Influence of Sensation Seeking on Response to Alcohol Versus Placebo: Implications for the Acquired Preparedness Model

CAITLIN SCOTT, M.A.,^{a,*} AND WILLIAM R. CORBIN, PH.D.^a

^aDepartment of Psychology, Arizona State University, Tempe, Arizona

ABSTRACT. Objective: Previous research has identified several aspects of behavioral undercontrol that are associated with heavy drinking and problems. Further, research on the acquired preparedness model (Smith and Anderson, 2001) has identified biased learning as a potential mechanism of these effects. Traits like sensation seeking have been linked to stronger positive and weaker negative expectancies, which, in turn, contribute to increased risk for heavy drinking and problems. Although expectancies are thought to represent potentially biased expectations about drinking outcomes, they may also reflect individual differences in alcohol response. The present study examined the strength of associations between sensation seeking and both expectancies (response to placebo) and subjective response under alcohol. **Method:** Using a between-subjects design, young adult social drinkers ($N = 236$) were randomly assigned to receive alcohol (target breath alcohol concentration

of .08%) or placebo, after which they reported on subjective experiences of stimulation and sedation. **Results:** Sensation seeking was significantly related to stimulant response, and the strength of this association did not differ by beverage condition (alcohol vs. placebo). **Conclusions:** The findings argue against a pharmacological explanation for results of prior studies of the acquired preparedness model and support a biased learning interpretation of relations between sensation seeking and positive expectancies. Results also extend the findings on the acquired preparedness model to an implicit measure of positive alcohol expectancies (subjective response to placebo). Future studies using additional measures of implicit expectancies (e.g., Implicit Association Test) would be helpful in determining the relative strength of implicit and explicit expectancies as mediators within the acquired preparedness model. (*J. Stud. Alcohol Drugs*, 75, 136–144, 2014)

LEVELS OF HEAVY EPISODIC DRINKING peak during the critical developmental period of emerging adulthood (ages 18–25 years). Further, heavy drinking contributes to the experience of a host of negative consequences, including driving while intoxicated, risk-taking behaviors, and alcohol-related injuries (Hingson et al., 2005). The incidence of alcohol use disorders also peaks during this age period (Grant et al., 2004). Studies have identified a range of risk factors for heavy drinking during this developmental period, including personality characteristics, expectancies, genetic and intergenerational risk, and subjective response to alcohol (Ham and Hope, 2003; Knopik et al., 2004; Leeman et al., 2009; Liu et al., 2004; Schuckit, 1994, 1998; Schuckit and Smith, 2000; Simons et al., 2004; Wechsler et al., 2002). Of primary interest to the current study, previous research has identified a number of traitlike personality characteristics that are associated with heavy drinking and problems. Despite recent research demonstrating developmental changes in personality (Caspi et al., 2005; Roberts and DelVecchio, 2000), personality tends to be difficult to change, as evidenced by rank order stability and poor treatment outcomes

among individuals with personality pathology (Reich and Vasile, 1993). Thus, a focus on the mechanisms through which trait characteristics contribute to negative drinking outcomes is important for both prevention and intervention efforts, as mediators of trait risk factors (e.g., alcohol-related cognitions) may be more amenable to change.

Although evidence for an association between trait behavioral undercontrol and drinking outcomes is well established (Baer, 2002), efforts to understand mechanisms of risk are relatively more recent. One theoretical model linking behavioral undercontrol (including impulsivity, sensation seeking, and urgency) with alcohol use and problems is the acquired preparedness model (APM). In this model, disposition and psychosocial learning are integrated to help account for alcohol-related risk processes and drinking behavior (Smith and Anderson, 2001). The model postulates that the presence of certain traitlike characteristics predisposes individuals to differentially attend to outcomes of alcohol-related behavior, thus enabling differential learning about alcohol outcomes (Settles et al., 2010). The idea that differences in personality contribute to different reactions and learning experiences surrounding the same environmental event is referred to as reactive person–environment transaction (Caspi, 1993). It can be presumed that this differential alcohol-related learning, at least in part, accounts for the influence of trait risk factors on drinking behavior (Settles et al., 2010).

According to the APM, differences in learning related to personality traits typically take the form of expectations

Received: March 21, 2013. Revision: July 1, 2013.

This research was supported by National Institute on Alcohol Abuse and Alcoholism Grant NIAAA R21 AA 016386.

*Correspondence may be sent to Caitlin Scott at the Department of Psychology, Arizona State University, 950 S. McAllister, Tempe, AZ 85287-1104, or via email at: cscott4@asu.edu.

about the outcomes of a particular behavior (i.e., outcome expectancies). Consistent with the theory, studies of the APM have demonstrated differential learning of both positive and negative alcohol expectancies associated with certain personality traits. Moreover, both cross-sectional and longitudinal studies have demonstrated that positive alcohol expectancies mediate relations between trait risk factors and both alcohol use and related problems (Anderson et al., 2003; Barnow et al., 2004; Corbin et al., 2011; Fu et al., 2007; McCarthy et al., 2001a; Settles et al., 2010). In evaluating expectancies as a potential mediator of personality influences, it is important to understand that self-reported expectancies may be reflective of multiple influences. In addition to differential expectancies, anticipated alcohol effects may reflect, at least in part, individual differences in subjective experiences of alcohol effects. Because self-report measures of expectancies have served as the norm in studies testing the APM, questions about the relative influence of personality on subjective alcohol response versus expectancies have gone unanswered. Much like expectancies, subjective effects of alcohol are relatively diverse, comprising both stimulant and sedative effects as well as both positive and negative effects. Thus, it is quite possible that personality traits will influence the extent to which people experience different aspects of subjective response (e.g., stimulation and sedation). Of course, placebo-controlled studies of alcohol effects are necessary to directly test this hypothesis.

