Published in final edited form as:

Drug Alcohol Depend. 2017 April 01; 173: 31–38. doi:10.1016/j.drugalcdep.2016.12.012.

Impact of alcohol use motives and internalizing symptoms on mood changes in response to drinking: An ecological momentary assessment investigation

Stephanie M. Gorka¹, Donald Hedeker², Thomas M. Piasecki³, and Robin Mermelstein^{4,5}

¹University of Illinois at Chicago, Department of Psychiatry, 1747 W. Roosevelt Road, Chicago, IL 60608

²University of Chicago, Department of Public Health Sciences, 5841 S. Maryland Avenue, Chicago, IL 60637

³University of Missouri, Department of Psychological Sciences, 210 McAlester Hall, Columbia, MO 65211

⁴University of Illinois at Chicago, Institute for Health Research and Policy, 1747 W. Roosevelt Road, Chicago, IL 60608

⁵University of Illinois at Chicago, Department of Psychology, 1007 W. Harrison Street, Chicago, IL 60607

Abstract

Background—Theory implies that individuals who use alcohol to cope with negative emotions experience the acute mood-altering effects they desire. However, no study to date has directly tested whether alcohol coping motives map onto alcohol-induced changes in mood in real-time or how co-occurring internalizing symptoms (i.e., depression and anxiety) impact the relation between coping motives and alcohol-induced changes in mood.

Method—The current study tested the unique and interactive effects of alcohol coping motives and internalizing symptoms on mood changes during drinking using ecological momentary assessment (EMA) in a sample of young adults ($n=257$). Participants completed a battery of questionnaires and a 7-day EMA assessment protocol.

Correspondence concerning this article should be addressed to Stephanie M. Gorka, University of Illinois at Chicago, 1747 Roosevelt Road, Chicago, IL, 60608. Phone: (312)-413-3221; sgorka2@uic.edu.

Contributors

Robin Mermelstein was the principal investigator of the study. Donald Hedeker conducted the statistical analyses and assisted with data interpretation. Thomas Piasecki made important contributions to the study rationale and the editing of the manuscript. Stephanie Gorka provided the initial study rationale, assisted with analyses, and wrote the first draft of the manuscript. All authors contributed and have approved the final manuscript.

Conflict of Interest

All authors declare that they have no conflicts of interest.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Results—In general, alcohol use was associated with greater positive mood and reduced negative mood while drinking. However, individuals who reported that they use alcohol to cope with anxiety, but not depression, experienced less mood benefits from alcohol relative to those without mood coping motives. In contrast, individuals with high internalizing symptoms experienced greater mood benefits while drinking relative to those with low levels of internalizing symptoms; and at high levels of anxiety, alcohol consumption was reinforcing for everyone regardless of coping motives. Only at low levels of anxiety symptoms, did coping with anxiety motives attenuate alcohol's acute reinforcing effects.

Conclusions—These results together confirm that alcohol has a robust impact on real-time mood in young adults and sheds light on the processes that may contribute to repeated alcohol use within individuals who do, and do not, use alcohol as a means of coping.

Keywords

alcohol coping motives; ecological momentary assessment; anxiety; depression

1. Introduction

Excessive alcohol use poses an enormous public health burden (Perkins, 2002; Stahre et al., 2014) and there is a critical need to understand who is at-risk, how, and why, in order to develop more effective prevention and intervention efforts. One influential theory on *why* individuals use alcohol is Cox and Klinger's (1988) motivational model of alcohol use, which posits that individuals consume alcohol to obtain positive or negative reinforcement, and the source of this reinforcement can be either internal or external. Importantly, dispositional motives for drinking are considered the "final common pathway" to excessive alcohol use through which other distal risk factors operate (Cox and Klinger, 1988; Cooper, 1994). In other words, drinking motives reflect a culmination of traits and factors (e.g., personality, expectancies) that underlie individuals' decisions about if and when to drink alcohol.

Based on this theory, Cooper (1994) developed the Drinking Motives Questionnaire-Revised (DMQ-R) to assess motives for alcohol use across different dimensions. The scale traditionally includes four subscales - enhancement, coping, social, and conformity motives – that predict unique aspects of drinking behavior (see Kuntsche et al., 2005 for a review). Of these, the enhancement and coping motives subscales are the most consistently linked to excessive and heavy alcohol use (Karwacki and Bradley, 1996; Kuntsche and Cooper, 2010). However, when taking into account drinking frequencies, coping motives appears to be the most robust predictor of alcohol-related problems (Cooper et al., 1995; Kuntsche et al., 2005) and alcohol dependence symptoms in adulthood (Carpenter and Hasin, 1998, 1999). Therefore, drinking to alleviate or avoid negative affective states appears to reflect a specific pathway to problematic alcohol use.

It is important to highlight that a major assumption of the motivational model of alcohol use is that drinking is a strategic behavior, such that individuals choose to drink because they desire specific alcohol-induced affective changes *and* these desired affective changes are achieved, which is reinforcing and increases the likelihood of using alcohol in the future

(Cox and Klinger, 1988; Baker et al., 2004). Remarkably, however, very few studies have directly tested this assumption, and, to date, the majority of research focused on drinking motives has been in relation to affective antecedents, alcohol expectancies, and/or alcohol-related outcomes (Kuntsche et al., 2005). This is noteworthy given that laboratory studies indicate substantial individual variability in alcohol's effects on mood and inconsistent evidence that alcohol is acutely 'stress-dampening' (see Curtin and Lang, 2007 for a review). Considered together, it is still relatively unclear whether self-reported motives map onto alcohol-induced changes in mood and if individuals who use alcohol to cope with distress actually receive their desired outcome. In order to develop more effective, mechanistically-driven prevention and intervention strategies for alcohol use, a better understanding of alcohol's functional role within individuals with coping motives is necessary.

