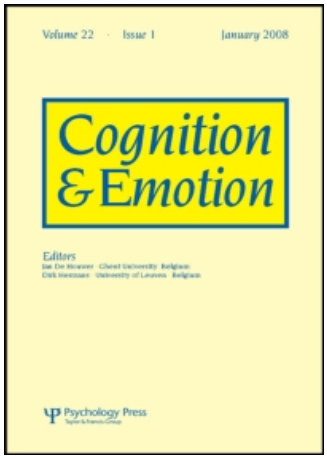

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Automatic attitudes and alcohol: Does implicit liking predict drinking?

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Automatic attitudes and alcohol: Does implicit liking predict drinking?

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Addictive behaviour has qualities that make it ideal for study using implicit techniques. Addictive behaviours are mediated in part by automatic responses to drug cues, and there is sometimes social pressure to distort self-reports. However, relationships between implicit attitudes and addictive behaviours have been inconsistent. Using a new implicit measure, the affect misattribution procedure (AMP), we found consistent evidence that drinking-related behaviours are systematically related to implicit attitudes. The procedure predicted a behavioural choice to drink beer and self-reported typical drinking tendencies, including hazardous drinking and alcohol-related problems. The AMP showed larger relationships with drinking behaviour than other implicit measures, and explained unique variance in drinking beyond those measures and beyond explicit measures. Though self-presentation distorted self-reports, it did not affect AMP scores. These studies highlight the importance of automatic affective responses in addictive behaviour and suggest a useful means for measuring those responses.

If the reasons people drink were as plain as the reasons they pay their taxes, studying alcohol abuse would be a simple and unsurprising business. But the reasons are not plain, the research is not simple, and this paper explores some of the surprises. In certain quantities or in certain company, drinking can be unpopular to admit, leading people to misreport their thoughts and behaviour. Even assuming perfect candour, asking heavy drinkers to report about why they drink is not likely to be useful because they may have no more insight into the causes of their drinking than a bystander. That is why researchers have turned increasingly to studying the pathways leading

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automatically from drinking-cues to drinking. Implicit attitude tests provide a promising way to study these pathways because they measure automatic responses without asking for self-report (e.g., De Houwer, 2003; Fazio, Jackson, Dunton, & Williams, 1995; Greenwald & Banaji, 1995; von Hippel, Sekaquaptewa, & Vargas, 1997). These tests might be expected to be important predictors of drinking. Surprisingly, much of the available research suggests otherwise. This puzzling finding is the topic of the present research.

THEORETICAL AND EMPIRICAL BACKGROUND

Previous research: Mixed evidence relating implicit attitudes to drinking

It seems plausible that favourable implicit attitudes toward alcohol should be associated with more drinking. People who like beer more ought to drink more beer. From a learning perspective, drugs act as reinforcers, supplying reward that increases the likelihood of seeking out drugs in the future (Everitt, Dickinson, & Robbins, 2001). From a biological perspective, the neural pathways that mediate drug reward are largely the same pathways that mediate natural reward (Wise & Rompre, 1989). Instrumental learning reinforces drug-taking behaviour, and classical conditioning leads people to like cues associated with alcohol. Although the learning process may begin with the pharmacological effects of alcohol, it can spread to other cues such as the sight and taste of certain drinks, or even places, people, and social situations associated with drinking. Viewing alcohol as a source of reinforcement suggests that men and women who have experienced greater reward from alcohol in the past (or who are more sensitive to that reward) should have more positive associations to alcohol-related cues. This learning theory suggests a positive correlation between implicit evaluations of alcohol cues and drinking behaviour.

Although the theory is simple, the data have turned out to be complicated. On the one hand, there is certainly evidence that drug cues elicit some types of implicit cognition (Wiers & Stacy, 2006). For example, alcoholics, smokers, and compulsive gamblers all show automatic attentional biases toward words related to their specific addictions, suggesting that addiction-related cues have the power to immediately capture attention (Cox, Fadardi, & Pothos, 2006; Gross, Jarvik, & Rosenblatt, 1993; Johnsen, Laberg, Cox, Vaksdal, & Hugdahl, 1994; McCusker & Gettings, 1997). On the other hand, although a great deal of research has revealed reliable effects of drug cues on attention, these biases do not distinguish between favourable or unfavourable evaluations. Either liking or disliking a drug cue might make it salient enough to capture attention.

Implicit attitude tests provide a way to measure the valence of implicit responses. A seminal study used the implicit association test (IAT; Greenwald, McGhee, & Schwartz, 1998) to examine implicit attitudes toward alcohol cues (Wiers, van Woerden, Smulders, & de Jong, 2002). In the IAT, two category pairs are presented on a computer screen, such as "alcohol versus soda" and "pleasant versus unpleasant". The task is to sort words or pictures into these categories as quickly as possible. The four response options are mapped onto only two responses keys, such as "alcohol or pleasant" and "soda or unpleasant" (see Figure 1). People can sort items into the joint categories faster when they are compatible—meaning that the two concepts are associated in the mind of the subject—than when they are incompatible. By measuring response times, researchers can infer whether alcohol is more closely associated with "pleasant" or "unpleasant" categories for a given participant. Wiers and colleagues (2002) examined both evaluative associations (between alcohol and good vs. bad categories) and arousal associations (between alcohol and active vs. passive categories). Results showed that arousal associations differentiated light versus heavy drinkers but evaluative associations did not; both light and heavy drinkers showed equivalent negative associations to alcohol.

This pattern was replicated in another study with patients undergoing treatment for alcohol abuse, using both the IAT and the Extrinsic Affective Simon Task (EAST). The EAST is an implicit test that relies on response compatibility as does the IAT, but it is not limited to relative evaluations (De Houwer, Crombez, Koster, & De Beul, 2004). Again, on the IAT, patients showed relatively negative evaluations of alcohol. On the EAST, patients showed neutral attitudes toward alcohol, but attitudes were relatively less favourable than toward soft drinks.

In contrast with these findings, some types of positive associations have been associated with greater drinking. Palfai and Ostafin (2003) examined whether drinkers associated alcohol with approach versus avoidance concepts, using the IAT. Participants who associated alcohol with the approach category reported more drinking in a retrospective report, and also reported greater urges to drink when the experimenter poured a glass of beer for them. Other researchers have suggested looking not at evaluations of alcohol, but at implicit outcome expectancies for drinking (Jajodia & Earleywine, 2003). This study used the IAT, focusing on associations between alcohol and pleasant or unpleasant consequences that may occur from drinking. For example, positive expectancies included items such as *confident*, *relaxed*, and *sociable*; negative expectancies included items such as *sick*, *mean*, and *noisy*. Research participants who associated alcohol with positive expectancies drank significantly more than those who did not. As the authors of this study noted, there is a difference between positive attitudes toward alcohol (e.g., "I like beer") and positive outcome

expectancies (e.g., "beer makes people more sociable"). Moreover, the positive expectancies all seem to describe a prototypical "happy drunk", whereas the negative expectancies describe a "mean drunk". This study provides interesting evidence for a link between drinking and positive expectancies. It is not clear, though, whether the associations in this study reveal expectancies for oneself when drinking or for stereotypes of different types of drinkers.

Taken as a whole, these findings do not offer an easy answer to the question of whether drinking is driven by, or associated with, automatic evaluations. On the one hand, certain aspects of implicit responses appear to be associated with drinking behaviour. On the other hand, it is unclear why implicit evaluations of alcohol have not been shown to play a consistent role (see De Houwer, Custers, & De Clercq, 2006; Payne, McClernon, & Dobbins, in press; Sherman, Rose, Koch, Presson, & Chassin, 2003; Swanson, Rudman, & Greenwald, 2001, for related findings on implicit attitudes and smoking).

Potential explanations

One explanation for the lack of relation between implicit evaluations and drinking is based on a distinction between "liking" and "wanting". According to a neurobiological model of addiction (Robinson & Berridge, 1993), sensitivity to rewarding cues that determine wanting (i.e., cravings) is mediated by different brain systems than those that determine pleasure or liking. As a result, the tendency to seek and take drugs may become independent of how much a person likes or dislikes the drug itself. Palfai and Ostafin (2003) and Wiers et al. (2002) suggested that this dissociation between liking and wanting may explain why arousal, approach, or outcome associations may predict drinking behaviour better than attitudes toward alcohol.

