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Implicit and Explicit Alcohol-Related Cognitions

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This article presents the proceedings of a symposium at the 2001 RSA Meeting in Montreal, Canada organized by Reinout W. Wiers and Alan W. Stacy. The purpose of the symposium was to present recent applications of implicit cognitive processing theory to alcohol research. Basic cognitive research has demonstrated that implicit cognition influences memory and behavior without explicit recall or introspection. The presentations from this symposium show that implicit cognition approaches yield new insights into understanding drinking motivation. The presentations were: (1) An introduction by Alan W. Stacy; (2) Implicit cognition and alcohol use. Involvement of other variables? (Susan L. Ames); (3) Alcohol expectancies and the art of implicit priming (Jane A. Noll); (4) Parental alcoholism and the effects of alcohol on semantic priming (Michael A. Sayette); (5) Implicit arousal and explicit liking of alcohol in heavy drinkers (Reinout W. Wiers); and (6) Negative affective cues and associative cognition in problem drinkers (Martin Zack). Comments were provided by the discussant Marvin Krank. The presented studies demonstrated that: (1) implicit memories of alcohol associations are powerful predictors and cross-sectional correlates of alcohol use; (2) implicit retrieval processes influence alcohol outcome expectancies and alcohol consumption; (3) alcohol consumption influences implicit memory processing; (4) heavy drinkers reveal different affective responses in implicit and explicit tasks; and (5) negative affect exerts an implicit priming effect for alcohol associations in problem drinkers. These findings illustrate the importance of implicit cognition in understanding alcohol abuse and demonstrate the potential of the theoretical framework for more widespread application across a variety of areas of alcohol research, including diagnostics for the risk of alcohol abuse, treatment, and prevention.

Key Words: Implicit Cognition, Implicit Association, Memory Association, Drinking Motivation, Implicit Priming, Alcohol, Expectancy.

OVER THE PAST decades, implicit cognition has become an influential area in research in cognitive science. In alcohol research, the assessment of implicit cognitions began during the 1990s, with relatively few empirical applications. In basic research, implicit cognitions are contrasted with explicit cognitions such as deliberately recalled memories, beliefs, considerations, and other introspections. Implicit cognition influences one's memory and behavior without explicit recall or introspection. The presentations from this symposium show that implicit cognition approaches yield new insights in understanding drinking motivation. These data also show that, in at least in some instances, implicit and explicit processes can be differentiated. Because of its foundation in basic research, neurobiological plausibility, and growing empirical support in understanding alcohol abuse, implicit cognition is an important area for increased emphasis in alcohol research.

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IMPLICIT COGNITION AND ALCOHOL USE: INVOLVEMENT OF OTHER VARIABLES?

Susan L. Ames

Implicit cognition theory (ICT) is one alternative approach to understanding alcohol and drug use motivation (Stacy, 1997). This theoretical approach maintains that the pattern of activation of concepts in memory influences behavior. According to ICT, memory associations are established and strengthened through repetitive experience with alcohol or other drugs. Strong memory associations between a behavior and its outcomes (e.g., drinking beer and feeling relaxed) or between a behavior and cues (e.g., seeing a drinking buddy and drinking) are motivationally significant in drug use. Through repeated experiences with drugs, specific cues automatically activate thoughts about use. Judgments, thought processes, and interpretations of

situations are influenced by strongly activated concepts resulting in the performance of behaviors related to that concept. Anything processed during a drug use episode may come to elicit a conceptually related response based on an association in memory. This may be thought of as conceptual priming where behavioral practice facilitates or influences subsequent performance.

Findings from research in human memory have shown the benefit of memory association assessment and concepts. For example, there is evidence that amnesics who show little recollection of prior experience on tests of explicit memory show nearly normal retention on implicit memory tasks (Shimamura and Squire, 1984). Strong associates revealed on association tests provide effective primes in semantic priming research (Lupker, 1984) and strong associates are effective cues in cued recall, including those that are not presented during study trials (Nelson et al., 2000). Additionally, false memories have been predicted by strong associates of words in a study list (Roediger and McDermott, 2000).

ICT research at the University of Southern California makes use of a variety of associative memory tasks (e.g., word association and picture association tasks) to study memory processes that promote and mediate drug use (Stacy, 1997). Extra-list cued recall (Stacy, 1994) and semantic priming paradigms (Weingardt et al., 1996) have also been used to study alcohol use. Word association and other implicit cognition measures assess cognitive processes unavailable to introspection. Individuals scoring higher on these measures exhibit a pattern of activation in memory that is more consistent with drug use than individuals who score lower on these measures; that is, they report more alcohol or drug-related responses to ambiguous stimuli on a variety of tests and thus appear to more spontaneously activate drug-related memories in a variety of situations.