One useful method for assessing alcohol-induced changes in mood is Ecological Momentary Assessment (EMA; Stone and Shiffman, 1994), which allows participants to provide in-the-moment reports of their mood and behavior, thereby minimizing recall bias and enhancing ecological validity (Shiffman et al., 2008). Using EMA, Piasecki and his colleagues initially addressed the aforementioned gap in the literature by exploring how alcohol use motives (assessed via the DMQ-R) relate to explicit appraisals of recently consumed alcoholic drinks in a sample of heavy, frequent alcohol users (Piasecki et al., 2014). In this study, participants were asked to rate via electronic device the extent to which their drinks were "pleasurable", "relieved an unpleasant feeling or symptom", or "made me feel worse". As theory would suggest, coping motives were uniquely associated with reports that consumed drinks relieved an unpleasant feeling or symptom, whereas enhancement motives were uniquely related to appraisals of drinks as pleasurable.

In a follow-up study, using data from the same sample of heavy drinkers, Piasecki and colleagues also probed changes in affect across drinking and non-drinking days, and how these affective trajectories were impacted by alcohol expectancies (Treloar et al., 2015) – a construct that is related to motives but more generally reflects individuals' beliefs about what will happen if they (or others) drink alcohol (Leigh, 1989). Results from this second study indicated that across all subjects, prior to drinking, and at first drink, individuals reported an increase in positive affect and a decrease in negative affect. However, somewhat counter-intuitively, 'tension-reduction' alcohol expectancies were associated with an attenuated decrease in negative affect at first drink but an enhanced perception of the first drink as providing relief. This suggests that individuals who believe that alcohol reduces tension perceive alcohol as providing relief. However, their actual reports of alcohol-induced changes in mood diverge from this picture and on average this subgroup does not experience the same affective 'benefit' from alcohol as individuals low in tension-reduction expectancies.

Together, these EMA studies provide important preliminary evidence to suggest that individuals who use alcohol to cope with distress appraise alcohol as 'stress-dampening' in naturalistic, drinking environments. However, in both studies the sample was comprised of heavy, frequent alcohol users and it is unclear whether the present findings generalize to individuals at earlier stages of problematic alcohol use who are still vulnerable for 'disease'

progression. In addition, neither study directly examined the link between alcohol motives and alcohol-induced changes in mood, which is essential given that the findings from Treloar et al. (2015) highlight that explicit appraisal of consumed drinks is not synonymous with changes in mood pre- and post-drinking and it is possible that these two constructs align with motives differently.

Relatedly, no prior study to our knowledge has investigated whether coping motives for depression versus anxiety are differentially related to alcohol-induced changes in mood. The DMQ-R was revised to distinguish between these two forms of coping-motivated drinking (Blackwell and Conrod, 2003) and in support of this distinction, it has been demonstrated that drinking to cope with anxiety is directly related to drinking problems whereas drinking to cope with depression is only indirectly associated with drinking problems through frequency of alcohol consumption (Grant et al., 2007). The two subscales are also associated with different affective antecedents (Grant et al., 2009), and interestingly, individuals with alcohol use disorder (AUD) more often report they use alcohol to cope with anxiety than depression (Mezquita et al., 2011). Therefore, in order to better understand pathways to problematic alcohol use, it is useful to parse these two distinct motives.

An additional remaining question is if and how coping motives impact alcohol's acute effects in the context of the negative moods that underlie them (i.e., depressive and anxiety symptoms). Previous studies have shown that coping motives and depressive and anxiety symptoms are highly correlated (e.g., Blumenthal et al., 2010), but that motives are the more proximal determinant of alcohol consumption (Cooper et al., 1995; Kassel et al., 2000) and mediate the relation between internalizing symptoms and problematic alcohol use (Ham et al., 2009; O'Hare and Sherrer, 2011; Stewart et al., 2001). Prior daily diary work has also shown that negative experiences/mood facilitate the initiation of drinking (Mohr et al., 2001, 2005; Hussong et al., 2005; Todd et al., 2009). As such, there is clear evidence that depression and anxiety symptoms are closely tied to alcohol consumption and the motivation to drink; however, it is less clear whether the relation between coping motives and alcohol-induced mood changes differs between individuals who experience chronically high (or low) depressive and anxiety symptoms.

The aim of the current study was to address these gaps by examining the unique and interactive effects of coping motives and depression and anxiety symptoms on self-reported mood changes in response to alcohol consumption using EMA methodology. The sample was comprised of a cohort of young adults with a full range of drinking behaviors and patterns. Consistent with the motivational model of alcohol use, we hypothesized that individuals who reported high coping motives (vs. low) would experience greater decreases in negative affect and/or increases in positive affect during alcohol consumption. We speculated that this relation would be more robust for individuals with anxiety-related coping relative to depression-related coping given the small literature suggesting anxiety-related coping confers more risk for problematic drinking. Lastly, we hypothesized that the reinforcing effects of alcohol on mood would be greatest for individuals who not only use alcohol to cope, but also have high levels of depressive and anxiety symptoms.

2. Methods

2.1 Participants and Procedure

Participants were drawn from a large, multi-wave study focused on contextual factors that influence adolescent and young adult smoking (i.e., the Social and Emotional Contexts of Adolescent Smoking Patterns [SECASPS]). Recruitment and enrollment procedures for SECASPS have been described in detail elsewhere (e.g., Dierker and Mermelstein, 2010). In brief, the study was designed to establish a cohort of adolescents at-risk for smoking escalation. All 9th and 10th graders, across sixteen Chicagoland high schools, completed an initial screener and were deemed eligible based on their lifetime smoking behavior. A total of 1,263 individuals were eligible and completed the baseline assessment. Participation in the larger study involved completion of self-report questionnaires, in-person interviews, and for a subset of participants, family interviews, psychophysiological laboratory assessments, and EMA data collection periods. During the time of enrollment, the sample was 15.6 ± 0.6 years. Parental consent and student assent were obtained and all procedures were approved by the University of Illinois at Chicago Institutional Review Board.

After baseline, 9 follow-up assessments have occurred, over the course of 10-years. At 5-years and 6-years post-baseline, participants completed additional EMA data collection waves, when participants were approximately 21 and 22 years old, respectively. In order to test the present hypotheses, the current study included a total of 257 participants who reported at least one drinking episode during the Year 5 ($n=65$) or Year 6 ($n=192$) EMA data collection period, when participants were on average 22.1 ± 1.8 years old. If a participant reported a drinking episode at both waves, only their Year 6 data was included.

