

# Effects of social drinking context on subjective effects, affect, and next-day appraisals in the natural environment

Samuel F. Acuff<sup>1,2,3</sup>  | Hayley Treloar Padovano<sup>2</sup>  | Ryan W. Carpenter<sup>4</sup>  |  
Noah N. Emery<sup>5</sup>  | Robert Miranda Jr.<sup>2,6</sup> 

<sup>1</sup>Department of Psychology, The University of Memphis, Memphis, Tennessee, USA

<sup>2</sup>Department of Psychiatry and Human Behavior, Brown University, Providence, Rhode Island, USA

<sup>3</sup>Recovery Research Institute, Massachusetts General Hospital and Harvard Medical School, Boston, Massachusetts, USA

<sup>4</sup>Department of Psychological Sciences, University of Missouri-St. Louis, St. Louis, Missouri, USA

<sup>5</sup>Department of Psychology, Colorado State University, Fort Collins, Colorado, USA

<sup>6</sup>Emma Pendleton Bradley Hospital, Riverside, Rhode Island, USA

## Correspondence

Robert Miranda Jr., Center for Alcohol and Addiction Studies, Brown University, Box S121-4, Providence, RI 02912, USA.  
Email: [robert\\_miranda\\_jr@brown.edu](mailto:robert_miranda_jr@brown.edu)

## Funding information

National Institute on Alcohol Abuse and Alcoholism, Grant/Award Number: K23AA029729, K24AA026326 and R01AA007850; National Institute of General Medical Sciences, Grant/Award Number: P20GM130414

## Abstract

**Background:** Drinking commonly occurs in social settings and may bolster social reinforcement. Laboratory studies suggest that subjective effects and mood are mechanisms through which the social context influences alcohol consumption. Ecological momentary assessment (EMA) may be useful for extending these findings to the natural environment. This pre-registered secondary analysis of EMA data investigated the influence of the social environment on: (1) stimulating and sedating subjective effects of alcohol, (2) contentedness and negative affect, and (3) next-day evaluations of the drinking occasion.

**Methods:** Nontreatment seeking adults reporting past-month heavy drinking ( $N = 131$ ;  $M_{\text{age}} = 28.09$ ; 42% female) completed 7 days of EMA (in the morning, at random, and following drinking prompts), which included questions on their social context (drinking in the presence of known others or alone), contemporaneous stimulating and sedating effects, contentedness and negative affect, alcohol consumption, and next-day evaluations of a prior day's drinking event (how satisfying/pleasant was drinking). We used multi-level models in SAS 9.4 M7 software to examine relations among the variables.

**Results:** Contemporaneous subjective effects (stimulating or sedating), negative affect, and contentedness did not significantly depend on the social context. For next-day evaluations of pleasure/satisfaction from drinking, context effects were dependent on consumption totals. As the total number of standard drinks consumed increased, recollections of pleasure/satisfaction were higher when drinking had occurred with others, relative to alone. At lower consumption totals, next-day evaluations did not appear to depend on social context.

**Conclusions:** When reported contemporaneously, subjective effects and affect do not appear dependent upon the presence of known others. However, heavier drinking events, relative to lighter drinking events, are appraised more favorably the following day when occurring within social contexts.

## KEYWORDS

alcohol, ecological momentary assessment, mood, social, solitary, subjective response

## INTRODUCTION

Despite decades of work in treatment and prevention, heavy alcohol consumption remains common in the United States (SAMHSA, 2020) and can lead to substantial psychosocial, physiological, and societal problems (Hingson et al., 2017; Jennison, 2004; Kahler et al., 2005; Sacks et al., 2015). Reductions in the prevalence of alcohol consumption have “stalled out” in recent years, with any signs of change trending upward, particularly for women and older adults (McKetta & Keyes, 2019). Further, there is some indication that COVID-19 resulted in increased alcohol consumption, at least in the United States (Acuff et al., 2022). Understanding mechanisms contributing to continued use despite adverse consequences may help develop novel interventions and optimize existing treatments.

Some research suggests that people may be more likely to consume greater amounts of alcohol in social contexts because it facilitates the developmental and evolutionarily relevant goal of establishing social connections with peers (Allen & Loeb, 2015; Collins & Steinberg, 2006; Ellis et al., 2012). Most drinking occurs in a social context of known peers, perhaps because social connection is often a benefit conferred through alcohol consumption (Acuff et al., 2021). To test this hypothesis, Sayette et al. (2012) randomized triads of social drinking adults without a history of alcohol use disorder (AUD) to consume alcohol, an alcohol placebo, or juice in a between-subjects human laboratory study. Compared with the placebo and juice conditions, drinking alcohol increased subjective feelings of social connection and potentiated objective markers of social engagement, such as physical touch, laughter, and number of words spoken (Sayette et al., 2012). Moreover, social drinking occasions are often rated as more enjoyable than other drinking contexts (i.e., greater positive subjective evaluations; Murphy et al., 2006; Plant et al., 1990).

Other research demonstrates that people with patterns of alcohol use most similar to those of their social groups are generally considered to have higher social statuses by other members of their social circle (Dumas et al., 2014). It is no surprise, then, that perception of higher normative levels of drinking is associated with greater levels of alcohol consumption (Neighbors et al., 2008). Daily diary studies investigating binge drinking during social and solitary drinking occasions in the context of an 18-week daily diary study (Acuff et al., 2021) found that, although a greater proportion of social, relative to solitary, drinking occasions across the study period was associated with lower rates of binge drinking overall, participants were four times more likely to report a binge drinking episode when in the presence of peers relative to when they drank alone. Importantly, participants who valued alcohol more strongly on an alcohol purchase task were more likely to drink heavily (4/5 drinks in a day for women/men) during social, compared to solitary, drinking occasions. This suggests that drinking with others may be a unique risk factor for heavy drinking among those reporting high reinforcing efficacy of alcohol. However, there is a dearth of research exploring

momentary, experiential mechanisms in social drinking conditions explaining the influence of the social environment on increases in alcohol use. Two variables known to covary with acute alcohol use, namely affect and subjective effects of alcohol, may be particularly salient for understanding how the social context influences alcohol consumption.

