Published in final edited form as:

Alcohol Clin Exp Res. 2012 January ; 36(1): 171–177. doi:10.1111/j.1530-0277.2011.01592.x.

Validity of the Hangover Symptoms Scale: Evidence from an Electronic Diary Study

Brandon M. Robertson^{1,2}, Thomas M. Piasecki^{1,2}, Wendy S. Slutske^{1,2}, Phillip K. Wood^{1,2}, Kenneth J. Sher^{1,2}, Saul Shiffman³, and Andrew C. Heath^{1,4}

¹Midwest Alcoholism Research Center

²Department of Psychological Sciences, University of Missouri

³Department of Psychology, University of Pittsburgh

⁴Department of Psychiatry, Washington University School of Medicine

Abstract

Background—The Hangover Symptoms Scale (HSS) assesses the frequency of 13 symptoms experienced after drinking in the past year. Cross-sectional analyses in college drinkers showed preliminary evidence for the validity of the HSS (Slutske et al., 2003). The current investigation extended this work by examining the construct validity of the HSS in an ecological momentary assessment investigation.

Methods—Frequent drinkers ($N = 404$) carried electronic diaries to track their daily experiences over three weeks. Each morning, the diary assessed prior-night drinking behaviors, the presence of current hangover, and intensity of current headache and nausea.

Results—Adjusting for sex and body mass, the HSS significantly predicted diary endorsement of hangover (OR = 2.11, 95% CI = 1.78–2.49, $p < .001$). Participants who endorsed the HSS headache and nausea items were especially likely to report elevations of corresponding symptoms in diary records made the morning after drinking. HSS scores incrementally predicted hangover when the number of drinks consumed in the episode was covaried but did not moderate the relationship between the number of drinks and diary hangover reports.

Conclusions—The HSS appears to be a valid tool for hangover research. Higher HSS scores identify individuals who complain of “real world” hangovers and who may be especially likely to display particular symptoms after a night of drinking. Past hangovers predicted future hangovers, suggesting hangovers do not necessarily discourage or inhibit future drinking, at least across the several-week time interval studied here. There is a need to develop and evaluate complementary measures that can more directly index individual differences in hangover susceptibility in survey designs.

Keywords

hangover; symptoms; questionnaire; Hangover Symptoms Scale; ecological momentary assessment

Introduction

Consuming large amounts of alcohol can result in “hangover” – aversive physical and subjective symptoms that typically arise as the blood alcohol concentration begins to decline and peak when blood alcohol approaches zero (Ylikarhri, Huttunen, Eriksson, & Nikkila, 1974; Swift & Davidson, 1998). Hangover is prevalent (Presley, Cheng & Pimentel, 2004; Slutske, Piasecki, & Hunt-Carter, 2003; Swift & Davidson, 1998) and of great interest to the general public (Pittler, Verster, & Ernst, 2005). However, it has not received serious or sustained attention from alcohol researchers until very recently (e.g., Verster & Stephens, 2010). A more systematic body of evidence concerning the correlates, causes, and consequences of hangover is needed because hangover may be related to a number of important domains, such as alcohol tolerance or withdrawal (e.g., Newlin & Pretorius, 1990; Earleywine, 1993), risk or protection from alcohol use disorders (Piasecki, Robertson & Epler, 2010; Piasecki, Sher, Slutske & Jackson, 2005), neuropsychological functioning (Squeglia, Spadoni, Infante, Myers, & Tapert, 2009), morbidity and mortality (e.g., Batty, Deary, & Macintyre, 2006; Kauhanen, Kaplan, Goldberg, Cohen, Lakka, & Salonen, 1997), and absenteeism and other workplace problems Ames, Grube & Moore, 1997; Frone, 2006).

The development, refinement, and evaluation of assessment tools has been identified as an important priority at this nascent stage of hangover research (Verster, et al., 2010). Until recently, the field has lacked well-validated, widely accepted instruments. The Acute Hangover Scale (AHS; Rohsenow, Howland, Minsky & Arendt, 2007) assesses the immediate severity of nine symptoms. The AHS has proved valid and useful in a number of recent investigations (e.g., Hesse & Tutenges, 2010; Howland, et al, 2008; Rohsenow, et al., 2010) and has emerged as a preferred instrument for gauging immediate symptoms in experimental research and naturalistic studies of acute hangover.

