AMERICAN PSYCHOLOGICAL ASSOCIATION

Experimental and Clinical Psychopharmacology

ISSN: 1064-1297

2023, Vol. 31, No. 3, 621–632
https://doi.org/10.1037/pha0000600

Changes in Affect and Alcohol Craving During Naturally Occurring Drinking Episodes: The Role of Day-Level Drinking Motives

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Day-level drinking motives are associated with intensity of drinking and occurrence of negative consequences. However, little is known about how day-level drinking motives relate to alcohol craving, an approach-oriented motivational state proximal to continued drinking. This study tested whether day-level (and between-person) drinking motives were associated with craving during drinking episodes and whether this effect varied by drinking-induced changes in negative/positive affect (PA). Emerging adults (N = 114) took part in up to two waves of 21-day ecological momentary assessments. Participants reported positive/negative affect (NA) prior to and during drinking episodes, drinking motives at beginning of episodes, and craving during all drink reports. Analyses tested whether day-level and between-person (aggregated) drinking motives were associated with heightened craving and whether any effects on craving were moderated by drinking-induced changes in affect. A significant interaction emerged for day-level coping by negative affect, such that higher-than-average coping was associated with less drinking-induced craving when negative affect decreased relative to predrinking levels. However, interactions of between-person coping by negative and positive affect also emerged, such that higher person-level coping was associated with more drinking-induced craving when negative affect and positive affect increased. Day-level and between-person conformity motives by negative affect interactions were also detected, such that higher day-level and between-person conformity motives were associated with more drinking-induced craving when negative affect decreased. Relations between day-level motivation and craving may be sensitive to changes in negative/positive affect while drinking. Future research is needed to differentiate mechanisms through which person-level versus day-level motives relate to craving.

Public Health Significance
Findings suggest that coping motives may operate differently at the event- and person-levels of analysis. For many drinkers, occasional use of alcohol to cope with negative moods may be a self-limiting phenomenon. However, postdrinking mood changes may promote desire for continued alcohol use in drinkers who habitually turn to alcohol for affective relief.

Keywords: alcohol craving, drinking motives, positive affect, negative affect, event-level

Decades of research into the motivational model of alcohol use have suggested that drinking for enhancement (i.e., to enhance positive affect; PA) is related to heavier drinking, whereas drinking to cope (i.e., to decrease negative affect; NA) is related to more negative consequences, both directly and indirectly through heavier drinking (e.g., Cooper et al., 1995; Corbin et al., 2020; Kuntsche et al., 2005; Merrill & Read, 2010, 2014; Piasecki et al., 2014; Waddell, Corbin, & Marohnic, 2021; Waddell, King, & Corbin, 2022). In addition, several studies also have sought to test Cox and Klinger's (1988) theory that acute elevations in negative and positive affect differentially predict subsequent drinking behavior for those high in coping and enhancement motives, respectively.

This article was published Online First September 15, 2022.
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This study was supported by National Institute on Alcohol Abuse and Alcoholism (Grant R01-AA025451; Multiple Principal Investigators (MPIs): Bruce D. Bartholow and Thomas M. Piasecki) and National Institute on Drug Abuse (Grant T32-DA039772; PIs: Nancy Gonzales and Cady Berkel), of which Jack T. Waddell is a T32 fellow. The authors have no conflict of interest to declare.

This study was not preregistered. Data are available from the corresponding author upon reasonable request.

Jack T. Waddell played lead role in conceptualization, formal analysis, methodology and writing of original draft. Bruce D. Bartholow played supporting role in conceptualization, supervision and writing of review and editing and equal role in funding acquisition. Thomas M. Piasecki played lead role in supervision and writing of review and editing, supporting role in conceptualization, formal analysis, methodology and writing of original draft and equal role in funding acquisition.

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However, findings have been mixed (e.g., Armeli et al., 2010; Carney et al., 2000; Corbin et al., 2020; Dora et al., 2022; Grant et al., 2009; Mohr et al., 2005; Todd et al., 2003, 2005; Waddell, Sher, et al., 2021).

Most of the early work in this area conceptualized drinking motives as traits—individual differences in drinking-related goals presumed to be fairly stable over time and situations. More recently, there has been increasing recognition that motivation for alcohol use is dynamic, showing notable within-person fluctuations (Cooper et al., 2015). This has spurred a second wave of research in which motives for drinking are assessed at the level of the individual drinking occasion (e.g., Votaw & Witkiewitz, 2021). Thus, rather than investigating why an individual *typically* drinks, day-level motives research examines why an individual is drinking *in a given instance*. Assessments of day-level drinking motives show promise in predicting near-term drinking outcomes. A recent review (e.g., Votaw & Witkiewitz, 2021) found that both day-level enhancement motives (e.g., Dworkin et al., 2018; O'Hara et al., 2014; Stevenson et al., 2019) and coping motives (e.g., Dvorak et al., 2014; Dworkin et al., 2018; O'Hara et al., 2014; Stevenson et al., 2019) were associated with heavier drinking, whereas only day-level enhancement motives were directly related to day-level alcohol-related problems (Dvorak et al., 2014; Stevenson et al., 2019). Thus, there appears to be divergence based upon level of analysis, such that between-person coping motives predict alcohol-related problems above and beyond use levels, whereas day-level (i.e., within-person) enhancement motives predict alcohol-related problems above and beyond use levels.

Typically, alcohol use has been treated as the outcome of interest in studies of dispositional or day-level drinking motives (Cooper et al., 1995; Votaw & Witkiewitz, 2021). Craving for alcohol, an inherently motivational psychological state, has been comparatively neglected as an outcome in this literature. Craving is perhaps the most proximal antecedent to drinking behavior (e.g., Lowman et al., 2000; Tiffany & Conklin, 2000), but is not subject to the variety of constraints often placed on drinking, such as countervailing work/school demands, social norms, alcohol availability/cost, or personal resolution to quit or cut down. In principle, acute activation of drinking motives should arouse an immediate desire to drink, which may or may not be translated into alcohol use. Supporting this idea, Waddell, Sher, et al. (2021) found that dispositional coping motives moderated the effect of negative affect on acute alcohol craving during nondrinking moments, and that dispositional enhancement motives moderated the effect positive affect on acute craving; the same moderated effects were not found in models predicting drinking per se. These findings suggest that affect and person-level motives may be more robustly related to acute desire to drink than to drinking behavior itself.

