Alcohol, Moods and Male–Female Differences: Daily Interactive Voice Response over 6 Months

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Abstract — Aims: The goal of this study was to better understand the predictive relationship in both directions between negative (anger, sadness) and positive (happiness) moods and alcohol consumption using daily process data among heavy drinkers. **Methods:** Longitudinal daily reports of moods, alcohol use and other covariates such as level of stress were assessed over 180 days using interactive voice response telephone technology. Participants were heavy drinkers (majority meeting criteria for alcohol dependence at baseline) recruited through their primary care provider. The sample included 246 (166 men, 80 women) mostly Caucasian adults. Longitudinal statistical models were used to explore the varying associations between number of alcoholic drinks and mood scores the next day and vice versa with gender as a moderator. **Results:** Increased alcohol use significantly predicted decreased happiness the next day ($P < 0.005$), more strongly for females than males. Increased anger predicted higher average alcohol use the next day for males only ($P < 0.005$). **Conclusion:** This daily process study challenges the notion that alcohol use enhances positive mood for both males and females. Our findings also suggest a strong association between anger and alcohol use that is specific to males. Thus, discussions about the effects of drinking on one's feeling of happiness may be beneficial for males and females as well as anger interventions may be especially beneficial for heavy-drinking males.

INTRODUCTION

Theories about the development and maintenance of problematic alcohol use suggest that mood states, both negative (e.g. anger, sadness) and positive (e.g. happiness), elicit alcohol use, which then also impacts mood (Khantzian, 1985; Wills and Shiffman, 1985; Cooper *et al.*, 1995; Koob and Le Moal, 1997). Empirical studies have generally supported these theories but the associations are complex (Simons *et al.*, 2005; Armeli *et al.*, 2008; Witkiewitz and Villarroel, 2009; Kelly *et al.*, 2010a,b; Jahng *et al.*, 2011). Longitudinal studies, which take a more ecologically valid approach compared with cross-sectional or lab-based studies (Tennen *et al.*, 2000; Simpson *et al.*, 2005), have helped to improve understanding of the prospective relations between moods and alcohol use. Most have focused on negative mood, and results have been mixed.

Consistent with emotion management and tension reduction theories of alcohol use, some studies show that negative mood is associated with increased alcohol use the same day and/or the next day (Hussong *et al.*, 2001; Park *et al.*, 2004; Hussong, 2007; Schroder and Perrine, 2007). For example, Hussong and colleagues (Hussong *et al.*, 2001) examined a range of moods in relation to alcohol use in a sample of 74 college students across 28 days of daily reports. Sadness and hostility predicted greater alcohol use, which then predicted more sadness and hostility (Hussong *et al.*, 2001). This negative mood-alcohol use cycle might be one important pathway to problematic alcohol use. However, others report inverse relations, where increased negative mood predicts less alcohol use (Armeli *et al.*, 2010; Simons *et al.*, 2010). In another sample of college students ($n = 530$) providing daily reports on alcohol use and mood over 30 days, Armeli and colleagues (Armeli *et al.*, 2010) found negative mood predicted less alcohol consumption the next day.

Findings from studies on positive mood and alcohol use have been more consistent but are fewer in number. Most have reported that higher levels of positive mood predict increased alcohol consumption (Steptoe and Wardle, 1999; Hussong *et al.*, 2001; Simons *et al.*, 2005, 2010). There is also evidence that alcohol use elevates mood and subjective well-being (Van Tilburg and Vingerhoets, 2002; Molnar *et al.*, 2009). In a large ($n = 627$) sample of first year college students reassessed once near the end of their third year, Molnar and colleagues (Molnar *et al.*, 2009) reported that alcohol use was related to increased subjective well-being prospectively.

More studies are needed to better understand how alcohol use affects subsequent moods. Lab-based studies have suggested that alcohol use generally dampens negative mood and enhances positive mood in the short term (Conrod *et al.*, 2001; Van Tilburg and Vingerhoets, 2002). While the aforementioned longitudinal findings on positive mood appear to support the lab-based findings (Molnar *et al.*, 2009), daily process findings on negative moods are inconsistent with those from lab studies (Hussong *et al.*, 2001). There is a clear need for further exploration of existing daily process data before conclusions are drawn about the negative or positive consequences of alcohol use.