Implicit cognition as measured with associative tasks predicts or is correlated with alcohol use among diverse populations, and findings have been replicated for HIV-risk behavior (Stacy et al., 2000). In a prospective study among a college population, controlling for outcome expectancies, impulsive sensation seeking, acculturation, gender, and previous habit, both a memory component and an outcome expectancy component were predictive of drug use (Stacy, 1997). Implicit cognition was a stronger predictor of alcohol use than outcome expectancies, acculturation, sensation seeking, and gender in this study. In cross-sectional studies, implicit cognition was correlated with alcohol use among adult drug offenders and among high-risk youth, when controlling for gender, acculturation, and ethnicity (Ames and Stacy, 1998; Stacy et al., 1996). Results indicated that measures of implicit cognition were stronger predictors of drug use than demographics and the predictive effects were not moderated by these other variables. Implicit cognition was also correlated with alcohol use among adult volunteers from a community sample, when controlling for gender, depression, sensation seeking, social conformity, and extraversion (Stacy and Newcomb, 1998). In this study, personality was not a mediator or moderator of implicit cognition, and memory indirectly affected drinking problems through consumption. More recently, in a cross-sectional study investigating the relationships among impulsive sensation seeking, implicit cognition, alcohol use, driving under the influence (DUI), and gender among drug offenders, implicit cognition was again correlated with alcohol use. In this population, implicit cognition independently predicted alcohol use and mediated the predictive effects of impulsive sensation seeking on alcohol use. Implicit cognition, but not impulsive sensation seeking, again had a significant indirect effect on DUI, which was mediated through consumption. Similar results have been replicated for marijuana use (Ames et al., unpublished data, 2001).

While debate continues in the memory literature about measurement of implicit processes, there is evidence that word association tasks are implicit tests of memory (Toth, 2000). Nevertheless, since prior experience is not manipulated in the research described above, it is not possible to fully verify that the tasks used are not occasionally contaminated by explicit processes. However, there is strong reason to believe that responses on associative measures represent automatic influences of memory and are implicit. The test instructions (e.g., "write the first word that pops to mind") are consistent with the definition of implicit memory tasks in the memory literature, and individuals are not asked to introspect about a prior experience or make expectancy judgments about their behavior.

Research on ICT has consistently found that implicit cognition variables are among the strongest prospective predictors and cross-sectional correlates of alcohol and marijuana use. These predictive effects are not attenuated or moderated by other variables. ICT studies are consistent with contemporary views of cognitive processes suggesting that there are two aspects of cognition: (1) an implicit cognition component, representing the effects of memory associations prompted relatively spontaneously by motivational and situational circumstances, and (2) an explicit cognition component, representing cognitions amenable to introspection and deliberate decision-making processes.

ALCOHOL EXPECTANCIES AND THE ART OF IMPLICIT PRIMING

Jane A. Noll

Alcohol expectancies is a term that refers to the anticipatory cognition associated with drinking-related behavior. In the form of dynamic information templates stored in memory, expectancies enable us to process incoming information in efficient and adaptive ways. Alcohol expectancies have been found to predict drinking behavior (Goldman et al., 1999a). Depending on measurement and analysis techniques used, expectancies can account for as much as 50%

of the variance in predicting drinking, both concurrently and prospectively. Alcohol expectancies have been measured in elementary school children (Dunn and Goldman, 1996), high school students before they began to drink (Christiansen et al., 1989), and have been found to predict drinking behavior prospectively (Stacy et al., 1991).

One way to identify alcohol expectancies is by asking people what they expect from alcohol. We have asked over 3000 first-year college students to finish the sentence stem, "Alcohol makes one..." To tap into more automatic processing, we instructed respondents to answer with the first responses that came to mind, without thinking too much about their responses. As one might expect, some of the most common responses were "drunk," "relaxed," "stupid," "sick," and "happy." The most interesting analysis of these data is to identify individual differences according to respondents' reported drinking level. Heavier drinkers more often give positive and arousing adjectives, such as "happy" and "sociable." The frequency of "happy" and "sociable" as the first response to "Alcohol makes one..." decreases as drinking level decreases. On the other hand, nondrinkers and light drinkers more often respond with negative and sedating responses. For example, the frequency of "sick" and "drowsy" decreases as drinking level increases.