2.2 EMA Data Collection Procedures

EMA data collection occurred via hand-held palmtop computers (i.e., electronic diaries). Each data collection wave (i.e., Year 5 and 6) included 7 consecutive days of monitoring. Five times per day the electronic diaries prompted participants to make an entry ('random prompts'), which were date- and time-stamped. In addition to random prompts, participants were instructed to initiate a diary recording whenever they: (1) smoked a cigarette, (2) had the opportunity to smoke but chose not to do so, and (3) wanted to smoke but could not at the time. The random and "smoke" interviews were identical; however, smoking-related items were added to the standard interview during self-initiated smoke data collection points.

2.3 EMA Measures

2.3.1 Mood States—During each diary interview, participants were asked to describe how they felt "just before the signal" (random prompts) or "right now" (user-initiated entries) using 10 adjectives on a 1–10 Likert scale. Consistent with our prior published studies (e.g., Hedeker et al., 2009; Piasecki et al., 2016), and based on factor analysis, composite positive mood (average score for happy, relaxed, cheerful, confident, and accepted by others) and negative mood (average score for frustrated, angry, stressed, irritable and sad) scales were created for each participant, at each data collection point (mean positive affect 7.3 ± 1.9 ; mean negative affect 3.0 ± 2.1).

2.3.2 Alcohol Use—Participants were asked to indicate whether they had used alcohol within the past hour during each interview. If they indicated “yes” they were instructed to report the number of drinks they consumed on a 7-point Likert scale, ranging from 1 (*less than 1 drink*) to 7 (*6 or more drinks*).

2.4 Non-EMA Measures

2.4.1 Drinking Motives—One-week prior to the EMA data collection period, participants completed the Modified Drinking Motives Questionnaire-Revised (M-DMQ-R; Grant et al., 2007). The M-DMQ-R is based on the original Drinking Motives Questionnaire (Cooper, 1994) but includes two distinct coping subscales (i.e., coping-depression and coping-anxiety) rather than one broad coping subscale. Coping-depression captures motives to reduce depressed mood and forget worries and negative thoughts, whereas coping-anxiety captures motives to reduce anxiety, feel more relaxed and boost self-confidence. The self-report measure includes 28-items in which participants respond using a 5-point Likert scale ranging from 1 (*almost never/never*) to 5 (*almost always/always*). Total scores for five motives subscales are computed: social, enhancement, conformity, coping-depression, and coping-anxiety. Of note, given the aims of the study, only the coping-depression and coping-anxiety subscales were examined.

2.4.2 Anxiety Symptoms—Anxiety symptoms were assessed using a modified, 12-item version of the Mood and Anxiety Symptom Questionnaire (MASQ; Watson et al., 1995). Similar to the full, 90-item MASQ, the present modified version included items assessing anxious arousal, distress and anhedonia. For each item, participants rated the extent that they had experienced the given symptom within the past week from 1 (*not at all*) to 5 (*extremely*), with higher total scores reflecting greater anxiety-related symptoms.

2.4.3 Depressive Symptoms—The widely-used, 20-item, Center for Epidemiologic Studies Depression scale (CES-D; Radloff, 1977) was used to assess the severity of current depressive symptoms within the past week. Participants rated each item on a 0–3 scale, with higher total scores reflecting greater depressive symptom severity.

2.5 Data Analysis Plan

To test our hypotheses, we conducted a series of mixed-effects location scale models, which represent an extension of the basic multilevel regression analysis to additionally include a log-linear sub-model for the error (within-subject [WS]) variance, allowing for tests of covariates on mean and variance structures (Hedeker et al., 2008, 2012). For each model, the MIXREGLS program (Hedeker and Nordgren, 2013) was used to estimate effects of covariates on mean and WS variance levels of positive or negative mood. We specifically ran four models – two testing the unique and interactive effects of alcohol use, coping-anxiety, and current anxiety symptoms (for positive and negative affect separately) and two testing the unique and interactive effects of alcohol use, coping-depression and current depressive symptoms (for positive and negative affect separately). Subject-level covariates including age and sex were entered as covariates. Each model was also adjusted for data collection wave (Year 5 vs. 6), type of EMA prompt (smoke vs. random) and time of week (weekday vs. weekend). The impact of acute alcohol use was modeled using the reported number of

alcoholic drinks the participant consumed. The primary model predictors were the main effects, and 2- and 3-way interactions, of coping motives, internalizing symptoms (i.e., depression and anxiety) and acute levels of alcohol use.

Mean-level effects are reported as estimated coefficients. To aid in the interpretation of the coefficients, coping motives and internalizing symptoms were mean-centered and scaled so that a unit change represents a 10-point difference. For the effects on the WS variance, we calculated variance ratios (VRs) by exponentiating the estimated coefficients (akin to what is done in Poisson regression which, like the model for WS variance, also has a log link function). VRs represent the ratio of WS variance per unit change of the variable. All models allowed the between-subject (BS) variance to vary across data collection wave, type of EMA prompt, and number of alcoholic drinks though these effects are not reported. Finally, to account for the correlation and heterogeneity in the data, both random subject mean and WS variance effects were included and allowed to be correlated in the model.

3. Results

3.1 Descriptives

Sample demographic and clinical characteristics are presented in Table 1. Participants provided a mean of 40.5 ± 16.9 prompts, yielding a total of 10,371 diary reports. Approximately 28% of prompts occurred on a weekend, as compared to a weekday. During 11% of prompts, participants reported that they were consuming alcohol and on average, had 2.3 ± 1.6 drinks per occasion. With regard to the non-EMA data, over 90% of the sample indicated that they currently drank alcohol 2+ times per month and 3% of the sample drank alcohol every day. In addition to alcohol, participants were light, occasional smokers, with most smoking, on average, less than 5 cigarettes a day. A substantial proportion of participants also reported that they had used cannabis at least once within the past three months. As expected, scores on the CES-D and MASQ were highly correlated ($r=0.84$, $p<0.01$), as were scores on the DMQ coping with anxiety and depression scales ($r=0.73$, $p<0.01$). However, anxiety symptoms were only moderately correlated with anxiety coping motives ($r=0.36$, $p<0.05$). The same was true for depressive symptoms and depression coping motives ($r=0.56$, $p<0.05$).

