January 2017

Effects of Experimental Pain Induction on Proxies of Alcohol Use

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Abstract

Identifying determinants of alcohol consumption remains an important approach to prevent or reduce harmful use. Recent work suggests one such determinant may be physical pain; however, current research is unable to discern causality. Therefore, the goal of this study was to test experimental pain as a determinant of self-reported urge to drink, intention to use alcohol, and alcohol demand (as proxies for ad-lib alcohol consumption). Secondarily, this study aimed to investigate negative affect as a mediator of this relation. We hypothesized that participants randomized to undergo experimental pain induction (vs. no pain) would report increases in proxies of alcohol use and that these effects would be mediated by increased negative affect. Participants included healthy undergraduate students who were moderate to heavy drinkers (N = 61). Pain was induced using a novel capsaicin-heat paradigm intended to approximate features of clinical pain. Main effects were tested using multiple hierarchical regressions and mediation was tested using the PROCESS macro for SPSS. Results confirmed that participants who underwent experimental pain induction subsequently endorsed greater urge to drink and intention to consume alcohol; levels of alcohol demand were unaffected by the manipulation. Increases in negative affect mediated the effects of urge to drink and intention to consume alcohol. This study provides the first experimental evidence that physical pain can be a potent antecedent of urge and intention to consume alcohol. Analyses also indicate that pain-related negative affect underlies this relation. Findings raise the possibility that individuals with co-occurring pain may develop unique Alcohol Use Disorder profiles that warrant tailored intervention.

Keywords: alcohol use, pain, negative affect, experimental pain

Effects of Experimental Pain Induction on Proxies of Alcohol Use

by

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B.A., Daemen College, 2011

Master's Thesis Submitted in partial fulfillment of the requirements for the degree of Master of Science in Clinical Psychology

Syracuse University
June 2017

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Acknowledgments

This work was supported by a Syracuse University Department of Psychology Master's Thesis Award to Dezarie Moskal.

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Alcohol consumption and related problems remain prevalent public health concerns. More than 139 million Americans endorsed current (i.e. past month) alcohol use in a 2014 national survey, and of them, over 60 million individuals reported binge drinking (defined as consuming five or more drinks on one occasion) (Center for Behavioral Health Statistics and Quality, 2015). Additionally, in the same survey sample, 17 million individuals met DSM-IV criteria for past-year alcohol use disorder (AUD). High rates of alcohol consumption are concerning because excessive and continued alcohol use are associated with a broad range of negative health consequences (e.g., poorer mental and physical health, increased risk for chronic diseases, and mortality) and economic costs (Chen, Strain, Crum, & Mojtabai, 2013; Rehm & Shield, 2014; Shield, Parry, & Rehm, 2014; Stahre, Roeber, Kanny, Brewer, & Zhang, 2014).

One approach to prevent or reduce the harmful use of alcohol is to identify determinants of alcohol use, as well as factors that may alter or explain such relations. Recent work has suggested that one such factor influencing alcohol use may be physical pain. Therefore, the purpose of this study was to examine the effects of experimental pain on proximal antecedents of alcohol use, as proxies for ad lib alcohol consumption, and to investigate a theoretically supported mechanism and moderators of this relation.

Although alcohol use is not always preceded by increased urge, craving, or demand (Kavanagh et al., 2013), these variables were selected as proxies of alcohol consumption because the four variables often are highly correlated (Flannery, Poole, Gallop, & Volpicelli, 2003; Heinz et al., 2016). Also, illustrating the importance of these variables, researchers have included proximal predictors of alcohol consumption, such as craving and demand, as outcome measures in clinical trials, and craving has been the target of many treatment interventions (Murphy et al.,

2015; Oslin, Leong, Lynch, & et al., 2015). Further, a benefit of examining proximal predictors of alcohol consumption over ad lib alcohol consumption is the ability to explore important alcohol-related relationships independent of factors that may constrain alcohol use, such as cost and availability. . Taken together, examining changes in proximal predictors of alcohol consumption may provide important information about contextual effects influencing alcohol use relations.

Aversive States Are Determinants of Alcohol Consumption

Negative reinforcement models of alcohol use (self-medication hypothesis, Khantzian, 1985; tension reduction hypothesis of alcohol use, Cappell & Herman, 1972; stress-response-dampening model, Sher & Levenson, 1982), state that alcohol use occurs as a means to alleviate aversive states. Specifically, the self-medication hypothesis asserts that substances are used as a means to alleviate unpleasant affective or emotional states, and, further, that the specific substance used is chosen based on the interaction it has with the negative affect state that one is experiencing. Similarly, the tension reduction hypothesis assumes that (1) alcohol can reduce tension and (2) that alcohol is used to reduce tension. In this context, "tension" is any aversive state, such as anxiety and depression. Lastly, the stress-response-dampening model asserts that alcohol is used as a means to escape from stressful life experiences by mitigating certain emotional states, such as anxiety, and physiological responses to stress. Therefore, one important determinant of alcohol consumption concerns the reduction or amelioration of aversive physical or emotional states.

Physical Pain is an Aversive State Associated with Alcohol Use

Pain is an aversive state composed of physical and psychological features that is highly prevalent and associated with alcohol use (Johannes, Le, Zhou, Johnston, & Dworkin, 2010;

Larson et al., 2007; Price & Harkins, 1992). The International Association for the Study of Pain (IASP) (1994) defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage." As such, pain is an ubiquitous experience that can be classified as acute, lasting a short time, or chronic (i.e. persistent pain lasting at least three months) (Nahin, 2015; VanDenKerkhof, Peters, & Bruce, 2013). Both the experience and anticipation of pain have been shown to share neural substrates with the experience of aversive psychological states (Ploghaus et al., 1999), and there is evidence of a moderate correlation between negative affect and physical pain (Ruiz-Aranda, Salguero, & Fernandez-Berrocal, 2011). Taken together, this research supports a close association between physical pain and negative affect.

Correlational studies of physical pain and alcohol use. Extant literature includes large population-based studies as well as studies of clinical populations that, overall, support an association between pain and alcohol use. For example, findings from one study suggest individuals who report physical pain are 1.6 times more likely to also have alcohol abuse/dependence (based on the DSM-IV criteria) compared to those who do not report pain (Demyttenaere et al., 2007). Similarly, the number of days that participants report pain and level of pain intensity are significantly associated with increased risk for AUD (Edlund, Sullivan, Han, & Booth, 2013), and alcohol use and alcohol-related problems, respectively (Lawton & Simpson, 2009). Furthermore, pain is associated with alcohol use in older adults with chronic pain conditions, and adolescents and young adults along a continuum of pain severity levels and durations of pain states (i.e., brief instances of pain to severe chronic pain conditions) (Bastardo, 2011; Edlund et al., 2013; Heaps, Davis, Smith, & Straker, 2011; Tsui et al., 2014). Lastly, several prospective studies suggest that physical pain is a significant predictor of alcohol use

(i.e., both heavy alcohol use and any alcohol use) and relapse to drinking after a period of abstinence, even after controlling for a number of variables known to be associated with alcohol use (Caldeiro et al., 2008; Larson et al., 2007; Witkiewitz, Vowles, et al., 2015).

Conceptualization of the Physical Pain-Alcohol Use Relation

Recent conceptual model. A recent comprehensive literature review by Zale and colleagues (2015) provides an overview of the research examining the interrelation between physical pain and alcohol use. On the basis of their review, Zale and colleagues (2015) proposed a reciprocal model of the physical pain-alcohol use relation, which included several mechanisms that may be involved. Specifically, the model posits that (1) excessive alcohol use may cause negative physical pain outcomes, (2) physical pain may serve as a situational motivator of alcohol use, and (3) negative affect may mediate the effects of situational pain on alcohol use.

Empirical evidence for the pain-alcohol conceptual model. In support of the reciprocal model, there is ample research to support that excessive drinking has been associated with the onset and severity of painful conditions in both human and non-human populations (Atkinson, Slater, Patterson, Grant, & Garfin, 1991; Bergeson et al., 2016; Brown, Patterson, Rounds, & Papasouliotis, 1996; Holmes et al., 2010). Additionally, the established correlation between physical pain, and alcohol use and alcohol-related variables may be explained by the acute analgesic effects of alcohol (James, Duthie, Duffy, McKeag, & Rice, 1978; Woodrow & Eltherington, 1988). This is consistent with both the negative reinforcement pathway hypothesized by Zale and colleagues (2015) as well as the self-medication hypothesis (i.e., a specific substance is chosen due to the interaction that the substance has with the undesired aversive state being experienced) (James et al., 1978; Perrino et al., 2008; Woodrow & Eltherington, 1988). Indeed, drinkers report that they consume alcohol in order to self-medicate

their physical pain (Aira, Hartikainen, & Sulkava, 2008; Brennan, Schutte, & Moos, 2005; Goebel et al., 2011; Riley & King, 2009), and there is empirical evidence to support negative affect as a mediator of the relation between self-reported pain and alcohol consumption (Witkiewitz, McCallion, et al., 2015). Together, the reviewed literature suggests that physical pain may increase alcohol use through its effects on pain-related negative affect, consistent with the reciprocal model.

Although Zale and colleagues (2015) propose a causal mechanism linking pain to alcohol use, there is no empirical evidence (i.e., human experimental research) to date to inform the validity of the hypothesized mediation effect of negative affect. Further, the empirical support for the effect of physical pain on alcohol use is composed of observational correlational and prospective studies and therefore, unable to discern causality. Thus, there is need for experimental designs to examine the relation between pain, alcohol use, and negative affect.

Physical pain and smoking. There is support to investigate the relation between physical pain, alcohol use, and negative affect in the literature on pain and smoking. Namely, the causal pathway from physical pain to increased alcohol consumption is consistent with models of pain and tobacco smoking that suggest physical pain motivates individuals to smoke (Ditre & Brandon, 2008; Ditre, Heckman, Butts, & Brandon, 2010). Similar to the conceptual model proposed by Zale et al. (2015), one hypothesized explanation for the pain-smoking relation is that smoking may be a means of coping with the physical pain and subsequent increases in negative affect. Several experimental studies with human subjects have examined and provided support for the influence of pain on smoking (Ditre & Brandon, 2008; Ditre et al., 2010; Parkerson & Asmundson, 2016), and the mediation effect of negative affect on the pain-smoking relation (Ditre & Brandon, 2008; Ditre et al., 2010). Taken together, the evidence in support of

physical pain as an important correlate with alcohol use, and alcohol serving as a means to self-medicate physical pain, suggests that it is reasonable that negative affect may also mediate the effect of physical pain on alcohol use.

Moderators of the Pain-Alcohol Use Connection

Based on extant literature suggesting that moderators are important variables to examine in physical pain, negative affect, and alcohol research, it is likely that the pain-alcohol use connection may depend on or vary according to one or more third factors. Such factors may include coping motives for drinking, alcohol outcome expectancies, pain-related alcohol expectancies, dispositional mindfulness, and pain catastrophizing. Therefore, research to discern how such factors are associated with alcohol consumption subsequent to physical pain is important for refining our theoretical conceptualization of the relation. Additionally, identifying modifiable moderating factors may be important for enhancing the effectiveness of intervention and prevention efforts.

Coping motives for drinking. The motivational model of alcohol use states that there are internal (e.g., coping and enhancement) and external (e.g., conformity and social) reasons for using alcohol (Cooper, 1994; Cox & Klinger, 1988). For instance, coping motives for drinking are internal reasons that include drinking alcohol to regulate or minimize negative affect (i.e. negative reinforcement framework). Because physical pain is an aversive experience, it is possible that individuals who endorse more frequent coping-motivated drinking may be more likely to drink as a result of a physically painful experience. Indeed, in studies that examined negative affect and alcohol use, coping motives emerged as a moderator of the relation between negative affect and alcohol use (Merrill & Thomas, 2013; Rousseau, Irons, & Correia, 2011). As

such, coping motives may moderate the pain-alcohol relation, specifically the link between negative affect and alcohol use.

Alcohol outcome expectancies. Based on outcome expectancy theory, people may come to hold anticipatory beliefs, or alcohol expectancies, about the outcome of a particular behavior based on direct or indirect experiences with alcohol (Goldman, Del Boca, & Darkes, 1999; Goldman & Rather, 1993; Smith & Smith, 1988). Specifically, expectancies, become activated when internal or environmental cues are present and consequently influence behavior. In tandem, behavior is more likely to occur when an individual anticipates reinforcement based on learned associations between the behavior and a desirable outcome. Measures of alcohol outcome expectancies most often categorize expectancies as either positive/desirable or negative/undesirable, and include subscales such as consequences, social effects and relaxation/tension reduction (Leigh, 1989; Leigh & Stacy, 1993).

Research suggests that alcohol outcome expectancies are associated with an array of alcohol-related variables. For example, positive alcohol outcome expectancies are associated with greater alcohol consumption (frequency and amount of alcohol use) (Fromme & D'Amico, 2000; Leigh & Stacy, 1993), greater number of alcohol-related problems (Turrisi, Wiersma, & Hughes, 2000), and higher motivation for alcohol use (Wapp, Burren, Znoj, & Moggi, 2015). Conversely, research suggests that negative expectancies are associated with less frequent alcohol use and fewer alcohol-related consequences (Cooper, Russell, Skinner, Frone, & Mudar, 1992; Fromme & D'Amico, 2000; Turrisi et al., 2000). Further, research has shown that alcohol expectancies moderate the effects of negative affect-induced drinking, such that individuals who endorse stronger positive expectancies for alcohol are more likely to consume alcohol in response to stress or negative affect (Armeli, Carney, Tennen, Affleck, & O'Neil, 2000; Frone,

Russell, & Cooper, 1993; Johnson & Fromme, 1994). Therefore, positive alcohol outcome expectancies may be an important moderator of the pain-alcohol relation.

Pain-related outcome expectancies. Extant research has begun to measure and examine the role of substance use expectancies that include pain-related outcomes (Ashrafioun, 2016; Ditre et al., 2010; Parkerson & Asmundson, 2016). For example, individuals who endorsed stronger pain-relief expectancies related to smoking were more likely to engage in smoking behavior and to report increases in smoking urge in response to pain (Parkerson & Asmundson, 2016). Another study examined the effects of an expectancy challenge targeting the smoking-related expectancies of pain relief compared to a control condition; individuals who received the expectancy challenge reported less smoking urge and longer latency to smoke (Ditre et al., 2010). Relatedly, stronger pain-reduction expectancies related to prescription opioids are associated with greater opioid craving and greater desire and intention to use opioids for individuals experiencing pain (Ashrafioun, 2016). However, no previous research has examined *alcohol* outcome expectancies as it relates to physical pain, despite theoretical and empirical evidence of the moderating effects of pain-related expectancies on the relation between pain and smoking and opioid use. Taken together with research suggesting that alcohol may have acute analgesic effects, and individuals' report of alcohol use to cope with their pain, physical pain-related alcohol expectancies may be particularly important in examining the pain-alcohol relation (Zale et al., 2015). That is pain-related outcome expectancies may moderate the effect of pain on alcohol use such that individuals may be more likely to drink if they believe that alcohol will ameliorate pain.

Dispositional mindfulness. Mindfulness is a concept that originates from Buddhist spiritual practices (Hanh, 1976) and has been defined as a level of awareness achieved by

purposeful attention to the present moment in a non-judgmental way (Baer, 2003; Kumar, 2002). State mindfulness refers to one's mindfulness state in the present moment whereas trait or dispositional mindfulness refers to one's overall tendency to be mindful. Although there is an ongoing debate as to whether mindfulness is a single or multidimensional factor, a well-supported structure is a five factor model of mindfulness including, observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). Evidence suggests that dispositional mindfulness may be an important moderator in the study of pain and alcohol use due to its association with both pain and alcohol use.

Relevant to the current study, facets of mindfulness have been found to be moderately inversely correlated with alcohol coping motives (e.g. describing and acting without judgment). However, only 11% of the difference in coping motives was accounted for by mindfulness after controlling for other motives for drinking (Reynolds, Keough, & O'Connor, 2015), suggesting that mindfulness and coping motives are related, yet district constructs. Therefore, coping motives and dispositional mindfulness may have differential moderating effects on the effect of pain on alcohol.

The role of mindfulness in the relation between negative affect and alcohol use.

Because central components of mindfulness are acceptance without judgment and non-reactivity, it stands to reason that individuals who are more mindful will be less reactive to unpleasant states. Indeed, mindfulness has been associated with decreased reactivity to aversive stimuli (Arch & Craske, 2006; Britton, Shahar, Szepsenwol, & Jacobs, 2012). Furthermore, mindfulness has been shown to moderate the association between perceived stress and alcohol consumption

(Adams et al., 2015). Hence, individuals who are low in mindfulness may be more at risk to use alcohol as a result of experiencing pain-induced negative affect.

The role of mindfulness in the relation between pain and negative affect. With regards to pain, dispositional mindfulness has also been found to be inversely related to pain intensity and pain disability (Cassidy, Atherton, Robertson, Walsh, & Gillett, 2012; Schutze, Rees, Preece, & Schutze, 2010). Similarly, healthy individuals who reported higher levels of dispositional mindfulness reported lower levels of pain intensity and higher pain tolerance in response to an experimental pain induction task (Petter, Chambers, McGrath, & Dick, 2013). Comparable associations have also been found in healthy individuals who regularly practiced meditation (a mindfulness-based practice); meditators had lower levels of pain sensitivity in response to acute thermal heat as compared to healthy control participants (J. A. Grant & Rainville, 2009). Therefore, dispositional mindfulness may moderate the effects of painful stimuli on negative affect as well as alcohol use.

Pain catastrophizing. Extant literature cites psychological factors, such as catastrophizing, as a primary determinant of one's pain experience. Pain catastrophizing is defined as "an exaggerated negative 'mental set' brought to bear during actual or anticipated painful experience" (Sullivan et al., 2001). Higher levels of self-reported pain catastrophizing are associated with greater negative affect (Keefe et al., 2004) and greater pain (France, France, al'Absi, Ring, & McIntyre, 2002; Sullivan, Martel, Tripp, Savard, & Crombez, 2006). Therefore, individuals who report higher levels of pain catastrophizing may be more susceptible to experiencing increased negative affect in response to a physically painful stimulus, as compared to those with lower levels of pain catastrophizing. Subsequently, individuals who report higher,

as compared to lower, levels of pain catastrophizing may be more likely to use greater amounts of alcohol.