However, we rarely articulate alcohol expectancies in sentences like "Alcohol makes one..." Instead, we say things that imply our expectancies about drinking alcohol. For example, we may say sentences like the following:

"Hey, join in the party, get yourself a drink!"

"What a day! I need a drink."

"She's a much better dancer once she's got a few drinks in her."

Sometimes no words are needed at all, such as a recent advertisement for an alcoholic beverage. The ad depicts a scene having been set with a romantic goal in mind. In the background is a crackling fire, soft lights, and prominent in the scene are two glasses and a bottle of the alcoholic beverage. This scene depicts expectancies about the sexual effects of drinking alcohol.

Alcohol expectancies have been measured by individuals rating their agreement to items on questionnaires. In this way, respondents must consciously access information in memory about the effects of alcohol. Evidence of alcohol expectancies can also be obtained via more implicit measures.

One model of alcohol expectancies in memory is an associative network of interconnected conceptual nodes, the central one being alcohol, with surrounding nodes depicting various effects of drinking alcohol. Based on the theory of spreading activation, one can expect that this network can be primed or facilitated by activating one node and looking for evidence of a spread of activation to corresponding nodes.

One of the first studies to show priming of alcohol expectancies was that of Roehrich and Goldman (1995) which showed increased drinking in relation to an implicit priming of alcohol expectancies. Participants were led to believe that they were taking part in a memory experiment. Half of the participants watched an episode of the television program *Cheers* while the other half watched an episode of *The Bob Newhart Show*. These episodes were as equivalent as possible, with the exception of alcohol content in the episode of *Cheers*. As a distracter task, participants performed a Stroop color-naming task (i.e., say the color in which the word is printed). Half of the participants ink-named alcohol expectancies words while the other half ink-named control words (e.g., *river*, *hammer*). Participants were told that they must wait for the next segment of the experiment and were invited to participate in another study while they waited. The "unrelated" study was a taste test of beers. Those participants who saw the *Cheers* episode as well as the expectancy words in the Stroop task drank the most beer. Those who saw the Cheers and control words consumed the next highest amount. Of the two groups who saw the *Newhart* episode, those who saw expectancy words in the Stroop task consumed more beer than did those in the control group. Thus, it appeared that an implicit exposure to alcohol expectancy words activated processing that caused increased drinking behavior.

In another priming experiment, we measured free recall of expectancy words. Again, students were invited to participate in a memory experiment and no mention was made of alcohol. Participants were presented with a list of 30 words to remember. Half of the words were alcohol expectancy words (e.g., *happy, mellow*), while the other half were food items that might be on a grocery list (e.g., *sugar, pasta*). Words were presented in random order after the first word which was varied between *milk* and *beer*. It was expected that the grocery words would be better recalled because they were concrete nouns that easily formed a semantic category. This was true for those participants who saw *milk* as the first word on the list. They recalled, on average, proportionally more grocery item words than alcohol expectancy words. However, those participants who saw *beer* as the first word on the list recalled a significantly higher proportion of alcohol expectancy words than grocery item words. Further, the difference in proportion of expectancy recall was significantly more pronounced for those participants reporting the highest drinking levels in a prescreening questionnaire. Alcohol expectancy words averaged almost 60% of the high drinkers' recall. Again, this pattern of results is interpreted as evidence of having primed the alcohol expectancy network, especially for more experienced drinkers.

While alcohol expectancies have been measured via more explicit methods, such as expectancy scales and questionnaires, and such measures have been found useful in predicting drinking behavior, it is important to explore the underlying mental structures of alcohol expectancies. To do so, it is necessary to design experiments that tap into automatic and implicit processing of alcohol-related stimuli. Further experiments should make use of nonlinguistic stim-

uli such as olfactory primes, contextual primes, and ambiguous stimuli. In this way, a better understanding of the mechanisms by which expectancies facilitate behavior may enable more effective preventive and intervention methods.

PARENTAL ALCOHOLISM AND THE EFFECTS OF ALCOHOL ON MEDIATED SEMANTIC PRIMING

Michael A. Sayette

Most investigations of the effects of alcohol on cognition have focused on limited capacity nonautomatic processing. In contrast, relatively little research has examined the effects of alcohol on cognitive organizational processes (Sayette, 1999). Research suggests, however, that organizational processes play a role in learning and memory, and that organization and cognitive capacity reciprocally influence each other (Stadler, 1995).

