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Testing Bidirectional Associations among Emotion Regulation Strategies and Substance Use: A Daily Diary Study

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Abstract

Background and aims—Alcohol and marijuana are widely used among college students. Emotion regulation strategies have been linked to alcohol and marijuana use but little attention has been devoted to modeling the directionality of these associations. Aims of the current study were to test whether (a) daytime use of emotion regulation strategies influences the likelihood of evening substance use and (b) evening substance use influences the likelihood of next-day use of emotion regulation strategies.

Design—Longitudinal daily diary data were collected for 30 days via online surveys.

Setting—Northeastern United States.

Participants—1,640 college students (*M*age = 19.2, 54% female, 80% European American) were recruited each semester between spring 2008 and spring 2012.

Measurements—Daily diaries assessed emotion regulation strategies (distraction, reappraisal, problem-solving, avoidance) and substance use (any drinking, heavy drinking, marijuana use, co-use of any drinking/heavy drinking and marijuana). Covariates included gender, age, race/ethnicity, fraternity/sorority involvement, and baseline depression.

Findings—Daytime distraction (odds ratio *OR*=.95), reappraisal (*OR*=.95), and problem-solving (*OR*=.94) predicted lower odds of evening marijuana use (*p-values*<.02). Evening heavy drinking (*OR*=.90) and marijuana use (*OR*=.89) predicted lower odds of next-day problem-solving, with

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heavy drinking also predicting higher odds ($OR=1.08$) of next-day avoidance and marijuana use also predicting higher odds ($OR=1.08$) of next-day reappraisal (p -values $<.03$).

Conclusions—There appear to be reciprocal relations among emotion regulation strategies (distraction, reappraisal, and problem-solving) and substance use: greater daytime use of emotion regulation strategies predicts lower evening substance use, while higher evening substance use predicts higher next day avoidance and reappraisal but lower next-day problem-solving.

Keywords

alcohol; drinking; marijuana; reappraisal; problem-solving; distraction; avoidance; substance use; emotion regulation

Alcohol and marijuana are widely used substances among college students internationally (1–4). Results of a national survey of college students (5) indicate high rates of past 30-day drinking (59%) and heavy drinking (i.e., consuming 4 standard drinks for females and 5 standard drinks for males; 39%). Moreover, roughly one in five college students (21%) report past 30-day marijuana use (3). These high rates of alcohol and marijuana use are particularly troubling given evidence of their deleterious outcomes among college students (6, 7), underscoring the need to understand the predictors and consequences of alcohol and marijuana use in this population.

One important factor related to alcohol and marijuana use is emotion regulation. Theoretical and empirical literature has linked emotion regulation to numerous health outcomes (8), and deficits in emotion regulation are considered a key mechanism in the etiology, maintenance, and course of a wide range of clinically-relevant difficulties (9). As defined here, emotion regulation refers to the processes through which individuals influence which emotions they have, when they have them, and how these emotions are experienced and expressed (10). Individuals may use a variety of emotion regulation strategies to modulate the intensity and/or duration of their emotional experiences. The specific strategies individuals use to regulate their emotions are differentially related to their health outcomes (11). For instance, strategies aimed at reducing distress such as distraction (i.e., temporarily directing attention toward something other than a distressing emotion), reappraisal (i.e., generating nonthreatening or positive interpretations of a situation), and problem-solving (i.e., specific actions aimed at changing a situation or reducing its negative consequences) are considered adaptive strategies because they are generally associated with better outcomes across a wide range of contexts (11). Conversely, avoidance (i.e., refraining, or escaping, from an action, person, or thing that elicits distress) is generally associated with poorer outcomes, and thus is considered a maladaptive strategy (11).

Regarding the association between emotion regulation and substance use in particular, theory suggests individuals use alcohol and marijuana to escape or avoid aversive emotions (12), consistent with negative reinforcement (13). Moreover, dysregulation of mood has been shown to be a stronger predictor of substance use than level of negative affect (14, 15). Indeed, emotion regulation deficits are common among individuals who report problematic alcohol (16) and marijuana (17) use. Specifically, and consistent with research on other health outcomes, past studies have found distraction, reappraisal, and problem-solving to be

related to less alcohol and marijuana use, and avoidance to be related to more alcohol and marijuana use (18–20). The differential emotional consequences of adaptive and maladaptive emotion regulation strategies may explain their divergent relations with substance use. In particular, adaptive strategies are related to larger decreases in negative affect than maladaptive strategies (21), thus, they likely result in greater reductions in motivations to use these substances (17, 22).

