

# Challenging implicit and explicit alcohol-related cognitions in young heavy drinkers

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## ABSTRACT

**Aims** To test whether an expectancy challenge (EC) changes implicit and explicit alcohol-related cognitions and binge drinking in young heavy drinkers. This is important for theoretical and practical reasons: the EC presents a critical test for the hypothesized mediational role of alcohol cognitions and the EC has been presented as a promising intervention to counter alcohol problems in heavy drinking youth.

**Setting, participants and intervention** Ninety-two heavy drinking college and university students (half women) were assigned randomly to the EC or control condition (a sham alcohol experiment in the same bar-laboratory).

**Measurements** Explicit alcohol cognitions and alcohol use were assessed with paper-and-pencil measures. Alcohol use was assessed prior to the experiment and during a 1-month follow-up. Implicit alcohol-related cognitions were assessed with two versions of the Implicit Association Test (IAT), adapted to assess implicit valence and arousal associations with alcohol.

**Findings and conclusions** The EC resulted in decreased explicit positive arousal expectancies in men and women alike. There was some evidence for a differential reduction in implicit arousal associations, but findings depended on the version of the IAT and on the scoring-algorithm used. In men (but not in women) there was a short-lived differential reduction in prospective alcohol use (significant in week 3 of the follow-up), and this reduction was partially mediated by the decrease in explicit positive arousal expectancies. These findings suggest that an EC successfully changes explicit alcohol cognitions and that this may have short-lived beneficial effects in heavy drinking young men.

**KEYWORDS:** Alcohol, expectancy challenge, IAT, implicit cognition, mediation, prevention.

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## INTRODUCTION

Recently, there has been great concern about college drinking. In the United States, each year 1400 students die and 500 000 are injured under the influence of alcohol (Hingson *et al.* 2002). In the Netherlands, where this study took place, alcohol-related disorders are the most prevalent psychiatric diagnosis in young men (Bijl, Ravelli & van Zessen 1998). Further, Dutch students drink

more than students from any other European country (Hibell *et al.* 2004).

Prevention efforts can be aimed at the individual or at the environment. Among the individual-focused strategies, cognitive-behavioural and motivational interventions have shown greater efficacy than educational interventions (Larimer & Cronce 2002). The same review indicated that the 'Expectancy Challenge' (EC) is a promising cognitive-behavioural intervention for college-age

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men. The idea behind the EC is that heavy drinkers hold positive expectancies, which are often incorrect. These expectancies are hypothesized to mediate the relationship between distal risk factors (that are difficult to change) and drinking outcomes (Goldman 1999). Therefore, a successful challenge of positive expectancies should result in reduced drinking (Darkes & Goldman 1993, 1998). In line with this idea, Darkes & Goldman (1993, 1998) presented evidence for reductions in both positive expectancies and in short-term drinking. However, 'mediation was not demonstrated in any of these studies' (Jones, Corbin & Fromme 2001b, p. 1673). Mediation will be tested formally here for the first time.

Despite some controversy regarding the evidence supporting the EC, there is agreement that a number of theoretical and practical issues should be addressed (Del Boca & Darkes 2001; Jones *et al.* 2001a,b; Wiers 2002a; Wiers *et al.* 2003). One important theoretical issue concerns the nature and measurement of expectancies. Traditionally this has been conducted with questionnaires. Recently there has been a growing interest in more implicit assessments of cognitive variables in alcohol and addiction research (e.g. Stacy 1997; Ames & Stacy 1998; Wiers *et al.* 2002; Wiers & Stacy in press). Implicit associations have been defined as 'introspectively unidentified (or inaccurately identified) traces of past experience that mediate favorable or unfavorable feeling, thought, or action' (Greenwald & Banaji 1995, p. 8). Implicit assessments are carried out for various reasons: first, to prevent social-desirable responding (e.g. Greenwald, McGhee & Schwartz 1998; Fazio & Olson 2003). This may be relevant here, because the message of the EC is clear: positive expectancies are largely incorrect (i.e. they are placebo effects) and one could benefit from drinking less. Hence, a tendency to respond in a socially desirable way could affect both self-reported expectancies and self-reported drinking and create a spurious 'treatment effect'. A second reason to include implicit measures is that they could tap different underlying cognitive motivational processes (e.g. Stacy 1997; Wiers *et al.* 2002; Palfai & Ostafin 2003). Neurobiological research demonstrated that subcortical circuits involved in emotion and motivation are important in addiction and these circuits are not directly accessible for introspection (White 1996; Bechara *et al.* 2003; Robinson & Berridge 2003). Implicit measures have been shown to correlate highly with activation of these structures in functional Magnetic Resonance Imaging (f-MRI) studies (e.g. Phelps *et al.* 2000) and very briefly presented pictures activate these structures in the absence of awareness (Cunningham *et al.* 2004). Further, several studies have found that implicit and explicit alcohol-related cognitions predict unique variance in alcohol use (Stacy 1997; Wiers *et al.* 2002; Kramer & Goldman 2003) and interventions may differentially affect implicit

and explicit cognitions (e.g. Teachman & Woody 2003). Hence, for both reasons it is desirable to assess implicit and explicit alcohol-related cognitions in an EC. This has not been conducted previously.

Here, implicit alcohol associations were assessed with two versions of the widely used Implicit Association Test (IAT, Greenwald *et al.* 1998): one assessing alcohol-valence associations (or implicit attitudes) and one assessing alcohol-arousal associations (arousal versus sedation, Wiers *et al.* 2002). With these two IATs, we found in previous research that heavy drinkers hold implicit alcohol-arousal associations which was not the case for light drinkers, and that both heavy and light drinkers hold negative implicit alcohol associations (both compared with sodas, Wiers *et al.* 2002). Recently, it has been found that alcoholics in treatment, like heavy drinkers, hold implicit negative and arousal associations with alcohol (De Houwer *et al.* 2004). Here, arousal and sedation expectancies and attitudes were also assessed with explicit tests, using the same words. We hypothesized that the EC would reduce explicit arousal expectancies and increase explicit sedation expectancies (cf. Dunn *et al.* 2000). We hypothesized further that if a change would occur in implicit associations, this would be on the arousal-IAT (as this dimension differentiated heavy from light drinkers, Goldman *et al.* 1999; Wiers *et al.* 2002). Recent research in social cognition has indicated that implicit associations may be more malleable than thought previously (for reviews, see Blair 2002; Wiers *et al.* 2004). Implicit and explicit assessments of valence were included because a differential change in the EC group in arousal would be more convincing in the absence of a change in valence (discriminant validity). Secondly, these two basic dimensions have been found to underlie both emotions and expectancies (Goldman *et al.* 1999).