Alcohol studies that have examined organizational processes have found intoxication to impair organization of information (Sayette, 1999). Birnbaum et al. (1980), for example, found alcohol interfered with the acquisition of new information and concluded that this effect might be due, in part, to a diminished ability to elaborate or extract meaning from new material by integrating it with previously stored information. In contrast, when alcohol is consumed following the acquisition of new material, memory is not consistently impaired and may, in some cases, even show retrograde enhancement (Sayette, 1999).

The appraisal-disruption model proposed that alcohol impairs the organization of information by interfering with associative recall processes (Sayette, 1993). According to models of associative recall, cognitive appraisal involves a spreading activation process resulting in the activation of information previously stored as nodes in a memory network, with related nodes sharing associated connections (Balota and Lorch, 1986; McNamara, 1994). We are unaware, however, of any research that has examined the effects of alcohol on spreading activation processes.

It has been suggested that parental history (PH) of alcoholism is associated with altered sensitivity to alcohol's acute effects (Sher, 1991). Newlin and Thomson (1990) concluded that, relative to PH- individuals, PH+ participants are more sensitive to alcohol's effects on the ascending limb of the blood alcohol curve but less sensitive to alcohol's effects on the descending limb. This appears to be true across a range of neurobiological and psychophysiological responses as well as for measures of mood and cognition (Sher, 1991). These studies indicate that PH+ individuals should show more pronounced disruption of cognitive processes when blood alcohol concentrations (BACs) are rising. It remains unclear whether PH influences the effects of alcohol on spreading activation.

Much of the support for spreading activation models comes from semantic priming research. According to spreading activation, when one node in a network is activated, activation spreads to related nodes. The activation process primes related areas of the memory network, making them more available for further processing (McNamara, 1994). One implication is that the amount of activation arriving at a node depends on the distance between a prime and target in the memory representation.

A popular approach to assessing semantic priming effects is the naming task, in which individuals pronounce a target word as fast and accurately as possible. This task requires execution of several component processes, including visual sensory processing, letter recognition, translation of an orthographic pattern into a lexical/phonological representation, and speech production (Balota, 1994). When the target word is preceded by a related prime, recognition of the target word is facilitated, which simplifies the task and reduces response latency. This study tested the effects of a moderate dose of alcohol on spreading activation using a mediated semantic priming task, in which target words were preceded by primes that were either unrelated or indirectly related to the target (e.g., "lion" indirectly primes "stripes" via "tiger"). A full version of this study is reported elsewhere (Sayette et al., in press).

Male and female participants ($n = 169$) with (PH+) or without (PH-) a parental history of alcoholism were administered the priming task after drinking a gender-adjusted dose of alcohol (males: 0.82 g/kg, females: 0.74 g/kg) or a placebo beverage. Parental history was assessed using separate structured clinical interviews with subjects and one of their biological parents. Ninety-one percent of the sample identified themselves as Caucasian and 9% as African-American. See Sayette et al. (in press) for methodological details.

Shortly after the 30-min drinking period, participants completed the mediated priming task. Twenty-three primes were paired with their targets (e.g., "lion" and "stripes"), and 23 primes were paired with an unrelated target word. These unrelated targets were matched to the related targets according to word length and frequency (Carrol et al., 1971) and initial phoneme. Ten additional unrelated prime/target word pairs were included at the beginning of the task to serve as practice trials, creating a total of 56 word pairs. Participants were asked to read the first word (prime) presented on a monitor silently and to say the second word (target) aloud (Sayette et al., in press).

Alcohol participants' mean BAC was 0.067% following the priming task and continued to rise to 0.075% over the next 38 min. Few errors (2.6%) occurred, and error rates were unrelated to response time latencies. Error data are reported in Sayette et al. (in press). Results of the response time data indicated that primed targets were named faster than unprimed targets ($p < 0.0001$). In addition, a PH $\times$ drink condition $\times$ word type interaction appeared ($p < 0.001$). Among PH- participants, alcohol significantly reduced priming effects ($p < 0.05$), whereas alcohol enhanced priming effects among PH+ participants ($p < 0.01$). The enhanced priming effect for intoxicated PH+ participants appeared to be due to their especially slow

responses to unprimed words. This latter effect may have arisen because accurately pronouncing an unprimed target is more difficult than doing so for a primed target, and PH+ participants may have found this task to be particularly challenging compared with PH- participants (Sayette et al., in press).