General Summary

Identifying determinants of alcohol consumption and factors that explain the relation between alcohol determinants and alcohol use are important objectives for addressing high rates of alcohol use and alcohol-related problems. Recent theoretical work (Zale et al., 2015) and empirical research suggest that physical pain may be one important determinant of alcohol use and that negative affect may mediate this connection. However, extant research with human participants is limited to observational cross-sectional and prospective study designs. Although these studies are informative and allow researchers to identify possible relations among variables, they cannot verify the hypothesized causal relation between physical pain and alcohol consumption. Therefore, experimental research is needed to investigate the causal effect of physical pain on alcohol-related constructs. To this point, it is important to note that experimental pain, though not equivalent to clinical pain, makes testing the pain-related hypotheses in a controlled environment possible.

Accordingly, this study sought to extend existing literature by being the first experimental study to examine the effect of situational experimental physical pain on proxies of alcohol consumption in human research participants. Male and female University undergraduates were randomly assigned to an experimental pain induction or no pain induction condition. Following application of the experimental pain or control stimulus, measures of pain perception and affect were recorded. Then, participants were asked to rate their degree of urge to drink alcohol and intention to use alcohol and to complete a task designed to measure alcohol demand. These precursors to alcohol consumption were the dependent variables instead of actual alcohol

consumption. This research was preceded by a pilot study designed to refine the pain administration procedures for the experimental study. The following primary experimental hypotheses were tested.

Study Aims

Primary aim and hypothesis 1. To examine experimental physical pain as a determinant of proxies of alcohol use –self-reported urge to drink and intention to use alcohol and alcohol demand. It was hypothesized that participants randomized to undergo experimental pain induction (vs. no pain induction) would report greater increases in alcohol urge, intention to use alcohol, and alcohol demand.

Primary aim and hypothesis 2. To test negative affect as a mediator of the effects of experimental pain on proxies of alcohol use (urge to drink, intention to use alcohol, and alcohol demand). It was hypothesized that increases in negative affect mediate increases in the urge to drink, intention to use alcohol, and demand associated with the experimental pain induction condition compared to the no pain condition.

Secondary aims and hypotheses. Exploratory aims of this study are also proposed to examine important, potentially modifiable moderators of the pain-alcohol relation. Based on extant literature, it was hypothesized that there is a stronger positive relation between negative affect and proxies of alcohol use among participants who report greater frequency of drinking for coping motives, hold stronger expectancies for tension reduction, and score lower in trait mindfulness. Second, it was hypothesized that participants who score lower in trait mindfulness and catastrophize their pain to a greater degree experience greater negative affect in response to pain. Lastly, it was expected that participants who hold stronger pain-relief expectancies for

alcohol experience a greater increase in proxies of alcohol use as a result of physical pain than those who hold lower pain-relief expectancies.

Method

Pilot testing preceded the main experiment and occurred in phases. The first and fourth phases included internal pre-testing that was conducted informally with project partners. Phases two and three were conducted with pilot study participants. An iterative approach was taken to achieve, on average, clinically significant pain throughout the experimental pain induction period.

The next sections, respectively, describe (1) recruitment procedures, (2) methodology that was consistent across all phases of the study, (3) rationale and aims for the pilot study, (4) methodology and results for each of the four phases of the pilot study, (5) discussion of the pilot study, and (6) the methodology, results and discussion for the main experimental study.

Recruitment Procedure

Participants were recruited from a larger pool of Syracuse University undergraduate students through SONA, a research recruitment system. Participants completed pre-screening in SONA to determine eligibility. Inclusion criteria were as follows: between the ages of 18 and 35; English speaking; and moderate or heavy drinker as defined by scoring 5+ and 7+ for females and males, respectively, on the Alcohol Use Disorders Identification Test – Consumption (AUDIT-C; Bush, Kivlahan, McDonell, Fihn, & Bradley, 1998). These cut-offs are consistent with research studying a similar population (C. E. Campbell, 2015; DeMartini & Carey, 2012). Those who drank less frequently (i.e., abstainers, light, and infrequent drinkers) were excluded from the study to create a more homogeneous sample and to reduce the potential for floor effects of the outcome variables that are expected with less frequent alcohol users. Exclusion criteria

were as follows: currently using pain medication; currently experiencing physical pain; and chili pepper allergies, due to a contraindication with the pain paradigm (capsaicin application). Those who met the inclusion criteria were provided access to the full study. Individuals who signed up for the study were invited to participate in a one-session in-person laboratory study and were asked to refrain from alcohol and other drug use for 24 hours prior to the appointment. Upon arrival to the laboratory, the informed consent was reviewed, and participants were consented prior to participation. Then, pre-screening criteria were confirmed; if eligible, participants proceeded with study procedures. Students were awarded course credit for their participation.

Measures, Chemicals, and Equipment

Screening measures. A screening questionnaire was administered to assess current acute or chronic pain conditions, current use of pain medications (in the last week), and allergies to peppers, whose consumption is contraindicated for capsaicin application. Participants were also asked their age and to indicate if they spoke and read English well, as indicated by their self-report. The AUDIT-C (Bush et al., 1998) was used to identify moderate-to-heavy drinkers for inclusion in this study. The AUDIT-C measures patterns of alcohol consumption over the past year. Specifically, the AUDIT-C consists of 3 items on a 5-point scale (0-4) that assess past-year drinking frequency, typical quantity, and frequency of heavy drinking, respectively. To ensure that participants reported the number of standard drinks accurately, they were provided with a definition and figure of a "standard drink" (i.e., a 12 oz. beer, 5 oz. glass of wine, or 1.5 oz. of hard liquor/distilled spirits; NIAAA, 2005).

Alcohol Use. In addition to the AUDIT-C, the National Institute on Alcohol Abuse and Alcoholism's (NIAAA, 2003) recommended set of three alcohol consumption questions was included to gather more nuanced information regarding participants' drinking patterns. This

measure assesses frequency and quantity of alcohol consumption during the past year. Participants reported the frequency of any alcohol use and binge drinking (5+/4+ for males/females within a two-hour period) via categorical responses ranging from "every day" to "1-2 times in the past year." Categorical ranges of drinking quantities were also provided for drinks per drinking day (e.g., 7 to 8). Similar to procedures that have been applied in other studies and that have provided reliable estimates, frequencies were converted to weekly estimates (e.g., every day = 7), and an average was taken of each range of alcohol consumption quantities (e.g., 7 to 8 drinks = 7.5) (Gallagher, Hudepohl, & Parrott, 2010; Leeman, Corbin, Fucito, Urwin, & O'Malley, 2013).

Contact-heat Pain. Contact-heat pain was induced using the Conditioned Pain Modulation (CPM) system (Q-Sense-CPM, Medoc Ltd, Ramat Yishai, Israel). The CPM system is one quantitative sensory testing (QST) method that is typically used to assess mechanisms of pain perception and pain inhibition capabilities. Although mechanistic processes are not the focus of this study, research has found contact-heat pain to produce ratings of moderate pain (Dirks, Petersen, & Dahl, 2003; Jensen & Petersen, 2006). The computerized Medoc Q-Sense-CPM system has two thermodes with an active area of 30 x 30 mm and a temperature range from 20 °C to a safety limit of 50 °C. Heat is produced using a heating foil and a Peltier element; the perception of heat pain in humans is thought to be mediated by activity in Aδ and C fibers (for reviews, see Reddy, Naidu, Rani, & Rao, 2012; Schepers & Ringkamp, 2009). That contact-heat pain can be evoked via a computer-controlled thermode exhibiting high levels of heat enables a standardized administration across participants.

Pain Ratings. Three indicators of the experience of pain were used in this study: Participant-determined ratings of threshold, tolerance, and an individualized pain. Pain threshold

was the point at which participants first noticed any pain. Pain tolerance was the point at which the participant stated the maximum limit for enduring the painful stimulus had been reached. The individualized pain rating was the level at which pain was at an 8/10 (P80) (or the average between an individual's threshold and tolerance rating in Phases 1-3 of the pilot study). The individualized pain rating was used to determine the level of heat to be administered during the pain paradigm. This approach was taken to calibrate the intensity of the heat-capsaicin paradigm to each individual to reduce individual differences related to pain sensitivity and because this method has been shown to be less susceptible to floor and ceiling effects than other methods (e.g., using 1 °C above the reported threshold or a fixed temperature) (Granot, Granovsky, Sprecher, Nir, & Yarnitsky, 2006). Each of the pain ratings was determined by averaging the results of three heat trials. During these trials, the heat stimuli began at 32 °C (baseline) and increased at a rate of 1 °C per second. Participants were instructed to press a button on a computerized handheld remote to identify the point at which the temperature reached the specified pain rating. Once the button on the remote was pressed, the temperature returned to the baseline temperature at a rate of 2 °C per second.

Capsaicin. Capsaicin is a derivative of chili peppers that is available in low concentrations over the counter (e.g., .01% and .05%) and can be mixed in a base compound of ethyl alcohol to form a solution. Various levels of capsaicin (e.g., .01% - 10%) have been used in human research in previous studies (e.g., Anderson, Sheth, Bencherif, Frost, & Campbell, 2002; Dirks et al., 2003). When applied topically, capsaicin stimulates transient receptor potential vanilloid (TRPV1) receptors on Aδ and C fiber nociceptors and causes a painful burning sensation similar to that experienced in clinical pain conditions, such as neuropathy (Lotsch et al., 2015). Capsaicin also sensitizes the skin to heat, therefore, lower levels of thermal heat can

be administered and perceived as more painful over a longer period of time without incurring harm (Schmelz, 2009). Also, the capsaicin-heat combination creates a longer-lasting stimulus than the contact-heat paradigm alone (Mohr et al., 2008). Capsaicin has been applied safely, both alone, and in combination with contact-heat in a number of studies (e.g., C. M. Campbell et al., 2009; Madsen, Johnsen, Fuglsang-Frederiksen, Jensen, & Finnerup, 2012; Magerl, Fuchs, Meyer, & Treede, 2001). The concentration of capsaicin used in the present study varied from .01% to 8% and was adjusted during the piloting process to refine the pain paradigm (see Table 1).

Study 1- Pilot Study

Study 1 Rationale and Aims

Although several experimental pain paradigms have been used (e.g., cold pressor test [CPT], mechanical pressure, and evoked thermal or chemical pain), most existing experimental pain induction paradigms evoke pain that is relatively short-lasting (i.e. several seconds to 5 minutes). Therefore, the primary goal of the pilot study was to collect parametric data on and refine the relevant parameters of a novel longer-lasting experimental pain paradigm to be used in the study proper. Specifically, the pilot study sought to determine what combination of heat and capsaicin was sufficient to incur clinical levels of non-harmful moderate pain for a prolonged period of time (15-minute duration). Another goal of the pilot study was to determine the point at which the experimental manipulation would be most sensitive to find an effect (i.e., when participants reported experiencing a peak level of pain) to inform the timing of study outcome measures in the study proper. The final goal of the pilot study was to estimate the completion time of the study measures for the main study.

Based on the thermal heat and capsaicin characteristics described previously, a novel capsaicin-heat paradigm was used in this study to safely deliver a prolonged stimulus (15 minutes) in an attempt to more closely resemble clinical pain while also maintaining standardization across participants. We aimed to evoke a moderate level of pain, because this level is representative of clinically significant levels of pain (Carr et al., 2013; Wang, Chu, et al., 2016) without being intolerable for a longer duration, as may be the case with a more severe level of pain (e.g., tolerance). A clinically significant level of pain has been defined as a pain intensity rating of greater than 4 out of 10 (Carr et al., 2013; Wang, Ho, et al., 2016). Further, evidence suggests that a moderate, or suprathreshold, level of pain provides a closer approximation of clinical pain compared to other levels of pain (e.g., threshold, tolerance) as measured by the association between pain ratings and clinical pain response (Valencia, Fillingim, & George, 2011).

Phase 1 – internal pre-testing. In this phase of the experiment, informal internal pre-testing was conducted with several project partners.

Measures, Chemicals, and Equipment. In addition to the threshold, tolerance, and individualized pain ratings (average between threshold and tolerance) mentioned previously, pain intensity was measured using a self-report computer-assisted visual analog scale (CoVAS). The scale ranges from 0 (no intensity) to 10 (maximum intensity) and records pain intensity ratings every 20 milliseconds. Project partners were asked to report their pain continuously throughout the pain paradigm by sliding the indicator of the CoVAS left to right according to the intensity of their pain. Heat was administered using contact-heat pain equipment described above, and a range of capsaicin concentrations was tested in this phase of the experiment including .01%, .05%, 1%, and 5%.

Procedure. Project partners underwent sensory testing to determine each individual's threshold, tolerance, and individualized pain rating. Capsaicin was then applied to each individual's vulvar forearm using a 3x3 gauze pad containing .25 mL of capsaicin solution and was covered with a transdermal patch. After a ramp-up period of 15 minutes (time in which the capsaicin increasingly sensitizes the skin) (Anderson et al., 2002; Bencherif et al., 2002), the transdermal patch was removed and the forearm was washed with hand soap and lukewarm water. Then, an individualized level of thermal heat (average temperature between participant's threshold and tolerance) was emitted via the computer-controlled thermode directly on top of the application site. Project partners continuously reported their pain intensity over a 20-minute period of time. Following the 20-minute period, the capsaicin was removed and participation was complete.

Results and discussion. Because this phase of the study was conducted informally, general impressions, as opposed to specific data are reported. Capsaicin at .01% and .05% concentrations were not sufficient to produce an average of 4/10 pain intensity throughout the 20 minutes of heat administration. Pain ratings reported when applying capsaicin at 1% and 5% concentrations appeared promising in their ability to reach and sustain an average of 4/10 pain intensity. To take a more conservative approach to testing with the target population, a 1% concentration of capsaicin was selected for use in the next phase of the pilot study. This decision was made based on preliminary evidence from the pre-testing phase that suggested this level may be sufficient to attain the desired pain intensity goal.

Phase 2 – pilot testing.

Participants. Participants in phase 2 of the pilot study included 5 adults (n = 2 men; n = 3 women), aged 18-35 (M = 18.4, range = 18-19), who met the above-mentioned inclusion and exclusion criteria.

Measures, Chemicals, and Equipment. In addition to screening measures, threshold, tolerance, individualized pain ratings (average temperature between a participant's threshold and tolerance), pain intensity, and 1% capsaicin, as previously described, were included in this phase of the study. The Alcohol Purchase Task, a measure of alcohol demand (described later) was also completed in this phase of the study to determine completion rates and to ensure participants understood task instructions.

Procedure. After completing the consenting and screening procedures, basic demographic information was collected. Then, participants completed pain rating and experimental pain induction procedures identical to those described in Phase 1, except that the concentration of capsaicin did not vary and was maintained at 1%. Prior to the completion of pain ratings and experimental pain induction procedures, participants were instructed to close their eyes and focus on the sensations on their arm. Once the 20-minute period of contact heat lapsed, participants completed the APT. Then, the thermode was removed and participants were debriefed.

Results and discussion. All 5 participants completed the full study procedures for this phase of the study. Pain intensity ratings collected over the 20-minute period were examined both by visual inspection of figures depicting CoVAS ratings over the 20-minute period and ratings at each 5-minute interval over the 20-minute period. Participants reported high levels of variability in pain reporting, and 2 of the 5 participants consistently reported intensity below the goal of 4/10 pain intensity (see Figure 1). Also, one participant reported an individualized pain

rating, which serves as the level of heat to be administered during the pain paradigm, greater than the level of heat that can be safely administered for 20 minutes (45 °C). Therefore, for this participant, the level of heat emitted during the pain paradigm was reduced to the maximum level of heat that could be safely administered.

Results from this phase of the pilot study indicated that the level of pain intensity achieved was lower than intended. Therefore, we sought to revise the pain procedures to increase the pain intensity evoked by the paradigm. We hypothesized that the 1% concentration of capsaicin was not high enough to sensitize the skin to the desired level. We also hypothesized that the continuous nature of the pain reporting may have had an effect on the accuracy of participants' reports. For example, because the rating was continuous for 20 minutes, participants may have become less attentive at points and may not have been tracking their experience accurately. Therefore, we proposed the following modifications to stabilize and enhance the pain intensity evoked by the pain paradigm: Increase the individualized level of heat pain being administered to P80, increase the concentration of capsaicin to 8%, and record pain intensity at 5-minute intervals as opposed to a continuous measurement. Due to limited study resources, these changes were made simultaneously as opposed to taking a more gradual approach to refining the pain paradigm, which may have resulted in a series of incremental adjustments.

Phase 3 – Pilot testing.

Participants. Participants in phase 3 of the pilot study included 5 adults (n = 3 men; n = 2 women), aged 18-35 (M = 19.4, range = 18-25), who met the previously mentioned inclusion and exclusion criteria.

Measures, Chemicals, and Equipment. In addition to the threshold, tolerance, and individualized pain ratings mentioned previously (P80), 8% capsaicin was used in this phase.

Pain intensity was assessed using the Numerical Rating Scale (NRS). The NRS is an 11-point scale from 0 (anchored at no pain) located at the far left to 10 (anchored at pain as bad as you can imagine) located at the far right. Participants were asked to click the number on the computer screen that reflects their level of pain intensity (0-10 as described previously) at that moment.

Procedure. The procedure was identical to those outlined in Phase 2 of the pilot study, except that a concentration of 8% capsaicin was applied, that the individualized pain rating was a level 8 out of 10 (P80), and that pain intensity ratings were recorded every 5 minutes. Individuals were instructed to close their eyes and focus on the sensations on their arm until they heard a tone sound on the computer. At the tone, participants were asked to open their eyes and record their pain intensity on the computer by clicking the appropriate number on the NRS scale described above.