However, research to date has relied almost exclusively on cross-sectional designs, so little is known about the directionality of associations among emotion regulation strategies and substance use. Current research primarily conceptualizes emotion regulation influencing substance use, yet there is preliminary evidence to support a bidirectional association, whereby substance use may decrease later adaptive strategies and increase later maladaptive strategies. For instance, substance use has been shown to increase next-day emotional vulnerability (e.g., heighten negative affect) (23, 24). Because greater negative affect is more difficult to modulate (25), individuals may be more likely to use strategies that function to immediately reduce these emotional experiences, such as avoidance, the day after substance use. Alternatively, and consistent with the ego-depletion model (26), this next-day emotional vulnerability may deplete self-regulatory resources (23), decreasing the likelihood of using strategies that require more cognitive resources, such as distraction, reappraisal, or problem-solving (27). These findings suggest possible reciprocal relations among emotion regulation strategies and substance use that need to be evaluated using intensive longitudinal data.

Extending prior research, the current study utilized daily diary data collected over 30 days among 1,640 college students to test whether (a) daytime emotion regulation strategies influence the likelihood of evening substance use, and (b) evening substance use influences the likelihood of next-day emotion regulation strategies. We hypothesized bidirectional relations such that (a) daytime adaptive strategies (distraction, reappraisal, problem-solving) would decrease the likelihood of evening substance use and daytime maladaptive strategies (avoidance) would increase the likelihood of evening substance use, and (b) evening substance use would decrease the likelihood of next-day adaptive strategies and increase the likelihood of next-day maladaptive strategies. Of note, we did not expect alcohol and marijuana use to differ in their associations with adaptive and maladaptive strategies.

Methods

Design

Longitudinal daily diary measures were collected for 30 days assessing daily use of emotion regulation strategies (i.e., distraction, reappraisal, problem-solving, avoidance) and substances (i.e., alcohol and marijuana). Time-lagged models were used to assess bidirectional relations: (a) use of emotion regulation strategies earlier in the day predicting evening substance use, and (b) evening substance use predicting next-day use of emotion regulation strategies.

Participants

Undergraduate psychology students were recruited as part of a project examining daily experiences and alcohol use over nine semesters (spring 2008–spring 2012). Eligibility criteria were: (a) 18 years of age, (b) alcohol use at least twice in the past 30 days, (c) no past treatment for alcohol problems. The final sample included 1,640 students; 54% were female and the average age was 19.2 ($SD=1.4$). In terms of race/ethnicity, 80% were European American, 12% Asian American, 4% African American, 4% Latino, and 1% Native American or other.

Procedures

Procedures were approved by the institutional review board at the University of Connecticut. Students were recruited through the undergraduate psychology participant pool and an email-based campus-wide announcements system. Students provided informed consent and completed an online baseline survey assessing demographics (e.g., gender, age, race/ethnicity, fraternity/sorority involvement) and a variety of behavioral and personality measures (e.g., baseline depression using the Beck Depression Inventory-11 [BDI-11]) (28). Students were then instructed to provide daily diary data for 30 days via online surveys, available from a secure website between 2:30pm and 7:00pm. Surveys assessed behaviors “since completing yesterday’s survey” and “since waking until the time of the report” to cover the entire daily period. If students missed that day’s survey, they were prompted to report about their drinking behavior for up to three days prior, which contributed an additional 5,259 reports, 14.4% of which ($n=1,293$) included evening drinking episodes. Sensitivity analyses with and without these backfilled data yielded similar results, so results are presented from all available data ($n=48,409$).

Daily Measures

Emotion regulation strategies—Use of emotion regulation was measured by asking what strategies had been used so far today (“since waking until the time of the report”) in response to any stressful events or experiences. Emotion regulation strategies included: *distraction* (“I tried to distract myself and keep my mind off of a problem”), *reappraisal* (“I tried to see the problem in a positive light”), *problem-solving* (“I put aside other activities/suppressed other thoughts to focus on a problem that needed my attention”), and *avoidance* (“I avoided dealing with a situation”), rated from 0 (not at all) to 3 (a lot). Responses were dichotomized into any use of the strategy (yes/no).