In our view, the distinction between liking and wanting presents an intriguing theoretical framework from which to investigate addictive behaviour. However, we question whether this framework is the best account of the null relationships observed. The dissociation between systems involved in wanting and liking may explain why cognitions related to wanting should predict drinking over and above liking. However, there seems little reason to predict that liking should *not* be related to drinking. Instead, it seems to us that separate systems mediating wanting and liking would predict that both liking and wanting should independently predict drinking. All else being equal, there still seems good reason to predict that people who like beer more should drink more beer.

So, why have previous studies failed to find greater consistency between automatic attitudes and drinking behaviour? There are several potential

reasons. One reason may be that none of the previous studies has taken motivational factors such as self-presentation into account. The accuracy of self-reported drinking behaviour depends on motivational factors (Del Boca & Noll, 2000). Although previous studies have attempted to minimise motivational pressures by ensuring confidentiality, drinking is likely to be a sensitive enough topic that at least some participants are motivated to under-report their drinking. Such motivations can mask the relationship between implicit and explicit measures (Fazio et al., 1995; Hofmann, Gschwendner, & Schmitt, 2005; Payne, 2001; Payne, Cheng, Govorun, & Stewart, 2005). In the studies that follow, we took self-presentation into account by both measuring it (Study 3) and manipulating it (Study 4).

A second potential reason is that most of the previous research used the same task—the IAT—to measure implicit attitudes. (Although the EAST is different from the IAT in several ways, they are similar in that they both rely on response times for compatible and incompatible judgements.) Different measures each have idiosyncratic strengths and weaknesses. The lack of a relation between evaluations of alcohol and drinking behaviour may be the result of using only one kind of measure. The mechanisms underlying the IAT effect are not well understood, which can lead to ambiguity in how to best interpret findings (e.g., De Houwer, Geldof, & De Bruycker, 2005; Greenwald & Nosek, 2001; Rothermund & Wentura, 2004). Some of the processes measured by the IAT may be unrelated to the attitudes of interest. For example, the IAT has been criticised for being influenced by environmental associations that may not reflect a person's own attitudes (Olson & Fazio, 2004). Consistent with this explanation, a study that used the "personalised IAT" (Olson & Fazio, 2004) to reduce the impact of environmental associations found favourable evaluations of smoking cues among smokers but not non-smokers (De Houwer et al., 2006). Cultural norms that treat alcohol as a vice may produce negative IAT evaluations even for individuals who like alcohol.

Each of these factors could potentially mask true relationships between implicit evaluations and drinking, making it wise to investigate multiple measurement approaches before drawing conclusions about implicit attitudes in general. Our goal in the present study is to show that with a new approach, a consistent relationship can be detected.

The affect misattribution procedure

Recently Payne et al. (2005) proposed a new approach to implicit measurement that may preserve the strengths of existing implicit measures, while overcoming some of their weaknesses. This affect misattribution procedure (AMP) relies on people's tendency to misattribute their affective reactions from one source to another when conditions are ambiguous.

Murphy and Zajonc (1993) showed that a subliminally presented photo of a smiling or scowling face could influence how participants rated the pleasantness of ambiguous Chinese pictographs. However, no priming effects were found when the primes were presented visibly. Payne and colleagues found that with certain modifications, the same kind of misattribution effects could be obtained without subliminal presentation. This task presented prime photos in a way that was plainly visible, followed by a Chinese pictograph. Participants were asked to judge each pictograph dichotomously as "more pleasant than average" or "less pleasant than average".

Participants in some conditions received a strong warning that the prime photos could bias their responses, and that they were to avoid any influence of the primes. The warning instruction serves the same purpose as exclusion instructions in studies of implicit memory (Jacoby, 1991). In exclusion studies, subjects are instructed to complete word fragments but to exclude any words from a certain study episode. If the subject remembers studying the word, then he or she can successfully exclude it. But if the fluency of a word is heightened by previous study and the subject does not consciously recollect it, then he or she is likely to complete the fragment with that word. Influences of past experience that persist despite exclusion instructions provide evidence for implicit uses of memory in the absence of conscious recollection. In the same way, affective influences of the primes in the AMP despite the warning instruction provide evidence for implicit effects of attitudes that subjects are unable to monitor and control.

Across six experiments, affect misattributions proved unaffected by warnings, suggesting that the task reveals evaluations independent of participants' intent. Because the warning instruction tells subjects not to be influenced by the primes, one might wonder whether the priming effect is driven by the ironic effects of thought suppression. When a person tries to suppress a thought, the thought can become hyper-accessible and therefore have more impact than if suppression had never been tried (Wegner, 1994). Although this kind of effect might influence AMP responses under some conditions, we doubt that this is a key mechanism in AMP effects. Suppressed thoughts are most likely to rebound when the suppression period is finished or when suppression is interrupted by distraction (Wegner & Erber, 1992), neither of which is the case in the AMP. A rebound explanation would also predict priming effects to be larger in warned than unwarned conditions, but our previous studies showed no evidence of this pattern (Payne et al., 2005). The available data are more consistent with the idea that people are poor at differentiating between their affective reactions to pictographs versus prime items shown milliseconds before. Lacking awareness of the source of their reactions, people have little basis to control them.

The misattributions that people made reflected their attitudes toward the prime items. For example, when pictures of US President George W. Bush and presidential candidate John Kerry were used as primes, Bush photos led to positive ratings of the pictographs for Bush supporters, but negative evaluations for Kerry supporters. Performance on the AMP strongly predicted voting intentions and explicit attitudes toward the candidates. In a second study, pictures of Black and White people were used as primes to study racial attitudes. This study found evidence of racial bias, consistent with many other implicit measures. As predicted, the AMP correlated strongly with self-reported racial attitudes for individuals who were unmotivated to control prejudiced responses. That relationship was eliminated for highly motivated subjects, who expressed no race bias on self-report measures but showed bias on the AMP.

Across six studies, the AMP performed as one would expect an implicit attitude measure to perform: it correlated highly with explicit measures when motivational pressure was low (i.e., for political attitudes and for individuals unmotivated to control prejudice), and it was dissociated from explicit measures when pressure was high (i.e., for participants motivated to avoid prejudice). These relationships were stronger than many previously reported in the literature, perhaps because the AMP showed strong measurement properties. Reliability was high (average $\alpha = .88$) and the effect size was large (average $d = 1.25$, $r = .53$). Together, these findings provided initial support for the AMP as a measure of unintentionally expressed attitudes. The present work extends this approach to measure attitudes toward alcohol, with the aim of resolving some of the intriguing puzzles raised in the literature.

Overview

In this paper we explore implicit evaluations of alcohol among college drinkers. Alcohol abuse, dependence, and binge drinking are much higher among college students than the general population (Dawson, Grant, Stinson, & Chou, 2005; Wechsler, Davenport, Dowdall, Moeykens, & Castillo, 1994). In fact, alcohol-related injuries are a leading cause of death among college students (McGinnis & Foege, 1993). Better understanding the role of implicit cognition in drinking behaviour could have important implications in this high-risk population. In the first experiment, we demonstrate that the AMP successfully predicts drinking behaviour. A second experiment compared the AMP to two other widely used implicit measures. The third experiment measured individual differences in motivations to conceal drinking, showing that motivations are important for the relationship between implicit responses and self-reported behaviour. Finally,

the fourth experiment manipulated motivations to conceal drinking to provide converging experimental evidence.

STUDY 1: TASTE TEST

The aim of our first experiment was to test whether implicit attitudes toward beer as measured by the AMP could predict beer drinking behaviour. We first measured participants' attitudes toward beer using the AMP. We then arranged a taste test, and asked participants to choose whether they preferred to taste a new brand of beer or bottled water. Of interest was which beverage participants chose to drink, and whether this choice was associated with AMP scores.

Method

Participants

Forty-three volunteers (26 men and 17 women) were recruited in the Ohio State University student centre to participate in an experiment on taste preferences. Participation was limited to individuals 21 years of age or older because the study was related to alcohol. Volunteers were paid four dollars.

Materials

Affect misattribution procedure. The AMP was constructed identically to the procedure reported by Payne et al. (2005). At the beginning of the task, participants were told that various Chinese characters would appear on a computer screen, and that they would evaluate each item on pleasantness. Participants were instructed to press the key labelled "pleasant" if they found a character to be more pleasant than the average Chinese pictograph, and to press the key labelled "unpleasant" if they found a character to be less pleasant than average. Participants were told that each character would be preceded by an image of water, beer, or a grey square, and that these images could bias their judgements of the pictographs. As part of the task instructions, participants were told that their task was to try their "absolute best" not to let their like or dislike for the images influence their judgement of the characters.

