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College Student Affect and Heavy Drinking: Variable Associations Across Days, Semesters, and People

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Abstract

This study tested associations between positive and negative affect and heavy drinking in 734 college students who completed daily diaries in 14-day bursts once per semester over 7 semesters (≤98 days per person). Three-level multilevel models tested whether affect and heavy drinking were linked across days, semesters, and persons. Higher daily, between-semester, and between-person positive affect were each associated with a greater odds of heavy drinking on weekdays and on weekend days. A significant interaction with semester in college showed that the association between daily positive affect and heavy drinking on weekend days became stronger over time. That is, heavy drinking on a weekend day with higher positive affect was more likely in later years of college (*OR*=2.93, Fall of 4th year), compared to earlier in college (*OR*=1.80, Fall of 1st year). A similar interaction was found for between-semester positive affect and heavy drinking on weekdays. Higher daily negative affect was associated with a *greater* odds of heavy drinking on weekdays only for students who first began drinking in 7th grade or earlier (*OR*=2.36). Results of this study highlight the importance of varied time spans in studying the etiology, consequences, and prevention of heavy drinking. Harm-reduction strategies that target positive affect-related drinking by encouraging protective behaviors during celebratory events may become increasingly important as students transition to later years of college.

The college years are an important time of developmental vulnerability for heavy drinking and its associated consequences. For many young people, college matriculation launches a phase of normative, time-limited heavy drinking that later diminishes as students age and transition into post-college roles (Baer, 2002; Dawson, Grant, Stinson, & Chou, 2004; Schulenberg et al., 2001; Staff et al., 2010). National surveys show that 37-44% of college students report *heavy drinking* during the last two weeks (Johnson, O'Malley, Bachman, & Schulenberg, 2013; Wechsler & Nelson, 2008), with heavy drinking defined as consuming five or more drinks (among men; sometimes four or more among women) within a single drinking occasion (Wechsler, Dowdall, Davenport, & Rimm, 1995). Conceptual motivational models for understanding alcohol use posit that affect or mood motivates drinking and that drinking can in turn regulate affect (Cooper, Frone, Russell, & Mudar, 1995; Cox & Klinger, 1988). In these models, drinking alcohol both motivates and enhances social activities that heighten positive affect. Indeed, many drinkers expect and report a variety of positive experiences as a result of drinking alcohol (Barnett et al., 2014; Park,

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2004). These models also posit that for some people, heightened negative affect motivates drinking to alleviate negative emotions.

Theories linking affect and heavy drinking often provoke questions about *within-person* processes, drawing attention to specific times of heightened risk (Curran & Bauer, 2011; Mohr et al., 2005). For example, do students drink more alcohol on occasions when they feel happier, and does alcohol consumption enhance positive affect? The same theories also point to possible *between-person* individual differences to identify *who* is more likely to drink heavily. For example, individual differences in beliefs about the effects of alcohol (Baer, 2002; Cooper, Kuntsche, Levitt, Barber, & Wolf, in press) and in general predispositions to drink to celebrate or to regulate negative emotions (Cooper, Russell, & George, 1988) are powerful concurrent and prospective predictors of alcohol consumption and problems (e.g., Cooper et al., 1988; Jones, Corbin, & Fromme, 2001; Patrick, Wray-Lake, Finlay, & Maggs, 2010; Sher, Wood, Wood, & Raskin, 1996; Wardell & Read, 2013). Whereas between-person associations indicate whether certain stable emotional dispositions are related to heavy drinking, within-person associations indicate whether certain emotions are temporarily heightened (or suppressed) at times of heavy drinking. Each, in turn, would have different implications for prevention or intervention efforts to reduce harmful drinking. In the current study, we examine whether heavy drinking on weekdays and weekend days rises and falls in tandem with fluctuations in positive affect and negative affect, and we examine longitudinal change in within- and between-person affect-drinking associations as students move through their college years.

Within- and between-person associations between affect and heavy drinking

The first aim of the present study is to assess within- and between-person associations between college students' positive and negative affect and their heavy drinking. The importance of testing within-person associations is well established in research on affect and alcohol use (Armeli, Carney, Tennen, Affleck, & O'Neil, 2000a; Grant, Stewart, & Mohr, 2009; Mohr et al., 2001; Neal & Fromme, 2007; Rankin & Maggs, 2006). Yet, the within-person vs. between-person distinction is a perennial source of confusion (Curran & Bauer, 2011), and the meaning of each type of association is rarely made explicit. Consequently, it is not always clear for whom and at what times affect may be linked to drinking. Several studies tested within-person but not between-person associations between affect and alcohol consumption: Higher daily and weekly positive and negative affect is associated with any drinking (Armeli, Conner, Cullum, & Tennen, 2010), with consuming more drinks (Armeli, Tennen, Affleck, & Kranzler, 2000b; Grant et al., 2009; Mohr et al., 2005; Mohr, Brannan, Mohr, Armeli, & Tennen, 2008; Simons, Gaher, Oliver, Bush, & Palmer, 2005; Todd, Armeli, Tennen, Carney, & Affleck, 2003), and with greater intoxication (Simons, Dvorak, Batien, & Wray, 2010), although drinking associations with negative affect are less consistent (Rankin & Maggs, 2006; Simons et al., 2010). These within-person findings indicate that at times of heightened positive or negative affect, students tend to drink more heavily. In other words, heavier drinking occurs in close proximity to when students feel more positive or negative than usual.

In contrast, students' usual or average levels of positive and negative affect are measures of between-person differences that are not necessarily associated with drinking in the same ways as observed at the within-person level. Studies that included between-person tests showed that higher average levels of negative affect were not related to drinking frequency (Armeli et al., 2010) or to number of drinks consumed (Park, Armeli, & Tennen, 2004). Higher average positive affect did not predict weekly episodes of heavy drinking (Rankin & Maggs, 2006), and higher average positive and negative affect were both unrelated to time-to-drinking onset within the weekly cycle (Armeli, Todd, Conner, & Tennen, 2008). These between-person findings suggest that students who tend to feel more or less positive or negative on average are equally likely to drink heavily. In other words, episodes of heavier drinking occur at similar rates among students possessing a variety of affective dispositions. There were two exceptions that suggest the relation between affect and heavy drinking may vary according to the timescale of measurement: Higher average positive affect predicted heavier daily drinking in one study (Park et al., 2004), and higher average negative affect predicted a higher number of drinking days over a 10-week period in another study (Rankin & Maggs, 2006).

To our knowledge, no studies have yet examined how affect and alcohol use are associated over multiple spans of time. In the current study, we extend prior research in a 3-level design by evaluating short-term within-person associations over days, long-term within-person associations over semesters of college, and between-person individual differences. Whereas most studies have focused on first-year students, this study uniquely examines within- and between-person associations between affect and alcohol over seven semesters, testing whether these associations operate similarly as students move through the college years.

Changes in the affect-drinking relation over the course of a college career

The second aim is to examine how within- and between-person associations of affect and heavy drinking change over the course of a college career. High school seniors heading for college show greater increases in their drinking behavior after high school relative to non-college peers (O'Malley & Johnston, 2002), and consequently there is a strong emphasis in longitudinal alcohol research on the transition to college (e.g., Baer, Kivlahan, & Marlatt, 1995; LaBrie et al., 2007; Read, Wood, & Capone, 2005; Sher & Rutledge, 2007). We know of no studies that have directly examined whether associations between affect and heavy drinking change over time through the college years, although one found that drinking motivated by tension-reduction diminished for female students moving from age 19 into the mid-twenties (Rutledge & Sher, 2001). Another study evaluated daily depressive affect and alcohol use associations over four years of college, but did not test whether the association changed with age (Armeli et al., 2010).

The current study tracks students' daily affect and heavy drinking over seven semesters, permitting us to test whether within- and between-person associations between heavy drinking and affect become stronger, weaker, or remain stable over the college years. On the one hand, we speculated that affect might be more strongly linked to heavy drinking during the first year, with the shift to new academic and social environments, excitement

surrounding the transition to university, and strong cultural and peer expectations about experimentation with alcohol. On the other, affect might be more strongly linked to heavy drinking later in college when most students are legally able to drink and have greater access to alcohol (see Wechsler, Lee, Nelson, & Kuo, 2002). It is possible that older students may leverage this greater access to alcohol at times of heightened positive and negative affect, creating opportunities for heavy drinking.