Alcohol use—Evening alcohol use was measured by asking how many standard alcoholic drinks (e.g., 12-oz can or bottle of beer, 5-oz glass of wine) were consumed last night (“since completing yesterday’s survey”). For ease of comparison with marijuana use and co-use (described below), alcohol use was dichotomized (yes/no) into 1) any drinking and 2) heavy drinking (based on NIAAA guidelines (29) 4 or 5 standard drinks for females or males, respectively). Models predicting evening alcohol use controlled for daytime alcohol use, measured in the same manner, with reference to “since waking until the time of the report.”

Marijuana use—Evening marijuana use was measured by asking if marijuana was used (yes/no) the night before (“since completing yesterday’s survey”). Models predicting evening marijuana use controlled for daytime marijuana use (“since waking until the time of the report”).

Alcohol and Marijuana Co-use—Polysubstance use was examined as the co-occurrence of 1) any drinking and marijuana use and 2) heavy drinking and marijuana use in the same evening. Models predicting evening co-use controlled for daytime alcohol and marijuana use.

Data Analysis

A series of multilevel models were tested using Hierarchical Linear Modeling (HLM) version 6.02 software to evaluate the relations among emotion regulation strategies and substance use during the 30-day period. Daily reports ($n=43,020$) comprised level-1 variables nested within person at level-2 ($n=1634$). Multilevel modeling allows us to estimate within-person relations among emotion regulation and substance use on a daily level while considering how these effects vary by individual and accounting for the autocorrelation structure of repeated assessments within an individual. All models included level-1 covariates of study day (time), and six contrast variables for days of the week to control for weekly substance use trends. Results are presented from unadjusted models and models adjusted for level-2 covariates (i.e., sex, race, age, fraternity or sorority status, and baseline depression score).

Time-lagged hierarchical linear models were used to examine the impact of emotion regulation strategies used earlier in the day on substance use later in the evening, controlling for substance use during the day.

$$\text{SubstanceUse}_t = \pi_{0i} + \pi_{1i}(\text{ERdaily}_{it}) + \pi_{2i}(\text{DayUse}_{it}) + \pi_{3i}(\text{Time}_{it}) + e_{it},$$

$$\pi_{0i} = \beta_{00} + \beta_{01}(\text{ERMean}_i) + u_{1i}$$

Emotion regulation strategies (distraction, reappraisal, problem-solving, avoidance) were entered as binary predictors (yes/no) at level 1. Then, person-level means of each strategy were entered at level-2 to disaggregate day-level effects (i.e., odds of substance use when a particular strategy was used that day, ERdaily_{it}) and person-level effects (i.e., odds of substance use based on person i 's overall frequency of using particular strategies, ERMean_i).

Next, substance use the night before was examined as a predictor of using emotion regulation strategies the next day (assessed in the same reporting period).

$$\text{ERstrategy}_{t+1} = \pi_{0i} + \pi_{1i}(\text{SubstanceUse}_t) + \pi_{2i}(\text{Time}_{it}) + e_{it},$$

$$\pi_{0i} = \beta_{00} + \beta_{01}(\text{SubstanceUseMean}_i) + u_{1i}$$

Person-level means were entered at level-2 to disaggregate day-level effects (i.e., odds of emotion regulation strategies after substance use the previous day, SubstanceUse_t) and

person-level effects (i.e., odds of emotion regulation strategies based on person i 's overall frequency of substance use).

Analyses specified a Bernoulli distribution with a logit link function to model the binary outcomes of substance use (any drinking, heavy drinking, marijuana use, co-use of alcohol and marijuana) and use of emotion regulation strategies (yes/no). Models were set with a random intercept and random effects for predictors of interest (emotion regulation strategies and substance use) to allow regression coefficients to vary across individuals. Models were run using full information maximum likelihood estimation, and converged normally. Results are presented from population-average models with robust standard errors.

Results

Table 1 presents the rates of endorsement for emotion regulation and substance use across the sample, estimated as the proportion of positively endorsed instances for each individual. On average, participants completed 26.3 ($SD=3.8$) of the 30 reports. Those who completed a majority (at least 25 of 30) of the daily assessments did not differ from those who completed fewer by age, race, fraternity/sorority status, or baseline depression score. However, more females (82.2%) than males (65.7%) completed at least 25 reports, $\chi^2(n=1,640)=58.98, p<.001$. Results focus on heavy drinking outcomes throughout since effects did not differ between outcomes of any drinking or heavy drinking (except where noted).

