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Effects of Negative and Positive Mood Phrases on Priming of Alcohol Words in Young Drinkers With High and Low Anxiety Sensitivity

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This study investigated whether potential emotional cues for drinking activate alcohol concepts in young drinkers. Participants were 84 university freshmen with high or low levels of anxiety sensitivity (AS). A verbal priming task measured activation (i.e., priming) of alcohol concepts (e.g., beer) by positive and negative mood phrases. Time to read alcohol target words was the dependent measure. Negative mood phrases consistently primed alcohol targets; positive mood phrases did not. Degree of negative mood priming did not differ as a function of gender or AS. Reported tendency to drink in bad moods predicted negative mood priming in women, whereas men showed negative mood priming irrespective of their reported drinking tendency. A general association between negative mood priming and severity of alcohol problems also emerged.

The events surrounding alcohol use have been implicated in the development and maintenance of problem drinking (Abbey, Smith, & Scott, 1993; Cooney, Litt, Morse, Bauer, & Gaupp, 1997; Rohsenow et al., 1994; Smith, Goldman, Greenbaum, & Christiansen, 1995). The associations between alcohol and these events are represented in semantic (i.e., verbal, conceptual) memory networks (Baker, Morse & Sherman, 1987; Rather, Goldman, Roehrich, & Brannick, 1992). Activation of alcohol-related memory structures in experimental settings has been shown to predict future alcohol use outside the laboratory (Stacy, 1997) and to induce drinking behavior within the laboratory (Roehrich & Goldman, 1995; Stein, Goldman, & Del Boca, 2000). These findings show that alcohol memory structures play an important role in alcohol use and problem drinking.

A procedure widely used in cognitive science to assess associative memory structures is the *semantic priming paradigm*. In this paradigm, faster responses to a target word following exposure to a prime word reveal associations between the prime and target concepts in memory (Meyer & Schvaneveldt, 1971). For example, the prime word *salt* will reduce response time (RT) to its conceptual associate, *pepper*, relative to a conceptually unrelated prime word like *tree*. Moreover, the stronger the association between the prime and target concepts, the greater the reduction in RT (Collins & Quillian, 1969).

Semantic priming effects typically involve RT differences of less than 100 ms (Neely, 1991). This is important, because such time differences are below the threshold of strategic control (Merikle, Joordens, & Stolz, 1995). In other words, semantic priming effects reflect automatic (i.e., effortless, involuntary) information processing (McNamara, 1992).[1]

Semantic priming procedures have been adapted to assess associative memory networks related to addiction (e.g., Feldtkeller, Weinstein, Cox, & Nutt, 2001; Weinstein, Feldtkeller, Law, Myles, & Nutt, 2000). In one of the first such studies, Hill and Paynter (1992) found that verbal priming of the alcohol network (e.g., drink—beer) reliably identified alcohol-dependent drinkers. Zack, Toneatto, and MacLeod (1999) assessed the ability of mood-related words to prime alcohol words in problem drinkers. This study

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[1] In this article, the term *priming* is used when referring to experimental effects—faster RT to a target word following exposure to a conceptually related as opposed to an unrelated prime phrase. The term *activation* is used when referring to the processes presumed to underlie these changes in RT (e.g., recruitment of an associate from memory or increased availability of a class of associates due to exposure to a stimulus linked with those associates in the memory network). Similarly, the term *prime* is used to describe experimental eliciting stimuli (phrases), and the term *cue* is used to describe such eliciting stimuli (e.g., mood states) outside the experimental context.

found that negative mood words (e.g., *worry*) significantly reduced RT to alcohol targets (e.g., *beer*) in problem drinkers with high levels of psychiatric distress, and that the degree of priming was predicted by a participant's reported tendency to drink during negative mood states.[2]

Weingardt, Stacy, and Leigh (1996) found that phrases describing the expected effects of alcohol primed RT to alcohol targets in university students, and that the degree of priming correlated with the severity of alcohol use. These findings corroborate previous research using self-report methodologies (Christiansen, Goldman, & Brown, 1985; Rather et al., 1992).

The present study further explored alcohol-related memory structures in young drinkers. As in the previous study with problem drinkers (Zack et al., 1999), we were interested in the ability of mood-related cues to automatically activate alcohol concepts in young drinkers. Self-report evidence suggests that both positive and negative moods may occasion alcohol use in young drinkers (Cooper, Agocha, & Sheldon, 2000; Evans & Dunn, 1995; Moore, 1988). Drinking at social gatherings—parties, celebrations—that are associated with positive moods is normative and nonproblematic for most drinkers (Kilty, 1990). In contrast, epidemiological data indicate that drinking in negative moods is consistently associated with problem drinking, both in the general population and in university students (Carey & Correia, 1997; Carpenter & Hasin, 1999; Holahan, Moos, Holahan, Cronkite, & Randall, 2001). These epidemiological data suggest that negative mood cues may be more effective or reliable than positive mood cues in recruiting alcohol concepts from memory in university drinkers (see Baker et al., 1987; Rather et al., 1992).