Thus, to determine if relations between trait risk factors and expectancies may be attributable to individual differences in actual experiences of alcohol effects, the current study used a placebo-controlled alcohol challenge to examine the strength of associations between sensation seeking and both expectancies (response to placebo) and subjective response under alcohol. In looking at this relation, we controlled for concurrent drinking, given well-established differences in subjective response in heavy versus light drinkers (Morean and Corbin, 2010; Quinn and Fromme, 2011). We chose to focus on sensation seeking as a subcomponent of behavioral undercontrol that is well suited to examination as a trait risk factor. Sensation seeking—the preference for physiologically arousing and novel experiences and the willingness to take social, physical, and financial risks to obtain this arousal (Bardo et al., 2007; Borsari et al., 2007)—is among the most consistent correlates of drinking outcomes (Borsari et al., 2007; Stacy et al., 1993) and has been widely examined in prior studies of the APM (Anderson et al., 2003; Corbin et al., 2011).

The current study also examined both the positive and negative aspects of subjective response as possible mediators of the relation between sensation seeking and drinking behavior. Although prior tests of the APM have provided more consistent support for positive expectancies as a mediating variable (Anderson et al., 2003; Corbin et al., 2011; Fu et al., 2007; McCarthy et al., 2001b), negative aspects of subjective

response have been consistently linked to drinking outcomes. Consistent with the literature on positive expectancies, stronger stimulant effects predict higher levels of future binge drinking among heavy drinkers (King et al., 2011), but an even more convincing literature exists for negative alcohol effects. A low subjective response to the negative sedating effects of alcohol has been found to predict the risk for alcohol use disorders over periods as long as 25 years (Schuckit et al., 2007). Given the strength of this literature and the absence of prior studies evaluating the effect of trait risk factors on subjective response, we felt it was important to evaluate both positive (stimulant) and negative (sedative) subjective alcohol effects.

Based on prior results of studies testing the APM, higher levels of sensation seeking were expected to be associated with greater stimulation and lesser sedation. Further, we tentatively hypothesized that the relation between sensation seeking and both stimulation and sedation would differ by beverage condition (placebo vs. alcohol). Although higher levels of sensation seeking were expected to be associated with stronger stimulant and weaker sedative response to both placebo and alcohol, the magnitude of these effects was expected to be larger among individuals in the alcohol condition, as evidenced by a Sensation Seeking $\times$ Beverage Condition interaction. We expected a stronger relation between sensation seeking and subjective response under alcohol because consumption of alcohol activates both expectancies and actual pharmacological effects, whereas consumption of a placebo activates only expectancy effects. Thus, an interaction between sensation seeking and beverage condition would suggest that sensation seeking contributes uniquely to response to alcohol, controlling for the effects of expectancy, which are constant across the two groups. A lack of a significant beverage interaction would provide further evidence for the current conceptualization of the APM, which focuses on expectancies as the key mediating variable.

Method

Participants

Analyses included data from 236 participants who completed an alcohol administration session in a simulated bar laboratory and follow-up surveys 1–2 weeks following the laboratory session. The sample was predominantly male (74.70%) and White (77.20%), with a mean age of 22.75 years ($SD = 2.32$). The study took place over a 2-year period across two sites. Participants were recruited from college campuses and their surrounding communities. One campus was located in the northeastern and the other in the southwestern region of the United States. This study was carefully reviewed and approved by the institutional review boards at both data collection sites to ensure the safety of all participants.

To be eligible, participants had to consume at least three drinks on one occasion at least once a week in the past 3 months. Also, the larger study from which this sample was drawn focused on alcohol effects on gambling behavior. Prior studies from this sample provide additional details about study methods (Morean et al., 2012, 2013). With respect to gambling criteria, participants had to report having played poker in the last year and rank poker in their top three favorite forms of gambling to be considered for the study. Additional exclusion criteria included adverse reactions to alcohol (e.g., an extreme flushing response), past or current enrollment in abstinence-oriented treatment for alcohol or gambling problems, and pregnancy (for women).

Measures

Demographics. Demographic measures included age, gender, and ethnicity.

Sensation seeking. Sensation seeking was assessed using the 11-item sensation-seeking subscale of the Zuckerman–Kuhlman Personality Questionnaire (Zuckerman et al., 1993). This scale uses true–false questions to capture the desire to seek out experiences that are physiologically arousing. Sample items include, “I like to have new and exciting experiences and sensations,” “I’ll try anything once,” and “I like wild ‘uninhibited’ parties.” In the present study, the sensation seeking scale demonstrated adequate internal consistency reliability (Cronbach’s $\alpha = .72$).