In addition to exploring both directions of the association between alcohol use and moods, the moderating effect of gender needs to be considered. Several studies have reported male–female differences in the associations between mood and alcohol use (Hussong *et al.*, 2001; Hussong, 2007; Simons *et al.*, 2010). In 102 college students with 21 days of daily data, hostility was positively associated with alcohol use among males but not females (Simons *et al.*, 2010). Hussong and colleagues (Hussong *et al.*, 2001; Hussong, 2007) found stronger relations between sadness and alcohol use for men than women. These male–female differences are consistent with several reports showing that men and women respond differently to stress, and experience mood and substance use disorders at different rates (Hall, 1996; Kessler *et al.*, 1997; Kudielka *et al.*, 2004). Despite this, male–female differences have not received the attention they deserve in the mood and alcohol use literature, perhaps in part because they are not often the focus of a priori research questions. This study

examines gender-specific relations between mood and alcohol use, and our findings may inform alcohol use prevention and intervention programs that could be tailored to better serve males and females.

A final gap in this literature relates to the dearth of studies that consider stress in the model. Stress and mood have been shown to be reciprocally predictive (Sinha, 2001). In a recent daily process study, Ayer and colleagues (Ayer *et al.*, 2011) reported that higher stress levels predicted higher alcohol consumption the next day, and that higher alcohol consumption predicted lower stress the next day (Ayer *et al.*, 2011). Though distinct constructs, stress and mood are highly related as well (Juster *et al.*, 2011). One of the strengths of this study is that it controls for stress as a potential significant confounder of the associations between mood and alcohol use.

In summary, there are several studies testing the relations between mood and alcohol consumption; however, findings have been contradictory with respect to negative moods and more studies exploring positive moods are needed. There may be several reasons for equivocal findings of negative moods including differences in study design (cross-sectional, longitudinal and daily process), failing to assess stress as a confounder or failing to design studies with a priori hypotheses of gender as a moderator. Our study tests the reciprocal relations between mood and alcohol use after accounting for stress and stratifying across gender when indicated. Our study also builds upon the existing daily process literature thus providing an opportunity to examine these associations in an ecologically valid manner that allows for observation of associations over an extended period time. The majority of daily process studies have been conducted on college students, and few have tested associations of mood and alcohol use for longer than 1 month. Since college students are not representative of the adult drinking population, still little is known about the day-to-day associations in the general adult drinking population, and since a single month may not be a sufficient period to effectively determine the relations between mood and alcohol use, our 6-month study may yield more reliable findings.

Our study examines 246 male and female community-dwelling adults reporting levels of anger, sadness, happiness and alcohol use daily across 180 days. We specifically hypothesize that (1) higher alcohol consumption will predict lower levels of anger and sadness and higher levels of happiness the next day after controlling for stress; (2) higher levels of anger, happiness and sadness will predict increased alcohol consumption the next day after accounting for stress and (3) the associations between anger and alcohol use will be stronger for males compared with females.

METHODS

Data for the current manuscript were obtained from a study that tested the feasibility and efficacy of an interactive voice response (IVR)-based therapeutic enhancement for brief alcohol intervention in primary care (Helzer *et al.*, 2008). This study was approved by the Institutional Review Board at the University of Vermont under identification number 99-022. The purpose was to determine whether self-monitoring of alcohol use and associated variables via IVR in the 6 months following brief intervention would produce better outcomes than no self-monitoring after brief intervention. The original study compared three experimental conditions: no IVR, IVR self-monitoring only and IVR self-monitoring plus feedback, wherein participants were given monthly feedback on their alcohol use reported to the IVR. The current study uses data from the two IVR groups completing, on average, 68% (standard deviation = 36%) of their calls over 180 days (Helzer *et al.*, 2008).