Twelve colour photographs of beer and drinking water served as primes. Six judges rated the visual appeal of 20 alcohol photos and 20 water photos on a 7-point scale. They were asked to rate the attractiveness of the drinks without regard to whether they liked the drink featured. The 12 beer photos and 12 water photos were selected from these to be matched on visual attractiveness so that there was no difference between beer and water items. On each trial, the prime was presented in the middle of the screen for 75 ms

and was replaced by a blank screen for a 125 ms interval (Figure 1, third panel). A Chinese pictograph then appeared for 100 ms and was followed by a pattern mask, which consisted of a white and black pattern of "noise". The mask stayed on the screen until participants made a response. Participants completed 72 trials, in which each of the 12 beer primes and 12 water primes was presented twice, and the grey square was presented 24 times. Seventy-two unique Chinese characters were used as targets and were randomly paired with the primes. At the end of the task, participants were asked if they

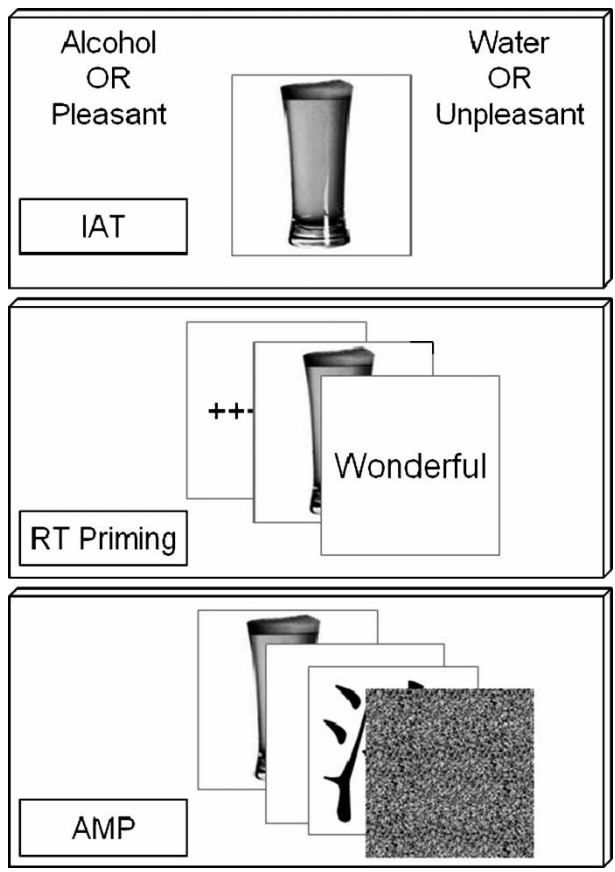

Figure 1. Illustration of test structures for the Implicit Association Test (top panel), Reaction-Time based Evaluative Priming (middle panel), and the Affect Misattribution Procedure (bottom panel). The task in the IAT is to categorise each item by pressing one of two keys for each pair of categories. The task in evaluative priming is to evaluate whether each word is favourable or unfavourable by pressing one of two keys. The task in the AMP is to evaluate whether each pictograph is relatively pleasant or unpleasant by pressing one of two keys. Whereas reaction times are the key variable in the IAT and evaluative priming, the pleasantness judgements are the key variable in the AMP.

spoke Chinese or Japanese so that those who did could be excluded from analysis (because the characters would not be ambiguous for them). In this sample, no participants were eliminated.

Procedure

Participants were recruited to participate from a table in a public area of the University student centre. Volunteers were escorted to a quiet testing room in the student centre for the actual experiment. Participants first completed the AMP on a laptop computer. They were then escorted into a different room for a taste test. They were informed that they could sample either a new brand of premium water or a new brand of beer. Non-alcoholic beer was used, but participants were not informed about the alcohol content until the end of the study.

Participants were asked to indicate to the experimenter which beverage they would like to sample. Participants reported how much they liked the beverage they sampled on a scale from 1 (*not at all*) to 10 (*very much*). Participants who chose beer were asked to estimate its alcohol content as a way to ensure that participants were not suspicious about the beverage options. They rated the beer from 1 (*no alcohol content*) to 10 (*very high alcohol content*). Participants were then fully debriefed and paid for their participation.

Results

As a first analysis, we report the mean level AMP performance to investigate overall evaluative reactions to beer and water items. We then explore individual differences in relation to drinking behaviour. The hypothesis was that participants with more positive reactions to beer as measured by the AMP would be more likely to choose to drink beer.

Mean performance. AMP performance was computed as the proportion of "pleasant" responses for each prime type. These were analysed using a repeated measures analysis of variance (ANOVA). Results showed a main effect of prime type, $F(2,\ 84) = 8.66,\ p < .001$. Participants made more "pleasant" responses on Water trials ($M = 0.76,\ SD = 0.20$) than on Neutral trials ($M = 0.53,\ SD = 0.29$) or Beer trials ($M = 0.57,\ SD = 0.28$). Focused comparisons showed that "pleasant" responses on Water trials were significantly higher than either Neutral or Beer trials (both Fs > 12.3). Responses did not significantly differ between Beer and Neutral trials, $F(1,\ 42) = 0.41,\ p = .53$. Neither Beer nor Neutral trials were significantly different from the chance level of .50 (both ts $< 1.67,\ p$s $> .10$). To summarise, participants showed an average positive reaction to water, with

both beer and neutral primes near the neutral point of .50. Next, we examine whether individual differences in AMP performance predicted the choice to drink beer versus water.

Individual differences. Participants' AMP scores were computed by subtracting the proportion of pleasant responses on Water trials from the proportion of pleasant responses on Beer trials. As described in Payne et al. (2005), the AMP can be scored as a relative preference (as done here) or as independent attitude estimates for beer and water. Because we were interested in predicting a relative choice between beer and water, the relative preference scoring is the most appropriate here. Higher numbers reflect a relative preference for beer.

Out of the sample of 43, 23 participants chose beer (53%). Participants who chose beer believed that the beer contained alcohol: the mean alcohol rating (on a 1–10 scale) was near the mid-point ($M = 4.4$, $SD = 1.44$). Only one participant rated the alcohol content as 1 (i.e., no alcohol). Because the AMP score was a continuous variable and drink choice was dichotomous, logistic regression was used to test this relationship. First, the AMP contrast score was standardised, and the drink choice was coded as 1 for beer and 0 for water. This analysis showed that the AMP was a significant predictor of drink choice, $b = .705$, $Wald = 3.88$, $p < .05$. Based on AMP scores, this model correctly classified 67.4% of participants as water-choosers or beer-choosers.

To interpret these results in more concrete terms, we can translate these results into probabilities of choosing beer versus water. To begin with, the base-rate probability of choosing beer was .53. A change of one standard deviation in the AMP score corresponds to a probability change of .17. In other words, at one standard deviation above the mean on AMP scores, the probability of choosing beer was .70. At one standard deviation below the mean, the probability was only .36.

Focused comparisons showed that responses on Beer trials primarily differentiated beer choosers ($M = 0.64$, $SD = 0.25$) from water-choosers ($M = 0.49$, $SD = 0.30$), $t(41) = 1.87$, $p = .07$. Responses on Beer trials were significantly above the chance value of .50 only for participants choosing beer, $t(22) = 2.73$, $p < .05$. In contrast, the proportion of pleasant responses on Neutral prime trials was similar for participants choosing beer ($M = 0.51$, $SD = 0.26$) and those choosing water ($M = 0.54$, $SD = 0.32$), $t(41) = 0.35$, $p = .73$. Responses on Water trials were non-significantly less positive for beer-choosers ($M = 0.73$, $SD = 0.23$) than water-choosers ($M = 0.79$, $SD = 0.16$), $t(41) = 0.98$, $p = .33$.