Drinking to regulate negative mood tends to be more prevalent in women than in men (Brady & Randall, 1999; Olenick & Chalmers, 1991; Perkins, 1999; Stewart, Karp, Pihl, & Peterson, 1997), although the literature on this issue is somewhat mixed (see Park & Levenson, 2002; Rutledge & Sher, 2001). This drinking tendency is also more common in individuals with certain personality profiles. In particular, young drinkers with high levels of anxiety sensitivity (AS) tend to drink more during negative mood states than their low anxiety-sensitive peers (Samoluk & Stewart, 1998; Stewart et al., 1997; but see also McWilliams & Asmundson, 1999). AS involves a tendency to respond catastrophically to ambiguous cues (e.g., a rapid heart rate means "I'm having a heart attack"; butterflies in the stomach mean "I'm about to be publicly humiliated"). In addition to their strong cue reactivity, high anxiety-sensitive students tend to experience more alcohol-related problems (Samoluk & Stewart, 1998). Thus, gender and AS are two trait variables likely to influence activation of alcohol concepts by negative mood cues. Conversely, activation of alcohol concepts by negative mood cues may contribute to the emergence of problem drinking in women and high anxiety-sensitive drinkers.

The present study adapted Weingardt et al.'s (1996) phrase-priming procedure to assess activation of alcohol targets by positive and negative mood-related cues. The effects of gender and AS were also examined in a factorial design. The epidemiological data led us to predict that negative mood-related phrases would prime RT to alcohol targets more strongly in women and high anxiety-sensitive participants, and that the degree of priming would coincide with a reported tendency to drink in negative mood states. This literature also predicted that negative mood priming would be associated with the severity of alcohol problems.

Method

Participants

Participants were students from an introductory psychology class ($N = 593$; 359 women, 234 men) at the University of Toronto who were screened for AS and drinking tendency during class at the beginning of the semester. To be eligible, a student must have consumed at least one alcoholic drink in the 7 days prior to screening and scored below the 30th percentile (low AS) or above the 70th percentile (high AS) for their gender on AS on the basis of the current sample. The AS inclusion criteria were designed to maximize statistical power by promoting a large group difference (high vs. low) in mean AS score, while at the same time permitting a large sample size. The cut-off scores for the low-AS group were 15 for women and 12 for men. The cut-off scores for the high-AS group were 38 for women and 34 for men. On the basis of these inclusion criteria, 84 participants (28 men, 56 women; 45 low AS, 39 high AS) were tested. They were paid $25 at the end of the test session.

Apparatus

The Anxiety Sensitivity Index—Revised (ASI; Peterson & Reiss, 1992) was used to measured AS. Participants reported how strongly they agreed with each of 16 statements about anxiety-provoking situations (e.g., "It scares me when I am nervous"), from 0 (*very little*) to 4 (*very much*), with the sum of these ratings determining their AS score.

A lifestyle questionnaire, designed to divert attention from the specific issue of alcohol use, identified current consumers of alcohol and measured drinking tendency. The questionnaire was developed in our laboratory to assess the extent to which eligible respondents perceive good and bad moods to be discriminative stimuli for drinking alcohol. Participants rated their tendency to engage in a variety of behaviors (eat junk food, drink caffeine, smoke cigarettes, drink alcohol) when they experienced good moods and bad moods. There were four questions for positive moods and four questions for negative moods, one for each of these behaviors. Participants were instructed to select the option that best described their general tendency to engage in each behavior. Thus, a single item assessed tendency to drink alcohol in good moods: "In general, when I am in a very good mood (e.g., happy, relaxed, pleased) I am more likely, less likely or not especially likely to drink alcohol." Likewise, a single item assessed tendency to drink in bad moods: "In general, when I am in a very bad mood (e.g., sad, anxious, upset) I am more likely, less likely or not especially likely to drink alcohol." The ASI and lifestyle questionnaire were given during class time at the start of the semester.

[2] Although the terms *mood*, *affect*, and *emotion* may have different clinical connotations, in the interests of narrative fluency we have used these terms interchangeably in this article.

Additional paper-and-pencil questionnaires were administered after the priming task on the test session. A personal drinking questionnaire (PDQ; Vogel-Sprott, 1992) measured the level and frequency of alcohol use. The Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, De La Fuente, & Grant, 1993) assessed the severity of drinking-related problems (e.g., blackouts). The State–Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970) measured typical levels of anxiety and anxiety at test. The Beck Depression Inventory (BDI; A. T. Beck & Beck, 1972) measured depressive symptoms in the 2 weeks preceding the test session. The Eysenck Personality Inventory (EPI; H. J. Eysenck & Eysenck, 1963) measured extraversion and neuroticism. The EPI Lie scale measured the bias to answer items in a socially appropriate manner (i.e., self-presentation bias). The revised Inventory of Drinking Situations (IDS), which assesses the frequency (0%–100%) of drinking at least one alcoholic drink in eight types of situations, has been used in previous studies of undergraduate students (Bruce & Pihl, 1997). In the present study, the IDS was administered along with the other self-report scales after the priming task, to validate participants' prior responses on the lifestyle questionnaire.