Another theoretical issue is how to treat the control group. Control groups in previous EC studies involved assessment-only groups or in one case an information-only contrast group (Darkes & Goldman 1993). Both types of control conditions took place in neutral rooms, which leaves the possibility open of a non-specific effect on alcohol-related cognitions of drinking alcohol in a group of youth in a bar-laboratory, because both implicit and explicit measures of drug-related cognitions have been shown to be sensitive to context effects (Wall *et al.* 2001; Sherman *et al.* 2003). For optimal comparability with respect to context, participants in our control group drank the same alcoholic or placebo drinks in the same bar-laboratory as the EC group. The crucial difference between conditions was the absence of placebo manipulation and expectancy information.

In addition to these theoretical issues, the present study addressed two more practical issues. The first con-

cerns the nature of the EC. Negative replications cited by Jones *et al.* (2001a) were either information-only ECs or constituted of a single experiential session (Wiers 2002a). Here we tested an extended single-session EC that combined contents of both experiential sessions of the original protocol into one session, followed by homework to promote cognitive elaboration. The second issue concerned gender: previous EC studies included either only young men (Darkes & Goldman 1993, 1998) or found no effect for women (Dunn *et al.* 2000; Musher-Eizenman, & Kulick 2003). In a recent study, we adapted the second session on sex expectancies to be more suitable for women and found a significant decrease in positive arousal expectancies in women (Wiers & Kummeling 2004). This adapted version was used here.

To summarize, the present study investigated the effects of a single-session extended experiential EC on implicit and explicit alcohol-related cognitions and on alcohol use during a 1-month follow-up. We hypothesized that the EC would reduce arousal expectancies (explicit and implicit) and alcohol use. In case both occurred, a formal test of mediation was performed.

## METHOD

### Participants

Initial recruitment took place in Maastricht University and vocational colleges close by. Students were asked to participate in a 'fun experiment on the effects of alcohol'. Interested students were administered a brief telephone interview, asking them their age, gender and weekly alcohol use (asked per average day). Inclusion criteria were: 15–50 European standard drinks per week for men and 13–45 for women (similar to Darkes & Goldman 1993: European standard drinks contain about 10 g pure alcohol compared with 14 g in the United States; however, a somewhat heavier drinking sample was recruited here). A randomization scheme (stratified for gender) was used to assign eligible participants to conditions.

A total of 96 undergraduate students (48 women) were scheduled to participate. Four failed to attend, leading to a final sample of 92 participants (46 women), with mean age of 20.5 years. Eleven participants self-identified with another nationality than 'Dutch', all of whom had passed a test demonstrating that they were fluent in Dutch. Average alcohol consumption per week was 29.5 standard drinks (range: 10–70; mean 34 for men and 24 for women per week). Participants binged on 4.3 occasions during the past 2 weeks (range: 0–12). On the Rutgers Alcohol Problems Index (RAPI, White & Labouvie 1989, 2000) participants scored 14.3 (range: 2–37), just below the average of clinical samples (White & Labouvie

1989). On the Alcohol Use Disorder Identification Test (AUDIT, Saunders *et al.* 1993) participants scored an average of 11.7 (range: 5–26). Here 74% scored 10 or higher (cut-off for alcohol problems, Saunders *et al.* 1993) and 90% scored 8 or higher (hazardous drinking, Palfai & Ostafin 2003). Men scored significantly higher on all alcohol variables ( $P < 0.01$ ), except the RAPI ( $P > 0.25$ ). Interestingly, only one participant indicated that he had an alcohol problem himself when asked in the context of a family tree. Hence, the sample can be described as hazardous or problem drinkers, who do not think they have a drinking problem themselves. For this case, the indirect recruitment (focus on alcohol use, not on problems) and the EC, which does not directly target alcohol problems, was judged ethically appropriate.

## MATERIALS AND MEASURES

### Alcohol use

Alcohol use was measured with a self-report questionnaire (Wiers *et al.* 1997) based on the time-line follow-back method, which has been found to be reliable and valid (Sobell & Sobell 1990). With this questionnaire, estimates for drinking prior to the experiment were generated (Wiers *et al.* 1997). After the intervention, participants were asked to keep an alcohol diary, which they handed in after 1 month (there was no check on actual daily recording). From these measures, a quantity–frequency index (drinks per week) and number of binges were calculated.

### Alcohol-related problems

The RAPI (White & Labouvie 1989) was used, which measures social and health-related problems adolescents and young adults experienced with alcohol. We used the 18-item version, which correlates 0.99 with the 23-item version (White & Labouvie 2000). Internal consistency (Cronbach's  $\alpha$ ) was 0.81. Further, the Alcohol Use Disorders Identification Test (AUDIT) (Saunders *et al.* 1993) was used ( $\alpha = 0.66$ ).

### Implicit alcohol associations

Two adapted versions of the IAT (Greenwald *et al.* 1998) were presented in balanced order, one measuring the positive–negative dimension (valence-IAT) and one the arousal–sedation dimension (arousal-IAT), both described in detail in Wiers *et al.* (2002). The IAT is a computerized categorization task that offers a method to assess indirectly the relative strength of associations between concepts. Participants sort stimuli into four con-

cepts, using two response buttons, in two combinations. Two concepts are the 'targets' (here: 'alcoholic drinks' versus 'sodas'), and two are the attributes (valence-IAT: 'positive' versus 'negative'; arousal-IAT: 'active' versus 'passive'). The IAT effect is the difference in reaction times for the two combinations of targets and attributes (see Table 1).