Reliability of measurement. An important psychometric feature of the AMP is high reliability. Reliability was computed using the same method as

detailed in Payne et al. (2005). A set of 24 difference scores was created and treated as individual "items" (for a conceptually similar approach using reaction time variables; see Bosson, Swann, & Pennebaker, 2000). First, each trial was scored as +1 for a pleasant judgement or 0 for an unpleasant judgement. Second, a randomly selected Neutral trial and a randomly selected Water trial were chosen and averaged together to create a baseline value. Third, a randomly selected Alcohol trial was chosen, and the baseline value was subtracted from it. This process was repeated until all trials had been used. Each trial was used in only one pair, producing a total of 24 difference scores as items. Each item could range between +1 and −1 (specifically, each difference score could be 1, .5, 0, −.5, or −1). For each difference score, higher numbers reflect greater probability of responding "pleasant" on alcohol trials than on non-alcohol trials. This analysis revealed high reliability, $\alpha = .92$.

Discussion

This study showed that, on average, implicit affective responses to beer measured using the AMP were neutral, or at least were similar to responses to a grey square. Individual differences in responses, however, were systematic and meaningful. The results were consistent with our hypotheses based on the reinforcing properties of alcohol. Men and women with strongly positive implicit responses to beer were the most likely to choose beer.

Most drinking, though, happens outside of the laboratory. Although this study established a positive relationship between AMP responses and drinking, it does not speak to daily drinking patterns or to problem drinking. In the following three studies, we examined reported drinking patterns over time in participants' daily lives. Study 2 measured the quantity and frequency of student drinking, beliefs about alcohol, and life problems related to drinking. This study examined not only AMP responses, but also compared the AMP with two other commonly used implicit measures to determine similarities and differences in the predictive utility of the tests.

STUDY 2: COMPARISON AMONG IMPLICIT TESTS

This study examined implicit responses using the AMP, the IAT, and evaluative priming. AMP and IAT designs were described previously. In evaluative priming (Fazio, Sanbonmatsu, Powell, & Kardes, 1986), a prime such as an alcoholic drink or water is presented before a target word, which is clearly positive (e.g., wonderful) or negative (e.g., awful). The task is to classify the target word as pleasant or unpleasant as quickly as possible. Responses are faster when the prime and target are either both pleasant or

both unpleasant, compared to when they differ. By including three implicit tasks in this study, we were able to replicate previous findings with the IAT and test whether evaluative priming and AMP tasks showed different results within the same design.

Method

Participants and procedure

Fifty-eight introductory psychology students (26 men and 32 women) participated for course credit. At the beginning of the study, participants were informed that they would complete a series of tasks related to alcohol and drinking. They were assured that their responses would be confidential. Participants completed the IAT, the AMP, the evaluative priming procedure, and a self-report questionnaire on alcohol attitudes, alcohol beliefs, and drinking-related behaviours. The order of measures was randomised for each participant using MediaLab software (Jarvis, 2006) to avoid order effects in the presentation of measures. Our rationale was that randomisation ensures that any order effects produce random error variance rather than systematic confounds. Random error can be overcome by aggregation over participants, but systematic order effects cannot. At the end of the experiment, participants provided demographic information and were debriefed.

Materials

The same 12 images of alcohol and water served as stimuli for each task so that performance on implicit measures could be directly compared. The three measures also relied on the same response keys labelled "pleasant" and "unpleasant". The structures of the three tasks are illustrated in Figure 1.

AMP. The instructions and procedure were similar to those in Study 1, except that the set of alcohol primes was expanded to include images of cocktails and wine in addition to beer. The new primes were added so that the AMP could assess attitudes toward a wider variety of alcoholic drinks. These images were matched on attractiveness to the water images. To minimise procedural differences between the AMP and the evaluative priming task, presentation times of the primes in the AMP were changed to match those in the evaluative priming task. Thus, the prime appeared for 200 ms and was immediately followed by the pictograph. The pictograph appeared for 100 ms and was then replaced by a mask, which stayed on the screen until participants responded.

IAT. The IAT was designed following the procedure outlined by Greenwald et al. (1998). At the beginning of the task, participants were

told that they would be shown words and images in the middle of the screen, and were asked to sort each item into an appropriate category as quickly as possible. Each trial block included instructions that described the category discriminations and key assignments. In the first 20 trials, participants categorised words as pleasant or unpleasant (e.g., good, win, bad, vile). In the next 20 trials, participants classified pictures of alcohol and water into the respective categories. Participants then completed the first block of combined categorisation trials, where "alcohol" and "pleasant" shared a left response key, and "water" and "unpleasant" shared a right response key. For the next block of trials, "alcohol" and "water" categories exchanged positions, such that "water" and "pleasant" shared a left response key, and "alcohol" and "unpleasant" shared a right response key. Participants completed 8 practice trials and 40 critical trials in each combined block. Participants were provided with feedback if they made an incorrect response and had to respond correctly to move on. The response keys assigned to the "pleasant" and "unpleasant" items were not counterbalanced and stayed constant throughout the task. This was done to minimise errors participants were likely to make if the response keys changed from task to task.

Evaluative priming. The procedure was designed following the recommendations for producing the optimal evaluative priming effect by Hermans, De Houwer, and Eelen (2001). Hermans et al. suggested that the stimulus onset asynchrony (SOA) between the prime and the target should be in the region of 200 ms. The target words were taken from Greenwald et al. (1998) and were the same as those used in the IAT. At the onset of the task, participants were told that they were to evaluate words as pleasant or unpleasant. They were also informed that each word would be preceded by an image of water or an alcoholic drink and were instructed to ignore these images. Participants completed 96 trials, wherein each of the 12 alcohol and 12 water primes was randomly paired with two pleasant and unpleasant words. In the procedure, participants were first presented with a row of fixation crosses in the middle of the screen for 500 ms. A prime then appeared for 200 ms, followed by a target word. There was a 500 ms interval between the trials. If participants made an incorrect categorisation, a warning message appeared on the screen. Participants had to provide a correct response to move on to the next trial.

Explicit alcohol attitudes and beliefs. Attitudes toward alcohol were measured using three Likert scale items. The items asked were: "What is your attitude toward (1) beer, (2) liquor/mixed drinks, and (3) wine". Participants rated their attitudes on a scale ranging from 1 (*extremely unfavourable*) to 6 (*extremely favourable*).

Positive beliefs about alcohol were measured using a scale from the Brief Alcohol Screening and Intervention for College Students (BASICS; Dimeff, Baer, Kivlahan, & Marlatt, 1999). Participants were presented with 14 positive statements about the effects of alcohol (e.g., Alcohol breaks the ice, Alcohol enhances social activity, Alcohol makes me sexier) and were asked to indicate their level of agreement with each statement. Participants made their ratings on a 6-point scale, from 1 (*strongly disagree*) to 6 (*strongly agree*).

Drinking-related behaviours. Participants' drinking behaviour was measured using several items from the CORE Alcohol and Drug Survey, designed specifically for college populations (Presley & Meilman, 1989). First, participants were asked if they drank alcoholic beverages at least occasionally. Those who responded "no" were classified as non-drinkers, and those who responded "yes" were classified as drinkers. For each class of drinks (beer, liquor/mixed drinks, and wine), participants were asked to estimate how often they drank that kind of drink. They rated their *frequency* of drinking using a scale with the following options: 1 (*never*), 2 (*once a year or less*), 3 (*more than once a year but less than once a month*), 4 (*at least once a month but less than once a week*), 5 (*more than once a week but not every day*) and 6 (*every day*).

For each kind of beverage, those participants who indicated anything other than "never" were asked to rate the *quantity* they drank, on average, when they drank. The instructions defined one drink as equivalent to one can or glass of beer, one glass of wine, one ounce of liquor, or one mixed drink. The scale contained the following options: 1 (*less than one drink*), 2 (*one or two drinks*), 3 (*three or four drinks*), 4 (*five or six drinks*), and 5 (*more than six drinks*). A review of drinking assessment methods has provided evidence that such quantity-frequency measures produce reliable and valid measurements of typical drinking behaviour, although they tend to underestimate atypical instances of extreme drinking (Sobell & Sobell, 1990). However, our interest in this study was in participants' typical drinking behaviour.

Finally, participants were asked to report a summary total of how many alcoholic drinks they drank per week (*drinks per week*), as a free-response number. This number was used to classify subjects as hazardous or non-hazardous drinkers based on norms from Sanchez-Craig, Wilkinson, and Davila (1995). Men who drank 16 or more drinks per week, and women who drank 12 or more, were counted as hazardous drinkers. Hazardous drinkers have an elevated risk of problems concerning interpersonal relationships, health, work, and legal domains.