A PC equipped with MEL software (Version 2.01; Psychology Software Tools, Pittsburgh, PA) administered the priming task and recorded the data with millisecond accuracy. The task was run entirely within MS-DOS, ensuring against RT anomalies that can arise when MEL is run within Windows (Myors, 1999). Prime stimuli were phrases, and target stimuli were single words, presented in lowercase, 14-point font in the center of the computer screen. In accordance with Weingardt et al. (1996), targets were degraded with asterisks (e.g., b*e*e*r) to enhance priming effects (Stanovich & West, 1983).[3] A microphone attached to the PC and held in place by a goose-neck clamp registered vocal reading responses. The microphone was calibrated to register responses that exceeded a threshold volume consistent with a clear speaking voice. This minimized activation of the voice key by ambient or unintended noises (e.g., coughs). Such responses and other errors (e.g., misread targets) were coded online by an experimenter using a button box (Psychology Software Tools) that interfaced with the PC. The vocal responses were digitized to RT scores by the MEL software. RTs from spoiled and error trials were excluded from the main analyses of RT (i.e., priming effects).

Procedure

Prospective participants who met inclusion criteria on the ASI and lifestyle questionnaire were contacted by telephone and invited to attend a test session. Test sessions were scheduled at least 2 weeks after initial screening (mean interval = 8 weeks; range = 2–20 weeks). Participants were tested individually. Upon participants' arrival at the laboratory, an experimenter explained the study, describing the priming task as a test of word recognition. Participants then signed a consent form, which confirmed that the study had received institutional review board ethics approval, and proceeded to the task.

During the task, participants sat facing the computer screen at a distance of 60 cm. Before commencing, the experimenter provided a standard set of instructions. Participants were told that they would be performing a series of trials. On each trial, a fixation stimulus would appear to focus their attention in the right spot. Shortly thereafter, a phrase would appear in the same location, which in turn would be replaced by a single word. Participants were instructed to read the phrase silently and to read the single word that followed it out loud as quickly and accurately as possible. No indication was given about the nature of the primes or targets, or the possible relation between them.

Stimuli and Conditions for the Priming Task

The task consisted of 20 initial practice trials, plus 10 trials in each of two alcohol target conditions, and 60 trials in a semantic control condition (see below). The practice trials enabled the participant to gauge how loud he or she had to speak to trigger the microphone (a successful response extinguished the target stimulus). Fifty percent of trials in each experimental condition contained related or hypothetically related prime–target pairs (test). The other 50% contained explicitly unrelated prime–target pairs (baseline). Conditions and items were randomly interspersed over trials. Within conditions, targets were randomly paired with test or baseline primes. Thus, each participant saw a different set of prime–target pairs.

The stimulus parameters for the task were identical on each trial. Participants saw a fixation stimulus (&&&&; 250 ms), followed by the prime phrase (2.5 s) and the target word (until response), with a blank screen (500 ms) occurring between trials. The entire task took about 12 min to complete, after which participants filled out the PDQ, AUDIT, STAI, BDI, EPI, and IDS. Upon completion of these scales, participants were paid and dismissed. To reduce "contamination" of future participants as a result of information sharing among classmates, debriefing was carried out by mail (Roehrich & Goldman, 1995).

Test prime stimuli were words derived from scales used to measure positive and negative affect (Chambless, Caputo, Bright, & Gallagher, 1984; Zuckerman & Lubin, 1965), including states specifically relevant to anxiety-sensitive individuals (e.g., *frightened*). Baseline primes were neutral words (e.g., *fragrant*) derived from a compendium of word norms (Kucera & Francis, 1967) in order to match their corresponding test primes on nonsemantic moderators of priming (see Neely, 1991) including first letter, length, and frequency of occurrence in print. Target stimuli (e.g., *beer*) were derived from previous research that tested verbal priming of alcohol concepts (Weingardt et al., 1996; Zack et al., 1999).

The conditions for the priming task are outlined in Table 1. These conditions were derived from Weingardt et al. (1996). Thus, RT to alcohol targets was examined when prime phrases denoted positive or negative mood states. RT in these test conditions was compared with RT in a baseline condition in which targets were preceded by the same phrase (When he was ____ he would have a ____), but with a neutral, unrelated descriptor. The gender of the subject in these phrases (he/she) was equated and randomized over trials in each condition. A positive difference (baseline minus test), reflecting faster test RT than baseline RT, indicated priming.