Techniques for assessing hangover in survey designs are less established. Survey measures are important for a number of research tasks, such as ascertaining the prevalence and correlates of naturally occurring hangovers (Verster, et al., 2010). The Hangover Symptoms Scale (HSS; Slutske, et al., 2003) is a retrospective measure developed for survey studies. The HSS assesses how frequently over the past year respondents experienced each of 13 symptoms the morning after drinking. An initial study of the HSS in a large sample of college undergraduates provided preliminary evidence for its validity. Scores on the HSS were related to the frequency of past-year drinking, frequency of getting drunk in the past year, typical number of drinks per drinking occasion, and reports of personal and parental alcohol problems (Slutske, et al., 2003). More recently, a study focused on changes in neuropsychological functioning in adolescents who did versus did not initiate drinking over a 3-year period found that, among boys, higher HSS scores at follow-up were significantly related to decrements in sustained attention (Squeglia, et al., 2009). Apart from these two studies, however, little is known about the validity or utility of the HSS.

The HSS asks respondents to report how frequently they experience particular symptoms after drinking. Answers to such questions would be expected to be strongly related to drinking practices; individuals who drink to intoxication more often will have more chances to develop hangovers. In theory, individual differences in *susceptibility* to hangover could also be reflected in ratings of past-year symptoms; all else being equal, drinkers who are more vulnerable to hangover effects should experience symptoms following a higher proportion of drinking episodes (Piasecki, et al., 2010). Investigators have sometimes examined past-year hangover scores after covarying estimates of typical drinking practices (e.g., Earleywine, 1993; Piasecki, et al., 2005; Slutske, et al., 2003). Such analyses are motivated by the inference that drinking-residualized hangover scores may more cleanly

isolate susceptibility variance. There is a need to empirically evaluate whether measures of hangover frequency reflect individual differences in hangover susceptibility.

In this article, we use data from an ecological momentary assessment (Shiffman, 2009) investigation to examine the construct validity of the HSS. Frequent drinkers completed the HSS at a baseline visit. They then carried palmtop computers designed to serve as electronic diaries in their natural environments over the course of three weeks. Each morning upon waking, the diary asked participants to indicate whether or not they had consumed alcohol the night before. When they indicated they had, the diary asked if they currently experienced a hangover and assessed the current severity of headache and nausea. The main goal of the current investigation was to evaluate whether HSS scores forecast the occurrence of hangovers in diary reports. Supplementary analyses evaluated the performance of each individual HSS item as a predictor of hangover endorsement in diary records and whether two HSS items (headache and nausea) predicted elevations of corresponding symptoms on mornings after drinking events. We also investigated the validity of using the HSS to make inferences about hangover susceptibility. A liberal form of the susceptibility hypothesis might be that, at a given level of drinking, higher scorers on the HSS are more likely to endorse hangover compared to low scorers. A stronger formulation might posit that the probability of hangover endorsement should increase more steeply with each additional drink consumed among individuals with higher HSS scores. To evaluate these issues, we tested whether the HSS (with or without adjustment for past-year drinking practices) incrementally predicted hangover endorsement after covarying the number of drinks consumed and whether the HSS moderated the association between the number of drinks in an episode and hangover endorsement.

Method

Participants

Four hundred and four volunteers participated in a three week electronic diary study focused on alcohol use among smokers and nonsmokers who reported frequent drinking. Participants were recruited from a large Midwestern university and the surrounding community using posted fliers, print advertisements, and mass emails. In order to be eligible to participate, volunteers had to meet the following criteria: able to speak English, 18 years of age or older, report drinking alcohol at least one time per week on average in the past month, smoking at least one cigarette per week on average with no interest in quitting (smokers) or smoking less than 20 cigarettes in their lifetime and none in the last year (nonsmokers). Those who reported interest in seeking treatment for an alcohol use disorder, a history of unsuccessful attempts to cut down or quit drinking, or a history of arrests for alcohol-related offenses (excluding status offenses) were excluded from participation. The primary aim of the larger diary investigation was to investigate the co-use of alcohol and tobacco. Therefore, by design, the majority of the sample were current smokers (64.1%, $n = 259$). The sample was 50.2% female ($n = 203$) and 85.6% White. The average age was 23.5 ($SD = 7.6$) with a range of 18–70. Restricting analyses to young adults (18–25 years, 82% of the sample) did not alter the findings. For completion of the study, participants were paid \$150.