Subjective response. Subjective response to alcohol and placebo was assessed using the Biphasic Alcohol Effects Scale (BAES; Martin et al., 1993), a 14-item unipolar adjective rating scale. The BAES is a self-report measure designed to capture stimulant and sedative subjective effects of alcohol. Seven items pertain to stimulant alcohol effects (e.g., energized and talkative), and seven items capture sedative alcohol effects (e.g., inactive and down). Participants were asked to use a scale where 0 = *not at all*, 5 = *moderately*, and 10 = *extremely* to rate their current subjective experience. Given clear evidence for alcohol’s biphasic effects (Newlin and Thomson, 1990), we used the BAES stimulation score assessed as blood alcohol levels were rising and the BAES sedation score assessed as blood alcohol levels were falling. Internal consistency reliability was adequate for stimulation (Cronbach’s $\alpha = .79$) and good for sedation (Cronbach’s $\alpha = .82$).

Alcohol use. Alcohol use during the 30 days before the laboratory session was assessed using the Timeline Followback interview (TLFB; Sobell and Sobell, 1992). With the assistance of an interviewer, participants completed a 30-day calendar starting from the day of the initial laboratory session and working backward. Weekly consumption was calculated as the average number of drinks per week over the prior 30 days.

Procedures

Participant eligibility was determined using a phone screener, which included the Daily Drinking Questionnaire (Collins et al., 1985) to assess the average number of drinks on each day of a typical week during the past 3 months. Once participants were selected as eligible for participation, they were scheduled in groups of two to four to attend the first of two sessions in the BARCA Lab, a naturalistic bar setting. Participants were instructed to abstain from alcohol and drugs 24 hours before the study, to refrain from using nicotine products during the study, and to refrain from eating in the 4 hours preceding the study. On arrival, participants provided informed consent and were given a breath alcohol analysis test to ensure a zero breath alcohol concentration (BrAC). Women were given a pregnancy test and verified a negative result to continue in the study.

All participants on a given night were randomly assigned as a block to either the placebo or alcohol condition. In the alcohol condition, the volume of alcohol in each drink was adjusted based on the participants’ gender and weight to target a BrAC of .08%. The beverage content was a ratio of one part 80 proof vodka to three parts mixer. In the placebo condition, participants received beverages that contained flattened tonic water in place of vodka. To ensure that research assistants who served the drinks remained blind to beverage condition, the protocol supervisor prepared the vodka or flattened tonic in branded vodka bottles before research assistants and participants entered the laboratory.

Beverages were mixed in front of participants, with the alcohol (or flattened tonic) poured from a vodka bottle. Glasses were rimmed with vodka and the bar was wiped down with vodka-soaked towels to provide olfactory cues in both beverage conditions. Last, the placebo drinks were topped with a vodka floater poured from a plastic lime (the alcohol beverages received a lime floater). All participants were told that they would be served alcohol up to a target BrAC of .08%. The protocol supervisor was responsible for taking BrAC readings at specific time intervals following beverage consumption to monitor the participants’ position on the blood alcohol curve as they completed the study tasks.

After completing baseline computerized tasks, participants were escorted into the BARCA Lab and administered one drink every 10 minutes for a total of three drinks over 30 minutes. This was followed by a 15-minute absorption period, after which participants’ BrAC was verified by the protocol supervisor using a breath alcohol analysis test. Participants were then asked to complete a rating of their subjective response to alcohol. A series of computer tasks was then administered every 15–20 minutes with subjective response measures and BrACs assessed between tasks.

After the final BrAC reading, participants were debriefed about their beverage assignment. In accordance with the

National Institute on Alcohol Abuse and Alcoholism Guidelines for Ethyl Alcohol Administration in Human Experimentation, participants in the alcohol condition were asked to remain in the laboratory until their BrAC dropped to .02% (measured by breath alcohol analysis tests) and their behavior returned to normal. All participants, regardless of beverage condition, were scheduled for their second session and provided with transportation to their place of residence.

Participants returned to the laboratory 1–2 weeks after the beverage administration session for the follow-up session. Participants were administered the TLFB (Sobell and Sobell, 1992) interview and completed additional self-report measures. Once participants completed the measures, they were debriefed and were paid \$12 per hour, along with a \$20 bonus for computerized tasks in which they were given the opportunity to win additional money.

Analytic plan

Before we conducted the primary analyses, distributions of all variables were examined for outliers and assumptions of normality. In the event that a variable was non-normally distributed, log transformations were used. Indices of multicollinearity were examined to ensure that correlations among the predictor variables would not create problems in the analyses. In addition, *t* tests of differences between the two data collection sites were conducted to determine if the samples differed on variables of interest. If differences by site were identified, site was entered as a covariate in subsequent analyses. *T* tests of differences between the alcohol and placebo condition on variables of interest were also conducted to ensure successful randomization. Last, we included *t* tests of differences between the alcohol and placebo groups on the ascending limb estimated BrAC and number of drinks as a check on the placebo manipulation.

The primary data analyses involved two separate simultaneous-entry multiple regression analyses. These models tested the hypothesis that the relation between sensation

seeking and expectancies/subjective response would be moderated by beverage condition (alcohol or placebo) while controlling for levels of weekly drinking and other covariates. Separate models were tested for BAES stimulation (as measured at Time 2 on the ascending limb) and BAES sedation (measured at Time 4 on the descending limb). Baseline levels of stimulation and sedation were used as covariates in the analyses to control for any baseline differences by group. Weekly drinking was also used as a covariate, given the well-documented association between weekly drinking and the other two variables of interest (sensation seeking and subjective response). Additional covariates included age, gender, and ethnicity. The study included 236 participants who completed both sessions, although the number of valid cases for individual variables ranged from 226 to 236. Given the small number of missing cases, listwise deletion was used. Thus, sample sizes varied slightly based on the number of available cases within each model (210 for the stimulation model and 208 for the sedation model).