In addition to amount of drinking, we also measured *life problems* resulting from drinking using a scale from the CORE Alcohol and Drug

Survey (Presley & Meilman, 1989). The scale asked participants to "Please indicate how often you have experienced the following due to your drinking during the last year", and listed 14 different consequences. Responses were made on a scale including 1 (*never*), 2 (*once*), 3 (*twice*), 4 (*3–5 times*), 5 (*6–9 times*), and 6 (*10 or more times*). Consequences included: "Had a hangover; Performed poorly on a test or important project; Been in trouble with police, residence hall, or other college authorities; Damaged property, pulled fire alarm, etc.; Got into argument or fight; Got nauseated or vomited; Driven a car while under the influence; Missed a class; Been criticised by someone I know; Thought I might have a drinking problem; Had a memory loss; Done something I later regretted; Been arrested for DWI/DUI; Been hurt or injured".

Results

Mean performance

AMP. Performance was calculated as the proportion of pleasant responses for each prime condition. Replicating previous results, participants made more pleasant judgements on Water trials ($M = 0.70$, $SD = 0.27$) than on Neutral ($M = 0.53$, $SD = 0.31$) or Alcohol trials ($M = 0.57$, $SD = 0.31$). Alcohol and Neutral trials were not significantly different from the chance level of .50 (ts < 1.73, ps $> .05$). Thus, participants showed relatively more positive attitudes toward water than toward alcohol, but attitudes toward alcohol appeared neutral on average, rather than negative.

IAT. Performance was scored using the recently introduced *D* measure according to recommendations by Greenwald, Nosek, and Banaji (2003). Response latencies on the Alcohol + Pleasant and Water + Unpleasant blocks were subtracted from latencies on Alcohol + Unpleasant and Water + Pleasant blocks, and the difference was divided by the pooled standard deviation across blocks. More positive values on the *D* measure reflect greater preference for alcohol, whereas negative values represent preference for water. The mean IAT *D* was $-.22$ ($SD = 0.47$). A single sample *t*-test showed that this value was significantly different from zero, $t(53) = -3.42$, $p < .001$. Overall, participants showed a relative preference for water over alcohol on the IAT, just as they did on the AMP. This relative preference could reflect either a negative attitude toward alcohol or a neutral or even positive attitude toward alcohol in the presence of an even more positive attitude toward water.

Evaluative priming. Latencies longer than 3000 ms were recoded to 3000 and those shorter than 300 ms were recoded to 300. Next, latencies were log transformed to reduce skew. Latencies were examined using a 2 (Prime:

Alcohol, Water) × 2 (Target valence: Pleasant, Unpleasant) ANOVA. Results showed that participants were faster when responding to pleasant than unpleasant targets, $F(1, 54) = 7.96$, $p < .01$. This main effect was qualified by a significant Prime × Target interaction, $F(1, 54) = 5.62$, $p < .05$. Participants were marginally faster when responding to pleasant words when they were primed with water ($M = 742$, $SD = 159$) than when they were primed with alcohol ($M = 759$, $SD = 168$), $F(1, 54) = 3.38$, $p = .07$. In contrast, they were marginally faster when responding to unpleasant words when they were primed with alcohol ($M = 760$, $SD = 159$) than water ($M = 769$, $SD = 153$), $F(1, 54) = 3.61$, $p = .06$. This pattern, like the other two implicit measures, shows a relative preference for water over alcohol.

Individual differences

Individual scores on the AMP were computed by averaging responses on water and control trials, and subtracting these from alcohol trials. IAT *D* scores served as individual IAT scores. Evaluative priming scores were computed by adding mean transformed latencies for Alcohol–Unpleasant and Water–Pleasant trials, and subtracting from those the mean latencies for Alcohol–Pleasant and Water–Unpleasant trials. This formed a contrast representing the Prime × Target interaction. On all three implicit measures, higher values represent more favourable attitudes toward alcohol.

Relations among attitude measures. All three implicit tasks were related to explicit attitudes. Explicit attitudes were significantly correlated with evaluative priming, $r = .28$, the IAT, $r = .36$, and with the AMP, $r = .33$, all ps $< .05$. The three implicit measures were, however, uncorrelated with each other. The correlation between AMP and IAT scores was $r = .11$; between AMP and evaluative priming, $r = .01$; and between IAT and evaluative priming, $r = -.05$ (none of which was significantly different from zero). The lack of correlation is consistent with prior research showing little or no correlation between different implicit measures (Bosson et al., 2000; Sherman et al., 2003). This lack of correlations may reflect high measurement error among some implicit measures (Cunningham, Preacher, & Banaji, 2001) or method variance related to differences in the structures of the tests (Payne, Burkley, & Stokes, 2007a). In any case, these null correlations between implicit tests should be interpreted in the context of the relationships with drinking behaviour, as described next.

Relations to criterion variables. Table 1 shows the correlations between the three implicit measures and each criterion variable. Evaluative priming was significantly related only to drinking quantity. Averaging across the six variables, evaluative priming showed a mean correlation of .15. The IAT also

TABLE 1
Correlations between implicit measures and self-reported attitudes and drinking behaviours in Study 2

	RT priming	*IAT*	*AMP*
1. Drinker/non-drinker	−.05	.10	.38*
2. Drinking frequency	.20	.31*	.39*
3. Drinking quantity	.29*	.24	.38*
4. Average drinks per week	.14	.14	.32*
5. Hazardous drinker	.16	.13	.28*
6. Life problems	.15	.26	.35*
Average	.15	.20	.35*

Notes: *$p < .05$. RT Priming = Reaction time measure of evaluative priming; IAT = Implicit Association Test; AMP = Affect Misattribution Procedure.

correlated significantly with one variable, drinking frequency, with an average correlation of .20 across all six variables. Neither evaluative priming nor IAT scores differentiated drinkers from non-drinkers, nor did they correlate with reported number of drinks per week, with hazardous drinking, nor with life problems from drinking.

AMP scores were a significant predictor for each of the six variables. Participants with more favourable attitudes toward alcohol on the AMP were more likely to be drinkers rather than non-drinkers. High scorers also reported drinking more frequently, in greater quantity, and were more likely to be hazardous drinkers. Finally, high scorers reported more life problems from drinking. The average correlation for the AMP was .35.[1]

Unique contributions of implicit measures. The three implicit measures were uncorrelated, as described above. This implies that the correlations shown by each measure reflect unique variance (i.e., variance that does not overlap with the other implicit measures). To more formally confirm that the relationships reflect unique variance, we performed a series of multiple regression analyses. Six regressions were conducted, in each analysis all three implicit measures were entered as predictors simultaneously, with one of the self-report measures listed in Table 2 as the dependent variable. As expected on the basis of the correlations, all of the relationships shown as zero-order correlations in Table 1 were unaffected by the inclusion of the other predictors. That is, each of the significant correlations remained significant, and each of the non-significant relationships remained non-significant. The

[1] Because drinker versus non-drinker status and hazardous drinking status were dichotomous variables, we also used logistic regression analysis to predict these variables using each of the implicit measures as independent variables. The logistic coefficients showed the same relationships as the simpler point-biserial correlations reported in Table 1.

TABLE 2
Correlations between self-reported attitudes and beliefs, motivation to conceal drinking, and AMP in Study 3

	Motivation to conceal	*AMP*
1. Explicit attitude	−.22**	.53*
2. Alcohol beliefs	.14	.32*
3. Behavioural consequences	.02	.42*
4. Frequency	−.17	.53*
5. Quantity	−.15	.60*
6. Average drinks per week	−.28*	.51*
7. Hazardous drinker	−.28*	.43*
Total drinking amount composite	−.25*	.59*

Notes: *$p < .05$; **$p < .06$. AMP = Affect Misattribution Procedure.

magnitude of all relationships was nearly identical to the correlation results. Because these results are largely redundant with the correlations reported in Table 2, they are not presented again here. This analysis confirmed that the observed relationships reflected unique contributions by each implicit measure.

Unique relationships controlling for explicit attitudes. For those variables that showed significant relationships with implicit tests, a set of partial correlations were run in order to examine the unique effect of the implicit measures while controlling for explicit attitudes. Evaluative priming was significantly related to drinking quantity. Controlling for explicit attitudes, this relationship was no longer significant, $pr = .15$, $p = .25$. The IAT was related to drinking frequency. Controlling for explicit attitudes, this relationship was no longer significant, $pr = -.04$, $p = .80$. Of the variables that were significantly related to the AMP, two of the six showed unique relationships after explicit attitudes were controlled. The AMP was uniquely associated with drinker versus non-drinker status, $pr = .28$, $p = .056$, and with life problems, $pr = .31$, $p < .05$. Implicit attitudes measured using the AMP thus explained some unique variance in drinking-related behaviours independent of explicit attitudes.