Results and discussion. Four out of the 5 participants in this phase of the study completed the full study procedures. One participant withdrew from the study during the experimental pain induction procedures due to discomfort caused by the pain manipulation. The average pain intensity reported by the remaining 4 participants was a level 3 out of 10, and again, there was variability in pain intensity ratings (see Figure 2). Peak pain intensity was achieved seconds after the thermode began emitting heat which is consistent with other research showing that the intensity of a stable contact heat pain peaked soon after heat administration began (Suzan, Aviram, Treister, Eisenberg, & Pud, 2015).

Based on the results, we hypothesized that the pain evoked by the capsaicin during the heat administration may have been declining as the heat was applied because (1) the capsaicin was removed prior to the heat administration, and (2) capsaicin had sensitized the skin for 15 minutes, presumably reaching a peak in pain intensity evoked by the capsaicin prior to the heat

administration. Therefore, we postulated that these factors resulted in an overall low-level of pain that declined over time. Therefore, we proposed the following modifications to stabilized and enhanced pain intensity evoked by the pain paradigm: Placing the thermode directly on top of the capsaicin bandage and applying the contact heat immediately after the capsaicin, eliminating the sensitization period.

Phase 4- Refinement/additional internal testing. The second round of internal pre-testing was performed with several project partners after evaluating the results from Phase 3 of the pilot study.

Measures, Chemicals, and Equipment. In addition to the measures, chemicals, and equipment used in Phase 3, a circular 2.5cm^2 spot bandage was used to apply and cover the capsaicin. The circular bandage replaced the use of the transdermal patch and the 3x3 gauze pad.

Procedure. Project partners completed pain ratings (threshold, tolerance, P80), then 8% capsaicin was applied and covered using a circular 2.5cm^2 spot bandage. Next, an individualized level of heat (P80) was administered directly on top of the bandage. Every 5 minutes project partners rated their pain intensity at the present moment. Because the sensitization period was removed in this phase, the stimulus duration increased to 30 minutes to ensure the full course of increased pain intensity was captured. After 30 minutes of contact heat administration, the thermode was removed and participation was complete.

Results and discussion. Project partners reported an average level of 6/10 pain intensity and little variability throughout the 30-minute time period. Also, pain intensity peaked approximately 5 minutes after the contact heat pain began (Figure 3). This was expected (as compared to peaking immediately after the start of contact heat administration) because capsaicin was being applied without a sensitization period in this phase of the pilot study.

Therefore, sensitization likely occurred during the heat administration, enhancing perceived pain intensity at approximately 5 minutes. Of note, a minor burn injury was produced in two individuals when the thermode emitted heat at 45 °C (the individualized level of heat for these individuals) for 30 minutes. Therefore, as a safety precaution for the next phase of the study, a maximum experimental pain induction temperature threshold was set to 44 °C and a maximum duration of 20 minutes.

Pilot Study- Overall Discussion

This pilot study was conducted to refine the pain parameters for the current experimental study. Specifically, this pilot study sought to determine the parameters required to achieve a relatively stable minimum pain intensity of greater than 4/10 (clinical pain) and to determine at what point peak pain is reached. Results of this pilot study indicate that an individualized level of pain (P80) applied directly on top of 8% capsaicin produces clinical levels of pain. Therefore, parameters described in Phase 4 of the pilot study were applied in the main experimental study.

Study 2- Experimental Study

Study Design. The next section describes the experimental study conducted to examine the effect of situational physical pain on proxies of alcohol consumption. This study employed a two-group, between-subjects repeated measures design. Participants were randomly assigned to either pain- or no-pain-induction conditions using block randomization based on gender and the order that each individual entered the study.

Participants. A total of 77 undergraduate students attended an experimental study session for the main experiment and 66 were randomized. Reasons that individuals were not randomized included equipment malfunction (n = 3), ineligibility based on the AUDIT-C (n = 7), and withdrawing prior to randomization (n = 1). Of those who were randomized, the

experimental manipulation did not lead to the intended effect in three participants (see results of manipulation check) who were subsequently removed from later analyses. Additionally, due to researcher error, one participant randomized to the no-pain control condition received contact heat pain and therefore was excluded from the analyses. Two participants who were in the pain condition withdrew from the study during the experimental pain induction; one of these participants completed outcome measures and thus was retained in the analyses. Therefore, a total of 61 participants were included in the current analyses.

Statistical power

The target sample size was determined by *a priori* power analyses for the first and second primary aims: (1) main effect of condition on proxies of alcohol use, and (2) the mediating potential of negative affect in this relation. The secondary hypotheses are exploratory aims and therefore the power analyses for these hypotheses was not considered. Extant literature was reviewed to obtain estimates of the expected effect sizes in these analyses.

Regarding the first aim, although no research has directly examined the relation between physical pain and urge to drink, intention to use alcohol, or alcohol demand, similar research was consulted. In experimental research examining the effects of stress on alcohol craving and demand for alcohol (M. Amlung & MacKillop, 2014; Owens, Ray, & MacKillop, 2015; Ray, 2011), effect sizes range from small to large. Also, experimental negative mood induction paradigms on desire for alcohol use showed a large effect size (Cooney, Litt, Morse, Bauer, & Gaupp, 1997). Based on this research, a small to medium effect size was projected in the power analysis for the first primary aim of the effects of pain on proxies of alcohol use.

Regarding the second aim, no research has examined whether negative affect mediates the effects of experimentally induced pain on proxies of alcohol use, and therefore related studies

were consulted. One study examining the effects of pain on alcohol use, mediated by negative affect showed medium effects on path *a* and small to medium effects on path *b* of the mediation model (Witkiewitz, McCallion, et al., 2015). Also, a large effect size was found in research examining the effect of experimentally induced pain on negative affect (Logan, 2003). Considering this research in the power analysis for the second aim of the present study, a medium effect size was projected for path *a* and a small to medium effect was projected for path *b* of the mediation model.

Power analysis for the first primary aim was computed using the statistical computer program G-power (Erdfelder, Faul, & Buchner, 1996). Results of the power analysis determined that a sample of $N = 90$ would provide a power of .80 to detect a 'small to medium' effect size ($f^2 = .09$) at α equal to 0.05, with one tested predictor and three total predictors are entered into the model. Published estimates by Fritz and MacKinnon (2007) were consulted to determine the sample size needed to sufficiently power the study to examine the second primary aim. With a projected medium effect size of path *a* and a small to medium effect size for path *b*, bias-corrected bootstrapping indicated that a sample size of 116 would be sufficient to detect the hypothesized effects.

Based on these power analyses, a target sample size of 120 was planned. However, due to limited resources, a total of 61 participants was included in the final analyses, resulting in a projected power of 0.63 for the first primary aim.

Measures and Equipment

Participant characteristics.

Demographics. A demographic questionnaire was used to collect information on the participant's gender, age, race, ethnicity, income, and class status.

***Drinking Motives*.** The Drinking Motives Questionnaire-Revised (DMQ-R) is a measure used to assess a four-factor model of motives for drinking. Although originally developed and tested in adolescents, it has been supported and well-validated in adult and college-aged populations (Crutzen, Kuntsche, & Schelleman-Offermans, 2013; Herberman Mash, Fullerton, Ng, & Ursano, 2014; MacLean & Lecci, 2000). The four categories include enhancement, social, conformity, and coping. Each category consists of 5 items, and the respondent is asked to rate on a 4-point scale the frequency that he or she has used alcohol for those reasons. These items are summed to create a total score for each category. The DMQ-R demonstrates good criterion and predictive validity in that it discriminates distinct patterns of drinking based on each motive and predicts levels of alcohol use and alcohol-related problems (Cooper, 1994; Merrill, Wardell, & Read, 2014). Also, items related to each subscale demonstrated acceptable internal consistency 79 to 0.88) (Digdon & Landry, 2013; Fossos, Kaysen, Neighbors, Lindgren, & Hove, 2011).

Dispositional Mindfulness. The Five Facet Mindfulness Questionnaire (FFMQ) is comprised of 39 items and was used to assess dispositional mindfulness (Baer et al., 2006). The five facets assessed in this measure are observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience. These items are rated on a 5-point scale ranging from 1 (never or very rarely true) to 5 (very often or always true) in terms of the frequency that each statement is generally true for him/her. A sum score is calculated for both the overall FFMQ as well as for each of the five subscales after the appropriate items are reverse coded. The FFMQ has been found to have acceptable validity (Christopher, Neuser, Michael, & Baitmangalkar, 2012) and, in the current study, the measure demonstrated good internal consistency ($\alpha = .81$).

Alcohol Outcome Expectancies. Positive alcohol outcome expectancies were assessed with the Alcohol Outcome Expectancies Scale (AOE: Leigh & Stacy, 1993). The AOE assesses participants' beliefs regarding the extent to which they expect to experience positive and negative consequences while drinking on a scale of 1 (“no chance”) to 6 (“certain to happen”). The positive expectancies scale assessed 19 positive perceived consequences, such as tension reduction (“I am able to take my mind off of my problems”). Responses were summed to obtain a final score and higher scores indicate stronger expectancies; excellent internal consistency was indicated ($\alpha = .91$).

Pain-related Alcohol Expectancies. Expectancies that alcohol would help participants manage or cope with their pain were assessed using the 5-item Pain and Smoking Expectancies scale adapted for alcohol use. (PSE; Ditre, 2006). Participants were asked to rate the likelihood of each statement on a scale from 0 (“completely unlikely”) to 9 (“completely likely”). Example items include: “Drinking alcohol would ease my pain if I were hurting,” and “If I were to experience pain, drinking alcohol would help reduce it.” The PSE has demonstrated excellent internal consistency in previous studies ($\alpha = 0.95$-0.96) (Ditre, 2006; Parkerson & Asmundson, 2016) and was sensitive to a smoking expectancy challenge (Ditre et al., 2010). Similar to previous studies, the PSE, adapted for alcohol use, demonstrated excellent internal consistency in the present study ($\alpha = 0.92$).

Pain Catastrophizing. The extent to which individuals catastrophize their pain was measured using the Pain Catastrophizing Scale (PCS) (Sullivan, Bishop, & Pivik, 1995). The PCS is a 13-item measure and participants are asked to indicate the degree to which they experience various thoughts and feelings when in pain. Items are rated on a 5-point scale ranging from 0 (“not at all”) to 4 (“all the time”). A total score is calculated by summing responses to all

13 items; higher scores reflect a greater level of pain catastrophizing. The PCS has been used with a college student population and demonstrated excellent internal consistency in the current study (α = 0.91) (Dixon, Thorn, & Ward, 2004).

Dependent Variables.

Urge to Drink. A one-item question on a 10-point Likert scale asked participants to indicate the strength of their urge to drink at that moment. Participants indicated their urge from 1 ("absolutely no urge") to 10 ("very strong urge"). Similar single-item measures have demonstrated both reliability and validity in assessing an individual's urge to drink alcohol (Monti, Rohsenow, Abrams, et al., 1993; Monti, Rohsenow, Rubonis, et al., 1993).

Intent to Use Alcohol. A state measure of the intention to use alcohol was measured using the intent to use alcohol scale of the Alcohol Craving Questionnaire (ACQ-NOW; Singleton et al., 1995). Each item was rated on a 7-point scale from strongly disagree to strongly agree. Specified items are first reverse scored, then the raw scores for each factor are summed and divided by the total number of items for that factor. Subscales of this measure have demonstrated high internal consistency (Connolly, Coffey, Baschnagel, Drobes, & Saladin, 2009). In the current sample, the intent to use alcohol scale demonstrated good internal consistency (α = .87)

Alcohol Demand. The Alcohol Purchase Task (APT) was used to measure the demand or reinforcing value of alcohol. This task is an assessment of self-reported hypothetical alcohol consumption and financial expenditure across a range of beverages. The APT demonstrates good reliability and validity (MacKillop, Miranda, et al., 2010; Murphy, MacKillop, Skidmore, & Pederson, 2009) and corresponds with decisions made with actual money and alcohol (M. T. Amlung, Acker, Stojek, Murphy, & MacKillop, 2012).

The following instructions were provided: “Imagine that you could drink alcohol ***RIGHT NOW.*** How many alcoholic drinks would you consume at the following prices? The available drinks are standard size domestic beer (12 oz.), wine (5 oz.), shots of hard liquor (1.5 oz.), or mixed drinks containing one shot of liquor. Please assume that you would consume every drink you request; that is, you cannot stockpile drinks for a later date or bring drinks home with you. In the following 24 slides, enter a number using the keypad that reflects how many drinks you would consume at the given price. Please assume that each slide represents a different drinking occasion; that is, the number of drinks you enter for each slide is not cumulative.”

Similar to other studies using the APT, there were 24 beverage prices (range $0 - $15) that increase by $0.05- $0.25 between $0 and $1.00 then increase by $1.00 increments between $1.00 and $15.00 (MacKillop et al., 2009; Murphy et al., 2009). Prices were presented in a random order. The APT yields five indices: Intensity (i.e., level of consumption when drinks are free), Breakpoint (i.e., price at which consumption is completely suppressed), O_{max} (i.e., maximum alcohol expenditure value), P_{max} (i.e., the price at which demand becomes elastic), and Elasticity (i.e., α; the aggregated slope of the demand curve). To assist with interpretation, the inverse value (i.e., 1/α) was calculated for Elasticity, so that greater α values indicate greater insensitivity to price, or inelasticity (Banks, Roma, Folk, Rice, & Negus, 2011).

The Intensity, Breakpoint, P_{max}, and O_{max} are data-driven observed values, whereas Elasticity is derived from a nonlinear exponential demand curve equation (Hursh & Silberberg, 2008):

$$\log Q = \log Q_0 + k(e^{-\alpha P} - 1)$$

In this equation, Q = quantity consumption at a given price; Q_0 = intensity, or consumption when price is zero; k = a constant across individuals that denotes the range of

consumption; C = price; and α = the rate of change constant. Larger values reflect a greater sensitivity to increasing drink prices. The calculator provided by the Institute for Behavioral Resources (www.ibrinc.org/centers/bec/BEC_demand.html) was used to estimate elasticity according to the equation above.

Mediating Variables.

Negative Affect. Negative affect was measured using the negative affect scale of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The PANAS is comprised of two dimensions of emotional experience labeled positive affect (i.e., interested, alert, strong) and negative affect (i.e., distressed, upset, irritable). Participants completed both a state and trait version of the negative affect scale of the PANAS. For the state version, participants were asked to what extent they felt a certain way "right now (that is, at the present moment)." The trait version asked participants in relation to how they generally felt over the past 30 days. The negative affect scale consists of 10 items rated on a 5-point scale from very slightly or not at all (1) to extremely (5). Scores on the scale were summed, resulting in a total score for the negative affect scale. The PANAS negative affect scale demonstrated good internal consistency in the current sample (α = .84-.86). Also, in previous research the PANAS demonstrated acceptable test-retest reliability in a college-aged sample (Watson et al., 1988).

Procedures

All participants completed participant characteristic questionnaires, baseline measures of negative affect and the dependent variables (i.e., APT, intent to use alcohol, urge to drink), and provided pain ratings (threshold, tolerance, P80). Then, participants were randomized to either the pain or no-pain induction condition as per the randomization scheme. Participants were in a seated position and informed to refrain from moving during the experimental procedures, aside

from when responding to questionnaires. Then, either the capsaicin (pain condition) or water (control condition) solution was applied to the participant's non-dominant vulvar forearm using a circular 2.5 cm^2 spot bandage. Then, an individualized safe level of heat (P80) or room temperature (32 ºC), for the pain and control condition respectively, was applied directly on top of the bandage via the computer-controlled thermode. After 5 minutes of the experimental pain/no-pain induction, participants began completing, in order, the post-experimental pain induction procedure measures of pain intensity, negative affect, urge to drink, intent to use alcohol and alcohol demand. Once the participant completed the post-manipulation measures, but not before 15 minutes elapsed, the temperature of the thermode decreased back to room temperature and a research assistant removed the thermode and the capsaicin bandage. The participants were then debriefed and provided with compensation. Table 2 outlines the content and time course of the experimental study. Participants randomized to the control condition experienced similar procedures to the pain condition to minimize potential confounds within the experimental conditions.

Overview of the Data Analyses

All analyses were conducted using the Statistical Package for Social Sciences (SPSS) versions 22 and 23 (SPSS, 2012) and GraphPad Prism 7.01 (GraphPad Inc., San Diego, CA). The criterion for statistical significance was an alpha level of 0.05.

Preliminary analyses. Prior to analyses, the skewness and kurtosis of variable distributions were examined for normality. Variables were also examined for the presence of univariate outliers. Following recommendations of Tabachnick and Fidell (2006), transformations were performed as appropriate for variables that were significantly non-normal as defined by a *z*-score for skewness or kurtosis in excess of 3.29 (Table 3). Following

transformations, a total of three outliers, values ≥ 3.29 SDs above the mean, were found in the measure of elasticity and were increased to one unit greater than the highest non-outlier value (Tabachnick & Fidell, 2006). Individuals who were eligible and included in the primary analyses were compared to those who were eligible, but who were not included in the primary analyses on a number of demographic characteristics.

Descriptive statistics for all variables and Cronbach alpha coefficients for relevant measures were computed. *T*-test and Chi-square analyses were conducted to test for differences in participant characteristic by condition to determine if randomization was successful of if there was a need to control for demographic variables in later analyses. To determine if the experimental pain induction procedures were effective in inducing pain, the pain condition and the no-pain condition were compared on reported level of pain intensity, controlling for baseline levels of pain, using a hierarchical regression analysis.

APT Demand Indices. To permit the use of logarithmic transformations in the calculation of elasticity, zero values for were replaced with arbitrarily low non-zero values (i.e., $0.001) as has been done in other studies (Jacobs & Bickel, 1999; MacKillop, O'Hagen, et al., 2010). APT data were also examined for evidence of low effort (e.g., inconsistent responding across prices; >3 contradictions at any given price level) (M. Amlung & Mackillop, 2012; Gray & MacKillop, 2014). Seven participants showed evidence of low effort on the APT and were excluded from subsequent APT analyses (total APT $n = 54$). Of the five demand indices, O_{max} and Intensity are most consistently correlated with alcohol use (Acker, Amlung, Stojek, Murphy, & MacKillop, 2012; Bertholet, Murphy, Daeppen, Gmel, & Gaume, 2015; Kiselica, Webber, & Bornovalova, 2016). Therefore, to reduce the potential for Type II error, and to examine

variables most closely related to alcohol use, O_{max} and Intensity were the demand indices analyzed as dependent variables.