Do biological sex and age of alcohol use onset moderate of the affect-drinking relation?

The third aim of the present study is to examine whether observed within- and between-person associations between affect and heavy drinking differ by students' gender and the age at which they first consumed alcohol. Many studies have found that men drink more often and in greater quantities than women (Wilsnack & Wilsnack, 2013), including college students (Armeli et al., 2010; O'Malley & Johnston, 2002), though gender differences in heavy drinking have been converging among teenagers worldwide (Kuntsche et al., 2011). The impact of gender on the association between affect and heavy drinking is less clear. In some studies gender did not moderate the effect of positive or negative affect on the number of drinks consumed (Armeli et al., 2000b; Mohr et al., 2005) or on heavy drinking episodes (Rankin & Maggs, 2006). In other studies, gender moderation was context-specific. For example, on days of lower positive mood, higher nervousness was associated with consuming more drinks at home but only among college men (Mohr et al., 2008). College women, but not men, who were higher in extraversion consumed fewer drinks away from home on days when they reported positive interpersonal exchanges (Mohr et al., 2001). However, gender differences in associations between affect and heavy drinking may not be present in traditional-aged college men and women that share similar social roles (Rankin & Maggs, 2006).

A second potential moderator is students' age of alcohol use onset. Heavy drinking prior to entering college is the strongest predictor of heavy drinking during the first semester of college (Sher & Rutledge, 2007). Heavier drinking prior to college and experimentation with drinking and being drunk before age 16 predict heavier alcohol use during the first two years of college (Read et al., 2005; Weitzman, Nelson, & Wechsler, 2003). Thus, for some students, heavy drinking in college represents continuity of a pattern of alcohol consumption that begins earlier in adolescence. To our knowledge, no studies have examined whether affect is linked to heavy drinking in college students with a history of early alcohol use. For positive affect, students who began drinking at earlier ages were more likely to engage in high-risk drinking games at parties and less likely to use protective behaviors such as setting limits and diluting alcohol (Ray, Stapleton, Turrisi, & Philion, 2012). Thus, heavier and higher-risk drinking in the context of positive affect may be more likely among students who began experimenting with alcohol at earlier ages. For negative affect, Hussong and colleagues argue that early alcohol use to reduce distress may be a precursor to later heavy drinking in relation to pathological negative affect (e.g., Hussong, Jones, Stein, Baucom, & Boeding, 2011). Continuity of such a pattern during the college years may emerge as a

stronger association between negative affect and heavy drinking among students who began experimenting with alcohol at earlier ages, compared to those with later ages of onset.

The current study

Using a daily diary measurement burst design tracking students across seven semesters of college, the current study aimed to assess: (1) whether positive and negative affect are uniquely associated with heavy drinking at daily, semester, and person levels (tested separately for weekday and weekend drinking); (2) whether these associations remain stable or change over the course of college careers; and (3) whether gender and age of alcohol use onset moderate associations between positive and negative affect and heavy drinking.

Method

Participants and Procedure

The current study used data from 734 students enrolled in the *University Life Study*, a longitudinal measurement burst study of first-year, first-time college students followed for seven semesters beginning in Fall, 2007 (hereafter, Fall 1st year). Students were eligible to participate if they were U.S. citizens or permanent residents, under age 21 during their first semester, and lived within 25 miles of campus. A stratified random sampling procedure ensured a sample that was diverse with respect to biological sex and race/ethnicity. All eligible students within the sampling frame were mailed an informational letter with a description of the study inviting them to participate. Packets included a pen and a $5 cash pre-incentive. Students then received an email with a link to a secure web-based baseline survey that included consent forms and information about participation rights, confidentiality, and payment. After completing the baseline survey, students were invited by email to complete short daily web-based surveys over 14 consecutive days, a measurement burst procedure repeated once per semester through Fall 2010 (hereafter, Fall 4th year), yielding up to 98 days of data per participant. Fall semester diary bursts were administered primarily in October, and Spring semester bursts were administered in March and April, after students returned from Spring Break. During data collection bursts, emails were sent each morning with a link to the daily survey, and students were able to access daily surveys for up to two days before they were closed to further entries (students' timeliness and compliance with daily surveys is reported in the Results section). In Semester 1, participants received $20 for completing the baseline survey and $3 for each daily survey completed. An additional $8 bonus was offered to students who completed all 14 of the daily surveys. Incentives were increased slightly across the 7 semesters. Completion rates were high and attrition was modest. Between 79.6% (Fall 4th year) and 89.7% (Fall 1st year) of participants provided data on heavy drinking and affect on at least 12 of 14 days in each semester. Retention at each measurement burst from the original sample of 744 students ranged from 96.2% in Fall 1st year to 79.4% in Fall 4th year.

Students completed self-reports about race and Hispanic/Latino ethnicity: 25.1% were Hispanic/Latino American; 27.4% were European-American Non-Hispanic/Latino (NHL); 23.3% were Asian-American NHL; 15.7% were African-American NHL; and 8.5% were

Multiracial NHL. The sample had an average age of 18.45 years in Fall 1st year (*SD*=.42; range=16.92 to 20.75) and 49.2% were men.

Design

Data for the present analyses are from daily diary assessments of college students' affect and drinking once per day over up to 98 days, with diaries administered in bursts of 14 consecutive days per semester in each of 7 consecutive semesters. This measurement burst design (Nesselroade, 1991; Sliwinski, 2008) allows us to explore associations between affect and heavy drinking at three distinct levels: (1) *Within-person, daily associations*. Significant associations between affect and heavy drinking at this level indicate that individuals are more likely to engage in heavy drinking on *days* they report temporarily elevated or suppressed affect, compared to their own personal average levels of affect that semester. (2) *Within-person, between-semester associations*. Associations between affect and heavy drinking at this level indicate that individuals are more likely to engage in heavy drinking in *semesters* (as assessed during the 14-day bursts) in which they report relatively more or less affect, compared to their own personal averages across all semesters. (3) *Between-person associations*. Significant associations between affect and heavy drinking at this level indicate that individuals who have a general propensity to report higher or lower positive and negative affect in general (as assessed across all study days), relative to their peers in the sample, are more likely to engage in heavy drinking.

The daily diary design of the current study also carries important information about dayof-week differences in associations between affect and heavy drinking. It is well established that college students' drinking patterns vary dramatically between weekdays (Sunday-Wednesday) and weekend days (Thursday-Saturday, Del Boca, Darkes, Greenbaum, & Goldman, 2004; Maggs, Williams, & Lee, 2011; O'Grady, Cullum, Tennen, & Armeli, 2011), but not well known whether associations between affect and drinking differ on weekdays versus weekends. College student heavy drinking primarily takes place on weekends (Del Boca et al., 2004; Maggs et al., 2011; Wood, Sher, & Rutledge, 2007), likely serving social and enhancement functions whereas weekday drinking is more likely tension-reduction drinking (Mohr et al., 2005). Indeed, negative affect was significantly reduced after weekday drinking but not weekend drinking (Orcutt & Harvey, 1991). Students who drink to cope also tend to initiate drinking earlier in the week during periods of high anxiety (Armeli et al., 2008). In the current study we chose to evaluate weekday and weekend heavy drinking separately. We preferred this strategy to the typical approach of controlling for time of week differences with dummy-coded variables in a single analysis because we anticipated different patterns of associations between affect and heavy drinking on weekdays versus weekends (Del Boca et al., 2004; Maggs et al., 2011; O'Grady et al., 2011), and it was beyond the scope of the current study to perform direct tests of the moderating influence of time of week on our affect-drinking and affect × covariate-drinking associations.

Measures

Measures used in the current study included daily assessments of heavy drinking and positive and negative affect, and baseline assessments of student gender (0=*male*, 1=*female*) and age (grade) at onset of alcohol use (1 = *6th grade or earlier*, 2 through 7 = *7th grade*

through *12th grade*, respectively, 8 = *first semester of college*, and 9 = *had not yet onset alcohol use* by the first semester of college). Students' median grade of first alcohol use was 11th grade, and only 12.7% initiated alcohol use prior to 9th grade; 59.8% of students initiated alcohol use between 9th and 12th grades. A further 7% initiated alcohol use during their first semester of university and 20.6% had not yet initiated alcohol use by the time the first-semester survey was administered.