Reliability of measurement. Reliability was calculated for each of the three implicit measures using the difference score method described in Study 1. The only difference in procedures was that response latencies rather than response probabilities were used for the IAT and priming tasks. Reliability for the evaluative priming task was very low, $\alpha = .12$. Reliability was much higher for the IAT, $\alpha = .79$, and higher still for the AMP, $\alpha = .89$.

Discussion

Two critical findings emerged from Study 2. First, all three measures detected a relative preference against alcohol, on average. But second, these measures differed in the extent to which variability in those preferences predicted drinking behaviour. The average correlations for all three measures were in the expected positive direction. Individuals with more positive attitudes toward alcohol tended to act more favourably toward alcohol, regardless of which measure was used. However, that relationship was stronger and more consistent for the AMP than for the other two measures.

The fact that the implicit measures were uncorrelated with each other suggests that each may detect different aspects of drinking attitudes and behaviour. This evidence argues for the usefulness of including multiple measures, as was pointed out many years ago (Campbell & Fiske, 1959). At the same time, the present results cast doubt on the idea that implicit attitudes and drinking behaviour are genuinely unrelated. While the relationship may be multifaceted, it can be detected. Moreover, the ability to detect it seems to relate to the specific measures used. Among the measures compared here, the AMP may be the most sensitive method for these purposes.

One problem with assessing attitude–behaviour consistency using self-reported behaviour is that self-reports are subject to response strategies. A potential alternative explanation for these findings is that the consistent relationships between the AMP and drinking behaviour are driven by intentional expressions of attitudes on the AMP as well. By this explanation, the AMP is not actually measuring implicit (unintentionally expressed) attitudes, but intentionally expressed attitudes.

On the one hand, we find this explanation unlikely because several previous studies have shown that participants perform in similar ways on the AMP regardless of whether they are blatantly warned to avoid expressing any attitudes on the task or not (Payne et al., 2005). In the present studies, all participants received such a warning. We take systematic effects of the primes that persist in direct violation of these warnings to reflect unintentionally expressed attitudes.

On the other hand, a warning manipulation and participants' own motivations may have different effects. That is, even warned participants might not invest effort to de-bias their judgements unless they are also highly motivated to do so. As a result, there remains the possibility that the attitude–behaviour relations detected by the AMP are artificially inflated by participants who are motivated to express both their attitudes and their drinking behaviour.

According to this alternative explanation, participants' motivations to conceal their attitudes toward alcohol should affect their AMP performance

just as strongly as it affects their self-reported attitudes and behaviour. If the AMP is easily manipulated by motivated participants, then those who are motivated to minimise their liking for alcohol should express less favourable attitudes toward alcohol on the AMP. In contrast, our view is that the AMP reflects unintentionally expressed attitudes over which participants have little control. This explanation predicts that motivations should affect self-reported attitudes and behaviours, but not AMP performance. The next two studies directly test the role of motivation in the AMP and self-reports of attitudes toward alcohol and behaviours involving drinking.

STUDY 3: MOTIVATION TO CONCEAL DRINKING

In this study, we investigated individual differences in motivation to conceal drinking as a moderator of the relationship between implicit and explicit attitudes toward alcohol. We hypothesised that participants who are motivated to conceal drinking will express less favourable attitudes toward alcohol and alcohol consumption on a self-report questionnaire than participants who are not motivated to conceal drinking. We also hypothesised that the AMP scores would not differ among participants low and high in motivation to conceal drinking, because responses on the measure are difficult to control. Thus, we predicted that a correlation between implicit and explicit attitudes toward alcohol will be strong among those low in motivation to conceal drinking and weak among those high in motivation to conceal drinking.

Method

Participants and procedure

Ninety-nine introductory psychology students (39 men and 60 women) participated in exchange for extra credit. Participants completed the AMP, followed by a self-report questionnaire on alcohol preferences, drinking-related consequences, beliefs about alcohol, and motivation to conceal drinking. At the end of the study, participants provided demographic information, were debriefed, and then were dismissed.

Materials

AMP. The instructions and procedure were identical to those in Study 2.

Explicit alcohol attitudes and beliefs. These measures were identical to those used in Study 2. Participants first reported on their attitudes towards beer, liquor/mixed drinks, and wine. Participants' positive beliefs about

alcohol were measured using a scale from the Brief Screening and Intervention for College Students (BASICS; Dimeff et al., 1999).

Drinking-related behaviours. Participants' actual drinking behaviour was measured with the same items as in Study 2. Specifically, for each class of drinks (beer, liquor/mixed drinks, and wine), participants were asked to estimate how often they drank that kind of alcohol (*frequency*) and how much they drank on average in one sitting (*quantity*). Participants were also asked to report a summary judgement of how many alcoholic drinks they drank per week (*drinks per week*). Life problems from drinking (*life problems*) were measured using a scale from the Core Alcohol and Drug Survey (Presley & Meilman, 1989).

Motivation to conceal drinking. Three questions were used to assess motivation to conceal drinking (I attempt to appear as though I do not drink much in order to avoid negative reactions from others; It is important to me not to let others realise when I've had too much to drink; I try to hide the fact that I like alcohol in order to avoid negative reactions from others). Participants indicated their level of agreement with each of the statements on a scale from 1 (*strongly disagree*); to 6 (*strongly agree*).

Results

Mean performance

Performance on the AMP was very similar to that in the previous studies. Replicating previous results, participants made more pleasant judgements on Water trials ($M = 0.78$, $SD = 0.23$) than on Neutral ($M = 0.48$, $SD = 0.33$) or Alcohol trials ($M = 0.49$, $SD = 0.29$). The main effect of prime was significant, $F(2, 196) = 35.01$, $p < .001$. Alcohol and Neutral trials were not significantly different from the chance level of .50 ($ts < .53$, $ps > .05$). Participants thus showed relatively more positive attitudes toward water than toward alcohol, but attitudes toward alcohol again appeared neutral on average, rather than negative.

Individual differences

Motivation to conceal drinking. The motivation to conceal drinking items were positively correlated ($\alpha = .68$), so we averaged them together into a single index. Motivation to conceal drinking was not related significantly to AMP performance (scored as in Study 2), $r = -.16$, *ns.* Motivation to conceal was, however, marginally related to explicit attitudes, $r = -.22$, $p = .056$. AMP performance and explicit attitudes were highly correlated, $r = .53$, $p < .001$. The slight negative relationship between AMP performance and

the motivation scale appears to derive from their common relationships with explicit attitudes toward alcohol. When explicit attitude was partialled out, the correlation between AMP and motivation to conceal receded further, $pr = -.07$. Participants motivated to conceal drinking did not express less liking for alcohol on the AMP, but they did tend to express less liking on the explicit items.

Attitude–behaviour relationships. As shown in Table 2, AMP scores were positively correlated with explicit attitudes, beliefs, and drinking behaviours. The results thus far show that AMP performance strongly and positively predicted self-reported drinking attitudes, beliefs, and behaviours. They further show that motivation to conceal was weakly and negatively related to self-reported drinking attitudes and behaviour. Our main prediction was that Motivation to Conceal Drinking would moderate the relationship between AMP performance and self-reported drinking behaviour. Self-reports should coincide with implicit attitudes for individuals who are not motivated to conceal their drinking. However, individuals motivated to conceal drinking should show equivalent implicit attitudes on the AMP, but they should under-report their drinking. This difference can be expected to show up most strongly for individuals with strongly positive implicit attitudes toward alcohol who presumably drink the most.

To test this idea, we created a composite measure of drinking behaviour including the three drinking behaviour measures (*frequency*, *quantity*, and *drinks per week*). We multiplied frequency and quantity to calculate total amount of drinks. Because this estimate and the number of drinks per week were strongly correlated, $r = .81$, we standardised them and averaged them together. This combined index, which we refer to as "total drinking amount" was significantly positively related to AMP scores, $r = .59$, $p < .001$, and negatively related to Motivation to Conceal Drinking, $r = -.25$, $p < .05$. People who showed more liking for alcohol on the AMP reported drinking more, and those who reported greater motivation to conceal drinking reported drinking less. To test whether Motivation to Conceal Drinking moderated the attitude–behaviour relationship, we conducted a hierarchical regression analysis.

