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Hangover Sensitivity after Controlled Alcohol Administration as Predictor of Post-College Drinking

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Abstract

Introduction—Predicting continued problematic levels of drinking after the early 20's could help with early identification of persons at risk. This study investigated whether hangover insensitivity could predict post-college drinking and problems beyond the variance due to drinking patterns.

Methods—In a preliminary study, 134 college seniors from a laboratory study of hangover (Time 1) were contacted and assessed 1–4 years (M = 2.3) later (Time 2). Hangover severity was studied after controlled alcohol administration to a specific dose while controlling sleep and environmental influences. Hangover severity at Time 1 was used to predict Time 2 drinking volume and problems while controlling for relevant demographics and Time 1 drinking volume.

Results—Hangover insensitivity at Time 1 tended to predict a clinical level of alcohol problems with a strong statistical effect. Hangover sensitivity also correlated positively with sensitivity to alcohol intoxication. Hangover severity did not predict future drinking volume.

Conclusions—Hangover insensitivity correlates with insensitivity to intoxication and might predict more serious alcohol problems in the future, suggesting that a future larger study is warranted. Hangover insensitivity could result from physiological factors underlying low sensitivity to alcohol or risk for alcoholism.

Keywords

hangover; drinking quantity; drinking problems; college drinking; transitions; level of response

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Conflict of Interest
No authors have any conflict of interest with this study.

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Ability to predict risk for drinking problems in early adulthood could inform prevention and early intervention efforts. Heavy drinking peaks in the early 20's and declines thereafter (Chen, Dufour & Yi, 2004/2005; Dawson, Grant, Stinson & Chou, 2004; Fillmore, 1988; Johnston, O'Malley & Bachman, 1998), yet some young adults continue to drink heavily. While some predictors have been investigated (Littlefield, Sher & Wood, 2009), sensitivity to hangover has not been considered.

Hangover refers to physical symptoms such as headache, nausea, and fatigue that occur after breath alcohol concentration (BrAC) has returned to near zero following an acute bout of heavy drinking (Rohsenow et al., 2007), not to be confused with withdrawal, which requires chronic administration and involves different neurological systems (Prat, Adan, & Sanchez-Turet, 2009). One survey showed that greater average quantity of drinking was associated with less intense (but more frequent) hangovers in the same period (Wall, Horn, Johnson, Smith & Carr, 2000). A second survey found a relationship between frequency of hangover and frequency of heavy drinking in early college among women more than men (Piasecki, Sher, Slutske, & Jackson, 2005); hangover severity was not studied. While surveys suggest promising directions, results may reflect multiple causes since these drinkers chose how much to drink (Piasecki, Robertson, & Epler, 2010; Verster et al., 2010). Results may be due to the frequent heavy drinkers experiencing more hangovers on mornings after very heavy drinking rather than indicating that hangovers predict greater ongoing drinking. Also, hangover requires drinking to 0.11 g% BrAC or higher (Rohsenow et al., 2007; Verster et al., 2010), and most heavy drinking indices in surveys are not designed to address this level of drinking. No controlled studies have investigated hangover in response to a fixed alcohol dose as a predictor of future drinking.

The failure to transition out of heavy drinking after college may be related to hangover insensitivity as well as to insensitivity to intoxication based on the following points. First, lower sensitivity to alcohol's effects during young adulthood and/or initial drinking predicted increased heavy alcohol use 5 years later (Schuckit et al., 2007; Schuckit, Smith, Trim, Fukukura, & Allen, 2009). Second, insensitivity to acute intoxication after 1.5 g/kg ethanol correlated with hangover insensitivity in a laboratory study by Ylikahri, Huttumen, Ericksson, & Nikkilä (1974). Third, given that around 25% of heavy drinkers do not experience hangover (Howland, Rohsenow & Edwards, 2008a; Howland et al., 2008b), hangover insensitivity may predict continued heavy drinking or future drinking problems just as insensitivity to intoxication does. The shared insensitivity could be due to common physiological processes that may underlie more rapid development of tolerance or insensitivity to the other adverse consequences of excessive drinking. Alternatively, learning theory might suggest that drinkers who experience minimal hangover effects after a night of heavy drinking might be less likely to eventually moderate their drinking compared to heavy drinkers who experience stronger unpleasant effects.