Students reported on drinks consumed "yesterday, that is, from the time you woke up until the time you went to sleep" with reference to the definition: "by ONE drink we mean half an ounce of absolute alcohol, for example 12 ounce can or bottle of beer or cooler, 5 ounce glass of wine, a drink containing 1 shot of liquor or spirits." Following this statement, students were asked, "How many drinks of alcohol did you drink?" and used a pull-down menu permitting responses from 0 to 25+ drinks. Responses were dichotomized to a measure of *heavy drinking*. Students who reported consuming 5 (4) or more drinks for men (women) were assigned a value of 1 and students who consumed below this threshold were assigned a value of 0.

Students were asked to report their positive and negative affect each day by thinking back over the previous day ("from the time you woke up until you went to sleep") and responding to 20 items from the Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988). Students were asked: "to what extent did you feel the following different emotions and feelings?" We calculated daily *positive affect* scores as the mean of 10 feelings such as "excited," "interested," and "proud," and daily *negative affect* scores as the mean of 10 feelings such as "upset," "hostile," and "lonely," each rated on a five-point scale ranging from 1 (*very slightly or not at all*) to 5 (*extremely*). Higher mean scores indicate higher levels of affect. Across all days and semesters, coefficient alpha reliability estimates ranged from .90 to .94 for positive affect and from .80 to .91 for negative affect.

Missing data

Students who supplied complete data on all between-person predictor variables and who completed at least one daily diary report of their heavy drinking were included in analyses. From the original sample of n=744, nine participants did not complete any diary reports and one did not report a grade at onset of alcohol use, reducing the final analytic sample to n=734. Because of the small number of missing cases (1.3% of the sample), we chose to delete these cases and conduct multilevel analyses with full information maximum likelihood estimation to retain participants with partial data on heavy drinking. When the number of cases missing is very small, listwise deletion does not tend to bias parameter estimates and standard errors (Graham & Coffman, 2013; see also Enders, 2010).

Analytic strategy

We tested 3-level multilevel models to model the log odds of heavy drinking, separately for weekdays and weekend days, using the PROC GLIMMIX procedure in SAS. Days (Level 1) were nested within 14-day bursts each semester (Level 2), and these bursts were in turn nested within people (Level 3). Daily reports of positive and negative affect were time-varying predictors of heavy drinking, and we modeled their unique effects on daily,

between-semester, and between-person variation in heavy drinking at corresponding levels of analysis using a person- and wave-mean centering strategy (Raudenbush & Bryk, 2002). At Level 1, *daily* positive (negative) affect scores were centered around the means of each person's set of up to 14 daily positive (negative) affect scores recorded in the same semester (resulting in up to 98 different wave-mean centered scores per person, per type of affect). Scores were then used to predict same-day heavy drinking, for example:

$$\text{Level 1:Log Odds of Heavy Drinking}_{tij}=\pi_{0ij}+\pi_{1ij}\text{PosAffect}_{tij}+\pi_{2ij}\text{NegAffect}_{tij} \quad (1)$$

where the outcome variable is the log odds of heavy drinking on day *t* in semester *i* for person *j*; π_{0ij} is the random intercept of semester *i* for person *j*; π_{1ij} and π_{2ij} are the coefficients representing the association of daily positive and negative affect on day *t* in semester *i* for person *j* with the log odds of heavy drinking on the same day.

At Level 2, *between-semester* positive (negative) affect scores were the means of daily scores recorded in each 14-day burst, centered around the mean of each person's positive (negative) affect scores recorded in all days and semesters (resulting in up to 7 different person-centered scores per person, per type of affect). Scores were then used to predict same-semester heavy drinking, for example:

$$\text{Level 2:}\pi_{0ij}=\beta_{00j}+\beta_{01j}\text{PosAffect}_{ij}+\beta_{02j}\text{NegAffect}_{ij} \quad (2)$$

where β_{00j} is the random intercept for person *j*; β_{01j} and $\beta_{02\,j}$ are the coefficients representing the association of semester-average positive and negative affect in semester *i* for person *j* with the log odds of heavy drinking on any given day in the two-week period sampled that same semester.

At Level 3, *between-person* positive (negative) affect scores were the means of all daily scores recorded in all 14-day bursts, centered around the sample grand mean (resulting in one person-mean score per person, per type of affect). Scores were then used to predict the average odds of heavy drinking for each person, for example:

$$\text{Level 3:}\beta_{00j}=\gamma_{000}+\gamma_{001}\text{PosAffect}_{j}+\gamma_{002}\text{NegAffect}_{j} \quad (3)$$

where γ_{000} is the intercept for all persons; γ_{001} and γ_{002} are the coefficients representing the association of person-average positive and negative affect for person *j* with the log odds of person *j* engaging in heavy drinking on any given day across the sampled days of the study.

A reduced-form expression for the fixed effects can be written by substituting terms from Equation 3 into Equation 2, and by substituting terms from Equation 2 into Equation 1:

$$\text{Log Odds of Heavy Drinking}_{tij}= \begin{array}{ll} \gamma_{000}+\gamma_{001}\text{PosAffect}_{j}+\gamma_{002}\text{NegAffect}_{j} & (\text{Level 3;Between-person effects}) \\ +\gamma_{010}\text{PosAffect}_{ij}+\gamma_{020}\text{NegAffect}_{ij} & (\text{Level 2;Between-semester effects}) \\ +\gamma_{100}\text{PosAffect}_{tij}+\gamma_{200}\text{NegAffect}_{tij} & (\text{Level 1;Daily effects}) \end{array} \quad (4)$$

Other predictors and interaction terms enter this reduced-form expression in a similar fashion according to their level of influence in the model.

Models were evaluated in stages. First, we established the optimal functional form of change in the rate of heavy drinking across seven semesters. Visual inspection of plotted drinking rates over time suggested possible curvilinear trends, thus we tested quadratic and cubic trajectories of change. Next, we added main effects of daily, between-semester, and between-person positive and negative affect and their interactions with time trends. We used a modified sequential testing strategy to trim non-significant interactions between affect and time trends one at a time beginning with higher-order terms and in order of largest to smallest *p*-values (see Aiken & West, 1991, pp. 111-113). Next, we added main effects of sex and age of alcohol use onset and their interactions with daily, between-semester, and between-person measures of positive and negative affect, again sequentially trimming non-significant interactions.

Results

Table 1 shows descriptive statistics for heavy drinking and positive and negative affect in each semester and pooled over all semesters. In total, 70.2% of students reported heavy drinking on at least one of the days in at least one of the 14-day bursts assessed in the study. Within bursts, 39.2% (Fall 1st year) to 48.3% (Fall 4th year) of students reported heavy drinking at least once. In total, across all days on which students completed daily surveys (up to 98 per person over 7 semesters), students engaged in heavy drinking on 8.6% of assessed days. Heavy drinking occurred on 2.1% of all weekdays (Sunday-Wednesday) and on 17.4% of all weekend days (Thursday-Saturday). Across all sampled days, 34.2% of students reported weekday heavy drinking at least once, and 68.3% of students reported weekend heavy drinking at least once. Pooling over all waves, 68.0% of diaries were completed the next day (referencing yesterday's events), 19.6% were completed one day later (next day + 1), and 11.7% were completed two days later (next day + 2). A further 0.7% were completed outside of the 2-day entry timeframe with special permission due to exceptional circumstances, and these diaries were removed from the analytic dataset. Timing of reporting was not related to rates of heavy drinking.

The final models shown in Table 2 incorporate time trends in heavy drinking based on the results of unconditional growth models. For weekdays, there was significant nonlinear growth in the probability of daily heavy drinking across semesters that we modeled as a cubic polynomial time trend (see γ_{030}, γ_{040}, γ_{050}) as this provided a significantly better fit to the data compared to a quadratic trend (-2LL change=34.22 (1), p<.001). For weekend days, there was significant nonlinear growth that we modeled as a quadratic polynomial time trend (see γ_{030}, γ_{040}), which fit significantly better than a linear trend (-2LL change=6.68 (1), p=.01).

