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An Ecological Momentary Assessment of Affect, Mental Health Symptoms, and Decisions to Drink Among First-Year College Women: A Pilot Study

Danica C. Slavish, Ph.D.[1], **Nichole M. Scaglione, Ph.D., C.H.E.S.**[2], **Brittney A. Hultgren, Ph.D.**[3], and **Robert Turrisi, Ph.D.**[4]

[1]Department of Psychology, University of North Texas, Denton, TX, USA

[2]Division of Behavioral Health & Criminal Justice Research, RTI International, Washington, DC, USA

[3]Center for the Study of Health & Risk Behaviors, University of Washington, Seattle, WA, USA

[4]Department of Biobehavioral Health & Edna Bennett Pierce Prevention Research Center, Pennsylvania State University, University Park, PA, USA

Abstract

College women experience more consequences (e.g., blacking out, unprotected/unwanted sex) on days when they engage in their heaviest drinking. To inform prevention efforts, research is needed to understand decision-making processes that influence women's drinking behaviors at the event-level. The present study used ecological momentary assessment (EMA) methods to examine: 1) associations between positive affect (PA) and negative affect (NA) and decision making processes on days leading up to, during, and following heavy drinking events; and 2) mental health symptoms as moderators of these associations. Female undergraduate drinkers (N = 57) completed a 14-day EMA protocol on their smartphones, which included three daily assessments of PA, NA, and willingness and intentions to drink. Trait anxiety and depressive symptoms were measured before the EMA protocol and assessed as moderators. Time-varying effect models were used to examine covariation among PA, NA, and willingness and intentions to drink on the days leading up to participants' heaviest drinking events, the day of the event itself, and the days following the event. Results revealed PA was positively associated with willingness to drink the two days before, the day of, and the day after the heaviest drinking event. Similar effects were observed for PA and intentions to drink. Trait anxiety moderated the association between PA and intentions to drink. Findings underscore that positive affect may influence drinking-related decision-making processes surrounding heavy drinking events, particularly in those college women low in anxiety. Results identify potential entry points for real-time intervention efforts targeting college women during times of elevated PA.

Correspondence concerning this article should be addressed to Danica C. Slavish, Danica.Slavish@unt.edu.

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Keywords

college women; willingness and intentions to drink; affect; ecological momentary assessment; time-varying effect models

Studies show that first-year college women experience increased risk for consequences (e.g., blacking out, unprotected sex) on days when they consume more than their typical amounts of alcohol (Neal & Carey, 2007; Scaglione et al., 2014). Although extensive work has examined the decision-making constructs that influence typical drinking behaviors (e.g., Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2008), a gap remains in understanding why women choose to consume more alcohol during some drinking events, relative to others. The current study attempted to address this limitation by examining decision-making processes on the days leading up to, the day of, and the days immediately following heavy drinking events among first-year college women.

Decision Making and Drinking

Several theoretical frameworks have been used to study students' decisions to engage in risk behaviors (Glanz, Rimer, & Viswanath, 2015). A series of recent papers examining drinking-related outcomes has shown the benefit of using a dual-process approach to understand decision making (Hultgren, Scaglione, Cleveland, & Turrisi, 2015; Mallett et al., 2015;Scaglione et al., 2015). Although terminology varies by field, this dual-process approach (Chaiken & Trope, 1999; Gerrard, et al., 2008) includes a socially and emotionally driven reactive pathway that functions through behavioral *willingness* (Gerrard, et al., 2008) and a planned or reasoned pathway that functions through behavioral *intentions* (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). Willingness has been described as an openness to engage in the behavior, whereas intention involves setting a deliberate goal to engage in the behavior (Gerrard, et al., 2008). While similar, willingness and intentions assess two separate decision-making processes. For example, while a student may be *willing* to drink if the opportunity presented itself, they may not have specific *intentions* to drink that day. Both willingness and intentions to drink have been positively associated with alcohol consumption in studies of adolescents and young adults (Gerrard et al., 2008). Recent longitudinal studies examining alcohol-related decision making in college students have demonstrated that willingness and intentions tend to be correlated; however, when examined simultaneously, they have unique effects on behavioral outcomes (Hultgren et al., 2015; Mallett et al., 2015). For example, Mallett et al. (2015) demonstrated that intentions to avoid and willingness to experience consequences were negatively correlated ($r = -.35$) but had unique significant influences on drinking outcomes across the first year of college. Despite the benefits of examining both willingness and intentions to drink, little is known about the extent to which these decision-making constructs shift from day to day or within a day as intra-individual factors change, or as new social options become available.

Examining Decision-Making Processes at the Event Level

College students' heavy drinking events tend to be cyclical, occurring primarily on the weekends (Kuntsche & Gmel, 2013), with more frequent events being associated with

increased acute consequences (Read, Beattie, Chamberlain, & Merrill, 2008). In addition to examining decisions made on days when students drink, it may be useful to examine decision-making processes leading up to heavy drinking events and in the days following these events, which in turn may influence subsequent events. Advances in event-level data collection and analytic techniques make it possible to examine complex behavioral processes over time. Ecological momentary assessment (EMA) is a data collection method that measures events, cognitions, or behaviors as they occur in real time in participants' natural environments (Shiffman, Stone, & Huffod, 2008). While several studies have demonstrated the utility of EMA in understanding drinking behavior in young adult populations (Muraven, Collins, Morsheimer, Shiffman, & Paty, 2005; Piasecki et al., 2014), none have examined drinking-related decision-making processes.