Daytime emotion regulation predicting evening substance use

Table 2 presents results from unadjusted and adjusted models (including level-2 covariates) examining the effects of daytime emotion regulation strategies on evening substance use, while controlling for daytime substance use. Although unadjusted results indicate significant person-level effects predicting heavy drinking (i.e., people who more often use distraction, reappraisal, or problem-solving are less likely to engage in heavy drinking), these effects were no longer significant once including other person-level covariates. In adjusted models, people who more often use distraction, reappraisal, and problem-solving were less likely to engage in marijuana use; distraction and problem-solving were also negatively related to co-use of alcohol and marijuana. At the daily level, the odds of marijuana use later in the day were significantly lower on days when distraction, reappraisal, or problem-solving were used, and similar results are seen for co-use with the exception that distraction was not significant.

Supplemental Tables 1a–c present full model results including all covariates. Evening substance use was more likely among those who are white, male, and a member of a fraternity or sorority (all p 's<.05) and co-use of alcohol and marijuana was more likely among younger individuals ($p<.01$). Additionally, those with higher baseline depression scores were more likely to engage in evening marijuana use or co-use of alcohol and marijuana ($p<.01$).

Evening substance use predicting next-day emotion regulation

Table 3 presents results from unadjusted and adjusted models (including level-2 covariates) examining the effects of evening substance use on next-day use of emotion regulation

strategies. Unadjusted results indicate several significant person-level effects, such that individuals who more often engage in marijuana use or co-use of alcohol and marijuana are less likely to use distraction, reappraisal, or problem-solving. Similar effects are seen for individuals who more often drink heavily, except the effect on next-day distraction is not significant ($p=.08$). However, once controlling for other level-2 covariates, the most robust person-level finding is that individuals who more often engage in co-use of alcohol and marijuana are significantly less likely to use problem-solving the next day. At the daily level, heavy drinking, marijuana use, or co-use on a given day reduced the odds of problem-solving the next day. Heavy drinking also increased the odds of next day avoidance, and this effect was specific to heavy drinking (not any drinking). Unexpectedly, use of marijuana on a given day increased the odds of using reappraisal strategies the next day.

Supplemental Tables 2a–c present full model results including all covariates. The most consistent finding among the level-2 covariates was that males were less likely to use all emotion regulation strategies, compared to females ($p<.001$). Additionally, those with higher baseline depression scores were more likely to use distraction, problem-solving, and avoidance strategies ($p's<.03$) but not reappraisal strategies ($p>.40$). Other covariates (age, white, fraternity/sorority status) were not consistently related to next-day use of emotion regulation strategies across models.

Discussion

The current study examined bidirectional daily associations among emotion regulation strategies and substance use. Relations among daytime emotion regulation strategies and evening substance use provide partial support for our first hypothesis. Building on past cross-sectional studies (11), our findings underscore the protective role of adaptive emotion regulation strategies (i.e., distraction, reappraisal, problem-solving) in reducing subsequent substance use. Specifically, at the person-level, individuals who used these strategies more frequently were less likely to report heavy drinking, marijuana use, or co-use of both alcohol and marijuana, with the most robust findings seen for marijuana use and co-use once including other person-level covariates. Furthermore, at the day-level, use of adaptive strategies was associated with lower odds of marijuana use or co-use later in the evening.

Inconsistent with expectations, daytime avoidance did not increase the odds of evening substance use. This finding may be an artifact of the sample. For instance, whereas avoidance has been identified as a key motive for substance use (17, 22), college students' substance use may be more strongly driven by internal (e.g., to elicit, maintain, or enhance positive emotional states) and external (i.e., to increase social affiliation) positive reinforcement than avoidance of stressors (30), suggesting that daytime avoidance may not predict evening substance use among college students. Given evidence to suggest that avoidance predicts drinking to cope among college students (31), it is also possible that avoidance predicts drinking motivation more than alcohol consumption (i.e., avoidance affects the reason for drinking but perhaps not the decision to drink or the amount consumed). Future research is needed to test whether avoidance predicts substance use in other populations and across various contexts.

