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Tension Reduction and Affect Regulation: An Examination of Mood Indices on Drinking and Non-Drinking Days among University Student Drinkers

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Abstract

Several theories posit problematic alcohol use develops through mechanisms of positive and negative reinforcement. However, the literature on these mechanisms remains inconsistent. This may be due to a number of issues including a failure to disaggregate negative mood or a failure to account for mood functioning (i.e., stability in mood). Alternatively, there may be differences in typical post-drinking/evening mood on drinking and non-drinking days, however, this has yet to be fully explored. We examined multiple indices of distinct mood states prior to and after typical drinking onset times on drinking and non-drinking days using ecological momentary assessment. College student drinkers (n = 102) carried personal data devices (PDDs) for 15 days. They reported on mood and alcohol use several times per day. Tonic positive mood was higher on drinking days than non-drinking days prior to typical drinking initiation. After typical drinking times, positive mood was higher on drinking days than non-drinking days. Similarly, negative moods (anxiety, stress, anger, and stress instability) indicated a pattern of lower levels relative to both pre-drinking mood on drinking days, and matched mood time-points on non-drinking days; though, not all of these differences were statistically different. Results suggest positive and negative reinforcing mechanisms may be at play – though the negative reinforcement effects may manifest through subjectively “better” mood on drinking vs non-drinking days.

Keywords

alcohol; mood; negative reinforcement; positive reinforcement

Introduction

For decades, research has examined the complex association between alcohol and emotion (Cooper et al., 2008; Dvorak, Sargent, et al., 2014; Kassel, 2010; Kuvaas, Dvorak, Pearson, Lamis, & Sargent, 2013; Leonard & Blane, 1999; Sher & Grekin, 2007). Two basic models

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of mood-alcohol associations have dominated the literature. The first model refers to alcohol's ability to reduce overall levels of arousal/tension and has been frequently referred to as Tension Reduction Theory (Cappell & Greeley, 1987). Tension reduction models often, though not always, focus on the physiological experience of high arousal states such as stress. More recently, affect regulation models, which focus on the subjective experience of emotion, have gained in popularity. Affect regulation models allow for a more nuanced understanding of the social and cognitive aspects that serve as reinforcement for alcohol consumption in the context of mood (Sher & Grekin, 2007).

In general, both models have two basic tenets: (1) tension/emotion serves as the impetus to drive alcohol consumption, and (2) alcohol consumption has an attenuating effect on the tension/emotion, thereby reinforcing future consumption. Though a host of research has examined cross-sectional and/or longitudinal associations between indices of alcohol involvement and between-subjects measures of affect (for examples see Dvorak, Simons, & Wray, 2011; Leeies, Pagura, Sareen, & Bolton, 2010; McMahon & Luthar, 2006; Shoal, Gudonis, Giancola, & Tarter, 2008; Wray, Simons, Dvorak, & Gaher, 2012), these approaches fail to capture proximal moment-to-moment associations between tension/ emotion and alcohol use.

Examining these two tenets requires a methodology that allows for (1) proximal assessment of antecedent states, (2) assessment of alcohol consumption, and (3) assessment of subsequent states following consumption. These three assessments can be captured by laboratory studies in which indicators of tension/emotion are assessed, alcohol is administered, and indicators of tension/emotion are subsequently re-assessed. The external validity of these experimental studies can be extended through the use of daily process research which captures snapshots of these three assessments throughout the day using a technique known as ecological momentary assessment (Mohr, Armeli, Tennen, & Todd, 2010; Shiffman, 2009). Below we discuss experimental and daily process research for tension-reduction and affect regulation models.

Tension Reduction

Tension reduction, spurred by early work grounded in Hull's (1943) Drive Reduction Hypothesis, posits that alcohol is consumed as a mechanism to reduce a state of tension (Cappell & Greeley, 1987; Greeley & Oei, 1999; Young, Oei, & Knight, 1990). The operationalization of "tension" has been used loosely throughout the literature. One approach has to been to operationalize "tension" as an objective physiological index of emotional response such as heartrate (Conrod, Peterson, & Pihl, 2001), heart-rate variability (Levenson, Sher, Grossman, Newman, & Newlin, 1980), startle response (Curtin, Lang, Patrick, & Stritzke, 1998), and skin conductance (Levenson et al., 1980). However, after several decades of early research on tension-reduction, the evidence for alcohol driven consumption in response to tension, as well as the evidence for alcohol's ability to attenuate tension following consumption, was scant (Cappell & Greeley, 1987). In their review, Cappell and Greeley concluded that research on tension reduction theory could benefit from a shift that operationalizes "tension" as the subjective emotional experience of stress, often tied to objective physiological indices. The addition of stress as a subjective measure within tension-reduction was driven largely by the introduction of the "stress-response dampening hypothesis," a new way of thinking about tension-reduction theory (Levenson et al., 1980; Sher, Bartholow, Peuser, Erickson, & Wood, 2007; Sher & Walitzer, 1986). This new approach changed the initial conception from a simple decrease in tension, to a decrease in the response to stressful events. Subsequently, tension-reduction has come to mean the dampening of both objective and subjective measures of stress in response to stressful events after consuming alcohol.

As noted above, early experimental work in objective tension reduction has been inconsistent. For example, a number of studies have shown that alcohol increases objective measures of tension/stress (for reviews see Cappell & Greeley, 1987; Greeley & Oei, 1999); however, there have been notable exceptions. Curtin and colleagues have shown that at sufficiently high doses, alcohol consumption has a direct dampening effect on physiological startle response (Curtin et al., 1998; Donohue, Curtin, Patrick, & Lang, 2007). Furthermore, this effect may be more robust at higher levels of stress, resulting in a stronger reinforcing effect (Moberg, Weber, & Curtin, 2011). Sher and colleagues (2007) found that alcohol consumption appears to be associated with *increased* objective physiological arousal/tension, but also an attenuated response to stress after consumption, a finding consistent with stress response dampening. These two differential effects have been individually reported in prior literature (see Brunelle, Barrett, & Pihl, 2007; Conrod et al., 2001; Finn, Zeitouni, & Pihl, 1990; Sayette, Contrada, & Wilson, 1990; Sher & Walitzer, 1986) and have likely led to some of the controversy surrounding tension-reduction theory. Laboratory studies examining the effect of tension/stress as predictor of alcohol consumption has been more difficult, resulting in mixed findings (Thomas & Bacon, 2013). While some studies do indicate stress may lead to alcohol use, this seems to be most evident among heavier drinkers (McGrath, Jones, & Field, 2016; Thomas, Bacon, Randall, Brady, & See, 2011). However, these studies are almost invariably plagued by the contrived nature of the experiment and other factors associated with consumption in a laboratory setting (Greeley & Oei, 1999; Thomas & Bacon, 2013).

Indeed, in experiments that are less contrived, the results do suggest tension/stress may lead to consumption. For example, Pelham and colleagues (1997) had 60 parents interact with a child confederate trained to behave appropriately or trained to exhibit externalizing symptoms consistent with attention deficit disorder, oppositional defiant disorder, and conduct disorder. Parents were then given free access to alcohol in anticipation of a second interaction with the child. Parents who interacted with a child displaying externalizing symptoms drank significantly more than parents in the non-externalizing condition. In another study, Fouquereau, Fernandez, Mullet, and Sorum (2003) found that the degree to which a scenario was judged to be stressful was associated with self-reported urge to drink, particularly among individuals with a diagnosis of alcohol dependence. Thus, there is a need to utilize more externally valid approaches when trying to directly test the tenets of tension-reduction. One way to do this is through ambulatory assessment of objective and subjective tension/stress using daily process techniques (Mohr et al., 2010).