One longitudinal survey study investigated the role of hangover frequency in drinking post-college (Piasecki et al., 2005). More frequent hangover was positively related to concurrent frequency of heavy drinking, but hangover frequency was not investigated as a prospective predictor of future heavy drinking. More frequent hangover as a college freshman predicted alcohol use diagnoses 7 and 11 years later controlling for baseline frequency of any heavy

drinking, sex and familial risk. However, quantity of baseline drinking (not assessed) could have been higher for those with more frequent hangovers and this quantity difference could have accounted for the relationship. Since severity of hangover was not investigated, the sensitivity issue was not addressed. Rigorous study of hangover severity requires controlled alcohol administration to a specific range of BrAC, a validated hangover measure (see Rohsenow et al., 2008, for critique), and control of amount of sleep and environmental influences.

We conducted a preliminary prospective cohort study of heavy drinking college seniors from a laboratory study of hangover (Howland et al., 2010) by asking about participants' drinking practices about 1 to 4 years later. Hangover severity was assessed after providing controlled alcohol doses adjusted for gender and weight, targeting a narrow range of breath alcohol, and controlling time in bed, food, caffeine, and time after awakening. We hypothesized that lower hangover severity would predict greater Time 2 drinking volume, number of problems, and meeting clinical screening criteria for probable alcohol diagnosis, even after controlling for Time 1 drinking practices and relevant demographics. We also hypothesized that hangover insensitivity would increase with Time 1 drinking volume and with lower perceived intoxication at peak BrAC.

Methods

College seniors (n = 134) from an experimental study of hangover (Time 1) were recontacted after college (Time 2) to assess post-college drinking. *Time 1 inclusion criteria* were: (1) college senior, (2) ages 21 to 24 years, (3) not on academic probation, (4) at least occasionally in the past month consumed six drinks or more if male, four or more if female during a single drinking episode (equivalent based on Flannery et al., 2002; level chosen for ethical purposes), (5) no treatment for alcohol use problems and below the cut-off for problem drinking on the Short Michigan Alcohol Screening Test (SMAST; Selzer et al., 1975), (6) no medical or medication contraindications for alcohol by physical exam, including pregnancy or nursing, (7) not a daily smoker (due to inability to smoke during the 18-hour sessions), (8) no use of recreational drugs, (9) zero BrAC on arrival at sessions, (10) weigh 120 to 240 lbs, (11) no sleep disorder nor extreme sleeping schedules per the Circadian Rhythm Questionnaire (Horne & Östberg, 1976). Participants maintained a regular sleep schedule for 5–7 days before the administration days.

Recruitment for Time 2 study

University seniors who had participated in the study of the residual effects of intoxication on next-day performance from 2004–2008 were assessed 6 months to 4 years later, after they had graduated university. Of 193 participants in that trial who met all study criteria, 190 had consented to be re-contacted; 134 were located, eligible and agreed. Because this additional prospective study was designed near the end of the original laboratory study, the re-contact time could not be narrowed to a single year at least two years out. Participants telephoned or emailed to contact us about the proposed study, then respondents were sent links to an informed consent form and the Web-based study questionnaire. Procedures were approved by the Institutional Review Board at Boston Medical Center and/or Brown University.

Time 1 laboratory study procedures

In the original study (see Howland et al., 2010), we administered alcohol to a mean of 0.12 g % breath alcohol, then assessed the intensity of hangover the next morning. The study used a placebo-controlled double-blind within-subjects design with each participant receiving alcohol one night and placebo on a second night 7 days later (order counter-balanced). For the current analyses, only data from the alcohol session are used. At 8:45 p.m., 3 hours after a light meal, participants were given high alcohol beer (8.1%) aimed at a BrAC of 0.12 g% (1.068 g/kg men, 0.915 g/kg for women), consumed across one hour. After 15 min absorption, if the BrAC was less than .11 g%, extra beverage was administered. At 11:00 p.m., after a final BrAC test, participants rated intoxication, then slept. At 7:00 a.m., participants were awakened and completed the hangover measure.

