Learning to dislike alcohol: conditioning negative implicit attitudes toward alcohol and its effect on drinking behavior

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Abstract
Rationale Since implicit attitudes toward alcohol play an important role in drinking behavior, a possible way to obtain a behavioral change is changing these implicit attitudes.
Objectives This study examined whether a change in implicit attitudes and in drinking behavior can be achieved via evaluative conditioning.
Methods Participants were randomly assigned to an experimental condition and a control condition. In the experimental condition, participants were subjected to an evaluative conditioning procedure that consistently pairs alcohol-related cues with negative stimuli. In the control condition, alcohol-related cues were consistently paired with neutral stimuli during the evaluative conditioning phase. Implicit attitudes, explicit attitudes, and drinking behavior were measured before and after the evaluative conditioning phase.
Results Following the evaluative conditioning procedure, participants in the experimental condition showed stronger negative implicit attitudes toward alcohol and consumed less alcohol compared to participants in the control condition. However, this effect was only found when the evaluative conditioning task paired alcohol-related cues with general negative pictures, but not when using pictures of frowning faces.

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Conclusions These results demonstrate that evaluative conditioning can effectively change implicit attitudes toward alcohol and also suggest that this procedure can be used to change drinking behavior. Hence, evaluative conditioning may be a useful new intervention tool to combat alcohol misuse.

Keywords Alcohol · Drinking behavior · Implicit attitudes · Evaluative conditioning

Introduction

Alcohol abuse and dependence are characterized by a preoccupation with obtaining and drinking alcohol despite awareness of potentially devastating physical, social, and occupational consequences. Alcohol misuse, thus, is a prime example of irrational behavior, but what are the roots of this behavior? Dual-process theories propose that addictive behavior is determined by the interplay of two qualitatively different systems: a fast, *impulsive* system that appraises stimuli automatically in terms of affective and motivational significance and a slower, *reflective* system, which includes controlled processes related to conscious deliberations, emotion regulation, and expected outcomes (Deutsch and Strack 2006; Wiers and Stacy 2006; Wiers et al. 2007). Importantly, with regular alcohol use, the impulsive system undergoes changes in its associative network. Through experience, the impulsive system automatically assigns stronger positive affect and increased motivational value to alcohol-related cues. These automatic processes are activated whenever alcohol-related cues are encountered and generate strong impulses to drink alcohol via the automatic activation of behavioral schemas (Deutsch and Strack 2006; Wiers et al. 2007). Consistent

with this idea, alcohol is automatically or implicitly associated with positive affect. Moreover, stronger implicit alcohol-positive associations reliably predict increased levels of alcohol use (e.g., Houben and Wiers 2007a, b, 2008a; Jajodia and Earleywine 2003; McCarthy and Thompsen 2006; Rooke et al. 2008).

Hence, dual-process models and recent research findings suggest that implicit affective associations or implicit attitudes may play an important role in drinking behavior. Therefore, intervention strategies to reduce alcohol use may want to include procedures to change implicit alcohol-related attitudes. This raises the question how to attain such changes in implicit attitudes. According to general theories of attitude learning, implicit attitudes develop primarily via repeated pairing of attitude objects with positive or negative affect (e.g., Olson and Fazio 2001). Similarly, existing implicit attitudes can be changed by introducing new implicit affective associations with attitude objects (e.g., Gawronski and Bodenhausen 2006), for instance through evaluative conditioning (EC). The intuitively appealing idea underlying EC is that repeated pairings of an attitude object (conditioned stimulus (CS)) with objects of positive or negative affective value (unconditioned stimulus (US)) changes the implicit attitude toward the attitude object in the direction of the objects with which it was paired. Recent examples of applying this principle concern research demonstrating that EC can effectively decrease implicit racial prejudice (Olson and Fazio 2006), and increase implicit self-esteem (Baccus et al. 2004).

