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10 617 - drug or ~~Dly - drink~~, pg 648

11 avg (2), pg 650

12 att (1) for att IAT, ~~2~~ belief (2) for arousal, pg 650

13 att (1) for global, bel (2) for arousal, expect pg 651 ~~pg 650~~

14 not (0), pg 650

15 self-rep past (1), pg 650

16 not rep (3), pg ~~651~~ 652 ← if guess, mdl.

17 words (0), pg 650

18 2 IATs (2), pg 650

I-E-B

19 1

20 2

21 3

22 bef (1)

23 bef (1)

pg 651

24 sep (1)

25 sep (1)

pg 651 ← Could be called sm or uncoded

26 sd - 4.5, pg 650

27 sd - 4.5, pg 651

28 CON - ~~4~~ 4.5, pg 650

29 spec - ~~4~~ 4, pg - 650

30 spec - ~~8~~ 4, pg - 651 & 650

31 comp - 1, pg ~~34~~ 650

32 NON (0), pg 648

33 dud (2), pg 650

✓

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Implicit and Explicit Alcohol-Related Cognitions in Heavy and Light Drinkers

Reinout W. Wiers, Nieske van Woerden, Fren T. Y. Smulders, and Peter J. de Jong
Maastricht University

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Implicit and explicit alcohol-related cognitions were measured in 2 dimensions: positive–negative (valence) and arousal–sedation, with 2 versions of the Implicit Association Test (IAT; A. G. Greenwald, D. E. McGhee, & J. L. Schwartz) and related explicit measures. Heavy drinkers (n = 24) strongly associated alcohol with arousal on the arousal IAT (especially men) and scored higher on explicit arousal expectancies than light drinkers (n = 24). On the valence IAT, both light and heavy drinkers showed strong negative implicit associations with alcohol that contrasted with their positive explicit judgments (heavy drinkers were more positive). Implicit and explicit cognitions uniquely contributed to the prediction of 1-month prospective drinking. Heavy drinkers' implicit arousal associations could reflect the sensitized psychomotor-activating response to drug cues, a motivational mechanism hypothesized to underlie the etiology of addictive behaviors.

During the past 2 decades, alcohol-related cognitions have received considerable attention in psychological theories on the etiology of alcohol use disorders. Several cognitive–motivational constructs have been proposed to predict alcohol use and abuse, such as outcome expectancies (e.g., Goldman, Del Boca, & Darkes, 1999), attitudes (e.g., Burden & Maisto, 2000), and motives (e.g., Cooper, Frone, Russell, & Mudar, 1995). These approaches have been successful in the prediction of alcohol use and abuse but have also been criticized on a number of conceptual and methodological grounds (e.g., Leigh, 1989b). Furthermore, the validity of self-report measures, commonly used to assess these constructs, has been criticized on more general grounds (e.g., Nisbett & Wilson, 1977). For this reason, and because it is unclear to what extent a questionnaire can tap underlying cognitive motivational processes, Greenwald and Banaji (1995) proposed using implicit measures that do not rely on self-report to assess attitudes and related concepts in addition to using explicit measures. In this study, implicit and explicit alcohol-related cognitions were assessed in light and heavy drinkers and related to prospective alcohol use.

Reinout W. Wiers, Nieske van Woerden, and Fren T. Y. Smulders, Department of Experimental Psychology, Maastricht University, Maastricht, the Netherlands; Peter J. de Jong, Department of Medical, Clinical, and Experimental Psychology, Maastricht University.