Electronic Diary

Participants kept electronic diaries using personal digital assistants (PDA; Palm m500, Palm Inc., Sunnyvale, CA) running custom diary software (invivodata inc., Pittsburgh, PA). The focus of the analyses in the present article was a subset of diary records, the Morning Reports. Participants used the electronic diary as an alarm clock. Before retiring for the evening, participants set an alarm which would wake them the next day and prompt them to complete a Morning Report including questions about the prior night's drinking and acute

hangover. Additional diary assessments (e.g., time-sampled prompted assessments) were administered but, except where otherwise indicated, the analyses reported here focus on responses to Morning Reports. Overall, diary records were completed on a total of 8,736 person-days. For 404 days (one per participant) no Morning Report was expected because participants started the first day of recording immediately following the training session visit (i.e., not upon waking). Morning Reports were completed for 7,449 (89%) of the remaining 8,332 person-days. The software did not allow participants to complete Morning Reports if they slept past noon, missed their morning alarm, or if they woke but delayed the Morning Report alarm past noon. A total of 879 Morning Reports (99% of the missing Morning Reports) were missed due to this software rule. The remaining missed Morning Reports were apparently due to technical malfunctions (e.g., low battery).

Procedure

Potential participants called the study site and were screened for eligibility over the telephone. Eligible volunteers were scheduled in small groups for an orientation session during which they provided informed consent, had their height and weight measured using a physician's scale, and completed a battery of questionnaires. Participants were scheduled to attend a 45-minute training session 1 to 2 days later. At this session, small groups of participants were trained to use the electronic diaries and were issued a diary for use in the field for 21 days. During the diary monitoring phase, participants visited the laboratory on four occasions. At these sessions, staff downloaded data from the electronic diaries, fielded any protocol questions, and attempted to resolve any technical issues.

Measures

Questionnaire Measures—The questionnaire battery administered at the orientation session included the HSS (Slutske, et al, 2003). The HSS consists of 13 items, each tapping an individual hangover symptom (listed in Table 1). Questions asked the participants to indicate the percentage of past-year drinking occasions that were followed the next morning by the symptom. Responses were provided on a 5-point scale ranging from 0 (0% of the time) to 4 (100% of the time). Following Slutske et al. (2003), we used a scoring scheme in which each item was dichotomized to reflect past-year presence vs. absence of the symptom (i.e., 0 = 0; 1 = 1–4). The dichotomized items were then summed to yield a scale with a possible range of 0–13. Internal consistency of the HSS was acceptable in the current sample (coefficient $\alpha = .78$).

Participants also completed the Alcohol Use Disorder Identification Test (AUDIT; Babor, Biddle-Higgins, Saunders & Monteiro, 2001) at the orientation visit. In the current analyses, we selected two items from the AUDIT as proxies for typical drinking quantity (Item 2, the number of drinks per typical drinking occasion) and heavy drinking frequency (Item 3, frequency of consuming 6+ drinks per occasion) respectively. The drinking quantity item asked participants to report how many drinks they typically consume when drinking. Responses were collected on a 5-point scale ranging from 0 (1 or 2 drinks) to 4 (10 or more drinks). Responses to the drinking frequency used a 5-point scale ranging from 0 (never) to 4 (daily or almost daily).

Diary Measures—Morning Reports included items which asked about drinking behaviors from the prior night and hangover that day. The first question was (yes/no) “Did you drink alcohol last night?” Drinking-related questions would stop if the subject answered “no” to the first question. If the subject answered the drinking question affirmatively, the next question asked “How many alcoholic drinks did you have?” Subjects were asked to report the number of drinks consumed (constrained to a possible range of 1–30). Following the number of drinks question, “Do you have a hangover from last night’s drinking?” (yes/no)

was asked. Nausea and headache were assessed as hangover symptoms in Morning Reports by asking subjects to report on a 1 to 5 scale, “In the past 15 minutes, did you feel nauseous?” and “In the past 15 minutes, did you feel headache?” These two items were administered later in the diary assessment and embedded in a longer series of adjectives describing various mood states and physical symptoms. This full list of adjectives was administered in every diary entry throughout the study. The location and frequency of nausea and headache items were intended to diminish bias or carry-over from the question asking about current hangover.

Data Analyses

A Generalized Estimating Equations approach (GEE; Liang & Zeger, 1986) was used to account for the clustered nature of the data (multiple days per participant). Analyses using dichotomous dependent measures specified a binomial family and logit link function while analyses with continuous outcome measures used a gamma family and identity link function. All analyses used an AR(1) autoregressive within-cluster working correlation structure. All analyses included sex and body mass index (BMI) as covariates because of their influence on alcohol pharmacokinetics.

Initial analyses sought to establish the validity of Morning Reports of hangover as a criterion against which to gauge the performance of the HSS. Specifically, these analyses evaluated whether hangover reports were related to the amount of alcohol consumed and same-day ratings of the intensity of headache and nausea.