The target words for both IATs were for the alcoholic drinks: beer, wine, port, whisky, vodka and rum; for sodas: coke, 'cassis', 'sinas' (lemonades), 'spa' (soda-water), tonic and juice. In the valence-IAT, positive words were: sociable, good, pleasant, nice, enjoyable, sympathetic; negative words: antisocial, bad, unpleasant, stupid, obnoxious, tedious. For the arousal-IAT, the arousal words were: energetic, lively, funny, cheerful, smart, aroused; sedation words: relaxed, sleepy, woozy, quiet, calm and listless. Words were based on previous research using multi-dimensional scaling (Goldman *et al.* 1999) and on first associates in Dutch students (Wiers 2002b). The Dutch words were matched for prevalence and number of syllables.

Because the IAT effect is a difference score between two different pairings of stimuli, it can be assessed in two different orders. The IAT effect is larger when the association that generates the fastest responses comes first (the 'compatible' or CR order) than in the reverse combination (RC order, Greenwald *et al.* 1998; Wiers *et al.* 2002). Order effects were controlled both as within and between-subject factors, generating two IAT effects per IAT, a CR-

IAT and an RC-IAT (Table 1; cf. Greenwald *et al.* 1998; Wiers *et al.* 2002).

Recently, Greenwald, Nosek & Banaji (2003) proposed a new scoring algorithm for the IAT effect, in which practice blocks are included and results are standardized at the level of the participant. We report the IAT effects for the new 'D-600' algorithm and tabulate the results for the original scoring algorithm (difference in RT between the two combination test phases), for ease of interpretation and comparability with earlier work. In the case of different results found for the original algorithm, these are reported.

The psychometric properties of the IAT have generally been described as good (Greenwald & Nosek 2001). The internal consistency (calculated as in Greenwald *et al.* 2003) was 0.65, for the valence-IAT and 0.68 for the arousal-IAT 0.68. Test-retest reliabilities were 0.73 and 0.75, respectively (controls only, whole sample, see Table 2). These values are much higher than for other measures of implicit associations (cf. Bosson, Swann & Pennebaker 2000).

### Explicit alcohol-related cognitions

The attribute words used in the two IATs were used to construct explicit equivalents of the valence and arousal dimension (as in Wiers *et al.* 2002). The explicit measure of valence (global attitudes) consisted of six semantic differentials (e.g. 'drinking alcohol is good----bad) with the

**Table 1** Sequence of blocks in the arousal IAT (CRRC type).

Phase	Block	Label	Words assigned to one key	Words assigned to the other key
Practice target	1	Target	Alcohol	Soda
	2	Target	Alcohol	Soda
Practice attribute	3	Attribute	Arousal	Sedation
	4	Attribute	Arousal	Sedation
Compatible 'C'	5	Comp. practice	Alcohol + arousal	Soda + sedation
	6	Comp. test 1	Alcohol + arousal	Soda + sedation
	7	Comp. test 2	Alcohol + arousal	Soda + sedation
Practice reverse target	8	Reverse target	Soda	Alcohol
Reversed 'R'	9	Reversed practice	Soda + arousal	Alcohol + sedation
	10	Reversed test 1	Soda + arousal	Alcohol + sedation
	11	Reversed test 2	Soda + arousal	Alcohol + sedation
	12	R target	Soda	Alcohol
Reversed 'R'	13	Reversed practice	Soda + arousal	Alcohol + sedation
	14	Reversed test 1	Soda + arousal	Alcohol + sedation
	15	Reversed test 2	Soda + arousal	Alcohol + sedation
	16	Target	Alcohol	Soda
Compatible 'C'	17	Comp. practice	Alcohol + arousal	Soda + sedation
	18	Comp. test 1	Alcohol + arousal	Soda + sedation
	19	Comp. test 2	Alcohol + arousal	Soda + sedation

Half the participants received the phases in the opposite order (reversed, compatible, compatible, reversed: RC-CR). The other IAT was the valence-IAT.

**Table 2** Correlations between implicit and explicit measures at pretest and alcohol use and problems at pre- and post-test and test-retest reliabilities.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	$R_{11-12}$
1. Val-IAT (D)	–															0.74***
2. Val-IAT (ms)	0.86***	–														0.65***
3. Arousal-IAT (D)	–0.41***	–0.43***	–													0.94***
4. Arousal IAT (ms)	–0.39***	–0.45***	0.86***	–												0.70***
5. Expl. attitudes	–0.18		0.22*	0.29**	–											0.70***
6. Expl. arousal						–										0.60***
7. Expl. sedation							–									0.57***
8. Pos reinf. exp.								–								0.76***
9. Negative reinf. exp.			0.24*	0.22*	0.32**	0.28*		0.25*	0.26*	–						0.66***
10. Negative exp.									0.31**	–						0.73***
11. Alc problems			0.19	0.23*				0.27**	0.40***	–						
12. Alcohol use pre		–0.18									0.36**	–				
13. Binge pre											0.25*	0.64***	–			
14. Alcohol use pos	–0.19	–0.19									0.30**	0.61***	0.64***	–		
15. Binge pos	–0.23*										0.22*	0.50***	0.59***	0.90***	–	

\*\*\* $P < 0.001$ ; \*\* $P < 0.01$ ; \* $P < 0.05$ , number without \* $0.05 < P < 0.10$ ; no number,  $P > 0.10$ ;  $n = 92$  (91 for post-test IATs); pre = measured as pretest (1 week before the intervention); pos = measured at post-test (1 week after the intervention). Val-IAT = valence IAT, combining positive and negative with alcohol and soda. Arousal-IAT = arousal IAT, combining arousal and sedation with alcohol and soda. D = the new IAT algorithm, ms = the original IAT algorithm in ms. Expl. = explicit, = expectancies (also explicit scales). Pos. reinf. exp. = positive reinforcement expectancies for a low and high dose of alcohol combined (expected social and sexual enhancement after drinking alcohol). Neg. reinf. exp. = negative reinforcement. Expectancies, for a low and high dose of alcohol combined (tension reduction). Neg. exp. = negative expectancies (negative consequences). Alc problems = scores on the Rutgers Alcohol Problems Inventory for Adolescents (RAPt). (Means are presented in Table 3).



Visual Analogue Scale (VAS). In line with expectancy-research, unipolar VAS-scales were used to assess explicit arousal and sedation expectancies. Internal consistencies were: VAS-attitudes 0.81; VAS-arousal 0.86; and VAS-sedation 0.75.