Sample

Participants were recruited from April 2000 to July 2003 from 15 primary care offices in a rural county of 150,000 in the USA. Providers screened their patients for heavy alcohol use and were trained to conduct brief alcohol interventions when appropriate. Patients who received a brief intervention and were willing to consider further intervention in a randomized trial were referred to the study team. This study included individuals with a recent (3-month) history of alcohol consumption that exceeded either (1) average daily or weekly alcohol use of no more than two drinks per day/14 per week for men or one per day/seven per week for women, or (2) daily maximums of five for men or four for women. Individuals were excluded if they had a current (1-year) DSM-IV diagnosis of substance dependence (other than alcohol, nicotine or marijuana) or a current (1-year) DSM-IV diagnosis of psychosis or major depression with recent initiation or change in antidepressant medication. The sample included 246 adults (166 men, 80 women) with a mean age of 46 years (SD = 13, range = 21–82). Of the 246 participants, 97% were Caucasian/non-Hispanic, their mean years of education was 15 (SD = 3, range = 5–24), 76% of the sample was employed full time and 66% were alcohol dependent at baseline. Twenty-five participants (10%) had completely missing data on the outcome variables, so final statistical analyses include 221 participants with little change to demographics and no change in percent alcohol dependent (66%) at baseline. Participants drank on average 51% of the days they were in the study (Table 1). Table 1 also provides mean number of drinks daily and on drinking days and provides mean mood scores across all 180 days.

Procedure

Research personnel contacted each referral by telephone to briefly explain the study. Participants were scheduled for an in-person consent and assessment at the research office. The full assessment battery and detailed study procedures were presented elsewhere (Rose *et al.*, 2010; Ayer *et al.*, 2011) and briefly summarized here. Participants were trained to use the 24-h IVR system and asked to call once each day for 6 months

Table 1. Summary information for drinking and mood variables

	Mean	Standard deviation	Range
Number of days alcohol was consumed	91.5	62.1	0–180
Number of drinks daily	3.8	2.5	0–16.9
Number of drinks on drinking days	5.0	2.5	1–17.5
Anger score daily	2.0	1.5	0–5.5
Happiness score daily	5.5	1.3	0–8.6
Sadness score daily	2.3	1.7	0–7.7

(180 days) to complete a 2 min questionnaire. The IVR variables included daily questions on alcohol consumption, mood (anger, happiness and sadness), stress, physical health, relationship with partner and partner alcohol use. All IVR questions were focused on the previous calendar day so as to ensure a consistent reporting period. Participants in the IVR plus feedback group were mailed a graph at the end of each month that displayed the number of drinks the participant had reported on each of the preceding 30 days and a horizontal line representing the goal the participant had stated at intake. The mailing also included a brief note of encouragement from the Principal Investigator.

Outcome and predictor variables

This manuscript focuses on four time-varying outcome variables assessed on the IVR daily questionnaire: anger, happiness, sadness and total number of alcoholic drinks. Moods were assessed with the following type of statement: 'Rate your highest level of anger yesterday, from 0 (not angry at all) to 9 (the angriest you've ever been).' Total number of drinks was a sum of the number of beers, drinks containing liquor and glasses of wine the individual reported. To determine these amounts, participants were asked how many drinks of each type of alcohol they consumed the previous day. At the start of the study they were trained to report in standard drink amounts (12 ounce beer, 5 ounce wine and 1.5 ounce liquor). Potential confounding variables included in all models were gender, stress, time (since beginning study), day of the week (Sunday as reference), alcohol dependency (assessed at baseline) and IVR intervention group (self-monitoring only as reference). Stress was assessed on a scale of 0–9, in the same fashion as the mood variables. Alcohol dependency was assessed using the Composite International Diagnostic Interview – Substance Abuse Module (Cottler *et al.*, 1989). In an attempt to run the most parsimonious models, age was not included in final models because adding it did not confound our relations of interest.

Analysis

All analyses were conducted in STATA 9.2 (Stata Corporation., 2005) utilizing the longitudinal data environment, clustering by unique identification number (ID) and sorting by treatment day consecutively from 1 to 180. Associations between repeated outcomes and predictors were modeled using the STATA command to fit population-averaged general linear models (generalized estimating equations, GEE) allowing for a user-defined within-ID correlation structure. We explored several potential within-ID correlations (exchangeable, independent, unstructured and auto-regressive) and determined that an exchangeable correlation structure fit the data best, and therefore, all GEE models assumed an exchangeable correlation structure.