Table 1 also shows a semantic concept condition (see Weingardt et al., 1996). This condition measured priming of semantic targets by related versus unrelated neutral phrases and controlled for individual differences in reactivity to semantically related and unrelated stimuli, which are common in semantic priming studies (Plaut & Booth, 2000). Faster overall mean RT to related semantic targets than to unrelated semantic targets would also confirm that participants were in fact reading the prime phrases as instructed.

Data Analytic Plan

Participant characteristics were analyzed by factorial analyses of variance (ANOVAs) with the between-subjects variables AS group and gender as factors (see Table 2 below). Frequency data were analyzed by chi-square tests of independence.

[3] The complete list of prime and target stimuli is available from Martin Zack upon request.

Table 1
Conditions for the Priming Task

Relation	Prime	Target[a]	Example
		Alcohol concepts	
Test	POS	ALC	When she was *happy* she would have a—pint
Baseline	UNR	ALC	When she was *hearing* she would have a—pint
Test	NEG	ALC	When he was *frightened* he would have a—beer
Baseline	UNR	ALC	When he was *fragrant* he would have a—beer
		Semantic concepts	
Test	REL	SEM	The accountant balanced the—books
Baseline	UNR	SEM	The accountant balanced the—ball

Note. POS = positive mood; ALC = alcohol-related; UNR = unrelated; NEG = negative mood; REL = hypothetically related; SEM = semantic.
[a]POS and NEG prime phrases each (randomly) used 50% male (he) and 50% female (she) subjects.

To validate the lifestyle questionnaire, Pearson's correlational analyses, with Bonferroni correction to control family-wise alpha, were used to assess the relation between ratings of bad mood drinking tendency and good mood drinking tendency and each of the eight subscales of the IDS (Bruce & Pihl, 1997).

With respect to task performance, preliminary ANOVAs were used to assess extraneous variables that could influence priming of alcohol targets, including frequency of outlier scores, priming (i.e., test RT vs. baseline RT) of semantic targets, and RT to alcohol targets on baseline trials (i.e., unrelated primes). Where the results of these analyses indicated differences as a function of AS group, gender, bad mood drinking tendency, or good mood drinking tendency, the dependent variable in question was included as a covariate in the analyses of alcohol priming effects. To ensure that the homogeneity of regression assumption for the ANCOVAs had been met, preliminary ANOVAs of alcohol priming effects, which included each potential covariate as a factor in the analysis, were performed (Norusis, 1994). The lack of significant interactions between any potential covariate and any of the four between-subjects variables in these analyses (*ps* $>$.19) confirmed homogeneity of regression.

Table 2
Mean (and SD) Demographic, Personality, and Alcohol Use Scores for University Freshmen Broken Down by Gender and Group

Index	Low-AS men	Low-AS women	High-AS men	High-AS women
n	13	32	15	24
Age	20.5 (3.3)	19.2 (1.4)	19.8 (1.9)	20.3 (6.6)
		Personality-related variables		
ASI	10.9 (3.9)	15.6 (4.1)**	35.1 (6.0)	40.3 (6.8)*
STAI-s	31.1 (7.2)†	33.3 (7.6)†	42.8 (11.7)	41.1 (12.1)
STAI-t	33.0 (8.9)	40.9 (9.6)	32.3 (4.6)	50.0 (9.6)*
BDI	2.2 (2.3)†	4.2 (3.4)†	6.5 (6.1)	7.8 (5.9)
EPI-e	14.7 (3.1)	13.8 (4.0)	13.5 (5.5)	13.0 (4.3)
EPI-n	8.9 (4.3)†	11.1 (4.1)†	13.3 (4.9)	14.9 (5.7)
EPI-l	2.5 (1.5)	2.9 (1.5)	2.6 (1.5)	2.8 (1.8)
		Alcohol use variables		
AUDIT	6.5 (4.0)	5.0 (3.4)	8.3 (6.0)	6.5 (5.7)
PDQ-freq	1.1 (0.9)	0.7 (0.4)	1.1 (1.1)	1.0 (1.1)
PDQ-vol	1.0 (0.6)	1.2 (0.7)	1.1 (0.5)	1.0 (0.8)
PDQ-dur	3.5 (1.3)	3.5 (1.6)	4.6 (3.3)	3.5 (1.6)
PDQ-rate	0.4 (0.5)	0.5 (0.5)	0.3 (0.2)	0.7 (1.8)
Drink years	3.2 (3.7)	2.0 (1.4)	1.8 (1.2)	3.3 (5.3)

Note. AS = anxiety sensitivity; ASI = score on Anxiety Sensitivity Index—Revised; STAI-s = score on State subscale of the State-Trait Anxiety Inventory (STAI); STAI-t = score on Trait subscale of the STAI; BDI = score on the Beck Depression Inventory (short form); EPI-e = score on the Extraversion subscale of the Eysenck Personality Inventory (EPI); EPI-n = score on the Neuroticism subscale of the EPI; EPI-1 = score on the Lie subscale of the EPI; AUDIT = score on the Alcohol Use Disorders Identification Test; PDQ-freq = weekly frequency of drinking on the Personal Drinking Questionnaire (PDQ); PDQ-vol = mean alcohol dose per drinking occasion (milliliters ethanol/kilogram bodyweight) on the PDQ; PDQ-dur = mean duration (hours) of a drinking occasion on the PDQ; PDQ-rate = mean rate of consumption (milliliters ethanol/kilogram bodyweight/hour) on the PDQ.
**p* $<$ .01. ***p* $<$ .005, comparisons between genders within low or high anxiety sensitive groups. †*p* $<$ .01, comparisons between low and high anxiety sensitive groups.

