Mood and Implicit Alcohol Expectancy Processes: Predicting Alcohol Consumption in the Laboratory

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Background: Implicit positive alcohol expectancy (PAE) processes are thought to respond phasically to external and internal stimuli—including mood states—and so they may exert powerful proximal influences over drinking behavior. Although social learning theory contends that mood states activate mood-congruent implicit PAEs, which in turn lead to alcohol use, there is a dearth of experimental research examining this mediation model relative to observable drinking. Moreover, an expectancy theory perspective might suggest that, rather than influencing PAEs directly, mood may moderate the association between PAEs and drinking. To test these models, this study examined the role of mood in the association between implicitly measured PAE processes (i.e., latency to endorse PAEs) and immediate alcohol consumption in the laboratory. Gender differences in these processes also were examined.

Method: College students (N = 146) were exposed to either a positive, negative, or neutral mood induction procedure, completed a computerized PAE reaction time (RT) task, and subsequently consumed alcohol ad libitum.

Results: The mood manipulation had no direct effects on drinking in the laboratory, making the mediation hypothesis irrelevant. Instead, gender and mood condition moderated the association between RT to endorse PAEs and drinking in the laboratory. For males, RT to tension reduction PAEs was a stronger predictor of volume of beer consumed and peak blood alcohol concentration in the context of general arousal (i.e., positive and negative mood) relative to neutral mood. RT to PAEs did not predict drinking in the laboratory for females.

Conclusions: The results show that PAE processes are important determinants of immediate drinking behavior in men, suggesting that biased attention to mood-relevant PAEs—as indicated by longer RTs—predicts greater alcohol consumption in the appropriate mood context. The findings also highlight the need to consider gender differences in PAE processes. This study underscores the need for interventions that target automatic cognitive processes related to alcohol use.

Key Words: Alcohol Expectancies, Implicit Cognition, Mood, Gender.

POSITIVE ALCOHOL EXPECTANCIES (PAEs)—beliefs about the desirable effects of alcohol use—are robust, proximal predictors of drinking (Goldman et al., 1999; Sher et al., 1996) and thus may be an important focal point in the prevention of problem drinking. Recently, there has been a growing interest in automatic or implicit PAE processes, which may be primarily stimulus driven and may have an immediate influence over drinking behavior (Tiffany, 1990; Wiers and Stacy, 2006; Wiers et al., 2006). However, few attempts have been made to study the link between PAEs and observable drinking behavior in the laboratory. Both social learning theory (SLT) and expectancy theory posit that alcohol expectancies have a mechanistic role in drinking, proximally influencing in-the-moment drinking behavior (see Goldman et al., 1999; Maisto et al., 1999). However, empirical tests of hypotheses derived from these theoretical models are limited.

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MULTIDIMENSIONALITY OF PAES: IMPORTANCE OF IMPLICIT COGNITIONS

PAEs are beliefs about the positive effects of alcohol that are the result of learning and are represented in memory (Goldman et al., 1999). Many different types of PAEs have been identified (e.g., social, enhancement, and tension reduction; Kushner et al., 1994). PAEs have been studied using self-report methods that are thought to tap into explicit (conscious, deliberate) cognitive processes, as well as behavioral (e.g., reaction time [RT]) methods that are thought to reflect implicit (unconscious, automatic) cognitive processes (see De Houwer, 2006; Wiers and Stacy, 2006; Wiers et al., 2002). The concept of implicit expectancy has been described in different ways. Here, we use the term *implicit* to refer to expectancy processes that are measured using indirect methods that do not rely on explicit self-report and are thought to reflect automatic cognitive processes (De Houwer, 2006).

Both explicitly and implicitly measured PAEs account for unique variance in self-reported drinking (Houben and Wiers, 2008; McCarthy and Thompsen, 2006; Palfai and Wood, 2001; Thrush and Wiers, 2007). Implicit PAE processes may be especially relevant as immediate determinants of drinking because of their automatic, stimulus-driven nature (Wiers and Stacy, 2006). Implicit PAE activation is also associated with craving and increased consumption, especially when self-control resources are depleted (Ostafin et al., 2008). Thus, implicit PAEs may be important targets for interventions. Currently, interventions tend to challenge only explicit beliefs about alcohol, leaving implicit PAEs intact (e.g., Wiers et al., 2005; see also Wiers and Stacy, 2006). Thus, the examination of implicit PAE processes as proximal determinants of actual drinking behavior has potential to inform the development of interventions that target implicit PAEs. Although some studies have examined alcohol consumption after priming PAEs (e.g., Roehrich and Goldman, 1995; Stein et al., 2000), there have been only a few that have implicitly measured individual differences in PAEs just prior to alcohol consumption (Ostafin et al., 2008; Palfai et al., 2000; Payne et al., 2008).

MOOD AND IMPLICIT PAE PROCESSES

Implicit alcohol expectancy processes are thought to be dynamic; that is, they become activated in response to contextual or situational cues (Krank and Wall, 2006). Mood state is one such cue (see Greeley and Oei, 1999; Simons et al., 2005), with both positive and negative moods serving as antecedents of drinking (Birch et al., 2008; Cooper et al., 1995). Moreover, the content of alcohol expectancies can be mapped onto 2 dimensions of affective space, arousal (i.e., aroused vs. sedated mood) and valence (i.e., pleasant vs. unpleasant mood; Goldman et al., 1999; Rather et al., 1992; Read et al., 2009). Mood may have an influence over implicit PAE processes in particular, as these processes are thought to respond automatically to phasic changes in external and internal stimuli, including mood (Krank and Wall, 2006; Wiers and Stacy, 2006).[1]

PAEs as a Mediator of the Mood-Drinking Association

According to SLT, PAE processes act as the mediating cognitive mechanism linking mood and alcohol use (Goldman et al., 1999; Maisto et al., 1999), such that mood states selectively activate mood-relevant PAEs, which in turn lead to alcohol consumption (Birch et al., 2008; Friedman et al., 2009; Goldstein et al., 2004; Hufford, 2001). Positive moods may be associated specifically with expectations that alcohol can enhance positive mood, whereas negative moods may be associated specifically with expectations that alcohol can relieve negative mood.

