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Anxiety and explicit alcohol-related memory in problem drinkers

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Abstract

Anxiety is associated with increased craving following in vivo cue exposure in alcoholics. Theoretical accounts [Psychol. Rev. 97 (1990) 147.] have proposed that conscious, deliberate cognitive processes underlie increased craving in drinkers who are trying to abstain. The present study tested the hypothesis that anxiety is associated with biases in explicit (i.e., conscious, deliberate) memory that promote recall of alcohol-related concepts in response to negative affective cues. Fifty-two (seven females) outpatient problem drinkers performed a cued recall task that assessed memory for alcohol-related (ALC), negative affective (NEG), and neutral (NEU) target concepts that had been paired with NEG, ALC, and NEU cues during an incidental study phase. Higher anxiety was associated with increased recall of ALC targets paired with NEG cues. State and trait anxiety were intercorrelated, with higher levels coinciding with a higher frequency of drinking in negative mood states. These findings demonstrate a correspondence between anxiety and alcohol-related memory, and suggest that explicit memory biases may contribute to increased subjective responses (e.g., craving, expectancies) to alcohol stimuli in anxious problem drinkers.

Keywords: Alcohol; Explicit memory; Anxiety; Recall; Reactivity

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1. Introduction

Stimuli previously associated with substance use have long been implicated in 'craving' for drugs and alcohol, and in relapse to these substances following a period of abstinence (Ludwig & Wikler, 1974). Experimental procedures testing reactivity to substance-related cues in laboratory settings have found that cue reactivity not only characterizes addicted populations, but also predicts those individuals who are most likely to relapse (Cooney, Litt, Morse, Bauer, & Gaupp, 1997; Rohsenow et al., 1994). Several forms of reactivity have been assessed, including physiological responses (e.g., salivation), subjective responses (e.g., desire to use, expected reinforcing effects of use), and cognitive responses (e.g., impaired information processing) (Cooney, Gillespie, Baker, & Kaplan, 1987; Cooney et al., 1997; Rohsenow et al., 1994; Sayette & Hufford, 1994). The types of cues administered have also varied widely, from physical drug stimuli (e.g., a glass of liquor) to imagined drug stimuli (e.g., scenarios involving drug use) and interoceptive states (e.g., induced negative affect) (Cooney et al., 1987, 1997; Tiffany & Drobes, 1990). These findings demonstrate a consistent effect of cue exposure on addictive motivation and addictive behavior (Carter & Tiffany, 1999).

Social learning theorists have argued that the effects of cue exposure are mediated by cognitive factors such as self-efficacy expectations — beliefs about one's ability to abstain from substance use in a given situation (e.g., Niaura et al., 1988). Subsequent investigators have proposed that cognitions themselves could act as conditioned stimuli and responses (Bradizza, Stasiewicz, & Maisto, 1994). Consistent with this, responses to alcohol-related verbal stimuli in reaction time tasks have been found to predict levels of alcohol use and alcohol-related consequences (e.g., Weingardt, Stacy, & Leigh, 1996). Exposure to word cues denoting the expected reinforcing effects of alcohol has also been found to increase actual drinking behavior (Stein, Goldman, & Del Boca, 2000). Activation of learned alcohol-related concepts in memory has been cited as a cause for these effects (Stacy, 1995; Stein et al., 2000).

'Conditionability,' a personality dimension strongly related to clinical anxiety (Gershuny & Sher, 1998), reflects the ease with which an individual can be conditioned (Eysenck & Eysenck, 1969). Trait measures of conditionability have been found to predict increased reactivity to alcohol-related stimuli during in vivo cue exposure. Thus, McCusker and Brown (1991) found that highly conditionable problem drinkers displayed greater anxiety when exposed to an alcoholic beverage than did drinkers low on this dimension. The degree of anxiety displayed in turn predicted the subjective desire to drink following cue exposure. Based on their findings, McCusker and Brown concluded that "a personality disposition akin to trait anxiety, and the degree to which cue exposure elicits state anxiety, mediated the relationship between cue responsivity and 'craving' in dependent drinkers" (p. 905). More recently, state anxiety has been found to predict conscious, subjective (as opposed to unconscious, physiological) responses to alcohol cues, suggesting that "alcohol-dependent patients may be divided into typological subgroups with respect to cue reactivity" (Szegedi et al., 2000, p. 721).

