Low Sensitivity to Alcohol: Relations With Hangover Occurrence and Susceptibility in an Ecological Momentary Assessment Investigation

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ABSTRACT. Objective: The current investigation tested whether low sensitivity to alcohol, as measured by the Self-Rating of the Effects of Alcohol (SRE) form, is associated with hangover occurrence or resistance, two potentially important predictors of later problematic drinking outcomes. **Method:** Drinkers who reported using alcohol at least four times in the past month ($N = 402$) completed the SRE at baseline and used ecological momentary assessment methods with an electronic diary to record drinking behaviors and related experiences over 21 days. Each morning, the diary assessed prior-night drinking behaviors and the presence of current hangover. **Results:** After adjustments for sex, body weight, age, and smoking status, higher SRE scores (indicating lower alcohol sensitivity) predicted hangover occurrence on postdrinking mornings (odds ratio [OR] = 1.24 per interquartile range [IQR], $p = .003$). However, when the number of drinks consumed in the drink-

ing episode was covaried, SRE scores were negatively associated with hangover (OR = 0.67 per IQR, $p < .001$). An interaction between SRE scores and the number of drinks consumed indicated that low-sensitivity drinkers tend to be differentially resistant to hangover at a given number of drinks. Higher SRE scores were associated with consuming more drinks on average (generalized estimating equations coefficient = 2.20 per IQR, $p < .001$). **Conclusions:** Individuals lower in alcohol sensitivity appear to be more resistant to hangovers per unit of alcohol. However, they are also more likely to engage in excessive drinking, and this may account for their increased odds of experiencing hangover during an arbitrary monitoring period. Heavy consumption, hangover resistance, and hangover frequency may each be manifestations of low sensitivity to alcohol, an established risk factor for alcohol use disorder. (*J. Stud. Alcohol Drugs*, 73, 925–932, 2012)

HANGOVER IS ONE OF THE MOST COMMON negative consequences of heavy drinking (Prat et al., 2009). Emerging evidence suggests that hangover is associated with numerous known risk factors for alcohol use disorder (AUD; for a review, see Piasecki et al., 2010).

Two prospective investigations have examined how hangover measures relate to drinking outcomes. Piasecki et al. (2005) examined survey data from a familial high-risk study of college undergraduates followed into young adulthood. A measure of hangover frequency during the freshman year of college predicted AUD diagnosis 7 and 11 years later, even after controlling for typical heaviness of drinking and AUD diagnoses during the freshman year, sex, and familial alcoholism risk. Supplementary analyses revealed that this

was fairly specific to hangover; other freshman-year drinking problems (e.g., blackout, tolerance, morning drinking) did not predict future AUD in comparable models.

Rohsenow et al. (2012) followed a sample of college students 1–4 years after they had participated in laboratory-based alcohol challenge experiments. In these studies, participants were administered alcohol to achieve an average breath alcohol concentration of .12 g% and rated the severity of hangover symptoms the next morning. After baseline drinking practices were controlled for, hangover severity scores were negatively associated (albeit marginally, $p = .09$) with exceeding a threshold of 8 on the Alcohol Use Disorders Identification Test (Saunders et al., 1993) at follow-up, an indicator of probable AUD diagnosis (Reinert and Allen, 2007).

Thus, available prospective findings suggest that frequent hangover and resistance to hangover are predictive of the escalation of problematic drinking. On the surface, these findings appear difficult to reconcile—are hangovers a risk factor or a protective factor? It is important to recognize, however, that measures of hangover frequency and susceptibility tap distinct information and could be complexly related to one another. For example, if hangover serves to discourage heavy drinking, relative insensitivity to hangover could be a risk

Received: May 22, 2012. Revision: July 23, 2012.

This research was supported by National Institutes of Health Grants P50AA011998 (to Andrew C. Heath), K05AA017688 (to Andrew C. Heath), and K05AA017242 (to Kenneth J. Sher). Saul Shiffman is a cofounder of invivodata, inc., which provides electronic diary services for research and was responsible for the software used in this study.

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factor for heavy alcohol use, thereby paradoxically conferring risk for the occurrence of hangover.

A low level of response or low sensitivity to alcohol has been identified as one factor that might contribute to the development of AUD (Morean and Corbin, 2010; Schuckit, 1994; Trim et al., 2009). Theoretically, low-sensitivity individuals must drink larger volumes to experience the same effects as other drinkers. This is thought to place low-sensitivity drinkers at risk for the hallmarks of AUD: repeated heavy drinking and its attendant consequences (e.g., Schuckit, 1994). Rohsenow et al. (2012) reported that hangover scores the morning after test sessions were significantly correlated with intoxication ratings the night before. This led the authors to suggest that hangover insensitivity may be related to a more general profile of low alcohol response. This insight is intriguing because it might be capable of unifying findings from the two prospective studies of hangover and problematic drinking. Low sensitivity could be associated with both decreased susceptibility to hangover at a given level of drinking and increased risk of escalating drinking to hangover-inducing levels.