Although some work supports this conceptualization (e.g., Birch et al., 2008; Read and Curtin, 2007), findings are far from uniform. For example, there are inconsistencies among studies with respect to which mood states affect PAEs and how individual differences influence these processes (e.g., Birch et al., 2004, 2008; Stewart et al., 2002). Also, virtually no experimental tests of the full mediated model exist, as little research has examined whether mood-induced activation of PAEs predicts subsequent observable drinking.

Another issue is that previous work in this area has tended to focus only on positive and negative mood valence and has overlooked the other dimension, arousal (Russell, 1980). Indeed, both positive and negative moods can involve heightened arousal, which may be very relevant for understanding mood-related PAE processes, given that alcohol has direct effects on arousal (both stimulating and depressing effects; Pohorecky, 1977). Moreover, many PAE items contain arousal content (e.g., tension reduction and activity enhancement PAEs; Kushner et al., 1994; see also Kramer and Goldman, 2003).

Mood as a Moderator of the PAE-Drinking Association

Mediation of mood and drinking by PAEs has been a predominant conceptualization, but it is not the only one possible. One alternative, informed by alcohol expectancy theory, follows from the notion that there are preexisting individual differences in the strength of implicit PAEs because of a number of stable individual difference factors (see Goldman et al., 1999; Mann et al., 1987). The degree to which these individual differences in implicit PAEs influence drinking behavior, though, may depend on whether they are relevant to the particular context. That is, mood states may moderate the implicit PAE-drinking association, such that mood-relevant PAEs influence drinking only when the relevant mood state is experienced. This is consistent with the expectancy theory view that "the influence of the expectancy remains latent until circumstances are encountered that make the information relevant" (Stein et al., 2000, p. 107; see also Bolles, 1972). So, whereas SLT focuses on the "activation" of implicit PAEs by mood, which may then lead to drinking (mediation hypothesis), this alternative model suggests that preexisting differences in implicit PAE strength may be more or less relevant for predicting drinking depending on mood context (moderation hypothesis). As there are so few data on the effects of these mood and PAE processes on immediate, observable drinking, we sought to test these associations in terms of both the mediation and moderation perspectives.

To examine how state-like, mood-related PAE processes influence an immediate drinking episode, it is important to

[1]We acknowledge that some studies have reported mood influences on explicitly measured PAEs (e.g., Birch et al., 2004; Grant and Stewart, 2007). However, these studies tend to measure explicit PAEs with instruments keyed to be more sensitive to dynamic changes in PAEs (e.g., "right now, alcohol would…"). We are not arguing that mood has no influence at all over explicit self-report of PAEs, only that mood states may have a greater impact on implicitly measured PAE processes such as latency to endorse PAEs.

take into account individual differences that may influence these processes. For example, individuals who drink more frequently or who drink great amounts of alcohol might be expected to have stronger implicit PAEs because these beliefs are better learned and more highly automatic (Read et al., 2004). In addition, gender differences have been observed in alcohol consumption and expectancies, and past research has demonstrated a stronger association between implicit alcohol expectancies and self-reported drinking in males, particularly with respect to tension reduction PAEs (Kidorf et al., 1995; Read et al., 2004; Thompson et al., 2009). Thus, we included these individual differences in our analyses, controlling for typical drinking and examining gender as a moderator.

Implicitly Measured PAE Processes: Accessibility or Attentional Bias?

Another issue relevant for understanding implicit PAEs as they relate to drinking involves the nature of implicit PAE processes. Some have argued that implicit PAE processes can be indexed by faster response times to endorse PAE items as this reflects the ease and automaticity with which alcohol beliefs are retrieved from memory (e.g., Palfai and Wood, 2001; Palfai et al., 1997). Others have contended that slower responding to alcohol concepts may be indicative of implicit PAE processes (e.g., Kramer and Goldman, 2003; see also Cox et al., 2006), as slowing may reflect heightened attention to alcohol-relevant cues (including PAE items), which occupy working memory resources and interfere with response times on simultaneous tasks.

Both accessibility and attention bias appear to be important automatic cognitive processes related to drinking, and so it may be that these processes are relevant in different contexts. For example, those PAEs that are more strongly associated with alcohol in memory should be more accessible, and so individuals will respond faster to those items. This may explain why heavier drinkers tend to respond faster to PAE items compared with lighter drinkers (Palfai and Wood, 2001; Read et al., 2004). However, the presentation of salient alcohol cues or an impending drinking situation may activate motivational brain systems in drinkers leading to the desire to drink (see Robinson and Berridge, 1993). In this motivational state, individuals may become preoccupied with motivationally relevant information, including alcohol expectancies (e.g., Kramer and Goldman, 2003; see also Field et al., 2009). This could lead to an attention bias toward these highly salient PAEs, occupying working memory resources and slowing RTs to endorse these PAEs.

Read and Curtin (2007) have examined how contextual factors may influence the operation of accessibility and attentional bias processes related to PAEs. In this study, participants in a stressful mood condition responded faster to tension reduction PAEs when they were exposed to neutral cues. However, participants in the stressful mood condition who were exposed to alcohol cues had *slower* RTs to endorse tension reduction PAEs. The authors argued that activation of implicit PAEs by motivationally relevant (i.e., alcohol) cues may have primed an attentional bias to alcohol information (i.e., PAE items), leading to slower processing and slower response times. In other words, the alcohol cues may have activated these PAEs to the point that they became intrusive and interfered with responding on the task. Thus, context may influence the nature (accessibility vs. attentional bias) of implicit PAE processes.