A second set of analyses tested whether higher scores on the HSS predicted the occurrence of hangover during the diary monitoring period. In this and all other models which used an HSS total score, the HSS predictor variable was computed by dividing the sum of dichotomized item scores by the inter-quartile range (IQR) so that the odds ratio is expressed in IQR units. (Figure 1 shows the distribution of HSS scores; $M = 7.6$, $SD = 2.9$; $IQR = 5$). Next, we conducted a series of analyses testing whether drinkers who complain of headache and nausea on the HSS are indeed more likely to show elevations of these symptoms on post-drinking mornings. Because HSS items ask about the frequency of symptoms on mornings after drinking, these analyses contrasted symptoms from all post-drinking mornings (i.e. regardless of hangover endorsement) vs. nondrinking days.

Finally, we conducted a set of analyses to investigate whether the HSS captures information about individual differences in susceptibility to hangover. This could be evident as either incremental prediction of diary hangover by the HSS after covarying the number of drinks in the episode or as moderation of the relation between the number of drinks and hangover by the HSS. In supplemental models, we included AUDIT items as covariates to evaluate whether the residual HSS variance more clearly reflects individual differences in hangover susceptibility.

Results

Validity of Diary-Measured Hangover

There were a total of 2,721 Morning Reports in which participants reported prior night drinking. Hangover was endorsed in 562 (20.7%) of the post-drinking reports. The number of drinks consumed the night before was strongly related to hangover endorsement in the post-drinking Morning Reports ($OR = 1.27$, 95% $CI = 1.23$ – 1.30 ; $p < .001$) indicating a 27% increase in the odds of endorsing hangover for every drink consumed. Participants averaged 9.8 drinks prior to hangover days ($SD = 4.7$, range = 2–30) and 4.9 drinks prior to post-drinking mornings in which they denied current hangover ($SD = 4.1$, range = 1–30).

Compared to days after abstinence, headache levels were significantly elevated on days after drinking when hangover was denied (GEE coefficient = 0.06, 95% CI = 0.02–0.09, $p < .01$) and more sharply elevated on mornings after drinking in which hangover was endorsed (GEE coefficient = 1.34, 95% CI = 1.23–1.45, $p < .001$). A similar pattern of results was found for nausea reports (drinking without hangover endorsement: GEE coefficient = 0.03, 95% CI = 0.01–0.06, $p < .05$; drinking and hangover endorsement: GEE coefficient = 0.83, 95% CI = 0.75–0.90, $p < .001$). Analyses limited to post drinking days, found that both headache (GEE coefficient = 1.30, 95% CI = 1.18–1.42, $p < .001$) and nausea (GEE coefficient = 0.79, 95% CI = 0.70–0.87, $p < .001$) were more intense on hangover mornings compared to mornings after drinking without hangover endorsement. A supplemental analysis examined headache and nausea ratings from prompted assessments (collected later in the day, up to 5 times per day) from hangover days ($N = 1,765$) and non-hangover post-drinking days ($N = 6,800$). In these diary assessments, participants were asked about symptom levels but were not administered the hangover question. Headache scores were elevated in prompted assessments collected on hangover days as compared to non-hangover post-drinking days (GEE coefficient = 0.33; 95% CI = 0.27–0.39; $p < .001$). The same was true for nausea levels (GEE coefficient = 0.21; 95% CI = 0.17–0.25; $p < .001$). These findings suggest that symptomatic elevations did not depend on carry-over from contemporaneous assessment of hangover.

Predicting Diary-Endorsed Hangover from HSS Scores

Figure 1 depicts the distribution of HSS scores, the percentage of all diary hangovers contributed by persons in at each score level, and the cumulative percentage of diary-measured hangovers as a function of HSS scores. A GEE analysis confirmed that HSS total score was related to an increased likelihood of endorsing hangover (OR = 2.11 per IQR, 95% CI = 1.78–2.49, $p < .001$; see Table 1). In addition, almost all of the individual items were related to diary-measured hangover. Only the vomiting item was a non-significant predictor of diary hangover. In general, the most commonly-reported items on the HSS were the most predictive of diary reports of hangover (see Table 1).