It is difficult to draw conclusions on objective measures of tension reduction from daily process research. In the only study to our knowledge (an unpublished study), Tomko (2015) found that ambulatory measured skin conductance was associated with a decreased likelihood of alcohol consumption among a sample of drinkers who were selected based on elevated levels of affect dysregulation. There is a need for research examining more objective measures of tension-reduction using a daily process approach; however, methodological tools for gathering objective measures of tension/stress using a daily process approach are complicated and not well validated. One potential mechanism for examining objective measures of tension, is to assess affective instability, rather than tonic levels of affect. This provides an index of emotional fluctuations across time and is less influenced by the subjective self-report of current mood (though, admittedly this still relies on self-report). Dvorak and colleagues (2016) found that mood instability, assessed as the mean square of successive differences across mood assessments prior to a drinking episode, predicted both the likelihood of alcohol use on any given day, as well as alcohol use frequency on drinking days. This is consistent with earlier research by Gottfredson and Hussong (2013). Thus, affective instability appears to predict alcohol consumption; however, to our knowledge, no studies have examined whether alcohol reduces affective instability using a daily process approach.

In contrast, several daily process studies have examined *subjective* measures of tension-reduction. For example, in a large nationally representative sample, Grzywacz and Almeida (2008) found a strong positive association between daily perceived stress and binge drinking. Similarly, Russell and colleagues (2017) found that daily stressors were positively associated with drinking among college students, and furthermore, stronger daily stress-drinking associations prospectively predicted more problematic alcohol use four years later. Indeed, a number of studies have confirmed a daily association between perceived stress (or stressful events) and alcohol consumption (Armeli, Carney, Tennen, Affleck, & O'Neil, 2000; Armeli, Dehart, Tennen, Todd, & Affleck, 2007; Carney, Armeli, Tennen, Affleck, & O'Neil, 2000; Grzywacz & Almeida, 2008; Park, Armeli, & Tennen, 2004). The subsequent link between alcohol consumption and reductions in subjective tension/stress has been more tenuous, with no studies (to our knowledge) directly examining subjective measures of tension (i.e., stress) after alcohol consumption using a daily process approach. However, Armeli and colleagues (2003) did show that alcohol use was inversely associated with several indices of high arousal negative mood (e.g., anger and nervousness) and positively associated with feeling “relaxed” post-alcohol consumption. Though, it could be argued that these findings are more consistent with affect regulation than tension-reduction.

In summary, experimental research does not clearly indicate that tension/stress drives alcohol consumption. However, more externally valid research using a daily process approach does suggest this may be the case for subjective measures of tension/stress. Objective measures of tension/stress as predictors of alcohol use in daily process research are lacking. In contrast, experimental research indicates a dampening effect on the response to tension/stress on several objective measures; though alcohol may initially produce an increase in objective tension/stress. There remains a dearth of research examining experiences of tension/stress following alcohol consumption in the daily process literature. Thus, although the experimental literature suggests that alcohol may attenuate responses to tension/stress, the external validity of this effect, via measures of subjective stress assessed in near real-time using daily process research, remains to be fully tested.

Affect Regulation

In contrast to tension-reduction approaches, affect regulation models allow for a more nuanced explanation of mood-alcohol associations that may be driven by more subjective experiences and influenced by variables such as expectations of alcohol's effects or other cognitively mediated variables (e.g., motivational influences). Affect regulation models fall into two basic categories: models of negative affect/emotion and models of positive affect/emotion. The same two basic tenets apply to affect regulation models; namely that (1) emotion drives alcohol consumption and (2) alcohol consumption has some form of reinforcing effect on emotion (either increasing positive affect or decreasing negative affect). Affect regulation models differs from tension-reduction in that they are exclusively focused on the subjective experiences of emotion. A variety of different theories have arisen to explain associations between emotion and alcohol. For example, positive reinforcement theories often describe use initiation as a mechanism of reward seeking (physically, emotionally, or socially; de Wit & Phan, 2010). Further, there is evidence that alcohol use results in more positively valenced emotional states (Wilkie & Stewart, 2005), a term referred to as mood enhancement, which can be predictive of use at the daily level (Dvorak, Pearson, & Day, 2014). In contrast, negative reinforcement theories describe use as a way to "cope" with or otherwise diminish uncomfortable mood states (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004; Khantzian, 1997). However, the effects of alcohol on negative mood are varied and often moderated by situational or constitutional factors (see Sher & Grekin, 2007).

Positive Mood—With regard to positive mood, experimental research suggests that inducing positive mood may increase alcohol consumption in the laboratory (Dinc & Cooper, 2015), though there are some contradictory findings in the literature (see Wardell, Read, Curtin, & Merrill, 2011). This, again, may be due to the contrived nature of the laboratory setting. Further, there is experimental research showing that positive mood decreases perceptions of risk (Cheung & Mikels, 2011), which may promote alcohol consumption. Daily process research on positive mood tells a more compelling story. Several daily process studies have shown a positive association between daytime positive mood and various indices of alcohol involvement (Dvorak, Pearson, et al., 2014; Dvorak et al., 2016; Dvorak & Simons, 2014; Simons, Dvorak, Batien, & Wray, 2010; Simons, Wills, & Neal, 2014; Swendsen et al., 2000). For example, among college students, Simons and colleagues (2014) found that positive mood was associated with a decreased likelihood of abstaining from alcohol on a given day, and increased alcohol consumption on drinking days. Similarly, Dvorak and colleagues (2016) found that average pre-drinking positive mood was associated with an increased likelihood of initiating drinking on a given day, as well as greater drinks consumed on days drinking was initiated.

Only a few studies have experimentally examined the direct effects of alcohol on positive mood. Wilkie and Stewart (2005) found that alcohol consumption resulted in increased positive mood, irrespective of whether individuals were identified as coping or enhancement drinkers. Similarly, Conrod and colleagues (2001) found higher rates of elation and agreeableness following alcohol administration among men with and without a family history of alcoholism. Using a daily process approach, Crooke and colleagues (2013) found that positive mood increased leading up to a drinking event, and continued to increase following the drinking event, which would support an enhancement model. In contrast, Treloar and colleagues (2015) found that on drinking days, positive mood increased sharply leading up to drinking initiation, but then gradually decreased following initiation – failing to support a strict enhancement model. It should be noted that the main effects of alcohol on positive mood is complicated, as research suggests that alcohol affects cognitive processes of appraisal which mediate mood expression (Sayette, Martin, Perrott, Wertz, & Hufford, 2001). For example, alcohol myopia theory predicts that alcohol use narrows attention to the most salient aspects of our environment (Steele, Josephs, Fein, & Spencer, 1996), and consequently our emotions may become a "response" to that environment, rather than a true effect of consumption. For college student drinkers, this likely means an increase in positive mood, simply because most consumption occurs in social settings.