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Correspondence concerning this article should be addressed to Reinout W. Wiers, Department of Experimental Psychology, UNS 40, Universiteit Maastricht, P.O. Box 616, 6200 MD Maastricht, the Netherlands. E-mail: R.Wiers@psychology.unimaas.nl

Explicit Alcohol-Related Cognitions

The cognitive–motivational construct that has received the most attention in the alcohol field is that of outcome expectancies (referred to hereafter as *expectancies*), or the beliefs individuals hold about the effects of alcohol on behavior, moods, and emotions (Leigh, 1989b). Since the development of the first alcohol expectancy questionnaires, hundreds of studies have investigated the relationship between expectancies and alcohol use (Goldman et al., 1999). Expectancies predict up to 50% of the variance in alcohol use when structural equation modeling (SEM) is used (e.g., Goldman et al., 1999; Leigh & Stacy, 1993; Wiers, Hoogeveen, Sergeant, & Gunning, 1997). Expectancies measured in young adolescents significantly predict drinking patterns up to 9 years later, after controlling for earlier alcohol and drug use (Stacy, Newcomb, & Bentler, 1991). Given this predictive power, several authors have argued that expectancies are an important cognitive mediator in the etiology of alcohol use disorders, mediating more distal biological and cultural influences (Goldman et al., 1999; Sher, 1991; Wiers, Gunning, & Sergeant, 1998). Current issues in expectancy research include the relationship between expectancies and other cognitive–motivational constructs, their structure, and their assessment using implicit and explicit measures.

Expectancies, Attitudes, and Motives

Attitudes are global evaluations of objects in people's environment that perform an important approach–avoidance function (e.g., Wilson, Lindsey, & Schooler, 2000). Attitudes can be measured in different ways: by directly assessing a global evaluation or, more indirectly, by multiplying specific expectancies (beliefs) with respect to their subjective value in forming attitudes that predict alcohol use and abuse through intentions (e.g., Fishbein & Ajzen, 1975). Note that in the indirect conceptualization, expectancies and attitudes are almost identical (the difference is value, but most expectancies have similar values to most people; Goldman et al., 1999). However, several studies have shown that *global* attitudes and specific expectancies predict unique variance in alcohol use "positive"). In this example, a large difference in RT between phases combining "Black–positive, White–negative" and "White–positive, Black–negative" indicates a strong implicit racial attitude (Greenwald et al., 1998).

The psychometric properties of the IAT are rather good. Several studies reported that the IAT has fairly good test–retest reliability (about .70), and split-half reliabilities around .90 (Bosson, Swann, & Pennebaker, 2000; Greenwald & Nosek, 2001). Speaking to the internal validity of the IAT, it has been demonstrated that the IAT effect is not influenced by the familiarity of items used and that the IAT cannot be faked (Greenwald & Nosek, 2001). Cunningham, Preacher, and Banaji (2001), using SEM, showed good convergent validity of the IAT and other measures of implicit attitudes. Discriminant validity between implicit associations as measured with the IAT and self-report measures has been demonstrated in a large number of studies. Typically, the correlation of the IAT and a related explicit measure is small but not zero (about .25; Dovidio, Kawakami, & Beach, 2001). Predictive validity has been shown in studies in which groups differed in expected ways in their implicit associations (e.g., Greenwald et al., 1998). Finally, there are indications that implicit and explicit measures predict different aspects of behavior (Dovidio et al., 2001).

Recently, varieties of the IAT have been applied to experimental psychopathology research of social anxiety (e.g., de Jong, Pasman, Kindt, & Van den Hout, 2001), phobia (Teachman, Gregg, & Woody, 2001), eating disorders (Roefs & Jansen, 2002), and depression (Gemar, Segal, Sagrati, & Kennedy, 2001). To our knowledge, this is the first application of the IAT to alcohol research.

This Study

We measured implicit and explicit alcohol-related cognitions in two dimensions: valence (positive–negative) and arousal (arousal–sedation). These two dimensions were chosen for several reasons. They were consistently found in semantic memory studies of expectancies (Goldman et al., 1999) and in emotion research (Lang et al., 1999). Furthermore, there is evidence that distinct neurobiological processess underlie these two dimensions and that the sensitized initial arousal reactions to drug-related stimuli are crucial in the development of addiction (Robinson & Berridge, 1993, 2001). Both dimensions were measured implicitly with two IATs (valence IAT and arousal IAT) and explicitly with paper-and-pencil tests using the same words. A general expectancy questionnaire was included to measure negative and positive (both positive and negative reinforcement) expectancies for a low and a high dose of alcohol (Wiers et al., 1997). Participants were light and heavy drinking undergraduate university students. On the basis of MDS research, we predicted that heavy drinkers would score higher on arousal expectancies than light drinkers and that both light and heavy drinkers would be moderately positive about alcohol. Finally, we explored the predictive power of participants' implicit and explicit alcohol-related cognitions pertaining to 1-month prospective alcohol use.