Affect and drinking motives frequently have been studied as *antecedents* of alcohol-related outcomes, but little is known about the interplay between changes in affect arising during a particular drinking episode and the motives animating that drinking episode. This is surprising, given that both coping and enhancement motives are defined by pursuit of affective change (e.g., Cooper, 1994). Particularly for these internally oriented motives, alcohol craving may be sensitive to affective changes occurring in the wake of alcohol consumption.

A change in affect/subjective experience may plausibly interact with day-level drinking motives to influence craving. However, the expected form of such mood-motive interplay is unclear. One possibility is that attainment of a sought-after affective change is *satisfying*, leading to diminished alcohol desire. In this scenario, craving would be predicted to decrease as positively valenced states are intensified within drinking episodes attributed to day-level enhancement motivation. Similarly, craving might subside as negative affect is diminished within coping-motivated drinking episodes. An alternative possibility is that attainment of affective goals has an *autocatalytic* effect, promoting desire to drink in order to maintain or further intensify affective gains. Under this account, craving would be predicted to increase in tandem with increases in positive affective states during enhancement-motivated drinking episodes. Similarly, acute decreases in negative mood would be expected to spur craving during coping-motivated drinking episodes in this account.

To our knowledge, only one prior study has tested relations between day-level drinking motivation and acute changes in affect, finding that day-level drinking to cope was associated with perceived relief from drinking but was not associated with a reduction in negative affect (Wycoff et al., 2021). However, this study treated mood change as an outcome variable, not as a potential moderator of day-level motives on desire to drink. The present study builds upon these findings by testing the interplay between affective changes (or lack thereof) during drinking episodes and occasion-specific drinking motives as predictors of momentary alcohol craving. We hypothesized that drinking-induced changes in positive affect would interact with day-level enhancement motives and that changes in negative affect would interact with day-level coping motives in predicting postdrinking craving intensity. Given the absence of prior studies, we were agnostic about whether these interactions would indicate reduced or intensified craving. We also tested two-way interactions among between-person motives and changes in affect to isolate whether interactions were driven by day-level or between-person variability; we anticipated that the hypothesized interactions would be present for day-level rather than between-person motives.

Method

Participants

Participants were 114 emerging adults (age 18–20 years) who participated in a parent study focused on alcohol sensitivity, laboratory-based cue reactivity, and day-level drinking in an underage population. Participants were recruited via a combination of in-person flyers, online advertisements, and email announcements around a midwestern University and surrounding community. Eligibility criteria were (a) being age 18–20, (b) endorsing at least monthly alcohol use, (c) endorsing a binge drinking episode in the past 6 months, (d) being able to read and write in English, and (e) normal or corrected-to-normal vision. Study exclusion criteria were a history of (a) attempting to quit/reduce drinking, (b) neurological disease, or (c) head injuries with a loss consciousness of >2 min (for more details, see Cofresí et al., 2022; Kohen et al., 2022). For the present study, participants were included if they reported at least one drinking episode during ecological momentary assessment (EMA) and had at least one report of day-level drinking motives. The current report is limited to participant data collected prior to March 2020, when data collection was interrupted by the global SARS-CoV-2 pandemic.

Participants were 66.2% female, 94.7% were undergraduate students, and were 93.8% White, 1.8% Black/African American, .9% Asian, and .9% American Indian/Alaskan Native, and 2.6% multiracial; 92.9% were non-Hispanic. Via a computer-administered timeline followback (TLFB), participants reported drinking an average of 7.10 (SD = 3.84) days per month, binge drinking an average of 4.89 (SD = 3.28) days per month, and drinking an average of 5.17 (SD = 2.64) drinks per drinking occasion (see Table 1 for descriptive statistics).

Procedure

All participants were scheduled for an in-person laboratory session, which consisted of informed consent, a battery of baseline questionnaires, and training for the subsequent EMA protocol. During the session, participants were instructed to download a diary phone application (TigerAware; Morrison et al., 2018) and were instructed how to use the app to complete both random and event-contingent reports. Following the laboratory session, participants began the 21-day burst of the EMA protocol. Participants were scheduled for a second laboratory session followed by a second 21-day burst of EMA 8–10 months later.

The diary protocol included four different types of app-administered surveys. Participants were instructed to complete a once-daily Morning report each day at upon waking. A reminder notification was sent at 11:30 a.m. when a morning report had not yet been initiated. This report was available to participants throughout the morning but closed at noon. Second, the app generated notifications signaling participants to complete random prompt reports four times each day. These prompts were spaced out into four blocks between 8 a.m. and 11 p.m. A reminder notification was sent 10 min after the first notification. Third, participants were instructed to initiate an event-contingent drink report after finishing their first alcoholic drink during a drink episode. Fourth, if a drink report was initiated, notifications to complete drink follow-up reports were triggered at 30, 60, 90, and 120 min after the first drink. Finally, both random prompts and morning reports asked participants whether they had consumed alcohol since the last report, and if so, if it was within the past 2 hr. If participants reported past-2-hr drinking, drink follow-up notifications were sent 30, 60, 90, and 120 min after said report. For the present study, drinking episodes describe day-level drinking events that span several drinking moments. Thus, drinking moments are nested within a drinking occasion.

Table 1
Participant Demographics and Typical Substance Use (N = 114)

Variable	M (SD) or %
Demographics	
Sex	57% female
Race	93.8% White
	1.8% Black/African American
	.9% Asian
	.9% American Indian/Alaskan Native
	2.6% Multiracial
Ethnicity	92.9% Non-Hispanic/Latinx
	7.1% Hispanic/Latinx
College enrollment status	94.7% undergraduate students
TLFB alcohol use descriptives	
Typical drinking frequency	7.10 (SD = 3.84)
Typical drinking quantity	5.17 (SD = 2.64)
Heavy drinking (6+) frequency	4.89 (SD = 3.28)

Note. Alcohol use variables were taken from a computer-administered timeline followback (TLFB) completed at baseline. Drinking frequency and binge drinking frequency were number of days over the past month reported, whereas typical drinking quantity was computed as the mean number of drinks reported on drinking days.

At each burst, participants received $75 if they completed at least 50% of daily Morning Reports and received either (a) an additional $35 if they completed 70%–84% of the additional Random Prompts, or (b) an additional $75 if they completed 85% or more of additional Random Prompts. Thus, participants could earn up to $300 in Amazon gift cards, including bonuses, across the two bursts of EMA based upon their compliance in the EMA protocol.

All procedures were approved the University of Missouri institutional review board.

