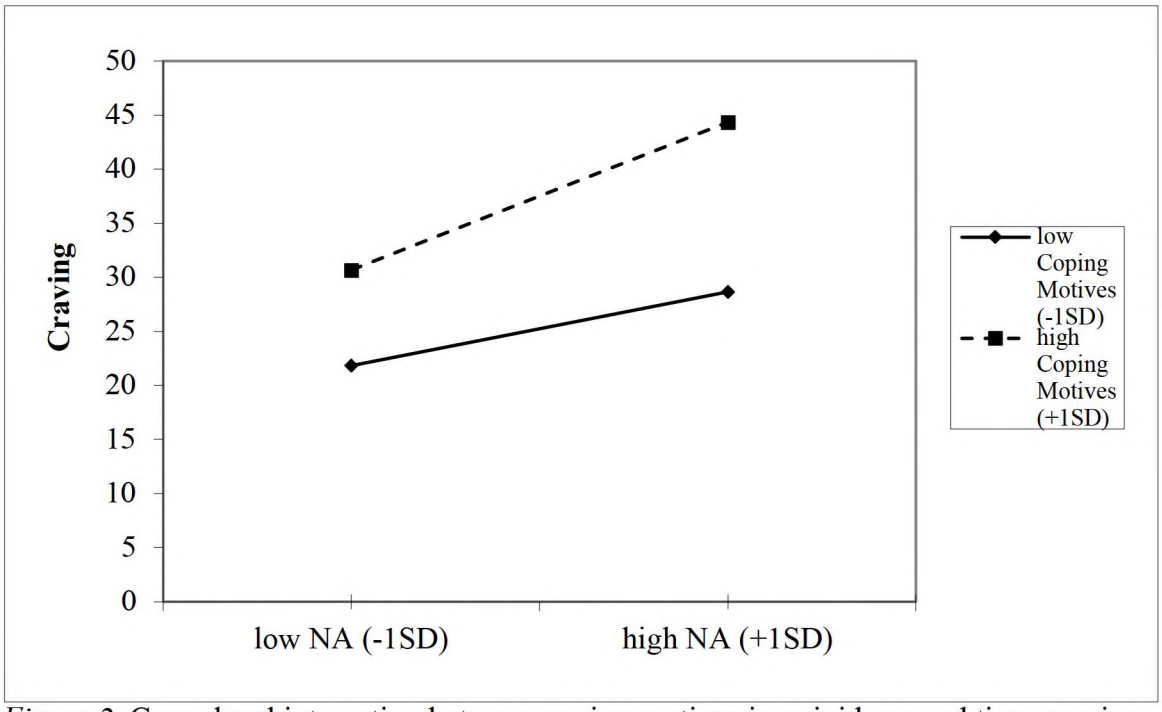

Figure 2. Cross-level interaction between coping motives in opioid use and time-varying negative affect in predicting craving. The effect of negative affect on craving is stronger in those who tend to use opioids to cope (broken line). NA= deviation around participant's average negative affect rating via EMA; Coping Motives= OMS coping subscale total score.