Previous EMA studies of risk behavior have typically used statistical techniques such as multilevel modeling (MLM) to examine variations within an individual and differences among individuals across time. Such approaches are useful for understanding different sources of variation, but require assumptions regarding the shape of relationships being assessed (e.g., linear, quadratic). Recent analytic advances allow associations to vary as a function of time without making assumptions about the shape of the data (i.e., time-varying effect modeling, or TVEM; Tan, Shiyko, Li, Li, & Dierker, 2012). Using TVEM, predictors may be either time- variant (i.e., change rapidly over time) or time-invariant (i.e., stable, or enduring, over time), but each can still have a time-varying *effect,* meaning their associations with an outcome may change over time. TVEM analyses are ideal for examining how associations between variables change over time or surrounding a meaningful event. For example, Merrill, Kenney, & Barnett (2017) used TVEM to demonstrate that the strength of the association between alcohol use (i.e., a time- variant predictor) and the odds of experiencing consequences decreased overall from freshman to sophomore year in a sample of college drinkers, and that this association was more dynamic across time for women, relative to men (i.e., gender was a time-invariant moderator). Together, this work suggests EMA and TVEM may be useful methodologies to examine momentary influences on decision-making processes surrounding heavy drinking events in college women.

Affect and Mental Health as Predictors of the Decision to Drink

The present study examined the time-varying effects of affect and baseline mental health symptoms on daily decision-making constructs (i.e., willingness and intentions to drink) surrounding heavy drinking events in college women. The justification for examining each of these predictors is discussed, in turn.

Affect.

Strong theoretical and empirical support shows people are motivated to use alcohol to regulate both positive and negative affect (see the motivational model of alcohol use; e.g., Cooper, Frone, Russell, & Mudar, 1995; Miles Cox & Klinger, 1988). Positive affect (PA) and negative affect (NA) have been associated with drinking both globally and at the event level (Kuntsche et al., 2014; Gottfredson & Hussong, 2013; Hussong, Hicks, Levy, & Curran, 2001). However, no studies have examined momentary associations between affect

and decisionmaking constructs that influence drinking, or how these associations might change leading up to and following heavy drinking events. Although some evidence indicates females exhibit greater variability in daily affect compared to males (Larson, Moneta, Richards, & Wilson, 2002), how this variability relates to their decisions to drink across time is unclear. Thus, the current study examined positive and negative affect as time-variant predictors of willingness and intentions to drink among college women.

Mental health symptoms.

Further evidence suggests mental health symptoms, specifically anxiety and depressive symptoms, may influence a student's decisions to drink for affect regulation (i.e., to increase PA or to decrease NA). Some studies have shown that anxiety and depression symptoms are associated with decreased probability of alcohol use in young adults (Colder, Frndak, Lengua, Read, Hawk, & Wieczorek, 2017; Colder, Shyhalla, Frndak, Read, Lengua, Hawk, & Wieczorek, 2018), whereas other studies have shown that anxiety and depression are associated with an increased likelihood of risky drinking (Cludius, Stevens, Bantin, Gerlach, & Hermann, 2013; Grant, Stewart, & Mohr, 2009; Kenney, Abar, O'Brien, Clark, & LaBrie, 2016).The tension-reduction theory (Conger, 1956) provides support for the notion that individuals with anxious-depressive tendencies may plan for or react to drinking situations differently from those without such tendencies. This perspective is particularly salient for college women, who experience anxiety at considerably higher rates than college men (Eisenberg, Gollust, Golberstein, & Hefner, 2007). Women also tend to exhibit stronger positive associations between anxiety, depression, and alcohol use relative to men (Alati, Kinner, Najman, Fowler, Watt, & Green 2004). However, no studies have examined how anxiety and depression impact the association between affect and college women's decisions to drink on the days surrounding a heavy drinking event. The current study extends the literature by exploring how mental health symptoms modify associations between momentary affect and decision-making processes over time.

The Current Study

The first aim of the current study was to use a 14-day EMA data collection approach and TVEM analytics to examine time-varying associations between momentary affect (positive and negative) and willingness and intentions to drink on the days leading up to, the day of, and the days following female college students' heaviest reported drinking events. We hypothesized that female students would report significant associations between affect and intentions and willingness to drink on the days immediately surrounding their heaviest drinking events. The second aim explored baseline trait anxiety and depressive symptoms as time-invariant moderators of these associations. Given the inconsistent findings in literature, we viewed Aim 2 as exploratory. The present study extends the research on the relationships between affect, mental health, and decision-making variables associated with drinking, and findings will inform prevention efforts focused on decreasing heavy drinking and related risk in college women.

Method

Participant Recruitment

A random sample of 750 first-year female students was selected from the university registrar's database at a large, public northeastern university and invited to participate in a study about college health behavior. Students received a pre-notification letter, an email invitation, and up to seven email reminders describing the research and providing an URL and a PIN for accessing the consent form and web-based screening survey. Nearly 60% (n = 436) completed screening, which is consistent with response rates observed in other studies using similar web- based recruitment methods (e.g., Turrisi et al., 2013). Approximately 54% (n = 235) of participants met eligibility criteria, which included (a) having a 4G or LTE network smartphone and (b) reporting at least one heavy drinking episode in the past 30 days (i.e., four or more drinks in a single occasion; Wechsler, Dowdall, Davenport, & Rimm, 1995). Ineligible participants were paid $5 and removed from the study. Eligible students were directed to the web-based baseline assessment, for which they received $15 ($20 if the survey was completed within three days of the initial invitation).

Study Procedures

After baseline completion, two-thirds of respondents (n = 156) were randomized to participate in the EMA study, while the remaining one-third were randomized to a control group, addressing an aim of a larger study. Participants assigned to EMA were invited to continue by signing up for training on Snap Mobile, the cellular application used for EMA data collection. Approximately 54% (n = 84) attended training and enrolled in the study.