The Present Study

Our primary aim was to examine the relationship between implicit PAE processes and subsequent alcohol consumption in the laboratory and to explore the role of mood in this association. First, we sought to provide a much needed test of the SLT prediction that mood-congruent implicit PAEs (enhancement, tension reduction) mediate the influence of mood on alcohol consumption. Following previous research that has identified both arousal and valence dimensions of mood effects (see Lang, 1995), we framed our hypotheses on the assumption that both the positive and negative mood conditions would increase arousal, and therefore both would have an influence on latency to endorse PAE items that primarily involve an arousal component. We also anticipated that mood effects would be associated with *slower* response times to PAEs as all participants were anticipating alcohol consumption and thus were primed by the drinking context to attend to alcohol information (Kramer and Goldman, 2003; Read and Curtin, 2007).

We forwarded the following hypotheses with respect to the proposed mediational model:

1. We predicted that participants in the positive and negative mood conditions would drink more alcohol than those in the neutral mood condition, given that both of these mood states are associated with drinking (e.g., Birch et al., 2008; Cooper et al., 1995).
2. Consistent with SLT, we predicted that the effects of mood on alcohol consumption would be mediated by activation of specific, mood-congruent implicit PAEs. We expected that tension reduction and activity enhancement PAEs would mediate the relationship between mood and in-laboratory drinking, as both of these PAE types involve arousal. We did not expect social lubrication PAEs to act as a mediator as they are not as directly mood relevant.
3. We also expected an effect of emotional valence; tension reduction RTs would be the strongest mediator of the mood-drinking association for those in the negative mood condition, and enhancement RTs would be the strongest mediator for those in the positive mood condition.

As noted, the role of mood in moderating expectancy effects on drinking has been virtually overlooked in the existing literature. Accordingly, a second objective of this study was to examine whether mood serves as a moderator of the link between implicit PAEs and subsequent alcohol consumption. We made the following predictions:

1. We expected the association between latency to endorse tension reduction and activity enhancement PAEs and in-laboratory drinking to be stronger in the context of arousal (positive, negative mood conditions, together) relative to the neutral condition, because both PAE types involve an arousal component. We did not expect mood to moderate the association between social lubrication PAEs and drinking.
2. We expected an effect of emotional valence, such that the association between tension reduction PAEs and drinking would be stronger in the negative mood condition than the positive mood condition, and the opposite would be true for activity enhancement PAEs.

MATERIALS AND METHOD

Participants

Participants were 146 (67 female) college students in the northeastern United States. To be eligible, participants had to be regular drinkers (at least once per week for the past 3 months) between the ages of 21 and 24, without any contraindications to alcohol consumption, and express a liking for beer (which was the beverage used in this study). Eligible students (N = 184) completed experimental procedures. Thirty-eight participants were dropped from analyses because they did not endorse at least 1 item from all 3 of the PAE scales, and so the final sample consisted of 146 participants. Before the session, a random number generator was used to randomly assign participants (within gender) to 1 of 3 mood conditions: neutral (n = 43), negative (n = 49), and positive (n = 54). The majority (n = 125, 86%) of participants were Caucasian, 1% (n = 1) was Hispanic, 2% (n = 3) were Asian, 7% (n = 10) were Black, and 3% (n = 6) identified themselves as "Other." One participant did not provide ethnicity data. Over half (n = 81, 56%) were seniors, and the average age was 21.45 (SD = 0.73). Participants reported drinking an average of 17.87 (SD = 12.05) drinks per week, on an average of 2.72 (SD = 1.19) weekly drinking occasions. They consumed at least 4/5 (women/men) drinks (heavy episodic drinking) on an average of 7.00 (SD = 4.27) occasions in the last month (see Results section for gender differences in drinking habits).

Overview of Procedure

Study procedures were approved by the university institutional review board. Participants were recruited through advertisements for a study about "college students' beverage taste preferences." Interested individuals completed a phone screen to determine their eligibility. At the beginning of the phone screen, participants were told that they would be asked to taste alcohol as part of the experiment. Eligible participants were scheduled for an appointment in the laboratory.

All experimental sessions took place in mid-afternoon to control for time of day effects. Sessions were scheduled on weekdays (Monday–Friday).[2] Upon arrival to the laboratory, female participants were administered hormonal pregnancy tests to confirm nonpregnant status, informed consent was obtained, and breath analysis was administered to ensure that the baseline blood alcohol concentration (BAC) was 0. Participants then completed demographics and baseline mood measures. Following this, the mood induction procedure (MIP; described below) took place, and mood measures were re-administered. Next, participants completed a computerized sentence completion task to assess implicit PAEs (ETASK; described below). Mood was re-assessed, and then the Time Line Follow Back (TLFB) interview (Sobell and Sobell, 1992) was administered to assess past 30-day drinking. At this point, approximately 20 minutes had elapsed since the MIP. So, to prolong the mood effects, a subset of International Affective Picture System (IAPS) slides (n = 8, for each mood condition) were re-administered (see description of MIP below) immediately prior to the alcohol administration.

The ad lib alcohol consumption component was completed next. Each participant was informed that they would engage in a 30-minute beer taste test. The participant was seated alone in a small, neutral room containing a table and chair. The research assistant provided the participant with 2 pitchers (each containing 24 ounces or 2 standard drinks) of 2 types of beer. The participant was given a "taste preference" questionnaire and was told that he or she must taste each type of beer, but that he or she could drink as much or as little of either or both types as desired. The research assistant checked on the participant and offered to pour more beer into the participant's glass after 5 minutes, and again after 15 minutes. When the participant had finished the taste testing questionnaire, the research assistant entered and reminded the participant that he or she must remain in this room for the full 30 minutes and offered to pour more beer. At the end of the 30-minute session, remaining beer was cleared from the table and measured to determine the volume of beer the participant had consumed. Fifteen minutes later, a breath analysis was given and the participant's BAC was recorded. Breath analyses were repeated every 15 minutes until the participant's BAC fell below 0.02, and the highest recorded BAC was used as an index of peak BAC achieved in the laboratory. After participants were debriefed, they were paid $50 and released.