The acute effects of alcohol intoxication are biphasic, with prominent stimulating effects on the ascending limb of the blood alcohol content (BAC) curve and sedating effects on the descending limb (Addicott et al., 2007; Martin et al., 1993). The stimulating effects on the ascending limb are considered euphoric and may be, in part, what drives the reinforcing effects of alcohol (King et al., 2022). Adolescents and young adults report greater stimulatory effects of alcohol, particularly at lower BACs, and stimulatory effects diminish more quickly among older individuals (Miranda et al., 2014; Treloar et al., 2017), highlighting an important age effect that may explain higher levels of consumption among younger demographics (SAMHSA, 2020). Repeated and persistent alcohol use (e.g., regular engagement in binge drinking) can result in increased stimulating and decreased sedating effects of intoxication (King et al., 2011). Studies exploring the effect of the social context on subjective effects of alcohol, however, are sparse. In Kirkpatrick and de Wit (2013), healthy social drinkers participated in four, counterbalanced conditions, in which the presence of peers and peer alcohol consumption (versus pairing with a peer who had not consumed alcohol) were manipulated. The stimulating effects of alcohol were strongest while drinking with peers who were also consuming alcohol relative to all other conditions; sedating effects did not change across studies. Similarly, Corbin et al. (2021) found that both high arousal positive and negative subjective response to alcohol were greater in social compared to solitary situations, and these effects were consistent across bar and laboratory physical contexts.

Most theoretical models of alcohol use and AUD pathology posit that drinking increases positive affect or decreases negative affect, which serves to reinforce alcohol consumption (Baker et al., 2004; Khantzian, 1997; Koob & Le Moal, 2008). Acute alcohol intoxication in the human laboratory consistently increases positive affect and decreases negative affect (Meredith et al., 2022). Further, laboratory research utilizing both self-report (Bowdring & Sayette, 2021) and behavioral indicators (Fairbairn et al., 2015) of positive mood suggests that alcohol may increase positive mood when consumed in the presence friends or other known peers. A review by Fairbairn and Sayette (2014) found positive effects of alcohol on mood during self-administration studies were greater in research designs where the participants could converse freely with research personnel, but not when participants could not converse freely, suggesting that socializing may improve alcohol's mood-altering effects. Alternatively, meta-analysis suggests that between-person solitary drinking is associated with drinking to cope motives (Skrzynski & Creswell, 2021), suggesting that negative affect may play a role in facilitating drinking while alone.

Next-day appraisals of the drinking event may be another pathway through which the social context may influence alcohol use. From this perspective, in addition to immediate euphoric effects felt during the drinking occasion, social and cognitive factors that persist or take place after the event may impact the appraisal of the drinking occasion, thereby influencing the impact the social context has on future drinking. Next-day appraisals likely differ from subjective effects in meaningful ways, as the latter measures in the moment subjective experiences, which is more likely influenced by the immediate environment and effects of alcohol, and the former captures an intertemporal evaluation that accounts for additional factors, such as cognitive appraisal of the full nights' events and physiological subjective experience in the morning. Evidence suggests negative consequences of drinking may be appraised more positively when the negative consequence occurs in the presence of friends (compared to strangers) and if peers evaluate it as funny, rather than concerning (Merrill et al., 2018, 2019). Alternatively, studies exploring social anxiety and rumination among college students who drink alcohol suggest that rumination following a social drinking event is common and increases monotonically with alcohol intake (Battista & Kocovski, 2010). These findings suggest that post-event evaluations of the drinking occasion may be influenced by the social context and may be a candidate reinforcement mechanism for increased drinking in social contexts.

Although the reliance on human laboratory self-administration studies provides important information about the influence of social contexts in carefully controlled experimental settings, whether these findings generalize to real-world settings remains largely unknown. Ecological momentary assessment (EMA) methods use repeated assessments to capture participants' emotional, behavioral, or cognitive experiences via mobile electronic devices, in real time, while participants are in their natural environment (Shiffman, 2009; Stone & Shiffman, 1994). This form of data collection allows researchers to understand momentary effects of acute alcohol intoxication while in the natural environment (Miranda & Treloar, 2016). Ecological momentary assessment also enhances the generalizability of findings by reducing recall bias that can affect more traditional global or single occasion measures that rely exclusively on retrospective reporting. Studies using EMA have found greater likelihood of drinking on days that they experience positive affect, but not negative affect without considering the presence of others during the drinking event (Dora et al., 2023), and that being among others is associated with decreased drinking to cope motives for depression (Wycoff et al., 2021). However, to our knowledge, no study has explored the effect of social context on subjective effects, affect, and next day appraisals using EMA.

This pre-registered (<https://osf.io/8d6us>) secondary analysis of EMA data sought to investigate the influence of the social environment on: (1) contemporaneous (same moment) subjective stimulating and sedating effects of alcohol, (2) contemporaneous negative affect, one element of positive affect (i.e., contentedness),

and (3) next-day subjective positive evaluations of the drinking occasion. Our hypotheses were as follows:

**Hypothesis 1.** Drinking in a social context will be associated with greater increases in subjective stimulation, accounting for predrinking moments, and a lower increase in subjective sedation, relative to drinking while alone. Both social and solitary drinking will be associated with higher contentedness and lower negative affect, accounting for predrinking affect ratings. Drinking in a social context, as compared to when drinking alone, will be associated with greater increases in contentedness and greater reductions in negative affect, accounting for pre-drinking affect ratings. Drinking in a social context, as compared to when drinking alone, will be associated with greater next-day positive subjective evaluations of the drinking occasion.

**Hypothesis 2.** Estimated BAC will account for some, but not all, of the variance in momentary subjective stimulation and sedation effects, and the presence of others will remain a significant predictor for affect and subjective effects analyses.

**Hypothesis 3.** The effect of social context will be greater at younger ages, such that the presence of peers will result in greater subjective stimulatory effects and contentedness, and reduced sedation and negative affect, at younger ages relative to older ages.

## METHODS

### Participants

Participants were 131 adults who reported multiple episodes of heavy drinking in the past month and who were not seeking treatment for alcohol problems. This manuscript reports secondary analysis of data previously published, including a full description of study methodology (Tidey et al., 2007). In short, the study was designed to evaluate the efficacy of naltrexone in reducing heavy drinking among non-treatment seeking heavy drinking adults. Inclusion criteria were as follows: (1) 21 years of age or older, (2) alcohol consumption on at least 4 days per week on average, and (3) heavy drinking on at least 2 days per week on average in the past month. Exclusion criteria were (1) DSM-IV-TR abuse or dependence on drugs other than nicotine or alcohol, (2) current interest in or past treatment for alcohol problems, (3) positive opiate screen, (4) risk of pregnancy (not using birth control), pregnancy, or recent pregnancy (currently nursing), (5) medications/medical conditions contraindicated for naltrexone. The full sample included 180

adults; the current evaluation only included participants with at least two heavy drinking occasions during the 7-day EMA period preceding randomization (i.e., 76%).