After standardising all variables, AMP scores and Motivation to Conceal Drinking scores were entered as predictors with Total Drinking Amount as the dependent variable. On a second step, the AMP × Motivation interaction was entered. As predicted, the two-way interaction was significant, $b = -.23$, $t = -2.44$, $p < .05$. The second step added a significant increment in variance explained, $\Delta R^2 = .05$, $F(3, 75) = 13.34$, $p < .01$. The shape of this interaction is displayed in Figure 2. Regression lines relating AMP performance and drinking are displayed at one standard deviation above and below the mean on Motivation to Conceal Drinking. As

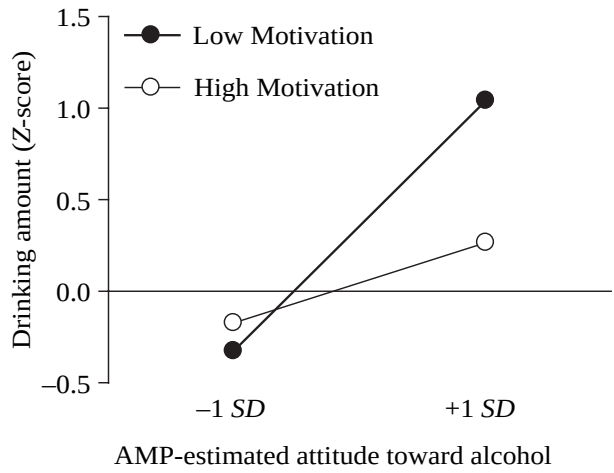

Figure 2. Regression lines relating AMP estimates of attitudes toward alcohol to self-reported amount of drinking, as a function of motivation to conceal drinking.

the figure shows, AMP performance was strongly related to drinking for those who were unmotivated to conceal their drinking ($b = .69$). However, the relationship was much weaker for those who were motivated to conceal drinking ($b = .22$). Because all variables were standardised, these coefficients can be interpreted on the same scale as a standardised regression coefficient. This interaction is driven by the fact that highly motivated participants were more likely to under-report their drinking on the self-report measures, but did not perform differently on the AMP, as indicated by the lack of correlation between AMP and motivation to conceal scores reported above.

Unique relationships controlling for explicit attitudes. To test whether the relationships between AMP responses and drinking-related behaviours explained unique variance beyond explicit attitudes, a series of partial correlations were examined, controlling for explicit attitudes. With the exception of alcohol beliefs ($pr = .05$, $p = .64$), all of the partial correlations remained significant. AMP scores were uniquely related to life problems, $pr = .20$, drinking frequency, $pr = .20$, drinking quantity, $pr = .36$, average drinks per week, $pr = .30$, and hazardous drinking, $pr = .28$, all $ps < .05$. As a final analysis, the regression analysis testing the AMP by Motivation interaction was re-run, controlling for explicit attitudes and their interaction with Motivation to conceal drinking. AMP responses ($b = .30$) and explicit attitudes ($b = .58$) both independently predicted drinking, and the AMP by

Motivation interaction remained significant ($b = -.19$) when the explicit attitudes × motivation (non-significant) interaction was controlled. These analyses show that implicit responses uniquely predicted several aspects of drinking behaviour independent of explicit attitudes.

Reliability of measurement. Reliability for the AMP was high and similar to the values in the previous studies, $\alpha = .93$.

Discussion

Whereas Studies 1 and 2 established that the AMP could predict drinking behaviour, Study 3 demonstrated an important moderator of that effect. When the behaviour is measured using a self-report questionnaire, it is important to take motivations to conceal drinking into account. Not all of our participants were motivated to conceal their drinking, but some of them were. The medium-to-large correlations observed between the AMP and drinking reports appeared to reflect a mix of a strong relationship among unmotivated participants and a weak relationship among highly motivated ones. This pattern parallels a well-established finding in research on implicit prejudice, which shows that the relationship between implicit and explicit measures of race attitudes depends on how motivated participants are to avoid expressing prejudice (Dunton & Fazio, 1997; Fazio et al., 1995; Payne, 2001; Plant & Devine, 1998).

However, this finding also inherits a problem that accompanies the parallel findings in prejudice research. Namely, if a participant wants to convincingly present her-/himself as drinking less than she/he does, she/he is also likely to present her-/himself as not particularly motivated to conceal drinking. To do otherwise would cast doubt on her/his sincerity. That is, if a participant responds that she/he drinks only one drink per week, and also that she/he tends to minimise her/his drinking to avoid negative reactions from others, then she/he has undermined her/his own claim.

Many participants undoubtedly can compensate for the appearances they project by completing the self-report motivation scale in a manner just as strategic as the drinking reports. Clearly, not all participants did so in our study, because if they had, we would not have been able to detect the moderated relationship that we found. Nonetheless, to overcome this potential weakness, we report a final study in which we manipulated social pressure to under-report drinking. Our prediction was that social pressure would reduce self-reported drinking and liking for alcohol, but that it would not affect AMP performance.

STUDY 4: MANIPULATING MOTIVATION

In the next study, we experimentally manipulated the social pressure to under-report drinking. We expected this manipulation to motivate participants to report less favourable attitude towards alcohol and to report drinking fewer drinks on a self-report measure. In contrast to explicit attitudes, we expected that the manipulation would not affect implicit attitudes, as measured by the AMP.

Method

Participants

Fifty-four introductory psychology students (27 males, 27 females) participated in exchange for course credit.

Procedure: Social pressure manipulation

This study had a two-group design: participants were either exposed to social pressure to under-report drinking or not. In the high-pressure condition, participants were first asked to report their name, date of birth, their school address, and their permanent (parents') address. After obtaining this information, the experimenter explained to participants that the study concerned agreement between parents' and students' attitudes toward drinking and drinking behaviour. The experimenter then informed participants that the "results of the study will be sent to your parents to the address you provided earlier". It was further emphasised that "responses to some items may be shared with your parents". Participants in the high-pressure condition then proceeded with the experiment.

Participants in the low-pressure condition also provided their personal information but were reassured that their responses would remain confidential. Half of the participants completed the AMP first and the self-report questionnaire on alcohol preferences and alcohol consumption second; the other half competed these measures in the reverse order.

Materials

AMP. The instructions and procedure were identical to those in Study 3.

Explicit alcohol attitudes and alcohol consumption. As in previous studies, participants reported how much they liked beer, wine, and liquor/mixed drinks on three 5-point scales. The average was taken to measure attitudes toward alcohol. Participants also estimated the average number of alcoholic drinks they had in a week. We elected to simplify our attitude and behaviour variables for this study to ensure that the warning remained

salient while participants were completing all measures. We chose these two measures in particular because they were the most straightforward and face valid.

Results

Mean performance

A preliminary analysis showed that the order in which the AMP and explicit measures were conducted had no effects, and so results will be reported collapsing across orders.

Explicit attitudes toward alcohol. Attitudes toward alcoholic drinks were computed by averaging liking ratings for beer, wine, and liquor/mixed drinks. A comparison of experimental groups showed that self-reported liking for alcohol was significantly lower in the high-social-pressure group ($M = 2.72$, $SD = 1.10$) than in the low-social pressure group ($M = 3.38$, $SD = 0.77$), $t(52) = 2.59$, $p < .05$. As predicted, when participants were told that their parents would be privy to their responses, they reported less liking for alcohol.

Reported alcohol consumption. Next, we analysed the number of drinks participants reported consuming per week. As expected, they reported drinking much less in the high-pressure condition ($M = 5.54$ drinks per week, $SD = 6.97$) than in the low-pressure condition ($M = 10.11$ drinks per week, $SD = 8.82$), $t(52) = 2.11$, $p < .05$. When participants believed their responses would be sent to their parents, they reported drinking only 55% of the alcohol they reported confidentially. When responses were classified as hazardous and non-hazardous drinkers, fully 30% of the low-pressure group reported hazardous levels of drinking, whereas only 11% did so in the high-pressure group, $\chi^2(1, N = 54) = 18.96$, $p < .01$.