HSS Items and Corresponding Symptom Levels on Post-Drinking Mornings

Participants who endorsed ever having experienced a headache the morning after drinking in the past year were especially likely to report elevated headache in post-drinking Morning Reports (HSS headache $\times$ Drinking Day interaction coefficient = 0.32, 95% CI = 0.21–0.43, $p < .001$; see Figure 2, top panel). The same was true for individuals who reported ever feeling nauseated the morning after drinking on the HSS (HSS nausea $\times$ Drinking Day interaction coefficient = 0.22, 95% CI = 0.15–0.28, $p < .001$; see Figure 2, bottom panel). Additional analyses investigated whether diary symptoms were associated with any HSS symptom or more specifically related to the corresponding HSS items. In these models, diary headache or nausea reports from post-drinking mornings were predicted simultaneously by (a) the HSS item corresponding to the diary dependent measure and (b) a dichotomized HSS total score with the target symptom item removed from scoring. Both the HSS headache item (GEE coefficient = 0.16, 95% CI = 0.19–0.31, $p < .05$) and the remaining HSS composite (GEE coefficient = 0.04, 95% CI = 0.02–0.31, $p < .001$) were simultaneously significant predictors of elevations in headache ratings the morning after drinking. The same was true for the nausea (HSS nausea item: GEE coefficient = 0.15, 95% CI = 0.06–0.25, $p = .001$; remaining HSS items: GEE coefficient = 0.03, 95% CI = 0.01–0.05, $p < .001$). Thus, individual HSS items contributed some incremental information specific to the prediction of corresponding morning-after symptoms, but diary headache and nausea could also be predicted from other indices of past-year hangover experiences.

HSS and Hangover Susceptibility

In the basic model, HSS total score did not moderate the relationship between the number of drinks in the episode and diary hangover (HSS $\times$ Number of Drinks interaction (OR = 1.00, 95% CI = 0.99–1.01, $p = 0.66$). In this model, there was a main effect for HSS total score predicting hangover (OR = 1.71, 95% CI = 1.14–2.56, $p < .01$) and a significant relation between number of drinks the night before and current hangover (OR = 1.24, 95% CI = 1.15 – 1.34, $p < .001$). Covarying AUDIT items assessing typical drinking heaviness and frequency did not change the result of the moderation test (HSS $\times$ Number of Drinks interaction OR = 1.00, 95% CI = 0.99–1.01, $p = 0.81$). In the model including AUDIT items, HSS total score again predicted hangover in diary records (OR = 1.87, 95% CI = 1.23–2.85, $p < .01$) and number of prior night drinks was simultaneously significant (OR = 1.26, 95% CI = 1.17 – 1.37, $p < .001$). Neither of the AUDIT items was related to Morning Reports of hangover in this model.

Discussion

The analyses presented provide evidence for the construct validity of diary-based measures of drinking and hangover endorsement. The number of drinks consumed the night before was strongly associated with contemporaneous diary reports of hangover, indicating that diary records reveal the commonly understood dose-dependent nature of hangover. Further, the average number of drinks consumed on the day before a hangover day exceeded levels often considered indicative of a “binge” (e.g., Wechsler & Nelson, 2001). Finally, headache and nausea levels were significantly elevated on days in which hangover was endorsed. These results join with others (Muraven, Collins, Morsheimer, Shiffman, & Paty, 2005; Piasecki, Slutske, Wood, & Hunt-Carter, 2010) in providing support for ecological momentary assessment as a valid and useful tool for hangover research.

The HSS total score significantly predicted diary-measured hangover, indicating that the HSS may be a valuable instrument for identifying individuals who are likely to have hangover experiences. Because the HSS directly asks participants how frequently they suffer from unpleasant symptoms after drinking, it would be surprising if this association were not found. Nonetheless, given the paucity of established hangover measures, it is important to empirically demonstrate such prospective associations. Hangovers were largely limited to drinkers who scored at least 4 or 5 on the HSS at baseline (Figure 1). Because the HSS is a symptom count measure, this finding may reflect the syndromal nature of the common hangover. That is, true hangover experiences are likely to be accompanied by a number of hangover symptoms, so genuine hangover sufferers are likely to endorse experiencing a large array of morning-after effects. Nearly all of the individual items on the HSS predicted hangover experiences with the exception of the vomiting item (Table 1). These results indicate that a majority of items on the HSS are part of the hangover domain and contribute to the validity of the measure while the vomiting item may not be. The value of HSS item concerning “trouble sleeping” has been questioned on the grounds that sleep disturbance occurs *before* the hangover (Verster, et al., 2010). The current analyses demonstrate that responses to this question are associated with ecological hangover reports. Removing the sleep item from the HSS total score did not change the conclusion of any of the reported analyses.

Endorsements of headache and nausea on the HSS predicted elevations of corresponding symptoms in Morning Reports completed the day after drinking. These results indicate that, at least for the tested symptoms, self-reports of past-year symptom occurrence after drinking can be useful in predicting who is likely to display corresponding symptoms after specific “real world” drinking events. This may be useful for some research purposes. For example, one approach to studying hangover effects asks that subjects report to the laboratory for

testing the morning after a normal night's drinking (e.g., McKinney & Coyle, 2006). Prescreening candidate participants using the HSS might allow investigators to recruit participants into such naturalistic studies who are especially likely to display the symptoms of interest.