## Procedure

After providing informed consent, participants completed a battery of measures and were trained to complete the EMA battery using a handheld electronic diary (ED) provided to them for this study (PalmPilot IIIxe; Palm, Inc., Sunnyvale, CA). The EMA software was custom designed for this project (invivodata, inc., Pittsburgh, PA). Participants completed ED assessments (1) upon awakening each day (Morning Reports), (2) in response to audible prompts presented at random times during the waking day, approximately five times per day (Random Assessments), (3) at the start of each of the first two drinks each day (Begin Drink Reports), and (4) after completing each of the first two drinks each day (End Drink Reports). Participants completed 7 days of EMA data collection during the baseline period. At the end of the baseline period, all participants received 1 week of placebo medication. At the beginning of Week 3, participants were randomized to a week of placebo or naltrexone. The participants then completed 2 weeks of postrandomization EMA data collection. This study uses data only from the 7-day prerandomization EMA data collection period.

## Measures

### Subjective alcohol effects

Subjective effects were measured at random prompts and at the *second* of two end-drink reports. Two items each were used to quantify stimulating and sedating effects of alcohol. Items were shown in the following format, with keywords filled in for each relevant item and answered on a scale from 1 (*Not at all*) to 11 (*Extremely*): "How \_\_\_\_\_ do you feel right now?" For stimulating effects, we created an average between "aroused" and "energized." For sedating effects, we averaged "tired" and "sleepy."

### Affect

Like subjective effects, items measuring negative affect were included at random prompts and at the *second* end drink report, with keywords filled in for each relevant item using the following prompt and answered on a scale from 1 (*Not at all*) to 11 (*Extremely*): "How \_\_\_\_\_ do you feel right now?" For negative affect, we averaged responses to "irritable," "frustrated," "miserable," "tense," and "sad." For contentedness, there was only one question included in the prompts: "How contented do you feel right now?" We separately calculated subjective effect and affect groupings for the second end drink assessment. Predrinking, day-level comparators were calculated using average ratings for each

variable across all predrinking prompts (any random prompts) throughout the day prior to alcohol consumption.

### Next day evaluations

Next-day subjective evaluations of the previous day's drinking episode were measured in the morning report if participants reported drinking the day before. Participants were first prompted with: "Thinking of all your drinking yesterday..." Next, participants answered the following two items on a scale from 1 (*Not at all*) to 11 (*Extremely*): "How satisfying was drinking?" and "How pleasant was drinking?"

### Social context

The social context was measured with a single question at the first end drink report: "Were others with you?" Response options included "yes," "no," and "others in view." For primary analyses, we combined "no" and "others in view" as a solitary reference. We also re-analyzed data combining response options "yes" and "others in view," using only the "no" option as a solitary reference. The results of the analyses did not change. We elected to report the analyses including the social context as operationalized in the preregistration.

### Estimated blood alcohol concentration (eBAC)

To account for effects of consumption levels on end-drink ratings, momentary eBAC values at the time of the second end drink report were computed using a formula well-suited for ad lib drinking (Matthews & Miller, 1979). The formula calculated eBAC values from sex, weight, the average population rate for metabolizing alcohol, time elapsed in hours (per EMA timestamps), and cumulative number of standard drinks consumed. Standard drinks are calculated from participant reports of ounces and type of alcohol consumed. For the first drink of an episode, if participants reported having already started their drink, the number of minutes ago that participants reported starting to drink was added to time elapsed and included in the calculation of eBAC.

### AUD Symptom count

Symptoms of AUD were derived from structured interviews Structured Clinical Interview for DSM-IV Axis I Disorders–Patient Version (First et al., 2002).

### Data analysis

Secondary analyses were implemented with SAS 9.4 M7 software (SAS Institute Inc., 2002–2012). Residuals of dependent variables

were normally distributed, with only minor deviations, and were modeled continuously in analyses using multilevel linear regression models (see Appendix S1). Multilevel models in SAS 9.4 (PROC MIXED) had a two-level structure (days [Level 1] nested with persons [Level 2]) with random intercepts to reflect person-level differences in drinking-event level social context on momentary subjective stimulating and sedating effects, and momentary negative affect and contentedness. Random variation in slopes were assessed systematically with a model building approach (i.e., increasing model complexity in steps), which means each potential random slope was examined individually for significance. However, any addition of a random slope led to convergence issues and a nonpositive definite Hessian matrix, and for this reason only random intercepts were used in the analyses. Contemporaneous and next-day outcomes were each assessed once per day, i.e., at the second end-drink report and the next morning, respectively. Thus, Level 1 refers to day-level repeated assessments. For Hypothesis 1, the relevant dependent variable in each model was regressed on the social context of the corresponding drinking episode (i.e., with others=1; alone=0). Drinking location was included as a Level 1 covariate (elsewhere=1; home=0). Further, a predrinking random prompt average for each dependent variable was included to control for predrinking levels of that variable and isolate drink effects. Level 2 covariates included age, sex assigned at birth, and AUD symptom count. These models, using the predictors listed above, evaluated social context effects on (1) the stimulating and (2) sedating subjective effects of drinking, (3) contentedness and (4) negative affect, and (5) next-day positive subjective evaluations of drinking, in five different models.

For Hypothesis 2, eBAC at the second end drink report was included to account for consumption level when evaluating subjective drink effects. In analyses predicting next-day evaluation of the entire drinking event, the total number of standard drinks consumed during the prior drinking day accounted for consumption differences. Finally, Hypothesis 3 explored a cross-level interaction between the social drinking context variable and age.

## Sample size considerations

Following the helpful recommendation of a reviewer, we conducted a series of power simulations to better understand our ability to detect effects given the data available to us. Although we conducted these simulations after our results were known, we did not base these analyses on the observed effects but examined power for a range of possible associations under a set of assumptions. Following the approach of Lane and Hennes (2018, 2019), we assessed power using Monte Carlo simulations with repeated sampling (10,000 times) in SAS 9.3. Power is complex in MLM analyses, as multiple within- and between-person parameters influence the ability to detect effects. Simulations were calculated assuming three drinking days per person and 131 participants. We specified a residual variance characteristic of daily life data ( $\beta=0.4$ ),  $\alpha=0.05$ , and medium-sized individual differences (i.e., random intercept and slope) in the

outcome and the association of social context with the outcome ( $\beta_s=0.25$ ). Based upon these parameters, simulations indicated  $\geq 80\%$  power for a medium or larger main effects for social context and age ( $\beta_s \geq 0.21$ ) and a slightly larger cross-level interaction of social context and age ( $\beta \geq 0.23$ ). However, it is important to note that additive interactions, as we predicted in this study, will generally be smaller than the component main effects. This means that we would likely have needed to observe large main effects to reasonably observe a moderately sized interaction.