Negative Mood—Affect regulation models of negative reinforcement presume that alcohol is consumed as a mechanism to cope with negative emotional states, and that alcohol has some form of ameliorating effect on negative emotion, reinforcing future use (Sher & Grekin, 2007; Wray et al., 2012). A point of distinction between "affect regulation" and "tension reduction" revolves around the operationalization of affect. Indeed, many researchers have used "affect regulation" and "tension reduction" interchangeably in the literature. However, affect regulation refers to the regulation of negative emotional states such as anxiety, sadness, anger, guilt, worry, frustration, etc. Though many of these are also inherently linked to physiological states of stress or tension, they are also qualitatively distinct aspects of emotion. Further, there is a difference between negative emotion and stress (Zautra, 2006), a subjective feeling of tension which can be linked to emotion but also has distinct cognitive (Lazarus & Folkman, 1984) and biological (Sapolsky, 2004) components that are tied to a stressful situation/experience. The most prominent distinction between affect regulation models and tension reduction, which was highlighted by Baker and colleagues (2004) in their reformulated negative reinforcement model, is a shift to affective components over somatic components as a way to understand negative reinforcement. They base this distinction on research indicating that, in contrast to somatic symptoms, negative affective symptoms are predominantly associated with approach/avoidance tendencies and consequently have greater motivational significance (Öhman, Dimberg, & Esteves, 1989; Sutton & Davidson, 1997). Finally, some of the inconsistencies in affect regulation models may stem from qualitative differences in the assessment of negative affect. For example, researchers have used the broad term "negative affect" to refer differentially to individual emotions such as sadness, guilt, anxiety, anger, etc. Hussong and Chassin (1994) have pointed out the need to disaggregate negative affect in order to best understand the mechanisms of negative reinforcement across the spectrum of negative emotional states.

Though some researchers have suggested a robust experimental effect of negative affect on indices of alcohol use, many of these studies rely on a stress induction paradigm that is more consistent with a tension-reduction approach (for example see Hogarth, Dickinson, & Duka, 2010). When looking at actual emotion, however, the story is more complicated. Grant and Stewart (2007) found that an anxious mood induction resulted in increased relief expectancies regardless of whether a person identified as an enhancement or coping motivated drinker. However, in this study the anxiety induction procedure resulted in increased levels of both depression and anxiety, confounding which aspect of emotion was driving this change. The effects of alcohol on post-drinking affect are also quite unclear. Furthermore, alcohol expectancies likely play a very prominent role in affect regulation models. Sitharthan and colleagues (2009) found that both alcohol and placebo resulted in a robust decrease in sadness following a sadness mood induction. Additionally, there is the complicating factor of context. As noted above, alcohol consumption results in a selective allocation of attention which influences mood to the most salient aspects of our current situation. This means that among social drinkers, alcohol will likely have a salutary effect on negative moods. However, this is a very difficult hypothesis to test in a laboratory setting.

Daily process research provides a slightly clearer picture when it comes to mood-drinking associations. Several researchers have shown that negative affect is linked with alcohol use at the daily level (Armeli, Tennen, Affleck, & Kranzler, 2000; Armeli, Todd, Conner, & Tennen, 2008; Simons, Gaher, Oliver, Bush, & Palmer, 2005; Simons et al., 2014). When disaggregating negative mood states, researchers have shown select negative moods may increase or decrease the likelihood of alcohol consumption. For example, Simons and colleagues (2010) found a direct negative association between daytime sadness and nighttime intoxication. Similarly, Swendsen and colleagues (2000) found that “quiet” mood, which may be analogous to sad/depressed mood, was inversely associated with daily alcohol use. In the same study, Swendsen and colleagues (2000) found that nervous mood was positively associated with daily alcohol use. Furthermore, these researchers showed that alcohol use resulted in a decrease in nervous mood, suggesting that anxiety/nervousness may drive alcohol use, and that alcohol use may subsequently reduce anxiety/nervousness. However, these results are not universal. Hussong and colleagues did not find evidence for a daily link between discrete aspects of negative emotion and drinking, though, they did find that weekend hostility (anger) predicted subsequent weekday drinking (Hussong, Galloway, & Feagans, 2005; Hussong, Hicks, Levy, & Curran, 2001). Importantly, many of the mood associations vary by context, and thus it is important to understand this context when identifying mood-drinking associations. For example, Mohr and colleagues (Mohr et al., 2010) have noted that various negative mood states are most strongly associated with drinking in non-social contexts (e.g., at home vs. away from home). This is again consistent with the notion that alcohol results in selective attention to the most salient aspects of our environment (Steele et al., 1996) which may be solitary and lonely while at home but exciting and pleasant when out with others.

Finally, some of the effects on mood may be attributable to biphasic effects of alcohol, which are dependent on the ascending and descending curve of blood alcohol (Addicott, Marsh-Richard, Mathias, & Dougherty, 2007; King, Houle, de Wit, Holdstock, & Schuster, 2002; Martin, Earleywine, Musty, Perrine, & Swift, 1993). Specifically, research has shown that shortly after drinking initiation, there is a positive and arousing effect of alcohol on mood. This effect dissipates, and even reverses, as blood alcohol transitions to the descending phase (King et al., 2002; Martin et al., 1993). In addition, across experimental studies, research indicates that the link between positive mood and alcohol use is mediated via positive/enhancing alcohol expectancies (Grant & Stewart, 2007; Stein, Goldman, & Del

Boca, 2000; Testa et al., 2006). Thus, there is an expectation that alcohol will increase positive mood. Further, individuals report expectations of biphasic effects of alcohol on mood, suggesting this is not simply a pharmacologic effect, but also a psychological one (Dunn & Earleywine, 2001).

Summary and Study Overview

The extant literature appears to suggest some commonalities. First, tension/stress does appear to increase the likelihood of alcohol consumption, at least in non-contrived environments. However, there is very little research examining “stress” as a predictor of alcohol use in daily process research. Based on the laboratory literature we hypothesized that daily stress would be positively associated with the likelihood of alcohol use. Further, if mood instability is a mark of overall tension/stress then, consistent with previous daily process research, mood instability should be positively associated with alcohol consumption. Next, given that previous research has shown that negative moods predict solitary alcohol use, but are not robust predictors of social alcohol use, we do not expect any aspects of negative mood to predict use likelihood at the daily level. However, consistent with previous daily process research, we do expect positive mood to predict the likelihood of alcohol consumption among a sample of college student drinkers.

With regard to alcohol’s effects, we hypothesized that alcohol would result in a significant decrease in both stress and mood instability – which would be consistent with the stress response dampening literature within the tension-reduction framework. In addition, we expected that all negative mood states would decrease following alcohol consumption. It is expected that this will occur either via alcohol expectancies (Goldman, Del Boca, & Darkes, 1999) or via a myopic effect (Steele et al., 1996) while drinking; however, the current study is not able to further test these potential explanations. Finally, we expect that positive mood will increase following alcohol consumption, an effect consistent with the limited previous research on post-drinking positive mood (see Conrod et al., 2001; Crooke et al., 2013).

A third, and novel goal of this study, is to compare and contrast emotional functioning across drinking and non-drinking days. This approach is often done when predicting drinking likelihood on a given day; however, only one previous study has examined emotion after typical drinking onset on drinking and non-drinking days (Treloar et al., 2015), but this study did not examine emotional instability. It is plausible that some mood-drinking associations are due to substantial differences in evening emotion across the two different types of days. This form of differential emotional functioning may increase the overall frequency of drinking, if drinking evenings are perceived as more favorable and or enjoyable.