Compliance

Compliance rates for random surveys were computed by determining the number of random surveys completed divided by the number of surveys received. Compliance was 81.2% for random reports. Compliance for morning reports was computed by dividing the total number of morning reports completed divided by the number initiated + number of reminders sent (i.e., a reminder each day at 11:30 a.m. when not completed). Compliance for morning reports was 80.2%. Finally, compliance with drink reports was computed by comparing discrepancies between past-night drinking reports and next-morning reported drinking during the previous day. In terms of drink reports, participants filled out at least one drink report the previous night on 63.8% of next day reported drinking episodes.

Measures

Event-Level Measures

Alcohol Craving. Alcohol craving was measured via two items asking: (a) "In the past 15 minutes, did you feel an urge to drink?" and (b) "In the past 15 minutes, did you crave a drink?" Participants responded using a scale from 1 (*not at all*) to 7 (*extremely*). The two items were averaged and showed high internal consistency ($\alpha = .87$). Craving was assessed in all reports, but the present study was restricted to ratings from drink reports and drink follow-ups.

Affect. Participants rated intensity of positive and negative affect in the past 15 min using the same response scale as the craving items. Positive affect was computed as the mean of feeling "happy," "joy," and "content," and negative affect was computed as the mean of feeling "sad," "afraid," and "angry." Both mean scores had adequate internal consistency during nondrinking ($\alpha = .76–.82$) and drinking moments ($\alpha = .75–.81$).

Drinking Motives. Day-level drinking motives were assessed at each First Drink report (but not Drink Follow-Up surveys) via four items assessing drinking motives for coping, conformity, enhancement, and social reasons. Participants were asked to respond to the stem "I am drinking now because . . . " with options stating: "it helps me when I feel depressed or anxious" (coping), "to fit in with a group I like" (conformity), "I like the feeling" (enhancement),

and "it makes social gatherings more fun" (social) on a scale of 1 (*not at all*) to 7 (*extremely*). Because day-level drinking motives were only assessed during participant-initiated drink reports, drink follow-ups not triggered by a prior first drink report (i.e., those from random prompts or morning reports indicating recent alcohol consumption) were omitted.

eBAC. Momentary estimated blood alcohol concentration (eBAC) was computed using the Matthews and Miller (1979) formula, which accounts for participant sex, weight, time elapsed since drinking, and the average rate of metabolization. This method shows superior accuracy for ad libitum consumption compared to other eBAC calculation methods (Hustad & Carey, 2005). During the first drink report, participants reported their total number of drinks consumed so far and the time elapsed since initiation of the first drink. During follow-up drink reports, participants reported on the total number of drinks consumed since the last report, and the time elapsed between reports was computed based upon time stamps for each report. Therefore, eBAC calculations were able to be made for each drinking moment, as there was time-stamp evidence of time elapsed and self-reports of total drinks consumed in successive reports.

Contextual Covariates. Time of day was specified as morning (6 a.m.–11:59 a.m.), afternoon (12 p.m.–4:59 p.m.), and night (5 p.m.–5:59 a.m.) in line with other studies (Trela et al., 2018; Waddell, Sher, et al., 2021). Due to a lack of drinking data present in the morning and afternoon (119 moments), morning/afternoon reports were compared to night reports (i.e., 0 = morning/afternoon, 1 = night). Weekend (vs. nonweekend) days were specified as happening between Thursday at 6 p.m. and Sunday at 6 p.m. (i.e., weekday = 0, weekend = 1) also in line with other EMA studies (Trela et al., 2018; Waddell, Sher, et al., 2021). Finally, being in the presence of others was coded as social (vs. solitary) context (i.e., solitary = 0, social = 1).

Person-Level Measures

Alcohol Sensitivity. The Alcohol Sensitivity Questionnaire (ASQ; Fleming et al., 2016) was used to assess individual differences in sensitivity to the acute effects of alcohol. The ASQ was administered during the screener survey and was used to balance recruitment across the full spectrum of alcohol sensitivity. The ASQ asks participants if they have experienced each of 15 alcohol effects (e.g., feeling buzzed, vomiting), of which nine query effects associated with lighter drinking (ASQ-L; e.g., feeling buzzed, feeling flirtatious; $\alpha = .877$) and six query effects associated with heavier drinking (ASQ-H; e.g., vomiting, passing out; $\alpha = .971$). For ASQ-L items, participants are asked to report the minimum number of drinks needed to achieve such effects; for ASQ-H items, participants are asked to report the maximum number of drinks they can consume without feeling such effects. Standardized person-mean imputation was used to create unbiased scores for both ASQ-L and ASQ-H (Lee et al., 2015). Higher scores represent lower alcohol sensitivity (i.e., more drinks required).

Dispositional Drinking Motives. The Drinking Motives Questionnaire–Revised (DMQ-R; Cooper, 1994) assessed global, person-level drinking motives via 20 items rated on a scale of 0 (*never*) to 5 (*almost always*). Enhancement, social, conformity, and coping motive subscales all had adequate internal consistency ($\alpha = .80$–$.87$). The DMQ-R subscales were used only in supplemental analyses as a validator of person-means of day-level motives as proxies for dispositional motives.

Data Analytic Plan

Data Setup. First, average predrinking negative and positive affect scores were computed for each drinking day, representing one's daily average positive/negative affect prior to drinking (Level 2). Once predrinking average affect scores were computed, all nondrinking moments were removed. Second, current affect (negative and positive) during drinking moments was centered around one's predrinking average daily affect, thereby testing changes in affect from predrinking to the current drinking moment (Level 1). Three affect variables were computed for analyses: average daily predrinking affect (day-level prior to drinking; Level 2), change from daily predrinking average affect (momentary-level; Level 1), and aggregated average predrinking affect over all days (between-person level; Level 3). Second, day-level drinking motives reported during drink reports were aggregated to the day-level, as follow-up drink reports did not assess one's drinking motives beyond the first drink report (Level 2). Thus, two drinking motives variables were computed for analyses: day-level drinking motives (day-level; Level 2) and aggregated drinking motives across days (between-person level; Level 3). Drinking moments that had a timestamp of 3+ hours after the previous drink report/follow-up drink report were removed to ensure that drinking moments were characteristic of the same drinking episode.

Primary Analyses. Preliminary analyses tested for assumptions of normality; however, the alcohol craving variable adhered to assumptions of normality (skewness = .277, kurtosis = −1.11). Thus, no transformations or alternative distributions were necessary.