Mood Induction Procedure. The MIP was a picture-slide method using the IAPS (Center for the Psychophysiological Study of Emotion and Attention, 1994). This method has been shown to reliably evoke negative, positive, and neutral mood across a number of populations (Davis et al., 1995; Lang, 1995). Moreover, subjective and physiological reactions to the slides map on to the arousal and valence dimensions of human affective responding (see Lang, 1995), with both positive and negative slides eliciting a general arousal response in addition to specific valence responses (pleasant and unpleasant, respectively; Lang et al., 2008).

For this study, we used the normed mood ratings for the IAPS to select 86 slides with the highest average ratings for positive, neutral, and negative mood. Also, we confirmed that slides selected for both the positive and negative mood conditions were high on arousal ratings. The average arousal rating for the subset of IAPS slides that we selected for our negative mood condition (M = 6.06, SD = 0.80) was higher than the overall average arousal rating (M = 5.04) for the entire pool of negatively valenced IAPS slides, $t(89) = 12.08$, $p < 0.001$. The same was true for the mean arousal rating of the slides in the positive mood condition (M = 4.95, SD = 0.93) compared with the pool of positively valenced IAPS slides (M = 4.68), $t(89) = 2.76$, $p = 0.007$. Moreover, arousal ratings for the positive and negative slides used in this study were significantly higher than the mean arousal rating for the neutral slides that were included in the study (M = 3.51, SD = 1.04, ps < 0.001).

For the negative and positive conditions, the IAPS slides were paired with nonlyrical classical musical pieces (McKee et al., 2003) to enhance mood effects. Although research assistants were not blind to mood condition, they followed standardized protocols for interacting with participants to reduce the potential for experimenter bias. The MIP lasted for approximately 9 minutes.

[2]It is possible that participants, knowing that the study would involve alcohol administration, may have scheduled their session on a day they planned to drink with intentions to use the experiment as a means for "preloading" before going out for the evening. However, because participants were randomly assigned to mood condition, we believe that any potential confounding influence of day of week effects was minimized by equalizing the days on which experiments were run across conditions.

Expectancy Task. We assessed both implicit and explicit PAEs with an RT task developed to measure the accessibility of PAEs from memory, which has also been used as measure of attentional bias to PAE information (Palfai et al., 1997; Read and Curtin, 2007). The ETASK is a computerized sentence completion task, in which participants are asked to respond to a series of PAE items (Kushner et al., 1994). Items used in the present analysis came from the PAE subscales—tension reduction, social lubrication, and activity enhancement—that we have examined in previous work (Read and Curtin, 2007).[3] Personality trait items were chosen randomly from the Big Five Inventory (John and Srivastava, 1999) and were used to control for individual differences in RTs. Participants were instructed to respond as quickly and as accurately as possible to PAE and personality statements (e.g., Alcohol helps me … [1 second delay]… RELAX; Usually I… [1 second delay]… TRUST PEOPLE) by pressing 1 of 2 response buttons ("yes" or "no") to indicate whether the stem/target word statement described them. Response times to PAE target words to which participants responded "yes" were averaged across items from each PAE subscale to provide an index of implicit PAEs for each scale (Read and Curtin, 2007). The total number of PAEs endorsed during the task provided an index of explicit PAEs. The ETASK demonstrated adequate reliability in our sample. RTs to each expectancy item were adjusted for individual differences in response time (i.e., mean RT to personality items) before calculating internal consistency estimates. Cronbach's alphas for RTs were 0.84 for tension reduction, 0.84 for social lubrication, and 0.78 for activity enhancement. Also, we observed good internal consistency for our index of explicit PAEs in our sample (alpha = 0.81).

As noted, our use of the term *implicit* refers to expectancy processes that are measured using indirect methods that do not solely rely upon explicit self-report and are thought to tap into automatic cognitive processes (De Houwer, 2006). For the ETASK, participants were asked to respond to items as quickly as possible, so this RT is thought to reflect automatic cognitive processes outside of participants' control (De Houwer, 2006; Fazio and Olson, 2003). Like other measures of implicit PAEs, RTs on the ETASK have been shown to correlate with explicit measures of PAEs as well as with self-reported alcohol use (Read and Curtin, 2007; Read et al., 2004).

Measures

Demographic Information. Demographic data gathered in the assessment battery included gender, age, ethnicity, and year in school.

Affect Grid. This measure was developed to assess arousal (arousal vs. sedation) and valence (positive vs. negative; Russell et al., 1989) dimensions of affect. Both before and after the MIP, participants marked an "X" on a 9 × 9 grid to indicate their current mood within the 2-dimensional space. Each dimension was rated on a 9-point scale with higher values indicating greater endorsement of that dimension.

Self-Reported Alcohol Use. Past 30-day drinking was assessed with the calendar-based TLFB method (Sobell and Sobell, 1992). This interview uses a visual calendar that includes key dates and maximizes respondent recall (Sobell and Sobell, 1992). Participants reported on the number of standard drinks consumed and the number of hours spent drinking for each day. The TLFB interview took approximately 10 minutes to complete.

Laboratory Alcohol Consumption. The measured volume of beer consumed during the taste test and the peak BAC measurement recorded following the taste test were the 2 outcome variables examined in this study.