We did not find evidence for a strong form of the susceptibility hypothesis; HSS scores did not moderate the relation between the amount of alcohol consumed and the likelihood of hangover endorsement in Morning Reports. However, the HSS significantly predicted diary hangover, controlling for the number of drinks consumed. It is possible to interpret this incremental prediction of hangover by the HSS in terms of hangover susceptibility, but it could reflect a variety of other influences (e.g., systematic bias in drink reporting, beverage preference, drinking style). There is a need to develop alternative survey instruments that might more directly index individual differences in hangover susceptibility. A potentially useful approach may be to ask drinkers how likely they would be to experience hangover after drinking various amounts of alcohol (cf. Bartholow, Henry & Lust, 2007; Wall, Horn, Johnson, Smith, & Carr, 2000; Wall, Shea, Luczak, Cook, & Carr, 2005). Laboratory alcohol challenge studies are needed to rigorously evaluate the extent to which the HSS or alternatives reflect hangover susceptibility.

Several limitations of the current study should be considered. Although participants were instructed to report alcohol consumption based on "standard drinks", the contents and size of the drinks reported was unknown, meaning that we could not determine alcohol doses with the precision characteristic of laboratory research. Past research has shown that the ethanol content of what individuals consider to be a "standard drink" can vary greatly (e.g., Lemmens, 1994; White, Kraus, McCracken, & Swartzwelder, 2003). Retrospective reports the morning after drinking could be in error, especially for high totals where blackout could affect recall. The study was limited to frequent drinkers and oversampled current smokers; results could differ in samples featuring a wider array of smoking and drinking patterns. However, including smoking status in the models presented above did not change the pattern of results reported (not shown). The diary software did not administer a Morning Report if participants did not arise before noon. Sleeping late (or failing to respond to a morning diary alarm) might be especially likely when hungover. Thus, some events of interest, possibly even the more extreme hangovers, may have been missed in the current study. Finally, alternative assessments, such as a simple, face-valid question concerning the number of hangovers in the past year or the Hangover Questionnaire (Newlin & Pretorius, 1990), were not administered in the current study. As a consequence, we could not evaluate the performance of the HSS relative to these other assessment options.

The current research examined the validity of the HSS by assessing whether it forecast the occurrence of future hangovers during an arbitrary self-monitoring period. This approach assumes that hangover experiences are stable or trait-like. If hangover discourages heavy drinking, at least in some individuals, then this test may not be appropriate. That is, the HSS could accurately reflect past-year hangover experiences without necessarily predicting future experiences. It may be informative in future research to gauge the accuracy of hangover retrospection per se. In such studies, participants might track drinking and hangover symptoms for a given period of time, then complete the HSS with reference to the same study period. It is noteworthy that the HSS was positively associated with hangover experiences in this study, suggesting hangover is at least modestly trait-like, or at least that reporting of hangover appears to be trait-like. The fact that drinkers reporting more hangovers in the past year were also likely to report hangovers during an arbitrary period of self-monitoring suggests hangover does not inevitably discourage subsequent heavy episodic drinking or that, at a minimum, past-year hangover does not discourage drinking to the point of eliminating future hangover experiences.

Taken together, these results suggest that the HSS identifies heavy drinkers and for subject recruitment, the HSS could potentially be a valuable tool for finding individuals who have had frequent, large-exposure drinking episodes or are likely to have future hangovers. Additionally, the HSS may be valuable in identifying individuals likely to experience specific hangover symptoms after drinking. The current study suggests HSS scores may reflect individual differences in hangover susceptibility. However, there is a need to evaluate this using laboratory designs, and it may be desirable to develop alternative measures that more directly assess hangover susceptibility. Future research using a mix of strategies will be necessary to comprehensively assess the validity and utility of the HSS.

Acknowledgments

Supported by National Institutes of Health grants P50AA011998 (Heath), K05AA017688 (Heath), K05AA017242 (Sher), and T32AA01352 (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.