Primary analyses encompassed a series of three-level multilevel models estimated in the lme4 package of Rstudio (Bates et al., 2014), with the use of the lmertest package to obtain specific *p*-values. A model building approach was taken, such that (a) covariate and main effects of motives and affect were entered, (b) all interactions of interest were entered, and (c) nonsignificant interactions were trimmed. Thus, main effects of day-level motives were Level 2 (day-level) predictors, between-person motives were Level 3 (person-level) predictors and change in affect was a Level 1 (momentary-level) predictor. Although our hypotheses focused on coping and enhancement drinking motives, main effects and interactions for social and conformity motives were also entered at both levels to parse apart unique interactive effects. In addition, average predrinking affect (day-level) was added as a predictor, and thus the affect change score represented a change in affect while accounting for the average level of affect prior to drinking. Between-person affect (person-level) was also included as a predictor to parse variance across all three levels. Models were separated by positive/negative affect.

Two-way interactions between day-level motives and affect change as well as between-person motives and affect change were entered into the model. However, nonsignificant interactions were trimmed. In the presence of a significant interaction, simple slopes were estimated for affect at levels of motives. Thus, in line with recommendations from Aiken et al. (1991), simple slopes were estimated at one *SD* below and above the mean, corresponding to a decrease and increase in affect, respectively.

Covariate effects were eBAC (both at the momentary level and person-level), weekend versus weekday, solitary versus social context, time of day (i.e., morning/afternoon vs. night), sex (male vs. female), burst of data collection (Wave 1 vs. Wave 2), and alcohol sensitivity scores for light and heavy alcohol effects. All continuous Level 1 predictors were centered around the day mean, continuous Level 2 predictors were centered around the person/group mean, and continuous Level 3 predictors were centered around the sample grand mean (Enders & Tofighi, 2007).

There were three forms of missing data in the current analyses: missing drink reports, drinking days with missing affect reports prior to drinking, and momentary reports where participants skipped a question/several questions. By definition, missing drink reports could not contribute data and therefore could not be included in analyses. Days when no random prompts (i.e., affect) were completed prior to drinking were excluded, as a primary variable (i.e., affect prior to drinking) was missing. This resulted in listwise deletion of 54 cases. Finally, there were occasional reports in which a participant skipped a variable of interest or only partially completed the survey, resulting in listwise deletion of 16 cases.

This study was not preregistered. Data are available from the corresponding author upon reasonable request. We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

Results

Descriptive Findings

Participants ($N = 114$) recorded a total of 1,392 drinking moments ($M_{person} = 12.21$, $SD = 12.23$) across 345 drinking episodes ($M_{person} = 3.03$, $SD = 2.68$). Average eBAC across drinking moments was .058 ($SD = .079$), and average craving was 3.22 ($SD = 1.84$). Average levels of momentary positive affect ($M = 4.73$, $SD = 1.26$) were higher than average levels of momentary negative affect ($M = 1.46$, $SD = .83$) during drinking moments. Average levels of day-level drinking motives were highest for enhancement ($M = 4.66$, $SD = 1.48$) and social motives ($M = 4.36$, $SD = 1.91$), and lowest for conformity ($M = 2.35$, $SD = 1.73$) and coping motives ($M = 2.00$, $SD = 1.59$).

Negative Affect Model

Model parameters for the negative affect model are shown in Table 2. Several covariates were significantly associated with craving: higher eBACs at the person-level ($b = 6.40$, $SE = 1.95$, $p < .001$), lower sensitivity to heavy-drinking alcohol effects (i.e., higher ASQ-H scores; $b = .55$, $SE = .19$, $p = .003$), and weekend days ($b = .32$, $SE = .16$, $p = .046$) were associated with heightened alcohol craving, and reports from Wave 2 ($b = -1.05$, $SE = .22$, $p < .001$) and solitary drinking ($b = -.82$, $SE = .17$, $p < .001$) were associated with attenuated alcohol craving. There were no main effects of day-level motives predicting alcohol craving; however, higher person-level enhancement motives were associated with heightened alcohol craving ($b = .18$, $SE = .09$, $p = .033$). Neither a momentary deviation in negative affect nor predrinking average negative affect was related to craving, but person-level negative affect was related to heightened craving ($b = .35$, $SE = .13$, $p = .011$).

Two-way interactions for day-level enhancement motives, day-level social motives, between-person enhancement motives, and between-person social motives by drink-related negative affect change were nonsignificant and trimmed from the model. Significant interactions emerged for day-level coping motives ($b = .14$, $SE = .07$, $p = .032$), between-person coping motives ($b = .20$, $SE = .07$, $p = .002$), day-level conformity motives ($b = -.19$, $SE = .08$, $p = .017$), and between-person conformity motives ($b = -.12$, $SE = .05$, $p = .026$) by change in negative affect in predicting alcohol craving.

Analysis of simple slopes for the day-level coping motives interaction indicated that higher-than-average coping motives were associated with less craving during drinking episodes when negative affect decreased ($b = -.19$, $SE = .09$, $p = .04$), but were unrelated to craving when there was no change in negative affect ($b = -.08$, $SE = .09$, $p = .38$) and when there was an increase in negative affect ($b = .04$, $SE = .11$, $p = .71$; See Figure 1, Panel A). For the between-person coping motives interaction, higher dispositional coping motives were not significantly associated with craving during drinking episodes when negative affect decreased ($b = -.06$, $SE = .10$, $p = .53$) or stayed the same ($b = .10$, $SE = .08$, $p = .21$), but were associated with more craving during drinking moments when negative affect increased ($b = .26$, $SE = .09$, $p = .005$; see Figure 1, Panel B). Thus, day-level coping motives were associated with less craving when negative affect decreased, whereas person-level coping motives were associated with more craving when negative affect increased.

Simple slopes analyses for the day-level conformity interaction indicated that higher than average conformity motives were nonsignificantly associated with more alcohol craving during drinking episodes when negative affect decreased ($b = .16$, $SE = 10$, $p = .11$) and stayed the same ($b = .01$, $SE = .08$, $p = .89$), and were nonsignificantly associated with less alcohol craving when negative affect increased ($b = -.14$, $SE = .10$, $p = .16$; See Figure 2, Panel A). Similarly, for the between-person conformity interaction, higher dispositional levels of conformity motives were nonsignificantly associated with more alcohol craving when negative affect decreased ($b = .04$, $SE = .09$, $p = .66$), but were nonsignificantly associated with less alcohol craving when negative affect did not change ($b = -.06$, $SE = .08$, $p = .45$) and increased ($b = -.16$, $SE = .09$, $p = .089$; see Figure 2, Panel B).