Results

Preliminary analyses

Examination of the distributions of all variables for outliers and assumptions of normality revealed that weekly drinking was positively skewed. This variable was log transformed for all subsequent analyses. Bivariate correlations among the variables of interest were examined for consistency with study hypotheses (Table 1). *T* tests were used to examine potential differences between the two data collection sites on key variables. Using a corrected *t* test to account for violation of the assumption of homogeneity of variance, there was a significant effect for baseline sedation, $t(190.22) = -3.73$, $p < .001$. There was also a significant effect for descending limb sedation, $t(229) = -2.89$, $p = .004$. Participants in the Northeast reported higher levels of sedation than participants in the Southwest. The corrected *t* test also identified

TABLE 1. Bivariate correlations

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. SS	—	.225**	.038	.199**	.042	-.051	.061	-.263**	.058	.157*
2. Weekly drinking		—	.093	.135*	.084	-.095	.038	-.258**	.081	-.009
3. T0 stimulation			—	.651**	-.169*	-.128	.037	-.140*	-.109	.170*
4. T2 stimulation				—	-.054	-.105	.109	-.206**	-.004	.117
5. T0 sedation					—	.456**	-.013	-.057	.115	-.247**
6. T4 sedation						—	-.116	.168*	.173**	-.188**
7. Age							—	-.137*	-.032	-.098
8. Sex								—	.001	-.053
9. Ethnicity									—	.041
10. Site										—

Notes: SS = Zuckerman–Kuhlman Personality Questionnaire sensation seeking; weekly drinking = Timeline Followback Interview number of weekly drinks log transformed; T0 stimulation = BAES stimulation at baseline; T2 stimulation = Biphase Alcohol Effects Scale (BAES) stimulation on ascending limb; T0 sedation = BAES sedation at baseline; T4 sedation = BAES sedation on the descending limb; sex: coded men = 0 women = 1; ethnicity: coded non-White = 0, White = 1; site: coded Northeast = 0, Southwest = 1.

* $p < .05$; ** $p < .01$.

an effect for baseline stimulation, $t(223.90) = 2.61, p = .01$, with participants in the Southwest reporting higher levels of baseline stimulation than participants in the Northeast. Last, there was a significant effect for sensation seeking, $t(229) = 2.40, p = .02$, with participants in the Southwest reporting higher levels of sensation seeking than participants in the Northeast. Given the significant differences among key study variables across the two sites, we controlled for site in all subsequent analyses. *T* tests were also used to check the success of randomization. There were no significant differences between the alcohol and placebo groups for sensation seeking, baseline stimulation, baseline sedation, weekly drinking, age, gender, site, or ethnicity, with all *p* values greater than .12.

Manipulation check

We conducted *t* tests of differences between the beverage conditions on the estimated number of drinks and BrAC as a check of the placebo manipulation. There were statistically significant differences between the two groups for estimated number of drinks, $t(217.11) = -5.37, p < .001$, and estimated BrAC, $t(227.51) = -4.98, p < .001$. However, the placebo response was robust, with placebo participants estimating they had received an average of 2.63 drinks and had a mean estimated BrAC of .04. This compares to values of 3.33 drinks and an estimated BrAC of .06 in the alcohol condition. This placebo response of 69%–79% relative to the alcohol condition is quite strong relative to prior placebo-controlled alcohol challenge studies. For example, the Hedges' *g* effect size (alcohol vs. placebo) for the estimated number of drinks was .69 and for estimated BrAC was .64. In contrast, a recent meta-analysis of placebo manipulations found an average weighted effect size of 1.38 for the estimated number of drinks consumed and 1.44 for subjective intoxication (Schlauch et al., 2010).

TABLE 2. Regression analyses for Biphasic Alcohol Effects Scale (BAES) stimulation ($n = 210$)

Predictor	<i>B</i>	<i>SE</i>	β
SS	9.428**	3.350	.154**
Beverage condition	5.170**	1.516	.174**
SS $\times$ Beverage Condition	1.597	6.270	.018
Weekly drinking (log)	1.974	2.572	.041
Baseline stimulation	0.632**	0.054	.619**
Age	0.493	0.321	.079
Sex	-1.478	1.862	-.044
Ethnicity	1.279	1.853	.036
Site	0.393	1.576	.013

Notes: $R^2 = .491$. Stimulation = BAES stimulation on ascending limb; SS = Zuckerman–Kuhlman Personality Questionnaire sensation seeking; weekly drinking = Timeline Followback Interview number of weekly drinks log transformed; baseline stimulation = BAES stimulation at baseline; sex: coded men = 0 women = 1; ethnicity: coded non-White = 0, White = 1; site: coded Northeast = 0, Southwest = 1.

** $p < .01$.

Primary analyses

Simultaneous-entry multiple regression analyses were conducted to test study hypotheses regarding the main effects of sensation seeking and Sensation Seeking $\times$ Beverage Condition interactions in the prediction of stimulant and sedative response while controlling for weekly drinking and other covariates. Separate models were tested for BAES stimulation and BAES sedation. None of the variables in any of the analyses exhibited problems with multicollinearity, with all tolerance values greater than .2 and variance inflation factor values less than 4. We report the standardized coefficients in the text, with unstandardized regression coefficients and standard errors from the regression models in Tables 2 and 3.