Methods

Participants

Participants were a sample of college student drinkers (n = 102; 65.69% female) from a moderate sized Midwest university. Participants ranged in age from 18 to 29 (M = 20.91, SD = 2.88). The sample was 89% Caucasian, 3% Black/African American, 8% other or did not wish to respond. All participants were treated in accordance with American Psychological Association ethical guidelines for research (Sales & Folkman, 2000) and the University IRB approved all aspects of this study.

Procedure

The current study was divided into two phases. In phase I, (n = 977) participants were screened for participation. During this phase, participants completed assessments of current drinking habits (i.e., use and problems), mental health issues, and temperament. College students who endorsed any alcohol consumption over the last two weeks and did not meet diagnostic criteria for any psychiatric condition, were eligible to participate in phase II (n = 561); this allowed for a sample with a wide range of involvement in alcohol use. Of the eligible participants, n = 145 individuals were randomly selected and offered the opportunity to participate in phase II. Of these individuals, n = 115 enrolled in phase II (the ecological momentary assessment [EMA] phase). Of these individuals, 102 had sufficient data for analyses. During phase II, participants carried a personal data device (PDD; a 7" Samsung Galaxy Tablet provided by the study) for up to 15 days. During this time, participants responded to four different types of assessments: (1) random assessments occurring up to 8 times per day from 8:00AM to 02:00AM, which asked primarily about current mood and whether the person was currently drinking, (2) self-initiated drinking assessments that simply marked the time a person began drinking, (3) morning assessments that asked various questions about the previous night, including if the participant consumed alcohol, which was used to capture drinking days missed during the random and self-initiated drinking assessments. In addition, if participants missed a mood assessment (due to missed time or a device error), they had the option (4) of self-initiating a mood assessment that mirrored the *in situ* random assessment. Participants were able to set the device to 'Do Not Disturb' (DND) during times they could not respond to surveys (e.g., class, bedtime, etc.). Participants checked in at the lab after week 1. At this point they were offered the opportunity to continue the study or discontinue participation. Participants were compensated each week, at a rate of $0.25/random assessment and $1 per morning assessment.

Measures

Demographics—Participants reported age, biological sex, sexual orientation, and race. Age and biological sex were added as model covariates. Individuals were also asked if they had consumed alcohol over the last two weeks. This was used as screening criteria.

Mood—At mood assessments, participants were asked: How [INSERT MOOD] are you feeling right now? Items were adapted from subscales of the PANAS-X (Watson & Clark, 1999) and Larsen and Diener's (1987) mood circumplex. These items were used to assess 5 distinct mood states, with each mood state comprised of 3 different mood items: Anger (angry, frustrated, irritated; α = .85), Anxiety (anxious, nervous, worried: α = .83), Sadness (sad, blue, downhearted: α = .91), Stress (stressed, overwhelmed, tense: α = .83), and Positive Mood (happy, joyful, excited: α = .88). Each individual mood item was rated on a 5-point scale of 0 (*not at all*) to 4 (*extremely*). This approach to assessing mood has been effectively used in previous EMA research with college student drinkers to assess distinct mood domains (Dvorak, Pearson, et al., 2014; Dvorak et al., 2016; Dvorak & Simons, 2014; Simons et al., 2010).

Drinking days—Drinking days were assessed three different ways in an attempt to capture as many drinking episodes as possible. To identify drinking days, and subsequently start times for drinking on drinking days, we followed a stepped procedure. First, if individuals self-initiated a drinking assessment, this was marked as a drinking day, and the 'begin drinking' time point was noted at the time this assessment occurred. Next, if individuals did not self-initiate a drinking assessment, *in situ* random assessments were utilized to mark the 'begin drinking' time point if they reported they were "currently drinking" during a mood assessment. Finally, if individuals had neither of the above two assessments, but reported in the morning assessment that they drank the night before, the previous day was coded as a drinking day and the mean 'begin drinking' time point, identified through self-initiated or random assessments on identified drinking days, was used as the division point for pre- and post-drinking on these days.

Data preparation and analysis plan

Study days were separated into drinking days and non-drinking days. Within each day (both drinking and non-drinking) we divided the day into pre- and post-drinking (labeled as Pre and Post) based on the time they reported that they started drinking. This presents an obvious problem for non-drinking days. For non-drinking days, we utilized the mean time that each individual began drinking on drinking days as the division point. Thirteen individuals reported no drinking episodes during the *in situ* (random or self-initiated) assessments (i.e., they only reported drinking episodes in morning assessments); thus, providing no accurate mean drinking start time. These individuals were removed from the analyses.

The analysis examined both tonic mood and mood instability. Mood instability was computed as the mean squared successive difference (MSSD) for each mood state on either side of the 'begin drinking' division point within each day. This approach involves subtracting the previous mood rating from the current rating, squaring this difference, summing the squared differences, and dividing this sum by the number of total mood assessments included in the sum. For instances in which the previous mood was missing, the most recent non-missing previous observation for that day was subtracted from the current mood. Previous research has indicated that this provides an accurate assessment of mood instability (Jahng, Wood, & Trull, 2008). Further, this has been effectively used as a measure of mood instability in previous EMA studies with college student drinkers (Jahng et al., 2011; Jahng et al., 2008). All of the mood instability variables had significant skew (*skew* = 4.24–5.79). To correct this, we performed a square-root transformation on each variable. This resulted in much lower skew across these variables (*skew* = 1.57–2.92). On 55 days, there was insufficient data to calculate MSSD, thus tonic mood models have 1,192 person-days while mood instability models have 1,137 person-days.

The analysis utilized a 3-level multilevel model with assessments (level 1) nested in days (level 2) and days nested in individuals (level 3). The models were tested in Stata 15

(StataCorp, 2012) using the "mixed" command (StataCorp, 2013). All analyses utilized maximum likelihood estimation with robust standard errors. Random variance components for the intercepts were specified at both level 2 and level 3, allowing mood to vary randomly across days within individuals and across individuals. Intra-class Correlation Coefficients (ICCs) for intercept only models are listed in Tables 3 and 4. All ICCs indicated significant variance across levels warranting the use of momentary, day, and person level predictors and the parsing of variance across the three levels. The analyses examined 10 different models (5 pooled tonic mood models and 5 pooled mood instability models). The models specified mood as the outcome with pre/post drinking (level 1 variable), drinking day (level 2 variable), and the cross-level interaction of pre/post drinking × drinking day as the primary predictors. Biological sex (0 = male, 1 = female) and age (both grand-mean centered) were added as model covariates. Six dummy-coded day-of-week variables were added to control for serial correlation between mood, drinking, and day of week. The drinking day variable (day: 0 = non-drinking day; 1= drinking day) and the pre/post-drinking variable (time: 0 = pre-drinking, 1 = post-drinking) were dummy coded. All coefficients are unstandardized.