3.2 Anxiety Coping Motives and Symptoms

Mean level and WS variance results are presented in Table 2 and Table 3, respectively. Findings are also summarized below.

3.2.1 Negative Mood—Greater number of drinks, and smoking, were associated with reduced negative mood. As expected, greater scores on the MASQ were associated with greater levels of negative mood. There was no main effect of coping-anxiety, but there was a trend-level ($p=0.06$) coping-anxiety by alcohol use interaction such that alcohol's effect on negative mood was *less robust* for individuals who reported high levels of coping-anxiety compared with low levels of coping-anxiety. Interestingly, there was a significant MASQ by alcohol interaction such that alcohol's effect on negative mood was *more robust* for individuals who had high MASQ scores relative to low MASQ scores.

As for WS variance, greater MASQ scores were associated with greater variability in negative mood. There were no other effects involving alcohol use, MASQ scores, or coping-anxiety.

3.2.2 Positive Mood—Greater number of drinks was associated with greater positive mood, as was smoking relative to not smoking. Individuals with higher MASQ scores indicated less positive mood. There were also significant coping-anxiety by alcohol, and MASQ by alcohol, interactions. At higher levels of coping-anxiety, alcohol's effect on positive mood was *less robust* compared with lower levels of coping-anxiety. In contrast, at higher levels of MASQ, alcohol's effect on positive mood was *more robust* compared with lower levels of MASQ. Results also indicated a 3-way interaction such that at high MASQ, there was no effect of coping-anxiety on alcohol's mood effects; rather, across all subjects, greater number of drinks was associated with greater positive mood. However, at low MASQ, alcohol's effect on positive mood was *less robust* at high coping-anxiety compared with low coping-anxiety (Fig. 1).

Greater MASQ scores were associated with greater variability in positive mood. There was also a significant coping-anxiety by alcohol interaction on WS variance such that at high coping-anxiety motives positive mood was more variable during drinking than at low coping-motives.

3.3 Depression Coping Motives and Symptoms

3.3.1 Negative Mood—There were main effects of both alcohol and tobacco use on negative mood. Greater CES-D scores were associated with greater levels of negative mood. Results also indicated a significant CES-D by alcohol interaction such that alcohol's effect on negative mood was *more robust* for individuals with high CES-D relative to low CES-D.

Greater CES-D scores were also associated with greater WS variability in negative mood. There was a trend-level ($p=0.06$) coping-depression by alcohol interaction such that individuals with greater coping-depression (vs. lower coping-depression) reported less variability in negative mood while drinking.

3.3.2 Positive Mood—Alcohol and tobacco use were associated with greater positive mood. Individuals with greater CES-D reported lower levels of positive mood, on average. There was a trend-level ($p=0.05$) 3-way alcohol by coping-depression by CES-D interaction such that at high CES-D, there was no effect of coping-depression on alcohol's mood enhancing effects but at low CES-D, greater coping-depression motives were associated with a *less robust* increase in positive mood while drinking.

Greater CES-D and alcohol were associated with greater positive mood variability. At high CES-D (vs. low CES-D), alcohol's effect on positive mood was more variable. Results also indicated a significant alcohol $\times$ coping-depression $\times$ CES-D interaction that mirrored the mean-level 3-way interaction. At low CES-D, but not high, greater coping-depression motives were associated with more negative mood variability while drinking.

4. Discussion

The present results indicated that young adults, in general, experience greater positive mood and reduced negative mood while drinking relative to not drinking, even when accounting for mood effects related to smoking. However, the extent to which alcohol was positively and negatively reinforcing differed depending on individuals' coping motives and internalizing symptoms. With regard to motives, individuals who reported that they used alcohol to cope with anxiety, on average, experienced less positive reinforcing benefits of acute alcohol consumption, and more varied positive mood while drinking, relative to those who did not use alcohol to cope with anxiety. Meanwhile, there was no independent relation between coping with depression motives and alcohol-induced changes in mood. As for internalizing symptoms, results indicated a somewhat opposite pattern such that those who reported higher levels of anxiety experienced greater decreases in negative affect and increases in positive affect during consumption relative to those who reported lower levels of anxiety. This enhanced mood benefit was also found in terms of depressive symptoms and changes in negative mood but for positive mood, individuals with high depressive symptoms reported more variable positive mood while drinking. Lastly, our results indicated that for anxiety, there was an interaction between coping motives, anxiety symptoms, and alcohol use. Among individuals with high anxiety, alcohol use was positively reinforcing regardless of coping motives. However, among individuals with low anxiety, greater coping with anxiety motives predicted reduced positive mood enhancement during consumption. Together, these results highlight that alcohol has a meaningful impact on mood and sheds light on the process that may contribute to repeated alcohol use within individuals who do, and do not, use alcohol as a means of coping.

In the present study, alcohol consumption was positively and negatively reinforcing in that it modulated positive and negative mood states. This fits with our hypotheses and several prominent theories of addiction (e.g., self-medication hypothesis [Khantzian, 1997]; tension-reduction hypothesis [Conger, 1956]), which postulate that alcohol brings perceived and real relief from aversive affective states, thereby reinforcing consumption and facilitating continued use. These findings also fit with extensive survey data indicating that individuals use alcohol to regulate their mood (Bibb and Chambless, 1986; Robinson et al., 2009). As noted above, however, not all laboratory-based, acute alcohol challenge studies have found alcohol to regulate mood (Curtin and Lang, 2007), suggesting that alcohol may only be mood enhancing for some groups of individuals. The current findings underscore that one such group of individuals, who particularly derive mood benefits from alcohol, are those with high levels of anxiety, and to some extent depressive, symptomatology. For individuals with high levels of baseline anxiety, alcohol is a robust mood modulator, which is likely reinforcing and could lead to excessive and continued use (Koob, 2003, 2013; Robinson et al., 2009). At the same time, not all anxious individuals rely on alcohol as a means of affect regulation, which coincides with data indicating that coping motives are a more proximal determinant of alcohol use than internalizing symptoms (Cooper et al., 1995; Kassel et al., 2000). Nevertheless, as has been theorized by many (Baker et al., 2004; Koob, 2003; Sher and Levenson, 1982), alcohol's acute mood altering properties are a key motive for repeated

use and those with high levels of baseline negative affect appear to be more vulnerable to this reinforcement cycle than those with low levels of negative affect.