In all variance analyses, simple effects decomposed significant interactions (see Table 3 below). The error terms for these analyses were defined in accordance with Winer (1971). Thus, for a given interaction, the mean square error term for that interaction in the variance analysis was used for within-subjects simple effects, as well as for between-subjects simple effects where no repeated measures were involved (e.g., participant characteristics; Table 2). Where repeated measures were involved, the weighted mean of the mean square error terms for the between- and within-subjects factor (or factors) involved in the interaction was used for between-subjects simple effects.

Results

Participant Characteristics

Table 2 reports the demographic, personality, and drinking-related information for each gender and AS group. The table shows that the sample was uniformly young, with a mean age just above the legal minimum for drinking in Ontario. Mean scores on the personality variables were generally modest and comparable to norms for this population. The mean ASI scores were 2–3 times higher for both genders in the high-AS group than in the low-AS group. The mean AUDIT score (M = 6.3, SD = 4.8) was below 8, the cutoff for problem drinking (Conigrave, Hall, & Saunders, 1995). Participants drank slightly less than once a week, on average, and consumed 1.1 ml ethanol per kilogram bodyweight, which corresponds to 4.5 standard drinks for a 70-kg man or 3.6 standard drinks for a 55-kg woman. This dose exactly matches the normative value for undergraduates on this scale (Vogel-Sprott, 1992). Participants had been drinking alcohol for just over 2.5 years. The scores on the EPI Lie scale are all below published norms (H. J. Eysenck & Eysenck, 1963), indicating that participants did not modify their self-report to create a good impression.

The genders did not differ on any variable but trait anxiety. Predictably, the high-AS group reported higher levels of state anxiety, depression, and neuroticism. They also showed a trend toward higher levels of alcohol-related problems on the AUDIT (p = .05, one-tailed). These results show that the AS groups and genders were similar in their demographic and drinking characteristics. Therefore, any differences in priming task performance as a function of AS group or gender are not attributable to these background variables.

A chi-square test of independence assessed the frequency of participants who said they were more likely, less likely, or not especially likely to drink in bad moods and in good moods. The analysis yielded a significant result, $\chi^2(4, N = 84) = 16.61$, $p = .01$. Inspection of the cell frequencies revealed that participants who were more likely to drink in

Table 3
Mean Difference (Δ = Related Minus Unrelated Trials) in Response Time to Alcohol Targets on Rapid Reading Task as a Function of Group, Gender, and Tendency to Drink in Bad Moods

Bad mood drinking tendency	*n*	Δ NEG	Δ POS	ASI	AUDIT	PDQ-freq
Low-AS women						
Less likely	10	11 (25)	59 (47)*	15.9	5.9	0.6
Not especially likely	13	14 (31)	10 (21)	14.9	4.5	0.7
More likely	9	72 (47)*	−24 (−38)	16.2	4.7	0.7
High-AS women						
Less likely	8	−30 (3)	−63 (−57)*	39.1	5.3	0.8
Not especially likely	6	47 (32)	−93 (−53)*	38.5	3.7	0.4
More likely	10	37 (63)*	27 (18)	42.3	9.2	1.5
Low-AS men						
Less likely	1	176 (127)*	−339 (−277)*	9.0	14.0	2.0
Not especially likely	8	51 (49)*	−30 (−38)	11.3	5.1	0.7
More likely	4	76 (78)*	−7 (71)*	10.8	7.5	1.6
High-AS men						
Less likely	5	71 (96)*	17 (41)	33.2	7.0	0.7
Not especially likely	3	−48 (−115)*	12 (17)	35.0	4.0	0.4
More likely	7	41 (51)*	62 (78)*	36.4	11.1	1.7

Note. Response time (RT) is indicated in milliseconds. Positive difference scores indicate priming; negative difference scores indicate interference (i.e., slower RT on test trials than on baseline trials). Scores in brackets show adjusted difference in RT, controlling (by analysis of covariance) for variation in RT on unrelated baseline trials and for variation in RT difference (related minus unrelated) on semantic trials. NEG = negative mood primes; POS = positive mood primes; ASI = mean score on Anxiety Sensitivity Index—Revised; AUDIT = mean score on the Alcohol Use Disorders Identification Test; PDQ-freq = mean weekly frequency of drinking on Personal Drinking Questionnaire; AS = anxiety sensitivity. Asterisks indicate a significant difference in RT (unrelated minus related primes; Bonferroni $p < .05$, two-tailed).

bad moods were less likely to drink in good moods; those who were more likely to drink in good moods were less likely to drink in bad moods; and those who were not especially likely to drink in bad moods were also not especially likely to drink in good moods. Thus, the tendency to drink in bad moods was inversely related to the tendency to drink in good moods.