Results

Descriptive, compliance, and bivariate statistics

Descriptive statistics are listed in Table 1. Participants completed an average of 12.68 days of monitoring (*SD* = 2.88; range 7–15 days). Eleven individuals opted to terminate participation following week 1. There was a total of 1,293 person-days; however, Pre or Post mood assessments were missing on 101 person-days, resulting in a total of 1,192 person-days for analysis. Due to device error and/or participant issues (e.g., discontinuation), there were 9,257 mood assessments initiated. Of these, 1,368 occurred during a 'Do Not Disturb' period resulting in a total of 7,889 possible mood assessments. Participants completed 4,787 of the random mood assessments (random mood assessment only compliance: 60.68%). However, they also initiated mood assessments following device errors, or when they missed a random assessment, on 1,573 occasions. Combining these self-initiated mood assessments to the completed random assessments brings the total of completed mood assessments to 6,360 (adjusted compliance: 80.62%). Compliance for morning assessments was 84.30%.

Bivariate correlations of between-subjects data are in Table 2. Participants endorsed drinking an average of 3.87 days (*SD* = 2.26). Age was correlated with lower positive mood, lower positive mood instability, and more frequent drinking. Female sex was associated with more stress, more stress instability, and more anxiety instability. Positive mood was inversely correlated with stress, and positively correlated with positive mood instability. Mean stress showed positive correlations with all the negative moods and negative mood instability indicators. Anxiety was positively correlated with all negative moods, and all the instability measures – including positive mood instability. Mean sadness and mean anger were positively correlated with all of the other mean negative moods and mean negative mood instability indicators. All of the mean mood instability indicators were positively correlated with each other.

Multilevel analyses

Stress was regressed onto drinking day (day), Pre/Post (time), and the interaction of day × time. The results are depicted in Table 3. The interaction of day × time was statistically significant. The simple effects indicated Pre stress was slightly lower on drinking days than non-drinking days ($B = -0.08$, $p = .069$). In addition, on drinking days, stress was lower Post relative to Pre ($B = -0.26$, $p < .001$). Finally, stress was significantly lower at Post on drinking days ($B = 0.31$, $p < .001$), as compared to Post on non-drinking days. These associations (depicted in Figure 1, panel a) seem to suggest both tension-reduction expectancies, as stress was slightly lower prior to drinking on drinking days, as well as a tension-reduction effect after drinking.

Positive mood was regressed onto drinking day (day), Pre/Post (time), and the interaction of day × time. The results are depicted in Table 3. The interaction of day × time was statistically significant. The simple effects indicated Pre positive mood was higher on drinking days than non-drinking days ($B = 0.09$, $p = .006$). In addition, on drinking days positive mood was higher Post relative to Pre ($B = 0.14$, $p = .003$). Relative to non-drinking days, positive mood was significantly higher at Post on drinking days ($B = 0.23$, $p < .001$). These associations (depicted in Figure 1, panel b) suggest possible anticipatory/expectancy effects, as well as a mood enhancement effects on drinking days.

Anxiety was regressed onto drinking day (day), Pre/Post (time), and the interaction of day × time. The results are depicted in Table 3. The interaction of day × time was statistically significant. The results were similar to those observed for stress. The simple effects indicated Post anxiety was lower than Pre anxiety on drinking days ($B = -0.18$, $p = .001$). Additionally, Post anxiety was significantly lower on drinking days ($B = -0.16$, $p < .001$) relative to non-drinking days. Thus, there appears to be a general affect regulation effect on drinking days, resulting in lower anxiety from Pre to Post, as well as lower anxiety than is generally experienced in similar Post time periods on non-drinking days. These associations are depicted in Figure 1, panel c.

Anger was regressed onto drinking day (day), Pre/Post (time), and the interaction of day × time. The results are depicted in Table 3. The interaction of day × time was statistically significant. Anger showed an interesting pattern. The simple effects indicated Pre anger was lower than Post anger on *non*-drinking days ($B = 0.06$, $p = .005$), but higher (though not statistically significant) on drinking days ($B = -0.06$, $p = .079$). Anger was also significantly higher Post on non-drinking days vs. drinking days ($B = -0.07$, $p = .023$). This may suggest a general trend of lower anger levels when drinking, relative to when not drinking, as well as slight reductions in anger (though not statistically significant here) when drinking. These associations are depicted in Figure 1, panel d.

Sadness was regressed onto drinking day (day), Pre/Post (time), and the interaction of day × time. The results are depicted in Table 3, panel e. There was not a significant interaction of day × time ($B = 0.02$, $p = .723$), and thus this was dropped. There was a significant main effect of time, with sadness being higher at the Post time on both drinking and non-drinking days.

Stress instability was regressed onto drinking day (day), Pre/Post (time), and the interaction of day × time. The results are depicted in Table 4. The interaction of day × time was statistically significant. The simple effects indicated that Post stress became significantly more stable following drinking onset on drinking days ($B = -0.08$, $p = .010$). This association is depicted in Figure 2.

Positive mood instability, Anxiety instability, Anger instability, and Sadness instability were also examined, though there were no significant effects on any of these indices of emotional functioning, see Table 4.

Discussion

The current study examined indices of tonic mood and mood instability prior to and following typical alcohol use time on drinking and non-drinking days using ecological momentary assessment. The results were mixed, and only partially supported hypotheses. We expected that stress, positive mood, anxiety, and anger would be higher at the typical Pre time-point on drinking days, indicating that these moods would predict an increased likelihood of drinking on a given day. This was only observed for positive mood. We also expected that mood instability would be higher at the typical pre-drinking time on drinking days; however, this was not the case with any of the mood instability measures. Thus, none of these associations supported a tension-reduction model nor a negative affect regulation model – providing little evidence in support of the first basic tenet of negative reinforcement. Regarding the second basic tenet of reinforcement, we found fairly strong support for alcohol's effects on reducing negative mood states as well as increasing positive mood. Following alcohol consumption, we observed decreases in tonic stress (consistent with tension-reduction), tonic anxiety (consistent with negative affect regulation), and modest decreases in tonic anger that did not reach conventional levels of statistical significance (consistent with a negative affect regulation). In addition, we found an increase in positive mood following drinking (consistent with positive affect regulation). Further, we found that stress became more stable following alcohol consumption, which may also indicate a tension-reduction/stress response dampening effect. Sadness showed a consistent pattern of increasing from Pre to Post, and this was constant across days. Finally, across all tonic moods except sadness, there was a salutatory effect of drinking days on Post moods when comparing drinking to non-drinking days. These findings are discussed in greater detail below.

Positive mood was higher on drinking days, prior to typical drinking time, than at the same time on non-drinking days. This seems to indicate one of two possible scenarios: (1) either individuals are engaging in alcohol use because they are experiencing heightened positive mood, or, (2) they are experiencing heightened positive mood as an anticipatory effect of drinking. Unfortunately, the current design does not allow us to tease apart these two complementary, yet distinct, explanations. This remains a question for future research. In addition, we found that positive mood increased after drinking, relative to mood prior to drinking. It may be that individuals expect more positive mood after drinking initiation, which results in alcohol exerting a positive effect on emotion. Indeed, previous research has shown that positive expectancy effects can have a significant impact on mood following drinking (e.g., Wall, Thrussell, & Lalonde, 2003). However, the association observed here was more general, and not tied to individual differences in positive expectancies. An alternative explanation may be found in the alcohol myopia literature (Josephs & Steele, 1990). The majority of college student drinking occurs within social groups during celebratory activities (Baer, 2002; Howard, Patrick, & Maggs, 2015; Wechsler, Dowdall, Davenport, & Castillo, 1995); thus, perhaps the observed results are a function of the typical college student drinking experience. This, too, remains a question for future research. Despite these open questions, the current results, in conjunction with the vast literature on college student drinking, seem to indicate that positive mood is associated with alcohol consumption and that alcohol consumption leads to more positive mood. One drawback of the current study was the lack of differential activation levels for positive mood. Future research should examine both high and low arousal forms of positive mood in the context of drinking.