The current study employed a 14-day EMA protocol that used a combination of event- and signal-contingent assessments. Upon waking each morning, participants logged into Snap Mobile to complete a short survey of the previous day's drinking behavior. This survey also collected participants' first momentary assessment of affect and willingness and intentions to drink later that day. Between the hours of 2:00 p.m. and 6:00 p.m. and between 7:00 p.m. and 11:00 p.m., participants received random text message prompts to complete additional momentary assessments of affect, willingness, and intentions. Compensation was $30 for EMA participation, with a $20 bonus for completing at least 12 of the 14 morning assessments.

Participants

Because the current study examined predictors of decisions to drink surrounding heavy drinking events, those who did not report drinking during the EMA portion of the study (n = 27) were excluded from analyses. Thus, the final sample included 57 participants who reported at least one drinking event during the study. On average, participants were 18.05 years old (SD = 0.23), primarily identifying as Caucasian (84.2%), with a variety of other racial and ethnic backgrounds represented (10.5% African American, 1.8% Asian, 3.5% other; 3.6% Hispanic or Latino). Most lived on campus (98.3%), reported involvement with either intramural or club sports (56.1%), and were not affiliated with a sorority 57.9%). At baseline, participants consumed an average of 8.89 drinks per week (SD = 6.02).

Measures

Willingness and intentions to drink.—Willingness and intentions to drink were assessed three times daily over the 14-day study period, using a two-step approach. First, participants were asked, “Should the opportunity arise, how willing are you to drink today/tonight?” with responses ranging from 1 (not at all willing) to 5 (completely willing). Participants who indicated any level of willingness (i.e., ≥ 2) received a second question asking them to indicate how many drinks they would be willing to have. Responses ranged from 0 to 11+ drinks. For intentions, a similar procedure was used. First, participants were asked, “Do you have plans/intend to drink today?” If they indicated “yes,” they were asked how many drinks they intended to have. For analyses, the current study utilized the number of drinks an individual was willing or intending to have, with the value zero (0 drinks) imputed for individuals who answered “no” to the first set of questions (i.e., “Are you willing/intending to drink?”).

Positive and negative affect.—Positive affect (PA) and negative affect (NA) were measured three times daily using items from the Positive and Negative Affect Schedule, which has been shown to be an internally consistent (α = 0.84 to 0.90) and valid measure of positive and negative mood (Watson, Clark, & Tellegen, 1988). Participants rated the extent to which they felt each emotion at the time of assessment on a scale of 1 (not at all) to 7 (a great deal). A PA index was produced for each time point by averaging responses to five PA items (happy, energetic, confident, relaxed, excited). An NA index was produced for each time point by averaging responses to five NA items (lonely, sad, irritable, angry, anxious).

Daily alcohol use.—At the daily morning assessment, participants indicated whether they drank alcohol the day or night before, and, if yes, they reported the number of drinks consumed and over how many hours. A typical drink was defined as a 12-ounce (oz.) beer, a 10-oz. wine cooler, 4 oz. of wine, or 1 oz. of 100-proof (1.25 oz. of 80-proof) distilled spirits (National Institute on Alcohol Abuse and Alcoholism, 2000). Students reported body weight at baseline, which was used to calculate an estimated blood alcohol concentration (eBAC) for each reported drinking occasion.

Trait anxiety.—Anxiety was measured at baseline using seven items from the trait portion of the State-Trait Anxiety Inventory (STAI), which has shown high internal consistency (α = 0.89) and test-retest reliability (r = 0.88; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Participants rated how they felt “in general” on a scale of 1 (almost never) to 4 (almost always) in response to items such as “I feel nervous and restless” and “I worry too much over things that really don’t matter.” Item responses were summed to produce a trait anxiety index, with possible scores ranging from 7 to 28 (α = 0.85).

Depressive symptoms.—Depressive symptoms were measured at baseline using 10 items from the Centers for Epidemiological Science-Depression scale, which has demonstrated high internal consistency (α = 0.85) and test-retest reliability (r = 0.51 to 0.67) across time (Hann et al., 1999; Radloff, 1977). Examples of questions include “I was bothered by things that usually don’t bother me” and “I felt depressed.” Participants indicated the number of times in the past week they identified with each statement, with

response options ranging from 0 (rarely or never, less than one day) to 3 (most or all of the time, 5–7 days). Items were summed to produce an index of depressive symptoms, with possible scores ranging from 0 to 30 ($\alpha = 0.77$).

Analytic Approach

Preliminary analyses examined frequencies and correlations among all study variables. TVEMs were conducted to examine the changes in relations among variables across participants over time surrounding each participant's heaviest drinking event. First, intercept-only (i.e., models with no predictors) zero-inflated Poisson (ZIP) TVEMs were conducted with willingness and intentions to drink, respectively, to ensure sufficient variability in each across time. Intraclass correlation coefficients (ICCs; see Table 1) were calculated to examine the proportion of variation at the between-person and within-person level. Next, ZIP TVEMs with predictor coefficients were used to estimate the time-varying effects of PA and NA on willingness and intentions to drink (Aim 1), using the %TVEM_ZIP macro (Li, Tan, Huang, Wagner, & Yang, 2012; Version 2.1.1) in SAS Software (Version 9.4.; SAS Institute, 2008).

ZIP models were used because of their ability to simultaneously model the Poisson count model and the logit model for predicting excess zeroes (Li et al., 2012). The ZIP macro uses B- spline methods for estimation, which splits the overall function into equal intervals based on k, the selected number of knots. The function within each interval is then approximated with a lower-order polynomial (e.g., a cubic function; Li et al., 2012; Selya et al., 2015). For each model, *k* was incrementally increased to select the ideal number of knots based on examination of the Akaike information criterion (AIC) and Bayesian information criterion (BIC; i.e., smaller values indicate better fit; see Table 1). Because the current study examined time-varying effects surrounding the day of the participants' heaviest drinking event, all momentary data were utilized, and time (coded as days 1–14 of the study) was centered on the day each participant achieved her highest eBAC. Thus, the heaviest drinking day was coded as 0, with preceding days coded as −1, −2, and so on, and subsequent days coded as +1, +2, and so on.