RESULTS

Descriptives and Bivariate Associations

See Table 1 for descriptive statistics and bivariate correlations. Participants drank an average of 21.81 (SD = 13.45) ounces of beer—nearly 2 standard drinks—during the 30-minute "taste test." The quantity of beer consumed in laboratory and peak BAC were positively associated with self-reported drinking (Table 1); heavier drinkers drank more in the laboratory. The RTs for all 3 PAE scales were correlated with the personality item RT (see Table 1). Thus, all PAE RT analyses included the number of PAEs endorsed and personality RT as covariates. Also, partial correlation analyses controlling for personality item RT showed that the number of PAE items endorsed was negatively correlated with RTs for all 3 PAE scales (pr = −0.38 for tension reduction; pr = −0.32 for social lubrication; and pr = −0.40 for activity enhancement; all $ps < 0.001$). This shows greater PAE accessibility for those with more explicit PAEs.

We also examined gender differences. Controlling for RT to personality items, there were no gender differences on the RTs to any of the PAE scales (all $ps > 0.05$). However, compared with women, men drank more beer in the laboratory ($M = 28.84$, SD = 12.90 vs. $M = 13.51$, SD = 8.46) and had a higher peak BAC ($M = 0.045$, SD = 0.024 vs. $M = 0.031$, SD = 0.026, $ps < 0.01$).

Manipulation Check

We performed analyses of covariance (ANCOVAs) to examine the effect of mood condition on post-mood induction arousal and valence ratings, with baseline ratings as covariates.[4] We also included gender as a moderator in the model. After controlling for baseline arousal ratings, there was a significant omnibus effect of mood condition on post-mood induction arousal, $F(2, 138) = 5.23, p = 0.006$. There was no significant effect of gender ($p = 0.763$), nor was there a significant interaction between gender and mood condition ($p = 0.279$). Contrast tests showed that relative to those in the neutral condition ($M = 3.96$, SE = 0.25), significantly greater arousal was reported by participants in both the positive ($M = 4.67$, SE = 0.22, $p = 0.033$) and negative ($M = 5.05$, SE = 0.23, $p = 0.002$) conditions. This confirmed that both positive and negative moods included a component of heightened arousal.

A significant mood condition effect also was observed for post-mood induction valence ratings, $F(2, 138) = 93.59$, $p < 0.001$. Contrast tests showed that relative to the neutral

[3]In order to limit the duration of the ETASK, items from the fourth subscale (performance enhancement; Kushner et al., 1994) were not included in the ETASK (consistent with Read and Curtin, 2007) because they were the least relevant to the mood manipulation.

[4]One participant was excluded from the manipulation check analysis due to missing data on baseline mood measures. Sample sizes for the manipulation check were neutral ($n = 43$), negative ($n = 48$), and positive ($n = 54$). Covariate adjusted means are presented for valence and arousal ratings.

Table 1. Intercorrelations, Means, and Standard Deviations of Reaction Times and Self-Report and Laboratory Alcohol Consumption

	1	2	3	4	5	6	7	8	9	10	*M*	SD
1. RT-TR	1										1,654.98	393.54
2. RT-SL	0.55**	1									1,621.86	440.85
3. RT-AE	0.56**	0.61**	1								1,637.55	395.06
4. RT-PI	0.63**	0.57**	0.54**	1							1,685.75	312.60
5. PAE-tot	−0.38**	−0.34**	−0.40**	−0.13	1						13.58	5.09
6. Peak BAC	0.07	0.04	0.00	0.06	0.08	1					0.04	0.03
7. Volume	0.17*	0.07	−0.02	0.14†	0.07	0.82**	1				21.81	13.45
8. Alc-freq	0.06	0.13	0.02	0.13	0.07	0.33**	0.35**	1			2.70	1.19
9. Alc-quant	0.01	0.04	−0.09	0.14	0.11	0.29**	0.40**	0.60**	1		17.87	12.05
10. Alc-heavy	−0.07	−0.02	−0.16†	0.06	0.12	0.28**	0.31**	0.57**	0.88**	1	6.99	4.27

RT-TR, reaction time (ms) for tension reduction expectancies; RT-SL, reaction time (ms) for social lubrication expectancies; RT-AE, reaction time (ms) for activity enhancement expectancies; RT-PI, reaction time (ms) for personality items; PAE-tot, total number of expectancies endorsed; Peak BAC, peak blood alcohol concentration achieved in the laboratory; Volume, volume (oz) of beer consumed in the laboratory; Alc-freq, self-reported typical weekly frequency of drinking; Alc-quant, self-reported typical weekly quantity of alcoholic beverages consumed; Alc-heavy, self-reported number of heavy drinking days over the past 30 days.
†$p < 0.10$, *$p < 0.05$, **$p < 0.01$.

condition ($M = 7.34$, SE = 0.20), participants reported greater pleasant affect in the positive mood condition ($M = 7.32$, SE = 0.19, $p = 0.003$) and less in the negative mood condition ($M = 3.64$, SE = 0.21, $p < 0.001$). Again, gender and the mood condition × gender interaction were not significant (*p*s > 0.606). Thus, consistent with past research using the IAPS (see Lang, 1995), the mood induction appears to have produced both general arousal (i.e., positive and negative mood conditions vs. neutral) and specific valence effects (i.e., positive vs. negative mood conditions).

Mediation Analysis

To test the hypothesis that the effects of mood on alcohol consumption would be mediated by latency to endorse specific, mood-congruent PAEs, we followed Baron and Kenny's (1986) steps for testing mediation. According to this procedure, a mediational effect can be present only if 2 direct effects first are established: (i) the effect of mood condition on alcohol consumption and (ii) the effect of mood condition of latency to endorse PAEs. We included gender and the interaction between mood and gender in our models to examine gender as a moderator of the mediated pathway.

To determine whether mood condition influenced drinking, we conducted ANCOVAs with mood condition, gender, and the mood × gender interaction as the independent variables. Typical quantity and frequency of alcohol use were included as covariates. With volume of beer as the dependent variable, we did not observe a significant main effect for mood condition, $F(2, 138) = 0.66$, $p = 0.520$, nor a mood × gender interaction $F(2, 138) = 1.93$, $p = 0.149$. Similarly, with peak in-laboratory BAC as the dependent variable, there was no significant main effect for mood condition, $F(2, 138) = 0.35$, $p = 0.708$, or mood × gender interaction $F(2, 138) = 0.79$, $p = 0.456$. There was a significant main effect of gender for both volume, $F(1, 138) = 43.29$, $p < 0.001$, and peak BAC, $F(1, 138) = 5.24$ $p = 0.024$, with means showing that males consumed more beer and had higher BACs than females.