Relations among evening substance use and next-day emotion regulation strategies provide partial support for our second hypothesis. Generally speaking, our results suggest that evening heavy drinking, marijuana use, or co-use of both alcohol and marijuana decrease the likelihood of next-day adaptive strategies and increase the likelihood of next-day maladaptive strategies. In models including other person-level covariates, the most robust finding was that substance use (alcohol use, marijuana use, or co-use) reduced the likelihood of next-day problem-solving, consistent with earlier literature. Research suggests this may be due to these substance's impact on executive functioning. For instance, there is a residual effect of marijuana on executive functioning that lasts approximately 12–24 hours (32). Likewise, “hangover,” one consequence of heavy drinking, also has been related to next-day deficits in executive functioning (33). This may be due to sleep deprivation and related fatigue stemming from heavy drinking (34), which have been linked to executive functioning deficits (35, 36). Research is needed to explore these and other mechanisms that may underlie the association between evening substance use and next-day problem-solving.

Evening heavy drinking was also related to higher odds of next-day avoidance. It is possible that greater negative affect accounted for this association (because heavy drinking increases next-day negative affect, which is more difficult to regulate and depletes self-regulatory resources) (23, 25). Alternatively, the physiological consequences of heavy drinking (e.g., “hangover”) may account for the increased odds of next-day avoidance. For instance, fatigue drains self-regulatory resources (37), which may increase the likelihood of emotion regulation strategies that require less cognitive resources, such as avoidance (27). Investigations that improve our understanding of this relation are warranted.

Unexpectedly, evening marijuana use did not predict next-day avoidance, but it was associated with a higher odds of next-day reappraisal, a strategy that is generally considered adaptive. Marijuana has been linked to enhanced creativity (38) and divergent thinking (39). As such, marijuana use may improve an individual's ability to generate nonthreatening or positive interpretations of a situation. Investigations examining the impact of marijuana use on subsequent reappraisal are needed.

Finally, it warrants mention that, inconsistent with past cross-sectional studies, our day-level analyses suggest that emotion regulation strategies demonstrate differential relations with heavy drinking and marijuana use. In general, marijuana use demonstrated more significant relations with emotion regulation strategies than heavy drinking. For instance, use of each of the adaptive emotion regulation strategies was related to a lower likelihood of later marijuana use but not heavy drinking, suggesting adaptive strategies may be more protective against marijuana use than heavy drinking among college students. Alternatively, counter to research suggesting overlapping motives for alcohol and marijuana use (12), college students' reasons for heavy drinking and marijuana use may have differed in our sample. For example, heavy drinking may have been more strongly linked to social or enhancement motives rather than coping motives (30), while marijuana use may have been used to manage ongoing, unresolved stressors. Indeed, drinking is both legal and normative among some college students (5) and thus social factors, such as the presence of drinking peers (40–42), may have exerted a greater influence on heavy drinking compared to marijuana use.

Although these findings provide important new information about the directionality of emotion regulation-substance use relations, limitations are noteworthy. First, whereas literature differentiates between “adaptive” and “maladaptive” emotion regulation strategies, recent conceptualizations have underscored the importance of context in determining whether a strategy is adaptive or maladaptive (43). Research is needed to better understand the role of context in the relations explored here. For instance, future investigations may examine the occurrence and severity of daily problems, stress, and/or negative affect that might have prompted the need for emotion regulation. Additionally, research is needed to better understand the role of peer context (e.g., quality of peer relationships, peer substance use) in the relations examined here given a robust body of evidence linking peer-related factors to substance use among college students (40–42). Moreover, we examined the use of emotion regulation strategies to manage stress in particular, however, these strategies may be employed at other times (e.g., to manage negative affect unrelated a particular situation [e.g., depression (44)] or to manage other emotions [e.g., positive (45)]). Further, while distraction has generally been found to be adaptive, our measure did not differentiate between the various functions distraction may serve (i.e., long- [which is likely maladaptive] versus short- [which is likely adaptive] term redirection).