Within-person, daily associations

Table 2 shows results for daily associations between affect and heavy drinking under the heading *Level 1*. Higher daily positive affect was associated with greater odds of heavy drinking (γ_{100}) on weekdays and on weekend days. The odds of heavy drinking were 2.5 times higher on the same weekday, and 1.8 times higher on the same weekend day per unit increase in daily positive affect. On weekdays, this association remained stable throughout

the college years. On weekend days, however, a significant interaction with linear time (γ_{110}) showed that this positive affect-heavy drinking association became stronger across college (see Figure 1). Specifically, in students' first semester (Fall 1st year), the odds of heavy drinking on a given weekend day were 1.8 times higher per unit increase in daily positive affect (*B*=.59, *SE*=.08; *OR*=1.80). By the Fall of 4th year, the odds of heavy drinking on a given weekend day were nearly three times higher for every unit increase in daily positive affect (*B*=1.07, *SE*=.09; *OR*=2.92).

There were no main effect associations of daily negative affect with daily heavy drinking (γ_{200}), but for weekend days only, a significant interaction of daily negative affect with grade of first alcohol use (γ_{201}) showed that students who began drinking in earlier grades had a *lower* odds of heavy drinking on weekend days when they reported higher levels of negative affect (see Figure 2), compared to days when they reported lower levels of negative affect. Analyses of simple slopes (see Preacher, Curran, & Bauer, 2006) showed that this negative affect-heavy drinking association was only significant for students who began using alcohol very early. Specifically, students who reported higher negative affect on a given weekend day and began drinking in 8th grade or earlier had a 19% or greater reduction in the odds of heavy drinking on that same day per unit increase in daily negative affect (for 8th-grade alcohol use onset, the simple slope of daily negative affect on heavy weekend drinking was γ = -.21, *SE*=.10, *OR*=.81; *p*=.03). Students who initiated alcohol use in 9th grade or later showed no link between negative affect and weekend drinking.

Within-person, between-semester associations

Table 2 shows results for between-semester associations between affect and heavy drinking under the heading *Level 2*. The direction of associations with positive affect differed for weekdays versus weekend days. In semesters that students reported greater positive affect across sampled days, they had a 35% higher odds of heavy drinking on weekend days in that semester but a 62% lower odds of heavy drinking on weekdays in that semester (γ_{010}). This latter association was qualified by a significant crossover interaction with linear time (γ_{060}), showing that the association of between-semester positive affect and heavy drinking changed from negative to positive over time (see Figure 3). Analyses of simple slopes showed that during the first year of college, heavy weekday drinking was *less* likely in semesters that students reported higher positive affect, but by the Spring semester of 3rd year, heavy weekday drinking was *more* likely in such semesters.

The direction of associations with negative affect differed for weekdays versus weekend days and by grade of drinking onset. In semesters that students reported greater negative affect across sampled days, they had a lower odds of heavy drinking on weekend days in that same semester (γ_{020}). The odds of heavy drinking on weekdays was not related to between-semester fluctuations in negative affect as a main effect, but a significant interaction with grade of first alcohol use (γ_{021}) showed that students who began drinking earlier had a *higher* odds of heavy weekday drinking in semesters they reported higher-than-usual levels of negative affect (see Figure 4). Analyses of simple slopes showed that significant differences in heavy weekday drinking in relation to between-semester negative affect were present only for students who began using alcohol in 7th grade or earlier or in

12th grade or later. For students who began drinking in 7th grade, the odds of heavy drinking on weekdays in a given semester were 1.4 times higher per unit increase in average negative affect that same semester (γ = .86, *SE*=.37; *OR* = 2.36; *p*=.02). For students who began drinking in 12th grade, the odds of heavy drinking on weekdays in a given semester were reduced by 50% for every unit increase in average negative affect that same semester (γ = -.70, *SE*=.32 *OR* = .50; *p*=.03).

To rule out the possibility that daily and between-semester associations between affect and heavy drinking differed for students who had reached the legal drinking age compared to those who had not, we re-analyzed the final models reported in Table 2 and included a time-varying dummy variable indicating whether each student was aged 21 (coded 1) or younger (coded 0) in each semester. The results were virtually identical (unstandardized coefficients were within +/− .05 of the values reported in Table 2, and all significance tests remained the same).

Between-person associations

Finally, Table 2 shows results for between-person associations between affect and heavy drinking under the heading *Level 3*. Students who, on average across the study, reported higher positive affect had 45% higher odds of heavy drinking on any given weekday and 36% higher odds of heavy drinking on any given weekend day (γ_{001}) per unit increase in between-person positive affect. In contrast, between-person differences in negative affect averaged across the study were not associated with heavy drinking on weekdays or weekend days (γ_{002}). There were no sex differences in the probability of weekday or weekend heavy drinking (γ_{003}), and sex did not moderate any associations between affect and heavy drinking. There was a main effect of grade of alcohol use (γ_{004}) showing that for each additional grade students delayed their first use of alcohol (or had not yet begun drinking by the first semester of college), the odds of heavy weekday drinking were 32% lower and the odds of heavy weekend drinking were 41% lower on any sampled day across the college years. This main effect was qualified by interactions with daily and between-semester negative affect noted earlier.

Discussion

The current study tracked associations between college students' positive and negative affect and heavy drinking over days nested within seven semesters, evaluated how these daily associations changed or remained stable through the college years, and examined moderating influences of biological sex and age of alcohol use onset. More than 7 in 10 students reported heavy drinking at least once across days assessed in the study[1], and most heavy drinking occurred on weekends. Weekday drinking was a far less frequent behavior, but was reported at least once by about a third of the sample. These data were analyzed in 3-level multilevel growth models that assessed the unique associations of daily, between-semester, and between-person affect with odds of heavy drinking and revealed three key

[1]This appears to exceed rates of 37-44% reported in national studies (Johnson et al., 2013; Wechsler & Nelson, 2008), however, those prior rates were based on single assessments of heavy drinking in the past two weeks whereas the present study assessed heavy drinking during seven two-week periods across 3.5 years.

findings: First, college students' heavy drinking occurred primarily in tandem with positive affect, while associations between negative affect and heavy drinking were rare. Second, patterns of change suggested a strengthening within-person association between positive (but not negative) affect and heavy drinking over time. Third, precollege history of alcohol use, especially for very early-onset drinkers, moderated within-person associations between negative affect and heavy drinking. Overall, there were many similarities in the findings across weekdays and weekends, but only greater *weekday* heavy drinking was associated with poorer-quality mood (less positive affect and more negative affect).

Daily, between-semester, and between-person positive affect, but not negative affect, are associated with heavy drinking

Our first aim focused on examining within- and between-person associations of affect and heavy drinking. In general, positive but not negative affect was linked to students' heavy drinking at all three levels of analysis. Significant and positive *daily* associations lend support to the interpretation that college students are more likely to drink heavily at specific times when they feel more positive affect than usual (Mohr et al., 2005). In the current study, students who reported higher-than-usual positive affect on any given weekday or weekend day were more likely to report heavy drinking that same day. However, students' daily reports retrospectively recalled the previous day's events (or up to two days prior) and thus daily associations may not reflect exclusively same-day emotions and events. Nonetheless, these short-term associations suggest some insights into possible social contexts of college students' heavy drinking (e.g., Read, Wood, Kahler, Maddock, & Palfai, 2003; Rutledge & Sher, 2001). Students' positive affect may increase in anticipation of events such as parties and events that are built around alcohol consumption as a main activity, and positive affect may also increase as students experience enjoyment while drinking alcohol in these social situations. This interpretation is consistent with prior research showing that positive affect is associated with drinking away from home (Mohr et al., 2005) and drinking in the company of other people (Mohr et al., 2001). In the current study we did not evaluate social contexts nor compare social to solitary drinking, so a test of this interpretation awaits further study.