Given that mood condition did not have a direct influence on in-laboratory alcohol consumption and gender did not moderate the association between mood condition and drinking, the first criterion in the test for mediation was not satisfied. We did not proceed with the mediation analysis as there was no pathway from mood to drinking to be mediated.

Moderation Analyses

We next sought to determine whether the effect of PAEs on drinking might be mood dependent (moderated), rather than mood derived (as a mediated pathway would suggest). To do so, we constructed general linear models for each of the 2 drinking outcomes (peak BAC, volume). Continuous predictors were standardized to facilitate interpretation of the results. Each model included the covariates (PAEs endorsed, RTs to personality items, typical quantity, and frequency of drinking) and RTs to 3 expectancy scales as predictors. To test our specific hypotheses based on the 2-dimensional model of human affective response (Lang, 1995; Russell, 1980), 2 orthogonal mood contrasts were included in each model to probe for arousal (the mean of the positive and negative mood conditions vs. the neutral condition) and valence (negative vs. positive mood conditions) effects. Gender was included in the model to test its role as a moderator. Three-way interactions between each ETASK variable, mood contrast, and gender were tested. Regression diagnostics conducted prior to analyses revealed no multivariate outliers.

Alcohol Volume. The overall model accounted for 37% of the variance in volume of beer consumed, adjusted $R^2 = 0.371$, $F(37, 108) = 3.31$, $p < 0.001$. We observed a significant 3-way interaction between gender, the arousal mood contrast, and latency to endorse tension reduction PAEs, $B = -18.43$, $t(108) = -2.48$, $p = 0.015$, 95% CI [−33.18, −3.69]. The 3-way interactions involving RTs to the other PAE scales were not significant (all *p*s > 0.385). To probe the significant 3-way interaction, we examined the 2-way interactions between RT to tension reduction PAEs and mood conditioned on male and female gender. For males, there was a significant 2-way interaction between the arousal mood contrast and latency to endorse tension reduction PAEs, $B = 13.91$, $t(108) = 2.70$, $p = 0.008$, 95% CI [3.70, 24.12], but this interaction was not significant for females, $B = -4.52$, $t(108) = -0.84$, $p = 0.401$, 95% CI [−15.15, 6.10]. We probed the 2-way interaction for men and found a significant simple effect of latency to endorse tension reduction PAEs in the context of arousal, $B = 7.42$, $t(108) = 3.58$, $p = 0.001$, 95% CI [3.31, 11.53], but not neutral mood, $B = -6.49$, $t(108) = -1.38$, $p = 0.171$, 95% CI [−15.83, 2.85]. So, latency to endorse tension reduction PAEs was a stronger predictor of volume of alcohol consumed in the context of arousal (i.e., positive and negative mood conditions) compared with neutral mood, and this effect applied only to men (see Fig. 1).

Peak BAC. The overall model accounted for 8.0% of the variance in BAC, adjusted $R^2 = 0.080$, $F(37, 108) = 1.34$, $p = 0.123$.[5] The pattern of findings for peak BAC mirrored that for volume. There was a significant 3-way interaction between gender, the arousal mood contrast, and latency to endorse tension reduction PAEs, $B = -0.035$, $t(108) = -2.00$, $p = 0.048$, 95% CI [−0.069, −0.001], but none of the other 3-way interactions were significant (all ps > 0.420). Inspection of the conditional 2-way interactions revealed a significant interaction between the arousal mood contrast and RTs for tension reduction PAEs for men, $B = 0.028$, $t(108) = 2.34$, $p = 0.021$, 95% CI [0.004, 0.052] but not for women, $B = -0.007$, $t(108) = -0.52$, $p = 0.602$, 95% CI [−0.031, 0.018]. Again, when conditioned on male gender, there was a significant simple effect of latency to endorse tension reduction PAEs in the context of arousal, $B = 0.013$, $t(108) = 2.60$, $p = 0.011$, 95% CI [0.003, 0.022], but not neutral mood, $B = -0.016$, $t(108) = -1.41$, $p = 0.161$, 95% CI [−0.037, 0.006] (Fig. 2).

DISCUSSION

As interest in implicit alcohol expectancy processes grows, evidence that these processes predict actual proximate alcohol consumption is essential. Remarkably, with only a few exceptions (e.g., Ostafin et al., 2008; Payne et al., 2008; Roehrich and Goldman, 1995; Stein et al., 2000), little research has attempted to acquire this evidence. The present study provides a theory-driven examination of implicitly measured PAE processes as determinants of immediate alcohol consumption. Rather than confirming the mediational hypothesis derived from an SLT perspective, our data supported an alternative model, suggesting that both mood and gender moderate the link between implicit PAEs and immediate alcohol consumption. The findings of this study are consistent with expectancy theory, which posits that the influence of PAEs on drinking emerges only in relevant contexts (Goldman et al., 1999; Stein et al., 2000).

Mood, Gender, PAE Processes, and Alcohol Consumption

We found that response times to tension reduction PAEs more strongly predicted drinking and peak in-laboratory BAC in the context of arousal relative to neutral affect. Moreover, this effect was observed only for men, a finding that is consistent with past studies (Kidorf et al., 1995; Read et al., 2004; Thompson et al., 2009). This may reflect the tendency for men to have more ingrained, habitual patterns of using alcohol for tension reduction reasons (Cooper et al., 1992). Over time, repeatedly associating alcohol use with tension reduction may lead to greater automaticity of tension reduction PAEs, along with a stronger relationship between these implicit PAEs and drinking.