Validation of the Lifestyle Questionnaire

The tendency to drink in bad moods and tendency to drink in good moods were each coded ordinally in terms of increasing inclination to drink in that mood state: less likely (-1), not especially likely (0), and more likely ($+1$). Correlational analyses were used to assess the relation between each scale on the lifestyle questionnaire and each of the eight IDS subscales. Tendency to drink in bad moods correlated with the Unpleasant Emotions subscale ($r = .45$; Bonferroni $p < .01$, two-tailed) but did not correlate significantly with any other subscales (Bonferroni $ps > .14$, two-tailed). Tendency to drink in good moods correlated with the IDS Pleasant Times with Others subscale ($r = .31$; Bonferroni $p = .02$, two-tailed) but did not correlate significantly with any other subscales (Bonferroni $ps > .13$, two-tailed). These results support the concurrent and discriminant validity of the drinking tendency scales on the lifestyle questionnaire.

Task Performance

Preliminary Analyses

Outliers. In line with standard practice in semantic priming studies (e.g., Stanovich & West, 1983), as well as with the original study that used this task to assess alcohol-related cognitions (Weingardt et al., 1996), RT scores > 2.5 *SD* from the mean for a given prime–target condition were designated as outliers. These scores were excluded from the main analyses of RT (see below).

A 4-between (AS Group, Gender, Good Mood Drinking Tendency, Bad Mood Drinking Tendency) $\times$ 2-within (Prime: positive mood, negative mood; Semantic Relation: related, unrelated) ANOVA of the percentage of outliers yielded no significant effects ($ps > .19$). The mean (*SD*) percentage of outliers for the six Prime $\times$ Relation conditions was 1.7% (0.5%). This low outlier rate supports the reliability of the means for the trimmed RT distributions.

Errors. A parallel 4×2 ANOVA of errors yielded several significant effects. The highest order effect was a Group $\times$ Gender $\times$ Good Mood Drinking Tendency $\times$ Prime $\times$ Relation interaction, $F(2, 112) = 3.90$, $p = .02$. Inspection of the means for each of these cells revealed that the highest error rate was 30% and the lowest error rate was 9.2×10^{-16}. The mean overall error rate was 8.2%.[4] The highest error rate occurred to targets paired with positive mood primes in low-AS women, who were less likely to drink in good moods. The lowest error rate occurred to targets paired with negative mood primes in high-AS men, who were not especially likely to drink in good moods. The generally low error rate, along with the exclusion of error trials from the analyses of RT, helps to ensure the reliability of the priming effects (below).

Semantic priming control condition. Because semantic targets were not intended for direct comparison with alcohol targets, these two classes of targets were not matched on length or frequency of occurrence in print. Therefore, RT to semantic targets was analyzed separately from RT to alcohol targets. A preliminary 4-between (AS Group, Gender, Bad Mood Drinking Tendency, Good Mood Drinking Tendency) ANOVA of RT to semantic targets on unrelated (i.e., baseline) prime–target trials yielded a significant four-way interaction, $F(1, 56) = 4.22$, $p = .05$. To assess priming of semantic targets while controlling for variation in unrelated, baseline RT, the difference in RT (unrelated minus related) to semantic targets was assessed by a 4-between ANCOVA, using baseline RT as the covariate. The intercept of this model was significant, $F(1, 55) = 10.15$, $p = .01$, indicating that the overall mean difference in RT corrected for baseline RT (83 ms), was significantly different from zero. In addition, the ANCOVA yielded a Gender $\times$ Bad Mood Drinking Tendency interaction, $F(2, 55) = 3.26$, $p = .05$, an AS Group $\times$ Gender $\times$ Good Mood Drinking Tendency interaction, $F(2, 55) = 7.01$, $p = .01$, and no other significant effects ($ps > .06$). These results indicated that reactivity to semantically related and unrelated stimuli varied as a function of AS group, gender, and drinking tendency. These differences were therefore controlled in the analyses of RT to alcohol targets, reported below.

Baseline RT: Alcohol words paired with neutral, unrelated phrases. A 4-between $\times$ 1-within (Prime: positive mood, negative mood) ANCOVA assessed RT to alcohol targets paired with unrelated (i.e., baseline) phrases, while controlling for the difference in RT (unrelated minus related) to semantic targets.[5] The ANCOVA yielded no significant effects involving prime ($ps > .21$). The mean (*SD*) baseline RT to alcohol targets in the two prime conditions was virtually identical: 893 (156) ms for alcohol targets assigned to the negative mood condition versus 890 (171) ms for alcohol targets assigned to the positive mood condition. These results confirm the effectiveness of the random assignment procedure and indicate that the alcohol target concepts assigned to the positive and negative mood conditions were equally accessible or salient in the absence of a priming stimulus. Therefore, any differential priming effects induced by positive versus negative mood phrases cannot be attributed to differences in baseline RT to their respective target stimuli.