Positive Affect Model

Model parameters for the positive affect model are shown in Table 3. Covariate effects remained largely stable across both the negative affect and positive affect models. However, between-person enhancement motives were no longer associated with craving, but between-person coping motives were ($b = .21$, $SE = .08$, $p = .009$). In addition, there were main effects of person-level positive affectivity ($b = .27$, $SE = .09$, $p = .002$) and momentary change in positive affect ($b = .45$, $SE = .06$, $p < .001$) on heightened alcohol craving during drinking episodes.

All two-way interactions among enhancement, social, and conformity motives by positive affect, as well as day-level coping motives by positive affect, were nonsignificant and removed. There was a significant interaction involving between-person coping motives and positive affect change ($b = .14$, $SE = .05$, $p = .002$). Simple slopes suggested that higher person-level coping motives were significantly associated with higher craving during drinking episodes when positive affect remained stable ($b = .22$, $SE = .08$, $p = .004$) and increased ($b = .37$, $SE = .10$, $p < .001$) but

Table 2
Fixed Effects From Final Negative Affect Model

Variable	*b*	*SE*	*p*	95% CI
Level 1 predictors				
eBAC WP	.05	.68	.941	[−1.28, 1.38]
Time of day	−.28	.22	.196	[−.68, .16]
Solitary drinking	−.82	.17	<.001	[−1.15, −.49]
Negative affect change	.09	.08	.278	[−.07, .25]
Level 2 predictors				
Weekend	.32	.16	.046	[.01, .62]
Wave	−1.05	.22	<.001	[−1.46, −.64]
Negative affect predrink average	.18	.18	.356	[−.19, .55]
Enhancement motives WP	.13	.09	.134	[−.03, .29]
Coping motives WP	−.07	.08	.389	[−.23, .08]
Social motives WP	.08	.07	.247	[−.05, .22]
Conformity WP	.002	.08	.979	[−.15, .15]
Level 3 predictors				
eBAC BP	6.40	1.95	<.001	[2.78, 10.02]
ASQ light	−.25	.18	.175	[−.59, .10]
ASQ heavy	.55	.19	.003	[.19, .91]
Sex	.22	.24	.371	[−.25, .67]
Negative affect BP	.35	.13	.011	[.09, .62]
Enhancement motives BP	.18	.09	.033	[.02, .34]
Coping motives BP	.12	.08	.126	[−.03, .27]
Social motives BP	.06	.07	.381	[−.07, .20]
Conformity BP	−.05	.08	.503	[−.21, .10]
Interactions				
Coping WP × negative affect change	.14	.07	.032	[.01, .27]
Coping BP × negative affect change	.20	.07	.002	[.06, .33]
Conformity WP × negative affect change	−.19	.08	.017	[−.33, −.03]
Conformity BP × negative affect change	−.12	.05	.026	[−.23, −.02]

Note. *SE* = standard error; CI = confidence interval; eBAC = estimated blood alcohol concentration; ASQ = Alcohol Sensitivity Questionnaire; WP = within-person; BP = between-person; Level 1 = momentary effects; Level 2 = day-level; Level 3 = person-level.

was nonsignificantly associated with craving when positive affect decreased ($b = .07$, $SE = .09$, $p = .42$; see Figure 3).

Supplementary and Sensitivity Analyses

To inform interpretation of the between-person motive effects, we estimated bivariate correlations between the aggregated person-means of day-level enhancement, social, conformity, and coping motives with both their respective items and subscale scores on the DMQ-R. Enhancement ($r = .81$, $p < .001$), social ($r = .93$, $p < .001$), conformity ($r = .81$, $p < .001$), and coping ($r = .78$, $p < .001$) person-means were highly correlated with each respective item on the DMQ-R. In addition, enhancement ($r = .42$, $p < .001$), social ($r = .36$, $p < .001$), conformity ($r = .53$, $p < .001$), and coping ($r = .48$, $p < .001$) person-means were moderately to highly correlated with each subscale of the DMQ-R.

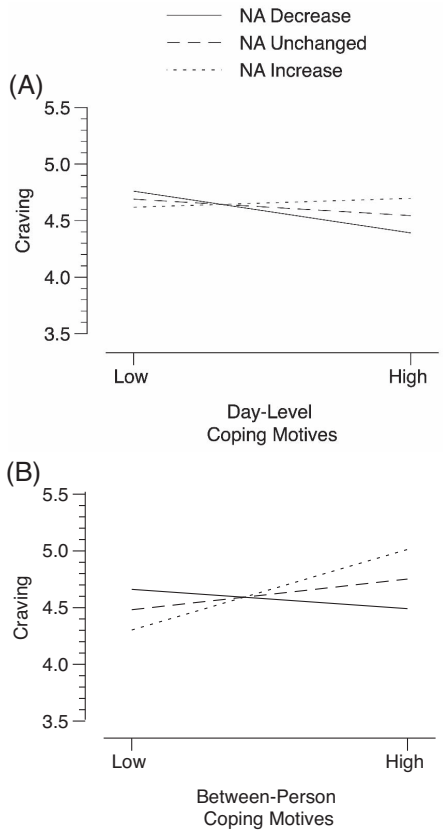
Sensitivity analyses were performed including each participant's number of drinking episodes as a covariate. Since drinking motives were parsed into day-level and person-level components, separation of these components would be expected to be less informative for individuals with fewer drinking episodes (i.e., they may have similar values for day-level and person-level motives). However, results were unchanged when accounting for number of drinking episodes—no statistically significant effects became nonsignificant or vice versa.

We also performed sensitivity analyses entering each significant interaction into the model singularly, testing if each was a stand-alone effect or depended on the presence of other interactions in the model. In the negative affect model, the person-level coping motives by negative affect change interaction remained significant ($b = .13$, $SE = .06$, $p = .04$), the day-level coping motives ($b = .12$, $SE = .07$, $p = .076$) and day-level conformity motives ($b = -.14$, $SE = .08$, $p = .077$) by negative affect change interactions became marginally significant, and the person-level conformity motives by negative affect change interaction became nonsignificant ($b = -.06$, $SE = .05$, $p = .21$). This procedure was not applicable for the positive affect model because it contained only a single significant interaction effect.