The first model tested the hypothesis that the relation between sensation seeking and BAES stimulation (ascending limb) would be moderated by beverage condition (alcohol or placebo), with baseline level of stimulation, weekly drinking, age, gender, ethnicity, and site used as covariates in the analysis. Although the Sensation Seeking $\times$ Beverage Condition interaction was not significant ($\beta = .02, p = .80$), there was a main effect for sensation seeking such that higher levels of sensation seeking were associated with the experience of greater stimulation, regardless of beverage condition ($\beta = .15, p = .01$). The second model tested the hypothesis that the relation between sensation seeking and BAES sedation (descending limb) would be moderated by beverage condition, with baseline level of sedation, weekly drinking, age, gender, ethnicity, and site used as covariates. Once again, the interaction between sensation seeking and beverage condition was not statistically significant ($\beta = -.05, p = .53$). In addition, there was no significant main effect for sensation seeking ($\beta = .06, p = .39$). In fact, contrary to study hypotheses, higher levels of sensation seeking were associated with higher levels of sedation across beverage conditions.

TABLE 3. Regression analyses for Biphasic Alcohol Effects Scale (BAES) sedation ($n = 208$)

Predictor	<i>B</i>	<i>SE</i>	β
SS	3.100	3.582	.055
Beverage condition	3.647*	1.620	.134*
SS $\times$ Beverage Condition	-4.226	6.782	-.052
Weekly drinking (log)	-5.348	2.832	-.120
Baseline sedation	0.472**	0.070	.414**
Age	-0.510	0.346	-.089
Sex	5.492**	1.960	.179**
Ethnicity	4.808*	1.962	.148*
Site	-2.871	1.696	-.105

Notes: $R^2 = .309$. Sedation = BAES sedation on descending limb; SS = Zuckerman–Kuhlman Personality Questionnaire sensation seeking; weekly drinking = Timeline Followback Interview number of weekly drinks log transformed; baseline sedation = BAES sedation at baseline; sex: coded men = 0 women = 1; ethnicity: coded non-White = 0, White = 1; site: coded Northeast = 0, Southwest = 1.

* $p < .05$; ** $p < .01$.

Discussion

Previous studies on the APM have supported positive expectancies, and to a lesser extent negative expectancies, as mediators of the relation between trait-like personality characteristics and alcohol outcomes. However, expectancies measured via self-report may reflect differences in learned expectancies despite similar alcohol-related responses, or they may reflect true individual differences in subjective responses to alcohol. To date, no study has examined trait risk as a predictor of individual differences in subjective alcohol response. The current study sought to address this gap in the literature. We hypothesized that results would parallel previous findings, with higher levels of sensation seeking associated with higher levels of stimulation and lower levels of sedation when controlling for concurrent drinking and baseline levels of stimulation and sedation. More important, we predicted a Sensation Seeking $\times$ Beverage Condition interaction such that sensation seeking would be more strongly related to stimulation and sedation under alcohol, relative to placebo. Such findings would suggest that individual differences in both expectations and actual experiences of alcohol effects may result from higher levels of sensation seeking.

Contrary to hypotheses, there was not a significant interaction between sensation seeking and beverage condition in the prediction of either stimulation or sedation when controlling for baseline levels of stimulation or sedation, concurrent drinking, and other relevant covariates. Although the direction of effects was as hypothesized for stimulation, with higher levels of sensation seeking related to more stimulation, this relation did not differ significantly by beverage condition. Although this effect might be significant with a larger sample size, the power to detect significant interactions of a medium effect size ($f = .15$) in this sample was greater than .95, providing confidence in the validity of the nonsignificant interactions. This pattern of results is consistent with current conceptualizations of the APM, which focus on expectancies as a key mediator of the relation between personality traits and drinking outcomes.

With respect to sedation, although the association was not significant ($p = .22$), the direction of the effect was contrary to study hypotheses, with higher levels of sensation seeking related to more sedation. The context of the data collection may have played some role in these findings. The simulated bar laboratory provides a cue-rich environment that is likely stimulating to participants regardless of beverage condition. As a result, participants may have reported higher levels of stimulation under both alcohol and placebo, thus making an interaction between sensation seeking and beverage condition difficult to detect. Although the context may have limited the ability to detect interactions between sensation seeking and beverage condition, it cannot explain the lack of a main effect of sensation seeking on sedation.

Although the lack of significant association between sensation seeking and BAES sedation was contrary to study hypotheses, this result is not entirely inconsistent with prior literature on the APM. Prior studies have shown inconsistent relations between traitlike personality characteristics and negative expectancies, and negative expectancies have inconsistently mediated effects of personality characteristics on drinking behavior (Anderson et al., 2003; Corbin et al., 2011; Fu et al., 2007; Jones et al., 2001; McCarthy et al., 2001b). The present study extends the existing literature by replicating null findings regarding relations between sensation seeking and negative expectancies using an implicit measure of negative expectancies (subjective response to placebo). Further, the current findings extend the results to subjective response in an alcohol challenge, suggesting that sensation seeking is not strongly associated with either expectations of or the experience of sedation.

