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Association Between Alcohol Intoxication and Alcohol-Related Problems: An Event-level Analysis

Dan J. Neal and **Kate B. Carey**
Dan J. Neal, Department of Psychology, Syracuse University; Kate B. Carey, Department of Psychology and Center for Health and Behavior, Syracuse University.

Abstract

Heavy drinking students experience a myriad of alcohol-related negative consequences. Use of event-level data permits predictions to be made regarding (a) the likelihood of alcohol-related consequences occurring after specific drinking events, and (b) moderators of the association between intoxication and consequences. College students (N = 183, 64% female) completed four consecutive 7-day drinking diaries and turned them in weekly. The diaries yielded prospective event-level data on daily drinks, time spent drinking, and negative consequences related to each drinking event. Alcohol intoxication on a given day was significantly associated with increased levels of risk, although this association was moderated by average level of intoxication. Furthermore, self-control was associated with increased likelihood of negative consequences at all levels of intoxication, and self-regulation and impulsivity moderated the event-level association between daily intoxication and likelihood of negative consequences. Results suggest that self-regulation subsumes impulsivity and self-control.

Keywords

Alcohol-related consequences; Event-level analyses; daily drinking diaries; moderation effects

College students report experiencing a wide range of academic, interpersonal, health, and legal consequences due to alcohol use (e.g., Presley, Meilman, & Lyerla, 1994); estimates place the number of alcohol-related deaths among college students at 1,400 per year and alcohol-related injuries at over 500,000 per year (Hingson, Heeren, Zakocs, Kopstein, & Wechsler, 2002). As such, alcohol-related problems continue to concern college administrators, alcohol researchers, and the parents of students (National Institute of Alcohol Abuse and Alcoholism, 2002). Relevant foci for research on alcohol-related consequences include: (a) identification of patterns of alcohol consumption that lead to problems; and (b) risk factors that can increase the likelihood of experiencing alcohol-related consequences.

The association between alcohol consumption and alcohol-related consequences can be characterized using global- or event-level data. Global measures summarize some aspect of a person's drinking as a sum or average (e.g., average drinks per drinking day), whereas event-level data capture details of a particular drinking event (e.g., daily quantities). Although global measures of alcohol use have considerable utility in many contexts, their use can obscure information such as frequency or variability. A similar problem exists with measures of alcohol-related consequences. Although questionnaires such as the Rutgers Alcohol Problem Index (RAPI; White & Labouvie, 1989) and the Young Adult Alcohol Problem Screening Test (YAAPST; Hurlbut & Sher, 1992) are useful in providing a summary measure of the frequency

Correspondence concerning this article should be addressed to Dan J. Neal, who is now at the Department of Psychology, Kent State University, P.O. Box 5190, Kent, OH, 44242-0001. E-mail: dneal2@kent.edu.

and intensity of alcohol-related consequences, they fall short in capturing the acute relation between a drinking event and consequences experienced *as a result of that event*.

The primary strength of event-level data collection is that it provides greater flexibility in modeling the relation between consumption and consequences, because specific consequences can be directly linked to specific drinking occasions. Retrospective event-level data can be collected using variations of the Timeline Follow Back procedure (TLFB; Sobell & Sobell, 1996); however, collecting the data prospectively via daily drinking diaries can help reduce the response burden and memory load on participants, potentially enhancing reliability and validity. Although use of daily drinking diaries does not guarantee prospective assessment, it does encourage data collection closer in time to target events when compared to standard retrospective TLFB assessments. Overall, the use of event-level methodology can enhance understanding of problematic patterns of alcohol consumption

Predictors of Alcohol-Related Consequences

Heavy consumption of alcohol has a direct effect on the frequency of alcohol-related consequences (Vicary & Karshin, 2002); in addition, person variables place students at risk for experiencing negative consequences (Baer, 2002). The remainder of this section provides a selective review of studies that have examined person variables that influence the likelihood of alcohol-related consequences at the global level.

Demographic variables—Men tend to be heavier drinkers than women, and correspondingly experience higher rates of alcohol-related problems (Carlucci, Genova, Rubackin, Rubackin, & Kayson, 1993; Clements, 1999). Perkins (1992) notes that men are more likely than women to cause injury, engage in aggressive behavior, and drive while intoxicated, but other consequences (e.g., hangover, poor academic performance) are equally likely in men and women. These findings are consistent with gender comparisons noted by O'Hare (1990). However, others have shown that women demonstrate stronger correlations between consumption and consequences (Harrington, Brigham, & Clayton, 1997), suggesting that gender moderates the consumption-consequences association.

Membership in a social Fraternity or Sorority (Greek membership) place individuals at risk for alcohol-related consequences. Qualitative reviews suggest that heavier drinking high school students self-select into fraternities and sororities in college, and once in college the environment promotes continued heavy drinking (Borsari & Carey, 1999); these patterns have been supported empirically in nationally representative samples (McCabe, Schulenberg, Johnston, O'Malley, Bachman, & Kloska, 2005). Not only do Greek students drink more than non-Greek students, they also report higher levels of alcohol consequences (Cashin, Presley, & Meilman, 1998; Larimer, Anderson, Baer, & Marlatt, 2000). It is not clear, however, whether Greek membership per se (and the social and environmental factors associated with it) is the cause of higher alcohol-related consequences, or whether differences in alcohol consumption by Greek members explain the higher rate of alcohol-related problems.

Self-regulation, self-control, and impulsivity—The constructs of self-regulation, self-control, and impulsivity have all been related to alcohol-related consequences. Self-regulation is a person's generalized ability to formulate and implement a long-term plan or goals (Brown, 1998), and self-control is a person's ability to exert control over consumption during drinking situations. Related to these two constructs is impulsivity (cf., Buss, 1995), i.e., the tendency to act "on the spur of the moment," without consideration for the possible consequences of behavior.