Finally, we tested whether effects remained significant when conceptualizing prior-to-drink affect as the most proximal report before drinking compared to a daily average of predrinking affect. Bivariate correlations suggested that the two methods of parsing affect were very similar, as average predrink negative affect was highly correlated with proximal predrink negative affect ($r = .83$), as was average predrink positive affect and proximal predrink positive affect ($r = .84$). Furthermore, when reestimating the models with proximal predrink affect instead of average predrink affect, findings were unchanged. The interactions of change in negative affect by day-level drinking to cope ($b = .19$, $p = .009$), person-level drinking to cope ($b = -.26$, $p < .001$), day-level

Figure 1

Simple Slopes Illustrating Interactions Involving Negative Affect (NA) Change and Day-Level Coping Motives (Panel A) and Person-Level Coping Motives (Panel B)



conformity ($b = -.20$, $p = .013$), and person-level conformity motives ($b = -.14$, $p = .011$) remained statistically significant and in the same direction as the primary model. Similarly, in the positive affect models, the interaction among person-level drinking to cope ($b = .10$, $p = .043$) remained statistically significant and in the same direction as the primary model.

Discussion

Drinking motives are strong predictors of drinking behavior, at both the between-person and event levels (e.g., Merrill et al., 2014; Votaw & Witkiewitz, 2021). However, research investigating day-level drinking motives is still in its nascent stage, and little research has investigated relations between day-level drinking and affective states experienced while drinking. The present study tested whether day-level drinking motives interacted with drinking-related changes in positive and negative affect to predict momentary alcohol craving during naturally occurring drinking episodes. It was hypothesized that alcohol craving responses would be moderated by changes in positive affect during drinking episodes motivated by enhancement motives and that craving would be modulated by changes in negative affect during coping-motivated episodes. Expectations concerning the form of these interactions were less certain. We anticipated that attaining desired affective outcomes might either reduce or increase craving, depending on whether this satisfies psychological needs or spurs attempts to chase further affective gains.

Consistent with predictions, our analyses showed a significant interaction between day-level drinking to cope and drinking-induced changes in negative affect in the prediction of alcohol craving. This interaction suggested that drinking episodes characterized by higher-than-average (within-person) levels of coping motives were associated with *less* momentary alcohol craving when negative affect decreased during a drinking episode. This is consistent with the satisfaction hypothesis—attainment of the desired affective outcome seemed to be related to diminished desire to continue drinking. This accords with theories of goal-directed behavior (Ajzen & Madden, 1986). Notably, Wycoff et al. (2021) found that day-level drinking to cope was *not* associated with negative affect reduction (Wycoff et al., 2021). Thus, it is possible that coping-motivated drinking events that entail negative affect reduction are relatively rare—but when they do occur, they are associated with less alcohol desire due to satiation after feeling tension reduction.

At the between-person level, coping motives also interacted with drinking-induced change in negative affect to predict craving. Comparison of the simple slope plots for the event- and

Figure 2

Simple Slopes Illustrating Interactions Involving Negative Affect (NA) Change and Day-Level Conformity Motives (Panel A) and Person-Level Conformity Motives (Panel B)

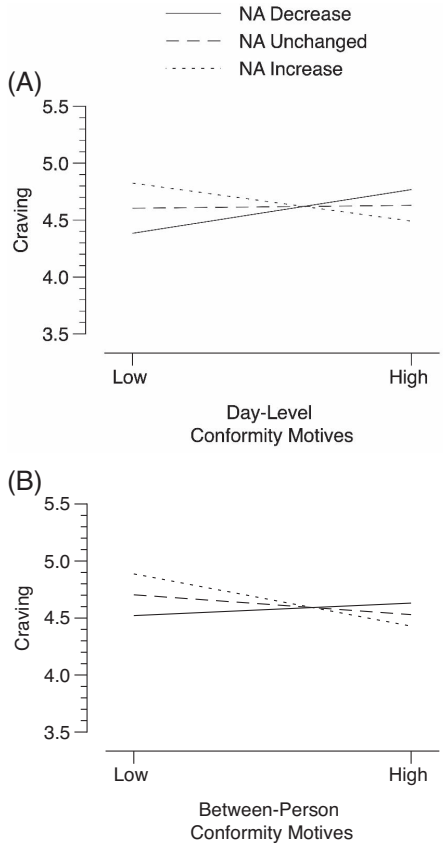


Table 3
Fixed Effects From Final Positive Affect Model

Variable	*b*	*SE*	*p*	95% CI
Level 1 predictors				
eBAC WP	−.09	.66	.891	[−1.37, 1.20]
Time of day	−.33	.21	.119	[−.73, .10]
Solitary drinking	−.57	.17	<.001	[−.90, −.24]
Positive affect change	.45	.06	<.001	[.34, .56]
Level 2 predictors				
Weekend	.35	.16	.027	[.04, .64]
Wave	−.94	.21	<.001	[−1.35, −.54]
Positive affect predrink average	.14	.13	.301	[−.12, .39]
Enhancement motives WP	.09	.09	.317	[−.08, .25]
Coping motives WP	−.01	.08	.900	[−.16, .14]
Social motives WP	.07	.07	.302	[−.06, .21]
Conformity WP	.03	.08	.725	[−.12, .17]
Level 3 predictors				
eBAC BP	5.70	1.91	.003	[2.08, 9.34]
ASQ light	−.22	.18	.236	[−.56, .13]
ASQ heavy	.63	.20	<.001	[.25, 1.00]
Sex	.21	.24	.384	[−.25, .66]
Positive affect BP	.27	.09	.002	[.10, .43]
Enhancement motives BP	.15	.09	.082	[−.01, .31]
Coping motives BP	.21	.08	.009	[.06, .36]
Social motives BP	.03	.07	.726	[−.11, .16]
Conformity BP	−.01	.08	.874	[−.16, .14]
Interactions				
Coping BP × positive affect change	.14	.05	.002	[.05, .24]

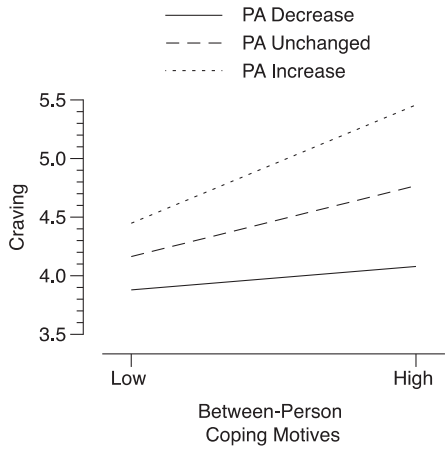
Note. *SE* = standard error; CI = confidence interval; eBAC = estimated blood alcohol concentration; ASQ = Alcohol Sensitivity Questionnaire; WP = within-person; BP = between-person; Level 1 = momentary effects; Level 2 = day-level; Level 3 = person-level.