[4] The mean error rate of 8.2% observed in the present study is quite similar to that found in a previous study that also used phrase primes and degraded targets (Stanovich & West, 1983). The highest error rate for a given condition in the present study (30%) corresponds to 1.5 errors out of 5 trials. Degradation of targets is generally associated with an increase in error rates (Neely, 1991).

[5] The difference score includes variation in RT to semantic targets on unrelated, baseline prime–target trials, so that this latter variable does not have to be included as a separate covariate.

The ANCOVA did yield a significant AS Group × Gender × Bad Mood Drinking Tendency × Good Mood Drinking Tendency interaction, $F(2, 55) = 6.93$, $p = .01$. Therefore, as was the case for the semantic priming differences, these differences in baseline RT to alcohol targets were controlled by covariance in the analyses of alcohol priming effects reported below.

Priming of Alcohol Words

A 4-between (AS Group, Gender, Bad Mood Drinking Tendency, Good Mood Drinking Tendency) × 1-within (Prime: positive mood, negative mood) ANCOVA, with baseline RT to alcohol targets from the two prime conditions and difference in RT to semantic targets as covariates, assessed the difference in RT (unrelated minus related) to alcohol target words.

A priori *t* tests found that the mean (*SD*) adjusted difference in the negative mood condition, 38 (112) ms, was significantly greater than zero, $t(56) = 2.61$, $p < .05$ (two-tailed).[6] The mean (*SD*) adjusted difference in the positive mood condition, 3 (120) ms, did not differ from zero, $t(56) = 0.19$, $p > .80$.

The ANCOVA yielded a significant AS Group × Gender × Bad Mood Drinking Tendency × Prime interaction, $F(2, 53) = 4.12$, $p = .02$, and no other significant effects ($ps > .07$). Thus, Bad Mood Drinking Tendency interacted with the other factors, whereas Good Mood Drinking Tendency did not. Accordingly, Table 3 reports the mean difference in RT to alcohol targets paired with positive mood or negative mood primes as a function of gender, AS group, and tendency to drink in bad moods. Scores in brackets have been adjusted for the covariates. Scores with asterisks indicate significant simple effects (difference from baseline RT). The Bonferroni correction procedure was used to control for Type I errors.

The number of participants at each level of bad mood drinking tendency is specified. The table also presents mean AS, AUDIT, and PDQ weekly drinking frequency scores for each subgroup. The table shows that the number of participants for each cell was reasonably distributed, with the exception of the less likely drinking tendency condition for low-AS men, which was represented by a single participant. It can be noted that the individual cell *n*s were modest. Although this does not compromise the validity of the statistical analyses (Winer, 1971), the reliability of the conclusions would, of course, be enhanced by a larger sample size.

Referring to the adjusted difference scores, the table shows that in both low- and high-AS women, negative mood phrases significantly primed alcohol words only in participants who said they were more likely to drink in bad moods. In contrast, low- and high-AS men generally displayed negative mood priming irrespective of bad mood drinking tendency.

Positive mood priming emerged in low-AS women who said they were less likely to drink in bad moods and in men of both AS groups who said they were more likely to drink in bad moods. Positive mood phrases were also associated with significant interference (i.e., slower RT on test trials than on baseline trials) in 3 of the 12 cells.

Between-subjects analyses found no overall differences in the degree of negative mood priming as a function of AS group or gender (Bonferroni $ps > .40$). The degree of positive mood priming was significantly greater in high-AS men than in high-AS women, who tended to show interference (i.e., slower RT to alcohol targets paired with positive mood vs. neutral, unrelated primes), $t(106) = 2.28$, Bonferroni $p = .05$ (two-tailed). None of the other between-subjects simple effects was significant (Bonferroni $ps > .11$, two-tailed).

The concordance between problem drinking and negative mood priming in the subgroups was assessed by a nonparametric rank correlation, Spearman's rho. The analysis revealed a significant positive relation between mean AUDIT scores and mean adjusted negative mood priming scores across the 12 cells ($r_S = .73$; $p = .01$, two-tailed). There was no relation between mean AUDIT score and mean adjusted positive mood priming score ($p > .38$). These results indicate a general association between greater negative mood priming and greater severity of alcohol problems across different subtypes of young drinkers.