First, simple regressions using GEE were conducted to explore associations between pairs of mood and stress variables. Next, three GEE models were run for total number of drinks predicting each of the three next day mood variables (anger, happiness, sadness) as outcomes, controlling for confounders. The last main GEE model reversed the causal question to explore whether mood variables predicted next day total number of drinks, controlling for confounders. Potential modifying effects of gender were explored by including an interaction between gender and total number of drinks predicting each of the three next day mood variables, as well as gender interacting with each of the three mood variables predicting next day total number of drinks. Significant interaction terms led to gender-stratified analyses.

RESULTS

GEE associations from simple regressions of mood and stress variables were all highly significant ($P < 0.0005$, Table 2), suggesting strong correlations between variables at individual time points and across time. Some associations were negative, as expected, such as every one point increase in happiness score predicted a 0.46 decrease in average sadness score. Other associations were positive, such as every one point increase in anger score predicted a 0.55 increase in average stress score. Including such highly associated covariates together in GEE models likely limits our ability to find large effects, but excluding these known confounders might result in biased results, so we include them.

In our first three GEE models exploring the question of whether alcohol use predicted each of the three next day mood scores, there were no associations between total number of drinks and next day anger or sadness scores (Table 3). However, every one additional drink predicted a significant decrease in the average happiness score the next day (Table 3). The three mood scores were all independent predictors of next day stress and of each of the three next day mood outcomes (Table 3); this was expected due to strong associations between mood and stress scores. Gender was not an independent predictor of any of the mood outcomes (P-values ranged between 0.09–0.32).

Table 2. Associations between pairs of main predictor variables from simple GEE models

	Anger	Happiness	Sadness	Stress
Anger	–			
Happiness	−0.24	–		
Sadness	0.47	−0.46	–	
Stress	0.55	−0.36	0.40	–

Table 3. Total number of drinks predicting next day mood (anger, happiness, sadness) scores

Variables	Beta	*P*-value	95% confidence interval	
DV[a]: next day anger				
Total drinks	0.00	0.199	−0.011	0.002
Happiness	−0.03	0.000	−0.049	−0.019
Sadness	0.14	0.000	0.123	0.148
Stress	0.13	0.000	0.114	0.136
DV: next day happiness				
Total drinks	−0.01	0.001	−0.015	−0.004
Anger	−0.03	0.000	−0.045	−0.021
Sadness	−0.12	0.000	−0.134	−0.113
Stress	−0.03	0.000	−0.043	−0.023
DV: next day sadness				
Total drinks	0.01	0.090	−0.001	0.013
Anger	0.15	0.000	0.132	0.160
Happiness	−0.14	0.000	−0.155	−0.126
Stress	0.10	0.000	0.085	0.110

[a]DV stands for dependent variable. Analyses were controlled for same-day time-varying covariates shown (anger, happiness, sadness and stress) as well as gender, time since beginning of the study, day of the week compared with Sunday, alcohol dependency at baseline, and feedback intervention status.

Table 4. Mood (anger, happiness, sadness) predicting next day total number of drinks stratified by gender

Variables	Beta	*P*-value	95% confidence interval	
Males and Females				
Anger	0.04	0.002	0.014	0.066
Happiness	0.03	0.020	0.005	0.059
Sadness	−0.03	0.039	−0.049	−0.001
Stress	0.02	0.120	−0.005	0.040
Males only				
Anger	0.06	0.001	0.024	0.095
Happiness	0.03	0.090	−0.005	0.069
Sadness	−0.03	0.102	−0.060	0.005
Stress	0.03	0.036	0.002	0.064
Females only				
Anger	0.01	0.486	−0.019	0.041
Happiness	0.03	0.073	−0.003	0.061
Sadness	−0.02	0.269	−0.044	0.012
Stress	−0.01	0.358	−0.038	0.014

Analyses were controlled for same-day time-varying covariates shown (anger, happiness, sadness, and stress) as well as time since beginning of the study, day of the week compared with Sunday, alcohol dependency at baseline and feedback intervention status. The 'Males and Females' model was also controlled for gender.