Method

Participants

Participants were 48 volunteer undergraduate students (24 men, 24 women) of Maastricht University. They were invited on the basis of their alcohol use and problem scores, reported in a screening 3 months before the study ($N = 182$). We selected 24 heavy drinkers (12 men, 12 women) with high weekly alcohol use and high scores on alcohol-related problems (alcohol use: $M = 32.0$ standard servings[3] per week, $SD = 12.9$; alcohol problems: $M = 15.8$, $SD = 8.6$) and 24 light drinkers (12 men, 12 women) with low scores on weekly alcohol use and on alcohol-related problems (alcohol use: $M = 5.1$, $SD = 4.4$; alcohol problems: $M = 3.6$, $SD = 2.8$). Light drinkers were selected to drink at least one alcoholic drink a week. Male participants scored nonsignificantly higher on alcohol consumption than female participants (19.0 vs. 16.6 drinks per week, $p > .30$) and alcohol-related problems (11.2 vs. 8.2, $p > .25$). Mean age was 21.5 years, with no difference between light and heavy drinkers ($p > .50$).

Materials and Measures

Alcohol use. Alcohol use was measured with a self-report questionnaire (Wiers et al., 1997) based on the timeline follow-back method (Sobell & Sobell, 1990). Self-report measures have been found valid when used in a research setting with sober participants who are given assurance of confidentiality (Sobell & Sobell, 1990). These requirements were fulfilled in our study. Participants indicated on grids how many standard drinks they consumed of different types of alcoholic drinks during each day of the past week, and for each day how many drinks they drank on a typical day. With this questionnaire, estimates for drinking prior to the experiment were generated. In addition, participants were asked to keep an alcohol diary, in which they filled out the number of different drinks (and circumstances) during the 28 days after the second experimental session. From this diary, prospective alcohol use was calculated.

Alcohol-related problems. The Rutgers Alcohol Problem Index (RAPI; White & Labouvie, 1989) was used, which measures social and health-related problems adolescents and young adults had experienced with alcohol (e.g., not able to do homework because of a hangover). Participants indicated on a 5-point Likert scale how often they had experienced each problem. The scale has a high reliability (.80 or higher) and accurately discriminates between clinical and nonclinical samples. Reported means for clinical samples on the RAPI are between 21 and 26, indicating that the average level of alcohol-related problems in heavy drinkers in our study was at a subclinical level ($M = 15.8$).

Implicit association tasks. Two IATs were presented in balanced order (valence IAT and arousal IAT). Both contained two sets of two word categories. The target words always consisted of alcoholic drinks (labeled *alcohol*: beer, wine, port, whisky, vodka, rum) and sodas (labeled *sodas*: "Coke," "Cassis," "Sinas" [the last two are lemonades], "Spa" [sparkling water], tonic, and juice). The attribute set consisted of either positive and negative words (valence IAT) or arousal and sedation words (arousal IAT). For the positive–negative dimension, the following words were used: *positive* words (labeled *positive*) were "sociable," "good," "pleasant," "nice," "enjoyable," "sympathetic"; *negative* words (labeled *negative*) were "antisocial," "bad," "unpleasant," "stupid," "obnoxious," "tedious." *Arousal* words (labeled *active*) were "energetic," "lively," "funny," "cheerful," "loose," "aroused"; *sedation* words (labeled *passive*) were "relaxed," "sleepy," "woozy," "quiet," "calm," "listless." The Dutch words were matched for prevalence and number of syllables.

Each IAT consisted of nine phases that came in one of two orders (see Table 1; we closely followed the design of Greenwald et al., 1998). Each IAT consists of two blocks in which the order of the two combination phases is reversed. The four mixed phases necessary to generate the two IAT effects per task were given in one of two orders: CRRC or RCCR, where C stands for *combination* and R for *reversed combination*. Every phase consisted of one practice block and either a single measurement block (single-dimension discrimination phases) or two measurement

30 14 28 11 15 29 17 12 18 33 31 26 29

[3] A standard alcohol serving in Holland contains somewhat less alcohol than a standard English or American serving: 12 g versus 14 g.