Generalized self-regulation capacity has been related to the occurrence of alcohol-related consequences, but not alcohol consumption, in two separate samples of college students

(Carey, Neal, & Collins, 2004; Neal & Carey, 2005). Furthermore, lower levels of self-regulation and perceived drinking control are associated with higher levels of alcohol-related problems; specifically, the association between self-regulation and problems appears to be mediated by perceived control and drinking levels (Patock-Peckham, Cheong, Balhorn, & Nagoshi, 2001). Wills, Sandy, and Yaeger (2002) demonstrated that both poor self-regulation and negative affect strengthened the association between alcohol use and alcohol-related problems. At a more alcohol-specific level, Werch and Gorman (1988) demonstrated that students lacking in self-control strategies for alcohol use had higher levels of alcohol problems. Furthermore, impaired alcohol-specific control predicts consequences, but not alcohol consumption per se (Nagoshi, 1999).

In a review of factors that influence college student drinking, Baer (2002) noted that personality variables such as impulsivity, nonconformity, and sensation seeking are related to earlier initiation into drinking, and heavier and more frequent drinking in college. Not only is impulsivity a predictor of use (e.g., Camatta & Nagoshi, 1995; Hutchinson, Patock-Peckham, Cheong, & Nagoshi, 1998), but it may also be a predictor of alcohol-related consequences (Hutchinson et al., 1998). However, this finding is not consistent across studies. Wood, Nagoshi, and Dennis (1992) found that impulsivity was related to higher rates of alcohol consumption but not alcohol-related problems after accounting for alcohol consumption. Others, however, have demonstrated that impulsivity and use are jointly predictive of alcohol- (Simons, 2003) and marijuana-related problems (Simons & Carey, 2002).

Drinking motives—It has been suggested that motivation for drinking can have an effect on drinking outcomes. Wood et al. (1992) found that negative alcohol outcome expectancies (e.g., impairment, hostility) and pathological reasons for drinking (e.g., drinking when nervous, angry, or sad) were related to higher levels of alcohol-related problems. Furthermore, drinking to cope with tension or negative emotions, or drinking for avoidance purposes has been shown to be related to both heavier alcohol intake and more frequent alcohol-related consequences (Cooper, Frone, Russell, & Mudar, 1995). Carey and Correia (1997) also found that negative reinforcement motives predicted alcohol problems directly, even when controlling for alcohol use. One possible mechanism for this association is that enhancement motives and coping motives may be related to both preoccupations with drinking and an inability to limit drinking (Stewart & Chambers, 2001).

In sum, several variables predict the occurrence of alcohol-related problems at the global level: gender and Greek membership, the personality constructs of self-control/self-regulation/impulsivity, and drinking motives. However, these variables have not yet been tested in an event-level context as predictors of negative consequences for specific drinking events. Because event-level relations may be different from global relations (e.g., Weinhardt & Carey, 2000), these variables must be investigated to further understand their contribution to the occurrence of alcohol-related consequences.

Overview of Study

In order to clarify the role of factors at the event level, at least two possibilities must be explored. A variable could serve as a primary predictor of consequences, that is, the presence of the characteristic makes a person more or less likely to experience consequences regardless of the amount of alcohol consumed. Alternatively, the variable may moderate the association between alcohol consumption and alcohol-related consequences; for example, it could increase the likelihood of consequences at increased levels of consumption. The main purpose of this study was to develop a statistical model of the relation between alcohol intoxication and alcohol-related problems at the event level. Use of a multi-level statistical model permits examination of the within-person, event-level association in order to evaluate whether variables that predict

and/or moderate the relation between alcohol intoxication and alcohol-related problems at the global level also predict and/or moderate the relation between alcohol consumption and alcohol-related problems at the event level.

Study Hypotheses

This study proposed two a priori hypotheses.

Hypothesis 1—Daily alcohol intoxication (measured as estimated BAC) will have a positive association with the likelihood of experiencing an alcohol-related consequence on that day. Intoxication was chosen as the primary variable of interest given that it controls for variables such as gender, weight, and length of drinking episode, and thus reflects a more accurate estimate of participants' level of intoxication on each day than number of drinks consumed.

Hypothesis 2—Individual differences variables will predict alcohol-related problems (main effect of variable), and/or moderate the relation between intoxication and problems (interaction between variable and alcohol intoxication). In particular, gender, Greek membership, perceived control over drinking, self-regulation, impulsivity, and drinking motives will be examined.

Method

Participant Selection and Recruitment

Participants were 206 undergraduate students recruited from an introductory psychology course. Questionnaires were administered in small groups; group sizes ranged from 2–13 (M = 7.4, SD = 3.9). All participants provided informed consent to participate, and received course credit in exchange for participating in the study. No students declined to participate in the study. The sample was 64% female (n = 131), 83% Caucasian (n = 170), and 77% freshmen (n = 159). Greek membership was reported by 20.4% with another 5.3% currently pledging. The average age was 18.8 (SD = 1.0) and average GPA was 3.2 (SD = 0.5). Comparable figures for all undergraduates are 56% female, 80% Caucasian, 27% freshmen, and 30% Greek affiliation. Thus, younger students were oversampled. Sample descriptive data can be found in Table 1. Men and women did not differ on any of the demographic, personality, or motives variables (all ps > .05).

Procedure

This study incorporated two distinct phases. First, global retrospective data and personality data were collected from each participant. Second, prospective event-level data were collected. Participants completed daily drinking diaries for a period of four weeks, returning their diaries each week. Weekly reminder emails were sent to participants, providing additional contact information for participant questions. Hypothesis testing was conducted on prospective daily drinking diary data treated as a nested (i.e., multilevel) design with days (level 1) nested within individuals (level 2).

Measures

Contact Information—Participants were asked to complete a contact information form to allow the investigator to provide reminder phone calls and emails.

Demographics—Age, gender, class level, grade point average (GPA) ethnicity, residence, fraternity/sorority membership, and weight were assessed.