In addition, participants filled out a longer questionnaire with items briefly describing situations that assessed positive and negative expectancies for low and high doses of alcohol (an updated version of Wiers *et al.* 1997). As in Wiers *et al.* (2002), three global scales were analysed: positive reinforcement expectancies ( $\alpha = 0.87$ ), negative reinforcement expectancies ( $\alpha = 0.76$ ) and negative expectancies ( $\alpha = 0.76$ ).

### Non-specific effects

The Subject Reaction Questionnaire (SRQ, Darkes & Goldman 1993) assessed the intervention's credibility and acceptability (1–5 Likert scales).

### Procedure

#### Pretest

One week before the intervention, participants came to the laboratory and performed the two IATs, followed by questionnaires (implicit before explicit assessment, cf. Bosson *et al.* 2000).

#### Intervention

The intervention took place in our bar-laboratory. Participants signed an informed consent, in which they agreed to drink two drinks containing alcohol (placebos contained a minimal dose of alcohol on the rim of the glass, as advised by Marlatt & Rohsenow 1980). All participants signed the same ethically approved informed consent. They then completed questionnaires assessing background variables. The rest of the session depended on experimental condition.

#### EC

The procedure followed closely the original protocol of the two experiential sessions by Darkes & Goldman (1993), with three differences: first, during the first drinking session, all participants were told they were drinking vodka and tonic (active deception, Marlatt & Rohsenow 1980). Secondly, these sessions were not separated by a week but by a short break. Thirdly, the second session targeting sexual expectancies was adapted for use in mixed gender groups (Wiers & Kummeling 2004). Details concerning the EC can be found in Darkes & Goldman (1993) and in Wiers & Kummeling (2004) and are

available upon request. The challenge ended with a homework assignment: participants were asked to write a short essay on expectancies in the media and in their own life and to keep an alcohol diary. Before leaving, the SRQ was completed and breath alcohol level was measured. Participants signed for the alcohol-level and were instructed to be extra careful. No participant left above the legal limit (0.5 per mil).

#### Control group: sham alcohol experiment

The control group was openly split in two: half the participants received vodka and tonic and half tonic only. After beverage consumption, participants performed neuropsychological tests. No information on expectancies followed. The session ended as in the EC: homework instruction (alcohol-diary), SRQ and breath alcohol level were measured.

#### Post-test

The post-test took place 1 week after the intervention and was identical to the pretest.

#### One month follow-up

One month after the post-test, participants handed in their alcohol diaries and received a monetary reward.

## RESULTS

### Success of randomization

There were no differences in any of the alcohol-related or background variables between the two experimental conditions or in the interactions between condition and gender (all  $P$ s > 0.25).

### Implicit alcohol associations

We first describe the analyses of the IAT effects at pretest for the whole sample, then the analyses of the change in implicit associations as a function of treatment.

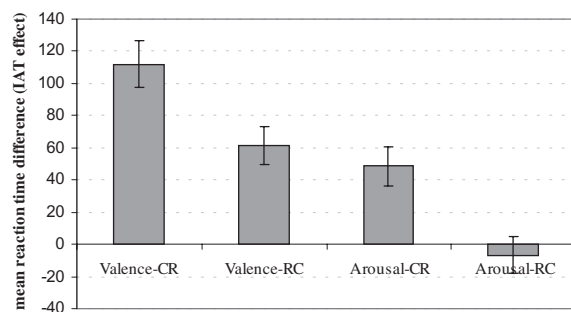
#### Implicit associations at pretest

As an initial analysis, we subjected the four IAT scores at pretest to a 2 (IAT-type, CR/RC)  $\times$  2 (affective dimension, valence/arousal)  $\times$  2 (IAT order, CR-RC/RC-CR)  $\times$  2 (affect order) mixed ANOVA (the first two are within-subject factors, the others between-subject factors). There were large main effects for IAT type,  $F_{(1,88)} = 169$ ,  $P < 0.001$  and affective dimension,  $F_{(1,88)} = 24.9$ ,

$P < 0.001$ , superseded by interactions between affective dimension and affective order,  $F_{(1,88)} = 17.8$ ,  $P < 0.001$  and between IAT type, affective dimension and affective order,  $F_{(1,88)} = 23.7$ ,  $P < 0.001$ . These effects are illustrated in Fig. 1. It can be seen that the valence IAT produced larger effects than the arousal IAT, and that the CR-IAT resulted in larger effects than the RC-IAT. For the arousal IAT, only the CR version yielded a significant effect. These effects were enhanced by IAT order effects: when a participant started with the arousal IAT, strong alcohol–arousal associations were found for the CR-IAT (81 ms), but not for the RC-IAT (15 ms). There was one other significant interaction: IAT  $\times$  type with IAT order and with affective dimension,  $F_{(1,88)} = 7.31$ ,  $P = 0.008$ . Implicit arousal associations in the CR-IAT were much larger in the CR-RC condition (144 ms) than in the RC-CR condition (24 ms). Even though the size of the IAT effects appeared to be strongly dependent on order of assessment, the relative effects (individual differences) were stable, as indicated by the pattern of correlations: the CR and RC-IAT correlated 0.69 for valence and 0.64 for arousal.

#### Change in implicit associations

The IAT data of one participant were lost due to a technical problem. One influential outlier on the IAT scores at post-test was removed, leaving 90 participants in these analyses (45 per condition). Type 1 errors were reduced by directly testing the hypothesized interaction of condition and time (Tabachnick & Fidell 2001).