Table 1
Measuring Alcohol Associations With the Valence and Arousal Implicit Association Tests (IATs)

	Valence IAT		Arousal IAT	
Phase	Concept, left hand	Concept, right hand	Concept, left hand	Concept, right hand
1	*alcohol*	*soda*	*alcohol*	*soda*
2	*positive*	*negative*	*active*	*passive*
3 (C_1)	*alcohol* or *positive*	*soda* or *negative*	*alcohol* or *active*	*soda* or *passive*
4	*soda*	*alcohol*	*soda*	*alcohol*
5 (R_1)	*soda* or *positive*	*alcohol* or *negative*	*soda* or *active*	*alcohol* or *passive*
6	*soda*	*alcohol*	*soda*	*alcohol*
7 (R_2)	*soda* or *positive*	*alcohol* or *negative*	*soda* or *active*	*alcohol* or *passive*
8	*alcohol*	*soda*	*alcohol*	*soda*
9 (C_2)	*alcohol* or *positive*	*soda* or *negative*	*alcohol* or *active*	*soda* or *passive*

Note. The following explanation is for the valence IAT (for an explanation of the arousal IAT, replace *positive* with *active* and *negative* with *passive*): In Phase 1, participants press the left response key when the target word on the screen is an *alcoholic drink* (e.g., "beer") and the right response key when the target word is a *soda* (e.g., "juice"). In Phase 2, participants press the left response key when the target is *positive* (e.g., "good") and the right response key when the target is *negative* (e.g., "bad"). In Phase 3 (the first combination phase, C), participants press the left response key when the target is an *alcoholic drink* or a *positive word*, and the right response key when the target is a *soda* or a *negative word*. Phase 4 is a reversal of Phase 1 (*alcohol* and *soda* are assigned to the other side). In Phase 5 (the first reverse combination, R), participants press the left response key when the target is a *soda* or a *positive word*, and the right response key when the target is an *alcoholic drink* or a *negative word*. Phase 6 repeats Phase 4, Phase 7 repeats Phase 5, Phase 8 repeats Phase 1, and Phase 9 repeats Phase 3. The first IAT effect is the difference in reaction times between the 3rd (C_1) and the 5th (R_1) phase. The second IAT effect is the difference in reaction times between Phase 9 (C_2) and Phase 7 (R_2).

blocks (R and C Phases 3, 5, 7, and 9). Each block consisted of 48 words. Words were selected randomly for each participant (all identical to Greenwald et al., 1998).

13 27 30

Explicit alcohol-related cognitions. The attribute words used in the two IATs were used to construct explicit measures of the valence and arousal dimensions. In line with attitude research, the explicit measure of the valence dimension consisted of 6 semantic differentials (e.g., "drinking alcohol is good——bad"), with an unmarked 11-cm visual analogue scale (VAS) as the response format. This measure is very similar to explicit measures of global attitudes (e.g., Stacy et al., 1990; Wall et al., 1998) and is labeled *global attitudes*. In line with expectancy research, arousal and sedation were measured with unipolar VAS scales (also 11 cm and unmarked; e.g., "After drinking alcohol, I become energetic"; disagree——agree).[4] The reliability of these three explicit scales (Global Attitudes, VAS-Arousal, VAS-Sedation) was reasonably good, and they were not significantly correlated (Table 2). In addition, participants filled out a more extensive questionnaire in which four types of expectancies were measured: positive and negative expectancies for low and high doses of alcohol (Wiers et al., 1997).[5] In line with the motivational framework (e.g., Cooper et al., 1995), positive expectancies were differentiated into a positive reinforcement scale (e.g., fun, sex) and a negative reinforcement scale (e.g., tension reduction). In order to reduce the number of scales, scores were combined for a low and a high dose of alcohol. The internal consistencies of the three resulting scales were all reasonably good (.78–.91; see Table 2).