Time 1 measures

Recent alcohol consumption was assessed with two items: (i) 'Considering all your drinking times in the past 30 days, about how often did you have any beer, wine or liquor?', rated from 1 'once a day' to 7 'did not drink' with each point anchored; and (ii) 'In the past 30 days, on a typical day that you drank, about how much did you have to drink in one day?', with their actual number of drinks specified. One drink was defined as 12 ounces of beer or wine cooler, 4 ounces of wine or 1 ounce of liquor. Frequency scores were reversed, then weighted by converting to number of days per month (e.g., 2–4 days per week converted to 12) divided by 30 (Dawson, 1998). Average daily drinking volume (ADV) was the quantity score times the weighted frequency score. At the highest BrAC, they rated "How intoxicated do you feel right now?" as "not at all" (1), "mildly" (2), "moderately" (3), "very" (4), or "completely" (5). Hangover was assessed with the Acute Hangover Scale (AHS), a 9-item assessment of hangover symptoms found valid in laboratory studies (Rohsenow et al., 2007), each rated from 0 (none) to 7 (incapacitating).

Time 2 assessments

The survey asked: (1) Current age, employment (yes/no), marital status, pregnancy (if female). Anyone reporting pregnancy was ruled out as this could temporarily change their drinking patterns. (2) Alcohol use was assessed with the same questions as Time 1, scored for ADV. (3) Alcohol problems were assessed using the Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, de la Fuente & Grant, 1993; Donovan, Livlahan, Doyle, Longabaugh, & Greenfield, 2006) which includes 10 questions: seven on problems or diagnostic indicators due to drinking in the previous year and three quantity-frequency items (current use). The seven problem items were summed (AUDIT-P) for data on number of problems. Scores of 8 or higher (AUDIT-Positive) indicate concordance with diagnoses of a past-year alcohol problem with high specificity (Reinert & Allen, 2007). Upon return of the completed survey, participants were mailed a gift card worth $25 and were eligible to receive one of four randomly drawn $250 prizes.

Data analysis methods

Outliers for ADV at Time 1 were recoded per Tabachnick and Fidell (1996). Change in drinking volume was analyzed, to confirm the expected decrease, in a Sex by Time analysis

using a linear mixed model. Two separate regression analyses used general linear modeling procedures for predicting Time 2 ADV and AUDIT-P, while logistic regression was used to predict meeting Time 2 AUDIT-Positive criteria. All three regressions used total AHS scale score as the predictor variable, entering age, gender, and employment at Time 2 in the first step, adding Time 1 ADV in the second step, and adding AHS in the third step. (Covariate choices were based on Gotham, Sher & Wood, 1997; O'Neill, Parra & Sher, 2001).

Results

Preliminary analyses

Participant characteristics (see Table 1) are similar to the original full sample (Howland et al., 2010). Forty-one (31%) said they felt no hangover (zero score on the first AHS item). The mean (range) number of years after their senior year involvement was $M = 2.3$ (0.5–3.8). Of 131 with AUDIT data at Time 2, 66 (50%) scored 8 or more, indicating hazardous drinking. ADV decreased significantly over time, $F(1,132) = 30.76$, $p < 0.0001$ (see Table 1), regardless of sex (interaction *ns*).

Univariate correlations

AHS correlated as expected with higher intoxication ratings at peak BrAC ($r = .42$, $p < .0001$), and with lower Time 1 ADV ($r = -.17$, $p < .05$) but unexpectedly not with Time 2 ADV ($r = -.02$), AUDIT-P ($r = .13$) nor with any AUDIT-P item. ADV at TIME 1 correlated significantly with Time 2 ADV ($r = .40$, $p < .0001$) and AUDIT-P ($r = .25$, $p < .005$). The AUDIT-P items significantly related to Time 1 ADV were #4 (unable to stop drinking, $r = .30$, $p < .0004$), #7 (unable to remember what happened, $r = .33$, $p < .0001$), and #9 (injured someone else due to drinking, $r = .20$, $p < .02$).