Second, the current study did not comprehensively examine all emotion regulation strategies (e.g., rumination, acceptance, suppression) or substances (e.g., opioids, cocaine, tobacco), nor did it examine substance-related factors (e.g., substance use motives). Further research should also consider severity of marijuana use given evidence for dose-dependent effects (46). Additionally, it will be important to consider how sequential days of substance use may impact emotion regulation. Third, the daily diaries were intentionally brief so surveys did not comprehensively assess whether any stressful event occurred, although all participants reported daily use of emotion regulation strategies. As such, days where no strategy was used could signal no need (i.e., no stressful event occurred) or a stressful experience without use of an emotion regulation strategy. Fourth, although the effects of measurement reactivity are generally small and occur only under certain conditions, daily collection methods may influence the behaviors being measured (e.g., participants may gain increased awareness of contingencies) (47). Finally, our findings may not generalize to other substance-using populations or more diverse samples (e.g., age, race/ethnicity, education). For instance, although we had high completion rates on average, missingness was associated with male gender, lower reappraisal, and greater substance use, suggesting the potential for reporting bias. Further, all participants reported past-month alcohol use (compared to 59% of college students in the general population) (5). Replication across diverse samples and substances is needed, especially given that some of the observed effect sizes estimates were small.

Despite these limitations, findings of the present study provide preliminary support for reciprocal relations among emotion regulation strategies and substance use, underscoring the potential utility of targeting (a) emotion regulation in the treatment of substance use and (b) substance use in the treatment of other disorders characterized by emotion regulation deficits. Many empirically-supported treatments for substance use (e.g., cognitive behavioral therapy, dialectical behavior therapy) include techniques that are thought to increase adaptive emotion regulation strategies (18, 48, 49). Similarly, in the past decade, treatments targeting emotion regulation have increased exponentially (9), and some of these treatments

include techniques for reducing substance use (49). Yet, a dearth of research has examined bidirectional effects of treatment. Investigations that test whether changes in emotion regulation mediate decreases in substance use following intervention as well as whether changes in substance use mediate improvements in emotion regulation following intervention are warranted. Further, future research should examine potential moderators of the emotion regulation-substance use relations to identify groups for whom these associations may be strongest (and thus in greatest need of intervention).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1
Rates of endorsement for emotion regulation and substance use across the sample

Variables				
Emotion Regulation Strategies	Overall	Completers (n=1224)	Non-Completers (n=416)	p-value
Distraction, M (SD)	45.4% (35.2%)	46.2% (35.4%)	42.9% (34.3%)	0.10
Reappraisal, M (SD)	50.6% (37.4%)	51.7% (37.7%)	47.2% (36.6%)	0.03
Problem-Solving, M (SD)	50.8% (36.0%)	51.7% (36.0%)	48.1% (35.6%)	0.08
Avoidance, M (SD)	32.6% (32.2%)	32.2% (32.2%)	33.7% (31.9%)	0.41
Substance Use				
Evening Heavy Drinking, M (SD)	11.7% (11.6%)	10.4% (10.4%)	15.6% (14.0%)	<.001
Evening Marijuana Use, M (SD)	6.9% (17.7%)	5.0% (14.8%)	12.4% (23.6%)	<.001
Evening Co-Use (Heavy Drinking and Marijuana), M (SD)	1.6% (4.3%)	1.3% (3.9%)	2.5% (5.4%)	<.001

Note: Rates of endorsement are estimated as the proportion of positively endorsed instances for each individual. T-tests evaluated differences between those who completed at least 25 out of 30 reports (completers) and non-completers.

Emotion regulation strategies used earlier in the day predicting evening substance use