## RESULTS

### Descriptive statistics

Descriptive statistics are reported in Table 1. Participants were, on average, 28.06 (SD=10.88) years of age. The sample was predominantly male sex assigned at birth (58.0%) and White (93.6%; 3.6% Black, 2.8% identified with another race). Participants consumed alcohol a mean 3.11 days out of seven (Median=3, SD=1.58). Approximately two-thirds (67.9%) of the sample drank exclusively while in the presence of other known people. 24.1% drank both alone and in the presence of others, while 8.0% drank exclusively

TABLE 1 Descriptive statistics of the analytic sample (N=131).

Variable	%	M (SD)
Age		28.09 (10.70)
Sex (% female)	42.0	
Race		
White	93.6	
Black	3.6	
Other	2.8	
Alcohol dependence symptoms		3.11 (1.80)
Number of drinking days		3.11 (1.58)
Participant-level drinking event social context		
Exclusively alone	8.0	
Mixed	24.1	
Exclusively with others	67.9	
Average person-level eBAC		0.038 (0.021)
Total drinks		7.45 (3.74)
Person-level contentedness		6.80 (1.78)
Person-level negative affect		2.82 (1.55)
Person-level stimulating subjective response		5.72 (1.90)
Person-level sedating subjective response		3.77 (2.06)
Person-level next day drinking evaluations		7.78 (1.37)

Note: Person-level affect and subjective response means and standard deviations are reported from end drink reports.

Abbreviation: eBAC, estimated blood alcohol content.

while alone. Among those who drank in combination, a mean of 57.33% (Median=67%) of the drinking occasions occurred in the presence of others. Across all drinking occasions, the average eBAC was 0.038 (SE=0.021, Min=0.001, Max=0.16); eBAC was significantly greater when the drinking occasion occurred among known others (M=0.04; SE=0.001) compared to when alone (M=0.034, SE=0.003;  $t[411]=-2.74, p=0.006$ ). However, there were no differences in total drinks reported during the morning report across social (M=7.85, SE=0.46) and solitary drinking occasions (M=7.10; SE=0.80;  $t[325], -0.95, p=0.34$ ).

### Effect of the social context on affect and subjective response

Table 2 provides results of multilevel models exploring the influence of the social context on subjective response and negative affect and contentedness (Hypothesis 1). Associations for social context with each dependent variable were nonsignificant. There were significant, autoregressive effects of the predrinking average for each dependent variable in each model. Of other covariates, only weekend appeared to have a significant effect, with sedation ratings being lower on the weekend compared to weekdays. In models controlling for eBAC (Hypothesis 2), social context remained nonsignificant. Higher estimated BAC at the second drink report (i.e., ascending limb effect) was associated with greater contentedness; eBAC was not significantly associated with any other dependent variable. The interaction between age and social context (Hypothesis 3) was not associated with any of the dependent variables.

### Posthoc moderation analyses

Given that our hypotheses were not supported, we explored two posthoc moderations to determine whether the social context influences subjective effects and affect in subpopulations or under certain specific conditions. All results can be found in Table S1. First, we tested whether the social context interacted with the eBAC value at the second end drink report to influence contemporaneous drink effects. These putative interactions were not significant. Next, we tested whether social context interacted with total drinks consumed to influence next-day drink appraisals. There was a significant social context  $\times$  total drinks interaction ( $B=-0.12 [0.04], p=0.01$ ) for next-day evaluations. Figure 1 shows that, at low levels of alcohol consumption, there was no difference in next-day evaluation of the drinking event between those who consumed alcohol in a social versus solitary setting. As the total number of alcoholic beverages increase, however, evaluations of drinking events that occurred in a social setting became more positive ( $B=0.09 [0.02], p<0.001$ ), whereas evaluations of drinking events that occurred in solitary settings did not change ( $B=-0.03 [0.04], p=0.51$ ). The difference in slopes for social and solitary drinking occasions was significant ( $B=0.12 [0.04], p=0.009$ ), an effect that remains significant after a

Bonferroni correction for three tests. We also tested whether the social context interacted with sex assigned at birth. There was no significant interaction between the social context and sex assigned at birth in predicting any of our dependent variables.

## DISCUSSION

Drinking occasions often occur in the presence of others, rather than alone (Acuff et al., 2021), and the social context is a well-studied correlate of greater alcohol consumption (Caudill & Marlatt, 1975; Fairbairn & Sayette, 2014; Sayette et al., 2012). The specific conditions under which the social context relates to alcohol and its effects, however, are less clearly defined. The current pre-registered analysis explored the influence of social context on contemporaneous subjective response to alcohol and affect, as well as next-day appraisals, in daily life. Contrary to our pre-registered hypotheses, we did not find evidence that social context is associated with contemporaneous stimulating or sedating subjective responses to alcohol or with contentedness or negative affect or with next-day evaluations of how pleasant/satisfying the drinking event was. These findings were consistent across age (pre-registered) and biological sex (tested posthoc), where total drinks consumed (tested posthoc) emerged as a potential moderator for next-day drinking appraisals.

Overall, the lack of effect of the social environment on subjective effects and affect deviates from past laboratory findings demonstrating that consuming alcohol in the presence of peers was associated with greater positive affect (Bowdring & Sayette, 2021; Fairbairn et al., 2015) and stimulation (Kirkpatrick & de Wit, 2013). In the current study, average peak blood alcohol level at the second end drink report was less than 0.04, whereas the average peak was above 0.06 for all three studies demonstrating an effect of the social context on positive affect and stimulation. The social effect thus may interact with alcohol consumption and may only emerge at higher blood alcohol levels. This would also be consistent with the posthoc next day evaluation findings reported in the current study.