For Aim 2, baseline trait anxiety and depressive symptoms were examined separately as moderators of the associations modeled in Aim 1. For ease of interpretation, results were graphec as a function of median split values of the anxiety and depressive symptoms moderators, in accordance with previous studies (Rohsenow, 1982; Schwarz et al., 1982). This approach was used because most college students do not meet clinical cutoffs for anxiety and depression (Eisenberg, et al., 2007). An example equation used to estimate the moderated effect of baseline trait anxiety on the relationship between PA and willingness to drink is provided below:

$$\text{Willingness to drink}_{ij} = \beta_0(t_{ij}) + \beta_1(t_{ij})\,\text{PA}_{ij} + \beta_2(t_{ij})\,\text{Anxiety} + \beta_3(t_{ij})\,\text{PA*Anxiety}_{ij} + \varepsilon_{ij}$$

In the above equation, at time t_{ij}, the mean willingness to drink (when all predictors = 0) is $\beta_0(t_{ij})$. The slopes $\beta_1(t_{ij})$ and $\beta_2(t_{ij})$ represent the strength and direction of the relationships between PA and willingness to drink and anxiety and willingness to drink, respectively, at a given time point, t_{ij}. The interaction effect $\beta_3(t_{ij})$ represents the strength and direction of the combined impact of PA and anxiety on willingness to drink at a particular time point, t_{ij}.

Both the intercept and the slopes are time-specific, allowing for different values at different points in time.

Results

Preliminary Analyses

Participants completed an average of 38.21 (SD = 4.73) out of 42 possible assessments (i.e., an 90.98% compliance rate). On average, female students reported drinking on 2.27 (SD = 1.38) out of 14 days (n = 18 students drank on one day; n = 15 on two days; n = 9 on three days; n = 10 on four days; n = 4 on five days; and n = 1 on six days) and consumed an average of 5.00 drinks per day (SD = 2.82). On their heaviest drinking day, female students consumed an average of 6.00 drinks (SD = 2.65), achieving eBACs of approximately 0.15 g/dL (SD = 0.08). For those students who reported multiple drinking days, the average difference between the eBAC achieved on the heaviest drinking day and the eBAC achieved on the next-heaviest drinking day was 0.02 g/dL (SD = 0.05). The average difference between the eBAC achieved on the heaviest drinking day compared to the eBAC achieved on the day immediately *prior* and the day immediately *after* was 0.08 g/dL (SD = 0.09), supporting the notion that the heaviest drinking day was a relatively isolated event. Preliminary examination of maximum eBACs by study day revealed two peaks: the 6th day and the 12th day of the study. As all participants initiated data collection on a Monday, these days map onto the first Saturday and the second Thursday within the 14-day period. See Table 1 for means and standard deviations of primary study variables.

TVEM Results

Coefficients are estimated as a function of continuous time; therefore, all TVEM results are presented as figures. Solid curves represent the strength of the association between the coefficients, and dotted lines indicate 95% confidence intervals (CIs). Places on the time continuum where the CI does not include zero indicate the association between the predictor and outcome is significant (i.e., non-zero). At any point in time, coefficients are interpreted the same way as (unstandardized) coefficients from standard regression: the level on the curve represents the mean level of willingness or intentions to drink when other predictors equal zero. When the line is above the center (zero), the association is positive, and when the line is below the center, the association is negative; the magnitude of that association is defined by how far the curve is from the center line. For moderation analyses, non-overlapping CIs represent significant differences between groups. Table 2 provides fit indices for all TVEM models conducted.

Intercept-only models.—Examination of ICCs revealed that 86% of the variance in willingness and 93% of the variance in intentions existed at the within-person (i.e., day-to-day) level (see Table 1). Intercept-only descriptive TVEM revealed significant variation in both willingness and intentions to drink across participants surrounding individuals' heaviest drinking events (Figures 1A and 1B, respectively). Across the study, greater variation was observed in willingness to drink than in intentions to drink across time, such that two peaks of willingness to drink emerged: on the heaviest drinking day and around seven days prior to that drinking event. Examination of intercept-only models for PA and NA also revealed that

affect fluctuated over the 14 days, with slight increases in PA and slight decreases in NA (approximately ± 0.5 unstandardized units on a total scale ranging from 1 to 7) occurring on day 6 and 14 (i.e., the first and second Saturday of the study; not shown).

Aim 1: Time-varying effects of affect on decisions to drink.—PA was positively associated with willingness to drink eight to six days before, as well as on the two days before, the day of, and up to one day after an individual's heaviest drinking event (based on examination of CIs not including zero; Figure 2A). This association became stronger as the day of the heavy drinking event approached (i.e., from day −2 to day 0) and weakened the day after the heavy drinking event (i.e., from day 0 to day 1). PA was positively associated with intentions to drink the day before and the day of an individual's heaviest drinking event (Figure 2B). NA was not significantly associated with willingness or intentions to drink at any point in time.

Aim 2: Examining moderation effects of anxiety and depressive symptoms.—Preliminary analysis of mental health characteristics revealed, compared to those with lower trait anxiety, individuals with higher trait anxiety had significantly greater average willingness and intentions to drink, lower average PA, greater average NA, greater baseline trait anxiety, and more depressive symptoms (Table 1). Those with fewer depressive symptoms differed from those with higher depressive symptoms on all these same constructs except average intentions to drink. Examination of TVEM main effects revealed anxiety was positively associated with willingness to drink from the day of to three days after the heaviest drinking event, and positively associated with intentions to drink on the day before and the day of the heaviest drinking event. Depressive symptoms were not significantly associated with willingness to drink at any time point but were positively associated with intentions to drink from the two days before to the day of the heaviest drinking event.