Bradizza et al.'s (1994) conditioning hypothesis suggests that these individual differences in response to alcohol cues may be mediated by cognitions. Accordingly, Zack, Toneatto, and

MacLeod (1999) found that problem drinkers with a history of drinking in negative mood states displayed faster responses to alcohol words (e.g., BEER) preceded by negative affective words (e.g., ANXIOUS) on a semantic priming task — an index of automatic associative cognition (Neely, 1991). Consistent with the 'conditionability' hypothesis, drinkers who scored high on the anxiety-related scales of the Symptom Checklist-90 (SCL-90; Derogatis, 1983) showed significantly more priming in this condition than did drinkers who scored low on anxiety. High anxiety drinkers also displayed faster responses in the reverse situation, where alcohol prime words preceded negative affect words. These results support the claim that conditioned alcohol-related responses are encoded in memory, and that a cognitive response (i.e., memory activation) can act as a conditioned stimulus for these responses.

Semantic priming effects like those of Zack et al. (1999) reflect implicit memory biases. That is, they occur without conscious awareness or control. Tiffany (1990) proposed that most ongoing substance use is governed by implicit or automatic mental processes, contained in 'drug use action plans' in memory. He suggested that conscious substance-related cognitions would only arise in two circumstances: when the substance abuser intends to use but is deprived of his/her substance, and when the substance abuser intends to abstain but is exposed to his/her substance or cues predicting that substance. It is, of course, in the latter situation that relapse can occur in treated alcoholics trying to abstain. Tiffany also suggested that negative affect could undermine abstinence by taxing the conscious mental resources required to reduce activation of the drug use action plan. For example, negative affect could impair the ability to recall or implement coping strategies or concepts designed to avert relapse. To the extent that negative affect has been paired with alcohol use in the past, this mood state could also act as a conditioned trigger for the drug use action plan, directly antagonizing efforts to abstain. In either case, conscious mental processes appear to be important in understanding relapse to alcohol use, and negative affect during cue exposure may be an important factor influencing these processes.

Conscious mental processes are best assessed using an explicit memory task (Graf, 1994). Explicit memory tasks measure the ability to voluntarily report stimuli one has previously been exposed to, either unprompted (e.g., free recall) or in response to specific stimuli (e.g., cued recall). The present study aimed to extend the evidence on anxiety and implicit alcohol-related cognition to explicit alcohol-related cognition in problem drinkers. A cued recall task measured conscious recall of alcohol-related target stimuli in response to negative affective cues, and recall of negative affective targets in response to alcohol-related cues. The State–Trait Anxiety Inventory (STAI) (Speilberger, Gorsuch, & Lushene, 1970) measured general anxiety and anxiety at test. A drinking history questionnaire measured a participant's tendency to drink in negative and positive moods. Based on the literature, we hypothesized that (i) state anxiety would predict recall of alcohol target words paired with negative affective cues; (ii) trait anxiety would predict recall of negative affective targets paired with alcohol cues; and (iii) a tendency to drink in negative affective states would correlate with each of these biases.

2. Method

2.1. Participants

Fifty-two consecutive outpatient problem drinkers (45 males, 7 females, ages 19–52, $M = 34.9$ years) participated. All participants met DSM-IV criteria for alcohol dependence (American Psychiatric Association, 1994). Use of psychoactive medication or presence of psychosis were grounds for exclusion. All participants spoke English fluently. They were tested between intake and treatment, at which time they were advised to abstain from alcohol, and received US$10 at the end of the study.