The Self-Rating of the Effects of Alcohol (SRE; Schuckit et al., 1997a) form is a widely used measure of individual differences in alcohol response. Using the SRE, investigators identify low-sensitivity individuals as those who report needing a larger number of drinks to experience a variety of alcohol effects. Drinkers who report higher SRE scores display diminished alcohol effects under laboratory challenge conditions, compared with other drinkers (Schuckit et al., 1997b), and are more likely to develop problematic drinking outcomes over time (Schuckit et al., 2007).

In the current study, we examined hangovers experienced in the course of real-world drinking, drawing on data from a sample of frequent drinkers who completed the SRE at a baseline session, then monitored drinking experiences and hangovers over a 21-day period using real-time ecological momentary assessment (Shiffman, 2009). We hypothesized that low sensitivity would be associated with heavier alcohol consumption and increased odds of hangover occurrence during the monitoring period. Based on the Rohsenow et al. (2012) findings, however, we hypothesized that individuals low in alcohol sensitivity would be more resistant to hangover. Thus, we expected that, after the number of drinks consumed in an episode was accounted for, drinkers lower in alcohol sensitivity would have decreased adjusted odds of hangover endorsement or a weaker functional relation between the amount of alcohol consumed and the odds of hangover.

Method

Participants

Current drinkers were recruited from the Columbia, MO, community through print advertisements, flyers, and

mass email solicitations to participate in a 21-day electronic diary study focused on alcohol use among smokers and nonsmokers. Interested volunteers called the study site and were screened over the telephone. To be eligible, candidates had to speak English, be 18 years of age or older, and report drinking alcohol at least one time per week on average in the past month. Individuals were excluded if they reported the use of noncigarette forms of tobacco more than once per month, interest in seeking treatment for an AUD, a history of unsuccessful attempts to cut down or quit drinking, or a history of arrests for alcohol-related offenses (except status offenses, i.e., offenses that would not be considered criminal if the arrestee were at or above the minimum legal drinking age). Because an aim of the larger investigation was to examine alcohol–tobacco co-use, approximately two thirds of the sample consisted of current smokers, defined as those self-reporting that they had consumed at least one cigarette per week on average and had no interest in quitting. The remaining participants were nonsmokers who reported having smoked fewer than 20 cigarettes in their lifetime and none in the last year.

In all, 891 candidate participants were screened, 523 were deemed eligible to participate, 416 were enrolled, and 404 went into the field with a diary. Grounds for exclusion among the 368 ineligible candidates were being a nonsmoker but engaging in past-year cigarette use (32.9%), having an alcohol-related arrest (12.8%), frequently using noncigarette forms of tobacco (12.2%), unsuccessfully attempting to quit or cut down drinking (11.7%), currently attempting to quit smoking (7.3%), having drunk alcohol fewer than four times in the past month (7.3%), being a current smoker who smokes less than one cigarette per week (4.3%), planning to quit smoking in next 30 days (4.1%), being a current nonsmoker who reports more than 20 lifetime cigarettes (3.8%), having an interest in alcohol treatment (3.3%), and being younger than 18 years of age (0.3%).

The current analyses focused on 402 individuals who recorded diary data and had complete data on key covariates (body weight and SRE). In the analyzed sample, 63.9% were current smokers ($n = 257$), 50.2% were female ($n = 202$), and 85.6% were White ($n = 344$). The average age was 23.4 years ($SD = 7.2$) with a range of 18–70.

Procedure

Eligible volunteers were scheduled in small groups for an orientation session in which they provided informed consent, had their height and weight measured using a physician's scale, and completed questionnaires. Approximately 1–2 days later, participants attended a session during which they were trained to use the diaries. Immediately after the training session, participants began carrying the electronic diary and used it to record daily experiences for 21 days. During the monitoring period, participants returned to the laboratory

for brief check-in visits on four occasions. Participants could receive up to \$150 for completing the study and returning the electronic diary.