TVEMs with affect and moderators revealed baseline trait anxiety significantly moderated the association between PA and intentions to drink (Figure 3), but not PA and willingness to drink. For individuals with low anxiety, PA was positively associated with intentions to drink the day of the heaviest drinking event. These associations were not observed for women who reported high anxiety. Significant differences between the high- and low-anxiety groups are shown in Figure 3 by non-overlapping CIs on day 0. Depressive symptoms did not moderate the effects of PA or NA on willingness or intentions to drink at any point in time.

Discussion

Interventions targeting high-risk drinking in college students are developed based on theories of behavior change that assume global associations between constructs without accounting for how these associations may vary from day to day. In addition, few existing intervention efforts specifically target women's needs. Women in the current sample achieved eBACs on their heaviest drinking occasions that were nearly two times the legal limit, defined as 0.08% in most states, which further supports the need for prevention efforts to reduce heavy drinking in this population. Toward this end, the current study was the first to examine time- varying associations between affect, mental health symptoms, and

momentary decision-making constructs surrounding heavy drinking events among first-year college women.

Descriptive findings revealed that, although there was significant variation in both intentions and willingness to drink over time, there was more variation in willingness, which extends findings from Lewis et al. (2016) who demonstrated high daily variability in willingness to drink. It is possible that in the current sample, there was more variability in willingness to drink than intentions to drink due to the passive nature of willingness, compared to the more active nature of intentions. Partially supporting our hypothesis in the first aim, we also observed positive associations between PA and willingness and intentions to drink on the few days before students' heaviest drinking events, but no significant effects of NA on willingness or intentions to drink at any time point. These findings corroborate previous research demonstrating that college students are more likely to drink to celebrate or to enhance PA than to cope with NA (Read, Wood, Kahler, Maddock, & Palfai 2003). However, in the current sample, participants reported lower mean values of NA compared to PA, suggesting that there also may have been a restriction in range of NA values. NA may emerge as a more important predictor of willingness or intentions to drink in other samples (e.g., older adults or those with alcoholism).

With regard to PA, it is plausible that women who plan to drink more, or who are more susceptible to pro-drinking contexts when their PA is elevated, may be at particularly increased risk for negative consequences. Scaglione et al. (2014) have shown that women, especially those who do not drink heavily on average, experience increased sexual risk on days when they drink more than their typical amounts. To inform intervention efforts, future work should examine the events that increase PA, as well as characteristics of drinking events that occur during periods of elevated PA (e.g., consequences, use of protective behaviors). Understanding the strength and temporal nature of these associations could enhance messaging and influence the timing of event-specific interventions (e.g., Neighbors, Lee, Lewis, Fossos, & Walter, 2009).

The second aim of the study examined anxiety and depressive symptoms as moderators of the time-varying associations between affect and drinking decision-making constructs. Results revealed the effects of PA on planned decisions to drink were not the same for all women. Women with low anxiety reported a positive relationship between PA and intentions to drink on the day of their heaviest drinking event. Women with high anxiety demonstrated no association between PA on intentions to drink, despite having greater intentions and willingness to drink on average, relative to their low-anxiety peers. For women with high anxiety, there may be factors other than PA impacting their decisions to drink, such as fear of social situations or consequences involving alcohol. Women with low anxiety may be less fearful of experiencing consequences associated with heavy drinking and, therefore, more sensitive to the effects of PA when planning to drink. To enhance interventions for women, additional work is needed to explore the social contexts that might interact with PA to elicit momentary reactive decisions to drink, and how these contexts may be different in those women with high versus low anxiety.

Prevention Implications

The current study has several implications for prevention. First, existing prevention efforts may be enhanced by addressing event-level risk factors that affect momentary decision making. For example, using brief motivational interviewing (e.g., Dimeff, 1999), women may be encouraged to explore how PA influences their decisions to drink in different social contexts or to proactively plan protective strategies to employ on days when they plan to drink. Prevention efforts also may benefit from investigating alternatives to drinking to enhance PA. For example, mindfulness-based stress reduction is one promising strategy shown to increase PA (Anderson, Lau, Segal, & Bishop, 2007). These individually-based approaches can be easily adapted and incorporated into counseling programs for women seeking treatment for anxiety. Alternatively, approaches that address population-based social norms may have added effects for women if they focus on celebratory drinking norms or alternatives strategies women use to celebrate positive experiences. Finally, results suggest the days immediately before and the day of expected heavy intoxication may be particularly salient for implementing event-specific interventions for female college students. Recent advances in adaptive mobile technologies hold promise for targeting decision making and behavioral modification in real time. For example, Riordan, Conner, Flett, and Scarf (2015) have demonstrated the utility of ecological momentary intervention (EMI) in reducing drinking among college women during freshman orientation week, and several studies have used normative feedback approaches to target particularly highprofile drinking events (e.g., spring break, 21st birthdays; e.g., Neighbors et al., 2009). However, our findings, coupled with the cyclical nature of college student drinking patterns (Kuntsche & Gmel, 2013), suggest the need to intervene more frequently than just prior to these anticipated heavy drinking events. Further, our results suggest that most days when first-semester college women drink appear to involve heavy drinking (i.e., eBACs over the legal limit of .08).