Drinking Behavior—Participants reported the number of drinks consumed on each day in a typical week and heaviest week (average/heaviest drinks per week), the number of times they consumed five or more drinks (for men) or four or more drinks (for women) in the past month (heavier drinking days), the frequency of alcohol use in the past month (drinking days), and typical and peak quantities of alcohol consumption (in standard drinks) and typical time spent drinking. The timeframe for all questions was the past month. Participants completed a group-administered 28-day Timeline Followback (TLFB; Sobell & Sobell, 1996) by estimating the number of drinks they consumed, the amount of time they spent consuming it, and any consequences that occurred because of the drinking episode. This served as practice for daily monitoring of these variables.

Marlow-Crowne Social Desirability Scale—The MCSDS (Crowne & Marlowe, 1964) is a 13-item measure developed to assess potential social desirability bias; participants who desire to be viewed in a positive manner tend to score high on this measure. Previous studies (Borsari, Neal, Collins, & Carey, 2001; Carey et al., 2004) indicate that social desirability accounts for significant variance in self-reported alcohol-related problems. Cronbach's α was .60.

Self-Regulation Questionnaire Short Form—The SSRQ (Carey et al., 2004) is a 31-item short form of the SRQ (Brown, Miller, & Lawendowski, 1999) that measures general capacity for self-regulation. Participants rate how much they agree with each statement on a 1–5 scale, where 1 = strongly disagree and 5 = strongly agree. Cronbach's α was .91.

Impaired Control Scale—The ICS (Brodie & Heather, 1998) is a 10-item scale designed to assess an individual's intention to limit alcohol consumption in certain situations. The ICS was used as a measure of drinking-specific self-control. Cronbach's α was .83.

Eysenck Impulsiveness Scale—The EIS (Eysenck, Pearson, Easting, & Allsopp, 1985) is a 19-item scale that assesses difficulty controlling behavior. The EIS was used as a measure of impulsivity. Cronbach's α was .77.

Reasons for Drinking Questionnaire—The RDQ (Farber, Khavari, & Douglass, 1980) consists of 14 items that assess motivations for drinking. The RDQ has two subscales, negative reinforcement motives (N-RDQ; escaping unpleasurable stimuli) and positive reinforcement motives (P-RDQ; gaining pleasurable stimuli). Cronbach's α was .71 for the N-RDQ and .54 for the P-RDQ.

Daily Drinking Diary—Participants completed the DDD each day for a period of 4 weeks. At the beginning of each day, participants were asked to estimate the number of drinks they consumed, the amount of time they spent consuming those drinks, and any consequences that might have occurred on the previous day. For each day, an estimated BAC level was calculated based on consumption, elapsed time, weight, and gender, using the formula provided by Matthews and Miller (1979). The Matthews and Miller formula demonstrated the highest association to breath BAC in a sample of college drinkers tested in a natural drinking environment, however this formula tended to overestimate BAC at heavier levels of drinking (Hustad & Carey, 2005). Average estimated BAC was computed by averaging estimated BAC for all days of self-monitoring.

The DDD also included a list of 30 consequences assembled from non-overlapping items from the RAPI, the College Alcohol Problems Scale (Maddock, Laforge, Rossi, & O'Hare, 2001; O'Hare, 1997), the Young Adult Alcohol Problems Screening Test (Hurlbut & Sher, 1992), the problems list used in the College Alcohol Study (Wechsler, Lee, Kuo, Seibring, Nelson, & Lee, 2002), and the Student Alcohol Questionnaire (Engs & Hanson, 1994). Items were

included in the DDD only if they were likely to ensue from a single drinking event. General categories of consequences include academic (e.g., missed class), social (e.g., argument with a friend), health (e.g., vomiting), legal (e.g., arrested), and risky behaviors (unsafe sex or drinking and driving). Participants returned their DDDs weekly, a schedule designed to reinforce the prospective nature of data collection.

Results

First, data were examined for missing values. For questionnaire data, regression imputation in Stata 7.0 (Stata Corp, 2001) estimated the participants' responses to the missing items based on data provided for the completed items on that questionnaire. For the event-level data, 35 participants skipped one or more days in the self-monitoring phase, or failed to return at least one week of diaries. For these participants, the missing days were dropped from analyses. Abstainers were also dropped from analyses due to a lack of within-person variability. Thus, a total of 183 participants were included in the final analyses, 168 (91.8%) of which provided 27 or 28 days of data. Participants with complete data did not differ from those without complete data on any of the DDD alcohol use and consequences variables (all *p*s > .05).

Next, descriptive statistics were calculated for demographic and personality variables measured at baseline (see Table 1). No gender differences were observed on these variables. All six of the predicted covariates/moderators were correlated significantly with each other, and the absolute values of the correlations ranged from .15 to .51. Summary statistics for alcohol use and consequences variables can also be found in Table 1. Significant gender differences emerged on several of the alcohol use variables derived from the DDD. Consistent with previous research on gender differences in college student drinking, men reported drinking more frequently, as well as consuming more drinks on an average drinking day and on the heaviest drinking day. Women, however, achieved significantly higher typical BACs. The participants in this study represent a heavier drinking sample compared to college students nationwide (The American College Health Association, 2005). Only 11% of participants (n = 23) reported no alcohol consumption. Among drinkers, the average BAC per drinking day in this study exceeded the national norm of BAC = .079 for both men and women (The American College Health Association, 2005). Over 82% of women and 92% of men were classified as "binge" drinking during the monitoring period, and 42% of women and 68% of men reported consuming 10 or more drinks at least once; these numbers far exceed those found in nationally representative surveys (Wechsler, et al., 2002).

