The Relationship Between Prospective Self-Rating of Alcohol Sensitivity and Craving and Experimental Results From Two Alcohol Challenge Studies*

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ABSTRACT. Objective: Determining whether individuals can provide accurate reports of alcohol sensitivity and craving, outside of a laboratory alcohol challenge, has important research and clinical implications. The primary goals of the present study are (1) to test the relationship between prospective self-ratings of the effects of alcohol and alcohol craving, and experimental results from alcohol challenge studies and (2) to examine potential moderators of that relationship. **Method:** Participants were heavy drinkers who completed either an intravenous ($n = 49$) or an oral administration ($n = 135$) alcohol challenge. Participants were asked to estimate their craving for alcohol in a drinking situation and their subjective intoxication after consuming three drinks. Subjective intoxication and alcohol craving were then assessed during the laboratory alcohol challenge. **Results:** Estimated subjective intoxication and alcohol craving were significant predictors of subjective intoxication and craving measured under laboratory conditions and accounted for, at most, 16% and 37%, respectively, of the variance in laboratory measures. **Conclusions:** Taken together, these findings suggest that sensitivity to the effects of alcohol and alcohol craving may be measured outside of the laboratory but that scales that are especially designed for nonlaboratory studies may be required. (*J. Stud. Alcohol Drugs* **68:** 379-384, 2007)

ALCOHOL SENSITIVITY AND ALCOHOL CRAVING represent two important theoretical constructs in the alcoholism literature. It is widely recognized that the way individuals experience the effects of alcohol may influence their pattern of use (Schuckit, 1994), such that individuals who demonstrate lower levels of response to alcohol are more likely to develop alcohol use disorders (Schuckit and Smith, 1996, 2000). Furthermore, alcohol sensitivity was found to be lower among individuals with a family history of alcoholism (Schuckit and Smith, 1996) and to be genetically influenced (Heath et al., 1999; Viken et al., 2003). As a result, alcohol sensitivity has been used as an endophenotype in genetic association studies of alcoholism risk (Ray and Hutchison, 2004; Schuckit et al., 1999).

Alcohol craving, in turn, is generally defined as strong urges to consume alcohol. Craving for alcohol has been associated with a loss of control over drinking (Bohn et al., 1995; Kozlowski et al., 1989), has been the target of pharmacological and behavioral interventions for alcoholism (e.g., Monti et al., 1999), was found to predict treatment outcomes (Ray et al., 2006), and has been examined as an endophenotype in genetic association studies (e.g., Hutchison et al., 2002). Craving for alcohol is traditionally examined under laboratory conditions using either drinking cues (Rohsenow et al., 2000) or a priming alcohol dose (Hutchison et al., 2001).

Several studies have examined alcohol sensitivity and craving under laboratory conditions; however, far fewer studies have examined the anticipated subjective effects of alcohol and craving. Efforts to assess these constructs outside of the laboratory are particularly important given that experimental procedures are often expensive and time consuming. In addressing this concern, Schuckit and colleagues have developed and validated the Self-Rating of the Effects (SRE) of alcohol (Schuckit et al., 1997a; Schuckit and Smith, 2004), a measure in which participants estimate the number of drinks necessary to experience different effects of alcohol intoxication (e.g., dizziness and slurred speech). The SRE has shown good sensitivity and specificity when compared to laboratory results (Schuckit et al., 1997a,b) and was found to predict alcohol pathology and a family history of alcoholism (Daeppen et al., 2000; Schuckit et al., 2003).

In addition to the SRE literature, previous studies have examined the anticipated effects of alcohol using the Anticipated Biphasic Alcohol Effects Scale (A-BAES; Earleywine, 1994b; Martin et al., 1993). Specifically, these

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studies found the following: (1) heavier drinkers anticipate higher levels of stimulation on the ascending limb of breath alcohol concentration (BrAC) and higher sedation on the descending limb of intoxication, as compared with lighter drinkers (Dunn and Earleywine, 2001; Earleywine, 1994a; Earleywine and Erblich, 1996); (2) social drinkers could make fairly accurate predictions regarding the sedative and stimulant effects of alcohol at various levels of alcohol intoxication (Demmel et al., 2004); and (3) current mood states influenced one's anticipated feelings of alcohol-induced sedation (Demmel et al., 2006). These finding are both consistent with reports that social drinkers are moderately accurate at retrospectively estimating their BrAC (Carey and Hustad, 2002) and contrary to findings that participants were not very accurate at prospectively estimating the effects of alcohol (Hammersley et al., 1993). In summary, these studies suggest that individuals may choose when and how much they drink based on the anticipation of alcohol's effects in addition to the subjective effects of alcohol.