Limitations and Future Directions

Despite its unique contributions to the literature, the current study has limitations that warrant further investigation. First, large TVEM CIs at certain time points may limit generalizability, suggesting a need to replicate findings in larger samples. The current study also shows these associations over a 14-day period within the first semester of college. Longer studies are needed to capture multiple drinking days and to compare associations between affect and intentions and willingness to drink on minimal drinking versus heavy drinking days. Relatedly, although the results of this study may be specific to the sample we utilized, we felt it was important to understand these processes in college women. College women are at higher risk for depression and anxiety, and their drinking-related decisions might impact what protective behaviors they use or what consequences they experience. Future work should examine how the observed results may change in other samples (e.g., college men, or non-college women). Second, it is also possible that the observed results can be attributed to day of the week trends in drinking and affect; future studies should examine these relationships over different and longer periods of time to untangle these potential day of the week trends. Multilevel modeling could also be used to examine if days with more positive affect than one’s individual average are associated within changes in willingness and intentions to drink. Third, baseline and EMA measures were abbreviated to minimize participant burden. Future studies may observe greater variability if replicated using more

comprehensive measures and more diverse samples that include those clinically diagnosed with depression or anxiety. Finally, the directionality of effects observed cannot be determined due to the correlational nature of the study. Investigation of lagged analyses between affect and momentary decisions to drink is an area of research needed to better infer causal processes.

Concluding Remarks

Findings from the current study hold theoretical, methodological, and applied implications for prevention research. Using TVEM, we were able to flexibly model time to examine dynamic associations between affect and drinking decision-making factors surrounding heavy drinking events in college women. Results of the current investigation indicate PA may play a more important role than NA in college women's decisions to drink heavily on some days relative to others. Individual differences in trait anxiety also appear to modify these time-varying relationships between affect and decisions to drink over time. These variables' effects on willingness and intentions to drink seem to be cyclical and strongest at times closest in proximity to heavy drinking events, identifying potential entry points for real-time interventions efforts targeting college women.

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Compliance with Ethical Standards

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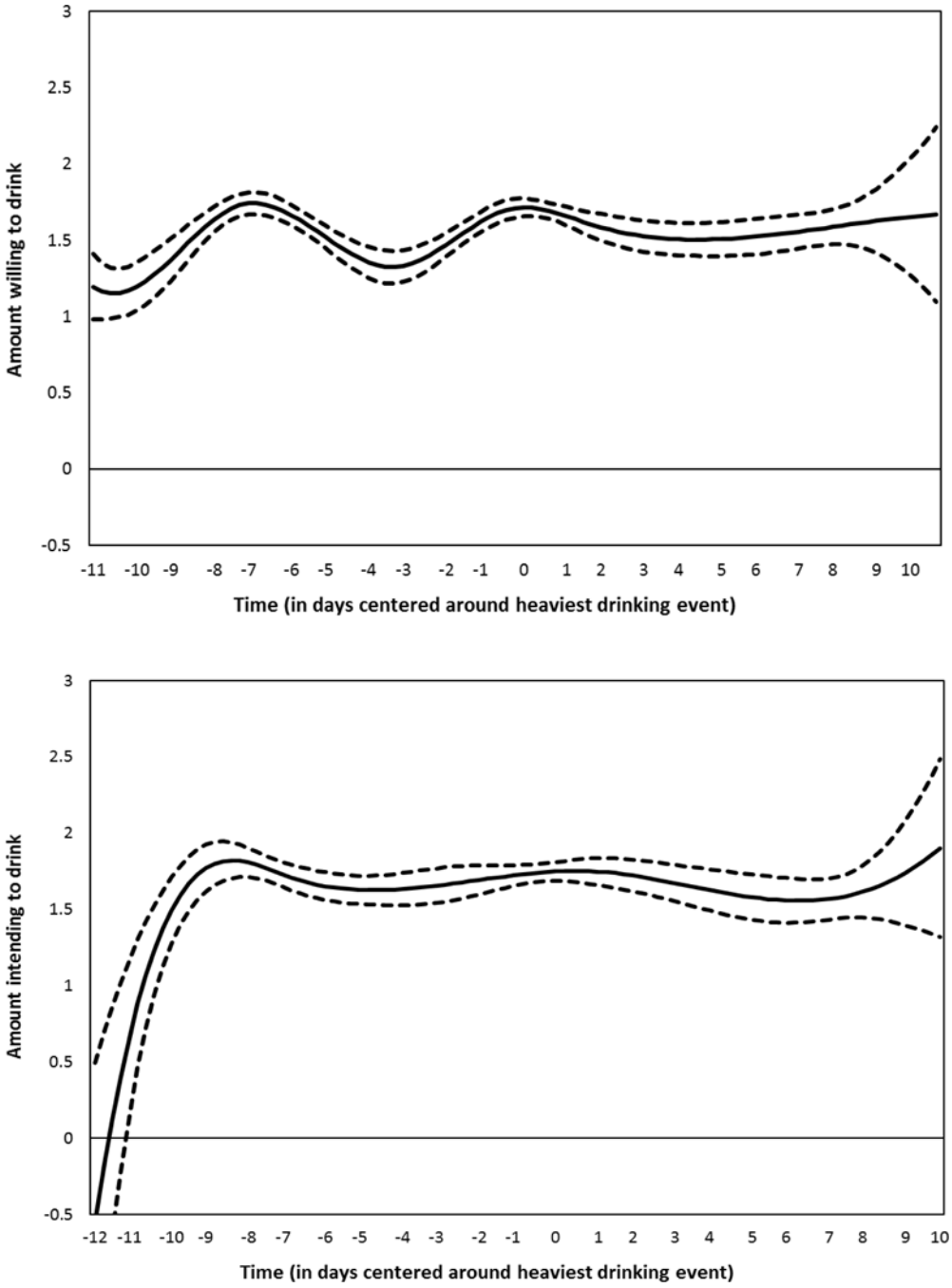

Figure 1A and 1B.