Overview of Hypothesis Testing

For the event-level data, a population-averaged (marginal) model estimated using Generalized Estimating Equations (GEE) was used. For hypothesis 1, the statistical model demonstrates the within-person association between amount of alcohol consumed and the likelihood of experiencing an alcohol-related problem:

$$\ln\left(\frac{P(P_{ij})}{1-P(P_{ij})}\right) = \beta_0 + \beta_1 * (C_{ij} - \overline{C}_{.j})$$
$$\beta_0 = \gamma_{00} + \gamma_{10} * \overline{C}_{.j} \quad \beta_1 = \gamma_{01} + \gamma_{11} * \overline{C}_{.j} \tag{1}$$

Where $P(P)_{ij}$ is the probability of a negative consequence, C_{ij} is intoxication (estimated BAC) on a specific day, and C_j is a person's average intoxication (average estimated BAC across all drinking and nondrinking days). The likelihood of a negative consequence is modeled as an intercept (β_0) and a slope (β_1) with these coefficients modeled as a function of average intoxication. Additionally, daily intoxication is person-centered to separate the between- and within-person differences in level of intoxication. Substitution for β_0 and β_1 yields the model:

$$\ln\left(\frac{P(P_{ij})}{1-P(P_{ij})}\right) = \gamma_{00} + \gamma_{10} * \overline{C}_{.j} + \gamma_{01} * (C_{ij} - \overline{C}_{.j}) + \gamma_{11} * \overline{C}_{.j} * (C_{ij} - \overline{C}_{.j}) \tag{2}$$

This model includes four estimated parameters: average level of risk for the average drinking day (γ_{00}), differences in risk associated with differences in average intoxication (γ_{10}); changes in risk associated with within-person variations in intoxication (γ_{01}); the cross-level interaction between daily and average intoxication (γ_{11}).

Hypothesis 2 examines the effect of covariates on the likelihood of experiencing alcohol-related consequences. First, a main effect is added for the moderating variable (M_j), yielding the model:

$$\ln\left(\frac{P(P_{ij})}{1-P(P_{ij})}\right) = \gamma_{00} + \gamma_{10} * \overline{C}_{.j} + \gamma_{01} * (C_{ij} - \overline{C}_{.j}) + \gamma_{11} * \overline{C}_{.j} * (C_{ij} - \overline{C}_{.j}) + \gamma_{20} * M_j \quad (3)$$

This model includes one new parameter representing changes in risk for the average drinking day associated with the moderating variable (γ_{20}). Next, the moderating variable is interacted with average intoxication ($C_{.j}$) and daily intoxication ($C_{ij} - C_{.j}$), yielding the model:

$$\ln\left(\frac{P(P_{ij})}{1-P(P_{ij})}\right) = \gamma_{00} + \gamma_{10} * \overline{C}_{.j} + \gamma_{01} * (C_{ij} - \overline{C}_{.j}) + \gamma_{11} * \overline{C}_{.j} * (C_{ij} - \overline{C}_{.j}) + \gamma_{20} * M_j + \gamma_{30} * M_j * \overline{C}_{.j} + \gamma_{21} * M_j * (C_{ij} - \overline{C}_{.j}) \quad (4)$$

This model includes two new parameters representing interactions of the moderating variable with average drinking (γ_{30}; a between-person moderation effect) and with daily drinking (γ_{21}; a within-person moderation effect).[1]

Preliminary analyses demonstrated that the MCSDS significantly predicted overall risk but did not interact with average or daily alcohol intoxication, indicating that social desirability bias led to constant underreporting by some individuals; thus, social desirability was included as a main effect in all models. Within-person dependence of observation was modeled using an autoregressive correlation matrix. To ease interpretation of odds ratios, BAC was multiplied by 100, such that an increase of 1 corresponded to an increase in BAC of .01. As previously noted, daily BAC was person-centered; average BAC was retained on its original scale. The covariates of self-regulation, impaired control, impulsivity, and drinking motives (positive and negative reinforcement) were all standardized to aid interpretability of the interaction terms; standardization also aided interpretation of odds-ratios, such that the odds-ratios reflected the increase/decrease in the odds of a negative consequence associated with an increase/decrease of one standard deviation in the covariate. Non-drinking days, which by definition cannot have alcohol-related consequences associated with them, were excluded from the analysis.[2] All hypothesis tests were done by using Wald *z* and χ^2 tests for nested models.

Hypothesis 1

The omnibus test was significant, $\chi^2(4) = 127.97$, $p < .0001$. Average BAC ($\gamma = 0.06$, OR = 1.06, z = 3.59, p < .001), daily BAC ($\gamma = 0.21$, OR = 1.23, z = 6.34, p < .001), the average BAC X daily BAC interaction ($\gamma = -0.01$, OR = 0.99, z = 3.01, p < .005), and social desirability ($\gamma = -0.37$, OR = 0.69, z = 3.13, p < .005) were all individually significant in predicting the likelihood of experiencing a negative consequence. The significant interaction between average and daily BAC implies that the odds ratio for daily BAC is not constant for different levels of average BAC; in particular, the odds associated with an increase of .01 in daily BAC is 0.99 as great when average BAC increases by .01. This interaction is presented graphically in Figure 1 (Panel A) which presents the regression lines for three levels of average BAC: moderate drinkers (average BAC = .12), light drinkers (1 SD below the mean, average BAC = .05) and heavy drinkers (1 SD above the mean, average BAC = .19). Light drinkers show

[1]Models that included three-way interactions between the moderator, average BAC and daily BAC were computed; the three-way interactions were nonsignificant.

[2]Analyses that included both drinking days and nondrinking days resulted in slightly different substantive conclusions. A summary of these differences can be obtained from Dan J. Neal.

sharper increases in risk for negative consequences as their level of intoxication increases (OR = 1.20), when compared to moderate (OR = 1.15) and heavy (OR = 1.11) drinkers.