person-level coping by negative affect interactions (Figure 1) show that the relative pattern of craving means was broadly similar. At low levels of coping, craving was predicted to be highest when negative affect decreased, intermediate when negative affect remained unchanged, and lowest when negative affect increased during drinking. At high levels of coping, the order of predicted means was reversed for both interaction effects. However, simple slopes indicated that the processes that gave rise to this pattern differed across level of analysis. While the day-level interaction reflected decreased craving when negative affect was diminished, the person-level interaction was driven by an *increase in craving* when *negative affect increased* during drinking. The form of this interaction differed from those hypothesized. Research suggests that coping motives are highly linked to tension reduction expectancies (e.g., Cooper et al., 1995; Corbin et al., 2020), and thus one possibility is that frustrative nonreward or expectancy violation might fuel craving in drinkers who habitually report drinking to cope.

It is notable that these discrepant effects emerge when event- and person-level components of coping motivation are parsed in the same model. One interpretation might be that net of any trait contribution, the process of drinking for affective relief might be a self-limiting one in which craving tends to recede as negative mood abates. All else being equal, this may be a relatively low-risk, utilitarian drinking pattern. In contrast, individuals who habitually report drinking to cope may be liable to a unique craving reactivity from escalated negative affect while drinking. If mood worsens for these individuals, they may respond with increased craving that may fuel a level of drinking to excess more often associated with negative consequences.

This finding that decreases in negative are associated with lower craving in coping-motivated drinking episodes appears to be discrepant from negative reinforcement models, (e.g., Baker et al., 2004; Shiffman & Wills, 1985), which suggest an autocatalytic process in which decreases in negative affect are reinforcing and accordingly should promote alcohol use. Conceivably, both

Figure 3
Simple Slopes Illustrating the Interaction of Positive Affect (PA) Change and Between-Person Coping Motives



satisfaction and negative reinforcement processes could be operative, but evident over different time scales. Acute affective relief may slow or inhibit drinking in the near term but increase the likelihood that negative affect will serve as a setting occasion for future drinking initiation.

An interaction effect was also present for between-person coping motives and positive affect change, such that a drinking-related increase in positive affect was associated with heightened craving for those with higher dispositional coping motives. It appears that coping-motivated individuals crave more alcohol in the presence of a change in affect, regardless of valence, as the sample pattern of effects was present for person-level negative affect as well. Dispositional coping motives are associated with blunted positive affect (e.g., Schick et al., 2021). Thus, increases in positive affect may be more salient for coping-motivated individuals. In addition, research suggests that coping motives are associated with difficulties in regulating both negative *and* positive affective states (Paulus et al., 2021). Thus, an increase in affect, regardless of valence, may lead to emotional dysregulation in a coping-motivated individual, thereby leading to heightened alcohol craving.

There were also significant interactions between conformity motives and drinking-induced changes in negative affect. At the day-level, none of the simple slopes were statistically significant from zero, but they differed from one another; thus, their pattern indicated that higher-than-average conformity motives tended to be associated with heightened craving in the presence of a decrease (vs. increase) in negative affect. A similar effect also was seen at the between-person level. Considering that conformity motives reflect alcohol use aimed at fitting in to the group and avoiding social reprobation (Cooper, 1994), affective changes experienced within conformity-motivated episodes (and people) may indirectly reflect the social processes playing out during a drinking episode. One possibility may be that, when anticipated aversive social feedback is avoided successfully, negative affect decreases and desire to drink may be maintained. When negative social consequences are experienced despite drinking, negative affect may be maintained or increased, and drinking may be appraised as a situationally ineffective avoidance strategy. Desire to continue drinking may decrease accordingly. Direct assessment of social processes and related appraisals during drinking would permit a more theoretically and mechanistically informative investigation of links among external drinking motives, social transactions, affective experience, and craving.

Several effects of covariates on craving were observed. First, both person-level positive affect and negative affect were associated with heightened craving. This is consistent with theoretical models that construe craving states as emotional responses (e.g., Baker et al., 1987); individuals who are prone to stronger emotions in general may also be liable to report strong craving. Alternatively, these effects could reflect individual differences in response bias, such that some individuals may be prone to using a higher range of responses on self-report rating scales.

At the event-level, only changes in positive (but not negative) affect were associated with heightened craving. Thus, alcohol craving appeared to be more of an affect-enhancement rather than avoidance-related process. One reason for this may be that participants were emerging adults and just starting their drinking careers; early stages of drug involvement may be especially driven by reward-related motivation and expectancies (Koob, 2013). Coping motives were the lowest-rated day-level reasons for drinking in this sample. This is consistent with findings from other studies of day-level (e.g., Stevens et al., 2021; Stevenson et al., 2019) and dispositional motives (e.g., Merrill & Read, 2010; Piasecki et al., 2011), which indicate that coping motivation is probably applicable to only a subset of individuals and drinking events.

It is interesting to consider the current findings with respect to the dual affect model of craving (Baker et al., 1987, 2004). This theoretical account postulates that urges are embedded into distinct schematic networks defined by positive and negative affect. From this perspective, the finding of an overall association between positive affect change and craving might be taken to indicate that drinking behaviors and approach-oriented craving are robustly embedded in a network of pleasurable associations in emerging adult drinkers. On the contrary, only coping-motivated drinkers showed increased craving in the presence of escalating negative affect changes. This subset of drinkers may have also developed a more elaborated "negative affect urge network" involving associations among negative experiences, alcohol use, and relief-oriented craving. Possession of both kinds of schema by coping-motivated drinkers might explain why they react to increases in either positive or negative affect with heightened craving.

No day-level motives were associated with alcohol craving—however, person-level coping motives were associated with craving in the positive affect model and person-level enhancement motives were associated with craving in the negative affect model. This pattern suggests that stronger habitual endorsement of internal drinking motives is linked to higher craving intensity when drinking. However, these effects may be eclipsed in particular models due to shared variance between congruent affective states and motives.

Solitary drinking (vs. social drinking) was associated with less alcohol craving. Although solitary drinking is a risk factor for negative alcohol consequences (e.g., Creswell et al., 2014; Waddell, Corbin, & Marohnic, 2021), day-level studies consistently find that social drinking is an day-level correlate of heavier drinking (e.g., Mohr et al., 2001; O'Donnell et al., 2019; Smit et al., 2015; Thrul & Kuntsche, 2015; Waddell, King, Okey, & Corbin, 2022). The present study shows that, compared to social drinking, solitary drinking was associated with blunted craving. Future research is needed to characterize more completely how drinking context is associated with alcohol outcomes (i.e., craving, drinking quantity, negative consequences) at the between-person versus day-level.