The time-varying effect of average (i.e., intercept-only) willingness (Figure 1A, top) and intentions (Figure 1B, bottom) to drink. Dotted lines indicate 95% confidence intervals. Time is measured and analyzed continuously but is centered and labeled in daily intervals for ease of presentation

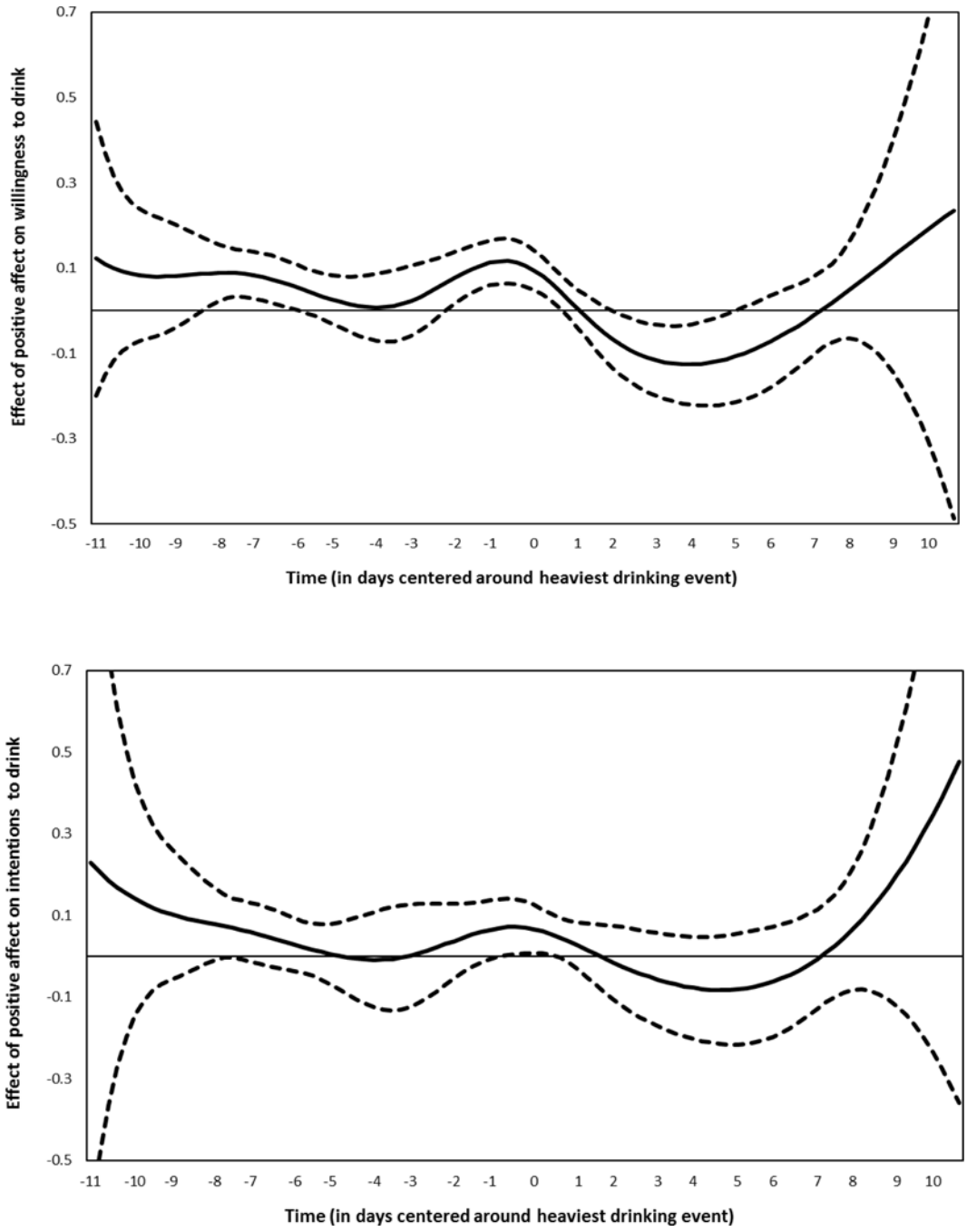

Figure 2A and 2B.

Time-varying effect of positive affect on willingness (2A; top) and intentions (2B; bottom) to drink. Dotted lines indicate 95% confidence intervals. Time is measured and analyzed continuously but is centered and labeled in daily intervals for ease of presentation