References

- Ames GM, Grube JW, Moore RS. The relationship of drinking and hangovers to workplace problems: An empirical study. *J Stud Alcohol*. 1997; 58:37–47. [PubMed: 8979212]
- Babor, TF.; Biddle-Higgins, JC.; Saunders, JB.; Monteiro, MG. AUDIT: The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Health Care. Geneva, Switzerland: World Health Organization; 2001.
- Bartholow BD, Henry EA, Lust SA. Effects of alcohol sensitivity on P3 event-related potential reactivity to alcohol cues. *Psychol Addict Behav*. 2007; 21:555–563. [PubMed: 18072838]
- Batty GD, Deary IJ, Macintyre S. Childhood IQ and life course socioeconomic position in relation to alcohol induced hangovers in adulthood: The Aberdeen children of the 1950s study. *J Epidemiol Community Health*. 2006; 60(10):872–874. [PubMed: 16973534]
- Earleywine M. Hangover moderates the association between personality and drinking problems. *Addict Behav*. 1993; 18:291–297. [PubMed: 8342441]
- Frone MR. Prevalence and distribution of alcohol use and impairment in the workplace: A U.S. national survey. *J Stud Alcohol*. 2006; 67:147–156. [PubMed: 16536139]
- Hesse M, Tutenges S. Predictors of hangover during a week of heavy drinking on holiday. *Addiction*. 2010; 105(3):476–483. [PubMed: 20402991]
- Howland J, Rohsenow DJ, Allesnworth-Davies D, Greece J, Almeida A, Minsky SJ, Arnedt JT, Hermos J. The incidence and severity of hangover the morning after moderate alcohol intoxication. *Addiction*. 2008; 103(5):758–765. [PubMed: 18412754]
- Kauhanen J, Kaplan GA, Goldberg DD, Cohen RD, Lakka T, Salonen JT. Frequent hangovers and cardiovascular mortality in middle-aged men. *Epidemiology*. 1997; 8:310–314. [PubMed: 9115028]
- Lemmens PH. The alcohol content of self-report and “standard” drinks. *Addiction*. 1994; 89:593–601. [PubMed: 8044126]
- Liang KY, Zeger SL. Longitudinal data analysis using general linear models. *Biometrika*. 1986; 73:13–22.
- McKinney A, Coyle K. Alcohol hangover effects on measures of affect the morning after a normal night’s drinking. *Alcohol Alcohol*. 2006; 41:54–60. [PubMed: 16260448]
- Muraven M, Collins RL, Morsheimer ET, Shiffman S, Paty JA. The morning after: Limit violations and the self-regulation of alcohol consumption. *Psychology of Addictive Behaviors*. 2005; 19:253–262. [PubMed: 16187803]
- Newlin DB, Pretorius MB. Sons of alcoholics report greater hangover symptoms than sons of nonalcoholics: A pilot study. *Alcohol Clin Exp Res*. 1990; 14:713–716. [PubMed: 2264599]
- Piasecki TM, Robertson BM, Epler AJ. Hangover and risk for alcohol use disorders: Existing evidence and potential mechanisms. *Curr Drug Abuse Rev*. 2010; 3:92–102. [PubMed: 20712598]