Second, significant associations *between-semesters* show that proximal elevations in positive affect (for example over a period of several days or weeks) are associated with students' drinking behavior. To our knowledge, this is the first study to show within-person links between affect and drinking across longer periods of time (i.e., semesters) that are distinct from shorter-term (i.e., daily) fluctuations. Consequently, we can draw an unambiguous interpretation that when students had higher-than-usual positive affect (averaged over a two-week period), over and above day-to-day fluctuations in positive affect and stable between-person tendencies, they were more likely to report heavy drinking on weekend days during those weeks. One explanation is that this association represents the influence of significant recent experiences (e.g., a new romantic relationship, a major football victory, doing well in school) that temporarily increase positive feelings over a period of days or weeks. Although studies of affect and alcohol use have largely emphasized effects of negative events (see Neff & Husaini, 1982), such significant experiences are associated with heavier consumption (Dawson, Grant, & Li, 2007; Wills, Vaccaro, &

McNamara, 1992). This interpretation aligns with findings about celebratory drinking. The heavier drinking that occurs on occasions such as 21st birthdays (Rutledge, Park, & Sher, 2008) and Spring Break (Lee, Maggs, & Rankin, 2006; Patrick, Lewis, Lee, & Maggs, 2013) may be related to positive affect that is higher than usual over the period of days or weeks leading up to and following such events. In contrast, for weekday heavy drinking in the current study, between-semester positive affect was associated with a *lower* odds of heavy drinking, but this relation was qualified by an interaction with time in college; we discuss this effect later in reference to patterns of change over time.

Significant *between-person* associations suggest that students who experience more positive affect in general relative to their peers are more likely to report heavy drinking on weekdays and on weekends. This finding is consistent with arguments that individual differences in predispositions for sensation-seeking (Cooper et al., 1995; Read et al., 2003) or seeking out positive affect rewards (Cooper et al., in press) predict alcohol use and heavy drinking. Expectancies about the effects of alcohol may also have affective components that underlie motivations to use alcohol (Baer, 2002; Cooper et al., in press). Future work should examine how students' alcohol expectancies or motives influence heavy drinking over time (e.g., Patrick & Schulenberg, 2011), as well as how these potential behavioral mechanisms may interact with positive and negative affect to influence the probability of heavy drinking. Nevertheless, we found that traditional-aged college students who reported more positive affect on average relative to their peers were more likely to engage in heavy drinking, and this relation is consistent with a model linking emotional dispositions to heavy drinking (Cooper et al., 1988).

Time-varying associations between positive affect and heavy drinking strengthen over time

Our second aim focused on whether associations between affect and heavy drinking changed over the course of students' college careers. Results for both weekdays and weekend days showed that students were more likely to engage in heavy drinking on days that they experienced greater daily and semester-level positive affect, and this within-person pattern became stronger as they moved through the college years. Specifically, *daily* variation in affect was associated with change over time in heavy weekend drinking (γ_{110}), and *between-semester* variation in affect was associated with change over time in heavy weekday drinking (γ_{060}). Thus, independent of overall trends in heavy drinking, the heavy drinking that does occur is increasingly tied to daily and semester fluctuations in positive affect.

Time-varying affect (daily, between-semester), but not average affect (between-person), became more strongly associated with heavy drinking over time. Students who reported more positive affect *on average* did not increase their odds of heavy drinking over time compared to students who reported less positive affect on average. These findings show that it is proximal and time-limited variations in positive affect—not between-person individual differences—that are increasingly tied to students' likelihood of heavy drinking over the college years. We did not assess social context or social and enhancement motivations for drinking, but the strengthening association between daily/between-semester positive affect

and heavy drinking may result from students more frequently incorporating alcohol consumption into their social lives during the later years of college.

We initially anticipated one of two alternative scenarios for when links between affect and heavy drinking might be stronger: during the transition to university versus later in college when access is less restricted. The latter scenario is more consistent with the results of this study. The stronger observed link between positive affect and heavy drinking during the later years of college calls for varied timing in interventions to prevent heavy drinking and related harms. There is a strong research and public health emphasis on underage drinking in general (e.g., http://www.surgeongeneral.gov/library/calls/underagedrinking/programs.html), and also a heavy focus on the transition to university as a particularly high-risk time period for heavy drinking (e.g., www.collegedrinkingprevention.gov). For example, the Task Force of the National Advisory Council on Alcohol Abuse and Alcoholism concluded that first-year students were among those who drank the most, especially within the first few weeks of their arrival on campus (2002). Furthermore, a meta-analysis showed that intervention programs to reduce college student drinking overwhelmingly targeted these younger students: 66% of all program participants were freshmen and 17% were sophomores (Carey, Scott-Sheldon, Carey, & DeMartini, 2007).

The transition to college is clearly important, but the current findings suggest that subsequent years may have unrecognized significance. Not only did drinking increase across college in our sample, but the links between affect and drinking also became stronger with time. Patterns, predictors, and mechanisms of alcohol use may change as students move toward young adulthood and potentially develop enduring lifestyles, suggesting an under-recognized need for ongoing intervention efforts and perhaps even different types of intervention as students mature. The fact that affect becomes a stronger short-term correlate of alcohol use later in college suggests that strategies targeting affect-related drinking—such as harm-reduction strategies that encourage protective behaviors during celebratory events and coping strategies to mitigate heavy drinking that co-occurs with negative affect—may become increasingly important across the college years.

Grade of alcohol use onset, but not gender, moderates the association between negative affect and heavy drinking

Our third aim focused on moderating effects of biological sex and students' precollege history of alcohol use on associations between affect and heavy drinking. There were no differences in men's and women's odds of heavy drinking, and sex did not moderate affect-drinking associations. Other daily diary research showed that college men were more likely to report heavy drinking (Patrick, Maggs, & Osgood, 2009; Sher & Rutledge, 2007) and more frequent drinking (Armeli et al., 2010), but our null finding is consistent with one other study that found freshman men and women were equally likely to report heavy drinking, and that gender was unrelated to positive or negative affect (Rankin & Maggs, 2006). They argued that gender roles of traditional-aged college men and women are relatively similar, and that gender differences in drinking behavior may be stronger in contexts that promote greater gender role differences (see e.g., Staff, Greene, Maggs, & Schoon, 2014; Wilsnack, Vogeltanz, Wilsnack, & Harris, 2000). Indeed, a cross-national

panel study of adolescent drinking showed significant gender convergence in rates of heavy drinking that has increased in recent years, possibly due to gender roles becoming less distinct (Kuntsche et al., 2011).

In contrast, precollege history of alcohol use was a strong predictor of students' odds of heavy drinking in general and revealed two within-person effects of negative affect. For weekday drinking, we found that students who began drinking in 7th grade or earlier (6.3% of sample) were more likely to drink heavily on weekdays in semesters that they felt higher-than-usual negative affect. However, this finding did not replicate for weekend heavy drinking and between-semester negative affect. Instead, at the daily level, students who began drinking in 8th grade or earlier (10.2% of sample) were *less* likely to drink heavily on weekend days when they felt higher-than-usual negative affect. These opposing findings provoke thought about the significance and consequences of drinking on weekends versus weekdays. Weekend heavy drinking is more statistically normative, accounting for over 70% of total weekly alcohol consumption reported by college freshmen (Del Boca et al., 2004; Maggs et al., 2011), and likely occurs in the context of campus social rituals and culture. The perceived consequences of feeling tired or ill after a night of heavy drinking may be minimal when students have no scheduled classes on Saturday and Sunday mornings, and often none on Fridays (Wood et al., 2007). Drinking has been shown to co-occur with reduced negative affect on weekdays but not on weekend days (Orcutt & Harvey, 1991), and the association between negative affect and alcohol consumption is weaker on days when students report spending more time with friends (such as weekends; Mohr et al., 2005).

In contrast, weekday heavy drinking is atypical, may require more effort to achieve, and is more likely to interfere with academic goals. For some, heavy drinking at atypical times may suggest a pre-existing propensity, and subsequent increased risk, for later alcohol problems. Given that very early-onset drinkers experiencing elevated within-semester negative affect were more likely to report the relatively rare behavior of heavy drinking on weekdays, this finding may suggest a pathway toward problem drinking that is reciprocally linked to negative affect and internalizing symptoms (Hussong et al., 2011). Indeed, consistent with our earlier interpretation, heightened between-semester negative affect and heavy weekday drinking may reflect recent stressful experiences. For example, the average daily volume of alcohol consumed was significantly higher in a national sample of adults who reported first drinking at age 14 or younger and who reported multiple stressful life events over the past year (e.g., problems at work, disruption of a romantic relationship, moving, financial difficulties, death in the family; Dawson et al., 2007). Whereas studies to date have focused on weekday-to-weekend differences in drinking rates and prevalence, future research would benefit from examining the meaning and risk potential of weekday versus weekend drinking.