Also, because tension reduction PAEs generally pertain to relaxation and calming effects (e.g., "drinking helps me to relax"), it stands to reason that they may relate to drinking behavior in the context of general arousal regardless of valence (positive or negative). Indeed, many of the items did not include specific emotional valence content (e.g., "drinking helps me to relax" and "drinking helps me deal with boredom"). Although we predicted that affective valence also would play a role, the association did not differ across positive and negative mood conditions for either gender.

The fact that we did not find support for our prediction that mood would influence the association between activity enhancement PAEs and drinking may again reflect the importance of context. Because activity enhancement PAEs reference excitement and stimulation, they may have been less relevant for influencing drinking as there was not much opportunity for excitement or stimulation in the laboratory context. Instead, it seems that tension reduction PAEs—which deal with relaxation promotion, boredom reduction, etc.—may have been more relevant.

The magnitudes of the effects support the practical significance of these findings. For example, in the context of arousal, a 1-standard deviation increase in latency to endorse tension reduction PAEs predicted an increase of 7.42 oz of beer consumed for men—more than half of a standard drink. For peak BAC, a 1-standard deviation increase in tension reduction PAE response latency predicted a BAC increase of 0.013 for men. Given that the mean peak BAC in this sample was 0.04, it is notable that these RTs meaningfully predicted BACs even when drinking was being observed nonnaturalistically (in a laboratory mid-afternoon).

[5]The overall model predicting in-laboratory BAC was not significant, which may be partially a result of the large number of nonsignificant interaction terms in the model. However, because we had specific, a priori hypotheses about the unique influence of PAEs on drinking in particular mood contexts, we probed significant interactions and interpreted significant regression coefficients despite the nonsignificance of the overall model (Bedeian and Mossholder, 1994).

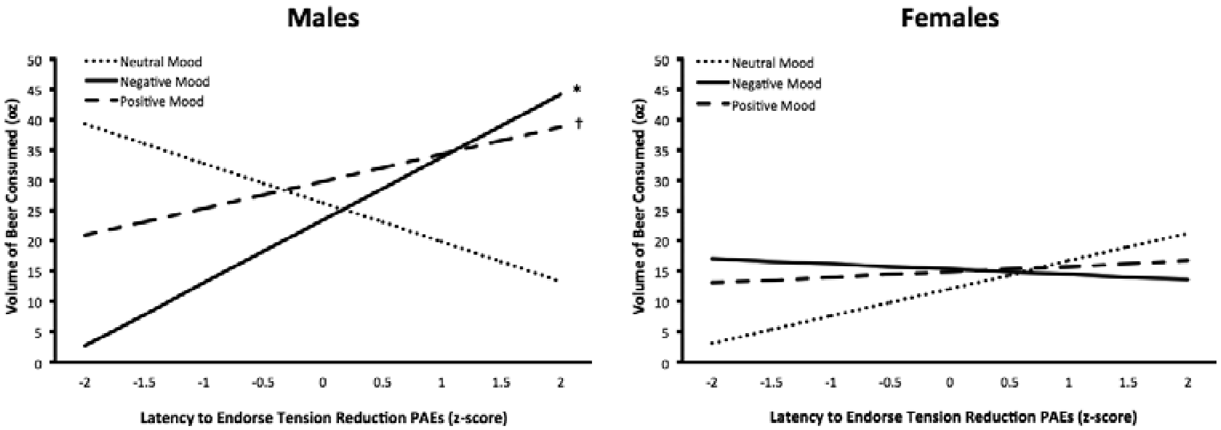

Fig. 1. Association between reaction time (RT) to tension reduction expectancies (*z*-score) and volume of beer consumed (oz) in the laboratory by gender and mood condition. A significant interaction between mood condition and RT to tension reduction expectancies was found for men but not for women. *Simple slope is significant at 0.05 level. †Simple slope is marginally significant at 0.10 level. PAEs, positive alcohol expectancy.

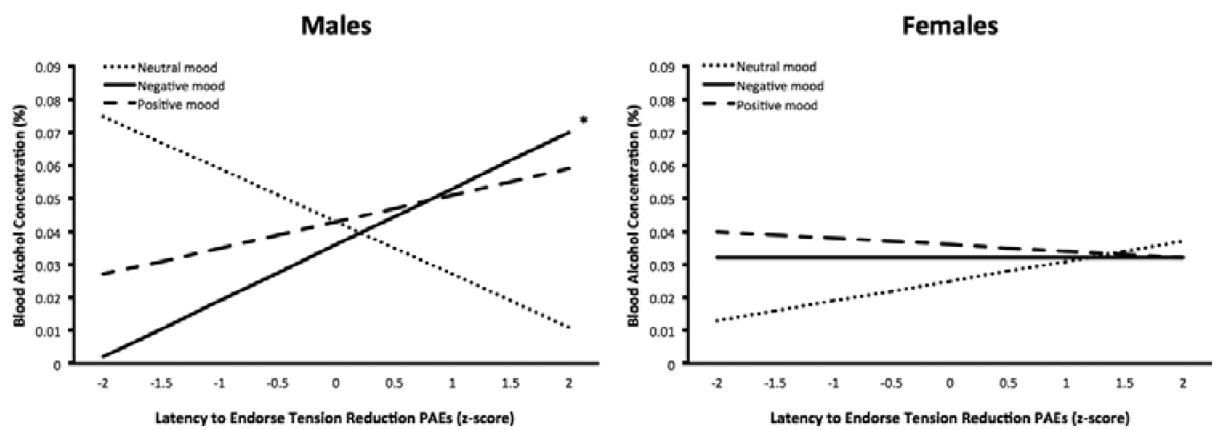

Fig. 2. Association between reaction time (RT) to tension reduction expectancies and peak blood alcohol concentration in the laboratory by gender and mood condition. A significant interaction between mood condition and RT to tension reduction expectancies was found for men but not for women. *Simple slope is significant at 0.05 level. PAEs, positive alcohol expectancy.