Hypothesis 2

Moderator analyses were conducted in two stages. First, the potential moderators were examined in isolation to determine their association with alcohol-related negative consequences. The main effects for the potential moderators were tested using the model in equation 3; the Wald z test was used to test the significance of each main effect. Then the interactions of the moderator with both average BAC and daily BAC were added, and a Wald χ^2 test was used to jointly test whether the inclusion of the two interactions accounted for a better model fit; in cases where this test was significant, Wald *z* tests for each individual term were examined. Second, the potential moderators were examined jointly to determine their unique association with alcohol-related negative consequences. The main effects for potential moderators that were significant in the first stage were added to the model. Then, interactions with daily BAC were added to the model. Each set of predictors (the main effect and interaction) was then evaluated, and retained only if the two combined were significantly associated with consequences. A final model was then computed, which retained only those significant predictors.

First, gender and Greek membership were evaluated as potential moderators. The addition of the main effect for gender was not significant, $\gamma = 0.16$, OR = 1.17, $z = 0.66$, *ns*. Addition of the gender by average BAC and gender by daily BAC terms was not significant, $\chi^2(2) = 01.03$, *ns*. The addition of the main effect for Greek membership was not significant, z = .14, *ns*, nor were the subsequent additions of the two interaction terms, $\chi^2(2) = 24.70$, ns.

Addition of the main effect for the SSRQ was significant, $\gamma = -0.38$, OR = 0.69, z = 3.55, $p < .001$. Subsequent inclusion of the two interaction terms also yielded a significant increase in model fit, $\chi^2(2) = 6.57$, $p < .05$. In the model with all three terms included, only the SSRQ by Daily BAC term reached significance, $\gamma = -0.03$, OR = 0.98, $z = 2.55$, $p < .05$; higher levels of self-regulation were associated with smaller increases in risk of consequences as intoxication increases, and this risk is 0.98 times as large for an increase of 0.01 in BAC. The regression lines for three levels of the SSRQ (mean and +/− 1 SD) are presented in Figure 1 (Panel B).

Addition of the main effect for the ICS was significant, $\gamma = 0.31$, OR = 1.37, z = 2.40, $p < .05$. Subsequent inclusion of the two interaction terms did not yield a significant increase in model fit, $\chi^2(2) = 1.35$, *ns*. The regression lines for three levels of the ICS (mean and +/− 1 SD) are presented Figure 1 (Panel C).

Addition of the main effect for the EIS was significant, $\gamma = 0.28$, OR = 1.33, z = 2.42, $p < .05$. Subsequent inclusion of the two interaction terms was associated with a significant increase in model fit, $\chi^2(2) = 7.37$, $p < .05$. In the model with all three terms included the EIS by Daily BAC interaction was significant, $\gamma = 0.02$, OR = 1.02, $z = 2.31$, $p < .05$; higher levels of impulsivity were associated with greater increases in risk of consequences as daily intoxication increases, and this risk is 1.02 times as large for an increase of 0.01 in BAC. The regression lines for three levels of the EIS (mean and +/− 1 SD) are presented Figure 1 (Panel D).

Addition of the main effect for the NRDQ was not significant, z = 0.32, *ns*. Subsequent inclusion of the two interaction terms was not associated with a significant increase in model fit, $\chi^2(2) = 0.87$, *ns*. Addition of the main effect for the PRDQ was not significant, z = 0.61, *ns*. Subsequent inclusion of the two interaction terms did not yield a significant increase in model fit, $\chi^2(2) = 4.22$, ns.

Second, the potential moderators were examined jointly to determine their unique association with alcohol-related negative consequences. The model was built as followed. First, the model represented in equation 2 was used as the base model. Second, those covariates that were significant in when examined independently were added to the model as main effects; these covariates included SSRQ, ICS, and EIS. Third, the interactions of SSRQ, and EIS with daily BAC were added to the model and tested individually and jointly. Fourth, items were eliminated in a step-wise fashion until only individually or jointly significant predictors remained.

Results for these analyses are presented in Table 2. First, for the base model the omnibus test was significant, $\chi^2(4) = 127.97$, $p < .0001$, and average BAC, daily BAC, and the average BAC X daily BAC interaction were all individually significant in predicting the likelihood of experiencing a negative consequence. Second, the addition of SSRQ, ICS, and EIS was significant, $\chi^2(3) = 16.73$, $p < .001$, although none of the individual effects achieved significance. Third, the addition of the cross-level interactions for SSRQ and EIS was significant, $\chi^2(2) = 8.60$, $p < .05$; however, examining the main effects indicated none were individually significant, nor were the joint tests of SSRQ and the SSRQ by Daily BAC and EIS by Daily BAC interactions. Because ICS was did not interact with Daily BAC in initial hypothesis testing, this variable was dropped and the final model was computed. This final model was significant, $\chi^2(8) = 135.71$, $p < .001$, and included a significant main effect for SSRQ ($\gamma = -0.31$, OR = 0.73, $z = 2.93$, $p < .01$). The joint test for the SSRQ and SSRQ by Daily BAC was significant, $\chi^2(2) = 10.99$, $p < .01$, but not the joint test for the EIS and the EIS by Daily BAC interaction, $\chi^2(2) = 3.80$, *ns*.

To facilitate interpretation of the final model, the predicted probabilities of a negative consequence for light (average BAC = 0.05), moderate (average BAC = 0.12) and heavy (average BAC = .19) drinkers with high and low SSRQ scores, at daily BACs of 0.05, 0.10, 0.15, and 0.20 are presented in Table 3. Inspection of these data indicate that although high SSRQ scores were correlated with lower likelihood of negative consequences, the effect of average level of intoxication was much more pronounced.

Discussion

Detailed assessment of alcohol-related consequences served two purposes in this study: (a) identification of risky patterns of drinking; and (b) identification of factors that can serve as risk or protective factors in the occurrence of alcohol-related consequences. The primary strength of this study lies in the event-level analysis of alcohol-related consequences. Although event-level methodology has been used previously in studies of drinking patterns of college students (e.g., Del Boca, Darkes, Greenbaum & Goldman, 2004), this is the first study that has used event-level methods to study moderators of the association between alcohol intoxication and alcohol-related problems.