In our next GEE model, reversing the research question (does an increase in any of the three mood scores predict a change in next day total number of drinks?) revealed that a one point higher anger score or happiness score predicted a significant increase in the next day average total number of drinks (Table 4), whereas a one point higher sadness score predicted a significant decrease in the next day average total number of drinks (Table 4) after controlling for confounders. In this GEE model, gender was a significant independent predictor of next day total number of drinks, and as anticipated, males reported nearly one more drink on average than females (Beta = 0.98, 95% confidence interval (CI): 0.25–1.72, *P* = 0.009) after controlling for confounders.

Male–female differences

Our GEE models that included an interaction term between gender and total number of drinks yielded mixed results. For the first research questions with mood variables as the outcomes, gender was not a moderator of total drinks predicting either anger or sadness scores. However, the interaction between total number of drinks and gender was significant in predicting happiness scores (Beta = 0.02, *P* = 0.03). Stratifying this model to test males and females separately revealed a slight quantitative difference such that with every increase of one drink, females reported a 0.02 decrease in their average next day happiness score (*P* = 0.01, 95% CI: −0.033, −0.004) while males reported a 0.01 decrease in their average next day happiness score (*P* = 0.006, 95% CI: −0.014, −0.002).

Testing gender as a moderator of the relationship in the other direction (moods predicting next day total number of drinks) revealed more prominent male–female differences. The interaction between the anger score and gender was significant in predicting next day total number of drinks (Beta = 0.08, *P* = 0.002), and stratifying this GEE model to test males and females separately revealed that among males only, reporting a one point higher anger score significantly

predicted an increase in next day total number of drinks (Table 4). All previously significant associations of mood variables predicting next day total number of drinks that were evident in the model with males and females combined were no longer significant in the females-only model, and sadness and happiness no longer predicted next day total number of drinks for males either (Table 4). The interactions between sadness/gender or happiness/gender predicting next day total drinks were not significant (Beta = −0.009, *P* = 0.709 for sadness/gender and Beta = −0.001, *P* = 0.982 for happiness/gender), so these analyses were not stratified by gender. Finally, in line with a previous report by this research team focusing on stress (Ayer *et al.*, 2011), only males showed that increased stress significantly predicted increased next day total number of drinks after controlling for confounders (Table 4).

DISCUSSION

While it is generally accepted that moods and alcohol use are associated, the current body of literature reports contradictory findings with regard to the directionality and strength of the association. Building on our previously published models showing significant, gender-specific, bi-directional relations between stress and alcohol use (Ayer *et al.*, 2011), this study explores the relations between three mood variables (anger, sadness and happiness) and alcohol use, after accounting for stress and other important confounders in a substantially sized sample of heavy drinking adults making daily process reports. This study helps to fill two main gaps in the literature by (1) examining the bi-directionality of the associations through daily longitudinal data over an extended period of time and (2) exploring the potential moderating effects of gender.

Before discussing the details of our results, it is important to highlight our unique study sample. Most of the existing literature examining daily reports of moods and alcohol use has been conducted over a short period of time on samples of college students. One limitation of these studies to ask temporal questions of these day to day associations is that college students typically have limited access to alcohol throughout the week, and drinking gets clustered over weekends. Therefore, day to day changes in moods associated with alcohol use may be difficult to reliably detect because of this limited access and cluster drinking. In our study sample of heavy-drinking community-dwelling adults, we can assume that alcohol is readily accessible throughout the week, and therefore, day to day associations may be more reliable, if they exist. Furthermore, while findings from the college student literature are relevant to our current study, our findings are not generalizable to the college age population of adults. Our sample represents a wider age range of adults (21–82 years) identified by primary care providers as having a potential alcohol use problem with over 60% meeting criteria for alcohol dependence at baseline. Therefore, our findings may be important for clinicians to consider when treating community-dwelling adults with alcohol use problems.

Contrary to our first hypothesis that increased alcohol consumption would predict lower levels of anger and sadness and higher levels of happiness the next day, we found no association between total number of drinks and next day anger or sadness. Surprisingly, we found that as the total number of drinks increased, average scores for next day happiness

decreased. The current scant literature on the association between alcohol and happiness may lead clinicians to believe that alcohol use results in increased positive mood, and therefore may deter them from exploring the subject with their patients. Future research should expand upon this question by testing models that explore other positive emotional states to see whether similar results are observed in daily process data.