Primary analyses.

Primary Aim 1 Analyses. Hierarchical multiple regression analyses were conducted to examine the effects of pain on the proxies of alcohol use (i.e., urge to drink, intent to use alcohol, and demand). Several proxies were examined in this study to increase the likelihood of capturing the effects of physical pain on this construct. Separate regression models were tested for each of the outcome measures, including the APT indices (O_{max} and Intensity). In this regard, empirical and theoretical research suggests that the APT demand indices are related but are not redundant and therefore may provide unique information on the alcohol-demand relation (Bickel & Vuchinich, 2000; Murphy et al., 2009). Pattern of alcohol consumption (binge drinking days per week) and the baseline level of the respective proxy of alcohol were entered first in the model as covariates. Pattern of alcohol consumption was controlled for because it is theoretically related to proxies of alcohol use and, in this study, it was highly correlated with intent to use alcohol and urge to drink ($p < .05$) (Table 4). Also, binge drinking days per week was selected as the covariate representing the pattern of alcohol consumption as opposed to other measures of alcohol use, because it was the most highly correlated with the outcome measures of interest in this study. The next variable entered was the experimental pain induction condition (dummy coded as either no-pain [0] or pain [1]).

***Primary Aim 2 Analyses*.** Negative affect as a mediator (M) of the relation between pain (X) and proxies of alcohol use (Y) was examined by performing mediation analyses by the PROCESS macro in SPSS (Hayes, 2013; Preacher & Hayes, 2008). This approach uses an ordinary least squares regression framework and produces a test of total (impact of X on Y; path

c), direct (impact of X on Y independent of the mediator; path *c*'), and indirect (impact of X on Y through M; path a*b) effects (Hayes, 2013). The conceptual path model tested in this study is shown in Figure 4.

Condition was specified as the independent variable, state negative affect (post-experimental induction) as the mediator, and, in separate models, each proxy of alcohol as the dependent variable. Baseline levels of alcohol use, proxies of alcohol, and state negative affect were entered as covariates. The statistical significance of indirect effects was assessed using 10,000 resamples and bias-corrected CI. The mediating and indirect effect were considered to be significant if zero is not within the 95% CI.

Secondary Aims. To test coping motives, dispositional mindfulness, positive alcohol expectancies, and pain catastrophizing as moderators, separate moderated mediation models were examined by performing moderated mediation analyses by a PROCESS macro in SPSS (Hayes, 2013; Preacher & Hayes, 2008). The conceptual path models tested in this study are shown in Figure 5. The hypothesized moderators of path *a* included pain catastrophizing (Figure 5, panel A), of path *b* included coping motives and positive alcohol expectancies (Figure 5, panels B and C, respectively), and of both path *a* and *b* included mindfulness (Figure 5, panel D).

Similar to the models tested in Aim 2, condition was entered as the independent variable. Covariates in all models included binge drinking days per week, baseline levels of state negative affect, and baseline level of the respective proxy of alcohol use. In the moderated mediation model that included coping motives, the other drinking motive categories were also entered as covariates (enhancement, conformity, social), because of the large correlations among motives, and because motives for drinking are not mutually exclusive (V. V. Grant, Stewart, & Mohr,

2009). Interaction terms consisted of the two predictor variables tested in each model, and each predictor variable was mean centered prior to analysis.

To test pain-related alcohol expectancies as a moderator between pain and proxies of alcohol, simple moderation analyses were conducted using procedures similar to those described earlier (Figure 5, panel E). Specifically, pain condition was entered as the independent variable and proxies of alcohol use were examined as the dependent variables, with each dependent variable in separate models. Covariates included binge drinking days per week and the respective proxy of alcohol use at baseline. The product term consisted of condition X pain-related alcohol expectancies, with each predictor mean centered.

Results

Attrition Analyses

Of the 70 individuals who were eligible, 61 completed the experimental study and were retained in the analyses. Individuals who were eligible but who were not randomized or retained in the analyses did not differ from those who were eligible and included in the analyses with respect to demographic factors (*ps* > .05).

Manipulation Check

Examination of the pain intensity ratings showed that the experimental manipulation did not lead to the intended effect in three participants. One participant who was in the control condition reported pain (6/10) and two participants in the pain condition reported pain intensity below the clinical pain threshold of 4/10 (1/10 and 2/10). These three participants were subsequently removed from the primary analyses.

The remaining 61 individuals randomized to the pain and no-pain conditions were compared on their reported level of pain intensity after the experimental manipulation while

controlling for their baseline levels of pain. Overall, results suggest that the experimental pain manipulation was effective in producing clinical levels of pain: Participants in the experimental pain condition reported significantly higher pain intensity (M = 7.61, SD = 1.45) than those who were in the no-pain condition (M = 0.70, SD = 0.77; b = 6.35, p = <.001) and met the criteria of clinical levels of pain (i.e., >4/10; M pain intensity = 7.61 in the pain condition).

Descriptive Results

Participants included moderate to heavy drinkers (N = 61; M age = 18.7; 49.2% female). On average, participants reported having 2.61 (1.21) drinking days per week and reported consuming 7.44 (3.33) drinks per drinking day. Of the drinking days, participants reported binge drinking (5+/4+ for males/females within a two-hour period) 1.77 (1.30) days per week. Participant characteristics are shown in Table 5; no significant differences were found in any of the baseline variables between participants in the pain and control experimental conditions. Descriptive results regarding primary variables of interest at pre- and post-experimental manipulation are summarized in Table 6. Bivariate correlation coefficients for key study variables are shown in Table 4. Binge drinking days per week was significantly positively correlated with urge to drink and intent to consume alcohol. Neither monthly discretionary income nor total household income was significantly correlated with any of the APT indices and therefore was not included as a covariate in later APT analyses (p > .05).

Primary Study Results

Aim 1. It was hypothesized that pain condition would predict increases in proxies of alcohol. Results of the hierarchical linear regression revealed that a significant proportion of the total variation in alcohol urge and intent to use alcohol (post-experimental manipulation) was predicted by experimental condition, after controlling for baseline level of alcohol use (binge

drinking days per week) and urge and intent to use alcohol, respectively, (b = 0.16, p < .05; b = 0.92, p < .05). Individuals in the pain group reported 1.18 times more urge to drink and 2.50 times more intent to consume alcohol. Multiple R^2 indicates that approximately 36.0% and 14.2% of the variation in urge and intent to use alcohol, respectively, was predicted by experimental condition. Contrary to hypotheses, experimental condition did not predict variation in alcohol demand, either by O_{max} or Intensity (b's = 0.05-0.56, p's = .33-.44) (see Table 6).

Aim 2. It was hypothesized that state negative affect (post-experimental manipulation) would mediate the effect of condition on increases in proxies of alcohol use. Results showed that condition significantly predicted state negative affect (path a_1: b = .13, p <.001; path a_2: b = .12, p <.001) and urge to drink and intent to use alcohol (path c_1: b = .16, p = .016; path c_2: b = .12, p = .011). State negative affect also significantly predicted urge to drink and intent to use alcohol (path b_1; b = .75, p = .01; path b_2; b = .49, p = .02; See Table 7). A test of indirect effects of pain condition on urge to drink and intent to use alcohol via state negative affect was significant using 10,000 bootstrap resamples (path ab_1: b = .10, 95% CI = .01-.19; path ab_2: b = .06, 95% CI = .00-.13). These results show that state negative affect mediated the relation between pain condition and urge to drink and intent to use alcohol. As mentioned previously, condition did not significantly predict alcohol demand (O_{max} and Intensity). Therefore, state negative affect was not tested as a mediator of this relation.

Exploratory Aims. Incorporating pain catastrophizing as a moderating factor into the negative affect mediated relationship between pain condition and urge (Figure 5, panel A), and holding constant baseline levels of alcohol use, urge to drink, and negative affect, pain condition to negative affect (path a) still reflected a significant relation, b = .13, p < .001. However, neither pain catastrophizing (b = .00, p = .92) nor the condition X pain catastrophizing interaction (b =

.00, p = .86) significantly predicted negative affect. Therefore, the indirect effect of pain condition on alcohol urge through negative affect is not moderated by pain catastrophizing. Similar results were found when examining pain catastrophizing as a moderating factor into the negative affect mediated relationship between pain condition and intention to use alcohol. Although condition remained a significant predictor of negative affect b = .12, p < .001, neither pain catastrophizing (b = .00, p = .80) nor the condition X pain catastrophizing interaction (b = .00, p = .80) significantly predicted negative affect.

Coping motives was examined as a potential moderator of path b in the relation between pain condition and urge to drink, mediated by negative affect (Figure 5, panel B). In these analyses, baseline levels of alcohol use, negative affect, alcohol urge, and other motives for drinking were held constant. The relation between negative affect (post-manipulation) and alcohol urge (path b) was not significant, b = .75, p = .05. Similarly, neither coping motives (b = .08, p = .36) nor the negative affect X coping motives interaction (b = .36, p = .44) significantly predicted urge to drink. Therefore, there is no evidence that coping motives moderates path b of the mediation model examined. Similar results were found when examining coping motives as a moderating factor into the negative affect mediated relationship between pain condition and intent to use alcohol. The relation between negative affect (post-manipulation) and alcohol urge (path b) was not significant, b = .46, p = .05. Again, neither coping motives (b = .06, p = .18) nor the negative affect X coping motives interaction (b = −.10, p = .80) significantly predicted urge to drink.

Next, positive alcohol outcome expectancies were incorporated as a potential moderator of path b in the relation between pain condition and urge to use alcohol, mediated by negative affect (Figure 5, panel C) while holding constant baseline levels of alcohol use, alcohol urge, and

negative affect. Within the context of the mediation model, the relation between negative affect and alcohol urge was reduced in effect size and was no longer significant with the addition of alcohol outcome expectancies as a moderator, b = .64, p =.06. Neither positive alcohol outcome expectancies nor the interaction between positive alcohol outcome expectancies and negative affect was significant, bs = .00 and .03, ps = .52 and .28, respectively. This analysis was also computed substituting intent to use alcohol for urge to use alcohol. In this model, findings were similar; the relation between negative affect and intent to use alcohol was not significant, b = .41, p = .09, and neither was the main effect of alcohol outcome expectancies or the interaction term, bs = .00 and .01, ps = .45 and .52. Therefore, there is no evidence that alcohol outcome expectancies moderate the negative affect mediated effect on the relation between pain condition and either urge or intent to use alcohol.

The construct of positive expectancies was probed further because it is possible that tension-reduction was the most important expectancy in the present experimental study. That is, the other positive expectancies, though generally having an effect on alcohol consumption (e.g., positive social expectancies and expectancies about sex), may be less salient in this study as compared to tension-reduction expectancies (e.g., It takes away my negative moods and feelings) given the aim of the study to induce physical pain in the experimental condition. Tension-reduction outcome expectancies were incorporated as a potential moderator of path b in the relation between pain condition and urge to use alcohol, mediated by negative affect, again holding constant baseline levels of alcohol use, alcohol urge, and negative affect. Within the context of the mediation model, the relation between negative affect and alcohol urge remained significant with the addition of tension reduction outcome expectancies as a moderator, b = .66, p =.04. However, neither tension-reduction alcohol outcome expectancies nor the interaction

between tension-reduction alcohol outcome expectancies and negative affect was significant, *bs* = .01 and .11, *ps* = .30 and .33, respectively. This analysis was also computed substituting intent to use alcohol for urge to drink. In this model, the relation between negative affect and intent to use alcohol was also still significant with the addition of tension reduction outcome expectancies as a moderator, $b = .44$, $p = .045$. The main effect of tension reduction outcome expectancies was not significant, $b = .00$, $p = .44$; however, negative affect X tension reduction was significant, $b = .16$, $p = .04$. A 95% bootstrap confidence interval for the index of moderated mediation did not include zero (.002 to .049), and the upper bound was positive ($b = .11$), reflecting that the indirect effect of negative affect on intent to use alcohol through negative affect is positively moderated by tension reduction expectancies for alcohol.

Panel D of Figure 5, the moderating effect of mindfulness in the mediated relation between pain condition and urge and intent to use alcohol, was examined next. Mindfulness was tested as a moderator of both paths *a* and *b*. First, examining alcohol urge as the dependent variable, the main effects of condition on negative affect was significant ($b = .13$, $p < .001$) and the effect of negative affect on alcohol urge was not significant ($b = .77$, $p = .07$). Neither the main effect of mindfulness (path *a:* $b = .00$, $p = .75$; path *b*: $b = .00$, $p = .53$), nor the interaction terms (mindfulness X condition: $b = .00$, $p = .29$; mindfulness X negative affect, $b = .00$, $p = .78$) were significant. Similar non-significant relations were observed when examining identical relations with intent to use alcohol as the dependent variable (see Table 8). Therefore, there is no indication that mindfulness moderates paths *a* and *b* of the mediation model with either alcohol urge or intent to use alcohol as the dependent variable.

Lastly, pain-related alcohol expectancies were examined as a moderator in the relation between pain condition and urge/intent to use alcohol (Figure 5, panel E) while holding baseline

alcohol use and baseline level of urge to drink/intent to use alcohol constant. With alcohol urge as the outcome, the main effect of pain-related alcohol expectancies was not significant, $b = .00$, $p = .244$. Similarly, the main effect of condition reduced and no longer significance, $b = .12$, $p = .07$. The interaction term (condition X pain-related alcohol expectancies) was also not significant, $b = .01$, $p = .52$. A slightly different pattern of relations was examined when intent to use alcohol was examined as the dependent variable. The direct effects of both condition and pain-related alcohol expectancies were significant (*bs* = .09 and .01, *ps* = .03 and .03, respectively). However, the interaction term remained non-significant, $b = .01$, $p = .19$. Therefore, there is no evidence that pain-related alcohol expectancies moderated the effects of pain condition on alcohol urge or intention to use alcohol.

Discussion

Results confirmed that subsequent to the experimental pain induction, participants reported significantly greater increases in their urge to drink alcohol and intention to use alcohol, as compared to participants in the control condition. Therefore, the current study builds on previous observational correlational research (e.g., Brennan et al., 2005; Witkiewitz, Vowles, et al., 2015) to provide additional evidence that pain may be a critical determinant of alcohol consumption. Further, findings in support of the pain-alcohol relation are consistent with the conceptual model of pain and alcohol use (Zale et al., 2015) as well as the negative reinforcement models of alcohol use (e.g. Khantzian, 1985). That experimental pain increased urge to drink and intention to use alcohol raises the possibility that clinical pain may directly influence alcohol consumption.

Contrary to study hypotheses, there was no relationship between physical pain and indices of alcohol demand (O_{max} and Intensity). Although significant correlations in the

hypothesized direction were observed between alcohol demand and both urge to drink and intention to use alcohol, the effects of experimental pain induction on alcohol demand did not reach significance. Rather, alcohol demand values were similar pre-and post-manipulation within both the experimental and control groups. The effects of physical pain on alcohol demand had not been studied previously. Therefore, study hypotheses were based on both previous research supporting significant correlations between alcohol use and indices of alcohol demand, and, albeit limited, research suggesting that alcohol demand is dynamic. Specifically, alcohol demand has been shown to be sensitive to the effects of experimental stress, alcohol cues, and alcohol interventions. Nonetheless, the current findings correspond with other research that examined the effects of negative mood induction on a measure of alcohol demand that also yielded null findings (Rousseau et al., 2011). Taken together, it is possible that changes in alcohol demand may not be robust to the effects of experimental physical pain.

An alternative explanation regarding null findings for the effect of pain on alcohol demand is that the APT may have had limited sensitivity due to the population being studied and the setting and interpretation of the task instructions. Specifically, the concept of alcohol demand may not be well-developed in young adult undergraduate students (Gallet, 2007). As compared to those who are older, younger individuals are likely to be less experienced with alcohol and therefore, have had less time to develop demand for alcohol. Also, the APT instructions ask participants to imagine that they "could drink alcohol right now." Because the study occurred in a research laboratory in a university building, participants may have interpreted the instructions literally and considered the implications associated with drinking alcohol within an academic setting, thereby restricting the range of alcohol they were willing to consume. Further, the anticipated consequences of drinking in this setting may have been particularly salient because

the majority of participants were under the legal drinking age (M = 18.70, SD = 0.82). If participants were informed that no additional drinking consequences would be imposed based on the setting of the study, it is expected that participants would increase their reported alcohol consumption following the experimental pain induction. Future studies may consider revising the instructions to explicitly indicate that the study setting would not contribute additional consequences.

Consistent with conceptual models of pain and substance use (e.g. Zale et al. 2015) and empirical research (e.g. Witkiewitz, McCallion, et al., 2015), the hypothesized mediation effect of negative affect on the relation between pain and proxies of alcohol use (urge to drink and intention to use alcohol) was significant. Therefore, the current study extends previous correlational studies that showed negative affect to be a mediator of self-reported pain scores and drinking outcomes among patients receiving treatment for AUD (Witkiewitz, McCallion, et al., 2015). Further, these findings also align with the pain and smoking research that showed negative affect mediated the relation between experimental pain, and smoking urge and smoking behavior (Ditre & Brandon, 2008). In the present study, negative affect was a mediator and accounted for 62.5% of the variance in increased urge to drink and 50% of the variance in increased intention to use alcohol. Although state negative affect accounted for a large percentage of variance in predicting proxies of alcohol consumption from pain, a portion of the variance remains unexplained. Future research may benefit from exploring additional factors that may account for this variance, such as coping behaviors (e.g., the lack of alternative coping strategies) (Maisto, Carey, & Bradizza, 1999) and positive reinforcement (Zale et al., 2015).