Procedure 19-23 24-25

Participants individually performed the two versions of the IAT in a standard laboratory at Maastricht University on 2 separate days approximately 1 week apart. After each IAT version, the related explicit measure followed (e.g., valence IAT followed by explicit global attitudes; total time was approximately 25 min). We judged that it was better to always administer the implicit measure first because the carryover effects of explicit measures to implicit measures appear to be larger than vice versa (Bosson et al., 2000). The second session ended with the more extensive questionnaires of expectancies, alcohol use, and alcohol-related problems, adding about 30 min to the testing. Participants were asked to keep an alcohol diary in the month after the end of the experiment and send this (anonymously) to the investigators. Participants received Hfl 25 (about US$10) for participation.

IAT stimuli. The IAT was programmed in ERTS 3.18 (Beringer, 1996). Words were presented in black smallfont (14-point) in the middle of the screen. Feedback appeared in red midfont letters (16-point) 1 inch below the stimuli words. The category word or words were always presented at the top of the screen, appropriately positioned on the left or the right side of the screen, depending on the required response (as in Greenwald et al., 1998). The interstimulus interval was 250 ms. In case of a wrong response, the word "ERROR" appeared on the screen. After responses that were too fast (<150 ms) or too slow (>3 s), feedback followed ("TOO FAST" or "TOO SLOW") with a warning beep.

Procedural variables and data reduction. Half of the participants received the valence IAT first, and half received the arousal IAT first (the factor session). For each IAT, half of the participants received the RCCR order, and half received the CRRC order (the factor order). A third between-subjects variable was response key (e.g., "soda" started on the left or right side). All procedural variables were balanced. Data reduction

[4] Leigh (1989a, 1989b) demonstrated that the use of a bipolar scale is unwarranted in expectancy research by comparing three scales, of which only the bipolar scale failed to predict alcohol consumption in contrast to two unipolar scales (see also Wiers et al., 1997). However, in attitude research, the format most commonly used is a bipolar scale. We decided to use the standard formats used in both research traditions.

[5] In fact, the follow-up version of the original expectancy questionnaire was used, which has the same set-up but some different items. The more recent version includes three lower order factors for each of the four higher order factors (positive and negative expectancies for low and high doses of alcohol). Positive expectancies (both for low and high doses) include a scale of negative reinforcement and two other scales of positive reinforcement.

Table 2
Pearson Correlations and Cronbach Alphas for Implicit and Explicit Cognitions and Alcohol (Ab)use at Time 1

	No. of items	α	1	2	3	4	5	6	7	8	9
1. Valence IAT	2	.58	—								
2. Arousal IAT	2	.56	−.41**	—							
3. Global Attitudes	6	.78	−.38**	.18	—						
4. VAS Arousal	6	.88	.10	−.03	.05	—					
5. VAS Sedation	6	.82	−.03	−.17	.09	−.20	—				
6. Pos. Reinforce. Expect.	17	.91	.19	−.12	.04	.68***	−.05	—			
7. Neg. Reinforce. Expect.	10	.81	−.18	.20	.32*	.22	.30*	.49***	—		
8. Neg. Expect.	15	.79	.28	.01	−.32*	.18	.08	.40**	.33*	—	
9. Alcohol (Ab)use	4	.93	−.37*	.30*	.52***	.23	.12	.15	.49***	−.16	—

Note. The valence IAT effect was calculated as the mean reaction times (RTs, in milliseconds) in the C phases (alcohol–positive, soda–negative) minus the mean RTs in the R phases (alcohol–negative, soda–positive). Hence, a larger value indicates a stronger negative association with alcohol. The negative correlation with alcohol use is in the expected direction. The arousal IAT effect was calculated as the mean RTs in the R phases (alcohol–passive, soda–active) minus the mean RTs in the C phases (alcohol–active, soda–passive). A larger value indicates a larger implicit arousal association with alcohol. IAT = Implicit Association Test; VAS = Visual Analogue Scales; Pos. Reinforce. Expect. = positive reinforcement expectancies (e.g., fun, sex); Neg. Reinforce. Expect. = negative reinforcement expectancies (e.g., tension reduction); Neg. Expect. = negative expectancies (e.g., insecure, sick, negative mood, risk); Alcohol (Ab)use = the combined score of alcohol use during the past week, average weekly alcohol consumption, number of binges during the past weeks, and alcohol-related problems (Rutgers Alcohol Problem Index).
* $p < .05$. ** $p < .01$. *** $p < .001$.