AMP. Responses on the AMP were analysed using a 3 (Prime Type: alcohol, neutral, water) × 2 (Social Pressure Group: high, low) mixed-model ANOVA. Overall means for the AMP were highly similar to previous studies. Participants made more pleasant judgements following water primes ($M = 0.68$, $SD = 0.27$) than either neutral primes ($M = 0.52$, $SD = 0.30$) or alcohol primes ($M = 0.57$, $SD = 0.24$). The main effect of Prime Type was significant, $F(2, 106) = 10.40$, $p < .001$. Post hoc tests showed that responses following water primes were significantly more positive than responses to either alcohol primes, $F(1, 53) = 15.72$, $p < .001$, or neutral primes, $F(1, 53) = 14.59$, $p < .001$. In this sample, pleasant responses to alcohol primes were significantly greater than the chance value of .50, $t(53) = 2.17$, $p < .05$.

Critically, the social pressure manipulation did not qualify these results. The Prime × Group interaction was not significant, $F(2, 104) = 0.40$, $p = .67$. As predicted, AMP responses were unaffected by the social pressure manipulation.

Comparison of measures. To compare the effects of social pressure on all three measures simultaneously, we computed a single standardised score for each measure. The AMP score was computed as in previous studies by subtracting the mean proportion of "pleasant" responses on water and neutral trials from the proportion of "pleasant" responses on alcohol trials. Scores for each measure were *z*-transformed to place them on a comparable scale. These scores were then analysed using an ANOVA with Social Pressure condition as a between-participants variable and Type of Test as a within-participants variable. The results are displayed in Figure 3. There was a significant Social Pressure Condition × Type of Test interaction, $F(2, 104) = 4.87$, $p < .01$. This interaction confirms that the effect of social pressure was greater on the two self-report measures than on the AMP.

Individual differences

As in previous studies, individual differences in AMP performance were associated with self-reported liking for alcohol ($r = .39$, $p < .01$) and drinking behaviour ($r = .44$, $p < .01$). The relationship between AMP responses and reported drinking behaviour was stronger in the low-pressure condition than the high-pressure condition. For the continuously scored number of drinks per week, the correlations were $r = .56$ in the low-pressure group versus $r = .38$ in the high-pressure group. For hazardous drinking, the correlations were $r = .55$ versus $r = .18$. The difference between correlations

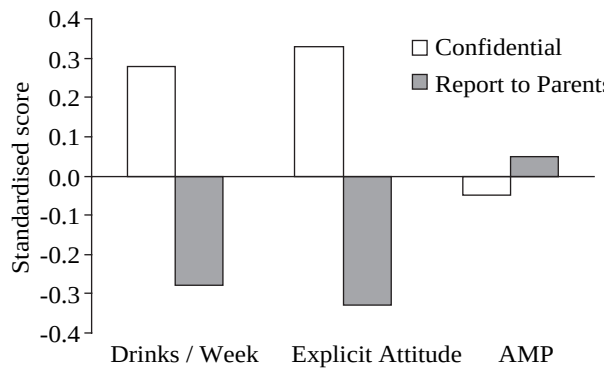

Figure 3. Effect of social pressure on self-reported drinks per week, explicit attitude toward alcohol, and AMP scores.

was significant for the latter, $z = 2.22$, $p < .05$ but not the former, $z = 1.18$, *ns*. The manipulation of social pressure in this study produced results similar to individual differences in motivation in Study 3. In both, highly motivated subjects reported less drinking, but showed similar AMP responses.

Reliability of measurement. Internal consistency for the AMP was high, consistent with previous studies, $\alpha = .91$.

Discussion

This experiment showed that social pressure affected self-report measures of drinking and liking for alcohol, but had no effect on AMP responses. The finding provides a conceptual replication of Study 3, but without relying on a self-report measure of motivation to conceal drinking. Together, these studies show that implicit attitudes toward alcohol can indeed predict drinking-related attitudes and behaviour, and that these relationships follow the same principles that have emerged in other topics of research on implicit attitudes. Namely, implicit and explicit measures tend to be most strongly correlated when there is no self-presentation concern. Introducing self-presentation concerns distorts responses on self-report measures, which can mask relationships between implicit and explicit measures.

GENERAL DISCUSSION

The relation between implicit attitudes and drinking has presented something of a puzzle. Early enthusiasm for implicit measurement made implicit aspects of addictive behaviour a natural target for research. However, those early studies often produced complex and inconsistent results. Using a new method, the present studies show that strong and stable relationships can be detected with implicit measures. We found that the more a person drank, the more positive his automatic evaluations of alcohol were. Study 1 showed that individual differences in AMP performance could reliably predict participants' drink choice. Study 2 extended these findings by comparing the utility of the AMP to two other implicit measures. Replicating previous studies, both the IAT and reaction-time-based priming methods showed small and inconsistent relations with behaviour. In contrast, the AMP showed more consistent relationships. Finally, Studies 3 and 4 showed that the AMP was resistant to motivations to conceal drinking attitudes and behaviour. Together, we believe these studies provide strong evidence that automatic evaluations of alcohol play an important role in drinking behaviour and that the AMP provides a valuable means for measuring these evaluations.

AMP performance was scored in the reported analyses as a difference score between prime trials. A potential limitation of this approach is that a difference score of zero may not indicate a true rational zero point, and hence interpretations are limited to relative differences rather than absolute statements about whether responses were "positive" or "negative" (Blanton & Jaccard, 2006). Blanton and Jaccard suggested the use of simultaneous regression analyses as an alternative approach that avoids the difficulty of the difference score method. We conducted a series of regression analyses using this method for the key analyses, entering responses on alcohol, water, and neutral control trials simultaneously as predictors. We found consistently that the same pattern of relationships held as for the difference scores reported. In the vast majority of cases, the total variance explained by the three simultaneous predictors was very similar to that of the difference scores. Moreover, the same patterns emerged when only responses on alcohol trials were used, although the variance explained was sometimes less using this variable alone. Using any of these methods, the conclusion is similar: AMP responses to alcohol cues were positively related to drinking behaviour. Among heavy drinkers, responses on alcohol trials appeared quite positive, either examined alone, or when controlling for either water or control trials, or both.

Relations between AMP and other implicit measurements

Like other implicit measures, the AMP presents an attitude object and then measures reactions to it indirectly, via the effect it has on other judgements. The AMP is most similar to other evaluative priming procedures, in that reactions to the primes are presumably the same. But they differ mainly in how spontaneous reactions to the primes are captured by the judgement task. Whereas reaction-time-based priming methods present target items that have a clear and obvious evaluation, the AMP presents items that have no correct answer. Rather than measuring facilitation or interference with responses, the AMP assesses evaluations by how they change participants' construal of the target items. The lack of a correct answer may be important because it forces participants to rely on internally generated reactions as cues for how to evaluate the novel item.

Because evaluations are transferred to the target judgement by different mechanisms, the AMP and reaction time tasks may resist correction for different reasons. In the case of RT priming, the task is difficult to control because subtle differences of a few dozen milliseconds are usually imperceptible to participants. In the case of the AMP, it is probably the causal effect of one's own affective reactions that is difficult to monitor and control. The failure to correct for prime-induced bias may be because

participants cannot perceive whether, on any given trial, their liking for the pictograph is in fact caused by their reactions to the primes.

Why, then, did the AMP show stronger relationships with drinking than other implicit tests have shown? One reason is that priming measures such as the AMP and evaluative priming may be less susceptible to environmental associations than the IAT and closely related tests (Olson & Fazio, 2004). If so, these measures may reflect participants' attitudes with greater specificity. But in contrast to evaluative priming based on reaction times, the AMP has greater reliability (average internal consistency in these studies was .91), which increases the test's sensitivity to detect relationships with other variables. The specificity, sensitivity, and reliability of a test are three critical considerations influencing a test's predictive validity.

Conclusion

Addictive behaviours are often soaked with emotion and covered by self-presentation, which makes addictive behaviours ripe for study using implicit measures of evaluation. Some early attempts at studying implicit affective reactions have produced inconsistent results, suggesting that both drinkers and non-drinkers have negative automatic responses to alcohol. These results imply that drinkers drink despite an automatic aversion, rather than because of automatic liking. Such a conclusion is important because it contradicts theories that emphasise learned automatic preferences as a mediator of addictive behaviour. The present findings add to a handful of studies that question that conclusion. These findings highlight the importance of automatically activated positive attitudes for addictive behaviours and offer an effective tool, the affect misattribution procedure, to gauge them more clearly.

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