Interestingly, although internalizing symptoms and coping motives are related constructs, their independent effects on mood during alcohol consumption differed. In the current study, individuals who reported that they use alcohol to cope with anxiety (specifically) did not experience the same increase in positive mood, or decrease in negative mood (trend-level), during drinking as those who reported that they do not use alcohol to cope with anxiety. In addition, individuals with high coping-anxiety motives experienced more variability in their positive mood while drinking, implying that alcohol has somewhat inconsistent mood enhancing effects in this group of individuals. These somewhat counterintuitive findings are remarkably consistent with the results of Trelor et al. (2015), which similarly reported that individuals with high tension-reduction alcohol expectancies had an attenuated decrease in negative affect at first drink relative to individuals with low tension-reduction expectancies. Thus, in two separate samples of young adults with varying degrees of drinking behaviors, relying on, and expecting, alcohol to reduce anxiety and tension is actually associated with a relatively blunted and variable mood effect. There are several likely explanations for this phenomenon including the possibility that individuals with high coping-anxiety motives reflect a specific subgroup of individuals who have broader affect regulation difficulties, and perhaps poorer coping skills, which leads to chronically dysregulated mood states. Notably, the fact that this subgroup *relies* on alcohol to modulate their anxiety, yet does not receive the same consistent benefit as others, could facilitate excessive drinking given that these individuals may ‘chase’ or pursue their desired level of mood benefit by consuming more beverages in a session and across sessions. It is possible that greater psychoeducation surrounding the potential mismatch between alcohol motives and real-world outcomes would aid in efforts to reduce or modulate drinking behaviors in this subgroup.

It is important to highlight that the above relation between coping-anxiety motives and mood states was only observed in the context of low levels of baseline anxiety symptoms. At high baseline anxiety, all individuals received reinforcing benefits of alcohol consumption, regardless of their coping motives. This implies that anxiety symptoms and coping-anxiety motives may reflect two pathways to excessive alcohol use. The first being a pathway marked by robust affective reinforcement and the second being a desire to achieve affective relief, but obtaining a somewhat attenuated and varied response possibly priming the individual for continued drinking. The possibility of two liabilities is underscored by the fact that anxiety symptoms and coping with anxiety motives were only moderately correlated and thus, not wholly redundant constructs.

The above three-way interaction was more robust for coping-anxiety motives, and anxiety symptoms, than depression. This is noteworthy given that coping with anxiety motives have a more robust association with problematic drinking (Grant et al., 2007; Mezquita et al., 2011), and laboratory studies have demonstrated that alcohol is particularly effective at dampening anticipatory anxiety relative to other forms of stress (Bradford et al., 2013; Hefner et al., 2013; Moberg and Curtin, 2009). This together suggests that there is a unique association between alcohol use and anxiety, which likely has both acute and long-term implications. It is plausible that within the ‘internalizing pathway’ to alcohol use, individual

differences in state and trait anxiety, and anxiety-related coping motives, may connote the most risk for continued use and onset of alcohol problems; though future studies are needed to directly test this hypothesis.

The current study had numerous strengths including a diverse sample and repeated data assessment points captured in real-time. There are also several limitations. First, the current sample included many young adults who were occasional cigarette smokers and although smoking events were statistically controlled for, it is unclear the extent to which smoking may have impacted mood states while drinking and/or during sobriety. Relatedly, many participants were also recreational cannabis users which may have affected the pattern of results. It is therefore necessary that future studies test whether the present findings generalize to other, non-smoking samples. Second, all study variables were collected via self-report and the effect of potential reporting biases are unknown. Lastly, the current study focused on only a few individual difference factors but it is likely that there are many other processes and traits that contribute to drinking behaviors. Therefore, future studies are needed to continue to elucidate the mechanisms that underlie risk for problematic alcohol use in young adults.

In sum, findings from the current study indicate that acute alcohol consumption has a robust impact on mood but that the magnitude of alcohol's effects differs depending on individual differences in internalizing symptoms and coping-related motives. Individuals with high baseline anxiety and depression were found to derive particular mood enhancing benefits from alcohol consumption; however, individuals who reported that they use alcohol to cope with their anxiety actually had an attenuated mood enhancing benefit. Together, these findings indicate that there may be separate mood-related mechanisms that facilitate drinking behaviors in individuals who use alcohol to cope and those who have high levels of negative affective symptoms. It may therefore be useful to consider separate, targeted prevention and intervention efforts for individuals depending on their coping motives and level of depressive and anxiety symptoms. Specifically, for individuals with high levels of anxiety and depression, efforts could focus on vulnerability to the reinforcing mood effects of alcohol whereas for individuals with high coping motives, efforts could focus on the mismatch between motives and real-world mood-related outcomes.

Acknowledgments

Role of Funding Source

This research was supported by the National Cancer Institute of the National Institutes of Health under award number 5P01CA098262. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References

- Baker TB, Piper ME, McCarthy DE, Majeskie MR, Fiore MC. Addiction motivation reformulated: An affective processing model of negative reinforcement. *Psychol Rev.* 2004; 111:3351.
- Bibb JL, Chambless DL. Alcohol use and abuse among diagnosed agoraphobics. *Behav Res Ther.* 1986; 24:49–58. [PubMed: 3947312]
- Blackwell, E., Conrod, PJ. A five-dimensional measure of drinking motives. Department of Psychology, University of British Columbia; 2003. Unpublished manuscript