- Piasecki TM, Sher KJ, Slutske WS, Jackson KJ. Hangover frequency and risk for alcohol use disorders: Evidence from a longitudinal high-risk study. *J Abnorm Psychol.* 2005; 114(2):223–234. [PubMed: 15869353]
- Piasecki TM, Slutske WS, Wood PK, Hunt-Carter EE. Frequency and correlates of diary-measured hangoverlike experiences in a college sample. *Psychol Addict Behav.* 2010; 24:163–169. [PubMed: 20307125]
- Pittler MH, Verster JC, Ernst E. Interventions for preventing or treating alcohol hangover: Systematic review of randomised controlled trials. *BMJ.* 2005; 331(7531):1515–1518. [PubMed: 16373736]
- Presley, C.; Cheng, Y.; Pimentel, E. Alcohol and drugs on American college campuses: A report to college presidents. Carbondale, IL: Core Institute, Southern Illinois University; 2004.
- Rohsenow DJ, Howland J, Arendt JT, Almeida AB, Greece J, Minsky S, Kempler CS, Sales S. Intoxication with bourbon versus vodka: Effects on hangover, sleep, and next-day neurocognitive performance in young adults. *Alcohol Clin Exp Res.* 2010; 34(3):509–518. [PubMed: 20028364]
- Rohsenow DJ, Howland J, Minsky SJ, Greece J, Almeida A, Roehrs TA. The Acute Hangover Scale: A new measure of immediate hangover symptoms. *Addict Behav.* 2007; 32:1314–1320. [PubMed: 17097819]
- Shiffman S. Ecological momentary assessment (EMA) in studies of substance use. *Psychol Assess.* 2009; 21:486–497. [PubMed: 19947783]
- Slutske WS, Piasecki TM, Hunt-Carter EE. Development and initial validation of the Hangover Symptoms Scale: Prevalence and correlates of hangover in college students. *Alcohol Clin Exp Res.* 2003; 27:1442–1450. [PubMed: 14506405]
- Squeglia LM, Spadoni AD, Infante MA, Myers MG, Tapert SF. Initiating moderate to heavy alcohol use predicts changes in neuropsychological functioning for adolescent girls and boys. *Psychol Addict Behav.* 2009; 23:715–722. [PubMed: 20025379]
- Swift R, Davidson D. Alcohol hangover: Mechanisms and mediators. *Alcohol Health Res World.* 1998; 22:54–60. [PubMed: 15706734]
- Verster JC, Stephens R. Editorial: The importance of raising the profile of alcohol hangover research. *Curr Drug Abuse Rev.* 2010; 3:64–67. [PubMed: 20822482]
- Verster JC, Stephens R, Penning R, Rohsenow D, McGeary J, Levy D, McKinney A, Finnigan F, Piasecki TM, Adan A, Batty GD, Fliervoet LAL, Heffernan T, Howland J, Kim D, Kruisselbrink LD, Ling J, McGregor N, Murphy RJL, van Nuland M, Oudelaar AM, Parkes A, Prat G, Reed N, Slutske WS, Smith G, Young M. on behalf of the Alcohol Hangover Research Group. The Alcohol Hangover Research Group consensus statement on best practice in alcohol hangover research. *Curr Drug Abuse Rev.* 2010; 3:116–126. [PubMed: 20712593]
- Wall TL, Horn SM, Johnson ML, Smith TL, Carr LG. Hangover symptoms in Asian Americans with variants in the aldehyde dehydrogenase (ALDH2) gene. *J Stud Alcohol.* 2000; 61:13–17. [PubMed: 10627091]
- Wall TL, Shea SH, Luczak SE, Cook TAR, Carr LG. Genetic associations of alcohol dehydrogenase with alcohol use disorders and endophenotypes in white college students. *J Abnorm Psychol.* 2005; 114:456–465. [PubMed: 16117582]
- Wechsler H, Nelson TF. Binge drinking and the American college student: What's five drinks? *Psychol Addict Behav.* 2001; 15:287–291. [PubMed: 11767258]
- White AM, Kraus CL, McCracken LA, Swartzwelder HS. Do college students drink more than they think? Use of a free-pour paradigm to determine how college students define standard drinks. *Alcohol Clin Exp Res.* 2003; 27:1750–1756. [PubMed: 14634490]
- Ylikarhri RH, Huttunen MO, Eriksson CJP, Nikkila EA. Metabolic studies on the pathogenesis of hangover. *Eur J Clin Invest.* 1974; 4:93–100. [PubMed: 4832720]

Figure 1. Percentage of participants (bars), percentage of diary hangovers (solid line) and cumulative percentage of diary hangovers (dashed line) as a function of HSS scores.

Figure 2. Model-adjusted means and 95% confidence intervals for immediate reports of headache (top panel) and nausea (bottom panel) on mornings after abstinence and mornings after drinking among drinkers who did versus did not endorse the corresponding item on the HSS scale.

Table 1

Past-year prevalence of hangover symptoms and results of models predicting diary hangover from HSS total score and individual HSS symptoms.

Symptom	OR	95% CI	Percentage of sample endorsing symptom
HSS total score	2.11 ^{***}	1.78–2.49	n/a
Felt extremely thirsty or dehydrated	7.18 ^{***}	2.51–20.57	95.3
Felt more tired than usual	4.17 ^{***}	1.96–8.85	94.3
Experienced a headache	3.09 ^{***}	2.06–4.62	85.9
Had difficulty concentrating	2.04 ^{***}	1.56–2.66	76.2
Felt very nauseous	1.96 ^{***}	1.55–2.47	70.0
Felt very weak	2.07 ^{***}	1.66–2.58	65.3
More sensitive to light and sound	1.72 ^{***}	1.40–2.10	60.6
Sweated more than usual	1.71 ^{***}	1.42–2.06	36.9
Had a lot of trouble sleeping	1.30 ^{**}	1.07–1.57	36.4
Vomited	1.15	0.95–1.39	35.9
Felt anxious	1.54 ^{***}	1.28–1.86	34.7
Experienced trembling or shaking	1.91 ^{***}	1.58–2.30	31.7
Felt depressed	1.28 [*]	1.06–1.56	30.7

Note. OR= odds ratio, CI = confidence interval. All analyses were adjusted for sex and body mass index. For the model involving the HSS total, the OR is expressed in terms of the HSS interquartile range. As described in the text, individual symptoms were dichotomized such that scores of 0=0 and scores 1–4 = 1).

* p < .05.

** p < .01.

*** p < .001.