Accessibility Versus Attentional Bias

Our data speak to the question of whether implicitly measured PAE processes that influence immediate drinking reflect greater accessibility of alcohol beliefs from memory or biased attention to alcohol-relevant information. Consistent with past research (e.g., Palfai and Wood, 2001; Read and Curtin, 2007; Read et al., 2004), we found that individuals with stronger explicit PAEs were quicker to access these PAEs from memory. However, our data also show that PAE accessibility may not be the process that is most relevant to proximal drinking behavior. In this study, it was *slower* RT to PAEs that was associated with greater alcohol consumption and peak BAC in the relevant mood context. This finding is consistent with those of Read and Curtin (2007), who found that exposure to alcohol cues (vs. neutral cues) leads to slower PAE RT (see also Kramer and Goldman, 2003). In the present study, participants were "cued" by the anticipation of an imminent drinking situation, and this cue may have primed the motivation to drink (Robinson and Berridge, 1993). As noted before, slower RTs to PAE items may occur when PAEs match a current motivational state; rather than facilitating endorsement, they automatically capture attention to the degree that they deplete resources needed to make a response on the RT task.

Given the dearth of research examining PAE processes relative to actual drinking behavior, our finding that RTs to PAE items predicted the amount of alcohol consumed in the laboratory represents a significant contribution. That men who exhibited slower RTs to mood-relevant PAE items also consumed more alcohol and achieved higher BACs is evidence that implicitly measured PAE processes have an influence over in-the-moment drinking. In a drinking situation, drinking depends not only on stable, declarative beliefs about alcohol's positive effects, but also on mood-relevant automatic cognitive processes, at least for men.

SLT and the Mediation Hypothesis

With this study, we have provided a much needed experimental test of a dominant SLT-based model describing a mediated pathway from mood to mood-relevant expectancy processes, and eventually, to drinking. Based on this model, we expected to find that latency to endorse specific PAEs would mediate the relation between mood condition and alcohol consumption. However, this hypothesis was not supported as mood condition did not influence in-laboratory drinking.

The lack of direct effects of mood condition on in-laboratory alcohol consumption is inconsistent with at least some prior work (e.g., Noel and Lisman, 1980). It may be that the type of affect induced by looking at pictures and listening to classical music was not analogous to the type of mood states that might influence real-world drinking patterns for college students (e.g., stress over failing an exam, excitement created by a party, etc.). It also is possible that the mood effects did not continue into the drinking paradigm, as there was a time lag between the initial MIP and the alcohol administration. Although we did re-administer a subset of the IAPS slides just prior to the drinking paradigm with the intention of prolonging the mood effects, we do not have a measure of mood immediately preceding drinking, which limits our ability to determine whether the groups differed on mood immediately before drinking commenced. Future studies could attempt to address this limitation by positioning the ad lib consumption component of the study closer in time to the MIP.

FUTURE DIRECTIONS

The present study points to several directions for continued inquiry. First, there are aspects of the ETASK which limit the interpretation of these indices as pure measures of explicit and implicit processes. For example, the correlation between endorsement frequency and RT might be influenced by factors particular to the task, and so interpreting these as measures of explicit versus implicit PAEs may not be straightforward. Furthermore, rather than instructing participants to ignore the semantic content of items as is done in other tasks measuring attention bias (e.g., the Stroop task; Cox et al., 2006), the ETASK requires participants to consciously process the semantic content of the items. Thus, slower RT in this task may be a function of explicit attention allocation and deliberative processing of motivationally relevant information. Future work should incorporate additional measures to help disentangle explicit and implicit expectancy processes.

Another limitation was the homogeneity of the sample, which consisted of fairly heavy-drinking college students. Future research should examine these processes in less alcohol-involved individuals and clinical populations. Future studies also should incorporate drinking paradigms with improved ecological validity (i.e., examinations in contexts more typical of real-world drinking situations) to further increase the generalizability of the findings. In our study, we sought to minimize the potential influence of experimenter bias by standardizing the protocol across conditions. Still, our research assistants were not blind to mood condition, and thus, we cannot rule out the possibility of experimenter bias.

In this study, the positive and negative mood conditions were associated with higher arousal compared with the neutral mood condition. Thus, we interpreted the moderating effect of mood condition as a function of differences in arousal. Yet, a more direct test of the moderating role of arousal in the association between implicit PAEs and drinking would involve direct assessment of individual differences on arousal, which would require the use of a more comprehensive and reliable measure of mood than was used in the present study. Thus, future studies are needed to assess the role of individual differences in mood in the link between PAEs and alcohol consumption.

IMPLICATIONS AND CONCLUSIONS

Our findings show that drinking behavior may be at least partially influenced by automatic cognitive processes. We found that mood moderates the association between implicit PAEs and alcohol consumption. These findings are consistent with expectancy theory, which posits that the influence of PAEs on drinking will emerge only in a relevant context. Thus, expectancy-based interventions should target implicit PAEs in addition to explicit ones. This is especially important because it has been argued that implicit alcohol-related cognitions have a powerful, automatic influence over drinking behavior that may thwart conscious attempts to regulate alcohol consumption, especially when self-control resources are depleted (Ostafin et al., 2008; Wiers and Stacy, 2006). The development of interventions that target implicit cognition is under way (Wiers and Stacy, 2006). Also, because the influence of implicit PAEs on immediate drinking behavior appears to be most pronounced in particular mood contexts, interventions might focus on helping individuals recognize the mood conditions under which their positive beliefs about alcohol are most likely to guide their immediate drinking behavior. In particular, teaching individuals to exercise conscious control over drinking in risky mood states may help reduce the impact that implicit PAEs have on alcohol consumption.

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