The study from which these data originated was not designed for the specific research questions herein, and characteristics of the data and it is important to understand how the characteristics of the methodology may have influenced results. Subjective effects and affect were measured after two drinks. While the in-daily-life assessment allowed for evaluating how social context influenced initial drinking effects, the assessment approach was likely insufficient to capture the full ascending blood alcohol curve for many drinking episodes and participants. It may be that the relationship between the social context and subjective effects and affect may differ nonlinearly as a function of the blood alcohol level, such that associations may only become apparent at BAC levels greater than those captured within the current study design. Further, because different questions were asked across different assessments, the current study tested hypotheses at a single assessment; however, relationships among variables may not be consistent across levels of analysis and may rather fluctuate over the course of the BAC.

**TABLE 2** Estimates of the effects of the social context on subjective effects and affect during a drinking episode.

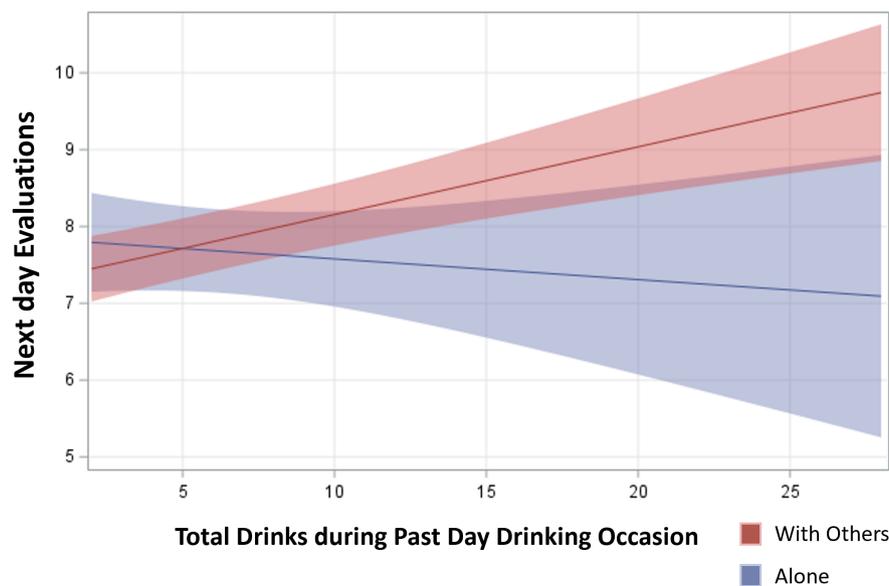
	Estimate	SE	df	t-Value	p-Value
<i>Stimulation</i>					
Intercept	3.68	0.63	223	5.84	<0.001
Sex (Ref. = Male)	0.11	0.27	104	0.42	0.68
Location (Ref. = Home)	-0.23	0.18	371	-1.25	0.21
Age	-0.02	0.01	123	-1.27	0.21
Weekend (Ref = Weekday)	0.27	0.16	297	1.69	0.09
AUD Symptoms	-0.07	0.07	107	-0.91	0.37
Pre-drinking average for stimulation	0.51	0.06	369	8.84	<0.001
Social context (Ref. = Alone)	0.13	0.25	358	0.54	0.59
Model 2					
Social context (Ref. = Alone)	0.10	0.25	362	0.38	0.70
Estimated BAC	7.21	4.75	366	1.52	0.13
Model 3					
Social context × Age	0.001	0.02	367	0.05	0.96
<i>Sedation</i>					
Intercept	1.07	0.61	210	1.76	0.08
Sex (Ref. = Male)	0.17	0.24	95.8	0.70	0.48
Location (Ref. = Home)	0.03	0.21	346	0.13	0.89
Age	0.02	0.01	116	1.35	0.18
Weekend (Ref. = Weekday)	-0.53	0.20	329	-2.69	0.007
Alcohol dependence symptoms	0.04	0.07	94.8	0.65	0.52
Pre-drinking average for sedation	0.51	0.05	268	10.51	<0.001
Social context (Ref. = Alone)	-0.17	0.29	371	-0.58	0.56
Model 2					
Social context (Ref. = Alone)	-0.17	0.29	367	-0.57	0.57
Estimated BAC	-1.05	5.44	363	-0.19	0.85
Model 3					
Social context × Age	0.003	0.02	354	0.15	0.88
<i>Negative affect</i>					
Intercept	1.00	0.40	213	2.5	0.01
Sex (Ref. = Male)	-0.08	0.17	105	-0.51	0.61
Location (Ref. = Home)	-0.02	0.14	366	-0.15	0.88
Age	-0.004	0.008	120	-0.46	0.65
Weekend (Ref. = Weekday)	-0.20	0.13	328	-1.61	0.11
Alcohol dependence symptoms	0.06	0.05	110	1.38	0.17
Pre-drinking average for negative affect	0.53	0.04	242	12.53	<0.001
Social context (Ref. = Alone)	0.04	0.19	376	0.20	0.84
Model 2					
Social context (Ref. = Alone)	0.05	0.19	374	0.24	0.81
Estimated BAC	-1.86	3.52	373	-0.53	0.60
Model 3					
Social context × Age	-0.002	0.01	369	-0.10	0.92
<i>Contentedness</i>					
Intercept	2.99	0.66	229	4.51	<0.001
Sex (Ref. = Male)	0.43	0.25	111	1.74	0.08

(Continues)

TABLE 2 (Continued)

	Estimate	SE	df	t-Value	p-Value
Location (Ref. = Home)	-0.07	0.20	383	-0.37	0.71
Age	0.01	0.01	128	0.45	0.65
Weekend (Ref. = Weekday)	-0.25	0.18	342	-1.35	0.18
Alcohol dependence symptoms	-0.03	0.07	118	-0.41	0.68
Pre-drinking average for contentedness	0.54	0.06	309	9.28	<0.001
Social context (Ref. = Alone)	0.26	0.28	389	0.92	0.36
<b>Model 2</b>					
Social context (Ref. = Alone)	0.20	0.28	388	0.71	0.48
Estimated BAC	11.79	5.21	386	2.26	0.02
<b>Model 3</b>					
Social context × Age	-0.007	0.02	380	-0.33	0.74
<i>Next-day evaluations</i>					
Intercept	7.15	0.56	213	12.83	<0.001
Sex (Ref. = Male)	0.12	0.26	131	0.47	0.64
Location (Ref. = Home)	-0.17	0.17	319	-1.00	0.32
Age	0.01	0.01	140	1.06	0.29
Weekend (Ref. = Weekday)	0.12	0.15	271	0.82	0.41
Alcohol dependence symptoms	0.05	0.07	132	0.76	0.45
Social context (Ref. = Alone)	0.18	0.25	312	0.71	0.49
<b>Model 2</b>					
Social context (Ref. = Alone)	0.19	0.25	314	0.75	0.46
Estimated BAC	-0.04	0.12	301	-0.31	0.76
<b>Model 3</b>					
Social context × Age	0.004	0.02	317	0.21	0.84

Abbreviations: BAC, Blood alcohol content; df, degrees of freedom; SE, Standard error.