Several limitations of the study should be considered in interpreting the results. First, the data were cross-sectional. We controlled for concurrent drinking when examining the relation between personality and the experience of alcohol effects given well-established differences in subjective response in heavy versus light drinkers (Morean and Corbin, 2010; Quinn and Fromme, 2011), but this precluded us from testing the full mediation model with weekly drinking as the criterion variable. Nevertheless, we did find a significant zero-order correlation between ascending limb stimulation and weekly drinking ($r = .14$, $p = .04$) consistent with prior research linking high levels of stimulation to heavier drinking. Future studies should expand on the current findings using longitudinal data. This will allow for a test of the full mediation model controlling for baseline drinking when examining sensation seeking and subjective response as predictors of future drinking.

Also, the nature of the inclusion criteria may have generated a sample from which it is difficult to generalize to the wider population of emerging adults. The broader study focused on alcohol effects on gambling behavior, and participants in the current study were selected, in part, based on gambling-related inclusion criteria. This sample of heavy drinkers and gamblers may differ from the general population of heavy-drinking emerging adults on important variables. For example, gamblers might report higher levels of stimulation or sedation or a restricted range of scores on these measures. Although reported levels of stimulation were somewhat higher than in similar studies that did not involve gambling inclusion criteria (Corbin et al., 2008), there was no evidence for restriction of range as indicated by the means and standard deviations reported in Table 4. In addition, data for this study were collected across two sites. Although we controlled for site in our analyses, the combination of the two samples may have affected the pattern of results.

It is also important to note that our measure of trait risk was restricted to sensation seeking, whereas previous stud-

TABLE 4. Descriptive statistics by beverage condition

Variable	Alcohol			Placebo		
	<i>M</i>	<i>SD</i>	Range	<i>M</i>	<i>SD</i>	Range
Sensation seeking	7.03	2.73	0–11	6.71	2.60	0–11
Weekly drinking	13.65	10.78	0.35–58.7	13.93	11.65	0.23–63.2
T0 stimulation	28.00	14.06	0–64	26.22	15.25	0–63
T2 stimulation	35.03	14.22	2–65	28.48	14.84	0–62
T0 sedation	14.97	10.98	0–45	13.45	12.90	0–55
T4 sedation	18.25	13.90	0–58	13.87	13.20	0–49

ies have used a variety of constructs including positive and negative urgency, impulsivity, and behavioral inhibition and activation. It is possible that different personality constructs would produce different patterns of results. Last, we surmised that, because the BAES captures actual as well as expected response to alcohol in the alcohol condition, whereas only expectancies are captured in the placebo condition, a significant interaction with beverage condition would be an accurate indicator of a pharmacological effect. However, it is possible that, particularly among heavy drinkers, those who receive a high level of stimulation from drinking may also come to expect high levels of stimulation, making a unique effect of pharmacology difficult to detect using the BAES. Although this is a possibility, data from our laboratory suggest that discrepancies exist between expected and actual stimulant response even among heavy drinkers. Using corresponding measures of expectancies and subjective response, correlations for parallel subscale scores (e.g., expected stimulation and experienced stimulation) were only modest, ranging from .45 to .64 (Morean et al., 2013).

A final limitation relates to the available tools for assessing subjective response to alcohol. The BAES captures a more narrow range of effects than do measures of alcohol expectancies. Although the BAES assesses both stimulant and sedative effects of alcohol, “sedation” captures primarily negative sedative effects, whereas “stimulation” captures primarily positively reinforcing stimulant effects. Thus, the measure of positive effects in the current study was limited to positively reinforcing effects. In contrast, previous APM literature has used multiple positive expectancy subscales (e.g., social, global positive), including subscales that tap into low-arousal positive effects (e.g., tension reduction). Given that previous literature has shown that negatively reinforcing effects of alcohol (e.g., tension reduction) play an important role in the prediction of drinking behavior (Sher and Levenson, 1982), inclusion of a measure that captures this dimension of positive subjective response would be useful. Future research should consider measures such as the Subjective Effects of Alcohol Scale (Morean et al., 2013) to capture the full valence by arousal space when measuring subjective response.

Despite the aforementioned limitations, the findings of the current study extend our knowledge of relations between

sensation seeking and positive (stimulant) expectancies by using an implicit measure of expectancies (placebo response). This is noteworthy given the modest correlations that have been observed between explicit and implicit measures of expectancies (Larsen et al., 2012). However, placebo response has not been widely used in previous studies examining relations between implicit expectancies and alcohol-related outcomes, nor has it been used in studies examining correlations between implicit and explicit expectancies. Rather, implicit measures have typically been formal measures of attentional bias (e.g., the Stroop Task) (Stroop, 1935) and memory associations using reaction time measures (e.g., the Implicit Association Test) (Greenwald et al., 1998). Therefore, future studies should use additional implicit measures of expectancies (e.g., Stroop, Implicit Association Test) to examine their relations with sensation seeking and their ability to serve as a mediating variable within the APM.

Although placebo response is an atypical measure of implicit expectancies, it has some advantages relative to other measures of both implicit and explicit expectancies. Whereas other expectancy measures do not specify the dose, context, or timing of the drinking episode, the current study assessed implicit expectancies regarding a specific anticipated dose (.08%) consumed over a specific time frame (30 minutes) in a specific context (bar setting). Future studies would benefit from the use of an explicit measure of expectancies that similarly specifies parameters of the imagined drinking episode. For example, the Anticipated Effects of Alcohol Scale (Morean et al., 2012) asks participants to imagine a specific dose and assesses expectancies of alcohol effects as BrACs both rise and fall. As an added benefit, the Anticipated Effects of Alcohol Scale has a subjective response complement (Subjective Effects of Alcohol Scale; Morean et al., 2013) with parallel item content. Use of these instruments (along with other measures of implicit expectancies) would provide a more complete test of the relative strength of implicit and explicit expectancies as mediators within the APM.