Results of the PH- data suggest that alcohol reduces semantic priming for indirectly associated targets. This finding is consistent with the view that alcohol constrains the spread of activation of associated information in memory. More generally, these data suggest that alcohol, in addition to affecting cognitive capacity, may also disrupt organizational processes. The finding that parental history moderated alcohol's effects on semantic priming is intriguing and, if replicated, would hold promise for improving understanding of the etiology of alcohol use disorders.

IMPLICIT AROUSAL AND EXPLICIT LIKING OF ALCOHOL IN HEAVY DRINKERS

Reinout W. Wiers

During the past decades, alcohol-related cognitions have received a lot of attention in psychological theories on the etiology of alcohol use disorders. Different cognitive-motivational constructs have been proposed to predict alcohol use and abuse, such as outcome-expectancies, attitudes, and motives. Expectancies are good predictors of current and prospective alcohol use (Goldman et al., 1999b; Jones et al., 2001). Current issues in alcohol-expectancy research include the structure of expectancies (e.g., are negative reinforcement expectancies one of the positive expectancies or, in nature, different from positive reinforcement expectancies such as fun and sex?), the relationship with other cognitive motivational variables (attitudes, motives), and the relationship with family history of alcoholism and the changeability of expectancies (Jones et al., 2001; Wiers et al., 1997,2000). A major recent issue involves the relationship between implicit and explicit expectancies (Stacy, 1997); there are different views regarding this relationship. The first view is that expectancies start as explicit cognitions and gradually become implicit (automated); the second is that they represent different underlying cognitive motivational mechanisms; and the third is that implicit expectancies better represent the underlying mechanism because they are less subject to problems related to introspection. Using Multidimensional Scaling (MDS), Goldman and colleagues (1999b) analyzed semantic judgments of expectancy words and found two dimensions: positive–negative and arousal–sedation. In a recent study (Wiers et al., unpublished data, 2001), we measured light and heavy drinkers' implicit and explicit expectancies in these two dimensions.

Twenty-four light drinkers (12 males, average of 5 alcoholic drinks per week) were compared with 24 heavy drinkers (12 males, average of 32 alcoholic drinks per week). On two different days one week apart, participants performed, in balanced order, two adapted versions of the Implicit Association Test (IAT) (Greenwald et al., 1998). In both versions, the target-words were alcoholic drinks or sodas (6 each). One version contained positive versus negative words as the attribute condition, the other version contained arousal (active) words versus sedation (passive) words. The IAT is a choice reaction time categorization task that is sensitive to dimensional overlap of targets and attributes. It measures the association strength between targets and attributes. Recent studies have demonstrated the validity and reliability of the IAT. After the IAT, related explicit measures were given using the same words as in the IAT (positive–negative: semantic differentials with VAS-scales; arousal–sedation: separate unipolar VAS-scales). After the second IAT, a more extensive expectancy questionnaire and measures of alcohol use (Wiers et al., 1997) and problems (Rutgers Alcohol Problem Index, White and Labourie, 1989) were given.

On the explicit measures, heavy drinkers were more positive than light drinkers ($p < 0.001$) and expected more arousal ($p = 0.008$) and more tension reduction ($p < 0.001$). On the implicit measures, a large IAT effect was found for the positive–negative IAT ($p < 0.001$; effect size 0.79). Unexpectedly, both heavy and light drinkers showed a strong negative attitude to alcohol. (They were slow to react when alcohol was mapped together with positive words and fast when alcohol was mapped with negative words.) The interaction with drinker type failed to reach significance ($p = 0.076$). Inspection of the means indicated that heavy drinkers were a little bit less negative about alcohol than light drinkers. On the arousal–sedation IAT, the interaction between the IAT effect and drinker-type was significant ($p = 0.029$). As expected, heavy drinkers were faster when alcohol and arousal words were mapped together than when alcohol and sedation words were mapped together. This was not the case for light drinkers (approximately equal reaction times for both conditions). Significant gender differences were found on the explicit but not on the implicit measures.

From these results, one emerging question is: Are heavy drinkers really positive or negative about drinking alcohol? At the implicit level we found a clear answer: negative. A similar finding was recently reported for smoking; at the implicit level, both smokers and nonsmokers showed an association of smoking with negative attitudes (Swanson et al., 2001). This raises the possibility that the high correlations of positive attitudes with behavior are primarily based on self-justification: "I am often smoking or drinking, I must be liking it." Similarly, one could argue that the gender differences on explicit measures primarily reflect (sub)cultural influences.