Based on the existing literature, the primary objectives of the present study are the following: (1) to examine the relationship between prospective estimates of the effects of alcohol and craving, and results from two alcohol challenge studies, and (2) to examine moderators of the relationship between estimated and laboratory-measured alcohol sensitivity and craving, such as BrAC, gender, level of alcohol use, and family history of alcoholism. To address these questions, we will present results from two alcohol challenge studies: one in which alcohol was delivered intravenously (IV) and one in which alcohol was taken orally (PO). As a secondary objective, this article will present a brief comparison of the two alcohol administration paradigms with respect to subjective intoxication and craving.

Method

Participants

In both the IV (n = 49; 23 women) and the PO (n = 135; 49 women) studies, participants met the following identical eligibility criteria: (1) a score of 8 or higher on the Alcohol Use Disorders Identification Test (AUDIT; Allen et al., 1997), indicating a heavy drinking pattern, and (2) self-reported drinking frequency of three or more drinks (two for women) at least twice per week. Participants who were trying to quit drinking were excluded and offered treatment referrals. Participants in the IV study were asked to complete a physical exam. All participants had a BrAC of 0 before each session, and all women tested negative for pregnancy. The average (SD) age was 21.98 (1.70) in the IV study and 22.36 (2.82) in the PO study. The average number of drinks per episode in the past year was 4.26 (1.71) and 5.17 (1.32), respectively.

Measures

Alcohol use was assessed by asking about drinking frequency and quantity, and both items were standardized and averaged to form an alcohol-use index.

The Subjective High Assessment Scale (SHAS) measured subjective feelings of intoxication. This measure was first adapted by Schuckit (1984) and has since been used widely in alcohol challenge studies. Participants in the IV study were asked to estimate their subjective intoxication after having three drinks in 30 minutes, using the Estimated SHAS (E-SHAS; $\alpha = .94$).

The Alcohol Urge Questionnaire (AUQ) was used to assess craving for alcohol (Bohn et al., 1995; MacKillop, 2006). The AUQ consists of eight items, each rated on a 7-point Likert scale, measuring urge to drink, such as "It would be difficult to turn down a drink this minute."

The Estimated Alcohol Craving Scale (EACS) is a 10-item scale analog to the AUQ that was developed in our laboratory for the purpose of this study and asked participants, in the PO study only, to estimate their urge to drink after consuming one or two alcoholic drinks ($\alpha = .94$).

Procedures

Both studies were approved by the local Human Subjects Committee. On arrival at the laboratory, participants provided informed consent, underwent breath alcohol analysis, and completed measures of alcohol use and family history of alcoholism. Participants were then asked to estimate their subjective intoxication (E-SHAS; IV study only) or alcohol craving (EACS; PO study only) after consuming a hypothetical number of drinks. Participants later completed an alcohol challenge in which subjective intoxication (SHAS) and alcohol craving (AUQ) were assessed at baseline and at each of the three target BrACs: .02, .04, and .06. In the PO study, participants consumed three doses of high-alcohol beer. Each dose took into account height, weight, and gender and consisted of 0.15 g/kg of alcohol (0.11 g/kg for females) (Watson, 1989). In the IV study, a 5% alcohol IV solution was used, and the following nomogram was developed taking into account participant's gender and weight: 0.166 ml/minute × weight/kg (0.126 for females).

Analytic strategy

Study hypotheses were examined using the general linear model (GLM) with repeated trials, such that estimated subjective intoxication and craving (i.e., E-SHAS and EACS) were used to predict laboratory scores in the SHAS and AUQ at the three levels of BrAC (i.e., BrAC = .02, .04, and .06). In the second step, we added the hypothesized moderators, each in turn, to the GLM described

above. Data from the two studies (IV and PO) were *not* pooled in these analyses because the E-SHAS was assessed only in the IV study, whereas EACS was assessed only in the PO study.

Results

Subjective intoxication

Results revealed a significant main effect of estimated subjective intoxication in all four models tested, suggesting that scores in the E-SHAS consistently predicted subjective intoxication in the laboratory. There was a significant E-SHAS × BrAC interaction, such that the relationship between anticipated and reported SHAS was strongest at the third target BrAC (r = .41; R^2 = .16), when the E-SHAS captured about 16% of the variance in subjective intoxication assessed in the laboratory. There was a significant moderating effect of gender, and two additional simple effects tests were calculated to probe this interaction, one for men (n = 26) and one for women (n = 23). Results indicated a significant and positive relationship among men (F = 12.94, 1/23 df, p < .01), and a nonsignificant relationship among women (F = 1.79, 1/21 df, p = .20). See Table 1 for all models.