In summary, the findings of the current study suggest that prior studies identifying alcohol expectancies as mediators of the relation between trait characteristics (e.g., sensation seeking, impulsivity) and drinking outcomes cannot be attributed to individual differences in the experience of

pharmacological alcohol effects. Rather, the results support an expectancy-based model of acquired preparedness and extend findings on the APM to an implicit measure of expectancies (placebo response). Future studies using additional measures of implicit expectancies are needed to replicate these findings, and longitudinal studies are needed to fully test the APM using implicit expectancy measures. Studies using explicit measures of expectancies that specify parameters of drinking episodes may also have the potential to refine our understanding of acquired preparedness.

References

- Anderson, K. G., Smith, G. T., & Fischer, S. F. (2003). Women and acquired preparedness: personality and learning implications for alcohol use. *Journal of Studies on Alcohol*, 64, 384–392.
- Baer, J. S. (2002). Student factors: Understanding individual variation in college drinking. *Journal of Studies on Alcohol, Supplement 14*, 40–53.
- Bardo, M. T., Williams, Y., Dwoskin, L. P., Moynahan, S. E., Perry, I. B., & Martin, C. A. (2007). The sensation seeking trait and substance use: Research findings and clinical implications. *Current Psychiatry Reviews*, 3, 3–13.
- Barnow, S., Schultz, G., Lucht, M., Ulrich, I., Preuss, U. W., & Freyberger, H. J. (2004). Do alcohol expectancies and peer delinquency/substance use mediate the relationship between impulsivity and drinking behaviour in adolescence? *Alcohol and Alcoholism*, 39, 213–219.
- Borsari, B., Murphy, J. G., & Barnett, N. P. (2007). Predictors of alcohol use during the first year of college: Implications for prevention. *Addictive Behaviors*, 32, 2062–2086.
- Caspi, A. (1993). Why maladaptive behaviors persist: Sources of continuity across the life course. In D. C. Funder, R. D. Parke, C. Tomlinson-Keasey, & K. Widaman (Eds.), *Studying lives through time: Personality and development* (pp. 343–376). Washington, DC: American Psychological Association.
- Caspi, A., Roberts, B. W., & Shiner, R. L. (2005). Personality development: Stability and change. *Annual Review of Psychology*, 56, 453–484.
- Collins, R. L., Parks, G. A., & Marlatt, G. A. (1985). Social determinants of alcohol consumption: The effects of social interaction and model status on the self-administration of alcohol. *Journal of Consulting and Clinical Psychology*, 53, 189–200.
- Corbin, W. R., Gearhardt, A., & Fromme, K. (2008). Stimulant alcohol effects prime within session drinking behavior. *Psychopharmacology*, 197, 327–337.
- Corbin, W. R., Iwamoto, D. K., & Fromme, K. (2011). A comprehensive longitudinal test of the acquired preparedness model for alcohol use and related problems. *Journal of Studies on Alcohol and Drugs*, 72, 602–610.
- Fu, A. T., Ko, H. C., Wu, J. Y., Cherng, B. L., & Cheng, C. P. (2007). Impulsivity and expectancy in risk for alcohol use: Comparing male and female college students in Taiwan. *Addictive Behaviors*, 32, 1887–1896.
- Grant, B. F., Dawson, D. A., Stinson, F. S., Chou, S. P., Dugour, M. C., & Pickering, R. P. (2004). The 12-month prevalence and trends in DSM-IV alcohol abuse and dependence: United States, 1991–1992 and 2001–2002. *Drug and Alcohol Dependence*, 74, 223–234.
- Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. (1998). Measuring individual differences in implicit cognition: The Implicit Association Test. *Journal of Personality and Social Psychology*, 74, 1464–1480.
- Ham, L. S., & Hope, D. A. (2003). College students and problematic drinking: A review of the literature. *Clinical Psychology Review*, 23, 719–759.
- Hingson, R., Heeren, T., Winter, M., & Wechsler, H. (2005). Magnitude of alcohol-related mortality and morbidity among U.S. college students ages 18–24: Changes from 1998 to 2001. *Annual Review of Public Health*, 26, 259–279.
- Jones, B. T., Corbin, W., & Fromme, K. (2001). A review of expectancy theory and alcohol consumption. *Addiction*, 96, 57–72.
- King, A. C., de Wit, H., McNamara, P. J., & Cao, D. (2011). Rewarding, stimulant, and sedative alcohol responses and relationship to future binge drinking. *Archives of General Psychiatry*, 68, 389–399.
- Knopik, V. S., Heath, A. C., Madden, P. A. F., Bucholz, K. K., Slutske, W. S., Nelson, E. C., . . . Martin, N. G. (2004). Genetic effects on alcohol dependence risk: Re-evaluating the importance of psychiatric and other heritable risk factors. *Psychological Medicine*, 34, 1519–1530.
- Larsen, H., Engels, R. C. M. E., Wiers, R. W., Granic, I., & Spijkerman, R. (2012). Implicit and explicit alcohol cognitions and observed alcohol consumption: Three studies in (semi)naturalistic drinking settings. *Addiction*, 107, 1420–1428.
- Leeman, R. F., Corbin, W. R., & Fromme, K. (2009). Craving predicts within session drinking behavior following placebo. *Personality and Individual Differences*, 46, 693–698.
- Liu, I. C., Blacker, D. L., Xu, R., Fitzmaurice, G., Lyons, M. J., & Tsuang, M. T. (2004). Genetic and environmental contributions to the development of alcohol dependence in male twins. *Archives of General Psychiatry*, 61, 897–903.
- Martin, C. S., Earleywine, M., Musty, R. E., Perrine, M. W., & Swift, R. M. (1993). Development and validation of the biphasic alcohol effects scale. *Alcoholism: Clinical and Experimental Research*, 17, 140–146.
- McCarthy, D. M., Kroll, L. S., & Smith, G. T. (2001a). Integrating disinhibition and learning risk for alcohol use. *Experimental and Clinical Psychopharmacology*, 9, 389–398.
- McCarthy, D. M., Miller, T. L., Smith, G. T., & Smith, J. A. (2001b). Disinhibition and expectancy in risk for alcohol use: Comparing black and white college samples. *Journal of Studies on Alcohol*, 62, 313–321.
- 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.
- Morean, M. E., Corbin, W. R., & Treat, T. A. (2012). The Anticipated Effects of Alcohol Scale: Development and psychometric evaluation of a novel assessment tool for measuring alcohol expectancies. *Psychological Assessment*, 24, 1008–1023.
- Morean, M. E., Corbin, W. R., & Treat, T. A. (2013). The Subjective Effects of Alcohol Scale: Development and psychometric evaluation of a novel assessment tool for measuring subjective response to alcohol. *Psychological Assessment*, 25, 780–795.
- Newlin, D. B., & Thomson, J. B. (1990). Alcohol challenge with sons of alcoholics: A critical review and analysis. *Psychological Bulletin*, 108, 383–402.
- Quinn, P. D., & Fromme, K. (2011). Subjective response to alcohol challenge: A quantitative review. *Alcoholism: Clinical and Experimental Research*, 35, 1759–1770.
- Reich, J. H., & Vasile, R. G. (1993). Effect of personality disorders on the treatment outcome of axis I conditions: An update. *Journal of Nervous and Mental Disease*, 181, 475–484.
- Roberts, B. W., & DelVecchio, W. F. (2000). The rank-order consistency of personality traits from childhood to old age: A quantitative review of longitudinal studies. *Psychological Bulletin*, 126, 3–25.
- Schlauch, R. C., Waesche, M. C., Riccardi, C. J., Donohue, K. F., Blagg, C. O., Christensen, R. L., & Lang, A. R. (2010). A meta-analysis of the effectiveness of placebo manipulations in alcohol-challenge studies. *Psychology of Addictive Behaviors*, 24, 239–253.
- 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. (1998). Biological, psychological and environmental predictors of the alcoholism risk: A longitudinal study. *Journal of Studies on Alcohol*, 59, 485–494.