The post-drinking moods for stress, anxiety, and anger all showed a consistent decrease relative to pre-drinking mood (though, for anger this did not reach conventional levels of statistical significance for anger). However, there were no observed changes in sadness following drinking. This seems to indicate that alcohol may be particularly effective at reducing high arousal negative mood states. This is consistent with basic tension-reduction models (Greeley & Oei, 1999), and may bridge some of the gap between tension-reduction and affect regulation. It appears that individuals may have a reduction specifically in high arousal moods once alcohol consumption is initiated. The fact that this does not occur for sadness, however, casts some doubt on basic affect regulation in typical college student drinking. Future research should attempt to replicate these findings across college and non-college samples, as well as among more problematic drinkers.

In addition to mean levels of stress, there was a significant reduction in stress instability following alcohol consumption initiation. This is particularly interesting, as it provides an index which is less attributable to subjective experiences and/or cognitive explanations (e.g., alcohol myopia, alcohol expectancies). This dynamic aspect of mood taps into the mood “roller-coaster” phenomena and seems to suggest that alcohol use results in a stabilization of mood functioning, at least for stress. Thus, if there are any “true” negative reinforcement effects (i.e., effects not tied to expectancies), instability seems to be a prime candidate. However, it is worth noting that stress instability did not differ prior to drinking across drinking and non-drinking days. This is inconsistent with research linking mood instability to the likelihood of drinking on a given day (Dvorak et al., 2016; Gottfredson & Hussong, 2013). Perhaps this is due to differing levels of consumption across studies. Future research should continue to evaluate this novel aspect of emotional functioning.

Finally, an aspect of mood regulation which has received no attention in the literature to date, is the differences in post-drinking mood across drinking and non-drinking days. The most consistent effect observed across moods was that high arousal negative mood (i.e., stress, anxiety, and anger), stress instability, and positive mood were all improved on drinking days, following drinking, relative to non-drinking days at the same time period. Indeed, this basic pattern was even observed for sadness, though this was not statistically significant. This result may help account for some of the conflicting findings observed in the negative mood-alcohol literature. For example, finding that there is no difference between pre-drinking and post-drinking negative mood on drinking days, may fail to capture the fact that mood is simply better, in general, on drinking versus non-drinking days (as was observed here with anger). Indeed, at least one study has shown similar patterns to those observed here (Treloar et al., 2015). Treloar and colleagues found that positive affect was substantially higher at the Pre time-point on drinking days relative to non-drinking days. Further, at the Post time positive mood was higher on drinking days than non-drinking days. A similar pattern was observed for negative affect, whereby negative affect was lower at Post time-points on drinking days relative to non-drinking days. Examining differences in mood across the day for different types of drinking days (i.e., low level, heavy episodic) or for different drinking expectancies at the daily level may provide needed insight into the ways in which alcohol can act as a reinforcing agent on mood.

Limitations and Future Directions

The current results should be interpreted in light of the limitations of the study. First, this study was conducted with relatively well adjusted, mostly Caucasian, college student drinkers from the Midwest. Thus, the observed associations may not be applicable for individuals with more problematic use patterns, minorities, or individuals from other parts of the country. Second, it should be noted that we did not have the most fine-grained assessment of drinking initiation. We are confident that we were able to effectively separate mood assessments during times of drinking from those when individuals were not drinking. However, the length of time between drinking initiation and the first mood assessment while drinking could range from minutes to hours. This precluded us from examining mood slopes across the drinking day (for example see Treloar et al., 2015), and instead forced the more cautious use of average mood across assessments within time-points. Given that research has clearly shown biphasic mood effects as a function of blood alcohol concentration curves, future research is needed that assesses specific drinking initiation times in order to calculate mood slopes across drinking and paired non-drinking days. Finally, all the data here were obtained by self-report. However, the use of ecological momentary assessment and the computation of mood instability gives us greater confidence in the assessed mood variables.

The current results suggest a very interesting area of future research. Recently, daily process research has begun using daily mood-alcohol use slopes as predictors of alcohol pathology (Mohr et al., 2013; Russell et al., 2017). For example, Russell and colleagues examined daily stress-alcohol slopes in college students across three years. Using individual-level stressor-alcohol slopes as predictors, they found these slopes predicted problematic alcohol use in the fourth year. To date, these effects have focused on mood-to-use associations as predictors. However, early research in tension-reduction focused on the physiological effects of alcohol on stress as a predictor of problematic use (Sher & Levenson, 1982). We would suggest that the same approach be used in daily process research. For example, future researchers might apply daily process approaches within the context of more extensive longitudinal research to examine the alcohol-to-mood slopes across time. This would allow for the reinforcing effects of alcohol on mood to be used as predictors of future alcohol pathology.

Summary and Conclusions

The current study examined indices of mood and mood instability across drinking and non-drinking days. The results suggest potential anticipatory effects on mood prior to drinking. In addition, there appear to be tension-reduction-like effects following consumption for high arousal negative moods and enhancement-like effects for positive mood. It is unclear if this is due to expectancy effects or true reinforcing effects on mood. The reductions in mood instability following drinking seem to suggest at least some of the observed effects are not due to expectancy. Finally, stress, anxiety, anger, positive mood, and stress instability were subjectively better on drinking nights following drinking, when compared to the same time on non-drinking nights. Future research should consider comparing alcohol's effect on mood to matched times when alcohol is not consumed.

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Public Significance

This study suggests that alcohol use may be reinforcing by increasing positive mood, decreasing select negative moods, and stabilizing daily stress. In addition, factors that differentiate post-drinking/evening mood, on drinking and non-drinking days, may reinforce the feeling that mood is better when drinking than when not.