2.2. Apparatus and materials

A J4X ALERT Breathalyzer (Alcohol Countermeasures Inc., Mississauga, Ontario, Canada) confirmed the absence of blood alcohol at the start of the test session. A 386 IBM-compatible PC with 14 in. color monitor administered the cued recall task. Participants sat 60 cm from the screen during the encoding phase and saw 56 pairs of words, one pair per trial (e.g., ANXIOUS–DRINK). Stimuli were 1 cm in height and displayed in white against a black background screen. A booklet containing the left-hand members of each word pair (e.g., ANXIOUS–_____), one cue per page, measured cued recall. The STAI (Speilberger et al., 1970) measured anxiety. The Timeline Followback (TLFB; Sobell & Sobell, 1992) measured the number of drinks per drinking day, heavy days (greater than four standard drinks), abstinent days, and drinks per week in the preceding 90 days. The Alcohol Dependence Scale (ADS; Skinner & Allen, 1982) measured severity of dependence. The Beck Depression Inventory (BDI; Beck & Beck, 1972) measured depression.

An Affective Drinking History Questionnaire (ADHQ) measured the frequency of drinking in negative and positive affective states. The negative affective items were synonyms of the 32 symptoms on the SCL-90 most strongly endorsed by co-morbid problem drinkers (Zack, Toneatto, & Streiner, 1998). The positive affective items were derived from the eight items that loaded $>.40$ on the Positive Emotions or Pleasant Times with Others subscales of the Inventory of Drinking Situations (Cunningham, Sobell, Sobell, Gavin, & Annis, 1995). Participants rated their frequency of drinking in each of the affective states from 1 to 7 (*Never–Always*) on a Likert-type scale. An item analysis demonstrated that coefficient α was .976 for the negative items and .849 for the positive items, indicating that the subscales of the ADHQ were internally consistent in this sample.

2.3. Stimuli and design

There were four different sets of cue–target pairs. Each set was seen by a random 25% of participants. The negative affective (NEG) stimuli were the 32 actual symptom or keywords from the SCL-90 items most strongly endorsed in the previous sample of co-morbid problem drinkers (Zack et al., 1998). Alcohol (ALC) stimuli were 32 words from previous studies on implicit alcohol-related cognition (Hill & Paynter, 1992; Weingardt et al., 1996; Zack et al.,

1999). Neutral (NEU) stimuli were the names of 48 articles of clothing derived from a compendium of word norms (Battig & Montague, 1969). To control for familiarity effects, the three stimulus categories were equated on mean frequency of occurrence in print (Kucera & Francis, 1967).

The conditions tested in the task are shown in Table 1. The table shows two test conditions, NEG–ALC and ALC–NEG. The facilitatory effects of cue exposure were assessed by comparing each of these test conditions with its respective 'cue control' condition, which involved the same type of target stimulus paired with a neutral, unrelated cue. The biasing effect of cue exposure on the likelihood of recalling a clinically relevant as opposed to a neutral stimulus was assessed by comparing each of the test conditions with its respective 'target control' condition, which involved the same type of cue stimulus paired with a neutral, unrelated target. The NEU–NEU condition measured associative memory for neutral, semantically related stimuli. The corresponding NEG–NEG and ALC–ALC conditions were excluded from the design because they neither tested a hypothesis nor provided an important control. As such, inclusion of these conditions would provide no useful information, yet would likely increase interference effects on recall of items in the critical conditions (Underwood, 1983).

2.4. Procedure

Before beginning, participants signed a consent form advising them that the study had received ethics approval from a formal review board. Absence of blood alcohol was then confirmed by breathalyzer. Absence of other psychoactive drugs was determined by self-report.