- Schuckit, M. A., & Smith, T. L. (2000). The relationships of a family history of alcohol dependence, a low level of response to alcohol and six domains of life functioning to the development of alcohol use disorders. *Journal of Studies on Alcohol*, 61, 827–835.
- Schuckit, M. A., Smith, T. L., Danko, G. P., Pierson, J., Hesselbrock, V., Bucholz, K. K., . . . 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.
- Settles, R. F., Cyders, M., & Smith, G. T. (2010). Longitudinal validation of the acquired preparedness model of drinking risk. *Psychology of Addictive Behaviors*, 24, 198–208.
- Sher, K. J., & Levenson, R. W. (1982). Risk for alcoholism and individual differences in the stress-response-dampening effect of alcohol. *Journal of Abnormal Psychology*, 91, 350–367.
- Simons, J. S., Carey, K. B., & Gaher, R. M. (2004). Liability and impulsivity synergistically increase risk for alcohol-related problems. *American Journal of Drug and Alcohol Abuse*, 30, 685–694.
- Smith, G. T., & Anderson, K. G. (2001). Adolescent risk for alcohol problems as acquired preparedness: A model and suggestions for intervention. In P. M. Monti, S. M. Colby, & T. A. O'Leary (Eds.), *Adolescents, alcohol, and substance abuse: Reaching teens through brief interventions* (pp. 109–144). New York, NY: Guilford Press.
- Sobell, L. C., & Sobell, M. B. (1992). Timeline follow-back: A technique for assessing self-reported alcohol consumption. In J. P. Allen (Ed.), *Measuring alcohol consumption: Psychosocial and biochemical methods* (pp. 41–72). Totowa, NJ: Humana Press.
- Stacy, A. W., Newcomb, M. D., & Bentler, P. M. (1993). Cognitive motivations and sensation seeking as long-term predictors of drinking problems. *Journal of Social and Clinical Psychology*, 12, 1–24.
- Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18, 643–662.
- Wechsler, H., Lee, J. E., Kuo, M., Seibring, M., Nelson, T. F., & Lee, H. (2002). Trends in college binge drinking during a period of increased prevention efforts. Findings from 4 Harvard School of Public Health College Alcohol Study surveys: 1993–2001. *Journal of American College Health*, 50, 203–217.
- Zuckerman, M., Kuhlman, D. M., Joireman, J., Teta, P., & Kraft, M. (1993). A comparison of three structural models for personality: The Big Three, the Big Five, and the Alternative Five. *Journal of Personality and Social Psychology*, 65, 757–768.