Electronic diary

Participants used personal digital assistants (Palm m500, Palm Inc., Sunnyvale, CA) running custom diary software by invivodata, inc. (Pittsburgh, PA). They were instructed to make a diary entry when prompted by the device and to initiate entries when smoking cigarettes or consuming alcohol. The current analyses focus on data recorded during once-daily morning reports. As in prior studies (e.g., Muraven et al., 2005), participants used the electronic diary as an alarm clock; before sleep each night, they set an alarm that would wake them the next day and prompt morning report completion, including questions about prior-night drinking and current hangover. In the analyzed sample, at least one diary report was made on 8,522 person-days. Participants did not complete a morning report on the first day of recording, which started after the training session. Thus, morning reports were possible for 8,120 person-days (8,522 – 402). Completed morning reports were available from 7,406 person-days, representing 91.2% of the expected total.

Measures

Alcohol sensitivity. The SRE (Schuckit et al., 1997a) form was administered at baseline to assess sensitivity to alcohol. The SRE consists of 12 items. It asks participants to report the number of drinks required for each of the following four effects: feeling different (i.e., any effect), becoming dizzy or slurring speech, incoordination or stumbling, and unwanted passing out or falling asleep. These questions are asked with respect to three different periods: the first five times drinking, the heaviest drinking period, and the most recent 3 months. An overall score can be calculated by taking the average number of drinks required across all endorsed effects and periods (Schuckit et al., 1997b). This overall score was the main focus of the present analyses because the pairwise correlations among the component scores were substantial ($r_s = .69-.90$). Note that a higher score on the SRE is indicative of lower alcohol sensitivity (viz., more drinks are required before intoxication effects are experienced). In the analyzed sample, the mean SRE overall score was 7.70 ($SD = 2.86$). In all models predicting diary-reported outcomes, the SRE score was divided by the sample interquartile range (IQR; sample value = 3.67) so that odds ratios would be scaled in IQR units. In keeping with this approach, the sample was subdivided into four SRE quartiles to facilitate sample description and illustration of selected model results.

Smoking status. Smokers were oversampled by design. Eligibility criteria for smoking and nonsmoking participants were described earlier. For the current analyses, we further

classified current smokers as daily or nondaily cigarette users on the basis of their responses to a smoking history questionnaire. Two dummy variables were created to index these two groups; when entered together in multivariate models, nonsmokers form the reference category.

Frequency of alcohol and cigarette use. At baseline, participants completed a 30-day Timeline Followback (TLFB) measure (Sobell and Sobell, 1992) that assessed daily alcohol and cigarette use. TLFB responses were used to calculate a mean weekly number of drinks and cigarettes for each participant. These estimates were used in descriptive analyses.

Morning reports of drinking and hangover. Diary morning reports included the question, “Did you drink alcohol last night?” (yes/no). If the participant answered “no,” the remaining drinking-related questions were skipped. If the participant answered the drinking question affirmatively, the next question asked was, “How many alcoholic drinks did you have?” Participants were asked to report the number of drinks consumed (range: 1–30). Following the number-of-drinks question, participants were asked, “Do you have a hangover from last night’s drinking?” (yes/no, coded as 1/0). Of the 7,406 morning reports, 2,695 (36.4%) indicated prior-night drinking. Hangover was reported in 555 records (20.6% of postdrinking mornings). Prior analyses of these data established the validity of the morning-report hangover item (Robertson et al., 2012). Specifically, hangover was related to the number of drinks consumed the night before, contemporaneous elevations of headache and nausea, and scores on the Hangover Symptoms Scale (Slutske et al., 2003), a retrospective measure of past-year hangover symptoms.

Data analysis. In the main sequence of analyses, diary-reported outcomes (either drinking or hangover) were predicted from SRE scores and covariates. A generalized estimating equations (GEE) approach (Zeger and Liang, 1986) was used to account for the clustered nature of the data (multiple days per participant). These analyses used an AR(1) autoregressive within-cluster working correlation structure. Sex and body weight were included as covariates because they are related to the pharmacokinetics of alcohol. Smoking status was covaried because the sample was enriched for current smokers, and smoking may affect propensity for drinking or hangover (Piasecki et al., 2010). Finally, age was included as a covariate because descriptive analyses revealed an association between age and SRE score (Table 1).