Hypothesis testing

Volume of drinking as a senior was a significant predictor of Time 2 volume of daily drinking, number of drinking problems, and AUDIT-Positive (see Table 2). Hangover severity did not add significantly to the predictions, but there was a non-significant trend for low hangover severity to predict meeting AUDIT-Positive criteria.

Discussion

In this preliminary study, insensitivity to hangover after a controlled dose of alcohol showed a non-significant statistical trend for predicting who would meet AUDIT criteria that indicate probability of meeting an alcohol diagnosis (Reinert & Allen, 2007). While of borderline statistical significance, a 2-point increase on the hangover scale corresponds to more than a 50% reduction in the odds of alcohol related problems, and a 3-point increase corresponds to 1/3 the odds of future alcohol related problems -- a fairly substantial effect size. The lack of significance might reflect a power issue in this relatively small preliminary sample. Thus, while degree of insensitivity to hangover per se does not appear to be a significant sign of increased risk for continued heavy drinking after leaving university in this study, it might be a marker of risk for future alcohol problems that are of clinical significance. This was the first study to investigate the role of hangover insensitivity as a

predictor of future drinking volume and problems among heavy drinkers in their twenties; replication in a larger population would be useful to follow up these preliminary results.

In a prior study, greater frequency of hangover in college predicted increased chance of future alcohol use disorder (Piasecki et al., 2005) yet greater hangover severity tends to predict reduced chance of developing clinical alcohol problems in our study. More frequent heavy drinking correlated positively with more frequent hangover independent of time in Piasecki's study. However, the prediction of alcohol use disorder by hangover frequency could have reflected an inability to control for quantity of drinking in that study -- people with more frequent hangover could also drink more heavily, in a way conducive to developing alcohol use disorders. This would be consistent with the fact that heavier quantity of drinking correlated with more frequent but less intense hangovers (Wall et al., 1000). Thus, more frequent but less intense hangovers may indicate increased risk of clinical level of problems.

When the present study and Piasecki's are considered in terms of theory, results give little for support the idea that hangovers would reduce drinking due to providing aversive consequences; understandable since consequences delayed by hours generally have weak effects on behavior. However, a person who drinks heavily while experiencing minimal hangover (regardless of frequency) might be more likely to continue drinking in a way that leads to drinking-related social and occupational consequences than does the person who experiences more severe hangover. In contrast to learning theory explanations, sensitivity to hangover, in terms of either degree of hangover or probability of any hangover, may instead be a marker for other characteristics that predispose one to increased risk of alcohol problems and diagnoses (reviewed by Howland et al., 2008a and b). Hangover frequency correlated with a measure of personality risk for alcoholism and other personality traits (Earlywine, 1993; Harburg et al., 1993), and family history of alcoholism and candidate genes have been found to predict hangover frequency or severity (Newlin and Pretorius, 1990; Piasecki et al., 2005; Wall et al., 2005). Thus, hangover sensitivity could be a marker for physiologic factors that predispose one to future alcohol abuse or dependence.

Hangover insensitivity correlated with perceiving oneself to be less intoxicated when at about 0.12 g% BrAC, suggesting that these two types of insensitivity are related. This is only the second study to investigate the relationship of hangover insensitivity to insensitivity to alcohol's acute effects, both using controlled conditions and high BrAC levels (Ylikahri et al., 1974). While there is unresolved controversy about the most relevant part of the BrAC curve for assessing level of response (Newlin & Renton, 2010, versus Schuckit, Smith & Trim, 2010) and while the time of true peak BrAC could not be determined in our study due to the need to have a standardized bedtime, our intoxication measure was unlikely to have been assessed significantly away from peak. Our analyses using level of response around peak BrAC are consistent with data across the entire BrAC curve (Ylikahri et al., 1974) in the direction of relationship to hangover severity. Both studies are consistent with the possibility of an underlying mechanism common to both insensitivities. Future work should relate hangover sensitivity to perceived sensitivity to the first drinks in one's life (Shuckit et al., 2007).