Higher person-mean eBAC was associated with more intense craving during drinking episodes. This is an important piece of validation evidence for the craving outcome measure and likely reflects bidirectional effects: those who tend to experience craving consume more alcohol and those who regularly drink heavily are motivated to approach and consume alcohol. A self-reported lower sensitivity to effects of alcohol typically experienced after heavy use (e.g., hangover, passing out) also was also associated with higher craving during drinking. Low alcohol sensitivity is a risk factor for heavy drinking (e.g., King et al., 2002; Schuckit, 1994) and is associated with exaggerated neural and behavioral responses to alcohol-related cues indicative of approach motivation (Cofresí et al., 2022; Martins et al., 2019).

The present study has implications for preventive interventions, particularly during emerging adulthood. Considering past findings

suggest that drinking to cope does not necessarily lead to a decrease in negative affect (Wycoff et al., 2021), it may be effective to target misperceptions related to alcohol's ability to decrease negative affect. The present study found that, for coping-motivated drinkers and episodes, no change and an increase in negative affect was related to more desire to drink. Thus, ecological momentary interventions may benefit from providing feedback about one's drinking-induced affective change, as well as the outcomes of a lack of change/increase (i.e., increased desire). This then points to activation of heightened emotions, regardless of valence, as a mechanism through which a coping-motivated drinking may lead to more alcohol desire. Therefore, interventions may also benefit from targeting emotion-regulation strategies, both related to positive and negative emotions. However, treatment-oriented studies are needed to evaluate these hypotheses.

Limitations

Findings must be interpreted alongside several limitations. First, the parent study was focused on underage drinkers (age 18–20) and findings may be specific to this population. Considering craving is a hallmark symptom of alcohol use disorder, it is possible that findings may differ in a higher severity sample. Similarly, Koob's (2013) model of negative reinforcement suggests that coping-motivated drinking is more indicative of compulsive process later in one's drinking career. Therefore, findings in the current sample of low-risk, early career drinkers may differ from those in higher risk young drinkers. In addition, the current sample was predominately White (93.8%), despite the surrounding city's racial/ethnic diversity (i.e., 76% White; U.S. Census Bureau, 2022). Although several of the reviewed studies have similarly low racial–ethnic diversity (e.g., Armeli et al., 2010; Dvorak et al., 2014; Stevenson et al., 2019), findings may not generalize to other racial–ethnic groups. However, it is important to note that studies of the motivational model at the between-person level are largely similar when comparing White and ethnic-racially diverse individuals (e.g., Bacio, 2021; Corbin et al., 2020; Waddell, Corbin, & Marohnic, 2021). However, future research in more ethnically/racial diverse and in higher risk samples is needed when investigating within- and between-person effects of drinking motives.

Second, single items were used to measure day-level drinking motives, despite the DMQ-R using five items to assess each motive. Although it is common in EMA research to use single items/abbreviated scales, future research is needed to test whether findings hold when assessing several dimensions of each motive. Third, the present study captured a modest number of drinking episodes (M_{person} = 3.03, SD = 2.68), which could have affected the between-person average of day-level drinking motives. However, sensitivity analyses found that between-person scores were highly correlated with respective items on the DMQ-R and moderately correlated with DMQ-R motive subscales. The negative affect interactions for day-level coping motives and day-level/person-level conformity motives were only present when parsing apart the interaction among negative affect and coping. This was likely because coping and conformity motives are highly related, yet each motive interacted with negative affect in distinct ways. Future research is needed to test the robustness and independence of these interaction effects. Another limitation was that day-level drinking motives were only assessed at the outset of the drinking episode. Repeated assessments of motives during drinking might provide useful process insights. For example, it would be interesting to determine whether coping motive ratings typically decay as negative affect decreases. This would also permit detection of possible motivational shifts (e.g., an episode initiated to cope may become progressively more enhancement-driven if positive affect increases). Finally, compliance for morning and random reports was good (~80%), but drink report compliance was only 63.8%. Findings could be biased if noncompliance with real-time drink reporting is related to variation in day-level drinking motives, craving, or affective states. Additional research is needed to determine the replicability of the effects, and future studies should consider ways to increase drink report compliance.

Future Studies

Although this study focused on alcohol craving, there are important future directions to build upon this study, especially studies investigating alcohol consumption outcomes. First, it would be interesting to model the time-lagged effects of changes in affect and repeatedly measured drinking motives within a drinking episode. A second interesting follow-up would move analyses to day-level, testing whether a change in affect at the first drink report is associated number of drinks consumed on coping-motivated drinking days and whether changes in craving mediate associations between affective change and consumption. Finally, it would be interesting to investigate whether and how within-episode affective and motivational dynamics are associated with changes in the affective antecedents of drinking episodes over time.

It also important for future studies to test unobserved moderators that could affect study conclusions. One possibility is that an increase in positive/negative affect for coping-motivated individuals may be associated with satiation (i.e., less craving) for some but associated with approach (i.e., continued craving/desire) for others. One such moderator could be impulsive personality traits. For instance, individuals who act rashly in positive mood states may feel acute desire in the presence of acute increases in positive (but not negative) affect, whereas individuals who act rashly in a negative mood state may feel acute desire in the presence of acute increases in negative (but not positive) affect (e.g., Waddell, Corbin, & Leeman, 2021). Thus, future research is needed to test whether other variables underly the directionality through which changes in affect are associated with increased versus decreased craving.

Conclusion

Despite study limitations, the present study's findings can contribute to motivational theories of alcohol use. Findings suggested that drinking episodes characterized by coping motives were associated with heightened craving when drinking led to decreases in negative affect, whereas people who were higher in coping motives craved more alcohol when either negative or positive affect increased during drinking episodes. In addition, drinking episodes characterized by conformity motives and higher person-level conformity motives were associated with heightened craving when negative affect decreased. Considering craving is a strong precipitant of continued, heavier drinking (e.g., Lowman et al., 2000; Tiffany & Conklin, 2000), interventions may benefit from targeting both day-level and person-level drinking motives based upon one's profile of acute affective responses to alcohol.

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Received April 29, 2022
Revision received August 2, 2022
Accepted August 3, 2022 ■