We first tested whether SRE scores and covariates were related to the occurrence of drinking during the study, using all morning reports. Next, a series of three models, limited to postdrinking mornings only, was estimated predicting hangover reports. Model 1 tested whether SRE scores were associated with the odds of hangover occurrence above and beyond any effects of covariates. To assess the question of hangover susceptibility, Model 2 added the number of prior-night drinks as a covariate, and Model 3 added an SRE $\times$

TABLE 1. Comparisons of Self-Rating of the Effects of Alcohol (SRE) quartile groups with respect to selected characteristics

Measure	SRE quartile group				Omnibus test
	1 (<i>n</i> = 102)	2 (<i>n</i> = 101)	3 (<i>n</i> = 97)	4 (<i>n</i> = 102)	
SRE score, <i>M</i> (<i>SD</i>)	4.48 (.89) ^a	6.50 (.48) ^b	8.20 (.54) ^c	11.58 (1.90) ^d	<i>F</i> (3, 398) = 737.18, <i>p</i> < .001
Age, in years, <i>M</i> (<i>SD</i>)	25.39 (9.28) ^a	23.18 (6.76) ^{ab}	23.08 (7.19) ^{ab}	21.77 (4.43) ^b	<i>F</i> (3, 398) = 4.52, <i>p</i> = .004
TLFB drinks per week, <i>M</i> (<i>SD</i>)	9.85 (7.52) ^a	14.47 (9.10) ^a	20.10 (12.60) ^b	32.71 (18.41) ^c	<i>F</i> (3, 398) = 62.37, <i>p</i> < .001
Male, <i>n</i> (%)	29 (28.4) ^a	38 (37.6) ^{ab}	54 (55.7) ^b	79 (77.5) ^c	χ^2 (3, <i>N</i> = 402) = 57.15, <i>p</i> < .001
Body weight, in lbs., <i>M</i> (<i>SD</i>)	154.98 (33.17) ^a	160.59 (36.58) ^a	165.36 (34.66) ^a	184.14 (36.19) ^b	<i>F</i> (3, 398) = 13.17, <i>p</i> < .001
Nondaily smoker, <i>n</i> (%)	19 (18.6)	13 (12.9)	19 (19.6)	23 (22.5)	χ^2 (3, <i>N</i> = 402) = 3.32, <i>p</i> = .345
Daily smoker, <i>n</i> (%)	40 (39.2)	51 (50.5)	48 (49.5)	44 (43.1)	χ^2 (3, <i>N</i> = 402) = 3.49, <i>p</i> = .322
TLFB cigarettes per week, <i>M</i> (<i>SD</i>)	29.05 (39.64)	37.21 (49.70)	42.90 (101.14)	38.01 (49.78)	<i>F</i> (3, 398) = 0.80, <i>p</i> = .493
Morning reports of drinking, <i>n</i> (%)	728 (37.2)	653 (34.9)	621 (35.2)	693 (38.2)	χ^2 (3, <i>N</i> = 7406) = 5.86, <i>p</i> = .119
Hangover, postdrinking mornings, <i>n</i> (%)	113 (15.5) ^a	146 (22.4) ^b	129 (20.8) ^{ab}	167 (24.1) ^b	χ^2 (3, <i>N</i> = 2695) = 17.91, <i>p</i> < .001

Notes: Mean overall SRE scores are presented in raw score units. Groups not sharing the same superscript differed significantly from one another in post hoc tests. TLFB = Timeline Followback.

Number of Drinks interaction term to evaluate whether the functional relation between the amount consumed and hangover endorsement differed as a function of SRE score.

Results

Descriptive analyses. Table 1 presents descriptive statistics and statistical comparisons for subsamples defined on the basis of SRE quartiles. As would be expected given the manner in which these groups were defined, they differed significantly with respect to overall SRE scores. Mean drinks per week and the proportion of men tended to increase with higher SRE scores. Members of the highest SRE quartile were younger and heavier than other participants. The groups did not differ with respect to the proportion of daily or nondaily smokers, cigarettes per week at baseline, or the proportion of days with diary drinking reports. The proportion of mornings after drinking on which hangover was endorsed, however, differed across SRE quartiles, with members of the lowest quartile reporting fewer hangovers.

Prediction of drinking. Table 2 summarizes results from a GEE model predicting the reports of prior-night drinking. Being male, older, or a daily or nondaily smoker was associated with increased odds of drinking. SRE scores did not predict the occurrence of drinking.

TABLE 2. Results from generalized estimating equations model predicting morning report of prior-night drinking

Predictor	OR	[95% CI]	<i>p</i>
Body weight	1.00	[0.99, 1.00]	.925
Male	1.26	[1.11, 1.43]	<.001
Age	1.02	[1.02, 1.03]	<.001
Nondaily smoker	1.58	[1.34, 1.85]	<.001
Daily smoker	1.27	[1.11, 1.46]	.001
SRE	1.02	[0.94, 1.11]	.595

Notes: As described in the Method section, the Self-Rating of the Effects of Alcohol (SRE) score was divided by the interquartile range (IQR). Therefore, associated odds ratios (ORs) refer to the effect of a 1-IQR-unit change (or 3.67 drinks). CI = confidence interval.