Hangover insensitivity was greater for those with higher volumes of past-month drinking at Time 1, consistent with survey results of Wall et al. (2000). These two studies support an additional possibility that acute tolerance could play a role in reducing sensitivity to hangover.

Limitations include having only 134 subjects, a limited set of variables, and a broader range of time for the Time 2 assessment than is optimal. Finding a trend for hangover insensitivity to predict future problems despite the variability inherent in this range underscores the strength of the effect. This supplemental study was designed near the end of the original laboratory study and had limited funding. While the AUDIT when participants were seniors could be a stronger predictor of future problems, it is unlikely that anyone would have been AUDIT Positive at Time 1 since anyone with a positive SMAST was excluded. Future research should also control for family history of alcoholism (e.g., Gotham et al., 1997; Piasecki et al., 2005) or genetic predisposition (e.g., Wall et al., 2005). The study indicates that hangover severity might be worth further investigation in a future larger study.

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Table 1

Participant Characteristics

Time 1	**N (%) or M ± SD**
Male	69 (51%)
Age at Time 1	21.4 ± 0.6 (range 21–24)
White	113 (84%)
Black	4 (3%)
Asian	9 (7%)
Other or mixed race	8 (6%)
Breath alcohol (BrAC) in lab study (g%)	0.12 ± 0.01
Mean intoxication rating at peak BrAC[a]	3.0 ± 1.0
Alcohol Hangover Scale (AHS)	1.47 ± 0.87
Average daily volume of drinks (ADV)	1.96 ± 1.63
Average days per month drinking	13.42 ± 6.13
Number of drinks on typical day	4.50 ± 2.69
Time 2	
Age at Time 2	23.6 ± 1.1 (range 21–26)
Employed	109 (81%)
AUDIT total score	8.37 ± 4.32
AUDIT Problems (AUDIT-P) score	2.76 ± 3.00
Average daily volume of drinks (ADV)	1.32 ± 0.99
Average days per month drinking	11.49 ± 6.53
Number of drinks on typical day	3.47 ± 1.73

[a]On a 5-point scale from 1 (not at all) to 5 (completely); 3 was labeled “moderately”.

AUDIT = Alcohol Use Disorders Identification Test
AUDIT Problems = AUDIT’s seven problem items only

Note: all data based on n = 134 with data at both time points

Table 2

Hangover Sensitivity Predicting Average Daily Drinking Volume (ADV), Number of Drinking Problems, and Meeting AUDIT-Positive Criteria at Follow up: Regression Results

Predicting ADV at Time 2 (Model F(5,128) = 8.05, p < .0001)			
Predictor	*Beta*	sr^2	*F*(1,128)
Gender (male)	0.35	.03	9.25*
Age at Time 2	−0.10	.00	0.68
Employed at Time 2	0.16	.00	0.62
Time 1 ADV	0.33	.18	29.10 **
Alcohol Hangover Scale score	0.06	.00	0.45
Predicting number of AUDIT Problems at Time 2 (Model F(5,125) = 2.15, p < .07)			
Predictor	*Beta*	sr^2	*F*(1,128)
Gender (male)	−0.11	.00	0.05
Age at Time 2	−0.36	.00	0.65
Employed at Time 2	0.61	.01	0.78
Time 1 ADV	0.56	.05	6.95**
Alcohol Hangover Scale score	−0.31	.01	1.07
Predicting AUDIT Positive at Time 2 (Model Wald X^2 (5, N = 131) = 10.15, p < .07)			
Predictor	*Odds Ratio*		Wald X^2 (*df* = 1)
Gender (male)	1.44 (0.69 – 3.00)		0.95
Age at Time 2	0.97 (0.52 – 1.79)		0.01
Employed at Time 2	1.92 (0.73 – 5.04)		1.76
Time 1 ADV	1.42 (1.03 – 1.96)		4.46 *
Alcohol Hangover Scale score	0.68 (0.44 – 1.06)		2.87 ‡

‡ p = .09;

* p < .05;

** p < .001

ADV = Average daily volume (number of standard drinks)
AUDIT Problems = Alcohol Use Disorders Identification Test, problem items only
AUDIT Positive = Score of 8 or more on AUDIT