Although this study is only a first indication of the causal effects of pain and pain-induced negative affect on proxies of alcohol use, together with previous correlational research,

pain and pain-induced negative affect may be of critical importance in determining alcohol use and treating AUD. This importance is further stressed by research showing that individuals who reported pain have an altered SUD presentation with more severe medical and psychiatric problems, which are undoubtedly more costly (Trafton, Oliva, Horst, Minkel, & Humphreys, 2004). Accordingly, some recent work has forged ahead and integrates the treatment of co-occurring pain and alcohol use using a combination of cognitive behavioral therapy and acceptance and commitment therapy, with promising results (Ilgen et al., 2016). Specifically, individuals randomized to receive the intervention, as compared to a supportive psychoeducation control condition, reported significantly lower pain intensity, less alcohol consumption, and higher pain-related functioning.

With regards to exploratory hypotheses regarding potential moderators of the relation between pain and proxies of alcohol consumption (pain-related alcohol expectancies), pain and negative affect (mindfulness and pain catastrophizing), and negative affect and proxies of alcohol use (mindfulness and positive alcohol outcome expectancies), only one significant moderation effect emerged. Specifically, within the model that examined the pain-alcohol relation mediated by negative affect, tension reduction positively moderated the relation between negative affect and intent to use alcohol. Although this relation was hypothesized, it should be interpreted with caution. It was not detected for alcohol urge, and in the context of the number of moderation analyses conducted, the one significant finding may be spurious. Overall, although these results diverge from earlier research, future research that is powered sufficiently to detect the hypothesized moderation effects should re-examine these relations. In addition, researchers may consider examining other moderators, such as coping behaviors, pain sensitivity, and discomfort intolerance to better understand the pain-alcohol relation.

Strengths

The present study had several areas of strength. First, this experimental design demonstrates a high level of internal validity that is not available in previous research regarding the relation between pain and alcohol consumption. Namely, participants were randomly assigned to pain or control conditions, all sessions occurred after 12 PM to reduce the potential for time of day effects, and procedures were conducted in a controlled experimental setting. High internal validity increases the confidence that the differences observed are due to the effects of the experimental pain induction manipulation. Additionally, the effects of pain and the mediating effect of negative affect were observed in the context of a conservative analysis, controlling for drinking patterns and the baseline level of urge to drink and intention to use alcohol. Also, the novel, longer-lasting experimental pain paradigm used in this study enhances the ecological validity of the current findings. Lastly, given that the study established temporal ordering between the independent variable, mediator, and dependent variable, it strengthens the interpretation that negative affect mediates the effect of pain on proxies of alcohol use.

Limitations

Several limitations of this study should be considered when interpreting its findings. First, although experimental pain paradigms are believed to simulate characteristics of clinical pain, the pain experienced is not equivalent to clinical pain and may limit the clinical relevance of the present findings (Edens & Gil, 1995; Rainville, Feine, Bushnell, & Duncan, 1992). However, experimental pain induction methods have been used as an analog for clinical pain and have been applied to advance the understanding of other pain relationships, such as the effects of pain on smoking (Ditre & Brandon, 2008; Ditre, 2010; Parkerson & Asmundson, 2016), and the effects of pain on decision-making (Koppel et al., 2017). Therefore, although experimental acute

pain induction does not allow an examination of clinical pain directly, it may provide initial evidence to better understand the causal effects of physical pain on alcohol use.

Second, these results are based on data collected from healthy undergraduate students who were moderate to heavy drinkers, which has implications for the generalizability of the findings. Recruiting a homogeneous sample of healthy participants allows for control that is not necessarily available when working with individuals experiencing clinical pain, which may vary in duration, severity, and locale. Accordingly, it is important for future studies to determine if the present findings extend to more diverse populations, such as same-aged, non-college students living in the community and individuals with clinical pain conditions.

Directions for Future Research

Future research may benefit from extending the current findings to both clinical pain and alcohol consumption directly. The relation between pain and actual alcohol use can be examined within the laboratory using a taste test in study procedures. Also, relations between in-vivo alcohol consumption and in-vivo clinical pain can be examined using ecological momentary assessment (EMA) methods (e.g., smart phone surveys). EMA methods offer the benefits of having high external validity and providing detailed information that is critical to understanding dynamic associations (Shiffman & Stone, 1998). As such, EMA may be particularly relevant in the study of pain and alcohol use because the relation is theorized to be bidirectional (Zale et al., 2015) and may vary by context. Therefore, researchers may wish to apply EMA methods in future studies on pain and alcohol use to extend the ecological validity of current findings. Specifically, researchers may apply these methods by prompting participants several times per day over a period of time to complete surveys reporting on their location, use of alcohol, and current levels of negative affect and physical pain intensity.

Taken together with extant research, the current study raises the need for future research to investigate whether physical pain is also a causal determinant of other substance use. Although some experimental studies have been conducted with regards to tobacco smoking to support a causal relation (Ditre & Brandon, 2008; Parkerson & Asmundson, 2016), the effects of experimental pain on other substance use (e.g. opioid use/craving) have not been tested in human research participants. Nonetheless, observational studies and animal research suggest pain may motivate opioid use (Griffin et al., 2016; Hipólito et al., 2015). Further, recent increases in rates of opioid misuse suggest that this is a public health concern and a particularly important area for future study (Rudd, Aleshire, Zibbell, & Matthew Gladden, 2016; Vowles et al., 2015). Therefore, future research may consider further expanding the current research base to explore how pain relates to other substances (e.g., opioids, cannabis) given the growing evidence for the critical role of physical pain in addiction.

Lastly, there is evidence that different pain modalities can produce effects that mimic aspects of different pain conditions (Rainville et al., 1992; Staahl, Olesen, Andresen, Arendt-Nielsen, & Drewes, 2009). Research that replicates the current finding with other experimental pain induction modalities (e.g., cold pressor, ischemic muscle pain) may be helpful to determine the qualities of pain that relate to alcohol outcomes. Similar results using other modalities would also strengthen evidence from the present study that physical pain is a determinant of alcohol use.

Conclusions

Limitations notwithstanding, this study provides the first experimental evidence that situational physical pain can be a potent antecedent of the urge to drink and intention to consume alcohol. Further, the significant mediation effect of negative affect corroborates previous

research that stresses the importance of pain and pain-related negative affective states in alcohol consumption (e.g., Witkiewitz, McCallion, et al., 2015). The finding that moderate to heavy drinkers experienced increased urge and intention to use alcohol in response to pain raises the possibility that individuals with co-occurring pain may develop unique AUD profiles that warrant tailored intervention. Also, granting that the present study by itself is limited in its ability to generate clinical implications because of the acute nature of the pain paradigm, current and previous research findings suggest pain-related negative affect is driving the pain-alcohol relation. Therefore, addressing negative affect and teaching pain-coping skills may be indicated in the treatment of alcohol use among individuals with pain conditions.

Table 1

Main pain parameters tested at each phase of the study

Study Segment	Participants	Pain Paradigm Parameters			
		% Capsaicin	Capsaicin application details	Heat-Pain	Pain Measurement Details
Pilot					
Phase 1	Project Partners	.01%, .05%, 1%, 5%	After 15-minute ramp-up period, wash off capsaicin then apply heat	Mean between threshold and tolerance	Continuous rating via CoVAS
Phase 2	Study volunteers (n = 5)	1%	After 15-minute ramp-up period, wash off capsaicin then apply heat	Mean between threshold and tolerance	Continuous rating via CoVAS
Phase 3	Study volunteers (n = 5)	8%	After 15-minute ramp-up period, wash off capsaicin then apply heat	P80	NRS scale (0-10) every 5 minutes
Phase 4	Project Partners	8%	Immediately after application, heat applied directly on top of small capsaicin bandage	P80	NRS scale (0-10) every 5 minutes
Experimental Study	Study volunteers (n = 61)	8%	Immediately after application, heat applied directly on top of small capsaicin bandage	P80	NRS scale (0-10) before experimental manipulation and 5 minutes after heat administration began

Note: CoVAS = computerized; P80 = individualized pain rating of an 8/10 intensity; NRS = numeric rating scale.

Table 2

Outline of Content and Time Course of Experimental Study

Start	Pain Ratings	Randomization	Pain = Yes	Pain = No	Post-Test Measures	End
- Informed Consent - Baseline Measures	- Threshold, Tolerance, P80 Rating	- Pain = Yes - Pain = No	- Capsaicin Application - P80 Active Heat (20 min)	- Control (Water) Application - Baseline Heat (20 min)	(begin completing measures after 5 minutes of heat, in order) - Pain Rating - Negative Affect - Proxies of Alcohol	-Remove Capsaicin -Debriefing
45 min	10 min	5 min	20 min			5 min

Note: P80 = individualized pain rating of an 8/10 intensity.

Table 3

Transformations for Variables of Primary Interest

Variable	Transformation
FFMQ Total	None
Positive alcohol outcome expectancies	None
Pain alcohol expectancies	None
Pain catastrophizing scale	None
Drinking Motives Questionnaire-Revised	
Enhancement	Square root
Coping	Square root
Conformity	Square root
Social	Square root
State Negative Affect	Log_{10}
Intent to Use Alcohol	Log_{10}
Urge to Drink Alcohol	Log_{10}
Alcohol Purchase Task	
Intensity	None
Breakpoint	None
Omax	Log_{10}
Pmax	None
Elasticity (inverse)	Log_{10}

Note. FFMQ = The Five Facet Mindfulness Questionnaire.

Table 4

Bivariate Correlations among Select Study Variables

	r																
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1. Condition	–																
2. BDDPW	−.11	–															
3. Intent to Drink†‡	.14	.31*	–														
4. Urge to Drink†‡	.14	.28*	.66*	–													
5. Intensity‡	−.07	.25	.50***	.41**	–												
6. Breakpoint‡	.01	.20	.56***	.45**	.68***	–											
7. Omax†‡	−.10	.26	.59***	.44**	.77***		–										
8. Pmax‡	.08	.10	.46**	.34**	.49***	.84**	.81***	–									
9. Elasticity†‡	−.01	.04	.36**	.25	.27	.42**	.51***	.37**	–								
10. State NA†‡	.36**	−.12	.15	.38**	.03	.21	.14	.18	.36*	–							
11. PC	−.01	−.01	.01	−.14	−.18	−.04	−.11	−.01	−.07	.09	–						
12. CM†	−.18	.24	.23	.34**	.09	.13	.14	.11	.09	.09	−.05	–					
13. PAE	.16	.13	.38**	.29*	.06	.23	.12	.25	.34*	−.01	.01	.33**	–				
14. AOES	.01	.27*	.28*	.240	.14	.25	.25	.25	.06	.24	.04	.48***	.23	–			
15. FFMQ Total	.02	−.01	.06	.01	.01	−.01	.02	.02	−.03	−.08	−.16	−.26*	.04	−.19	–		
16. Income	−.04	.12	.21	.20	−.02	.07	−.04	−.04	.01	−.03	−.14	.07	.24	.13	.08	–	
17. Discretionary	−.13	.17	.31*	.20	.03	.18	.15	.12	.11	−.05	−.01	−.08	.08	−.02	.08	.17	–

Note. N =53-61 due to missing data. AOES= Positive alcohol outcome expectancies. BDDPW = Binge drinking days per week, CM = Coping Motives, Condition = Experimental Condition, Discretionary = Monthly discretionary income; Elasticity= inverse of elasticity where higher scores reflect greater price insensitivity, FFMQ = Five factor mindfulness questionnaire, Income = Total family income at permanent residence; NA = Negative affect, PAE = Pain alcohol expectancies, PC = Pain catastrophizing.

‡Indicates variables that were measured after the experimental manipulation

†Indicates variable was transformed prior to analyses.

*p < .05. **p < .01. ***p < .001.

Table 5

Characteristics of Participants in the Experimental Study, by Condition

Characteristic	Overall *n* = 61 N (%)/ M (SD)	Pain *n* = 28 N (%)/ M (SD)	Control *n* = 33 N (%)/ M (SD)	*p*-value[†]
Gender (male)	31 (50.8%)	14 (50.0%)	17 (51.5%)	.906
Age	18.70 (0.82)	18.82 (0.86)	18.61 (0.79)	.313
Race (White)	53 (86.9%)	22 (78.6%)	31 (93.9%)	.127
Hispanic	5 (8.2%)	24 (85.7%)	32 (97.0%)	.170
English first Language	57 (93.4%)	26 (92.9%)	31 (93.9%)	.865
Class Status				.511
Freshman	39 (63.9%)	17 (60.7%)	22 (66.7%)	
Sophomore	17 (27.9%)	9 (32.1%)	8 (24.2%)	
Junior	4 (6.6%)	1 (3.6%)	3 (9.1%)	
Senior	1 (1.6%)	1 (3.6%)	0 (0%)	
Household Income				.853
Less than $10,000	2 (3.3%)	1 (3.6%)	1 (3.0%)	
$10,000 – 25,000	1 (1.6 %)	1 (3.6%)	0 (0%)	
$25,000 – 50,000	6 (9.8%)	2 (7.1%)	4 (12.1%)	
$50,000 – 75,000	7 (11.5%)	4 (14.3%)	3 (9.1%)	
$75,000 – 100,000	9 (14.8%)	4 (14.3%)	5 (15.2)	
More than $100,000	36 (59%)	16 (57.1%)	20 (60.6%)	
Discretionary Income ($)[a]	538.08 (953.07)	397.04 (569.86)	653.48 (1174.90)	.304
AUDIT-C Total	7.92 (1.58)	7.61 (0.31)	8.18 (1.49)	.160
Drinking Days/Week	2.61 (1.21)	2.63 (1.29)	2.60 (1.15)	.917
Drinks Per Drinking Day	7.44 (3.33)	7.00 (3.74)	7.82 (2.94)	.343
Binge Drinking Days/Week	1.77 (1.30)	1.62 (1.17)	1.89 (1.41)	.420
FFMQ Total	128.87 (13.90)	129.21 (13.46)	128.58 (14.46)	.860
AOES- positive [a]	85.52 (1.50)	85.64 (10.20)	85.41 (12.93)	.938
Pain Catastrophizing Scale	14.11 (9.46)	14.11 (10.36)	14.12 (8.80)	.995
Pain Alcohol Expectancies	17.10 (9.30)	18.68 (9.92)	15.76 (8.67)	.225
DMQ-R				
Enhancement	17.92 (4.33)	17.71 (4.13)	18.09 (4.56)	.738
Coping	10.16 (3.82)	9.39 (2.99)	10.82 (4.34)	.148
Conformity	8.07 (3.79)	8.29 (4.49)	7.88 (3.13)	.679
Social	19.43 (4.01)	18.89 (4.20)	19.88 (3.86)	.343
QST Ratings				
Threshold (°C)	41.80 (3.81)	41.75 (3.67)	41.83 (3.99)	.936
Tolerance (°C)	46.29 (2.11)	46.23 (2.03)	46.34 (2.22)	.829
P-80 (°C)	44.56 (2.39)	44.52 (2.40)	44.59 (2.42)	.915

Note. AOES= Alcohol outcome expectancies; AUDIT-C = Alcohol Use Disorder Identification Test- Consumption; DMQ-R= Drinking Motives Questionnaire-Revised; FFMQ = The Five Facet Mindfulness Questionnaire; P-80 = individualized pain rating in which participant reported 80/100 pain intensity; QST = quantitative sensory ratings. [a] one participant's data was not included in this analysis, either due to missing data or improbability (i.e., one person reported their monthly discretionary income as 100,000). [b] n = 59 (2 participants missing data). † = chi-square (categorical) or t-test (continuous) inferential difference test between pain and control group. Statistics were computed using untransformed data. Sample included individuals who completed pre- and post-test measures and who reported pain ratings consistent with experimental condition [i.e., 3 participants removed 1 participant in the control condition reported pain (6/10) and 2 participants in the pain condition reported no pain (1-2/10)].

Table 6

Effects of Experimental Pain Manipulation on Pain, Negative Affect, and Proxies of Alcohol Use

Variable	Pain (n = 28)		Control (n = 33)					
	Pre *M (SD)*	Post *M (SD)*	Pre *M (SD)*	Post *M (SD)*	*b* (SE)	*t*	*p*	ΔR^2
Pain Levels (Intensity)	0.14 (0.45)	7.04 (1.45)	0.21 (0.49)	0.70 (0.77)	6.35 (.29)	21.58	<.001	.89
State Negative Affect [a]	12.93 (3.85)	17.93 (7.12)	14.58 (4.83)	13.73 (4.00)	.14 (.03)	4.74	<.001	.21
Proxies of Alcohol Use								
Intent to Use Alcohol [a]	17.36 (10.00)	22.14 (10.36)	20.06 (9.59)	19.70 (10.91)	.12 (.05)	2.61	.01	.07
Urge to Drink Alcohol [a]	1.43 (2.03)	1.54 (1.97)	1.82 (2.04)	1.00 (1.71)	.14 (.07)	2.11	.04	.05
Alcohol Purchase Task								
Intensity	4.81 (3.67)	5.08 (3.59)	5.96 (3.55)	5.61 (4.16)	.62 (.55)	1.13	.26	.01
Omax [a]	13.81 (17.87)	12.41 (12.23)	17.75 (19.62)	15.59 (17.15)	.04 (.07)	.56	.58	<.01

Note. [a] Variable was Log10 transformed prior to regression analyses. *b* = unstandardized coefficient. Statistical comparison presented represents the effects of experimental condition on the respective measure, controlling for pre-experimental manipulation values. Means and Standard Deviations were computed using untransformed data. Pre and post refer to pre- and post-experimental manipulation. N = 54 – 61.