Prediction of hangover. The sequence of GEE models predicting hangover endorsement in postdrinking morning reports is summarized in Table 3. In the most basic model (Model 1), higher SRE scores (indicating low sensitivity) were associated with increased odds of hangover (OR = 1.24 per IQR, 95% CI [1.08, 1.43], *p* = .003) after covariates were controlled for. When this model was expanded to include the number of drinks consumed the night before as a covariate (Model 2), the number of drinks was positively related to hangover (OR = 1.30, 95% CI [1.26, 1.34], *p* < .001), and higher SRE scores were associated with decreased odds of hangover (OR = 0.67 per IQR, 95% CI [0.56, 0.79], *p* < .001). Finally, when an interaction between SRE and the number of drinks consumed was included (Model 3), a significant interaction term indicated that the relationship between the number of drinks and hangover endorsement was weaker among drinkers with higher SRE scores (interaction OR = 0.95, 95% CI [0.92, 0.98], *p* < .001).

To explore this interaction effect, we estimated a simple model in which hangover was predicted from the SRE quartile, the number of drinks, and their interaction. Predicted values from this model are depicted in Figure 1. As the figure shows, the probability of hangover increased more sharply with each additional drink in the lower quartiles. The probability of hangover was first predicted to exceed 50% at approximately 9, 11, 13, and 17 drinks in Quartiles 1, 2, 3, and 4, respectively. Thus, low sensitivity, as indicated by a higher SRE score, appeared to be associated with resistance to hangover at a given level of alcohol consumption.

Supplementary analyses. We explored the consistency of the key findings across alternate indicators of the amount of alcohol consumed in an episode. As described in greater detail elsewhere (Piasecki et al., 2012), the diary software was designed to track states and behaviors during drinking episodes. This design permitted calculation of the number of drinks logged during the episode and peak intra-episode estimated blood alcohol concentration (BAC; Matthews and Miller, 1979). When Model 3 (Table 3) was reestimated

TABLE 3. Results from generalized estimating equations models predicting morning report of hangover

Model/predictor	OR	[95% CI]	<i>p</i>
Model 1: Mornings after drinking			
Body weight	0.997	[0.993, 0.999]	.016
Male	0.97	[0.77, 1.21]	.773
Age	0.95	[0.93, 0.97]	<.001
Nondaily smoker	0.85	[0.64, 1.14]	.280
Daily smoker	1.06	[0.83, 1.34]	.661
SRE	1.24	[1.08, 1.43]	.003
Model 2: Consumption covaried			
Body weight	0.994	[0.991, .998]	.001
Male	0.78	[0.60, 1.00]	.054
Age	0.98	[0.96, 0.99]	.023
Nondaily smoker	1.03	[0.75, 1.41]	.856
Daily smoker	1.37	[1.05, 1.78]	.021
SRE	0.67	[0.56, 0.79]	<.001
Number of drinks	1.30	[1.26, 1.34]	<.001
Model 3: Consumption × SRE interaction			
Body weight	0.995	[0.991, 0.998]	.002
Male	0.77	[0.60, 0.99]	.046
Age	0.99	[0.97, 1.00]	.096
Nondaily smoker	0.96	[0.70, 1.31]	.785
Daily smoker	1.26	[0.96, 1.64]	.090
SRE	1.03	[0.77, 1.39]	.822
Number of drinks	1.47	[1.37, 1.58]	<.001
SRE × Number of drinks	0.95	[0.92, 0.98]	<.001

Notes: As described in the Method section, the Self-Rating of the Effects of Alcohol (SRE) score was divided by the interquartile range (IQR). Therefore, associated odds ratios (ORs) refer to the effect of a 1-IQR-unit change (or 3.67 drinks). CI = confidence interval.

FIGURE 1. Model-predicted probabilities of hangover endorsement as a function of morning-reported number of prior-night drinks and Self-Rating of the Effects of Alcohol (SRE) quartile

using each alternate consumption index, comparable SRE $\times$ Consumption interactions were found in both cases (real-time diary drinks model: interaction OR = 0.95, 95% CI [0.92, 0.98], $p < .001$; peak estimated BAC model: interaction OR = 0.10, 95% CI [0.02, 0.50], $p = .005$).