Results were generally consistent with predictions. Daily intoxication was predictive of the occurrence of an alcohol-related consequence, and risk for such consequences increased fairly rapidly as intoxication increased. Specifically, the average drinker experiences an increase of 1.15 in the odds of experiencing a negative consequence for each increase in .01 of BAC. Average intoxication was also associated with greater risk for consequences; the more one typically drinks, the more likely one is to experience adverse consequences. Interestingly, average intoxication moderated the association between daily drinking and consequences (i.e., a “tolerance effect”). Light drinkers have odds-ratios of 1.20 for each increase of .01 in BAC, compared to odds-ratios of 1.11 for heavy drinkers. Thus, heavier drinkers can “handle a couple extra drinks” (i.e, consume more than their average amount) before experiencing problems compared to their light-drinking peers. Such a finding is particularly relevant, given that it can only be quantified through the use of event-level data. However, as previously noted heavier

average intoxication does place an individual at a higher level of risk; therefore, while heavier drinkers experience a smaller increase in risk associated with increases in daily drinking, their average level of drinking is clearly more risky relative to lighter drinkers. Finally, the interaction must be interpreted cautiously, given that the formula used to estimate BAC in this sample tends to overestimate actual BAC levels. It is possible that the true effect size of the observed interaction is not as large as observed in these data.

Covariates/Moderators

This study provided data confirming the risk/protective roles of several person characteristics at the event-level. Gender and Greek membership failed to add predictive value; thus, group differences in consequences males versus females, and for fraternity and sorority members versus non-members, were likely due to increased consumption levels.

The personality variables of impaired control, impulsivity, and self-regulation all significantly predicted consequences. Impulsivity and self-regulation were moderators of the relation between daily intoxication and likelihood of consequences, whereas impaired control served only as a main effect. That impaired control failed to moderate the intoxication-consequences association is surprising, in light of the similar findings at the global level demonstrated by Werch and Gorman (1988) and Nagoshi (1999). The role of impulsivity as an event-level moderator is also surprising, given some previous research has demonstrated that impulsivity predicts only consumption (e.g., Camatta & Nagoshi, 1995; Wood, et al., 1992). Nonetheless, our data are consistent with the findings that impulsivity has a direct effect on alcohol-related (e.g., Hutchinson et al., 1998, Simons, 2003) consequences.

The role of self-regulation as an event-level moderator is perhaps the most interesting, in that it retained its independent contribution in conjunction with other covariates. Individuals with a high capacity for self-regulation were less likely to experience negative consequences as they increased their daily drinking compared to individuals with moderate or low capacity for self-regulation, a finding that is consistent with global level studies (Wills et al., 2002). That impulsivity and impaired control were not significant predictors of consequences when controlling for self-regulation, along with the moderate correlation between the measures, may indicate that impulsivity and impaired control are subsumed by self-regulatory processes. Perhaps students with a high capacity for self-regulation are choosing to drink in places, at times, or with people where negative consequences are less likely to occur; this selectivity would be inconsistent with impaired control over alcohol use. It is also possible that students with a high capacity for self-regulation continue to make wiser choices while intoxicated, which reflects an ability to control impulsive behavior. However, these potential explanations for the protective effect of self-regulation cannot be addressed by these data.

Finally, findings regarding the moderation effects of drinking motives were not consistent with previous global level studies. Neither positive reinforcement nor negative reinforcement motives did not predict consequences or moderate the association between intoxication and consequences. Previous research has established that drinking to escape or cope is associated with alcohol-related consequences (Cooper et al., 1995; Wood et al., 1992), but the present findings indicate that drinking to relieve boredom, tension, or sadness leads does not lead to increased risk of consequences at a given level of intoxication.

In sum, the results indicate that self-regulation skills are a protective factor against the occurrence of negative alcohol-related consequences, whereas impulsivity and impaired control over alcohol use are vulnerability factors. Examined jointly, only self-regulation served as a protective/risk factor, which may indicate that these other factors are components of self-regulatory processes.

Clinical Implications

At least three implications for designing intervention and prevention programs emerge from these findings. First, at high levels of intoxication light drinkers are much more likely to experience negative consequences compared to heavier drinkers. Given that relatively inexperienced lighter drinkers may be prone to becoming unintentionally intoxicated, prevention programs that focus on addressing the importance of limiting excessive consumption could be valuable. Such an approach could also benefit heavier drinkers, but not to the same extent that it would for lighter drinkers.

Second, although the magnitude of the effect is not as pronounced as the effect of average intoxication levels, self-regulatory capacity does reduce the likelihood of experiencing negative consequences at all levels of consumption. The effect is most pronounced, however, at moderate-to-high levels of intoxication. Although this study is not in a position to evaluate why self-regulation serves as a protective factor, the fact that it does has implications for prevention interventions. Specific interventions designed to address deficits in self-regulation may yield positive results. For example, an intervention broadly designed to teach self-regulation skills may be quite useful. Alternatively, identifying the cognitive and behavioral processes that comprise self-regulation in the context of drinking situations may lead to interventions that help individuals who are low in self-regulatory capacity to function more like individuals who do not show such deficits. Thus, such interventions may reduce the consequences of alcohol use, even if actual consumption levels remain constant.

Third, this study provides further insight into identification of individuals who may be at need for focused interventions. Individually-based interventions for college student drinking can be a time-intensive process, given the large number of heavy drinking students and the relatively small number of counseling or psychological staff members on campus. Thus, if a system is in place to identify individuals who drink heavily and show one or more risk factors then services can be provided to the people with the greatest need. This would considerably ease the strain on campus mental health providers.