Table 7

Mediating Effects of Negative Affect in the Relation Between Condition and both Urge to Drink and Intention to Use Alcohol

Outcomes	Total effect (*c*)	Direct effect (*c*')	Indirect effect (*ab)*		Percent mediation (%)
	b (SE)	*b* (SE)	*b* (SE)	95% CI	
Urge to Drink	.16 (.07) *	.07 (.07)	.10 (.05)	.01, .19	62.5
Intent to Use Alcohol	.12 (.05)*	.06 (.05)	.06 (.03)	.00, .13	50.0

Note. All estimates are unstandardized. 95% CI = lower and upper bound of a 95% bootstrapped confidence interval of the indirect/mediating effects based on 10,000 resamples; *b* = unstandardized regression coefficient; SE = standard error

* $p < .05$

Table 8

Path Results for Moderated-Mediation and Moderation Models Examined to Test the Exploratory Aims in this Study

		Negative Affect (Me)		Urge to Drink (Y1)	Intent to Use (Y2)
Model A		*b (SE)*		*b (SE)*	*b (SE)*
Condit (X)	$a_1 \rightarrow$	.13 (.03)***	$c'_1 \rightarrow$	.07 (.07)	.06 (.05)
Negative Affect (Me)			$b_1 \rightarrow$	.75 (.30)*	.49 (.21)*
Catastrophizing (Mo)	$a_2 \rightarrow$	.00 (.00)			
Condit *Catastrophizing	$a_3 \rightarrow$	.00 (.00)			
		R^2 = .50		R^2 = .34	R^2 = .48
		F (6, 54) = 8.89***		F (5, 55) = 5.60***	F (5, 55) = 10.02***
Model B		*b (SE)*		*b (SE)*	*b (SE)*
Condit (X)	$a_1 \rightarrow$	.13 (.03)***	$c'_1 \rightarrow$	.06 (.07)	.04 (.05)
Negative Affect (Me)			$b_1 \rightarrow$	.75 (.31)*	.46 (.21)*
Coping Motives (Mo)			$b_2 \rightarrow$	.08 (.07)	.06 (.04)
Condit *Coping Motives			$b_3 \rightarrow$	.37 (.42)	−.10 (.27)
		R^2 = .49		R^2 = .51	R^2 = .59
		F (4, 55) = 13.10***		F (10, 50) = 5.21***	F (10, 50) = 10.00***
Model C		*b (SE)*		*b (SE)*	*b (SE)*
Condit (X)	$a_1 \rightarrow$	.13 (.03)***	$c'_1 \rightarrow$	.09 (.08)	.07 (.24)
Negative Affect (Me)			$b_1 \rightarrow$	.64 (.33)†	.41 (.05)
Positive AE (Mo)			$b_2 \rightarrow$	.00 (.00)	.00 (.00)
Condit *Positive AE			$b_3 \rightarrow$	.03 (.03)	.01 (.02)
		R^2 = .47		R^2 = .45	R^2 = .48
		F (4, 55) = 12.01***		F (7, 52) = 5.97***	F (7, 52) = 6.86***
Model D		*b (SE)*		*b (SE)*	*b (SE)*
Condit (X)	$a_1 \rightarrow$	.13 (.03)***	$c'_1 \rightarrow$	.07 (.08)	.06 (.05)
Negative Affect (Me)			$b_1 \rightarrow$	.77 (.32)*	.35 (.21)
Mindfulness (Mo)	$a_2 \rightarrow$	.00 (.00)	$b_2 \rightarrow$	.00 (.00)	.00 (.00)*
Condit *Mindfulness	$a_3 \rightarrow$	.00 (.00)	$b_3 \rightarrow$	.00 (.01)	−.10 (.27)
		R^2 = .49		R^2 = .43	R^2 = .54
		F (6, 54) = 8.75***		F (7, 53) = 5.73***	F (7, 53) = 8.71***
Model E				*b (SE)*	*b (SE)*
Condit (X)				.12 (.07)††	.09 (.04)*
Pain AE (Mo)				.00 (.00)	.01 (.00)*
Condit *Pain AE				.01 (.01)	.01 (.02)
				R^2 = .34	R^2 = .50
				F (5, 55) = 5.60***	F (5, 55) = 11.18***

Note. AE = alcohol expectancies; *b* = unstandardized coefficients; Condit = experimental condition; Intent to Use = Intent to use alcohol; Me = mediator; Mo = moderator; SE = standard error; X = independent variable; Y1/Y2 = dependent variables. Variables entered into the interaction term were mean centered. Covariates are not displayed in the table. Similar path *a* results for urge to drink and intent to use alcohol; to reduce redundancy, only path *a* statistics for urge to drink are shown.

$^{***}p < .001$. $^{*}p < .05$. $^{\dagger}p < .06$. $^{\dagger\dagger}p < .08$

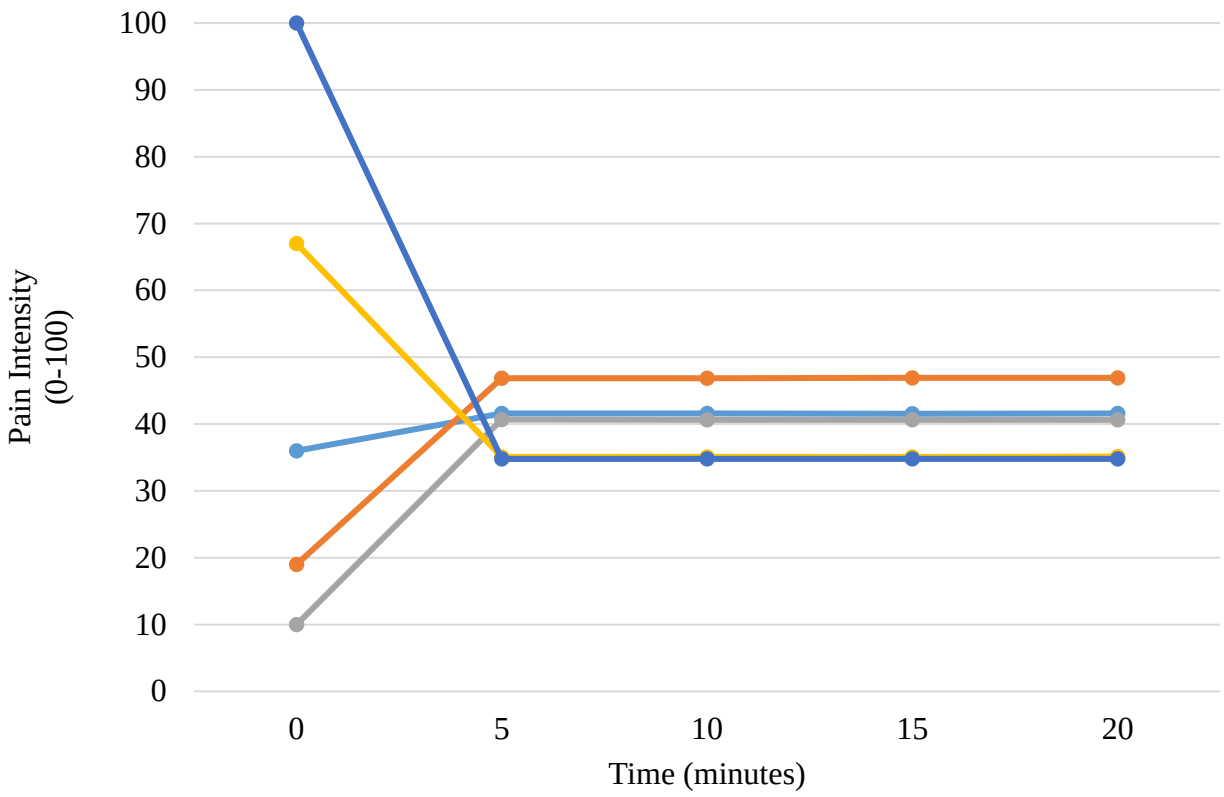


Figure 1. Pain intensity ratings (at each 5-minute interval) of participants in Phase 2 of the pilot study. For consistency across figures, pain ratings at each 5-minute interval are shown, but note that they do not depict the high level of variability in pain ratings between the intervals.

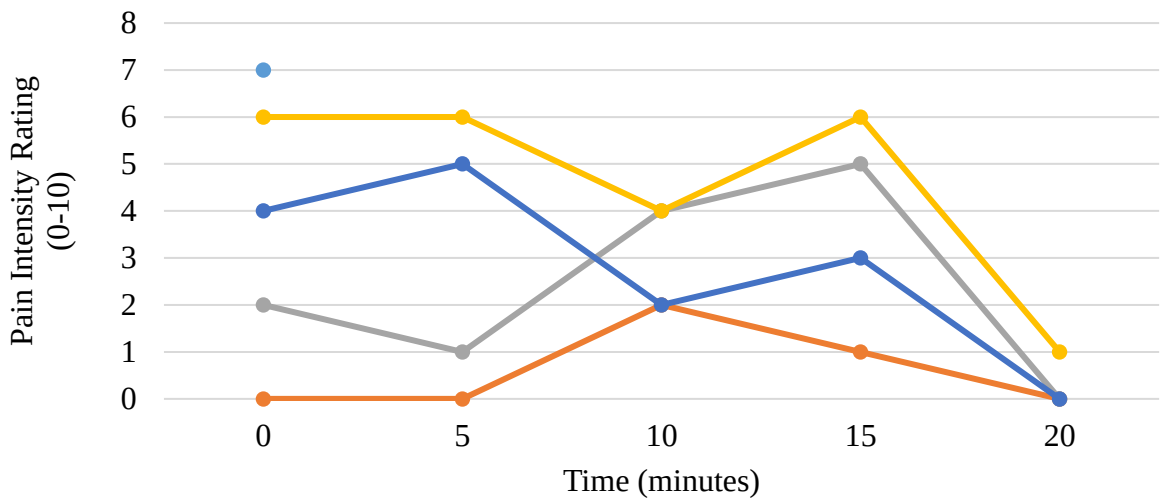


Figure 2. Pain intensity ratings (at each 5-minute interval) of participants in Phase 3 of the pilot study. Note that one participant withdrew during the pain induction procedure. Also note that the heat administration was ending at 20 minutes, resulting in decreased pain intensity ratings at that timepoint.

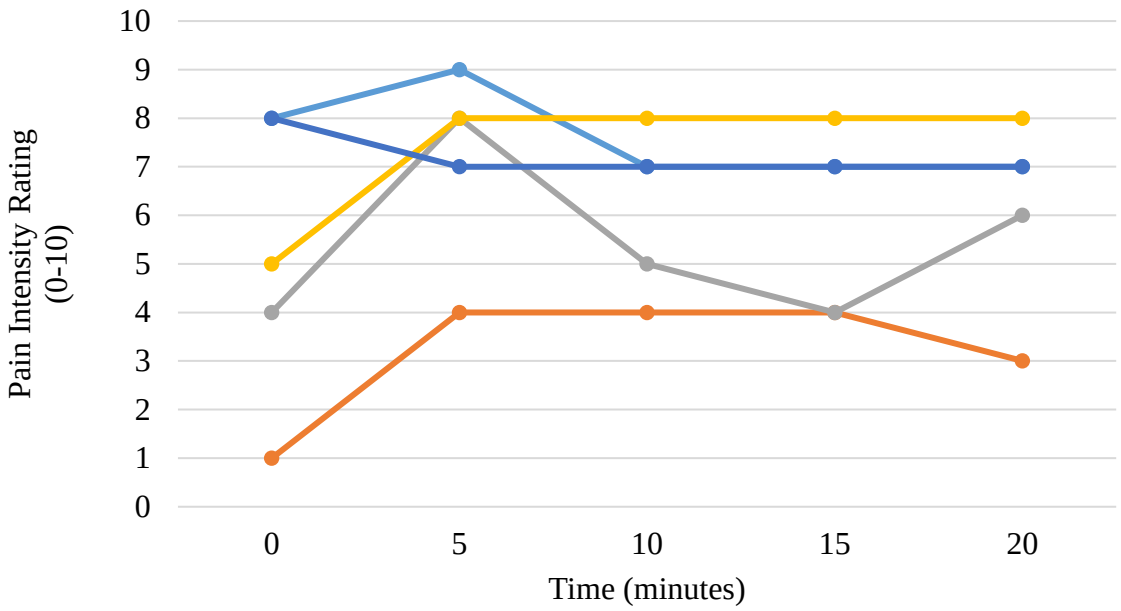


Figure 3. Pain intensity ratings (at each 5-minute interval) of project partners in Phase 4 of the pilot study.

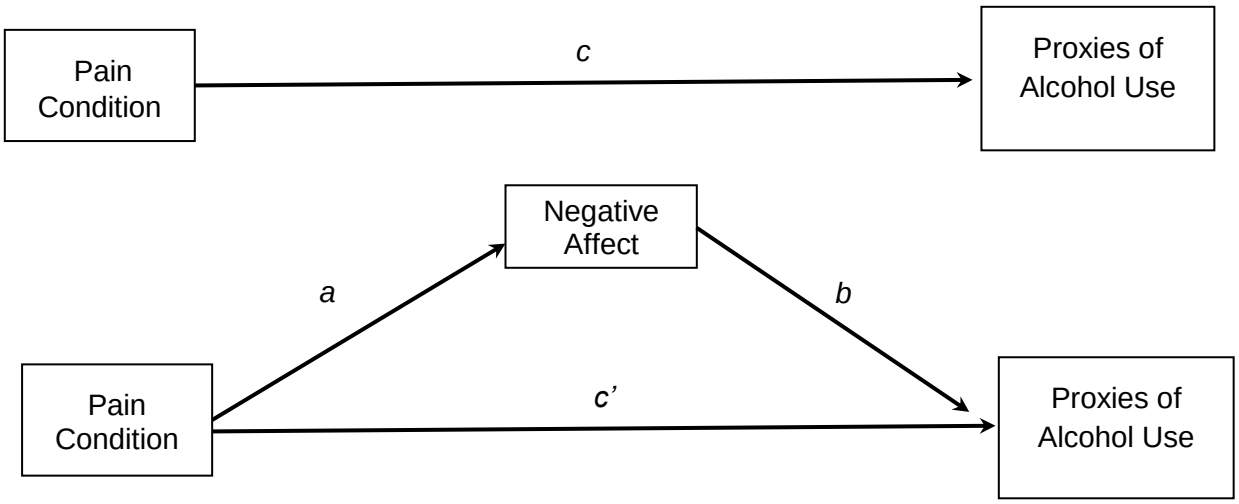


Figure 4. Conceptual path model for the effect of pain on proxies of alcohol use with negative affect as a mediator. Proxies of alcohol use tested in this study included alcohol demand (intensity and O_{max}), urge to drink, and intent to use alcohol.

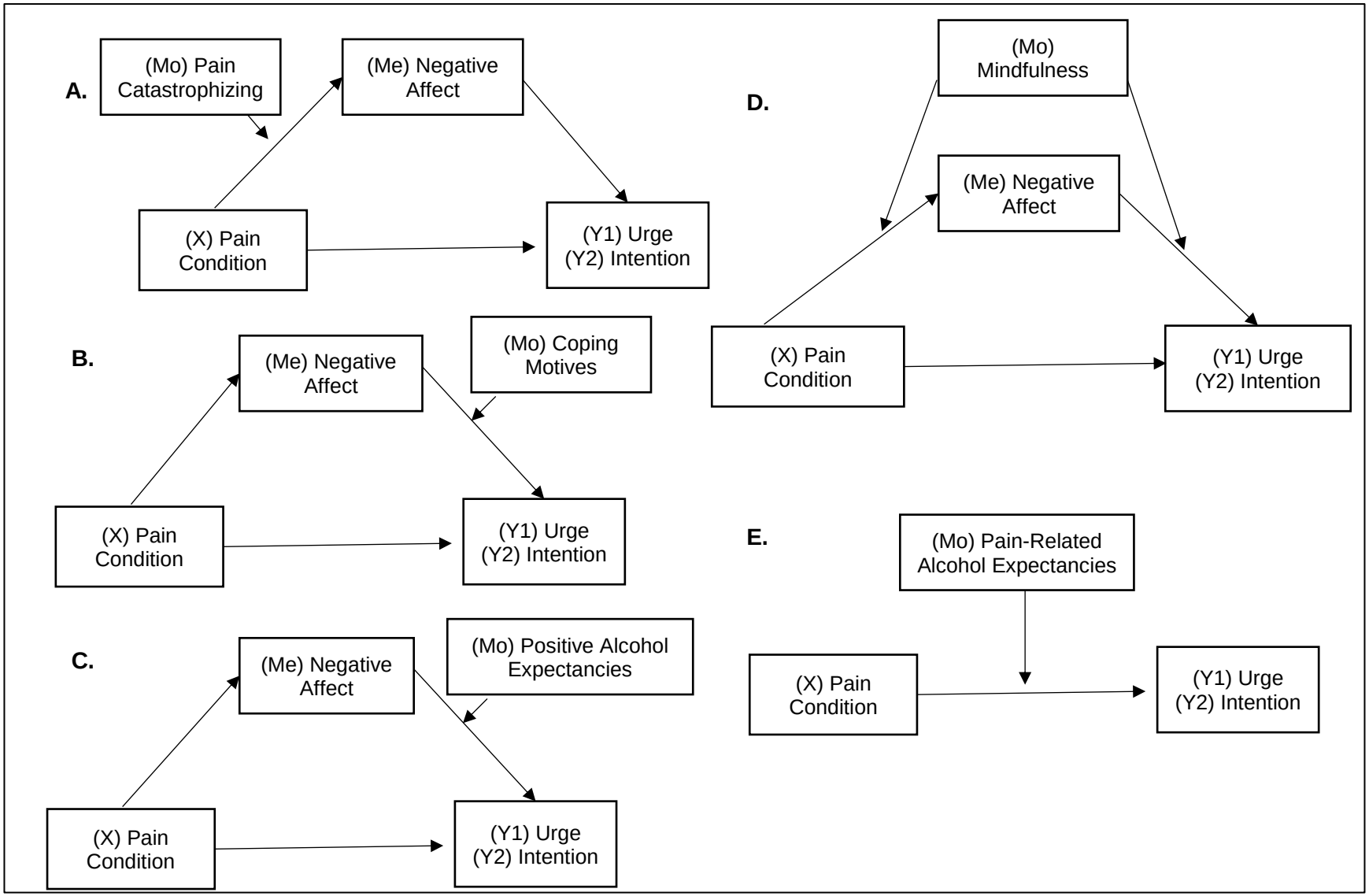


Figure 5. Moderated-mediation (Models A-D) and moderation (Model E) models examined to test the exploratory aims in this study. Pain condition as the predictor (X) on the outcome (Y1 and Y2) of urge and intentions to use alcohol, both directly and indirectly through negative affect (Me) (Models A-D), and effects influenced by the moderator (Mo) which varies by model.