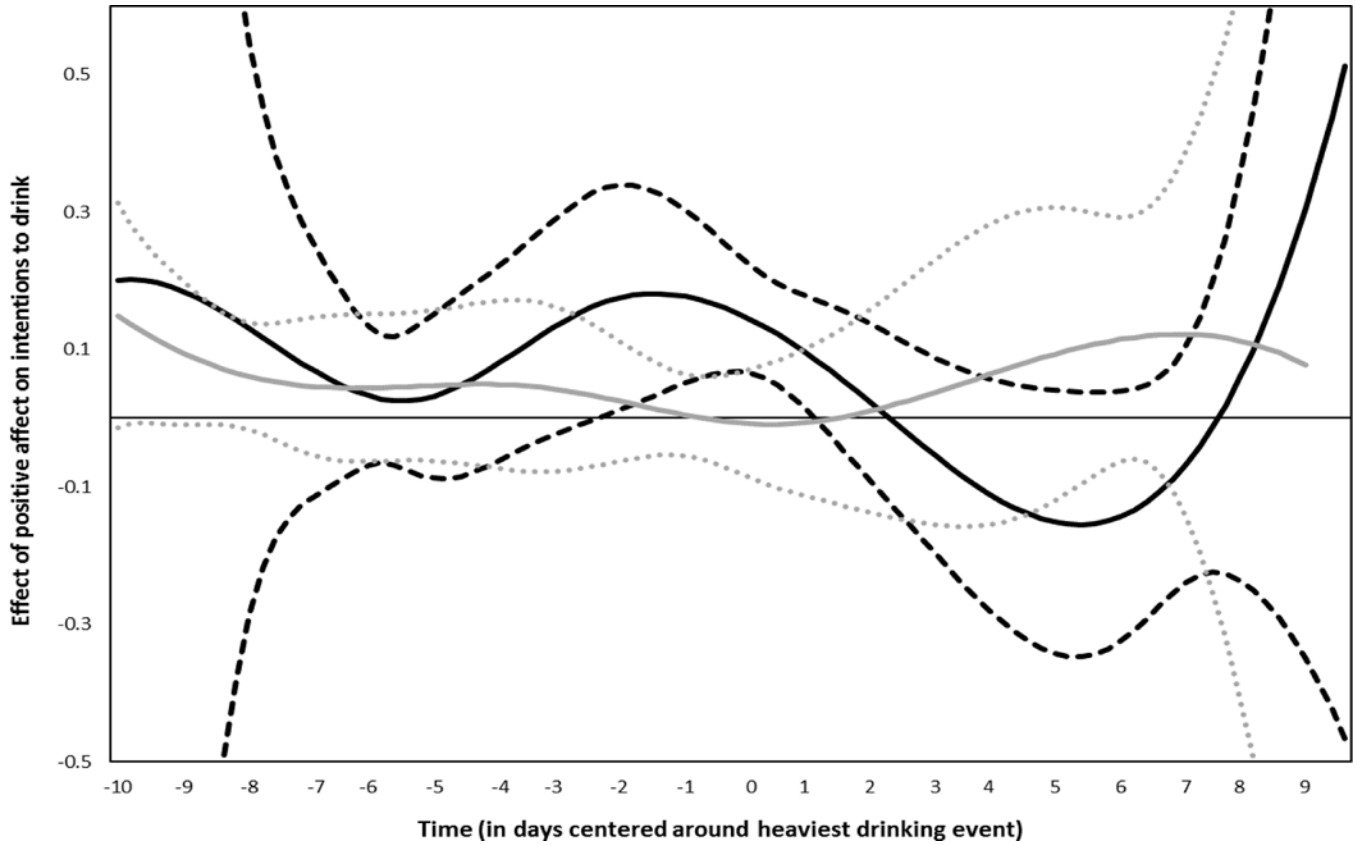

Figure 3.

Time-varying moderated effect of anxiety on positive affect and intentions to drink. Dotted lines indicate 95% confidence intervals. Black dashed lines represent low anxiety and gray dotted lines represent high anxiety. Time is measured and analyzed continuously but is centered and labeled in daily intervals for ease of presentation

Table1.

Intraclass Correlation Coefficients and Means and Standard Deviations for Total Sample and by Median Split of Moderators

	ICC	Entire Sample (n = 57)	Low Dep (n = 28)	High Dep (n = 29)	Low Anx (n = 25)	High Anx (n = 32)
Will	0.14	2.10 (1.16)	1.96 (1.12)	2.22 (1.20)	1.78 (0.98)	2.34 (1.24)
Int	0.07	1.30 (0.80)	1.21 (0.74)	1.39 (0.87)	1.06 (0.60) *	1.49 (0.90) *
PA	0.33	4.33 (0.79)	4.62 (0.71) *	4.05 (0.78) *	4.68 (0.79) *	4.05 (0.70) *
NA	0.49	2.33 (0.85)	2.09 (0.83) *	2.56 (0.83) *	2.05 (0.84) *	2.54 (0.81) *
Dep	--	6.35 (4.44)	2.82 (1.61) *	9.76 (3.53) *	3.48 (2.63) *	8.59 (4.29) *
Anx	--	14.55 (4.28)	12.11 (2.92) *	17.00 (4.06) *	10.88 (1.65) *	17.31 (3.50) *
Max eBAC	--	0.15 (0.08)	0.15 (0.09)	0.14 (0.08)	0.13 (0.07)	0.16 (0.09)

Notes.: Will = willingness to drink; Int = intentions to drink; PA = positive affect; NA = negative affect; Dep = depressive symptoms; Anx = trait anxiety; Max eBAC = maximum estimated blood alcohol content. ICC = intraclass correlation coefficient (i.e., ratio of between-person variance to total variance; 1 - ICC = ratio of within-person variance total variance). Values with an asterisk (*) are statistically significant ($p < .05$) between high and low median split groups of the same variable (based on independent samples t-tests).

Table 2.

Model Fit Indices

	k=3		*k*=4		*k*=5	
	AIC	**BIC**	**AIC**	**BIC**	**AIC**	**BIC**
Intercept-only for Will	5938.54	5983.09	5913.15*	5963.26*	5911.32	5967.00
Intercept-only for Int	3930.70*	3975.24*	3931.40	3981.51	3932.05	3987.73
Anx on Will	5831.64	5914.90	5807.00*	5901.36*	5804.60	5910.07
Anx on Int	3847.91*	3931.16*	3850.68	3945.03	3851.90	3957.35
Dep on Will	5944.46	6027.97	5919.63*	6014.29*	5913.74	6019.53
Dep on Int	3917.07*	4000.58*	3919.08	4013.73	3919.79	4025.57
PA on Will	5924.08	6007.59	5896.04*	5990.68*	5895.86	6001.64
PA on Int	3933.70	4017.21	3935.88*	4030.52*	3938.13	4043.90
PA * low Anx on Int	1566.05*	1637.28*	1564.16	1644.89	1558.82	1649.05
PA * high Anx on Int	2336.61*	2411.38*	2337.34	2421.50	2338.02	2432.73

Notes.: Will = willingness to drink; Int = intentions to drink; Anx = trait anxiety; Dep = depressive symptoms; PA = positive affect. Model fit indices are based on examination of Akaike information criterion (AIC) and Bayesian information criterion (BIC) for $k = 3$, 4, and 5 knots. Smaller values indicate better fit. Values with an asterisk (*) indicate best model fit (i.e., final chosen model).