Discussion

This study investigated automatic activation of alcohol concepts by positive and negative mood phrases in young university drinkers. The primary goal was to determine whether mood-related phrases denoting potential antecedents of drinking would prime alcohol-related words in individuals at the early stages of their drinking careers. Additional goals were to determine whether priming varied for positive versus negative mood phrases or as a function of gender and AS. We predicted that negative mood phrases would produce greater priming than positive mood phrases, and that this differential effect would be greater for women and high anxiety-sensitive drinkers. We further predicted that self-reported tendency to drink in bad moods and severity of alcohol problems would moderate the degree of negative mood-alcohol priming.

The overall analysis revealed that negative mood phrases consistently primed alcohol words, whereas positive mood phrases had inconsistent effects. There were no significant overall differences in the degree of negative mood priming as a function of gender or AS. The tendency to drink in bad moods did moderate negative mood priming, but this effect varied by gender. Only those women who said that they were more likely to drink in bad moods displayed significant negative mood priming, whereas men generally displayed significant negative mood priming regardless of their reported tendency to drink in bad moods.

Positive mood priming also varied by gender, AS group, and tendency to drink in bad moods. Among women, positive mood priming emerged in low-AS participants who

[6] Simple effects may be computed to assess an a priori hypothesis in the absence of a significant interaction (Howell, 1992).

said they were less likely to drink in bad moods. Among men, positive mood priming emerged in both low- and high-AS participants who said they were more likely to drink in bad moods. In addition, positive mood phrases were associated with significant interference (i.e., slower responses to alcohol words) in 3 of the 12 subgroups. Indeed, there were as many cases of significant interference as there were of significant priming by positive mood phrases.

A nonparametric analysis revealed a significant rank correlation between mean AUDIT scores and mean negative mood priming across the subgroups in the sample. No such association emerged in the case of positive mood priming. These results suggest a general association between activation of alcohol concepts by negative mood cues and greater severity of alcohol problems across different subtypes of young drinkers.

The significant effect of negative mood primes is consistent with previous research that used a verbal priming task in problem drinkers with high levels of psychiatric distress (Zack et al., 1999). However, what is noteworthy about the present finding is that negative mood primes automatically activated alcohol concepts in young drinkers with low overall levels of alcohol use and alcohol-related problems. This finding suggests that negative moods may trigger thoughts about alcohol or drinking behavior in some young drinkers, much as they do in established problem drinkers (Ludwig, 1986).

The lack of reliable positive mood priming is also consistent with previous research that found no priming effect of positive mood induction on drinking behavior in university undergraduates (Stein et al., 2000). In addition, some research reported since the present study was undertaken also found no priming of alcohol concepts by positive mood words using another associative memory task (Wiers et al., 2002). The reason for the lack of reliable positive mood priming is unclear, given the prevalence of drinking in the context of positive moods. However, it may be that for most social drinkers, positive moods are concomitants of social gatherings where alcohol is served (parties, celebrations) rather than specific instigators of alcohol use (see MacLean & Lecci, 2000). In conditioning terms, positive moods might therefore represent secondary or redundant cues, relative to the context in which drinking occurs.

In contrast to the case for women, there was no congruent relationship between reported drinking tendency and negative mood priming in men. This finding indicates that negative mood cues activate alcohol cognitions in young male drinkers irrespective of their reported drinking history. The reason for this gender difference is unclear. One possibility is that males are not attuned to their feelings as direct instigators of their drinking (Helmers & Mente, 1999). A second possibility is that men have been acculturated (i.e., vicariously rather than directly conditioned) to view drinking as an acceptable means of dealing with stress or tension (Rutledge & Sher, 2001), even if they themselves do not use alcohol in this manner. Either of these possibilities could account for negative priming in the absence of reported negative mood drinking in men.

The lack of greater negative mood priming in high versus low anxiety-sensitive participants is consistent with a previous study, which found no differential effect of negative mood induction on alcohol consumption in high versus low anxiety-sensitive students in an analogue drinking procedure (Samoluk & Stewart, 1996). Thus, although high anxiety-sensitive students say they are more likely to drink in negative moods than low anxiety-sensitive students, the experimental evidence suggests that additional factors beyond negative mood priming contribute to this propensity.

The lifestyle questionnaire used in this study assessed the extent to which good and bad moods were perceived as discriminative stimuli for drinking. The correlations with the IDS subscales support the validity of this instrument. Nevertheless, further research is needed to establish its reliability in other populations. Assessment of young, noncollegiate drinkers and drinkers with clinically documented alcohol problems would help to establish the reliability of the lifestyle questionnaire as well as the reliability of the priming task itself.

Activation of alcohol-related memory networks can bias decisions and behavior toward alcohol and away from more adaptive alternative behaviors (Stacy, Ames, Sussman, & Dent, 1996). Experimental indices of activation also prospectively predict alcohol use in adolescents (Stacy, 1997). Taken together with these prior findings, the present results suggest that automatic activation of alcohol cognitions by negative mood states may contribute to the epidemiological relation between drinking in negative moods and alcohol dependence, particularly in women. This possibility could be investigated further by assessing the relation between negative mood priming and problem drinking in a prospective design.

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