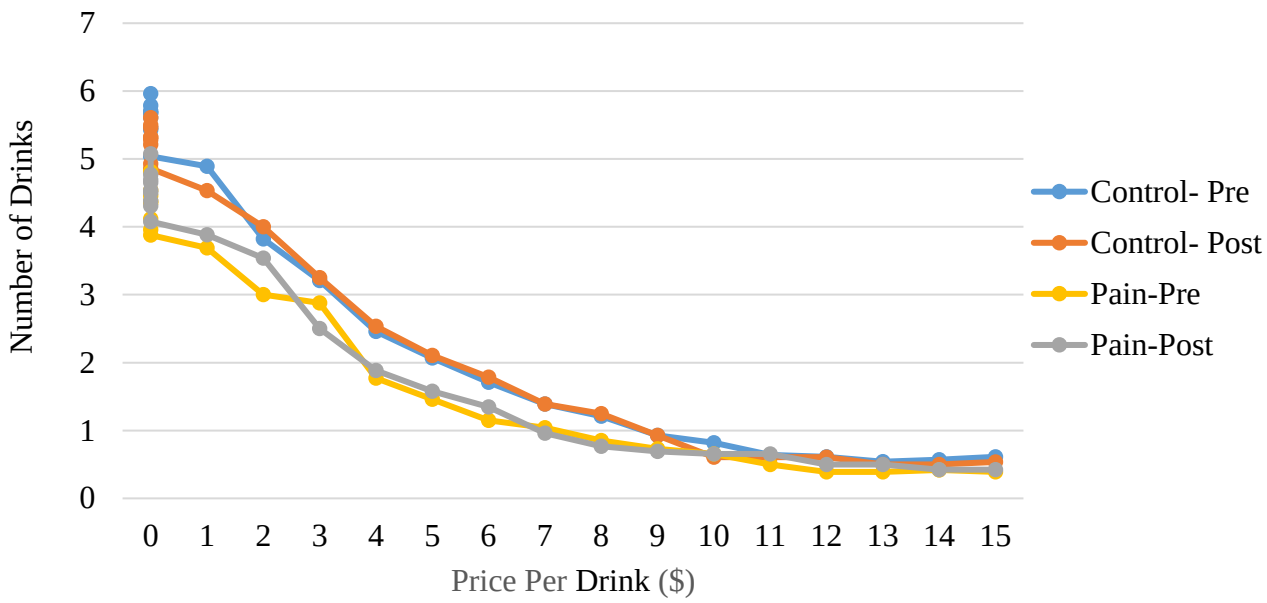


Figure 6. Consumption across price levels by condition and timepoint. Pre- and post- refer to pre- and post- experimental manipulation. Drinks are reported in standard drink units.

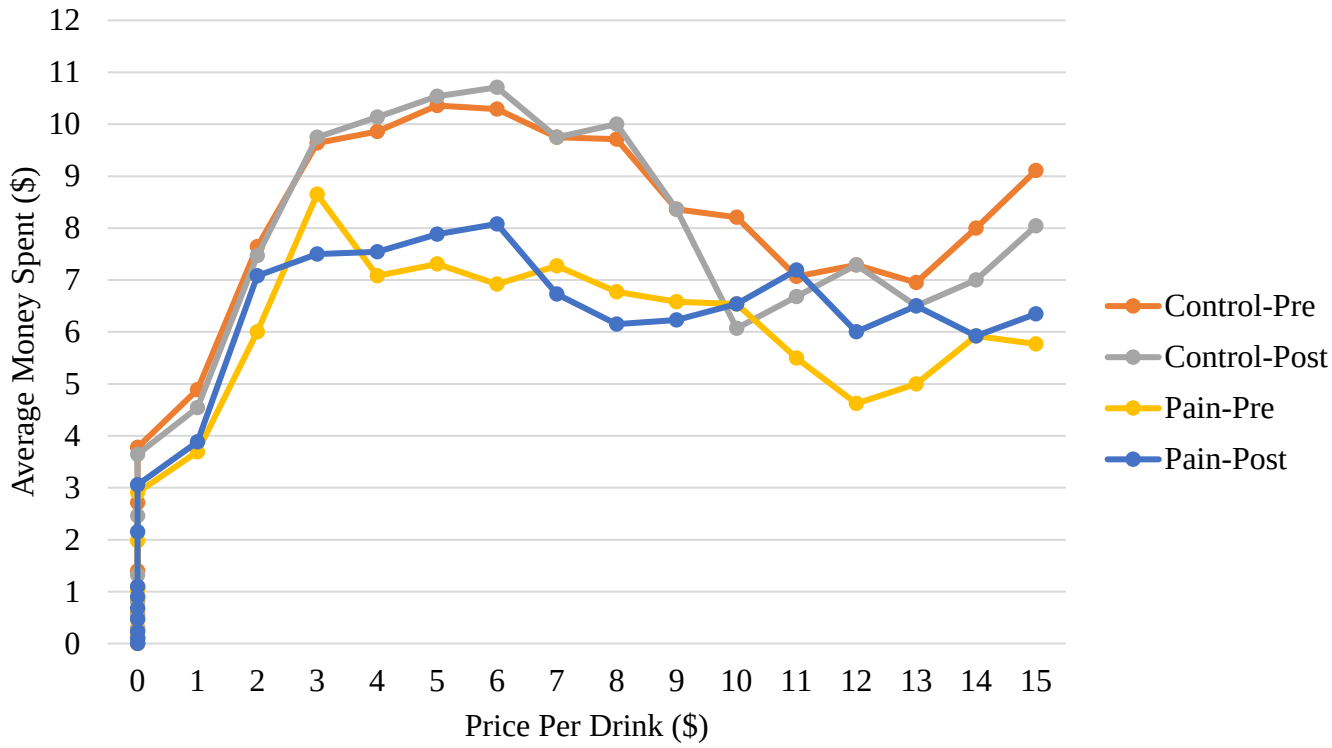


Figure 7. Average amount of money spent by price level. Pre- and post- refer to pre- and post-experimental manipulation.

Appendix: Measures

1) Drinking Motives Questionnaire- Revised (DMQ-R)
2) Positive and Negative Affect Schedule: Negative Affect (PANAS NA)
3) Alcohol Outcome Expectancies Scale (AOES)
4) Five Facet Mindfulness Questionnaire (FFMQ)
5) Pain Smoking Expectancies, adapted for alcohol (PSE)
6) National Institute on Alcohol Abuse and Alcoholism, 3Qs (NIAAA)
7) Alcohol Craving Questionnaire, intent scale (ACQ)
8) 1-item urge measure
9) Pain Catastrophizing Scale (PSC)
10) Pain Intensity Rating

Drinking Motives

Instructions: The following is a list of reasons that people sometimes give for drinking alcohol. Thinking of all the times you drink, how often would you say that you drink for each of the following reasons. In the space provided next to each reason, write the number that corresponds to how often it serves as a reason for you to drink, using the scale below:

1	**=**	**Almost never/never**
2	**=**	**Some of the time**
3	**=**	**Half of the time**
4	**=**	**Most of the time**
5	**=**	**Almost always/always**

1.	_____	To forget your worries.
2.	_____	Because your friends pressure you to drink.
3.	_____	Because it helps you to enjoy a party.
4.	_____	Because it helps you when you feel depressed or nervous.
5.	_____	To be sociable.
6.	_____	To cheer up when you are in a bad mood.
7.	_____	Because you like the feeling.
8.	_____	So that others won't kid you about not drinking.
9.	_____	Because it's exciting.
10.	_____	To get high.
11.	_____	Because it makes social gatherings more fun.
12.	_____	To fit in with the group you like.
13.	_____	Because it gives you a pleasant feeling.
14.	_____	Because it improves parties and celebrations.
15.	_____	Because you feel more self-confident and sure of yourself.
16.	_____	To celebrate special occasions with friends.
17.	_____	To forget about your problems.
18.	_____	Because it's fun.
19.	_____	To be liked.
20.	_____	So you won't feel left out.

Positive and Negative Affect Schedule (PANAS)

INSTRUCTIONS: The next scale consists of a number of words that describe different feelings and emotions. Read each item and mark the appropriate answer in the space next to that word. Indicate to what extent **you feel this way RIGHT NOW**.

1) Distressed…

1	2	3	4	5
very slightly/not at all	a little	moderately	quite a bit	extremely

2) Upset…

1	2	3	4	5
very slightly/not at all	a little	moderately	quite a bit	extremely

3) Guilty…

1	2	3	4	5
very slightly/not at all	a little	moderately	quite a bit	extremely

4) Scared…

1	2	3	4	5
very slightly/not at all	a little	moderately	quite a bit	extremely

5) Hostile…

1	2	3	4	5
very slightly/not at all	a little	moderately	quite a bit	extremely

6) Irritable…

1	2	3	4	5
very slightly/not at all	a little	moderately	quite a bit	extremely

7) Ashamed…

1	2	3	4	5
very slightly/not at all	a little	moderately	quite a bit	extremely

8) Nervous…

1	2	3	4	5
very slightly/not at all	a little	moderately	quite a bit	extremely

9) Jittery…

1	2	3	4	5
very slightly/not at all	a little	moderately	quite a bit	extremely

10) Afraid…

1	2	3	4	5
very slightly/not at all	a little	moderately	quite a bit	extremely

ALCOHOL OUTCOME EXPECTANCIES SCALE (AOES)

Barbara C. Leigh & Alan W. Stacy (1993)

Here is a list of some effects or consequences that some people experience after drinking alcohol. How likely is it that these things happen to **you** when you drink alcohol? Please circle the number that best describes how drinking alcohol would affect you.

(If you do not drink at all, you can still fill this out: Just answer it according to what you think would happen to you if you **did** drink.)

WHEN I DRINK ALCOHOL:

HOW LIKELY IS IT THAT THIS WOULD HAPPEN?

	No chance	Very unlikely	Unlikely	Likely	Very likely	Certain to happen
1. I am more accepted socially	1	2	3	4	5	6
2. I become aggressive	1	2	3	4	5	6
3. I am less alert	1	2	3	4	5	6
4. I feel ashamed of myself	1	2	3	4	5	6
5. I enjoy the buzz	1	2	3	4	5	6
6. I become clumsy or uncoordinated	1	2	3	4	5	6
7. I feel good	1	2	3	4	5	6
8. I get into fights	1	2	3	4	5	6
9. I can't concentrate	1	2	3	4	5	6
10. I have a good time	1	2	3	4	5	6
11. I have problems driving	1	2	3	4	5	6
12. I feel guilty	1	2	3	4	5	6
13. I get a hangover	1	2	3	4	5	6
14. I feel happy	1	2	3	4	5	6
15. I get a headache	1	2	3	4	5	6
16. I am more sexually assertive	1	2	3	4	5	6

WHEN I DRINK ALCOHOL:

HOW LIKELY IS IT THAT THIS WOULD HAPPEN?

	No chance	Very unlikely	Unlikely	Likely	Very likely	Certain to happen
17. It is fun	1	2	3	4	5	6
18. I get mean	1	2	3	4	5	6
19. I have problems with memory and concentration	1	2	3	4	5	6
20. I am more outgoing	1	2	3	4	5	6
21. It takes away my negative moods and feelings	1	2	3	4	5	6
22. I have more desire for sex	1	2	3	4	5	6
23. It is easier for me to socialize	1	2	3	4	5	6
24. I feel pleasant physical effects	1	2	3	4	5	6
25. I am more sexually responsive	1	2	3	4	5	6
26. I feel more sociable	1	2	3	4	5	6
27. I feel sad or depressed	1	2	3	4	5	6
28. I am able to talk more freely	1	2	3	4	5	6
29. I become more sexually active	1	2	3	4	5	6
30. I feel sick	1	2	3	4	5	6
31. I feel less stressed	1	2	3	4	5	6
32. I am friendlier	1	2	3	4	5	6
33. I experience unpleasant physical effects	1	2	3	4	5	6
34. I am able to take my mind off my problems	1	2	3	4	5	6

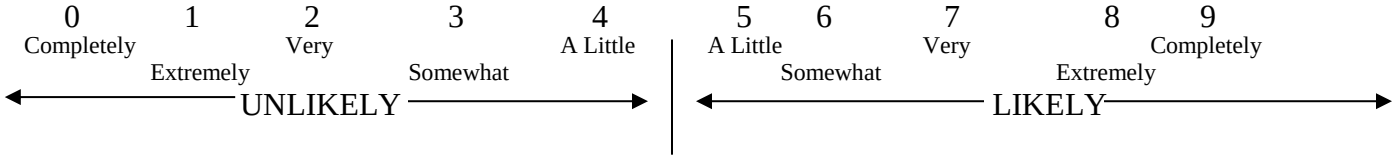
Five Facet Mindfulness Questionnaire (FFMQ)

Please rate each of the following statements with the number that best describes *your own opinion* of what is *generally true for you*.		Never or very rarely true	Rarely true	Sometimes true	Often true	Very often or always true
FFQM 1	When I'm walking, I deliberately notice the sensations of my body moving. (OBS)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFQM 2	I'm good at finding words to describe my feelings. (D)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFQM 3	I criticize myself for having irrational or inappropriate emotions. (NJ-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFQM 4	I perceive my feelings and emotions without having to react to them. (NR)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFQM 5	When I do things, my mind wanders off and I'm easily distracted. (AA-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFQM 6	When I take a shower or bath, I stay alert to the sensations of water on my body. (OBS)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFQM 7	I can easily put my beliefs, opinions, and expectations into words. (D)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFQM 8	I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted. (AA-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFQM 9	I watch my feelings without getting lost in them. (NR)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFQM 10	I tell myself I shouldn't be feeling the way I'm feeling. (NJ-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFQM 11	I notice how foods and drinks affect my thoughts, bodily sensations, and emotions. (OBS)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFQM 12	It's hard for me to find the words to describe what I'm thinking. (D-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFQM 13	I am easily distracted. (AA-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFQM 14	I believe some of my thoughts are abnormal or bad and I shouldn't think that way. (NJ-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFQM 15	I pay attention to sensations, such as the wind in my hair or sun on my face. (OBS)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFQM 16	I have trouble thinking of the right words to express how I feel about things. (D-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFQM 17	I make judgments about whether my thoughts are good or bad. (NJ-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFQM 18	I find it difficult to stay focused on what's happening in the present. (AA-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1

		Never or very rarely true	Rarely true	Sometimes true	Often true	Very often or always true
FFOM 19	When I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting taken over by it. (NR)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFOM 20	I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing. (OBS)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFOM 21	In difficult situations, I can pause without immediately reacting. (NR)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFOM 22	When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words. (D-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFOM 23	It seems I am "running on automatic" without much awareness of what I'm doing. (AA-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFOM 24	When I have distressing thoughts or images, I feel calm soon after. (NR)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFOM 25	I tell myself that I shouldn't be thinking the way I'm thinking. (NJ-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFOM 26	I notice the smells and aromas of things. (OBS)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFOM 27	Even when I'm feeling terribly upset, I can find a way to put it into words. (D)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFOM 28	I rush through activities without being really attentive to them. (AA-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFOM 29	When I have distressing thoughts or images, I am able just to notice them without reacting. (NR)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFOM 30	I think some of my emotions are bad or inappropriate and I shouldn't feel them. (NJ-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFOM 31	I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow. (OBS)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFOM 32	My natural tendency is to put my experiences into words. (D)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFOM 33	When I have distressing thoughts or images, I just notice them and let them go. (NR)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFOM 34	I do jobs or tasks automatically without being aware of what I'm doing. (AA-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFOM 35	When I have distressing thoughts or images, I judge myself as good or bad depending what the thought or image is about. (NJ-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFOM 36	I pay attention to how my emotions affect my thoughts and behavior. OBS)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFOM 37	I can usually describe how I feel at the moment in considerable detail. (D)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
FFOM 38	I find myself doing things without paying attention. (AA-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
FFOM 39	I disapprove of myself when I have irrational ideas. (NJ-R)	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1

Pain Smoking Expectancies (PSE)

Instructions: This questionnaire is designed to assess beliefs people have about the consequences of consuming alcohol. Below is a list of statements about alcohol. We would like you to rate how LIKELY or UNLIKELY you believe each consequence is for you when you drink alcohol. If the consequence seems UNLIKELY to you, circle a number from 0-4. If the consequence seems LIKELY to you, circle a number from 5-9. That is if you believe the consequence would never happen, circle 0; if you believe a consequence would happen every time you drink alcohol, circle 9. Use the guide below to aid you further. For example, if a consequence seems completely likely to you, you would circle 9. If it seems a little unlikely to you, you would circle 4.



1. Drinking alcohol would ease my pain if I were hurting.

   0 1 2 3 4 5 6 7 8 9

2. If I were to experience pain, drinking alcohol would help reduce it

   0 1 2 3 4 5 6 7 8 9

3. If I hurt myself, I would feel less pain if I could drink alcohol.

   0 1 2 3 4 5 6 7 8 9

4. When I feel pain, drinking alcohol can really help.

   0 1 2 3 4 5 6 7 8 9

5. I feel like drinking alcohol would help me cope with pain.

   0 1 2 3 4 5 6 7 8 9

National Institute on Alcohol Abuse and Alcoholism, 3Qs (NIAAA)

During the last 12 months, how often did you usually have any kind of drink containing alcohol? By a drink we mean half an ounce of absolute alcohol (e.g. a 12 ounce can or glass of beer or cooler, a 5 ounce glass of wine, or a drink containing 1 shot of liquor). Choose only one.

- Every day
- 5 to 6 times a week
- 3 to 4 times a week
- Twice a week
- Once a week
- 2 to 3 times a month
- Once a month
- 3 to 11 times in the past year
- 1 or 2 times in the past year

During the last 12 months, how many alcoholic drinks did you have on a typical day when you drank alcohol?