**Figure 1** IAT effects at pretest for the two emotional dimensions valence and arousal, per IAT version (CR or RC). IAT effects are represented as difference in the reaction times between the compatible ('C') phases and the reverse compatible ('R') phases. Compatible phases generate the fastest responses, here the alcohol–negative combination (and soda–positive) for the valence-IAT and the alcohol–arousal combination (and soda–sedation) for the arousal-IAT. In the CR versions of the task the compatible phase comes first, followed by the reverse compatible phase. All participants performed both a CR and an RC-IAT for both affective dimensions (see Table 1). This was performed both at pre- and post-test. The CR-IATs generally generate stronger IAT effects. For the arousal-IAT, only the CR-IAT differed significantly from zero

#### Implicit arousal associations

Given the analyses of the pretest data, we decided to consider only the CR-IAT arousal data (for which significant alcohol–arousal associations were found). The CR-arousal-IAT scores at post-test were subjected to a 2 (condition)  $\times$  2 (gender)  $\times$  2 (IAT order)  $\times$  2 (affect order) ANCOVA, with pretest scores as covariate (which has more power than a repeated-measures ANOVA, Laird 1983). There was no significant effect of condition ( $P > 0.25$ ). Results using the original IAT algorithm showed a different outcome: the condition effect was significant,  $F_{(1,73)} = 4.82$ ,  $P = 0.031$ . Follow-up analyses indicated that participants showed no difference at pre-test ( $P > 0.50$ ). Participants in the EC condition showed a larger decrease in implicit alcohol–arousal associations at post-test (EC group changed from 45 to 17 ms, controls from 53 to 50 ms, Table 3).

The implicit attitudes were not expected to change as a function of treatment. This was analysed with the same ANCOVA, now on the implicit valence–IAT effects at post-test with pretest scores as covariate. There was no significant effect of condition ( $P_s > 0.19$ ).

#### Explicit cognitions

The EC was designed to change positive reinforcement expectancies, a combination of positive and arousal effects (Dunn *et al.* 2000; cf. Table 2). Explicit cognitions were analysed in two MANOVAs: one including measures where a differential treatment effect was expected (positive, arousal and sedation expectancies) and one on measures where no differential effect was expected. The pre- and post-test measures of VAS-arousal, VAS-sedation and positive reinforcement expectancies were analysed in a 2 (time)  $\times$  2 (gender)  $\times$  2 (condition) mixed MANOVA. The interaction of main interest (time  $\times$  condition), was significant  $F_{(3,86)} = 3.09$ ,  $P = 0.03$ , with main effects for time,  $F_{(3,86)} = 3.89$ ,  $P = 0.01$ , and gender,  $F_{(3,86)} = 3.63$ ,  $P = 0.02$  (no interactions between gender and condition,  $P > 0.50$ ). The relative contributions to this multivariate effect were determined with discriminant analysis (Huberty & Morris 1989; with structure coefficients): VAS-arousal (0.78), VAS-sedation (–0.68) and positive reinforcement expectancies (0.48). Inspection of the means (Table 3) confirmed the expected direction of the effects: VAS-arousal scores and positive reinforcement expectancies decreased in the EC condition only and VAS-sedation increased more strongly in the EC condition than in controls.

The second 2 (time)  $\times$  2 (gender)  $\times$  2 (condition) mixed MANOVA contained the explicit variables that were not expected to change differentially as a result of the EC: attitudes, negative expectancies and negative

**Table 3** Implicit and explicit cognitive variables before and after the intervention.

Variable	Expectancy challenge				Control condition			
	<i>T<sub>0</sub> (before intervention)</i>		<i>T<sub>1</sub> (after intervention)</i>		<i>T<sub>0</sub> (before intervention)</i>		<i>T<sub>1</sub> (after intervention)</i>	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Valence IAT-CR (ms)	142.52	150.26	81.34	86.43	76.75	116.6	48.17	81.21
Valence IAT-RC (ms)	81.15	115.76	69.57	82.70	37.43	106.76	20.45	81.71
Arousal IAT-CR (ms)	44.81	127.62	16.56	94.30	52.64	111.60	50.38	74.84
Arousal IAT-RC (ms)	-15.98	111.49	7.34	90.42	7.63	109.03	-5.08	87.06
Valence IAT-CR (D)	0.61	0.42	0.53	0.44	0.43	0.41	0.35	0.45
Valence IAT-RC (D)	0.30	0.37	0.31	0.47	0.16	0.38	0.12	0.41
Arousal IAT-CR (D)	0.22	0.49	0.21	0.47	0.28	0.39	0.33	0.41
Arousal IAT-RC (D)	-0.10	0.45	-0.01	0.46	-0.08	0.36	-0.03	0.40
VAS-arousal	67.6	17.4	63.1	11.1	69.3	16.1	71.7	14.0
VAS-sedation	47.2	17.8	53.4	13.0	47.9	13.3	48.8	11.0
VAS-attitudes	66.6	11.0	68.6	10.8	68.0	11.5	68.8	12.6
Pos. reinf. exp.	3.34	0.59	3.13	0.61	3.33	0.60	3.25	0.60
Neg. reinf. exp.	2.40	0.68	2.09	0.64	2.43	0.58	2.25	0.68
Neg. exp	1.55	0.34	1.57	0.36	1.61	0.42	1.60	0.40

Valence IAT is the mean difference in reaction time between the phases that combine 'alcohol' and 'negative' words with the phases that combine 'alcohol' with 'positive' words. A positive value denotes an association between 'alcohol' and 'negative' (compared with soda and positive). CR-type means that alcohol and negative were combined first, followed by the alcohol-positive combination. RC-type means that alcohol and positive were combined first, followed by the alcohol-negative combination. The arousal IAT is the mean difference in RT between the phases that combine 'alcohol' and 'arousal' words with the phases that combine 'alcohol' with 'sedation' words. A positive value denotes an association between 'alcohol' and 'arousal', a negative value an association between alcohol and sedation. CR-type means that alcohol and arousal were combined first, followed by the alcohol-sedation combination. RC-type means that alcohol and sedation were combined first, followed by the alcohol-arousal combination. Values are given both for the difference in reaction times in milliseconds, and for the new D-algorithm, which includes an error-penalty and a personalized standardization (see Methods). For the IAT measures,  $n = 45$  in both groups (computerized assessment missing for one participant and one outlier excluded). For the other measures,  $n = 46$  in both groups. VAS-scales in mm (range 0–110). Scores are shown by condition only, as there were no significant gender differences. Expectancy scores are item means (range 1–5). VAS = visual analogue scale. Pos. reinf. exp. = positive reinforcement expectancies for a low and high dose of alcohol combined (expected social and sexual enhancement after drinking alcohol). Neg. reinf. exp. = negative reinforcement expectancies, for a low and high dose of alcohol combined (tension reduction). Neg. exp. = negative expectancies (negative consequences).

reinforcement expectancies. The effect of interest (time  $\times$  condition) was not significant,  $P > 0.40$ , nor any higher order interaction involving these factors.