Table 2

UNADJUSTED	Heavy Drinking					Marijuana Use					Co-Use				
	B	SE	OR	[95%CI]	p	B	SE	OR	[95%CI]	p	B	SE	OR	[95%CI]	p
Level-Two															
Distract Mean	-0.16	0.08	0.86	[0.74-0.99]	0.04	-0.28	0.08	0.75	[0.64-0.88]	0.001	-0.41	0.06	0.66	[0.58-0.76]	<001
Reappraisal Mean	-0.22	0.07	0.80	[0.69-0.92]	0.003	-0.30	0.08	0.74	[0.63-0.86]	<001	-0.21	0.07	0.80	[0.70-0.92]	0.003
Problem-Solving Mean	-0.18	0.08	0.83	[0.72-0.96]	0.02	-0.58	0.20	0.56	[0.38-0.82]	0.004	-0.34	0.07	0.71	[0.62-0.82]	<001
Avoidance Mean	-0.08	0.08	0.91	[0.78-1.08]	0.28	0.10	0.22	1.10	[0.72-1.70]	0.64	-0.22	0.07	0.79	[0.69-0.92]	0.002
Level-One															
Distract	-0.004	0.03	0.99	[0.93-1.06]	0.88	-0.03	0.02	0.96	[0.93-1.01]	0.11	-0.002	0.04	0.99	[0.92-1.07]	0.94
Reappraisal	-0.01	0.03	0.99	[0.92-1.06]	0.82	-0.04	0.02	0.95	[0.92-0.99]	0.02	-0.18	0.04	0.83	[0.78-0.90]	<001
Problem-Solving	-0.04	0.03	0.95	[0.89-1.02]	0.16	-0.06	0.07	0.94	[0.81-1.08]	0.35	-0.12	0.03	0.88	[0.82-0.94]	<001
Avoidance	0.02	0.03	1.02	[0.95-1.08]	0.62	-0.02	0.07	0.97	[0.84-1.12]	0.72	0.06	0.04	1.07	[0.99-1.15]	0.07
ADJUSTED															
ADJUSTED	Heavy Drinking					Marijuana Use					Co-Use				
	B	SE	OR	[95%CI]	p	B	SE	OR	[95%CI]	p	B	SE	OR	[95%CI]	p
Level-Two															
Distract Mean	0.01	0.08	1.01	[0.86-1.18]	0.88	-0.16	0.08	0.84	[0.72-0.98]	0.03	-0.29	0.07	0.74	[0.64-0.86]	<001
Reappraisal Mean	-0.06	0.07	0.93	[0.80-1.08]	0.34	-0.16	0.08	0.85	[0.73-0.98]	0.03	-0.07	0.07	0.92	[0.80-1.07]	0.32
Problem-Solving Mean	-0.06	0.08	0.94	[0.80-1.09]	0.41	-0.21	0.08	0.81	[0.69-0.94]	0.009	-0.22	0.08	0.80	[0.69-0.93]	0.004 ⁺
Avoidance Mean	0.08	0.08	1.08	[0.91-1.28]	0.36	0.01	0.08	1.01	[0.85-1.18]	0.94	-0.14	0.08	0.87	[0.75-1.01]	0.06
Level-One															
Distract	0.01	0.04	1.01	[0.94-1.08]	0.86	-0.04	0.02	0.95	[0.92-0.99]	0.02	-0.02	0.04	0.98	[0.90-1.05]	0.52
Reappraisal	-0.01	0.04	0.99	[0.92-1.06]	0.88	-0.04	0.02	0.95	[0.91-0.99]	0.02	-0.19	0.04	0.82	[0.76-0.89]	<001
Problem-Solving	-0.04	0.04	0.96	[0.89-1.03]	0.30	-0.06	0.02	0.94	[0.89-0.97]	0.001	-0.11	0.04	0.89	[0.83-0.96]	0.002
Avoidance	0.02	0.03	1.02	[0.96-1.10]	0.44	-0.02	0.02	0.98	[0.94-1.02]	0.40	0.08	0.04	1.08	[0.99-1.16]	0.06

Note: Level-two=person level. Level-one=daily level. OR=Odds Ratio. 95%CI=Confidence Interval. Significant effects ($p<.05$) are indicated in bold text. Unadjusted models included study day (time), daytime substance use, and days of the week at level-1 to account for substance use trends over time. Adjusted models also included level-2 covariates (age, race, sex, fraternity/sorority status, baseline depression score (Beck Depression Inventory)). See Supplemental Tables 1a–c for full covariate results. Binary outcomes included heavy drinking, marijuana use, and co-use where both heavy drinking and marijuana use occurred. Similar results were seen in both heavy drinking and any drinking outcomes.

⁺ Similar results were seen in models estimating co-use based on any drinking and marijuana use, except problem-solving at level-2 was no longer significant ($B=-0.06$, $SE=0.07$, $p=0.35$).