Alcohol craving

Results revealed a significant and positive main effect of estimated craving on craving reported in the laboratory. Correlation analyses indicated that estimated craving accounted for a substantial proportion of the variance in alcohol craving measured in the laboratory (R^2's across BrACs were .32, .37, and .31 for BrACs of .02, .04, and .06, respectively). There was a significant EACS × Alcohol Use interaction, and, to probe for this interaction, the following three additional simple effects tests were calculated: one for the effect of estimated craving at 1 SD above the mean of alcohol use, another for 1 SD below the mean alcohol use, and one for scores between +1 and -1 SD. The relationship between estimated and reported craving was found to be strongest for individuals within the average range of alcohol use (n = 98; F = 63.93, 1/96 df, p < .0001) as compared with individuals within the high (n = 16; F < 5.72, 1/14 df, p < .05) and low (n = 21; F = 4.65, 1/19 df, p < .05) levels of drinking.

Table 1. Associations tested applying the general linear model to predict subjective intoxication and alcohol craving across trial using estimated scores, moderators, and their interactions

Model	F	df[a]	p
Model 1: Subjective intoxication, SHAS			
Estimated SHAS	7.18	1/45	<.05
BrAC (i.e., trial)	3.05	1/45	<.05
Estimated SHAS × BrAC	3.51	2/90	<.05
Model 2: Subjective intoxication, SHAS			
Estimated SHAS	14.81	1/43	<.001
Gender	1.53	1/43	.22
Estimated SHAS × Gender	5.83	2/86	<.05
Model 3: Subjective intoxication, SHAS			
Estimated SHAS	7.96	1/43	<.01
Alcohol use	0.69	1/43	.41
Estimated SHAS × Alcohol Use	1.09	2/86	.30
Model 4: Subjective intoxication, SHAS			
Estimated SHAS	8.52	1/38	<.01
Family history	0.54	1/38	.47
Estimated SHAS × Family History	0.22	2/76	.64
Model 5: Craving, AUQ			
Estimated craving	80.0	1/133	<.0001
BrAC (i.e., trial)	0.34	1/133	.69
Estimated Craving × BrAC	0.73	2/266	.47
Model 6: Craving, AUQ			
Estimated craving	15.16	1/130	<.001
Gender	0.61	1/130	.44
Estimated Craving × Gender	1.40	2/260	.24
Model 7: Craving, AUQ			
Estimated craving	53.39	1/127	<.0001
Alcohol use	2.25	1/127	.14
Estimated Craving × Alcohol Use	4.47	2/254	<.05

Notes: SHAS = Subjective High Assessment Scale; BrAC = breath alcohol concentration; AUQ = Alcohol Urge Questionnaire. [a]Varying degrees of freedom are a result of missing data for a given variable and the nature of the test (i.e., main effect vs interaction).

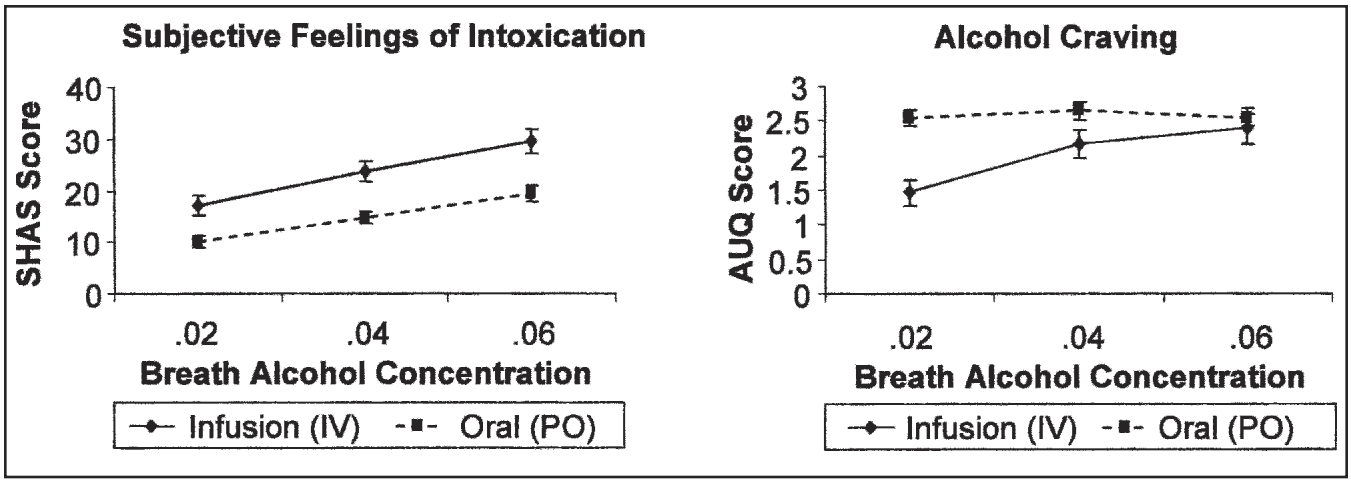

FIGURE 1. Mean subjective intoxication (Subjective High Assessment Scale [SHAS]) and alcohol craving (Alcohol Urge Questionnaire [AUQ]), along with standard errors, at each target breath alcohol concentration (BrAC), for participants in the alcohol infusion (IV) and oral administration (PO) studies. Analyses revealed that the IV paradigm elicited higher overall subjective intoxication ($p < .05$), whereas the PO paradigm elicited higher craving for alcohol ($p < .05$)