- 25 or more drinks
- 19 to 24 drinks
- 16 to 18 drinks
- 12 to 15 drinks
- 9 to 11 drinks
- 7 to 8 drinks
- 5 to 6 drinks
- 3 to 4 drinks
- 2 drinks
- 1 drink

During the last 12 months, how often did you have 5 or more (males) or 4 or more (females) drinks containing any kind of alcohol in within a two-hour period? [That would be the equivalent of at least 5 (4) 12-ounce cans or bottles of beer, 5 (4) five ounce glasses of wine, 5 (4) drinks each containing one shot of liquor or spirits - to be provided by interviewer if asked.] Choose only one:

- Every day
- 5 to 6 days a week
- 3 to 4 days a week
- two days a week
- one day a week
- 2 to 3 days a month
- one day a month
- 3 to 11 days in the past year
- 1 or 2 days in the past year

Alcohol Craving Questionnaire- NOW (ACQ-NOW)

INSTRUCTIONS: Please indicate how much you agree or disagree with each of the following statements by placing a single checkmark (like this: _X__) along each line between STRONGLY DISAGREE and STRONGLY AGREE. The closer you place your checkmark to one end or the other indicates the strength of your disagreement or agreement. We are interested in how you are thinking or feeling right now as you are filling out this questionnaire. Please complete every item.

RIGHT NOW

1. If I had the chance to use alcohol, I think I would drink.

   STRONGLY DISAGREE___:___:___:___:___:___:___STRONGLY AGREE

2. Even if it were possible, I probably wouldn't drink right now.

   STRONGLY DISAGREE___:___:___:___:___:___:___STRONGLY AGREE

3. I am going to drink as soon as I possibly can.

   STRONGLY DISAGREE___:___:___:___:___:___:___STRONGLY AGREE

4. Right now, I am not making any plans to drink.

   STRONGLY DISAGREE___:___:___:___:___:___:___STRONGLY AGREE

5. I would do almost anything for a drink.

   STRONGLY DISAGREE___:___:___:___:___:___:___STRONGLY AGREE

6. I am thinking of ways to get alcohol.

   STRONGLY DISAGREE___:___:___:___:___:___:___STRONGLY AGREE

7. I will drink as soon as I get the chance.

   STRONGLY DISAGREE___:___:___:___:___:___:___STRONGLY AGREE

8. If I were offered some alcohol, I would drink it right away.

   STRONGLY DISAGREE___:___:___:___:___:___:___STRONGLY AGREE

9. If I had some alcohol right now, I would probably drink it.

   STRONGLY DISAGREE___:___:___:___:___:___:___STRONGLY AGREE

1-item urge

How strong is your urge to drink alcohol right now.

0	1	2	3	4	5	6	7	8	9	10
no urge at all										very strong urge to drink alcohol

Pain Catastrophizing Scale

Everyone experiences painful situations at some point in their lives. Such experiences may include headaches, tooth pain, joint or muscle pain. People are often exposed to situations that may cause pain such as illness, injury, dental procedures or surgery.

We are interested in the types of thoughts and feeling that you have when you are in pain. Listed below are thirteen statements describing different thoughts and feelings that may be associated with pain. Using the scale, please indicate the degree to which you have these thoughts and feelings when you are experiencing pain.

	Not at all	To a slight degree	To a moderate degree	To a great degree	All the time
I worry all the time about whether the pain will end	0	1	2	3	4
I feel I can't go on	0	1	2	3	4
It's terrible and I think it's never going to get any better	0	1	2	3	4
It's awful and I feel that it overwhelms me	0	1	2	3	4
I feel I can't stand it anymore	0	1	2	3	4
I become afraid that the pain will get worse	0	1	2	3	4
I keep thinking of other painful events	0	1	2	3	4
I anxiously want the pain to go away	0	1	2	3	4
I can't seem to keep it out of my mind	0	1	2	3	4
I keep thinking about how much it hurts	0	1	2	3	4
I keep thinking about how badly I want the pain to stop	0	1	2	3	4
There's nothing I can do to reduce the intensity of the pain	0	1	2	3	4
I wonder whether something serious may happen	0	1	2	3	4

Pain Intensity Rating

Please rate the intensity of your pain by selecting the one number that tells the intensity of your pain **RIGHT NOW**.

No Pain										Pain as bad as you can imagine
0	1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○	○

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Wang, W., Ho, S., Wu, S., Chu, C., Sung, C., Wang, K., & Liang, C. (2016). Trends in clinically significant pain prevalence among hospitalized cancer patients at an academic hospital in Taiwan: A retrospective cohort study. *Medicine, 95*(1), e2099. doi: 10.1097/md.0000000000002099

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Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063.

Witkiewitz, K., McCallion, E., Vowles, K. E., Kirouac, M., Frohe, T., Maisto, S. A., . . . Heather, N. (2015). Association between physical pain and alcohol treatment outcomes: The mediating role of negative affect. *Journal of Consulting and Clinical Psychology, 83*(6), 1044-1057. doi: 10.1037/ccp0000033

Witkiewitz, K., Vowles, K. E., McCallion, E., Frohe, T., Kirouac, M., & Maisto, S. A. (2015). Pain as a predictor of heavy drinking and any drinking lapses in the COMBINE study and the UK Alcohol Treatment Trial. *Addiction, 110*(8), 1262-1271. doi: 10.1111/add.12964

Woodrow, K. M., & Eltherington, L. G. (1988). Feeling no pain: Alcohol as an analgesic. *Pain, 32*(2), 159-163. doi: 10.1016/0304-3959(88)90064-4

Zale, E. L., Maisto, S. A., & Ditre, J. W. (2015). Interrelations between pain and alcohol: An integrative review. *Clinical Psychology Review, 37*, 57-71. doi: 10.1016/j.cpr.2015.02.005

CURRICULUM VITAE

Dezarie J. (Hutchison) Moskal

EDUCATION

Syracuse University, Syracuse, New York
Clinical Psychology Doctoral Program, August 2014 - present
Advisor: Stephen A. Maisto, Ph.D.

Daemen College, Amherst, New York
Bachelor of Arts in Psychology, May 2011
Senior Thesis: Relationships between Coping Strategies, Neuroticism, and Conscientiousness
Advisor: Colleen M. Specht-Kashino, Ph.D.

HONORS AND AWARDS

2015, 2016 – Syracuse University Graduate Student Organization Research Travel Grant
2016 – Syracuse University Psychology Department Research Travel Grant
2016 – Syracuse University Psychology Department Master's Thesis Research Funding ($1000)
2016, 2017 – Research Society on Alcoholism Student Merit Award ($120, $100)
2011 – Graduated Magna Cum Laude
2010 – Psi Chi National Honors Society
2008 - 2010 – Daemen College Alumni Grant

RESEARCH EXPERIENCE

Syracuse VA Medical Center, Center for Integrated Healthcare, Syracuse, NY
Graduate Research Assistant, May 2017 - present
Supervisor: Dr. Jennifer Funderburk, Ph.D.
Examine the effects of behavioral activation in veterans with depression on a study entitled *A Pilot Study of the Effects of Brief Behavioral Activation on Depression and Suicidal Ideation (IIR 14-047)*

Syracuse University, Alcohol Research Laboratory, Syracuse NY
Graduate Research Assistant, August 2015 - present
Supervisor: Dr. Stephen A. Maisto, Ph.D.
Conduct research on a multi-site study entitled *Alcohol and Implicit Process in Sexual Risk Behavior in men who have sex with men (MSM) (NIAAA 1R01AA022301-01A1).*

Syracuse VA Medical Center, Center for Integrated Healthcare, Syracuse, NY
Graduate Research Assistant, August 2014 - August 2015
Supervisors: Drs. Kyle Possemato, Ph.D. & Stephen A. Maisto, Ph.D.
Continued to conduct research on the project entitled *Web-Based Cognitive Behavioral Therapy for Substance Misusing and PTSD Symptomatic Operation Enduring Freedom and Operation Iraqi Freedom Veterans (NIAAA 1R01AA020181-01).*

Syracuse VA Medical Center, Center for Integrated Healthcare, Syracuse, NY
Research Health Science Specialist, March 2011 - July 2014
Supervisor: Larry J. Lantinga, Ph.D.
Researched the effects of a web-based intervention for PTSD and substance use on a large multi-site project entitled *Web-Based Cognitive Behavioral Therapy for Substance Misusing and PTSD Symptomatic Operation Enduring Freedom and Operation Iraqi Freedom Veterans (NIAAA 1R01AA020181-01).*

Supervisor: Laura O. Wray, Ph.D.
Conducted focus group meetings and analyzed focus group data using qualitative methodology (grounded theory, frequency analysis) for a project entitled *Facilitators and Barriers to Recovery-Oriented Mental Health Services in Primary Care.*

Daemen College, Amherst, NY
Student Researcher, September 2010 - May 2011
Supervisor: Colleen M. Specht-Kashino, Ph.D.
Proposed and conducted an original research project to examine the relationship between personality and coping style in a convenience sample of undergraduate students.

CLINICAL EXPERIENCE

Syracuse University, Psychological Services Center, Syracuse, New York
Student Clinician, January 2016 - Present
Provide individual therapies in a university-based outpatient training facility to adults with diverse psychiatric conditions and conduct clinical/neuropsychological assessments (e.g., ADHD assessment) with adults and adolescents.

Baker Victory Services, Lackawanna, NY
Mental Health Specialist, June 2011 - March 2012
Supervisor: Janilyn Kogut, M.S.
Functioned as part of the interdisciplinary treatment team to maintain a safe, nurturing environment that promoted learning, growth, and change for a diverse population of children and young adults ranging in ages from 10 to 22 years old.

Crisis Services, Buffalo, NY
Telephone Counselor, May 2011 - January 2012
Supervisor: Deborah Schutt, M.A.
Provided immediate assistance to callers experiencing anxiety, stress, grief or other intense emotions surrounding a crisis.

Roswell Park Cancer Institute, Buffalo, NY
Psychology Intern, September 2009 - June 2011
Supervisor: Brandee Aquilino, Psy.D.
Assisted child psychologist in the pediatric oncology unit by creating and introducing diversionary activities for children and families and collaborated with medical professionals at team meetings to develop plans to meet the children's needs.

PEER-REVIEWED MANUSCRIPTS

Maisto, S. A., Roos, C. R., Hallgren, K. A., **Moskal, D.**, Wilson, A. D., & Witkiewitz, K. (2016). Do alcohol relapse episodes during treatment predict long-term outcomes? Investigating the validity of existing definitions of alcohol use disorder relapse. *Alcoholism: Clinical and Experimental Research, 40*(10), 2180–2189. doi: 10.1111/acer.13173

Maisto, S. A., Witkiewitz, K., **Moskal, D.,** & Wilson, A. D. (2016). Is the construct of relapse heuristic and does it advance alcohol use disorder clinical practice? *Journal of Studies on Alcohol and Drugs, 77*(6), 849-858.

Possemato, K., Funderburk., J., Spinola, S., **Hutchison, D.**, Maisto, S. A., Lantinga, L. J., & Oslin, D. (2016). Reliability and validity of a treatment barriers scale for individuals with alcohol dependence. *Substance Use and Misuse*.

Wray, L.O., Pikoff, E., King, P., **Moskal, D.**, Beehler, G.P., & Maisto, S. A. (2016). Veterans' Mental Health Beliefs: Facilitators and Barriers to Primary Care-Mental Health Use. *Families Systems & Health.*

PRESENTATIONS

Listed in reverse chronological order
*denotes undergraduate student co-author

Maisto, S. A., **Hutchison, D.** (2016, June). *Alcohol Intoxication, Implicit Cognition, Executive Function and Sexual Risk in MSM*. In the Symposium: Recent Advances in The Understanding of Alcohol-Related HIV Risk Among Men Who Have Sex with Men (MSM): Steps Toward Enhanced Prevention Tools. Symposium conducted at the 39th Annual Research Society on Alcoholism, New Orleans, Louisiana.

Maisto, S. A., **Hutchison, D.** (2016, June). *Moderated Mediation and Alcohol Treatment Outcome Research: Are We Ready to Be That Precise?* 12th Annual Satellite Session Research on Mechanisms of Behavior Change. Invited talk, Research Society on Alcoholism, 12th Annual Pre-Conference Satellite Meeting on Mechanisms of Behavior Change, New Orleans, Louisiana.

Hutchison, **D.** Maisto, S. A., Possemato, K., Lynch, K. G., & Oslin, D. W. (2016, June). *Do Cravings Moderate and Mediate Decreases in Drinking for Veterans Who Use Naltrexone?* Poster presented at the 39th Annual Research Society on Alcoholism, New Orleans, Louisiana.

Spinola, S**.**, **Hutchison, D.**, Maisto, S. A., Park, A., & Chung, T. A. (2016, June). *Mediating Effects of Alcohol Use in Marijuana Use Treatment Outcomes Among Adolescents Presenting for Substance Use Treatment.* Poster presented at the 39th Annual Research Society on Alcoholism, New Orleans, Louisiana.

Buckheit, K. A., **Hutchison, D.**, Spinola, S. Maisto, S. A., Chung, T. A. (2016, March). *Alcohol Treatment Goal Choice Predicts Longitudinal Drinking Outcomes in Adolescent Substance Users*. Poster presented at the 37th Annual Meeting and Scientific Sessions of the Society for Behavioral Medicine, Washington, DC.

Hutchison, D., Cottone, K.*, Maisto, S. A., Palfai, T. (2016, March). *The Effects of Age, Sexual Sensation Seeking, and Alcohol on Determinants of Sexual Risk Among Men Who Have Sex with Men.* Poster presented at the 4th Annual Collaborative Perspectives on Addiction meeting, San Diego, California.

De Stefano, L., **Hutchison, D**., Possemato, K., Kuhn, E., Hoffman, J. (2015, November). *Adding Clinician Support to Increase Patient Use of a Symptom Management Mobile App*. Poster presented at the 31st International Society for Traumatic Stress Studies, New Orleans, Louisiana.

Acosta, M., Possemato, K., **Hutchison, D.**, Barrie, K., Lantinga, L., Marsch, L., Maisto, S. A., Rosenblum, A. (2015, August). *Veterans' adherence to a web-based CBT intervention for trauma and problematic substance use*. Paper presented in the Symposium: Promises and pitfalls of technology in delivering interventions to traumatized populations at the Annual American Psychological Association Conference, Toronto, Canada.

Hutchison, D., Possemato, K., Lynch, K., Maisto, S. A., & Oslin, D. W. (2015, June). *Cravings mediate decreases in drinking for veterans who use Naltrexone*. Poster presented at the 38th Annual Research Society on Alcoholism meeting, San Antonio, Texas.

Hutchison, D., Spinola, S., Buckheit, K. A., Maisto, S. A., & Chung, T. A. (2015, June). *Treatment outcome expectancies and readiness to change as predictors of alcohol outcomes following addiction treatment in adolescent substance users.* Poster presented at the 38th Annual Research Society on Alcoholism meeting, San Antonio, Texas.

Buckheit, K. A., **Hutchison, D.**, Spinola, S., Maisto, S. A., & Chung, T. A. (2105, June). *Predictors of alcohol treatment goal choice in adolescent substance users.* Poster presented at the 38th Annual Research Society on Alcoholism meeting, San Antonio, Texas.

Spinola, S., Park, A., Maisto, S. A., Chung, T. A., **Hutchison, D.**, & Buckheit, K. A. (2015, June). *Relationship between motivation and goal-setting in adolescent outpatient treatment outcomes.* Poster presented at the 38th Annual Research Society on Alcoholism meeting, San Antonio, Texas.

Loitsch, A.*, Huddleson, T.*, Kaszycki, A.*, Navarro, V.*, Otero, K.*, Botero, V.*, Spinola, S. **Hutchison, D**., & Maisto, S.A. (2015, April). *Examining the role of education as a moderator of the relationship between executive functioning and alcohol consumption*. Poster presented at the Syracuse University Undergraduate Psychology Conference, Syracuse, New York.

Hutchison, D., Emery, J. B., Barrie, K., Lantinga, L. J., Possemato, K., Maisto, S. A., & Rosenblum, A. (2014, April). *Associations of Nicotine Use, Pain, and Quality of Life with Subthreshold Versus Diagnostic-Level PTSD in OEF/OIF Veterans with Co-Occurring Substance Misuse.* Poster presented at the 35th Annual Meeting and Scientific Sessions of the Society for Behavioral Medicine, Philadelphia, Pennsylvania.

Wray, L. O., Vair, C. L., Pikoff, E., **Hutchison, D.**, King, P., & Beehler, G. P. (2012, November). *Acceptability of screening for memory problems in primary care veterans*. Paper presented at the annual scientific meeting of the Gerontological Society of America, San Diego, California.

Pikoff, E., Beehler, G. P., **Hutchison, D.**, & Wray, L. O. (2011, October). *Patient perceptions of facilitators and barriers to mental health services in primary care.* Poster session presented at the Collaborative Family Healthcare Association Conference, Philadelphia, Pennsylvania.

TEACHING EXPERIENCE

Guest Lecturer, Health Psychology, Pain and Alcohol, Spring 2017
Guest Lecturer, Abnormal Psychology, Alcohol Research, Spring 2017
Guest Lecturer, Drugs and Human Behavior, Marijuana, Summer 2016

PROFESSIONAL MEMBERSHIP AND SERVICE

Syracuse University
2015 - Undergraduate Student Mentor
2015 - Graduate Student Mentor
2016 - 2017 Psychology Action Committee – elected Co-President
2015 - 2016 Psychology Action Committee – elected Secretary

National
April 2016 - August 2016 Membership Survey Subcommittee, Division 50, APA – Student Representative
2015 - Student Social Committee, Division 50, APA – Student Representative
2015 - Student Membership Committee, Division 50, APA – Student Representative

Conference Programming
2016 Abstract Reviewer for the American Psychological Association Division 50

Professional Society Membership

2015- Research Society on Alcoholism student member
2012- American Psychological Association student affiliate
Division 19, Military Psychology
Division 28, Psychopharmacology and Substance Abuse
Division 44, Psychological Study of Lesbian, Gay, Bisexual, and Transgender Issues
Division 50, Addictions
Division 56, Trauma Psychology
2010- Psi Chi Honor Society member