Because the pattern of results was the same for the implicit arousal associations (CR-IAT) and for the explicit arousal expectancies, we tested whether these changes were correlated, using residual gain scores (cf. Teachman & Woody 2003). This was not the case ( $r = 0.01$ ,  $P > 0.50$ ).

### Alcohol use

#### One month follow-up

Weekly alcohol consumption and the number of binges per week showed significant departures from normality. Inspection of the data indicated that there were influential outliers. Inspection of the drinking diaries confirmed their validity (e.g. as a context for a heavy drinking episode, 'party' was indicated). The analyses were continued with the raw data and checked using a bootstrap regression analysis that makes no assumption for the distribution (see below).

Weekly alcohol consumption was analysed in a 4 (time)  $\times$  2 (condition)  $\times$  2 (gender) mixed ANCOVA, with weekly drinking during post-test as within-subjects variables and pretest values of weekly consumption as covariate. The time  $\times$  condition–gender interaction was significant,  $F_{\text{Greenhouse-Geisser}(GG)2.9,249} = 3.91$ ,  $P = 0.01$ , and the same was found for binges per week,  $F_{GG(2.9,248)} = 4.20$ ,  $P = 0.007$ . Analyses were split for gender.

For men, there was a significant time  $\times$  condition effect for both variables: weekly consumption:  $F_{GG(2.8,118)} = 3.77$ ,  $P = 0.014$ ; binges  $F_{GG(2.9,121)} = 3.99$ ,  $P = 0.010$ , in the absence of time main effects ( $P_s > 0.20$ ). Figure 2 indicates that alcohol use in the EC first increased and then decreased compared with the controls (same pattern for binges). Between-subject ANCOVAs for each of the four time-points indicated that the difference in weekly consumption was marginally significant in week 3,  $F_{(1,42)} = 4.08$ ,  $P = 0.05$ , but not during other time-points ( $P_s > 0.10$ ). Binges showed trends in week 2 ( $P = 0.08$ ) and week 3 ( $P = 0.09$ ). More powerful bootstrap analyses (described below) confirmed the sig-

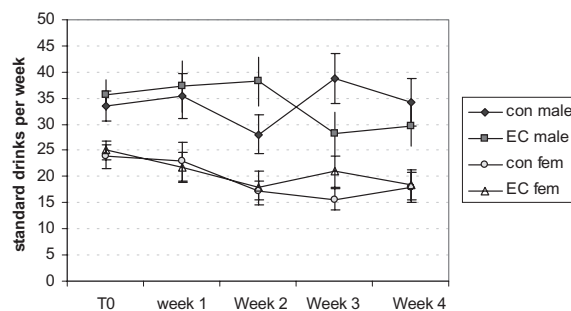


nificance effect of the difference in alcohol use and number of binges in week 3 ( $P < 0.01$ ) in the absence of significant effects in other weeks. Note that analyses using the average weekly consumption or binges at post-test (controlling for pretest) did not indicate a significant time  $\times$  condition effect.

For women, there was no significant time  $\times$  condition effect for both variables ( $P$ s  $> 0.30$ ). For weekly alcohol consumption (but not for binges) there was a significant time effect, indicating that alcohol use decreased in both conditions,  $F_{GG(2.8,120)} = 2.97$ ,  $P = 0.034$ .

## Correlations

Correlations between dependent variables are presented in Table 2. The general pattern was that the implicit measures correlated and that most explicit measures of alcohol-related cognitions correlated, with few correlations



**Figure 2** Weekly alcohol use in the 4 weeks after the expectancy challenge ('EC') or control condition ('con') in male and female heavy drinkers, after controlling for baseline levels of weekly consumption and number of binges

between these two clusters. One correlation is remarkable: implicit arousal associations correlated significantly with tension reduction expectancies (e.g. relaxation). Implicit arousal associations correlated with alcohol problems, as did explicit negative expectancies and tension reduction expectancies.

## Mediation

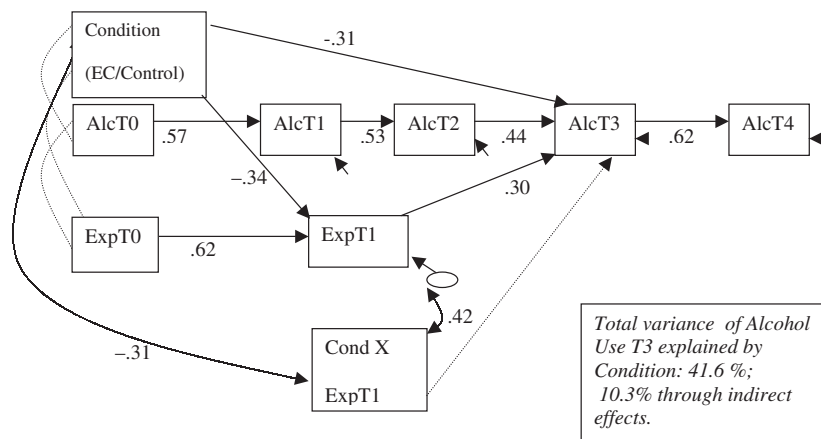
A prerequisite for mediation analysis is that the intervention differentially changes the mediator and the outcome variable (Baron & Kenny 1986). It was tested whether the EC-induced reduction in arousal expectancies mediated the significant reduction in alcohol use in men in week 3, using a model specifically proposed for the present design (MacKinnon 1994). In this model, condition is an independent variable, the change in arousal expectancies the mediator and alcohol use the dependent variable. To test for the possibility that the inclusion of the control group suppressed a mediation effect (Shrout & Bolger 2002), we included the interaction term into the regression model (Cohen & Cohen 1983). Because the mediation analysis was performed in men only ( $n = 46$ ), its power was limited. In these circumstances a bootstrap method is advised (Shrout & Bolger 2002). This approach has the advantage that the typical non-normal distribution of alcohol use is not problematic. A recent simulation study comparing different methods found that the bias-corrected bootstrap method has the best power to detect mediation effects and is the current 'method of choice' (MacKinnon *et al.* 2004). Mediation was tested for weekly alcohol use and weekly binges during follow-up (see Fig. 3 and Table 4).