- Blumenthal H, Leen-Feldner EW, Frala JL, Badour CL, Ham LS. Social anxiety and motives for alcohol use among adolescents. *Psychol Addict Behav.* 2010; 24:529–534. [PubMed: 20853939]
- Bradford DE, Shapiro BL, Curtin JJ. How bad could it be? Alcohol dampens stress responses to threat of uncertain intensity. *Psychol Sci.* 2013; 24:2541–2549. [PubMed: 24145332]
- Carpenter KM, Hasin D. A prospective evaluation of the relationship between reasons for drinking and DSM-IV alcohol-use disorders. *Addict Behav.* 1998; 23:41–46. [PubMed: 9468741]
- Carpenter KM, Hasin DS. Drinking to cope with negative affect and DSM-IV alcohol use disorders: A test of three alternative explanations. *J Stud Alcohol.* 1999; 60:694–704. [PubMed: 10487740]
- Conger JJ. Alcoholism: Theory, problem and challenge—II. Reinforcement theory and the dynamics of alcoholism. *Q J Stud Alc.* 1956; 17:296–305.
- Cooper ML. Motivations for alcohol use among adolescents: Development and validation of a four-factor model. *Psychol Assessment.* 1994; 6:117–128.
- Cooper ML, Frone MR, Russell M, Mudar P. Drinking to regulate positive and negative emotions: A motivational model of alcohol use. *J Pers Soc Psychol.* 1995; 69:990–1005. [PubMed: 7473043]
- Cooper ML, Krull JL, Agocha VB, Flanagan ME, Orcutt HK, Grabe S, Dermen KH, Jackson M. Motivational pathways to alcohol use and abuse among black and white adolescents. *J Abnorm Psychol.* 2008; 117:485–501. [PubMed: 18729604]
- Cox WM, Klinger E. A motivational model of alcohol use. *J Abnorm Psychol.* 1988; 97:168–180. [PubMed: 3290306]
- Curtin, JJ., Lang, AR. Alcohol and emotion: Insights and directives from affective Science. In: Rottenberg, J., Johnson, SL., editors. *Emotion and Psychopathology: Bridging Affective and Clinical Science.* Washington, DC: 2007.
- Dierker L, Mermelstein R. Early emerging nicotine-dependence symptoms: A signal of propensity for chronic smoking behavior in adolescents. *J Pediatr.* 2010; 156:818–822. [PubMed: 20097354]
- Grant VV, Stewart SH, O'Connor RM, Blackwell E, Conrod PJ. Psychometric evaluation of the five-factor Modified Drinking Motives Questionnaire—Revised in undergraduates. *Addict Behav.* 2007; 32:2611–2632.
- Grant VV, Stewart SH, Mohr CD. Coping-anxiety and coping-depression motives predict different daily mood-drinking relationships. *Psychol Addict Behav.* 2009; 23:226–237. [PubMed: 19586139]
- Ham LS, Zamboanga BL, Bacon AK, Garcia TA. Drinking motives as mediators of social anxiety and hazardous drinking among college students. *Cogn Behav Ther.* 2009; 38:133–145. [PubMed: 19306146]
- Hedeker D, Mermelstein RJ, Berbaum ML, Campbell RT. Modeling mood variation associated with smoking: an application of a heterogeneous mixed-effects model for analysis of ecological momentary assessment (EMA) data. *Addiction.* 2009; 104:297–307. [PubMed: 19149827]
- Hedeker D, Mermelstein RJ, Demirtas H. An application of a mixed-effects location scale model for analysis of ecological momentary assessment (EMA) data. *Biometrics.* 2008; 64:627–634. [PubMed: 17970819]
- Hedeker D, Mermelstein RJ, Demirtas H. Modeling between-subject and withinsubject variances in ecological momentary assessment data using mixed-effects location scale models. *Stat Med.* 2012; 31:3328–3336. [PubMed: 22419604]
- Hedeker D, Nordgren R. MIXREGLS: A program for mixed-effects location scale analysis. *J Stat Softw.* 2013; 52:1–38. [PubMed: 23761062]
- Hefner KR, Moberg CA, Hachiya LY, Curtin JJ. Alcohol stress response dampening during imminent versus distal, uncertain threat. *J Abnorm Psychol.* 2013; 122:756–769. [PubMed: 24016014]
- Hussong AM, Galloway CA, Feagans LA. Coping motives as a moderator of daily mood-drinking covariation. *J Stud Alcohol.* 2005; 66:344–353. [PubMed: 16047523]
- Karwacki SB, Bradley JR. Coping, drinking motives, goal attainment expectancies and family models in relation to alcohol use among college students. *J Drug Educ.* 1996; 26:243–255. [PubMed: 8952209]
- Kassel JD, Jackson SI, Unrod M. Generalized expectancies for negative mood regulation and problem drinking among college students. *J Stud Alcohol.* 2000; 61:332–340. [PubMed: 10757145]