Strengths and limitations

One limitation of the current study is that its survey design does not allow us to determine whether affect and heavy drinking are causally related, or in which direction. Given that daily reports were recorded one or two days later on one-third of the study days,

retrospective recall of affect and alcohol use limits our ability to infer that Level-1 effects and interactions represent affect-drinking associations within a single day. At the daily level, it is plausible both that higher positive affect leads to heavy drinking and/or that heavy drinking leads to higher positive affect. However, participants' daily reports of yesterday's affect (and earlier days, for those who responded one or two days later) may have also been susceptible to cues about affective states at the time of reporting (Bolger, Davis, & Rafaeli, 2003), possibly leading to systematically elevated daily reports of both positive and negative affect (Miron-Shatz, Stone, & Kahneman, 2009; Shiffman et al., 1997).

At the semester level, we suggested that higher-than-usual positive affect averaged over two weeks influenced heavy drinking, but it may also be that drinking more heavily over a period of time leads to improved mood. A strength of the current study is that we were able to isolate associations between affect and heavy drinking that operate at distinct levels of experience. Future research could further disentangle the specific times when causal sequences likely unfold by gathering data multiple times per day (i.e., an ecological momentary assessment design (EMA); Shiffman, Stone, & Hufford, 2008) to capture how affect varies throughout the day and across drinking episodes.

A related limitation of the current study is that we do not explore mechanisms that may underlie the observed associations between affect and heavy drinking. Motives for alcohol use, beliefs or expectancies about the properties of alcohol, and contexts in which students' drinking takes place are all part of the process by which affect and heavy drinking are reciprocally linked. By building on this research with an EMA design that narrows down locations in time at which associations between affect and heavy drinking are most meaningful, future research may benefit from a more nuanced approach that incorporates potential mediating mechanisms. Such an approach would also facilitate closer examination of associations between affect and extreme drinking (Polak & Conner, 2012; White, Kraus, & Swartzwelder, 2006) and between affect and alcohol problems (Gottfredson & Hussong, 2013; Hussong, Hicks, Levy, & Curran, 2001).

This study is the first to describe associations between college student affect and heavy drinking at three levels (daily, between-semester, between-person), and to examine changes in associations at all three levels across the college years. Strengths include the large and ethnically diverse sample of traditional-aged residential college students followed for seven semesters using an intensive measurement burst design with a high rate of retention. These rare data allowed us to examine not only within- and between-person associations between affect and heavy drinking, but to also examine how these associations changed over time across seven semesters. Indeed, daily and between-semester experiences of positive affect were more strongly related to heavy drinking as students progressed through college.

These results emphasize that timing matters when considering further study and interventions for student heavy drinking, as its public health consequences can be catastrophic (fatalities due to alcohol-related traffic accidents and unintentional injury, sexual assault; Hingson, Zha, & Weitzman, 2009). Although it is important to identify characteristics of *individuals*, such as emotional predispositions that place students at greater risk for heavy drinking, these individual differences provide an incomplete picture of

specific *times of increased risk.* Weeks, days, and drinking episodes characterized by unusually high positive affect may signal time-limited windows of heavy drinking, and present time-limited opportunities to intervene against concomitant health consequences.

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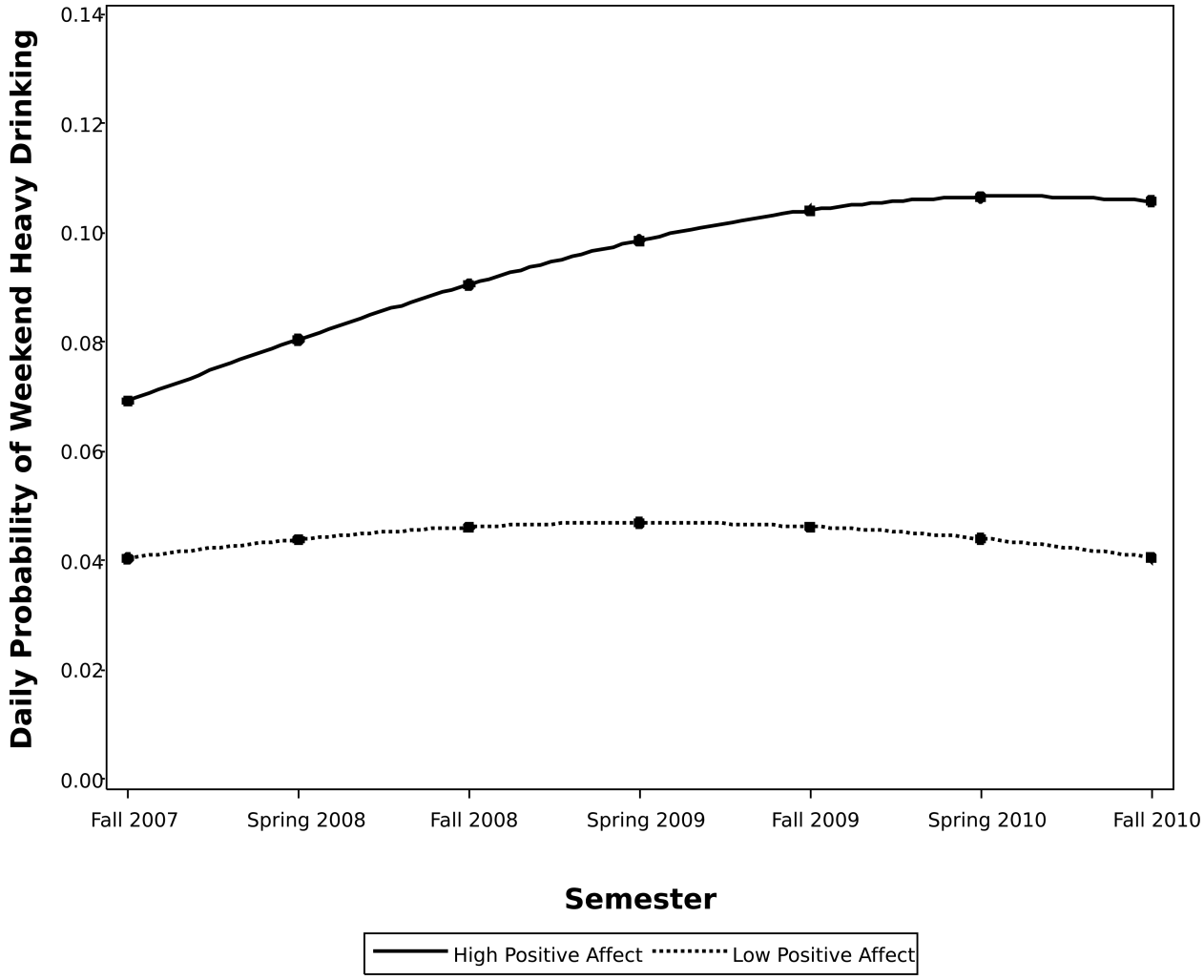

Figure 1. Effect of Daily Positive Affect on the Daily Probability of Weekend Heavy Drinking Across Seven Semesters of College

High and low positive affect are +1SD and −1SD around the mean of daily positive affect.