If heavy drinkers are so implicitly negative about alcohol, one may question why they drink so much. The significant difference between heavy and light drinkers in the arousal IAT suggests that it is primarily for the (expected) arousing effects. This finding is in line with the incentive sensitiza-

tion theory of addiction of Robinson and Berridge (2001) that differentiates wanting (activation of the psychomotor activation system) from liking (preferences). The wanting system is the critical underlying motivational system in addiction. This theory is based on a wealth of animal research but has not yet been tested in humans. Our findings that the differences between heavy drinkers and light drinkers are primarily found on the arousal dimension parallel the MDS results of Goldman and colleagues (1999b). However, our finding of implicit disliking of alcohol contrasts with their findings, which is likely due to the fact that the MDS results are based on more explicit paper and pencil tests. It is an open question whether negative reinforcement expectancies (tension reduction) are also related to this cognitive motivational arousal system or whether they represent a different system (Zack et al., 1999). It could be that tension reduction is mediated by implicit arousal expectancies (alleviate a state of negative de-activation), but it could also be tension reduction expectancies reflect a different mechanism. Finally, one may ask how implicit and explicit alcohol-related cognitions are related. My view is that they represent different underlying cognitive motivational mechanisms that can give output in opposite directions. For example, long-term negative expectancies are related to the motivation to change behavior in alcoholics (Jones et al., 2001). The problem for an abstinent alcoholic then arises when an alcohol cue activates the implicit wanting system, while he or she explicitly strongly does not want to take alcohol any more. It seems relevant to study how both implicit and explicit expectancies can be changed.

NEGATIVE AFFECTIVE (DISTRESS) CUES AND ASSOCIATIVE COGNITION IN PROBLEM DRINKERS: THE ROLE OF ANXIETY

Martin Zack

Negative affect, or distress, is a frequent antecedent of relapse in problem drinkers. Like environmental stimuli, distress can serve as a conditioned, interoceptive cue for alcohol, particularly among individuals who tend to drink more often when they are distressed. Anxiety is especially relevant with respect to relapse because anxiety tends to persist long after drinking has stopped and because it often coincides with increased susceptibility to conditioned responding or conditionability.

The present research examined the role of situational or state anxiety in implicit and explicit associative memory for alcohol. It was predicted that verbal distress cues (e.g., worry) would increase retrieval of alcohol concepts (e.g., drink) relative to neutral cues (e.g., window) and that anxiety during verbal cue exposure would directly correlate with the degree of increase displayed. We further predicted that the correlation between anxiety and cue-induced alcohol associations would be stronger in participants who tended to drink more during distress as opposed to pleasant situations.

Two studies were performed, each involving different participants. All participants were treatment-seeking problem drinkers who met DSM-IV criteria for an alcohol use disorder. Study 1 included 36 (7 female) participants and study 2 included 52 (7 female) participants. In each study, mean scores on the Alcohol Dependence Scale fell in the third percentile for this population, indicating substantial dependence in each sample. Mean scores on the Trait and State scales of the State-Trait Anxiety Inventory were moderate but also quite variable in each study. On average, each sample was equally likely to drink during distress as in pleasant situations, as determined by a drinking history questionnaire. However, as in the case of anxiety, there was considerable variation across individuals in the relative frequency of drinking during distress versus pleasant situations.

A semantic priming task assessed implicit (automatic, involuntary) distress-alcohol associations in study 1. Lexical decision time (msec) to a target stimulus (e.g., alcohol word) paired with a neutral or distress prime was the dependent variable. A cued recall task assessed explicit (conscious, deliberate) distress-alcohol associations in study 2. Percent recall of alcohol target words paired with distress versus neutral cues was the dependent variable. A drinking history questionnaire measured the frequency of drinking (0–7; never–always) during distress and pleasant situations.

In each study, participants attended a single session soon after intake but before treatment began. They signed a consent form and provided a breath sample to confirm their blood alcohol was zero prior to testing. No participant was taking a medication that could impact either task. In each study, participants completed self-report scales after the memory tasks, were fully debriefed, and paid $10 prior to departure.