**FIGURE 1** Interaction between total drinks and the social context predicting next day evaluations of the drinking event. Next-day evaluations of the past day drinking occasion split by whether the individual drank alone or with other known people. When drinking with known others, next-day evaluations increased as the total number of drinks increased. When drinking alone, however, next-day evaluations decreased as the total number of drinks increased.

Additionally, characteristics of the sample may also explain the lack of findings. Most of the extant research in this area studied college students, emerging adults, or social drinkers, whereas the current study examined people with higher levels of drinking and AUD severity. Higher levels of drinking overall may lead to greater tolerance, and thus known effects at low doses of alcohol would have been less likely to emerge. Indeed, eBAC was not associated with stimulation effects, although the effect was in the right direction. The second interpretation is that social context does not influence subjective effects or affect and there are, instead, alternative mechanisms through which the social context increases alcohol consumption. Perhaps the social context effects are anticipatory and occur before the drinking event begins. Our study averaged pre-drinking subjective effects and affect, which may obscure anticipatory effects. The sample was largely White, and a more diverse sample would increase representation and may reveal group differences that our data is unable to evaluate.

It is important to note that, although we had a moderately large sample, the number of drinking days per person was relatively small. Although the number of participants has a larger impact on power (Lane & Hennes, 2019), this still likely restricts our ability to detect effects. Power simulations conducted after analyses indicate that we had power to detect medium-sized associations but were underpowered to detect small associations that may still be of clinical importance. In particular, we were underpowered to detect cross-level interactions of social context of age of a size that we would be likely to observe. Thus, the observed null effects should be viewed in light of this. Nevertheless, they provide some indication that at low levels of alcohol consumption, the social context may have a small effect, if any, on subjective effects and affect, and that future research should extend these findings in samples measuring higher levels of eBAC.

Despite this, in posthoc analyses, we found a significant interaction between social context and the total number of drinks consumed in predicting next day evaluations of the drinking event. These effects suggest that, while the momentary effects may be important, some of the reinforcing effects of the social context may occur through next-day perceptions of the past drinking event. This is consistent with past research suggesting that social interactions may influence appraisals of past drinking consequences (Merrill et al., 2018, 2019). Interestingly, differences in appraisals for social and solitary drinking occasions did not deviate until approximately 10 or greater drinks during the drinking episode in our data, suggesting that these effects may not be observed at low drinking levels. It is possible that subjective effects and affect may have differed at this level of drinking as well; however, the current study did not record these data after the first two drinking reports, which reflects only the first two drinks. It should be noted that these analyses were secondary, posthoc analyses and therefore should be considered exploratory.

Future studies exploring similar research questions may consider a few additional points to maximize confidence in findings. Our study preregistered univariate outcome models, but models with correlated outcomes (e.g., sedation and stimulation) may provide an additional avenue to understand effects of the social context on subjective effects and affect. Further, we were unable to model random slopes, which

is a limitation of the current analyses. Finally, the internal consistency for stimulation was lower than for sedation, and future research may consider additional items to maximize internal consistency.

## CONCLUSION

The current study extends previous work demonstrating that the social context increases alcohol value and consumption through an investigation into the influence of the social context during the first two drinks of a drinking event on subjective effects, affect, and next-day evaluations among heavy drinking adults. Our results do not provide evidence supporting event-level subjective effects and affect as conditions under which the social context increases alcohol value or consumption. However, given some limitations of the data and analytic strategy, these findings do not conclusively rule out the role of the social context as a determinant of subject effects or affect in drinking. Posthoc analyses suggest that the social context during the first two drinks is associated with greater next-day evaluations of the drinking event at higher levels of alcohol consumption. This preliminary and exploratory result provides an initial basis for future research to understand the real-world relations of social context with subjective recollections of prior drinking events. The social context may exert a greater influence on subjective effects and affect at the person or momentary level; however, future research should explore other potential mechanisms. Further, the current study lacked variability in social context drinking, with most drinking occasions occurring in a social setting. Future research with a larger sample size and greater sampling rate of drinking events may reveal social context effects that the current study was underpowered to detect.

## ACKNOWLEDGMENTS

This work was supported by grants from the National Institute on Alcohol Abuse and Alcoholism (R01 AA007850, K23 AA029729, K24 AA026326) and the National Institute of General Medical Sciences (P20 GM130414). The content is solely the responsibility of the authors and does not necessarily represent the official views or policy of the National Institutes of Health.

## CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## ORCID

Samuel F. Acuff  <https://orcid.org/0000-0002-1934-2639>

Hayley Treloar Padovano  <https://orcid.org/0000-0001-5347-4291>

Ryan W. Carpenter  <https://orcid.org/0000-0002-1351-7071>

Noah N. Emery  <https://orcid.org/0000-0002-4891-2303>

Robert Miranda Jr.  <https://orcid.org/0000-0001-6418-6148>

## REFERENCES

- Acuff, S.F., Stoops, W.W. & Strickland, J.C. (2021) Behavioral economics and the aggregate versus proximal impact of sociality on heavy drinking. *Drug and Alcohol Dependence*, 220, 108523. Available from: <https://doi.org/10.1016/j.drugalcdep.2021.108523>
- Acuff, S.F., Strickland, J.C., Tucker, J.A. & Murphy, J.G. (2022) Changes in alcohol use during COVID-19 and associations with contextual and individual difference variables: a systematic review and meta-analysis. *Psychology of Addictive Behaviors*, 36, 1–19.
- Addicott, M.A., Marsh-Richard, D.M., Mathias, C.W. & Dougherty, D.M. (2007) The biphasic effects of alcohol: comparisons of subjective and objective measures of stimulation, sedation, and physical activity. *Alcoholism: Clinical and Experimental Research*, 31(11), 1883–1890. Available from: <https://doi.org/10.1111/j.1530-0277.2007.00518.x>
- Allen, J.P. & Loeb, E.L. (2015) The autonomy-connection challenge in adolescent peer relationships. *Child Development Perspectives*, 9(2), 101–105. Available from: <https://doi.org/10.1111/cdep.12111>
- Baker, T.B., Piper, M.E., McCarthy, D.E., Majeskie, M.R. & Fiore, M.C. (2004) Addiction motivation reformulated: an affective processing model of negative reinforcement. *Psychological Review*, 111(1), 33–51. Available from: <https://doi.org/10.1037/0033-295X.111.1.33>
- Battista, S.R. & Kocovski, N.L. (2010) Exploring the effect of alcohol on post-event processing specific to a social event. *Cognitive Behaviour Therapy*, 39(1), 1–10. Available from: <https://doi.org/10.1080/16506070902767613>
- Bowdring, M.A. & Sayette, M.A. (2021) The effect of alcohol on mood among males drinking with a platonic friend. *Alcoholism: Clinical and Experimental Research*, 45(10), 2160–2166. Available from: <https://doi.org/10.1111/acer.14682>
- Caudill, B.D. & Marlatt, G.A. (1975) Modeling influences in social drinking: an experimental analogue. *Journal of Consulting and Clinical Psychology*, 43, 405–415. Available from: <https://doi.org/10.1037/h0076689>
- Collins, W.A. & Steinberg, L. (2006) Adolescent development in interpersonal context. In: Damn, W. & Lerner, R.M. (Eds.) *Handbook of child psychology*. Hoboken, NJ: Wiley, pp. 551–578.
- Corbin, W.R., Hartman, J.D., Bruening, A.B. & Fromme, K. (2021) Contextual influences on subjective alcohol response. *Experimental and Clinical Psychopharmacology*, 29(1), 48–58. Available from: <https://doi.org/10.1037/pha0000415>
- Dora, J., Piccirillo, M., Foster, K.T., Arbeau, K., Armeli, S., Auriacombe, M. et al. (2023) The daily association between affect and alcohol use: a meta-analysis of individual participant data. *Psychological Bulletin*, 149(1–2), 1–24. Available from: <https://doi.org/10.1037/bul0000387>
- Dumas, T.M., Graham, K., Bernards, S. & Wells, S. (2014) Drinking to reach the top: young adults' drinking patterns as a predictor of status within natural drinking groups. *Addictive Behaviors*, 39(10), 1510–1515. Available from: <https://doi.org/10.1016/j.addbeh.2014.05.019>
- Ellis, B.J., Del Giudice, M., Dishion, T.J., Figueredo, A.J., Gray, P., Griskevicius, V. et al. (2012) The evolutionary basis of risky adolescent behavior: implications for science, policy, and practice. *Developmental Psychology*, 48(3), 598–623. Available from: <https://doi.org/10.1037/a0026220>
- Fairbairn, C.E. & Sayette, M.A. (2014) A social-attributional analysis of alcohol response. *Psychological Bulletin*, 140(5), 1361–1382. Available from: <https://doi.org/10.1037/a0037563>
- Fairbairn, C.E., Sayette, M.A., Aalen, O.O. & Frigessi, A. (2015) Alcohol and emotional contagion: an examination of the spreading of smiles in male and female drinking groups. *Clinical Psychological Science*, 3(5), 686–701. Available from: <https://doi.org/10.1177/2167702614548892>
- First, M.B., Spitzer, R.L., Gibbon, M. & Williams, J.B.W. (2002) *Structured clinical interview for DSM-IV-TR Axis I disorders, research version, patient edition. Biometrics research*. New York, NY: New York State Psychiatric Institute.
- Hingson, R.W., Zha, W. & White, A.M. (2017) Drinking beyond the binge threshold: predictors, consequences, and changes in the U.S. *American Journal of Preventive Medicine*, 52(6), 717–727. Available from: <https://doi.org/10.1016/j.amepre.2017.02.014>
- Jennison, K.M. (2004) The short-term effects and unintended long-term consequences of binge drinking in college: a 10-year follow-up study. *American Journal of Drug and Alcohol Abuse*, 30(3), 659–684.
- Kahler, C.W., Strong, D.R. & Read, J.P. (2005) Toward efficient and comprehensive measurement of the alcohol problems continuum in college students: the brief young adult alcohol consequences questionnaire. *Alcoholism, Clinical and Experimental Research*, 29(7), 1180–1189. Available from: <https://doi.org/10.1097/01.ALC.0000171940.95813.A5>
- Khantzian, E.J. (1997) The self-medication hypothesis of substance use disorders: a reconsideration and recent applications. *Harvard Review of Psychiatry*, 4(5), 231–244. Available from: <https://doi.org/10.3109/10673229709030550>
- King, A.C., de Wit, H., McNamara, P.J. & Cao, D. (2011) Rewarding, stimulant, and sedative alcohol responses and relationship to future binge drinking. *Archives of General Psychiatry*, 68(4), 389–399. Available from: <https://doi.org/10.1001/archgenpsychiatry.2011.26>
- King, A.C., Vena, A., Howe, M.M., Feather, A. & Cao, D. (2022) Haven't lost the positive feeling: a dose-response, oral alcohol challenge study in drinkers with alcohol use disorder. *Neuropsychopharmacology*, 47(11), 1892–1900. Available from: <https://doi.org/10.1038/s41386-022-01340-2>
- Kirkpatrick, M.G. & de Wit, H. (2013) In the company of others: social factors alter acute alcohol effects. *Psychopharmacology*, 230(2), 215–226. Available from: <https://doi.org/10.1007/s00213-013-3147-0>
- Koob, G.F. & Le Moal, M. (2008) Addiction and the brain antireward system. *Annual Review of Psychology*, 59, 29–53. Available from: <https://doi.org/10.1146/annurev.psych.59.103006.093548>
- Lane, S.P. & Hennes, E.P. (2018) Power struggles: estimating sample size for multilevel relationships research. *Journal of Social and Personal Relationships*, 35(1), 7–31. Available from: <https://doi.org/10.1177/0265407517710342>
- Lane, S.P. & Hennes, E.P. (2019) Conducting sensitivity analyses to identify and buffer power vulnerabilities in studies examining substance use over time. *Addictive Behaviors*, 94, 117–123. Available from: <https://doi.org/10.1016/j.addbeh.2018.09.017>
- Martin, C.S., Earleywine, M., Musty, R.E., Perrine, M.W. & Swift, R.M. (1993) Development and validation of the biphasic alcohol effects scale. *Alcoholism: Clinical and Experimental Research*, 17(1), 140–146. Available from: <https://doi.org/10.1111/j.1530-0277.1993.tb00739.x>
- Matthews, D.B. & Miller, W.R. (1979) Estimating blood alcohol concentration: Two computer programs and their applications in therapy and research. *Addictive behaviors*, 4(1), 55–60.
- McKetta, S. & Keyes, K.M. (2019) Heavy and binge alcohol drinking and parenting status in the United States from 2006 to 2018: an analysis of nationally representative cross-sectional surveys. *PLoS Medicine*, 16(11), 1–24. Available from: <https://doi.org/10.1371/journal.pmed.1002954>
- Meredith, L.R., Grodin, E.N., Montoya, A.K., Miranda, R., Jr., Squeglia, L.M., Towns, B. et al. (2022) The effect of neuroimmune modulation on subjective response to alcohol in the natural environment. *Alcoholism, Clinical and Experimental Research*, 46(5), 876–890. Available from: <https://doi.org/10.1111/acer.14821>
- Merrill, J.E., Miller, M.B., Dibello, A.M., Singh, S., Carey, K.B., Miller, M.B. et al. (2019) How do college students subjectively evaluate “blackouts”? *Addictive Behaviors*, 89, 65–69. Available from: <https://doi.org/10.1016/j.addbeh.2018.09.022>
- Merrill, J.E., Rosen, R.K., Boyle, H.K. & Carey, K.B. (2018) The influence of context in the subjective evaluation of “negative” alcohol-related