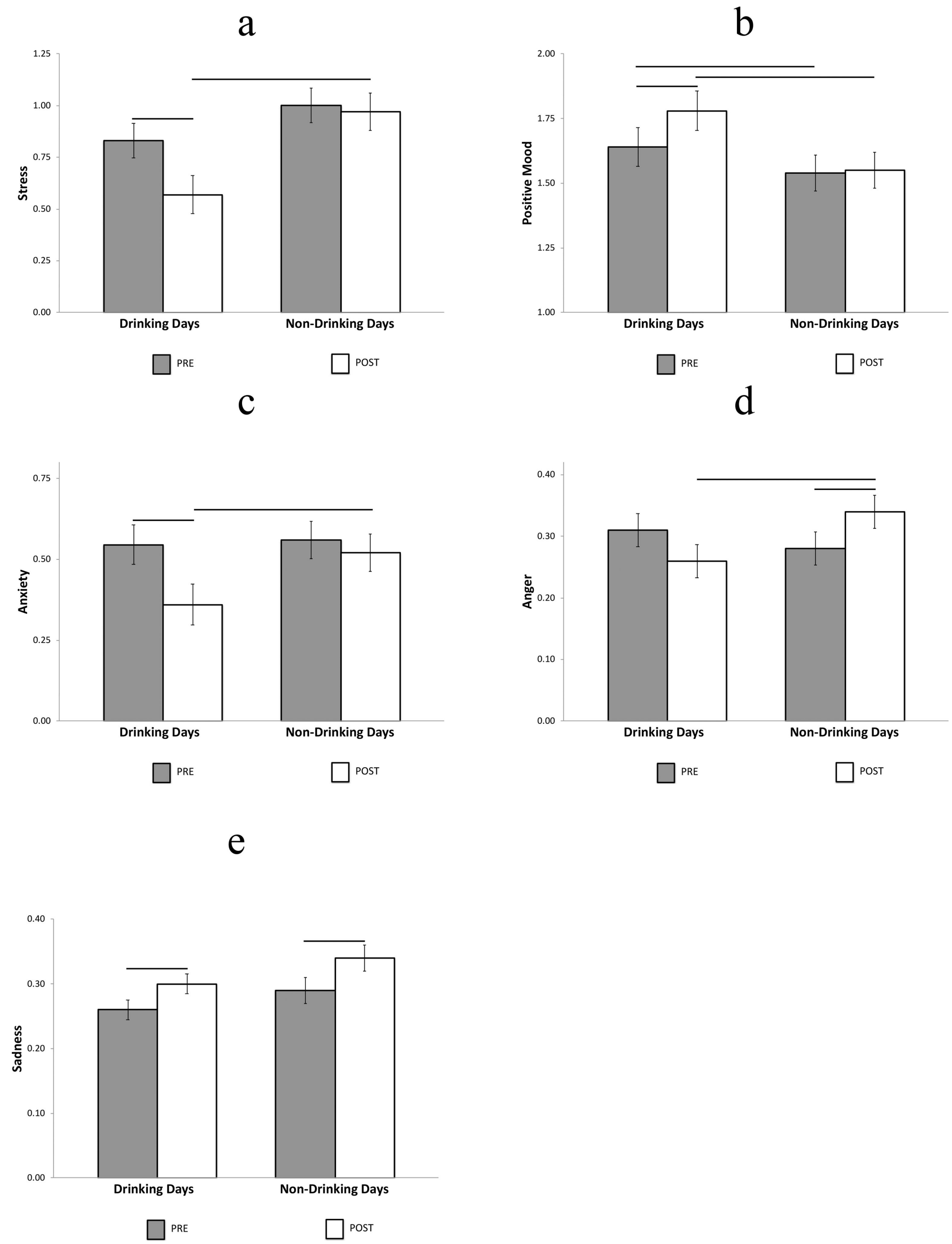

Figure 1.

Differences in pre and post moods on drinking and non-drinking days

Note. Y-axis scales differ across panels. Significant differences ($p \leq .05$) in mood intercepts across time periods indicated by connecting bars. Error bars are standard errors.

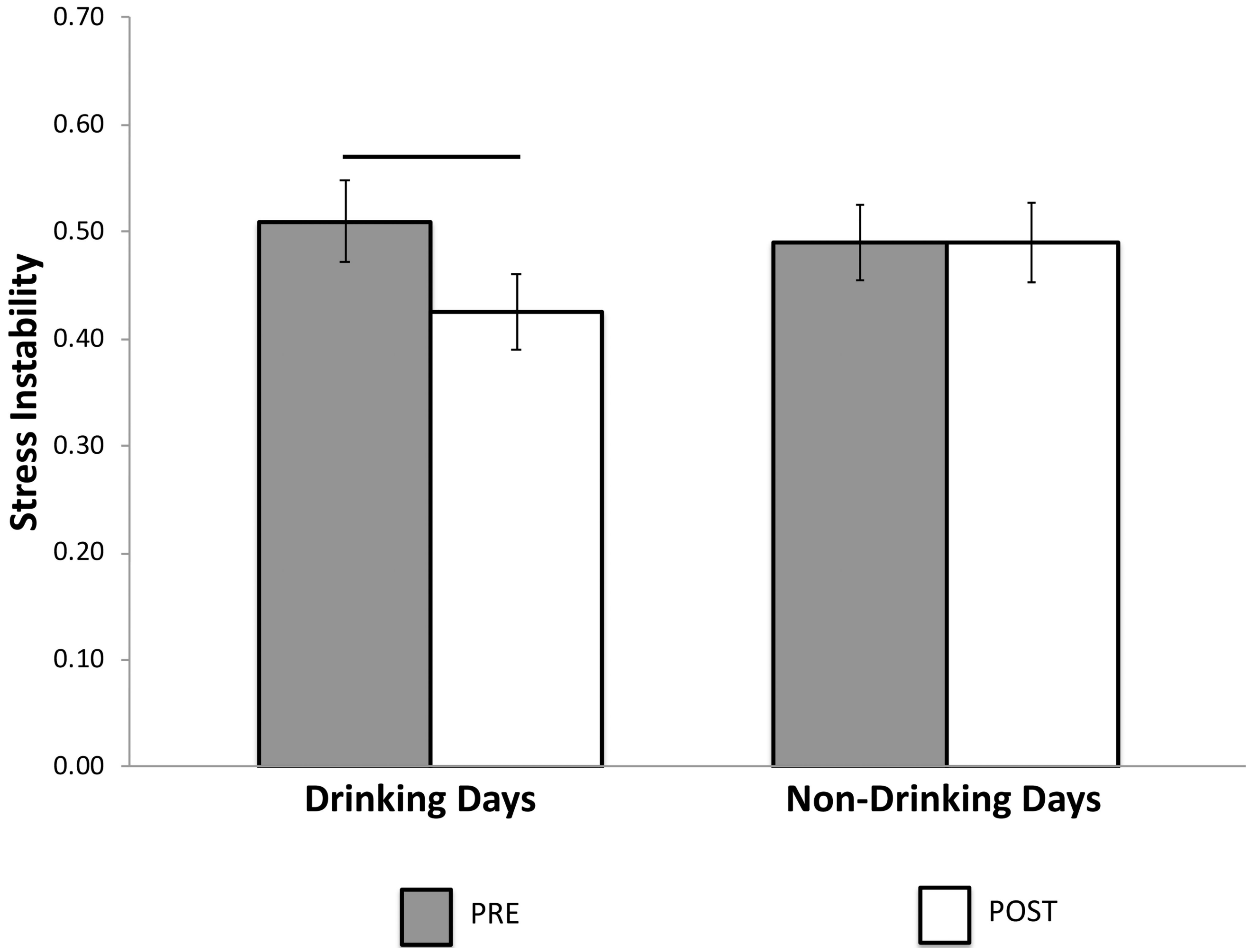

Figure 2.
Differences in pre and post stress instability on drinking and non-drinking days
Note. Significant differences ($p \leq .05$) in stress instability intercepts across time periods indicated by connecting bars. Error bars are standard errors.

Table 1

Descriptive statistics

Variables	Mean	SD	Skew	Range
Age	20.91	2.88	1.09	18–29
Biological sex	0.34	0.48	0.66	0–1
Stress	0.95	1.06	1.06	0–4
Positive mood	1.49	0.98	0.43	0–4
Anxiety	0.62	0.79	1.50	0–4
Anger	0.36	0.67	2.49	0–4
Sadness	0.32	0.67	2.83	0–4
Stress instability	0.59	0.76	1.82	0–4
Positive mood instability	0.64	0.66	1.57	0–4
Anxiety instability	0.46	0.59	1.84	0–4
Anger instability	0.40	0.64	2.31	0–4
Sadness instability	0.31	0.59	2.92	0–4
Completed days	12.68	2.88	−1.05	7–15
Drinking days	3.87	2.26	1.21	1–12

Note. Age, biological sex, completed days, and drinking days are between-subjects. Mood variables are within-subjects.