- Khantzian EJ. The self-medication hypothesis of substance use disorders: A reconsideration and recent applications. *Harv Rev Psychiatry*. 1997; 4:231–244. [PubMed: 9385000]
- Koob GF. Alcoholism: Allostasis and beyond. *Alcohol Clin Exp Res*. 2003; 27:232–243. [PubMed: 12605072]
- Kuntsche E, Cooper ML. Drinking to have fun and to get drunk: Motives as predictors of weekend drinking over and above usual drinking habits. *Drug Alcohol Depend*. 2010; 110:259–262. [PubMed: 20363080]
- Kuntsche E, Knibbe R, Gmel G, Engels R. Why do young people drink? A review of drinking motives. *Clin Psychol Rev*. 2005; 25:841–861. [PubMed: 16095785]
- Leigh BC. In search of the seven dwarves: Issues of measurement and meaning in alcohol expectancy research. *Psychol Bull*. 1989; 105:361–373. [PubMed: 2660178]
- Perkins HW. Surveying the damage: A review of research on consequences of alcohol misuse in college populations. *J Stud Alcohol Supplement*. 2002; (14):91–100.
- Piasecki TM, Cooper ML, Wood PK, Sher KJ, Shiffman S, Heath AC. Dispositional drinking motives: Associations with appraised alcohol effects and alcohol consumption in an ecological momentary assessment investigation. *Psychol Assessment*. 2014; 26:363–369.
- Piasecki TM, Hedeker D, Dierker LC, Mermelstein RJ. Progression of nicotine dependence, mood level, and mood variability in adolescent smokers. *Psychol Addict Behav*. 2016; 30:484–493. [PubMed: 26974687]
- Mezquita L, Stewart SH, Ibanez MI, Ruipérez MA, Villa H, Moya J, Ortet G. Drinking motives in clinical and general populations. *Eur Addict Res*. 2011; 17:250–261. [PubMed: 21691118]
- Moberg CA, Curtin JJ. Alcohol selectively reduces anxiety but not fear: Startle response during unpredictable vs. predictable threat. *J Abnorm Psychol*. 2009; 118:335–347. [PubMed: 19413408]
- Mohr CD, Armeli S, Tennen H, Carney MA, Affleck G, Hromi A. Daily interpersonal experiences, context, and alcohol consumption: Crying in your beer and toasting good times. *J Pers Soc Psychol*. 2001; 80:489–500. [PubMed: 11300581]
- O'Hare T, Sherrer M. Drinking motives as mediators between PTSD symptom severity and alcohol consumption in persons with severe mental illnesses. *Addict Behav*. 2011; 36:465–469. [PubMed: 21315519]
- Radloff LS. The CES-D scale a self-report depression scale for research in the general population. *Appl Psych Meas*. 1977; 1:385–401.
- Robinson J, Sareen J, Cox BJ, Bolton J. Self-medication of anxiety disorders with alcohol and drugs: Results from a nationally representative sample. *J Anxiety Disord*. 2009; 23:38–45. [PubMed: 18571370]
- Sher KJ, Levenson RW. Risk for alcoholism and individual differences in the stressresponse-dampening effect of alcohol. *J Abnorm Psychol*. 1982; 91:350–367. [PubMed: 7142573]
- Shiffman S, Stone AA, Hufford MR. Ecological momentary assessment. *Annu Rev Clin Psychol*. 2008; 4:1–32. [PubMed: 18509902]
- Stahre M, Roeber J, Kanny D, Brewer RD, Zhang X. Contribution of excessive alcohol consumption to deaths and years of potential life lost in the United States. *Prev Chronic Dis*. 2014; 11:130293.
- Stewart SH, Zvolensky MJ, Eifert GH. Negative-reinforcement drinking motives mediate the relation between anxiety sensitivity and increased drinking behavior. *Pers Individ Differ*. 2001; 31:157–171.
- Stone AA, Shiffman S. Ecological momentary assessment (EMA) in behavioral medicine. *Ann Behav Med*. 1994; 16:199–202.
- Todd M, Armeli S, Tennen H. Interpersonal problems and negative mood as predictors of within-day time to drinking. *Psychol Addict Behav*. 2009; 23:205–215. [PubMed: 19586137]
- Treloar H, Piasecki TM, McCarthy DM, Sher KJ, Heath AC. Ecological evidence that affect and perceptions of drink effects depend on alcohol expectancies. *Addiction*. 2015; 110:1432–1442. [PubMed: 25959045]
- Watson D, Weber K, Assenheimer JS, Clark LA, Strauss ME, McCormick RA. Testing a tripartite model: I. Evaluating the convergent and discriminant validity of anxiety and depression symptom scales. *J Abnorm Psychol*. 1995; 104:3–14. [PubMed: 7897050]

Highlights

- Theory assumes those who use alcohol to cope receive mood benefits while drinking.
- This was tested using ecological momentary assessment methods.
- Drinking generally resulted in increased positive and decreased negative affect.
- Individuals who use alcohol to cope with anxiety received less mood benefit.
- Individuals with high baseline negative affect received more mood benefit.

Figure 1.

Graph illustrating the three-way interaction between number of alcoholic drinks, coping with anxiety motives and anxiety symptoms on positive affect. The relation between number of drinks and positive affect is plotted by low (A), mean (B), and high anxiety symptoms (C) and within each graph, by low, mean, and high coping with anxiety motives. Anxiety = MASQ scores; Cope-Anx = DMQ coping with anxiety scores; Hi = high; Lo = low.

Table 1

Demographics and clinical characteristics.

Variable	Mean (SD) or % N = 257
Demographics	
Age (years)	22.1 (2.8)
Sex (% female)	53.3%
Race/Ethnicity	
White/Non-Hispanic	65.8%
Black/Non-Hispanic	11.7%
Hispanic	16.7%
Other	5.8%
Alcohol Use in Past 3 Months	
1× per month or less	8.2%
>1× per month but < 1× per week	21.8%
1+ times per week	66.9%
Every day	3.1%
Other Substance Use	
Number of days smoke in past month	18.7 (12.3)
Number of cigarettes smoked per day	5.9 (5.6)
Cannabis use in the past 3 months (yes/no)	70.0%
Daily cannabis user	26.5%
Internalizing Symptoms	
Depressive Symptoms (CES-D)	14.2 (10.7)
Anxiety Symptoms (MASQ)	25.8 (8.2)
Alcohol Use Motives	
Social	16.7 (4.4)
Coping with Anxiety	8.3 (3.5)
Coping with Depression	15.6 (7.9)
Enhancement	14.4 (5.0)
Conformity	6.7 (2.7)

Table 2

Mean results on self-reported negative and positive affect.