Table 3

Evening substance use predicting next-day use of emotion regulation strategies

UNADJUSTED	Distraction				Reappraisal				Problem-Solving				Avoidance			
	B	SE	OR [95%CI]	p	B	SE	OR [95%CI]	p	B	SE	OR [95%CI]	p	B	SE	OR [95%CI]	p
Level-Two																
Heavy Drinking Mean	-0.50	0.29	0.60 [0.34-1.07]	0.08	-0.80	0.31	0.44 [0.24-0.82]	0.01	-0.64	0.30	0.52 [0.28-0.95]	0.03	-0.10	0.28	0.90 [0.52-1.58]	0.72
Marijuana Use Mean	-0.48	0.20	0.61 [0.42-0.90]	0.01	-0.66	0.22	0.52 [0.33-0.81]	0.004	-0.52	0.22	0.59 [0.38-0.90]	0.01	-0.12	0.18	0.88 [0.62-1.26]	0.50
Co-Use Mean	-1.95	0.78	0.14 [0.03-0.65]	0.01	-2.23	0.88	0.11 [0.02-0.60]	0.01	-2.44	0.81	0.08 [0.02-0.42]	0.003	-0.86	0.76	0.42 [0.09-1.88]	0.26
Level-One																
Heavy Drinking	0.002	0.02	1.00 [0.94-1.06]	0.95	-0.04	0.02	0.96 [0.92-1.01]	0.12	-0.10	0.02	0.90 [0.86-0.96]	0.001	0.07	0.02	1.08 [1.02-1.14]	0.007
Marijuana Use	0.06	0.04	1.06 [0.97-1.15]	0.18	0.08	0.04	1.08 [1.01-1.18]	0.04	-0.10	0.04	0.90 [0.82-0.98]	0.01	0.02	0.04	1.02 [0.94-1.12]	0.62
Co-Use	0.06	0.06	1.06 [0.92-1.20]	0.40	0.02	0.06	1.02 [0.92-1.14]	0.66	-0.18	0.06	0.82 [0.74-0.93]	0.002	0.12	0.06	1.12 [0.98-1.28]	0.07
ADJUSTED	Distraction				Reappraisal				Problem-Solving				Avoidance			
	B	SE	OR [95%CI]	p	B	SE	OR [95%CI]	p	B	SE	OR [95%CI]	p	B	SE	OR [95%CI]	p
Level-Two																
Heavy Drinking Mean	0.02	0.30	1.02 [0.56-1.87]	0.94	-0.30	0.32	0.74 [0.39-1.40]	0.36	-0.35	0.32	0.70 [0.38-1.32]	0.28	0.33	0.30	1.39 [0.78-2.50]	0.26
Marijuana Use Mean	-0.24	0.19	0.78 [0.54-1.16]	0.22	-0.36	0.23	0.69 [0.44-1.08]	0.11	-0.32	0.22	0.72 [0.47-1.12]	0.14	-0.06	0.18	0.94 [0.66-1.34]	0.74
Co-Use Mean	-0.93	0.78	0.39 [0.08-1.80]	0.23	-1.15	0.89	0.32 [0.06-1.83]	0.20	-1.68	0.84	0.18 [0.04-0.96]	0.04	-0.40	0.74	0.66 [0.16-2.82]	0.58
Level-One																
Heavy Drinking	0.002	0.02	1.00 [0.94-1.06]	0.95	-0.04	0.02	0.96 [0.92-1.01]	0.12	-0.10	0.02	0.90 [0.86-0.96]	0.001	0.08	0.02	1.08 [1.02-1.14]	0.01 ⁺
Marijuana Use	0.06	0.04	1.06 [0.97-1.16]	0.17	0.08	0.04	1.08 [1.01-1.18]	0.03	-0.10	0.04	0.89 [0.82-0.98]	0.01	0.02	0.04	1.02 [0.94-1.12]	0.60
Co-Use	0.06	0.06	1.06 [0.92-1.21]	0.38	0.02	0.05	1.02 [0.92-1.15]	0.65	-0.18	0.06	0.82 [0.74-0.93]	0.002	0.12	0.06	1.13 [0.99-1.30]	0.06

Note: Level=two=person level. Level-one=daily level. OR=Odds Ratio. 95%CI=Confidence Interval. Significant effects ($p < .05$) are indicated in bold text. Unadjusted models included study day (time), daytime substance use, and days of the week at level-1 to account for substance use trends over time. Adjusted models also included level-2 covariates (age, race, sex, fraternity/sorority status, baseline depression score (Beck Depression Inventory)). See Supplemental Tables 2a-c for full covariate results. Binary predictors included heavy drinking, marijuana use, and co-use where both heavy drinking and marijuana use occurred.

[†] Similar results were seen in both heavy drinking and any drinking outcomes, except any drinking did not predict greater next-day avoidance ($B=0.02$, $SE=0.02$, $p=.50$).