After pre-screening, participants received oral instructions for the encoding phase from the experimenter. These instructions were repeated on the computer screen before the task began. It is well established that the manner in which a stimulus is encoded can influence how well it is recalled (Craik & Lockhart, 1972). Previous research has found that schematic information in memory (e.g., self-representations) exerts its effects most reliably when participants encode target stimuli in a self-relevant manner (Derry & Kuiper, 1981). In the present study, this was achieved by having participants evaluate pairs of words (e.g., ANXIOUS–BEER) with respect to the question: "Do these concepts go together based on your own personal

Table 1
Stimulus conditions in the cued recall task[a]

Test[b]		Cue control		Target control	
Cue	Target	Cue	Target	Cue	Target
NEG	ALC	NEU	ALC	NEG	NEU
ALC	NEG	NEU	NEG	ALC	NEU
–	–	NEU	NEU	NEU	NEU

[a] $n = 8$ trials/cue–target condition.
[b] NEG: negative affective; ALC: alcohol-related; NEU: neutral.

experience?" If they deemed the concepts in a given pair to be congruent, participants answered "yes" by pressing the "?" key. If they deemed the concepts to be incongruent, participants answered "no" by pressing the "z" key. They were told that this was not a reaction time test and that they should consider each pair of words carefully. The task consisted of 64 trials: eight pairs of neutral practice words (e.g., DATE–FLOWERS, BOOKS–BUG) and 56 pairs of test words. Conditions were randomized over trials such that each participant saw a different sequence of word pairs. The intertrial interval was 1 s. The computer recorded the congruity judgment (yes/no) and the decision time on each trial.

Immediately after the encoding phase, participants were given the booklet containing the cue words. They had not been advised beforehand that they would undergo a recall test. They were instructed to complete the booklet to the best of their ability by filling in the blank next to each cue with the word that was paired with that cue during the computer trials. They were told to work carefully and to proceed at their own pace. Upon completion of the booklet, the experimenter administered the TLFB followed by the self-report questionnaires. Following these measures, participants were debriefed, paid, and dismissed.

2.5. Dependent measures

The difference in percent correctly reported targets between a given test condition and its corresponding control condition (e.g., NEG–ALC minus NEU–ALC) measured the impact of cue type on recall. Larger difference scores indicated a greater effect of the cue. The term 'facilitation' will be used to describe increased recall of a class of targets due to clinically relevant vs. neutral cues (e.g., NEG–ALC vs. NEU–ALC). The term 'response bias' will be used to describe increased recall of clinically relevant vs. neutral targets in response to a given class of cues (e.g., NEG–ALC vs. NEG–NEU).

Pearson correlations measured the relation between recall and anxiety. To control for shared variance between test and control scores that can confound interpretation of a correlation involving difference scores (i.e., test–control) (Cohen & Cohen, 1983), each difference score was first regressed onto to its corresponding control score, and the residual of this analysis was used in the correlational analyses.

3. Results

3.1. Participant characteristics

The mean (S.D.) score on the ADS was 23.2 (10.1), indicating 'substantial dependence' (Skinner & Horn, 1984). Scores from the TLFB showed that participants consumed an average of 9.5 (4.3) drinks per drinking day and 43.2 (20.0) drinks per week. They abstained an average of 2.1 (1.5) days per week and drank more than four standard drinks on 4.3 (1.8) days per week. The average duration of problem drinking was 14.2 (8.5) years.

The mean (S.D.) item rating on the positive affective scale of the ADHQ was 3.9 (1.2), with a range of 1.1–7.0. The mean (S.D.) rating on the negative affective scale was 3.9 (1.4),

with a range of 1.0–6.8. Thus, on average, participants were equally likely to drink in positive and negative affective states, and there was high variability across participants in the likelihood of drinking in each mood state.

The mean score on the STAI–trait was 48.4 (13.4) with a range of 20–74. The mean score on the STAI–state was 40.8 (12.7) with a range of 14–67. The mean score on the BDI was 9.9 (7.1) with a range of 0–27.

3.2. Performance

3.2.1. Encoding

A repeated-measures ANOVA comparing the congruity ratings of items in each of the seven conditions yielded a significant result [$F(1,51)=43.86$, $P<.0001$]. *Posthoc* contrasts revealed that the congruity ratings in each condition differed significantly from those in every other condition ($P<.004$). Mean (S.D.) congruity ratings for 'yes' responses ranged from 19.5% (21.1) in the NEG–NEU condition to 59.9% (24.8) in the ALC–NEG condition. A parallel ANOVA comparing decision times across conditions yielded a nonsignificant result ($P>.30$). The mean (S.D.) time to render a congruity judgment was 3.9 (1.3) s.