Male–female differences played a critical role in our second set of hypotheses that higher levels of anger, sadness and happiness would predict increased alcohol consumption the next day. Our hypothesis that higher levels of anger predicted increased alcohol consumption the next day was supported in our full model of both males and females together; in stratified analyses, the association was much stronger and significant for males only. Increased anger predicting increased alcohol use for males only has been reported from the analysis of another longitudinal data set (Schroder and Perrine, 2007). Therefore, working on strategies for male drinkers to manage their anger may warrant special emphasis in alcohol treatment approaches. Furthermore, results from a recent study of relapse after alcohol use treatment suggest that targeting the relationship between high negative affect (especially anger) and alcohol use could decrease the probability of relapse, thus improving alcohol treatment outcomes (Witkiewitz and Villarroel, 2009).

While results for anger scores predicting levels of alcohol use the next day should be considered separately for males and females, the results from the full model should be used for conclusions related to happiness and sadness and their effects on level of alcohol use the next day. Since our testing of interaction terms indicated that gender did not modify the relationship of sadness or happiness predicting total number of drinks, there was little change in the magnitude of effect resulting from the sadness or happiness variables in the stratified analysis. However, the decrease in sample size in the stratified analysis resulted in a decrease in power to detect the same magnitude difference. Therefore, in the full model, increased happiness was related to increased alcohol use the next day, while increased sadness was related to decreased alcohol use the next day. However, both significance levels may be considered borderline, indicating the need for further investigation before conclusions are drawn.

There are limitations to these data that are important to note. First, all included variables were based on self-report. While it was not feasible to collect daily alcohol use data via biological indicators (e.g. breathalyzer) in this study, an earlier study did demonstrate the validity of IVR self-reports against both breathalyzers and collateral reports (Perrine *et al.*, 1995). Nonetheless, incorporation of biological indicators of alcohol consumption in future multi-method investigations might help to validate and expand upon this literature. Second, the three mood variables were based on three single items scored between zero and nine and were not a detailed assessment of negative or positive moods. This was a necessary sacrifice; brevity was a requirement in maintaining high call compliance. Third, the clinical relevance of our findings needs further discussion. The significant effects reported here might be interpreted as relatively small (every one-unit increase on the ten-point anger scale was predictive of a 0.06 drink increase the following day for males). We note that our models included all three highly correlated mood variables, resulting in some co-linearity and potential dampening of an effect, and several other important confounders (including stress) which

resulted in less parsimony yet less bias. It is also possible that unmeasured confounders exist, and examination of theoretical confounders in future studies, such as personality and family history of mood or alcohol use disorders, may help to further understand these complex relations. Future research should test hypotheses between mood and drinking among moderate drinkers (providing more variability in the data than just heavy drinkers) and over longer periods of time to study the association of moods and progression between stages of alcohol use. Other studies have shown that the progression from first drink to alcohol dependence is a multi-stage process typically occurring over a number of years (Langenbucher and Chung, 1995; Sartor *et al.*, 2008). Finally, this study did not utilize same day measurements because we had no indication which came first that day, the drinking or the mood. We are aware that a larger effect may be seen within the same day, instead of the next day, requiring daily IVR studies to assess mood and alcohol use more than once per day so to better determine temporal relations within a given day. Whether the subject was already drinking when he or she made the IVR call is also a potential limitation because one's prior day mood score is potentially biased by their current mood state. It is less likely that this bias would affect their ability to count the number of drinks they had the previous day unless they were so drunk that their memory was affected, and in this case, he or she may also forget to make the IVR call that day.

With respect to interventions, it is often assumed that alcohol use helps moderate emotions, yet the results of this study do not support the theory that alcohol enhances positive mood or dampens negative mood. On the contrary, these results suggest that an increase in alcohol use dampens next day happiness, a topic that can be explored in primary care brief interventions, and does not have a significant effect on next day anger or sadness. Our results do support the theory that negative mood (specifically anger) predicts alcohol use. In particular, males seem to react to increases in anger by increasing their alcohol use the next day while females do not. This suggests an important gender difference that should be emphasized in clinical interventions and explored in future research.

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