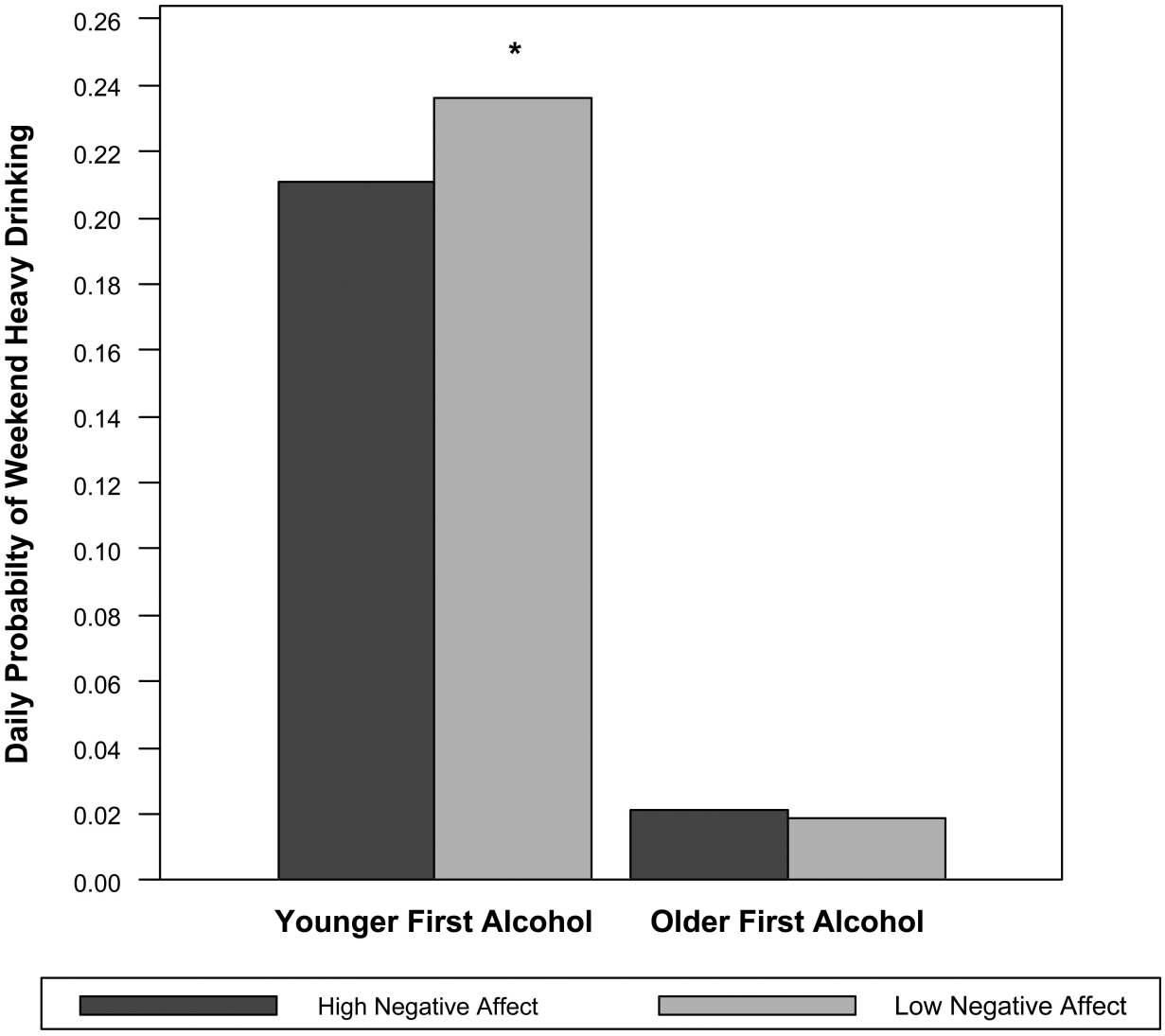

Figure 2. Interaction Effect of Daily Negative Affect and Grade of First Alcohol Use on the Daily Probability of Weekend Heavy Drinking

High and low negative affect are +1SD and −1SD around the mean of within-day negative affect. "Younger first alcohol" compares students who initiated alcohol use in Grade 8. "Older first alcohol" compares students who initiated alcohol use in their first semester of university.

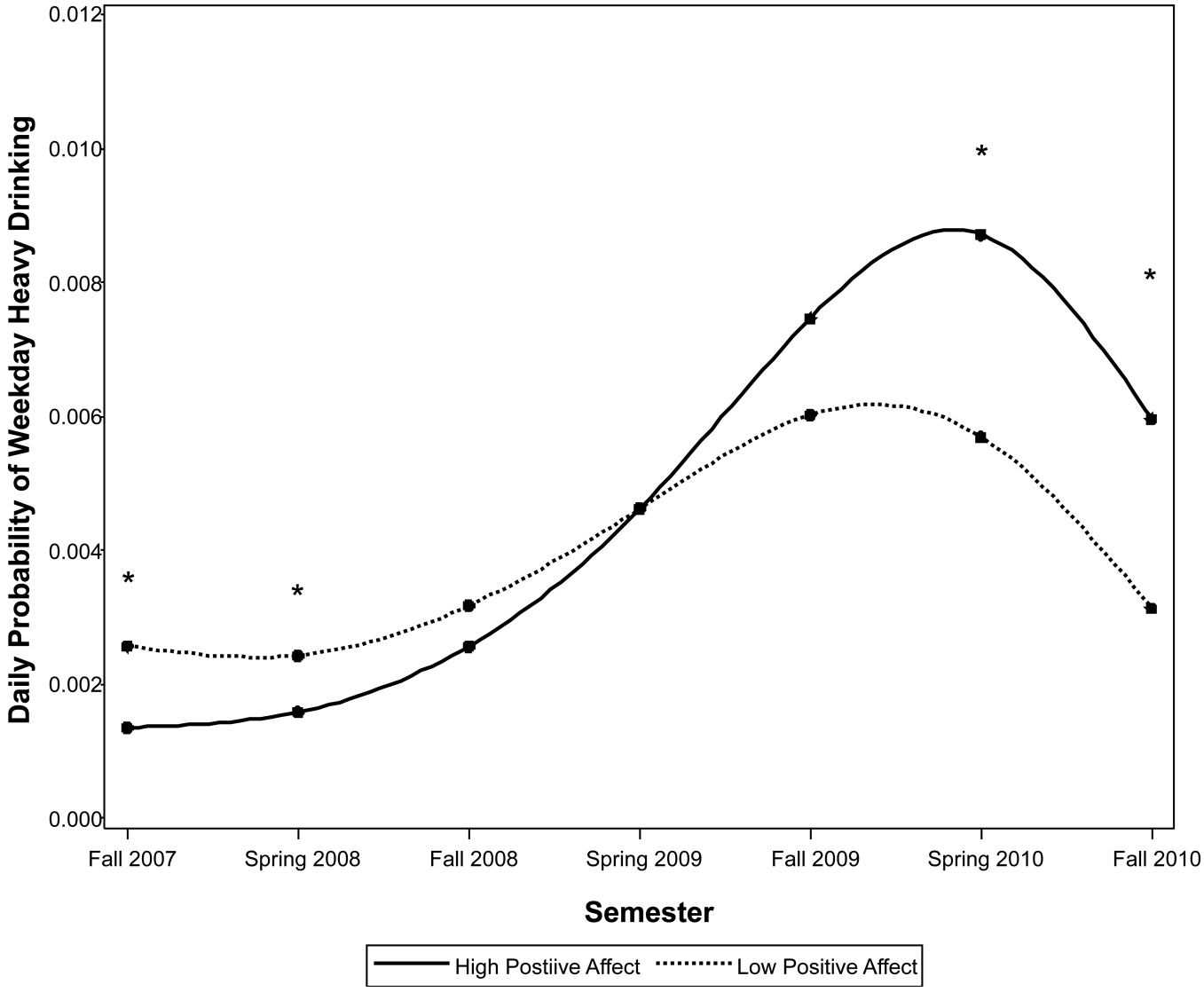

Figure 3. Effect of Between-Semester Positive Affect on the Daily Probability of Weekday Heavy Drinking Across Seven Semesters of College

*odds of heavy weekday drinking differ for students with higher vs. lower positive affect in these semesters, $p<.05$.