3.2.2. Recall

Table 2 reports the mean (S.D.) and range in percent recall as a function of cue–target condition. The table shows that the overall rate of recall, while low, also showed considerable variation.

Our principal predictions concerned the correlational pattern in the data. The Pearson correlations between the residualized difference scores, the scores on the two scales of the STAI, and the scores on the two subscales of the ADHQ are shown in Table 3. In line with our directional hypotheses, one-tailed probabilities were computed. The table shows that facilitation and response bias in the NEG–ALC and ALC–NEG conditions were significantly intercorrelated. Trait anxiety significantly predicted facilitation and response bias in the NEG–ALC condition, and marginally predicted response bias in the ALC–NEG condition ($P=.052$). The pattern of correlations was identical for state anxiety. The frequency of drinking in positive affective states predicted facilitation in the ALC–NEG condition. The frequency of drinking in negative affective states marginally predicted facilitation in the NEG–ALC condition ($P=.064$). Negative affect drinking was also strongly correlated with trait and state anxiety and with drinking in positive affective states. Thus, higher frequency of

Table 2
Cued recall (%) as a function of cue-target relation in outpatient problem drinkers ($N=52$)

	Cue–target relation[a]						
	NEG–ALC	ALC–NEG	NEG–NEU	ALC–NEU	NEU–ALC	NEU–NEG	NEU–NEU
M	10.3	9.6	4.8	5.5	8.9	9.4	12.5
S.D.	12.8	16.1	9.3	9.1	12.5	12.8	17.2
Range	0–75	0–62.5	0–37.5	0–37.5	0–50	0–62.5	0–75

[a] NEG: negative affective; ALC: alcohol-related; NEU: neutral.

Table 3
Pearson correlation between recall performance (facilitation, response bias), anxiety, and affective drinking history in outpatient problem drinkers ($N = 52$)

	Facilitation[a]		Response bias[b]		Anxiety [c]		Affective drinking history[d]	
	NEG–ALC	ALC–NEG	NEG–ALC	ALC–NEG	Trait	State	Positive	Negative
Facilitation								
NEG–ALC								
ALC–NEG	0.09							
Response bias								
NEG–ALC	0.78***	0.28**						
ALC–NEG	0.25**	0.66***	0.37***					
Anxiety								
Trait	0.33**	− 0.05	0.24**	0.23*				
State	0.40***	− 0.04	0.30**	0.22*	0.74***			
Affective drinking history								
Positive	− 0.05	0.26**	− 0.07	0.13	0.15	0.12		
Negative	0.22*	− 0.07	0.10	0.17	0.66***	0.47***	0.38***	

[a] Facilitation = residualized difference in percent recall (Test − Cue Control; e.g., NEG–ALC minus NEU–ALC).
[b] Response bias = residualized difference in percent recall (Test − Target Control; e.g., NEG–ALC minus NEG–NEU).
[c] STAI scale score.
[d] ADHQ subscale score.
* $P < .10$.
** $P < .05$.
*** $P < .01$.

drinking in one mood state predicted a higher frequency of drinking in the other, but only negative affect drinking predicted anxiety.

3.2.3. Control of potential mediators

Other variables that correlate with anxiety or affective drinking history and also with recall could mediate the correlation between these critical variables (Baron & Kenny, 1986). In addition, encoding factors (perceived congruity, decision time) can influence rates of recall (Cooper & Pantle, 1968; Lewandowsky & Hockley, 1987). To identify potential mediators, the Pearson correlations between the key variables and the additional variables were examined. To provide the same level of stringency in these analyses as in the primary analyses, one-tailed probabilities were again computed.