Paradigm comparisons

Repeated-measures analyses of variance (ANOVAs) were conducted in which alcohol administration was a two-level between-subjects factor (IV vs PO). We began by comparing the two paradigms on BrAC and found no significant overall group differences ($F < 1.0$, 1/180 df, $p = .72$). However, there was a significant Paradigm × Trial interaction, suggesting that participants in the IV study reached higher BrACs, on average, at the third target point. The average BrAC at Time 3 was .060 (.002) for the IV study and .056 (.013) in the PO administration ($F = 12.07$, 2/360 df, $p < .001$). There was also a main effect of paradigm on both craving ($F = 13.1$, 1/181 df, $p < .01$) and subjective intoxication ($F = 16.49$, 1/166 df, $p < .001$), indicating that the IV paradigm elicited higher overall subjective intoxication, whereas the PO paradigm elicited higher alcohol craving. Finally, there was a significant Paradigm × Trial interaction, such that craving increased steadily across rising BrAC in the IV study, but remained mostly unchanged in the PO study ($F = 25.02$, 2/362 df, $p < .0001$). See Figure 1.

Discussion

Alcohol administration studies are widely used in alcohol research and have provided important insights into risk factors for alcoholism (e.g., level of response to alcohol; Schuckit and Smith, 1996). More recently, these studies have allowed us to parse out endophenotypes for genetic association studies (e.g., Hu et al., 2005; Hutchison et al., 2002). However, there are many circumstances in which an alcohol challenge study may not be feasible (e.g., in twin or family studies), in addition to being expensive and time consuming. Therefore, it is important to determine whether these phenotypes can be successfully measured outside of the laboratory, which was the primary objective of this study. Results revealed that subjective intoxication measured in the laboratory was significantly predicted by participants' a priori estimates and that the association was strongest when BrAC was .06, which most closely matches the imaginary level of intoxication presented in the E-SHAS. This finding is consistent with a study suggesting that social drinkers can make moderately accurate retrospective estimates of their BrAC (Carey and Hustad, 2002). Nevertheless, it should be noted that E-SHAS explained only as much as 16% of the variance in subjective intoxication measured in the laboratory. Analyses of alcohol craving revealed that estimated craving was strongly associated with laboratory-measured craving, accounting for as much as 37% of the variance in craving assessed in the laboratory and that level of alcohol use moderated this relationship.

In summary, our results suggest that subjective intoxication, measured by the E-SHAS, may not lend itself to nonlaboratory studies given that only a small percentage of the variance in laboratory-measured subjective intoxication was captured by this scale. It appears as though a scale that is specifically constructed for nonlaboratory investigations, such as the SRE (Schuckit et al., 1997a), may be better suited for capturing individuals' level of response to alcohol when an alcohol challenge is not possible. Research directly comparing the SRE to the E-SHAS or the A-BAES, for example, is needed to more adequately address this empirical question. The results for alcohol craving are more encouraging and suggest that asking heavy drinkers to estimate their craving for alcohol in a drinking situation captures a sizeable percentage of the variability in alcohol

craving assessed under experimental conditions. Nonetheless, the majority of the variance in alcohol craving (i.e., 63%) remains to be explained, suggesting that laboratory paradigms remain the optimal method for assessing craving for alcohol.

The present study has several limitations, such as culling from two distinct alcohol administration paradigms and sampling only heavy drinkers. Analyses comparing the two paradigms suggested that they differed in eliciting subjective intoxication and craving, such that the IV paradigm elicited higher subjective intoxication, whereas the PO study elicited higher alcohol craving. A disadvantage of the IV administration concerns external validity, given that it does not resemble a normal drinking situation, whereas advantages include more control over BrAC and greater focus on the pharmacological effects of alcohol. Conversely, the literature suggests that the presence of exteroceptive alcohol cues, such as taste and smell, is important to elicit craving (Rohsenow et al., 2000), which in turn may explain the higher levels of craving noted in the PO study.

Finally, a common criticism of alcohol challenge studies is that they may be biased by individuals' expectancies of the effects of alcohol. Participants' estimates of subjective intoxication and craving may be conceptualized as an index of their expectancies of alcohol's effects, and, as such, we would conclude that "expectancies" account for an important proportion of the constructs of subjective intoxication and craving, although a great deal of the variability in these constructs appears to be unique to drinking situations.

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