A series of linear GEE models explored the relationship between SRE scores and the various alcohol consumption metrics. After sex, age, body weight, and smoking status was covaried, each 1-IQR-unit increase on the SRE was associated with reporting approximately two additional drinks in the morning report (GEE coefficient = 2.20, 95% CI [1.94, 2.47], $p < .001$), logging nearly one and one-half additional drinks during the drinking episode (GEE coefficient = 1.43, 95% CI [1.18, 1.67], $p < .001$), and an increase in maximum estimated BAC of more than .02 g/dl (GEE coefficient = 0.026, 95% CI [0.021, 0.031], $p < .001$). To further characterize these effects, the same analyses were repeated using SRE quartile as a predictor to generate marginal means for each group. The average number of morning-reported prior-night drinks in Quartiles 1, 2, 3, and 4 was 4.07, 5.15, 6.06, and 8.39, respectively. Marginal means for real-time drink tallies in Quartiles 1, 2, 3, and 4 were 3.13, 4.14, 4.89, and 6.12 and for corresponding peak estimated BAC were .052, .074, .092, and .108 g/dl.

Finally, we investigated the consistency of the findings when substituting SRE subscales in place of the overall SRE score in the hangover models. SRE scores reported with respect to the heaviest period of drinking and the past 3 months were strongly correlated ($r = .90$) in this sample, and each of these facets was strongly related to the overall SRE score ($r_s \geq .94$). Not surprisingly, models incorporating either of these SRE components closely reproduced the pattern of findings in Table 3. SRE scores reported with reference to the first five drinking occasions were relatively less strongly related to the overall SRE score ($r = .86$), the heaviest period score ($r = .69$), and the past-3-months score ($r = .70$). When the first-five-times SRE score was substituted in the models in Table 3, the pattern of effects was similar, but the only statistically significant effect was found in Model 2 (first-five-times SRE OR = 0.76 per IQR, 95% CI [0.65, 0.89], $p < .001$).

Discussion

The current findings are consistent with the suggestion that some drinkers are more resistant to hangover compared with others (Howland et al., 2008b). Based on an observed correlation between intoxication ratings and subsequent hangover effects in their investigation, Rohsenow et al. (2012) conjectured that resistance to hangover might be an indicator of a more general insensitivity to alcohol effects. The current results buttress this interpretation, demonstrating that individual differences in self-reported alcohol sensitivity moderate the relation between the amount of alcohol

consumed and the odds of next-day hangover endorsement. Specifically, individuals scoring higher on the SRE (indicating diminished alcohol sensitivity) were less likely to report hangovers at a given drink total.

Although drinkers with higher SRE scores were more resistant to hangover per unit of alcohol, they were simultaneously more likely to experience a hangover during the course of the study, compared with individuals more sensitive to alcohol effects. This result appears to be driven by the fact that low-sensitivity drinkers consume more per occasion and attain higher peak BACs. Therefore, they have greater opportunity to display hangovers. In this regard, the current findings expand on the prior research finding that high SRE scores are associated with both heavy consumption and negative drinking consequences (e.g., Morean and Corbin, 2008; Schuckit et al., 2007). This pattern would seem to explain how both higher hangover frequency and hangover resistance forecast problematic drinking outcomes (Piasecki et al., 2005; Rohsenow et al., 2012). Additionally, the findings reinforce the importance of taking care to distinguish between measures tapping frequency versus susceptibility in hangover research (Piasecki et al., 2010).

In some prior studies, individuals with a family history of alcohol problems have been found to report more frequent hangovers, compared with other drinkers (e.g., Newlin and Pretorius, 1990; Piasecki et al., 2005; Slutske et al., 2003). Low alcohol sensitivity was identified as a risk factor for AUD based on familial high-risk studies; sons of alcoholics were found to display diminished responses to alcohol challenge compared with offspring of nonalcoholics (Schuckit, 1980). It is interesting to speculate that hangover resistance, frequent hangover, and low alcohol sensitivity may be related manifestations of the genetic risk for AUD. This speculation requires further study. Notably, results from some laboratory challenge investigations contradict one derivative prediction—that familial alcoholism risk would be associated with decreased hangover sensitivity. Available evidence indicates either null findings (Howland et al., 2008a) or enhanced hangover sensitivity among offspring of alcoholics (McCaul et al., 1991; Span and Earleywine, 1999).