procedures were consistent with other IAT research (Greenwald & Nosek, 2001): RTs below 300 ms were recoded to 300 ms, and RTs above 3,000 ms were recoded to 3,000 ms. Only RTs on correct answers were analyzed.

Results

Explicit Cognitions

The six scales representing the explicit cognitive–motivational variables were subjected to a 2 (Drinker Type) × 2 (Gender) multivariate analysis of variance (MANOVA). Heavy drinkers differed significantly from light drinkers, $F(6, 39) = 4.75$, $p = .001$, and men differed significantly from women, $F(6, 39) = 3.24$, $p = .011$, in the absence of a significant interaction, $F(6, 39) = .55$, $p > .50$.[6] In order to assess the relative contribution of the different variables to the MANOVA, a discriminant analysis was performed that focused on the structure coefficients (Huberty & Morris, 1989). The relative contributions to the multivariate difference between light and heavy drinkers were (in descending order, with structure coefficients in parentheses): global attitudes (.66), negative reinforcement expectancies (.59), VAS-arousal (.42), positive reinforcement expectancies (.34), negative expectancies (.10), and VAS-sedation (.05). Inspection of the means confirmed the expected direction of the effects: Heavy drinkers had more positive global attitudes and scored higher on positive and arousal expectancies (Table 3). The relative contributions to the multivariate gender difference were as follows: VAS-arousal (.78), positive reinforcement expectancies (.66), VAS-sedation (−.49), negative expectancies (.16), global attitudes (−.14), and negative reinforcement expectancies (−.03). Unexpectedly, women scored higher than men on arousal and positive reinforcement expectancies, and lower on sedation (Table 3).

Implicit Cognitions

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RT data and errors ~~for the~~ valence IAT and the arousal IAT are found in Table 4. Note that the C phases in the valence IAT (*alcohol–positive* and *soda–negative*) were performed more slowly than the R phases (*alcohol–negative* and *soda–positive*), indicating that both light and heavy drinkers had *negative* implicit associations with alcohol. In the arousal IAT, the expected pattern was found in heavy drinkers: faster responses in the C phases (*alcohol–active* and *soda–passive*) than in the R phases (*alcohol–passive* and *soda–active*), whereas in light drinkers these combinations were performed about equally fast. The pattern of errors generally corresponded to the pattern in RTs (as in other IAT research; Greenwald & Nosek, 2001).

The IAT effects were analyzed with a 3 (within-subjects) × 4 (between-subjects) mixed analysis of variance (ANOVA), with gender, drinker type, and the procedural variables of order (CRRC or RCCR) and session (valence IAT or arousal IAT in the first session) as between-subjects variables. Dependent variables were the RTs on the four combination phases (C or R) for both IATs. In these analyses, the IAT effect was analyzed as a within-subject factor (C vs. R), with block (first CR or second CR), and IAT type (valence vs. arousal) as other within-subject factors. For ease of interpretation, the combination phases of the valence IAT were entered in the reverse order from those of the arousal IAT (RC vs. CR). In that way, both IAT effects were in the same direction, which made their comparison easier (this procedure is analytically equivalent to an analysis with the same orders for both versions but makes the interactions comparable to other IAT research in which the C phase involves the faster combination). RTs were log trans-

[6] We checked whether the nonsignificant gender difference in mean alcohol consumption accounted for the multivariate difference in explicit cognitive–motivational variables by running an additional analysis with mean alcohol consumption as a covariate. The multivariate gender difference in performance on the explicit measures remained significant, $F(6, 38) = 2.81$, $p = .023$. Furthermore, an analysis was run with session as an extra factor (as in the IAT analyses). No session effects were found ($p > .50$).