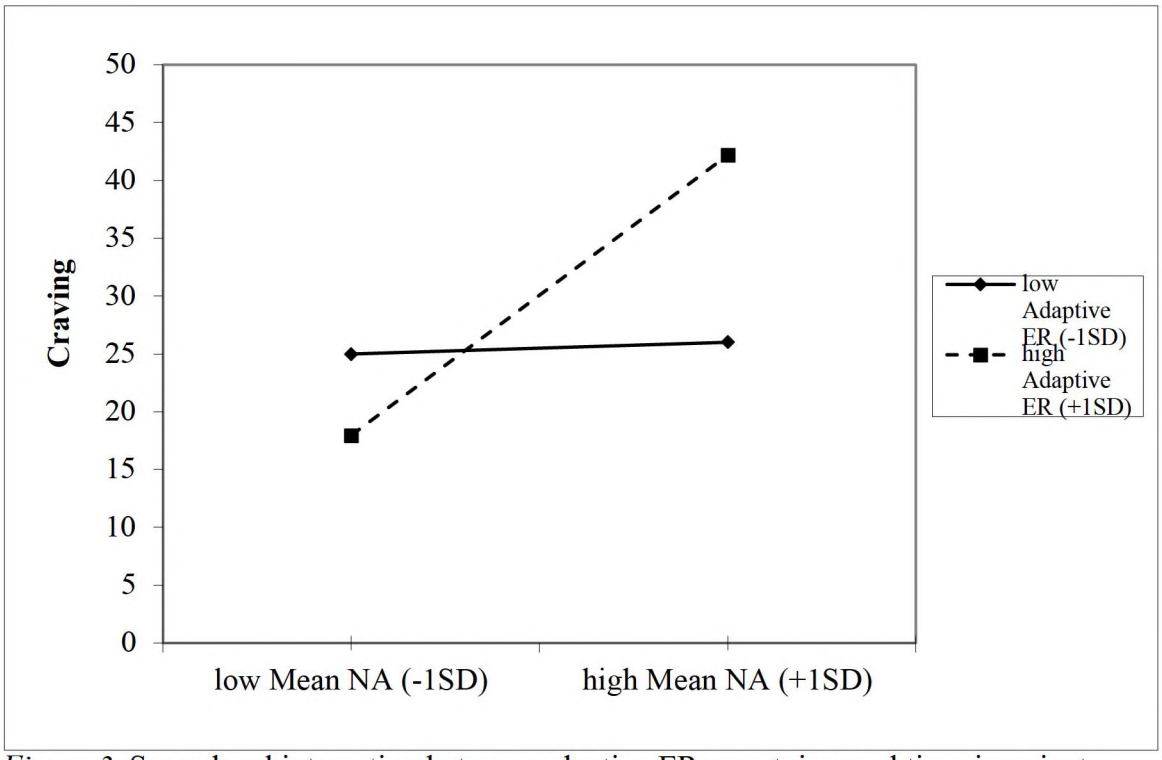

Figure 3. Same-level interaction between adaptive ER repertoires and time-invariant negative affect in predicting craving. The effect of negative affect on craving is stronger in those with robust adaptive ER repertoires (broken line). Mean NA= participant's average negative affect rating via EMA; Adaptive ER= FAM adaptive subscale total score.

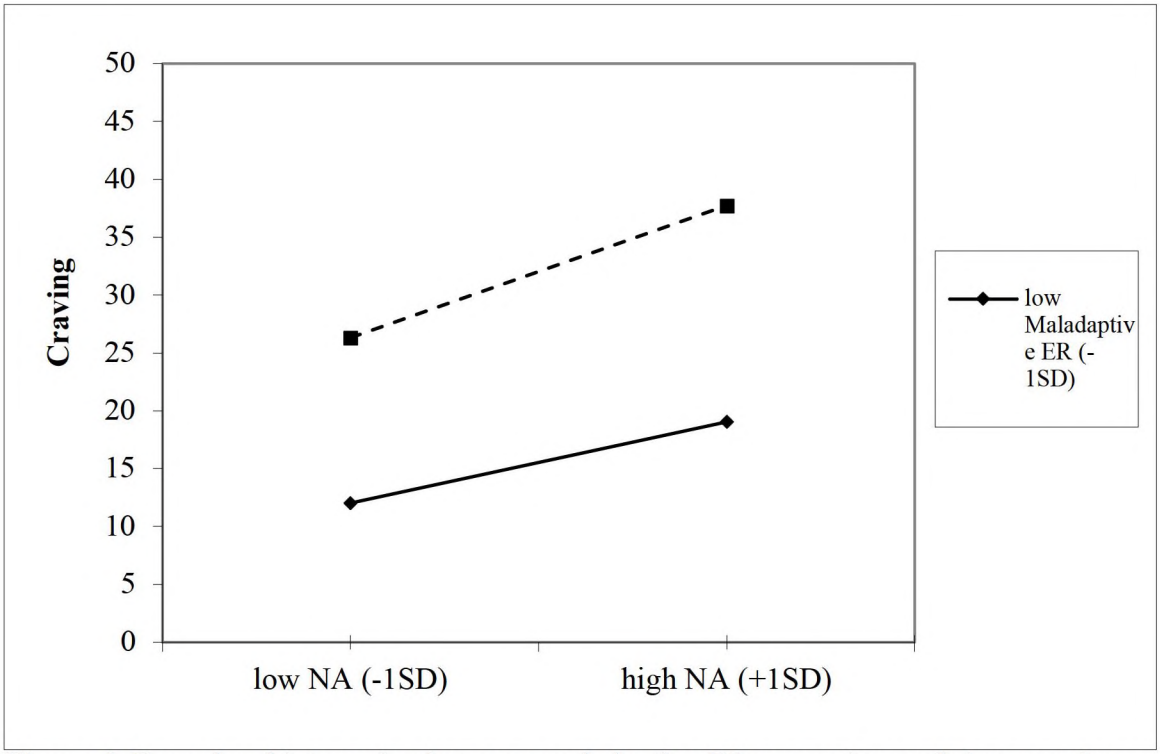

Figure 4. Cross-level interaction between maladaptive ER repertoires and time-varying negative affect in predicting craving. The effect of negative affect on craving is stronger in those with robust maladaptive ER repertoires (broken line). NA= deviation around participant's average negative affect rating via EMA; Maladaptive ER= FAM maladaptive subscale total score.