Exploratory analyses indicated that prediction of hangover was more consistent when examining SRE scores reported with reference to the heaviest period of drinking or the past 3 months compared with the first five lifetime alcohol-use occasions. The first-five-times SRE score is theoretically interesting because it assesses a period that would antedate the onset of any AUD (Schuckit et al., 1997a) and because it may provide a benchmark against which to judge the acquisition of tolerance via drinking experience (Morean and Corbin, 2008). Thus, the findings might hint that acquired tolerance or other emergent consequences of prior drinking are important for understanding the risk for current heavy drinking and hangover. On the other hand, the pattern of results might reflect error attributable to the difficulty in

recalling one's early drinking experiences. Finally, consistent with the notion of acquired tolerance, first-five-times SRE scores tended to be lower than scores for other periods. Thus, a restriction of range may make it more difficult to detect significant effects with the first-five-times score.

Several limitations of the current investigation should be considered. First, this study was based entirely on self-report measures of consumption. Although participants were instructed to report consumption based on "standard drinks," drinkers commonly have trouble identifying what constitutes a standard drink (White et al., 2003), and drinks consumed in naturalistic conditions can be highly variable in ethanol concentration (Barnett et al., 2009). Retrospective morning reports after drinking could be flawed, especially after a night of heavy consumption in which a blackout could affect recall. Biases in retrospective drink reporting could influence both SRE scores and morning reports. If so, the apparent resistance to hangover at a given drinking level among high SRE scorers might reflect exaggeration of drinking rather than a genuine phenomenon. On the other hand, it is also possible that low-sensitivity drinkers systematically under-report the number of drinks they consume; in this case, our results would understate the true effect sizes. It is reassuring that we obtained the same pattern of results when we substituted real-time drink tallies for morning-reported drink totals.

The study was limited to individuals who drank at least four times in the past month and oversampled current smokers; results could differ in a more heterogeneous sample. By design, the diary software did not administer a morning report if participants slept past noon. Participants' sleeping in or failing to complete a morning report could have been attributable to current hangovers.

Finally, the SRE asks about sensitivity to a select set of alcohol effects. Low sensitivity to these effects may not generalize to all drinking-contingent effects (e.g., increased sociability, tension reduction, craving responses).

Taken together, these findings help to refine our understanding of low sensitivity to alcohol and the role it plays in hangover experiences. Less-sensitive drinkers are more likely to experience hangover, but this relationship may arise because they drink more heavily, perhaps in pursuit of the desired effects of alcohol. Low sensitivity to alcohol, diminished sensitivity to hangover effects, and frequent hangover experiences may be interrelated processes that mark an underlying risk for AUD.