The supplemental analyses determined that scores on the BDI co-varied with facilitation in the NEG–ALC condition as well as with scores on both scales of the STAI and both scales of the ADHQ ($.26 < r < .74$; $.001 < P < .034$). Decision time in the NEG–ALC condition correlated with facilitation and response bias in that condition, as well as with

Table 4
Partial correlation between critical predictors and recall performance, controlling for potential mediators in outpatient problem drinkers ($N = 52$)[a]

	Facilitation[b]		Response bias[c]	
	NEG–ALC	ALC–NEG	NEG–ALC	ALC–NEG
Controlled variable				
BDI				
Anxiety[d]				
Trait	0.17			
State	0.28**			
Affective drinking history[e]				
Positive	−0.18			
Negative	0.03			
Controlled variable				
NEG–ALC decision time				
Anxiety				
Trait	0.24**		0.11	
State	0.34***		0.23*	
Controlled variable				
NEU–NEU recall				
Anxiety				
Trait	0.22*	−0.14	0.13	0.13
State	0.37***	−0.09	0.27**	0.12

[a] Only variables with significant zero-order correlations (Table 3) are shown.
[b] Facilitation = % difference in recall test − cue control (e.g., NEG–ALC minus NEU–ALC).
[c] Response bias = % difference in recall test − target control (e.g., NEG–ALC minus NEG–NEU).
[d] Anxiety = score on the trait or state scale of the STAI (Speilberger et al., 1970).
[e] Affective drinking history = score on the positive or negative affective subscale of the ADHQ.
* $P < .10$.
** $P < .05$.
*** $P < .01$.

trait anxiety and the positive affect subscale of the ADHQ ($-.28 < r < .45$; $.001 < P < .023$). Recall of neutral, semantically related items (NEU–NEU) co-varied with facilitation and response bias in the NEG–ALC and ALC–NEG conditions, as well as with scores on both scales of the STAI ($.28 < r < .45$; $.001 < P < .025$), but not with either subscale of the ADHQ ($|r| < .07$; $P > .20$).

Partial correlations between the key variables were computed to assess their significance when variance due to these potential mediators was controlled. These are shown in Table 4. The table shows that depression scores on the BDI mediated the relation between NEG–ALC facilitation and trait anxiety and each scale of the ADHQ. This is consistent with factor

analytic research showing that the STAI–trait scale taps depressive as well as anxious symptomatology (Beiling, Antony, & Swinson, 1998). Decision time in the NEG–ALC condition mediated the relation between NEG–ALC response bias and trait anxiety. Recall of neutral, related items mediated the relation between ALC–NEG facilitation and each scale of the STAI. NEU–NEU recall also mediated the relation between NEG–ALC response bias and trait anxiety, and the relation between ALC–NEG response bias and each scale of the STAI. Whereas the effects of drinking history and trait anxiety on recall were mediated by other dispositional or situational factors, the correlation of state anxiety with NEG–ALC facilitation and NEG–ALC response bias remained significant when potential mediators were partialed out.

4. Discussion

Previous research suggested that cognitive processes may underlie cue exposure effects in problem drinkers, and that anxiety may augment the operation of these processes. The present study assessed the role of anxiety in conscious, alcohol-related cognition during exposure to verbal negative affective and alcohol-related cues. The role of conditioning in these processes was explored by assessing participants' affective drinking histories.

Consistent with our hypotheses and with previous research, state anxiety significantly predicted recall of alcohol concepts in response to negative affective cues. Drinkers with higher levels of anxiety at test displayed greater recall of alcohol concepts when cued with a negative affective word as opposed to a neutral word. State anxious drinkers also displayed greater recall of alcohol targets rather than neutral targets when exposed to negative affective cues. Although the zero-order correlation between trait anxiety and recall of negative affective concepts in response to alcohol cues approached significance, the partial correlation revealed that this correspondence was mediated by greater recall of neutral, semantically related stimuli. Both state and trait anxiety correlated with the frequency of drinking in negative mood states. However, the relation between affective drinking history and recall of alcohol targets paired with negative affective cues was mediated by depression. Thus, current level of anxiety was the single unique predictor of recall of alcohol concepts in response to negative affective cues.