**Table 4** Bootstrapped bias corrected estimates of the regression coefficients of the mediation analysis and 95% Confidence Intervals for the indirect effects of condition on later drinking in men, for the combined effects of two mediators: the change in explicit arousal expectancies and the interaction between condition and the change in arousal expectancies.

Mediator	Y	Time	a	SE(a)	P	b	SE(b)	P	Low 95	Up 95	P
									CL	CL	
Change in arousal expectancies	Binge	t3	-0.399	0.132	0.003	0.787	0.314	0.012			
		t4	-0.399	0.132	0.003	0.577	0.332	0.059			
	Alc use	t3	-0.399	0.132	0.003	11.26	4.84	0.020			
		t4	-0.399	0.132	0.003	8.67	4.20	0.039			
Change in arousal exp $\times$ condition (interaction)	Binge	t3	-0.059	0.029	0.042	-1.146	0.523	0.028	-0.75	-0.069	0.030
		t4	-0.059	0.029	0.042	-1.04	0.551	0.059	-0.647	0.020	0.14
	Alc use	t3	-0.059	0.029	0.042	-12.30	7.86	0.12	-9.90	-0.95	0.035
		t4	-0.059	0.029	0.042	-18.60	6.81	0.006	-9.93	0.35	0.16

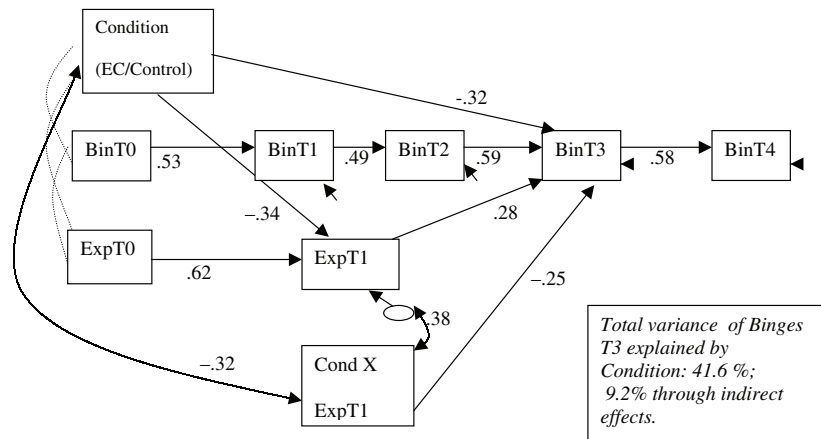
$n = 46$ . The pathmodel is illustrated in Fig. 3. a = regression estimate for the path from independent variable (condition) to the mediator (the change in arousal expectancies or the interaction between the change in arousal expectancies and condition). b = regression estimate for the path from the mediator to the outcome variable (weekly alcohol consumption or the number of binges in weeks 3 or 4). Low CL = lower bound of the 95% bias-corrected estimate for the confidence interval of the indirect effects of the independent variable (condition) through the two mediators to the outcome variables. Alc use = alcohol use.

3a. Mediation Model Alcohol Use Week 3 Posttest (Standardized Bootstrap Estimates)



**Figure 3** Mediation analysis of weekly alcohol use in men after the intervention. The model tested to what extent the experimentally induced change in explicit arousal expectancies mediated changes in prospective drinking in men, using bias corrected maximum likelihood bootstrap estimation, which has optimal power for the present sample size. This was done for weekly alcohol use (a) and for weekly number of binges (b). Drawn lines depict significant paths, dashed lines non-significant paths. Standardized regression weights are presented for significant paths and for dashed paths that showed a statistical trend ( $0.05 < P < 0.10$ ). Alc = alcohol use in standard drinks; Exp = explicit arousal expectancies; T0 = pretest, T1 = week 1 after the intervention, T2 = week 2 after the intervention, etc

3b. Mediation Model Binges Week 3 Posttest (Standardized Bootstrap Estimates)



The indirect effect of condition on alcohol use in week 3 was significant ( $P = 0.03$ ), in the presence of a direct pathway from condition to use in week 3 ( $P = 0.014$ ). The change in arousal expectancies was a significant mediator of alcohol use in week 3, indicating partial mediation. The indirect effect of condition on binges in week 3 was significant ( $P = 0.03$ ), as was the direct effect ( $P = 0.002$ ). Both the change in arousal expectancies and the interaction of this change with condition were significant mediators (Table 4, Fig. 3b).

#### Non-specific effects

Participants in the EC scored higher than participants in the control group on two questions of the SRQ: usefulness of the information ( $P < 0.001$ ) and potential influence on drinking ( $P < 0.001$ ). The EC group felt slightly more pressure to change ( $P = 0.09$ ; both groups scored low: below 2).

## DISCUSSION

This study investigated the effects of an extended single-session EC on implicit and explicit alcohol-related cognitions and prospective alcohol use in hazardous drinkers. The results can be summarized as follows: first, the EC successfully changed targeted positive arousal expectancies in men and women alike, while non-targeted explicit cognitions (negative expectancies, attitudes) did not differentially change. Secondly, for the first time implicit measures were included in an EC; two adapted versions of the implicit association test (IAT) were used in this research. Results at pretest were in line with earlier findings with these measures (Wiers *et al.* 2002; De Houwer *et al.* 2004): heavy drinkers showed strong negative implicit alcohol associations and alcohol–arousal associations (here only on the CR-IAT). The EC differentially reduced the implicit arousal associations as assessed with this version of the IAT, but only when the original scoring

algorithm was used. Thirdly, the EC differentially changed alcohol use in men, but the effect was delayed (week 3 post-intervention) and short-lived (no longer significant in week 4). Fourthly, for the first time the hypothesized mechanism of an EC was tested formally with mediation analyses. The decrease of alcohol use in men 3 weeks after the EC was mediated partially by the change in explicit arousal expectancies. These findings raise a number of theoretical and practical issues.