Limitations of the Current Study and Future Directions

The limitations of this study must be acknowledged. First, we cannot be certain that all daily diaries provided prospective data as intended; in some cases, they may have represented a series of one-week retrospective estimations of consumption and consequences. More technologically sophisticated data collection methods (i.e., palm pilots or web-based methods) could identify data that were collected prospectively, as these methods provide a date and time stamp for each submitted datum. Second, the consequences assessed in this study were defined as only occurring in the context of alcohol use. As such, participants were required to make an attribution that a specific consequence occurred because of their alcohol use. However, base rates of consequences independent of alcohol use were not assessed, so it is difficult to determine how much *additional risk* is associated with alcohol use per se. Weinhardt, Carey, Carey, Maisto, and Gordon (2001) used log odds ratios (LOR) to demonstrate that in an outpatient psychiatric sample, concurrent alcohol use was not associated with increased HIV risk behavior. Such a study, using a multilevel framework similar to this study, would strengthen the findings of the current study. Third, the sample included predominantly younger students (i.e., Freshman) who were relatively heavy drinkers. The generalizability of these results to the general population of students at this university and others must be established in future studies.

Many directions for future research are possible. Although several individual differences variables were included in this study, a myriad of other theoretically relevant variables could be considered (e.g., alcohol use expectancies) as protective or vulnerability factors. In addition,

all of the predictors in this study were treated as constant within the individual. However, many potential predictors of risk vary from day to day. Situational variables such as location, or number and type of peers present (e.g., O'Hare, 1990), may lead to changes in risk associated with drinking. Internal motivations, such as mood or reasons for drinking specific to a certain day, could also be associated with risk. One of the most interesting aspects of event-level methodology is that these time varying covariates can be included in models.

Overall Conclusions

Use of an event-level methodology to address alcohol-related consequences in a college student sample expands the potential research questions that can be addressed. Results clearly showed that heavier daily intoxication is related to increased risk for consequences, and that how much a person typically drinks moderates this risk. The moderators identified a priori did, for the most part, help to explain the likelihood of negative alcohol consequences for a given level of intoxication. In particular, self-regulation abilities emerged as a protective factor that may subsume other factors such as impaired control over alcohol intoxication and impulsivity. Such information may allow for more personalized prevention strategies tailored to drinkers known to be more vulnerable to experiencing negative consequences. Finally, this study demonstrates that daily monitoring of alcohol use and alcohol-related consequences is feasible in this population, and future studies can use such a methodology to further understand the experiences of students who choose to drink heavily.

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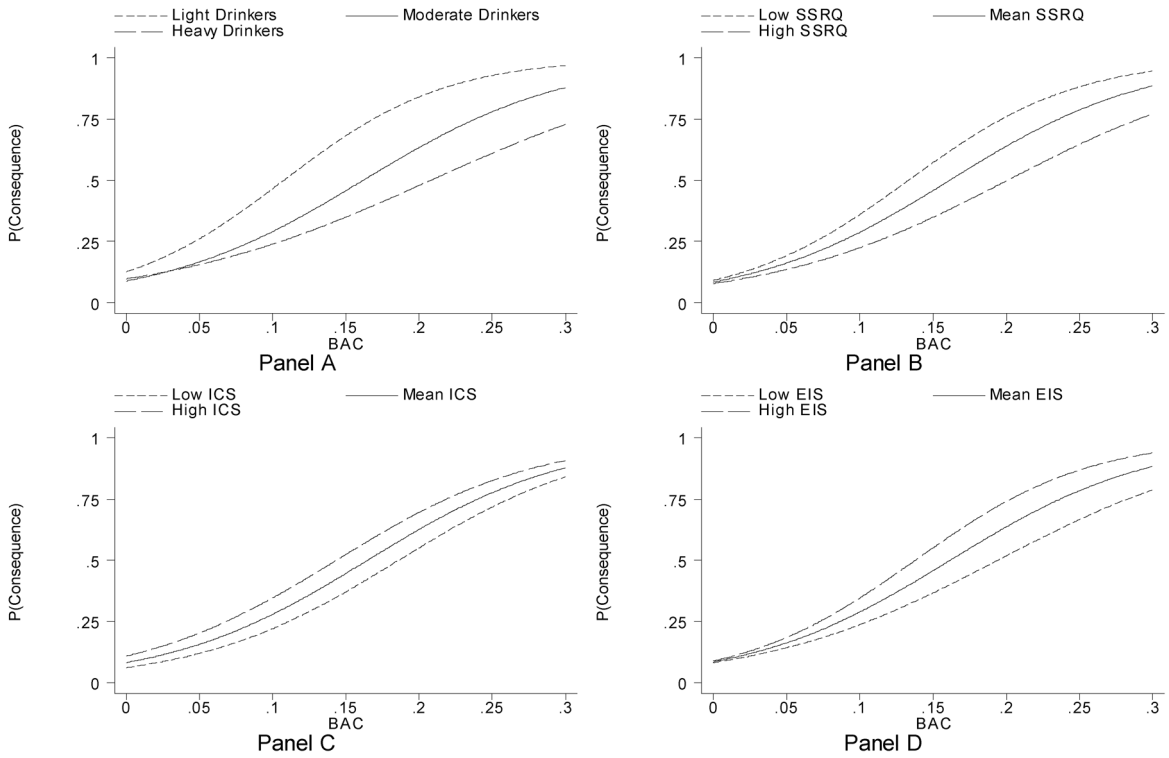

Figure 1.
Probability of experiencing a negative alcohol-related consequence as a function of level of intoxication for light, moderate, and heavy drinkers, and as a function of level of intoxication for low, average, and high levels of the moderating variables Self-Regulation Questionnaire Short Form (SSRQ), Impaired Control Scale (ICS), and Eysenck Impulsiveness Scale (EIS). BAC = blood alcohol concentration.

Table 1

Descriptive data of the sample by gender.