References

- Barnett, N. P., Wei, J., & Czachowski, C. (2009). Measured alcohol content in college party mixed drinks. *Psychology of Addictive Behaviors*, 23, 152–156.
- Howland, J., Rohsenow, D. J., Allensworth-Davies, D., Greece, J., Almeida, A., Minsky, S. J., . . . Hermos, J. (2008a). The incidence and severity of hangover the morning after moderate alcohol intoxication. *Addiction*, 103, 758–765.
- Howland, J., Rohsenow, D. J., & Edwards, E. M. (2008b). Are some drinkers resistant to hangover? A literature review. *Current Drug Abuse Reviews*, 1, 42–46.
- Matthews, D. B., & Miller, W. R. (1979). Estimating blood alcohol concentration: Two computer programs and their applications in therapy and research. *Addictive Behaviors*, 4, 55–60.
- McCaul, M. E., Turkan, J. S., Svikis, D. S., & Bigelow, G. E. (1991). Alcohol and secobarbital effects as a function of familial alcoholism: Extended intoxication and increased withdrawal effects. *Alcoholism: Clinical and Experimental Research*, 15, 94–101.
- Morean, M. E., & Corbin, W. R. (2008). Subjective alcohol effects and drinking behavior: The relative influence of early response and acquired tolerance. *Addictive Behaviors*, 33, 1306–1313.
- Morean, M. E., & Corbin, W. R. (2010). Subjective response to alcohol: A critical review of the literature. *Alcoholism: Clinical and Experimental Research*, 34, 385–395.
- Muraven, M., Collins, R. L., Morsheimer, E. T., Shiffman, S., & Paty, J. A. (2005). The morning after: Limit violations and the self-regulation of alcohol consumption. *Psychology of Addictive Behaviors*, 19, 253–262.
- Newlin, D. B., & Pretorius, M. B. (1990). Sons of alcoholics report greater hangover symptoms than sons of nonalcoholics: A pilot study. *Alcoholism: Clinical and Experimental Research*, 14, 713–716.
- Piasecki, T. M., Robertson, B. M., & Epler, A. J. (2010). Hangover and risk for alcohol use disorders: Existing evidence and potential mechanisms. *Current Drug Abuse Reviews*, 3, 92–102.
- Piasecki, T. M., Sher, K. J., Slutske, W. S., & Jackson, K. M. (2005). Hangover frequency and risk for alcohol use disorders: Evidence from a longitudinal high-risk study. *Journal of Abnormal Psychology*, 114, 223–234.
- Piasecki, T. M., Wood, P. K., Shiffman, S., Sher, K. J., & Heath, A. C. (2012). Responses to alcohol and cigarette use during ecologically assessed drinking episodes. *Psychopharmacology*. Advance online publication. Retrieved from <http://www.springerlink.com/content/tl11122j228k81n9/>
- Prat, G., Adan, A., & Sánchez-Turet, M. (2009). Alcohol hangover: A critical review of explanatory factors. *Human Psychopharmacology: Clinical and Experimental*, 24, 259–267.
- Reinert, D. F., & Allen, J. P. (2007). The alcohol use disorders identification test: An update of research findings. *Alcoholism: Clinical and Experimental Research*, 31, 185–199.
- Robertson, B. M., Piasecki, T. M., Slutske, W. S., Wood, P. K., Sher, K. J., Shiffman, S., & Heath, A. C. (2012). Validity of the Hangover Symptoms Scale: Evidence from an electronic diary study. *Alcoholism: Clinical and Experimental Research*, 36, 171–177.
- Rohsenow, D. J., Howland, J., Winter, M., Bliss, C. A., Littlefield, C. A., Heeren, T. C., & Calise, T. V. (2012). Hangover sensitivity after controlled alcohol administration as predictor of post-college drinking. *Journal of Abnormal Psychology*, 121, 270–275.
- Saunders, J. B., Aasland, O. G., Babor, T. F., de la Fuente, J. R., & Grant, M. (1993). Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption—II. *Addiction*, 88, 791–804.
- Schuckit, M. A. (1980). Self-rating of alcohol intoxication by young men with and without family histories of alcoholism. *Journal of Studies on Alcohol*, 41, 242–249.
- Schuckit, M. A. (1994). Low level of response to alcohol as a predictor of future alcoholism. *American Journal of Psychiatry*, 151, 184–189.
- Schuckit, M. A., Smith, T. L., Danko, G. P., Pierson, J., Hesselbrock, V., Bucholz, K. K., Kramer, J., . . . Chan, G. (2007). The ability of the self-rating of the effects of alcohol (SRE) scale to predict alcohol-related outcomes five years later. *Journal of Studies on Alcohol and Drugs*, 68, 371–378.
- Schuckit, M. A., Smith, T. L., & Tipp, J. E. (1997a). The Self-Rating of the

- Effects of alcohol (SRE) form as a retrospective measure of risk for alcoholism. *Addiction*, 92, 979–988.
- Schuckit, M. A., Tipp, J. E., Smith, T. L., Wiesbeck, G. A., & Kalmijn, J. (1997b). The relationship between self-rating of the effects of alcohol and alcohol challenge results in ninety-eight young men. *Journal of Studies on Alcohol*, 58, 397–404.
- Shiffman, S. (2009). Ecological momentary assessment (EMA) in studies of substance use. *Psychological Assessment*, 21, 486–497.
- Slutske, W. S., Piasecki, T. M., & Hunt-Carter, E. E. (2003). Development and initial validation of the Hangover Symptoms Scale: Prevalence and correlates of hangover symptoms in college students. *Alcoholism: Clinical and Experimental Research*, 27, 1442–1450.
- Sobell, L. C., & Sobell, M. B. (1992). Timeline followback: A technique for assessing self-reported alcohol consumption. In R. Z. Litten & J. P. Allen (Eds.), *Measuring alcohol consumption: Psychosocial and biological methods* (pp. 41–72). Totowa, NJ: Humana Press.
- Span, S. A., & Earleywine, M. (1999). Familial risk for alcoholism and hangover symptoms. *Addictive Behaviors*, 24, 121–125.
- Trim, R. S., Schuckit, M. A., & Smith, T. L. (2009). The relationships of the level of response to alcohol and additional characteristics to alcohol use disorders across adulthood: A discrete-time survival analysis. *Alcoholism: Clinical and Experimental Research*, 33, 1562–1570.
- White, A. M., Kraus, C. L., McCracken, L. A., & Swartzwelder, H. S. (2003). Do college students drink more than they think? Use of a free-pour paradigm to determine how college students define standard drinks. *Alcoholism: Clinical and Experimental Research*, 27, 1750–1756.
- Zeger, S. L., & Liang, K. (1986). Longitudinal data analysis for discrete and continuous outcomes. *Biometrics*, 42, 121–130.