As hypothesized, state anxiety significantly predicted distress-alcohol priming ($r = 0.32, p < 0.05$) in study 1 and facilitation in cued recall ($r = 0.35, p < 0.05$) in study 2. The tendency to drink during distress versus pleasant situations significantly predicted semantic priming ($r = 0.24$, $p < 0.05$) but did not predict cued recall. State anxiety and tendency to drink during distress were also strongly intercorrelated in study 1 ($r = 0.58, p < 0.001$) as well as study 2 ($r = 0.41, p = 0.002$). When the samples were split based on participants' drinking histories, state anxiety significantly predicted distress-alcohol priming ($r = 0.30$, $p < 0.05$) and cued recall ($r = 0.36$, $p < 0.05$) in those who tended to drink more often during distress than in pleasant situations. In contrast, state anxiety was not significantly related to priming or recall in those who tended to drink more often during pleasant situations, although this correlation was marginal in study 2 ($p = 0.069$).

Trait anxiety, depression, and alcohol dependence each correlated with state anxiety in study 1. Trait anxiety and

depression correlated with state anxiety in study 2. None of these variables significantly predicted distress-alcohol associations in study 1 or study 2. Thus, these trait factors did not mediate the correlation between state anxiety, semantic priming, and facilitation of cued recall. The correlation between state anxiety and distress-alcohol associations is consistent with in vivo cue exposure studies. The finding that this correlation was only significant in participants who drank more often during distress is consistent with a conditioning explanation of cognitive distress-alcohol associations. Although these results cannot establish whether anxiety at test influences task performance or vice versa, they do indicate that anxiety is an important marker of distress-alcohol associations and that drinking history moderates the strength of the relation between anxiety and cued alcohol-related memory.

The correlation between state anxiety and distress-alcohol associations may reflect mood-congruent memory, such that the congruity between participants' internal state and the cues to which they were exposed at test influenced retrieval of alcohol concepts. Alternatively, anxiety may have combined with verbal distress cues in the task to form a compound cue. This explanation emphasizes the role of cue salience rather than compatibility on alcohol-related memories. Finally, the link between anxiety and conditionability suggests that high anxiety at test may have characterized those individuals who were most likely to form and/or recruit distress-alcohol associations when exposed to distress cues.

Regardless of the explanation, the present findings demonstrate that state anxiety coincides with biases in both implicit and explicit alcohol-related memory. The implicit bias may skew decisions toward alcohol during distress in an automatic manner. The explicit bias may promote conscious retrieval of alcohol concepts when one encounters a distressing situation and is trying to decide how to respond to it.

The findings may also have implications for treatment. Specifically, extinction-based procedures for relapse prevention aim to revise existing associations between conditioned antecedent cues and alcohol. The present data suggest that, in some individuals, the impact of conditioned cues may be reduced indirectly by reducing a drinker's anxiety, either behaviorally or pharmacologically, during cue exposure (i.e., high-risk situations). Future research should address the causal effects of anxiety on distress-alcohol associations by manipulating anxiety in an experimental design. The countervailing effects of anxiety reduction on distress-alcohol associations should also be examined.

DISCUSSION

Marvin Krank (with Alan W. Stacy and Reinout W. Wiers)

The research presented in this symposium discussed the application of implicit cognitive processing to alcohol research. Main findings concluded that (1) implicit memories of alcohol associations are powerful predictors and cross-sectional correlates of alcohol use (Ames); (2) implicit retrieval processes influence alcohol outcome expectancies and alcohol consumption (Noll); (3) alcohol consumption influences implicit memory processing (Sayette); (4) heavy drinkers reveal different affective responses in implicit and explicit tasks (Wiers); and (5) negative affect exerts an implicit priming effect for alcohol associations in problem drinkers (Zack). These findings illustrate the potential importance of implicit cognitive processing and the value of a general cognitive processing approach to alcohol research.

Implicit cognitive processing, as applied to alcohol research, should be discussed within the broader context of cognitive theories and memory systems in particular. A memory processing approach naturally poses four main questions. These questions address the conditions of learning, the encoding and storage of information, retrieval processes, and the impact of retrieval. Implicit cognition provides unique and stimulating answers to these questions as well as suggesting important new directions for alcohol research.