	Women (n = 131)		Men (n = 75)	
	n	**%**	**n**	**%**
Class Standing				
Freshman	107	81.6	52	69.3
Sophomore	16	12.2	11	14.7
Junior	6	4.6	10	13.3
Senior	2	1.5	2	2.7
Ethnicity				
Caucasian	106	80.9	64	85.3
African-American	7	5.3	1	1.3
Asian	13	9.8	5	6.7
Multiracial	2	1.5	1	1.3
Other	3	2.3	4	5.3
Person Variables	M	SD	M	SD
MCSDS	6.7	2.7	6.4	2.5
SSRQ	118.0	13.8	119.6	13.7
ICS	9.0	5.9	8.2	5.0
EIS	6.7	3.8	7.6	4.0
N-RDQ	2.6	2.1	2.6	2.3
P-RDQ	2.2	1.1	2.6	1.2
	Women (n = 117)		Men (n = 66)	
Consumption	M	SD	M	SD
Drinking Days**	7.1	4.3	9.5	4.8
Typical Consumption***	5.0	2.5	6.8	3.2
Peak Consumption***	8.3	4.5	12.9	6.6
Average BAC/Drinking Day*	.13	.07	.10	.05
Peak BAC	.22	.14	.20	.12
Consequences	n	%	n	%
Academic	52	44.4	31	47.0
Social	59	50.4	32	48.5
Health	78	66.7	45	68.8
Legal*	6	5.1	9	13.6
High Risk*	23	19.7	22	33.3
Any	89	76.1	55	83.3

Note. The top half shows data for the original 206 participants; the bottom half shows data for the 183 participants who completed all requirements. MCSDS = Marlowe-Crown Social Desirability Scale; SSRQ = Short Self-regulation Questionnaire; ICS = Impaired Control Scale; EIS = Eysenck Impulsiveness Scale; N-RDQ = Reasons For Drinking – Negative Reinforcement; P-RDQ = Reasons For Drinking – Positive Reinforcement. BAC = Blood Alcohol Concentration.

* $p < .05$;

** $p < .01$;

*** $p < .001$;

Table 2

Results of models of concurrent prediction of alcohol-related consequences

		OR	Wald z	Omnibus Test	Incremental Test	Main Effect + Interaction Test
Step 1				$\chi^2(4) = 127.97^{***}$		
γ_{01}	Daily BAC	1.23	6.34^{***}			
γ_{10}	Avg. BAC	1.06	3.59^{***}			
γ_{11}	Daily X Avg. BAC	0.99	3.01^{**}			
γ_{40}	Social Desirability	0.69	3.13^{**}			
Step 2				$\chi^2(7) = 128.20^{***}$	$\chi^2(3) = 16.73^{***}$	
γ_{01}	Daily BAC	1.23	6.42^{***}			
γ_{10}	Avg. BAC	1.04	2.28^{*}			
γ_{11}	Daily X Avg. BAC	0.99	3.11^{**}			
γ_{20}	SSRQ	0.79	1.87			
γ_{30}	ICS	1.19	1.24			
γ_{40}	EIS	1.21	1.59			
γ_{50}	Social Desirability	0.82	1.59			
Step 3				$\chi^2(9) = 133.49^{***}$	$\chi^2(2) = 8.60^{*}$	
γ_{01}	Daily BAC	1.24	6.73^{***}			
γ_{10}	Avg. BAC	1.04	2.42^{*}			
γ_{11}	Daily X Avg. BAC	0.99	3.50^{***}			
γ_{20}	SSRQ	0.79	1.86			$\chi^2(2) = 5.79$
γ_{21}	SSRQ X Daily BAC	0.98	1.57			
γ_{30}	ICS	1.19	1.26			
γ_{40}	EIS	1.20	1.48			$\chi^2(2) = 3.63$
γ_{41}	EIS X Daily BAC	1.02	1.37			
γ_{50}	Social Desirability	0.82	1.58			
Step 4				$\chi^2(8) = 135.71^{***}$		
γ_{01}	Daily BAC	1.24	6.69^{***}			
γ_{10}	Avg. BAC	1.05	3.26^{***}			
γ_{11}	Daily X Avg. BAC	0.99	3.45^{***}			
γ_{20}	SSRQ	0.73	2.93^{**}			$\chi^2(2) = 10.99^{**}$
γ_{21}	SSRQ X Daily BAC	0.98	1.56			
γ_{30}	EIS	1.21	1.60			$\chi^2(2) = 3.80$
γ_{31}	EIS X Daily BAC	1.02	1.36			
γ_{40}	Social Desirability	0.77	1.85			

Note. Daily BAC = Estimated Blood Alcohol Concentration for each day of self-monitoring; Avg. BAC = Average Estimated Blood Alcohol Concentration across all days of self-monitoring; SSRQ = Short Self-regulation Questionnaire; ICS = Impaired Control Scale; EIS = Eysenck Impulsiveness Scale; N RDQ = Negative Reinforcement Reasons for Drinking; Omnibus test is the overall test for all predictors in the model; incremental test is the test of all added covariates; main effect + interaction test is the test of the main effect and interaction with Daily BAC for each individual covariate.

$^{*}p < .05$;

$^{**}p < .01$;

$^{***}p < .001$

Table 3

Probability of alcohol-related consequences as a function of daily intoxication, average intoxication, and self regulation.

BAC	Light Drinkers		Moderate Drinkers		Heavy Drinkers	
	Low SR	High SR	Low SR	High SR	Low SR	High SR
.05	.33	.21	.19	.11	.10	.05
.10	.58	.38	.35	.22	.20	.11
.15	.79	.59	.55	.40	.36	.23
.20	.91	.77	.73	.61	.56	.41

Note. Light drinkers, average BAC = .05; Moderate drinkers, average BAC = .12; Heavy drinkers, average BAC = .19; BAC = estimated daily blood alcohol concentration; SR = self-regulation.