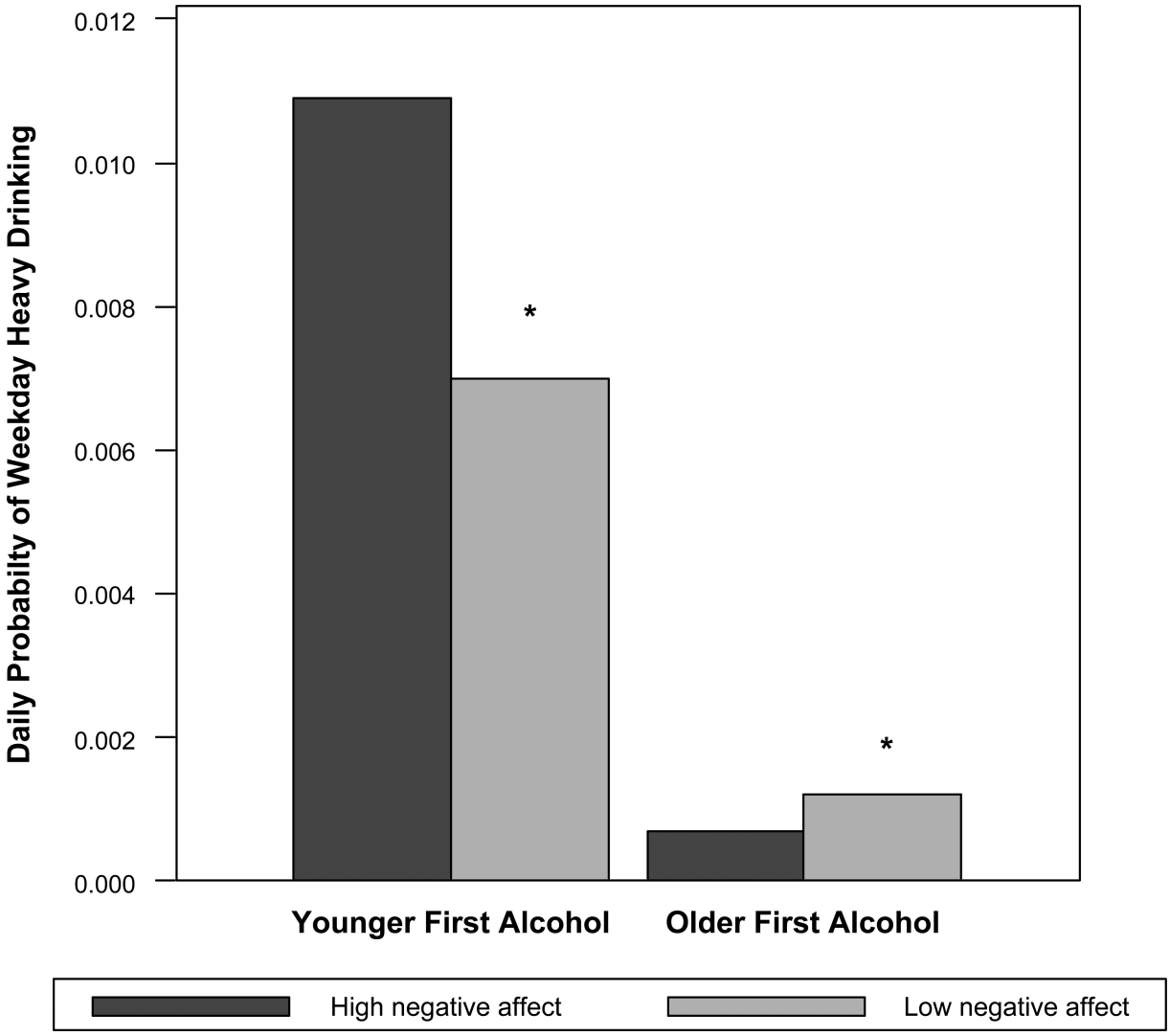

Figure 4. Interaction Effect of Between-Semester Negative Affect and Grade of First Alcohol Use on the Daily Probability of Weekday Heavy Drinking

High and low negative affect are +1SD and −1SD around the mean of between-semester negative affect. “Younger first alcohol” compares students who initiated alcohol use in Grade 7. “Older first alcohol” compares students who initiated alcohol use in their first semester of university.

Table 1

Rates of Heavy Drinking, Mean Levels of Positive and Negative Affect, and Diary Completion by Semester of Assessment

	Total	Year of College						
		1st		2nd		3rd		4th
		Fall	Spring	Fall	Spring	Fall	Spring	Fall
Heavy drinking								
(% of people)	70.2	39.2	40.4	43.3	45.6	45.2	46.9	48.3
(% of days)	8.6	7.5	7.1	7.9	9.2	9.4	10.2	9.8
(% of weekdays)	2.1	1.5	1.5	1.5	2.3	1.9	3.9	1.9
(% of weekend days)	17.4	15.4	14.5	16.4	18.4	19.2	18.5	20.4
Diaries completed[a,b]								
Next day (%)	68.7	79.5	74.2	69.1	67.9	63.7	62.1	60.0
Next day +1 or 2 days (%)	31.3	20.5	25.8	30.9	32.1	36.3	37.9	40.0
Mean positive affect (*SD*)	2.22 (.86)	2.22 (.85)	2.15 (.87)	2.21 (.86)	2.23 (.86)	2.23 (.84)	2.24 (.89)	2.24 (.87)
Mean negative affect (*SD*)	1.46 (.57)	1.39 (.49)	1.43 (.54)	1.47 (.59)	1.47 (.57)	1.51 (.60)	1.50 (.61)	1.51 (.60)
Days of assessment	56,637	9353	8088	8178	8307	7793	7610	7308
Sample size	734	715	624	638	642	611	697	590

[a] All diaries in analyses reported here were completed the next day (referencing yesterday's events), or 1 or 2 days later (next day + 1, next day +2).

[b] There was some variation in timing of reports by day of week. Of the diaries completed on the next day + 1, 21.8% were completed on Sundays (referencing Friday's events). Of the diaries completed on the next day + 2, 21.7% were completed on Sundays (referencing Thursday's events) and 18.4% were completed on Mondays (referencing Friday's events). No other days of the week showed a pattern of systematic over- or under-reporting.

Table 2

Daily, Between-Semester, and Between-Person Effects of Positive and Negative Affect on the Daily Probability of Weekday and Weekend Heavy Drinking

	Weekdays		Weekend Days	
	B (SE)	**OR**	**B (SE)**	**OR**
Fixed effects				
Level 1				
Intercept (γ_{000})	−6.27 (.29)	.002	−2.88 (.12)	.06
Daily positive affect (γ_{100})	.92* (.09)	2.51	.59* (.08)	1.80
Daily negative affect (γ_{200})	−.09 (.12)	.91	.03 (.07)	1.03
Daily PA x linear time (γ_{110})	-	-	.08* (.02)	1.08
Daily NA x grade first alcohol (γ_{201})	-	-	.08* (.03)	1.08
Level 2				
Between-semester positive affect (γ_{010})	−.95* (.32)	.39	.31* (.09)	1.36
Between-semester negative affect (γ_{020})	−.41 (.26)	.66	−.28* (.11)	.76
Linear time (γ_{030})	−.19 (.23)	.83	.14* (.05)	1.15
Quadratic time (γ_{040})	.27* (.09)	1.31	−.02* (.01)	.98
Cubic time (γ_{050})	−.04* (.01)	.96	-	-
Between-semester PA x linear time (γ_{060})	.32* (.09)	1.38	-	-
Between-semester NA x grade first alcohol (γ_{021})	−.31* (.11)	.73	-	-
Level 3				
Between-person positive affect (γ_{001})	.37* (.14)	1.45	.31* (.12)	1.36
Between-person negative affect (γ_{002})	−.21 (.23)	.81	−.18 (.20)	.84
Sex (Male = 1) (γ_{003})	−.11 (.17)	.90	−.23 (.15)	.79
Grade first alcohol use (γ_{004})	−.38* (.04)	.68	−.53* (.04)	.59
Random effects				
Level-2 random intercept (γ_{0ij})	.66* (.22)	-	.27* (.05)	-
Level-3 random intercept (u_{00j})	3.97* (.86)	-	2.80* (.29)	-
Level-3 random slope (linear time; u_{03j})	.13* (.04)	-	.09* (.01)	-
Level-3 int-slp covariance (cov(u_{00j}, u_{03j}))	−.50* (.17)	-	−.11* (.05)	-

Note.

* p <.05. PA=positive affect; NA=negative affect. Non-significant interaction terms between PA, NA, time trends, sex, and grade of first alcohol use were removed. Thus, not all interaction terms in the Weekday model appear in the Weekend model and vice-versa.