Parameters	Negative Affect			Positive Affect		
	Estimate	95% CI	p-value	Estimate	95% CI	p-value
Anxiety Model						
Age	0.19	(-0.01, 0.39)	0.07	-0.19 *	(-0.36, -0.01)	0.03
Wave	-0.31	(-0.73, 0.10)	0.14	0.39 *	(0.04, 0.75)	0.03
Smoke Beep	-0.06 *	(-0.12, -0.04)	0.04	0.10 *	(0.03, 0.16)	<0.01
Weekend Status	-0.01	(-0.04, 0.01)	0.28	<-0.01	(-0.02, 0.02)	0.87
Sex	-0.17	(-0.48, 0.14)	0.28	-0.06	(-0.32, 0.20)	0.65
Alcohol	-0.06 *	(-0.04, -0.08)	<0.01	0.13 *	(0.11, 0.15)	<0.01
Cope-Anx	0.06	(-0.44, 0.55)	0.82	-0.06	(-0.48, 0.36)	0.78
MASQ	0.83 *	(0.60, 1.00)	<0.01	-0.85 *	(-1.00, -0.66)	<0.01
Cope-Anx by MASQ	-0.07	(-0.56, 0.41)	0.77	0.27	(-0.12, 0.66)	0.17
Alcohol by Cope-Anx	0.06	(< 0.01, 0.13)	0.06	-0.15 *	(-0.22, -0.07)	<0.01
Alcohol by MASQ	-0.04 *	(-0.07, -0.02)	<0.01	0.07 *	(0.04, 0.09)	<0.01
Alcohol by Cope-Anx by MASQ	0.01	(-0.04, 0.06)	0.59	-0.10 *	(-0.16, -0.04)	<0.01
Depression Model						
Age	0.18	(-0.02, 0.39)	0.08	-0.14	(-0.31, 0.04)	0.12
Wave	-0.30	(-0.71, 0.12)	0.16	0.28	(-0.07, 0.64)	0.12
Smoke Beep	-0.11 *	(-0.17, -0.04)	<0.01	0.12 *	(0.05, 0.18)	<0.01
Weekend Status	-0.02	(-0.04, 0.01)	0.17	<-0.01	(-0.02, 0.02)	0.94
Sex	-0.17	(-0.47, 0.13)	0.26	-0.05	(-0.31, 0.20)	0.69
Alcohol	-0.06 *	(-0.09, -0.04)	<0.01	0.12 *	(0.03, 0.11)	<0.01
Cope-Dep	0.05	(-0.21, 0.30)	0.72	0.15	(-0.25, 0.41)	0.19
CES-D	0.65 *	(0.44, 0.85)	<0.01	-0.71 *	(-0.96, -0.51)	<0.01
Cope-Dep by CES-D	-0.07	(-0.22, 0.08)	0.38	0.05	(-0.09, 0.18)	0.49
Alcohol by Cope-Dep	0.01	(-0.02, 0.03)	0.48	<-0.01	(-0.01, 0.07)	0.85

Parameters	Negative Affect			Positive Affect		
	Estimate	95% CI	p-value	Estimate	95% CI	p-value
Alcohol by CES-D	-0.03 *	(-0.05, -0.01)	<0.01	0.02	(<-0.01, 0.07)	0.16
Alcohol by Cope-Dep by CES-D	0.01	(-0.01, 0.03)	0.16	-0.03	(-0.05, <0.01)	0.05

Note.

* $p < 0.05$;

Cope-Anx = coping with anxiety motives subscale; Cope-Dep = coping with depression motives subscale; Alcohol = number of drinks consumed; Anxiety = current level of anxiety symptoms; Depression = current level of depressive symptoms; Smoke Beep = user-initiated smoking prompt (yes/no).

Table 3

Within-subject variance results on self-reported negative and positive affect.

Parameters	Negative Affect			Positive Affect		
	Variance Ratio	95% CI	p-value	Variance Ratio	95% CI	p-value
Anxiety Model						
Age	0.99	(0.82, 1.19)	0.87	1.04	(0.89, 1.22)	0.61
Wave	0.70	(0.47, 1.03)	0.07	0.73	(0.53, 1.02)	0.07
Smoke Beep	0.86 [*]	(0.78, 0.95)	<0.01	0.86 [*]	(0.78, 0.95)	<0.01
Weekend Status	1.10 [*]	(1.03, 1.18)	0.01	1.10 [*]	(1.03, 1.18)	0.01
Sex	0.81	(0.61, 1.08)	0.15	0.90	(0.71, 1.15)	0.41
Alcohol	1.01	(0.47, 1.03)	0.51	1.04 [*]	(1.00, 1.07)	0.01
Cope-Anx	0.92	(0.58, 1.45)	0.72	0.95	(0.65, 1.40)	0.81
MASQ	1.73 [*]	(1.41, 2.11)	<0.01	1.41 [*]	(1.19, 2.67)	<0.01
Cope-Anx by MASQ	0.70	(0.46, 1.08)	0.11	0.77	(0.54, 1.11)	0.16
Alcohol by Cope-Anx	0.92	(0.83, 1.01)	0.09	1.11 [*]	(1.01, 1.22)	0.04
Alcohol by MASQ	1.00	(0.97, 1.04)	0.85	1.02	(0.98, 1.06)	0.38
Alcohol by Cope-Anx by MASQ	1.08	(0.98, 1.19)	0.11	0.97	(0.88, 1.06)	0.47
Depression Model						
Age	0.98	(0.81, 1.18)	0.82	1.02	(0.87, 1.20)	0.80
Wave	0.72	(0.48, 1.08)	0.11	0.78	(0.56, 1.10)	0.16
Smoke Beep	0.86 [*]	(0.78, 0.95)	<0.01	0.86 [*]	(0.78, 0.95)	<0.01
Weekend Status	1.10 [*]	(1.03, 1.18)	0.01	1.10 [*]	(1.03, 1.17)	0.01
Sex	0.81	(0.60, 1.07)	0.14	0.91	(0.71, 1.16)	0.44
Alcohol	1.01	(0.99, 1.04)	0.59	1.05 [*]	(1.02, 1.08)	0.01
Cope-Dep	1.05	(0.83, 1.33)	0.69	0.98	(0.81, 1.20)	0.86
CES-D	1.37 [*]	(1.14, 1.65)	<0.01	1.18 [*]	(1.01, 1.37)	0.04
Cope-Dep by CES-D	0.96	(0.83, 1.10)	0.53	1.04	(0.92, 1.17)	0.53
Alcohol by Cope-Dep	0.96	(0.92, 1.00)	0.06	0.99	(0.95, 1.03)	0.48

Parameters	Negative Affect		Positive Affect		p-value
	Variance Ratio	95% CI	Variance Ratio	95% CI	
Alcohol by CES-D	1.01	(0.98, 1.05)	1.07 *	(1.03, 1.11)	<0.01
Alcohol by Cope-Dep by CES-D	1.01	(0.98, 1.04)	0.97 *	(0.94, 0.99)	0.04

Note:

* $p < 0.05$;

Cope-Anx = coping with anxiety motives subscale; Cope-Dep = coping with depression motives subscale; Alcohol = number of drinks consumed; Anxiety = current level of anxiety symptoms; Depression = current level of depressive symptoms; Smoke Beep = user-initiated smoking prompt (yes/no).