Table 2

Bivariate correlations of between-subjects (n = 102) data

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	---											
2. Biological sex	.12	---										
3. Stress	.18	.24*	---									
4. Positive Mood	−.24*	−.00	−.22*	---								
5. Anxiety	.03	.19	.72*	.05	---							
6. Anger	.02	.11	.56*	−.14	.63*	---						
7. Sadness	−.05	.09	.44*	−.04	.65*	.60*	---					
8. Stress instability	.01	.25*	.56*	−.01	.56*	.53*	.56*	---				
9. Positive mood instability	−.29*	−.01	.06	.25*	.20*	.25*	.17	.40*	---			
10. Anxiety instability	−.02	.20*	.56*	.02	.77*	.60*	.56*	.77*	.43*	---		
11. Anger instability	−.03	.10	.52*	−.13	.54*	.85*	.51*	.65*	.44*	.67*	---	
12. Sadness instability	−.09	.05	.43*	.00	.65*	.60*	.85*	.70*	.25*	.68*	.64*	---
13. Drinking Days	.22*	.05	.16	−.12	−.02	.16	−.04	.15	−.05	.09	.19	−.03

Note. Biological sex coded 0 = male, 1 = female.

* $p \leq .05$

Table 3

Multilevel models of tonic moods as a function of Pre/Post time on drinking and non-drinking days

	Tonic Mood Models				
Model Predictors	**Stress *B* (*SE*)**	**Positive Mood *B* (*SE*)**	**Anxiety *B* (*SE*)**	**Anger *B* (*SE*)**	**Sadness *B* (*SE*)**
Intercept	0.865* (0.083)	1.554* (0.080)	0.544* (0.055)	0.283* (0.036)	0.293* (0.039)
Drinking Day	−0.078 (0.049)	0.086* (0.032)	0.001 (0.034)	0.013 (0.032)	0.037 (0.023)
Pre/Post	0.027 (0.035)	−0.000 (0.033)	0.027 (0.026)	0.057* (0.019)	0.042* (0.017)
Drinking Day × Pre/Post	−0.235* (0.087)	0.144* (0.053)	−0.157* (0.059)	−0.104* (0.053)	n/a
Biological sex	0.316* (0.135)	0.025 (0.126)	0.200* (0.102)	0.069 (0.030)	0.077 (0.074)
Age	0.037 (0.022)	−0.054 (0.022)	0.001 (0.015)	0.001 (0.011)	−0.008 (0.008)
Monday	0.200* (0.055)	−0.134* (0.053)	0.101* (0.041)	0.067* (0.033)	−0.008 (0.055)
Tuesday	0.248* (0.071)	−0.091 (0.059)	0.222* (0.045)	0.061 (0.039)	0.012 (0.071)
Wednesday	0.255* (0.068)	−0.189* (0.059)	0.201* (0.053)	0.095* (0.043)	−0.004 (0.068)
Thursday	0.164* (0.058)	−0.065 (0.061)	0.160* (0.040)	0.105* (0.040)	0.009 (0.058)
Friday	−0.005 (0.060)	0.007 (0.057)	0.084* (0.042)	0.065 (0.042)	0.013 (0.060)
Saturday	−0.173* (0.050)	0.038 (0.054)	−0.037 (0.034)	0.029 (0.030)	−0.016 (0.050)
Intercept Only ICCs					
Day level	0.544* (0.025)	0.492* (0.027)	0.502* (0.026)	0.298* (0.024)	0.439* (0.023)
Person level	0.337* (0.035)	0.344* (0.034)	0.329* (0.034)	0.186* (0.022)	0.233* (0.029)

Note. Gender (grand-mean centered) coded 0 = men, 1 = women. Pre/Post coded 0= pre-typical drinking, 1 = post-typical drinking; Drinking Day coded 0 = non-drinking day, 1 = drinking day. This coding provides the intercept on non-drinking days at the Pre time point. To calculate non-drinking day Post intercepts, add the Pre/Post slope to the intercept. To calculate drinking day Pre intercept, add Drinking Day slope to intercept. To calculate drinking day Post intercept, add the slope for the interaction and the slope for Drinking Day to the intercept. n = 102 subjects, n = 1,192 person-days.

* $p \leq .05$

Table 4

Multilevel models of mood instability as a function of Pre/Post time on drinking and non-drinking days

	Mood Instability Models				
Model Predictors	**Stress** ***B*** **(*SE*)**	**Positive Mood** ***B*** **(*SE*)**	**Anxiety** ***B*** **(*SE*)**	**Anger** ***B*** **(*SE*)**	**Sadness** ***B*** **(*SE*)**
Intercept	0.483* (0.040)	0.595* (0.038)	0.393* (0.032)	0.328* (0.037)	0.259* (0.036)
Drinking Day	0.026 (0.030)	0.027 (0.023)	0.019 (0.023)	−0.005 (0.025)	−0.034 (0.023)
Pre/Post Drinking	0.001 (0.026)	0.043 (0.017)	−0.017 (0.017)	0.004 (0.021)	0.033 (0.019)
Day × Pre/Post	−0.084* (0.038)	n/a	n/a	n/a	n/a
Biological sex	0.165* (0.069)	0.007 (0.052)	0.092 (0.051)	0.048 (0.056)	0.037 (0.058)
Age	−0.004 (0.009)	−0.028 (0.007)	−0.003 (0.008)	−0.006 (0.008)	−0.009 (0.006)
Monday	0.135* (0.046)	0.044 (0.045)	0.073* (0.032)	0.077* (0.033)	0.031 (0.036)
Tuesday	0.086* (0.039)	−0.013 (0.041)	0.059 (0.033)	0.008 (0.037)	0.048 (0.031)
Wednesday	0.138* (0.041)	0.012 (0.034)	0.063* (0.031)	0.074* (0.035)	0.004 (0.036)
Thursday	0.147* (0.044)	0.055 (0.044)	0.122* (0.035)	0.104* (0.040)	0.048 (0.034)
Friday	0.061 (0.038)	0.077* (0.038)	0.045 (0.028)	0.074 (0.042)	0.039 (0.036)
Saturday	−0.034 (0.040)	0.044 (0.049)	−0.022 (0.032)	0.049 (0.036)	0.008 (0.031)
Intercept Only ICCs					
Day level	0.255* (0.022)	0.214* (0.020)	0.244* (0.021)	0.244* (0.021)	0.314* (0.022)
Person level	0.157* (0.022)	0.112* (0.019)	0.142* (0.021)	0.139* (0.021)	0.171* (0.024)

Note. Gender (grand-mean centered) coded 0 = men, 1 = women. Pre/Post coded 0= pre-typical drinking, 1 = post-typical drinking; Drinking Day coded 0 = non-drinking day, 1 = drinking day. This coding provides the intercept on non-drinking days at the Pre time point. To calculate non-drinking day Post intercepts, add the Pre/Post slope to the intercept. To calculate drinking day Pre intercept, add Drinking Day slope to intercept. To calculate drinking day Post intercept, add the slope for the interaction and the slope for Drinking Day to the intercept. $n = 102$ subjects, $n = 1{,}137$ person-days.

* $p \leq .05$