### Assessing and changing implicit alcohol associations

Although the findings using the alcohol IAT have been consistent and reliable (cf. Wiers *et al.* 2002; De Houwer *et al.* 2004), the external validity of IAT has been criticized (e.g. De Houwer 2002; Fazio & Olsen 2003). One concern is the bipolar nature of the IAT. Note that in the IAT, both the target categories (alcohol–soda) and the attribute categories (positive–negative or arousal–sedation) are bipolar. First, with respect to the target categories, the alcohol associations measured in the IATs used here are relative to soda associations (hence, negative alcohol associations could theoretically be due to positive soda associations). Secondly, the attribute dimensions are also bipolar. This may be problematic in the context of alcohol: for explicit measures there is evidence that people hold both positive and negative expectancies (e.g. Leigh 1989) and the same may be true for implicit associations (Jajodia & Earleywine 2003; Kramer & Goldman 2003). In a recent study we compared associations for the four attribute categories used here in a balanced series of unipolar IATs and found that negative associations were strongest ( $d > 1$ ), followed by positive and arousal associations ( $d$  approximately 0.8) and sedation associations ( $d$  approximately 0.5), and this was the case both for the soda contrast and for an irrelevant animal contrast (Houben & Wiers 2004). These findings are consistent with the findings using bipolar IATs: stronger negative than positive alcohol associations, and stronger arousal than sedation alcohol associations (Wiers *et al.* 2002; De Houwer *et al.* 2004; this study). However, the findings of strong negative alcohol associations are inconsistent with assessments with explicit measures (Goldman *et al.* 1999; Wiers *et al.* 2002; this study). The strong negative alcohol associations found with the IAT could be related to an aspect of the IAT assessment procedure (e.g. Rothermund & Wentura 2004), or could be meaningful and represent negative experiences with alcohol (e.g. Jones & McMahon 1998; Rudman 2004). In line with the latter view, negative associations have also been found with memory associations (Gadon *et al.* 2004). The implicit (positive) arousal associations for alcohol found with the IAT are consistent with other research using

the IAT (Wiers *et al.* 2002; De Houwer *et al.* 2004), and with other implicit and explicit methods (Dunn *et al.* 2000; Goldman *et al.* 1999; Kramer & Goldman 2003). The fact that they were found only with one version of the IAT and were sensitive to order effects may have attenuated effects of the EC on implicit alcohol–arousal associations. In future treatment studies it might be wise to use only this version or a unipolar IAT. The finding that the expected decrease in implicit alcohol–arousal associations was found only for the original but not for the new scoring algorithm (Greenwald *et al.* 2003) may either indicate that the finding here is not reliable or that the new algorithm is less appropriate for intervention studies (the individual normalization procedure could take away variance crucial for detecting change). Clearly, these issues require further research. The present study adds to the growing evidence that implicit and explicit measures assess different constructs (e.g. Stacy 1997; Wiers *et al.* 2002; Rudman 2004), and that interventions may differentially affect implicit and explicit cognitions (cf. Teachman & Woody 2003). Therefore, it is important to assess effects of interventions on both types of measures and to develop new ways to change implicit associations (Wiers *et al.* 2004).

### A causal role for explicit expectancies?

Our EC successfully reduced the explicit expectancies related to arousal and positive reinforcement in men and women. The effect size was equal ( $d = 0.67$ ) to the original study using multiple sessions (Darkes & Goldman 1993), supporting the validity of the adapted EC and control condition in changing expectancies. Further, it was confirmed that our adapted protocol changed expectancies in women too (Wiers & Kummeling 2004). The expected change in heavy drinking was found in men, but only in week 3 after the EC (not in other weeks, nor in the overall follow-up month). A delayed effect could be related to the homework assignment (albeit *post hoc*). Alternatively, the short-lived significant reduction in alcohol use could be a chance finding. In women, no differential effects of the EC were found on drinking variables despite similar effects on explicit and implicit arousal expectancies, which could be interpreted as a disconfirmation of the hypothesized causal role of expectancies (Jones *et al.* 2001a,b). An alternative could be that the control condition was somehow equally effective in reducing drinking in women (not mediated by expectancies). The change in explicit arousal expectancies in men significantly mediated the short-lived delay in alcohol use, which is the first empirical confirmation of the hypothesized mediational role of expectancies (cf. Goldman 1999; Goldman *et al.* 1999; Jones *et al.* 2001a,b;

Wiers 2002a), although the validity of this finding depends on the interpretation of the significant difference in week 3 as meaningful or chance.

### Limitations

An experimental design was chosen that included an active control group instead of the more usual assessment-only control group. The advantage of our choice was that an effect of the EC could be related more specifically to the intervention and that non-specific context effects could be excluded as alternative explanations for the effects found. The drawbacks are that a comparison with studies using the more usual passive control group is more difficult, and that a potential effect of the EC on drinking in women may have been obscured by an effect on drinking in the control group (not mediated by expectancies). Future studies could include both control conditions. Finally, assessment strategies for implicit (alcohol) associations are developing rapidly and it is possible that implicit associations assessed with a different method would show stronger effects in an EC.

### Practical implications

There is now some evidence for short-term reductions of alcohol consumption in men following an EC (Darkes & Goldman 1993, 1998; Dunn *et al.* 2000; this study), but little evidence for its effect on drinking in women (although our adapted version consistently changed expectancies in women). The practical utility of the EC may be that it is an attractive group intervention for young problem drinkers who are typically unaware of their alcohol problem. In this way, it may provide a low-threshold initial contact that could be followed-up with a motivational interview (cf. Del Boca *et al.* 2002; Wiers & Kummeling 2004), for which longer-term effects on alcohol use have been established (e.g. Marlatt *et al.* 1998; Baer *et al.* 2001). In addition, prevention efforts aimed at the environment rather than at the individual hold promise in binge-drinking students (e.g. De Jong & Langford 2002).

### CONCLUSION

An adapted EC reduced explicit positive arousal expectancies in men and women in the absence of such changes in the control condition. The effects of the EC on implicit alcohol associations were less clear-cut and need further investigation. There is accumulating evidence that the EC results in a modest, short-term reduction in alcohol consumption in heavy drinking young men, which was found here to be partially mediated by the EC-induced

change in explicit positive arousal expectancies. Key questions for further research are how implicit alcohol associations can be changed successfully, and which combination of preventive interventions results best in long-term changes in young problem drinkers.

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