There is no single explanation for this result. One possibility is that state anxiety led to a mood-congruent memory effect whereby negative affective cues were better able to recruit their associated targets (Bower, 1981). In participants who drank more often in negative affective states, negative affective cues would be more likely to recruit alcohol-related targets. A second possibility is that state anxiety created a 'compound cue' in the NEG–ALC condition, so that anxious participants had both visceral and semantic negative affective stimuli to cue their memory (cf. Chapman & Robbins, 1990). Future research that employs a factorial assessment of anxiety and affective drinking history would help to determine the role of mood congruency in these effects.

Regardless of the specific mechanism, the present results suggest that negative affective cues increase retrieval of alcohol concepts to a greater degree in problem drinkers who are

anxious at the time of exposure than in those who are not. Negative affective cues also increased the *relative* likelihood of recalling alcohol concepts rather than neutral concepts in state anxious participants. Therefore, being anxious also deterred retrieval of alternative, nonalcohol-related thoughts. This bias is important as it may skew a drinker's thoughts toward alcohol use rather than toward a more adaptive coping response to negative affect (Stacy, 1995). In addition, problem drinkers often display selective deficits in conscious (rather than unconscious) retrieval of neutral concepts (Weingartner, Eckardt, Hommer, & Johnson, 1994). The present results suggest that negative affective cues may promote alcohol use by selectively improving conscious retrieval of alcohol-related concepts (i.e., 'hot' cognitions) rather than neutral concepts (i.e., 'cool' cognitions) in drinkers who are anxious.

The fact that anxiety during cue exposure predicts explicit alcohol-related memory is a new and potentially important finding. It implies that interventions that reduce state anxiety (e.g., evoked by interpersonal conflict, social evaluation) may also reduce the ability of negative affective stimuli to promote thoughts about alcohol. It also implies that simple mnemonics and clear injunctions against drinking in programs like AA may deter relapse, in part, by offsetting a bias to recall alcohol-related concepts in negative affective states. The strong correspondence between trait and state anxiety in this study and elsewhere (e.g., Beiling et al., 1998) further suggests that trait anxious problem drinkers may be more likely to benefit from memory-based interventions (Sussman, Horn, & Gilewski, 1990), although trait anxiety may be neither necessary nor sufficient for explicit memory biases to emerge.

These conclusions must be tempered by the strength of the present evidence. The statistical effects in this study were modest. This may be due partly to the limited statistical power of regression residuals (Heise, 1975). Replication is required to confirm the reliability of the findings. In addition, the frequency or severity of state anxiety in this sample may be elevated, as anxiety is common during the early stages of alcohol abstinence (Linnoila, 1989). Further research is needed to determine the role of anxiety in problem drinkers who have been abstinent for a more extended period. Finally, although anxiety is a common clinical manifestation of 'conditionability' (Gershuny & Sher, 1998), the present study cannot directly address the role of this variable. Research that includes psychophysiological measures, as well as self-report scales designed to tap this construct (Eysenck & Eysenck, 1969), could directly assess the role of conditionability in explicit alcohol-related memory.

In sum, the results of this study extend the findings from previous in vivo cue exposure and memory studies. They highlight the importance of state anxiety as a 'proximal' predictor of explicit alcohol-related memory in problem drinkers. The correspondence between state anxiety and a history of drinking in negative mood states further suggests that the dipsogenic effects of negative affect may involve a conditioned enhancement of explicit alcohol-related memory as well as a disturbance of explicit inhibitory cognitions (Tiffany, 1990). A variety of processes have previously been implicated in the association between negative affect and relapse to alcohol use, including increased thoughts about the reinforcing effects of alcohol and decreased thoughts about one's ability to abstain (Cooney et al., 1987, 1997; Niaura et al., 1988). The present results suggest that differential recall of alcohol-related concepts may be a basic mechanism underlying these biases in conscious cognition.

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