The first question is: *What are the learning conditions that result in alcohol-related memories?* The specific conditions that generate new learning about alcohol cognitions and use in humans are relatively unexplored. Most symposium speakers assumed that alcohol-related cognitions are learned through experience with associative contingencies (Ames, Noll, Sayette, Zack). This is a useful heuristic assumption building on learning theory, social learning theory, and cognition; but what is needed is the development of methodologies that provide a detailed analysis of how specific drinking experiences change memory. One approach is to categorize drinkers by self-reported drinking style or history (Ames, Wiers, Zack) (Stacy, 1997). This allows inferences about general drinking experiences on alcohol-related cognitions. Another approach is to analyze the effects of exposure to particular associative contingencies such as alcohol advertising (Noll). Ultimately, our interest is not just in any alcohol-related experiences, but in those specific experiences that change memory representations about alcohol in a manner that leads to changes in alcohol use or abuse.

A second basic question is: *How is alcohol information represented in memory?* Researchers in this symposium generally assumed that alcohol-related memories are associative in nature (e.g., memory associations, Ames; alcohol outcome expectancies in an "if-then" memory structure, Noll; or more generally as associative networks, Noll, Sayette, Wiers, Zack). Such an associative model is a standard assumption in many memory systems and its application to alcohol cognitions is natural and useful; however, it is only one view of memory representation. Many recent models include episodic details of particular training experiences (Hintzman, 1986). The particulars of a specific alcohol-related learning experience may be important to the assess-

ment of alcohol-related cognitions and whether such cognitions influence decisions about alcohol use.

Most symposium speakers did not explicitly assume separate implicit and explicit memory representations. Although such a differentiated memory system approach is typical, Ratcliff and McKoon (1999) have argued that implicit priming arises from "a bias in processing, not the operation of a separate memory system" (p. 578). This functional memory processing approach suggests that processing differences between tasks can produce the dissociations found with implicit and explicit memory tasks. Implicit memory as the result of differential processing does not decrease the value of differentiating implicit and explicit memory. Instead, the processing approach changes the primary focus of this distinction to an interaction between retrieval process demands at the time of testing and the nature of the representation stored in memory. It remains an open question whether implicit and explicit cognitive processes are best represented as a processing continuum or as separate processes. A more important question for alcohol research is: What does a specific cognitive task measure and is the result important to alcohol use? In fact, implicit memory tasks may be more likely to assess associative memory representations than explicit cognitive tasks, which may be based on summary judgments (Stacy, 1997). From this perspective, implicit memory tasks are worth exploring precisely because they assess cognitions that influence alcohol use decisions better than explicit memory tasks.

A memory processing approach must then ask: *When, how, and under what conditions are alcohol-related memories retrieved?* An overriding generalization of many recent memory models is that memory retrieval is driven by similarity between encoding and retrieval conditions (Tulving and Thomson, 1973). (For applications to implicit memory, see Ratcliff and McKoon (1999) and Roediger and Srinivas (1993).) According to these approaches, the retrieval of specific memories depends on the similarity of processing operations at the time of retrieval and processing operations at the time of encoding. Implicit and explicit memory tests differ because the task demands are different. Thus, dissociations in implicit and explicit memory tasks are due to differential retrieval of alcohol-related memories. The research reported here underscores the importance of task demands on retrieval of alcohol-related memories. Several studies systematically manipulated context variables as a method for biasing retrieval: induction of negative affect (Zack), context priming (Noll), and alcohol effects (Sayette). Researchers also introduced several procedural variants as representative of differences between implicit and explicit memory, including the Stroop task (Noll), priming (Noll, Sayette, Zack), behavioral associates production (Ames), homograph identification (Ames), and the Implicit Association Test (Wiers). From a memory-processing perspective, different processing demands generate the differences in retrieval during implicit and explicit memory tasks. The effects of these differential task demands highlight the potential importance of encoding and retrieval processes for alcohol-related cognitions.

The fourth question from a memory processing approach is: *How do behaviors and cognitions change as a consequence of the retrieval of alcohol cognitions?* Symposium speakers employed various measures, including reaction times, word associations, and outcome expectancies. These valuable cognitive indicators can predict future drinking behavior. Future research, however, needs to draw the theoretical link between the study of implicit cognitions and behavioral choices. For example, how do alcohol cognitions relate to incentive and the decision to drink on a particular occasion? The simple distinction between implicit and explicit memory is whether subjects are able to report that current processing is the result of a specific experience. Important topics for further investigation include how implicit retrieval processing influences alcohol use decisions, the usefulness of implicit processing tasks as diagnostics for the risk of alcohol abuse, and how our understanding of implicit processing improves our approaches to treatment and prevention. The demonstrations of implicit cognition effects in this symposium suggest that understanding implicit processing will be important in addressing these questions and developing improved models of alcohol use.

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