- consequences. *Psychology of Addictive Behaviors*, 32(3), 350–357. Available from: <https://doi.org/10.1037/adb0000361>
- Miranda, R., Monti, P.M., Ray, L., Treloar, H.R., Reynolds, E.K., Ramirez, J. et al. (2014) Characterizing subjective responses to alcohol among adolescent problem drinkers. *Journal of Abnormal Psychology*, 123(1), 117–129. Available from: <https://doi.org/10.1037/a0035328>
- Miranda, R. & Treloar, H. (2016) Emerging pharmacologic treatments for adolescent substance use: challenges and new directions. *Current Addiction Reports*, 3(2), 145–156. Available from: <https://doi.org/10.1007/s40429-016-0098-7>
- Murphy, J.G., Barnett, N.P. & Colby, S.M. (2006) Alcohol-related and alcohol-free activity participation and enjoyment among college students: a behavioral theories of choice analysis. *Experimental and Clinical Psychopharmacology*, 14(3), 339–349. Available from: <https://doi.org/10.1037/1064-1297.14.3.339>
- Neighbors, C., O'Connor, R.M., Lewis, M.A., Chawla, N., Lee, C.M. & Fossos, N. (2008) The relative impact of injunctive norms on college student drinking: The role of the reference group. *Psychology of Addictive Behaviors*, 22(4), 576–581. Available from: <https://doi.org/10.1037/a0013043>.The
- Plant, M.A., Bagnall, G. & Foster, J. (1990) Teenage heavy drinkers: alcohol-related knowledge, beliefs, experiences, motivation and the social context of drinking. *Alcohol and Alcoholism*, 25(6), 691–698. Available from: <https://doi.org/10.1093/oxfordjournals.alcalc.a045067>
- Sacks, J.J., Gonzales, K.R., Bouchery, E.E., Tomedi, L.E. & Brewer, R.D. (2015) 2010 national and state costs of excessive alcohol consumption. *American Journal of Preventive Medicine*, 49(5), e73–e79. Available from: <https://doi.org/10.1016/j.amepre.2015.05.031>
- SAMHSA. (2020) *Key substance use and mental health indicators in the United States: results from the 2020 National Survey on Drug Use and Health*. Rockville, MD: Center for Behavioral Health Statistics and Quality, p. 156.
- SAS Institute Inc. (2002–2004). *SAS 9.1.3 Help and Documentation*, Cary, NC: SAS Institute Inc.
- Sayette, M.A., Creswell, K.G., Dimoff, J.D., Fairbairn, C.E., Cohn, J.F., Heckman, B.W. et al. (2012) Alcohol and group formation: a multimodal investigation of the effects of alcohol on emotion and social bonding. *Psychological Science*, 23(8), 869–878. Available from: <https://doi.org/10.1177/0956797611435134>.Alcohol
- Shiffman, S. (2009) Ecological momentary assessment (EMA) in studies of substance use. *Psychological Assessment*, 21(4), 486–497. Available from: <https://doi.org/10.1037/a0017074>
- Skrzynski, C.J. & Creswell, K.G. (2021) A systematic review and meta-analysis on the association between solitary drinking and alcohol problems in adults. *Addiction (Abingdon, England)*, 116(9), 2289–2303. Available from: <https://doi.org/10.1111/add.15355>
- Stone, A.A. & Shiffman, S. (1994) Ecological momentary assessment (EMA) in behavioral medicine. *Annals of Behavioral Medicine*, 16(3), 199–202. Available from: <https://doi.org/10.1093/abm/16.3.199>
- Tidey, J.W., Monti, P.M., Rohsenow, D.J., Gwaltney, C.J., Miranda, R., McGeary, J.E. et al. (2007) Moderators of Naltrexone's effects on drinking, urge, and alcohol effects in non-treatment-seeking heavy drinkers in the natural environment. *Alcoholism: Clinical and Experimental Research*, 32(1), 58–66. Available from: <https://doi.org/10.1111/j.1530-0277.2007.00545.x>
- Treloar, H., Celio, M.A., Lisman, S.A., Miranda, R. & Spear, L.P. (2017) Subjective alcohol responses in a cross-sectional, field-based study of adolescents and young adults: effects of age, drinking level, and dependence/consequences. *Drug and Alcohol Dependence*, 170, 156–163. Available from: <https://doi.org/10.1016/j.drugalcdep.2016.11.009>
- Wycoff, A.M., Carpenter, R.W., Hepp, J., Piasecki, T.M. & Trull, T.J. (2021) Real-time reports of drinking to cope: associations with subjective relief from alcohol and changes in negative affect. *Journal of Abnormal Psychology*, 130(6), 641–650. Available from: <https://doi.org/10.1037/abn0000684>

## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

**How to cite this article:** Acuff, S.F., Padovano, H.T., Carpenter, R.W., Emery, N.N. & Miranda, R. Jr. (2024) Effects of social drinking context on subjective effects, affect, and next-day appraisals in the natural environment. *Alcohol: Clinical and Experimental Research*, 48, 755–765. Available from: <https://doi.org/10.1111/acer.15286>