Based on these insights, the present study examined whether EC can be used to change implicit attitudes toward alcohol in a non-clinical student sample. Further, we tested whether EC would also induce a behavioral change with respect to weekly alcohol consumption. The EC was based on the procedure by Baccus et al. (2004) and consistently paired alcohol-related CSs with negative USs in the experimental condition, or with neutral USs in the control condition. As a secondary aim, we compared the effectiveness of two different types of USs, which were photographs of facial expressions or general affective pictures. While Baccus et al. (2004) demonstrated that facial stimuli could be effectively used to change implicit self-esteem, it was unclear whether this kind of social feedback would also effectively change implicit alcohol attitudes. We therefore also included an experimental and a control condition that presented general affective USs, which is more similar to traditional EC research. Hence, participants were divided into four conditions: an experimental condition that consistently paired alcohol stimuli with negative facial expressions, a control condition in which alcohol stimuli were consistently paired with neutral facial expressions, another experimental condition in which alcohol stimuli were consistently paired with general negative stimuli, and

another control condition in which alcohol stimuli were always paired with neutral affective pictures. It was expected that participants in both experimental conditions would show stronger negative explicit and implicit attitudes toward alcohol after exposure to the critical CS–US pairings and decreased alcohol consumption compared to participants in the two control conditions.

Method

Participants

Participants were 116 students from Maastricht University (88 females; mean age=21.32 years, SD=5.33). Participants were recruited through advertisements for experimental volunteers posted in the university buildings. Participants were included only if Dutch was their first language and were excluded if they were colorblind or dyslectic. On the Alcohol Use Disorder Identification Test (AUDIT; Saunders et al. 1993), participants had an average score of 8.26 (SD=4.79) with 43% of the participants scoring above 8, indicating hazardous drinking (Saunders et al. 1993), and 28% of the participants scoring above 10 which has been proposed as a cut-off score for problem drinking in students (Fleming et al. 1991).

Materials and measures

Evaluative conditioning task During the EC task, participants were instructed that on each trial, a word would appear in one of four quadrants on the computer screen. Their task was to respond to the word as quickly as possible by pressing the space bar. They were also told that an image would be displayed briefly (400 ms) in the same quadrant upon pressing the response key. This procedure was repeated for 120 trials: 30 trials presented an alcohol-related CS, 30 trials presented a soft drink related CS, and 60 trials presented filler CS. Alcohol-related CSs were the words wine, beer, pint, vodka, breezer, and whisky; soft drink-related CSs consisted of the words coca-cola, fanta, orange soda, cassis, juice, water; filler CSs consisted of 12 words referring to vegetables and fruits.

In the two experimental conditions, alcohol-related CSs were consistently paired with negative USs, while soft drink-related CSs were always followed by positive USs. Filler CSs were consistently followed by neutral USs. The two experimental conditions differed in the type of affective USs used during the EC task: These were either pictures of smiling, frowning, and neutral expressions of men and women taken from the NimStim Set of Facial Expressions (Tottenham et al. 2009) or general positive, negative, and

neutral pictures of the International Affective Picture System (IAPS; Lang et al. 2005)[1]. Hence, in the experimental conditions, alcohol-related CSs were consistently paired with negative USs, which were frowning faces in one experimental condition (i.e., "faces" experimental condition) and general negative IAPS pictures in the other experimental condition (i.e., "IAPS" experimental condition). In the two control conditions, filler CSs were always followed by positive and negative USs, while alcohol- and soft drink-related CSs were consistently followed by neutral USs. As in the experimental conditions, these USs were images of smiling, frowning, or neutral faces of men and women or general positive, negative, and neutral IAPS pictures. Thus, in the control conditions, alcohol-related CSs were consistently paired with neutral USs, which were either neutral faces (i.e., faces control condition) or neutral IAPS pictures (i.e., IAPS control condition). In all conditions, participants were exposed to the same stimuli. In each condition, all stimuli were presented five times.

Contingency awareness We assessed awareness of the critical CS–US pairings with an open question asking participants whether they noticed anything about the way the words and pictures were presented during the EC task.

Implicit association test Implicit attitudes toward alcohol were measured with the implicit association test (IAT; Greenwald et al. 1998). The IAT is a computerized classification task during which participants have to quickly and accurately classify stimuli into two target categories (e.g., alcohol and soft drinks) and two affective attribute categories (e.g., positive and negative), using a left and a right response key. Importantly, the target and attribute categories are assigned to the two response keys in two different combinations. The underlying idea is that this simultaneous classification of targets and attributes should be easier (i.e., faster) when the response assignment of the target and attribute categories is compatible, or corresponds to respondents' implicit associations, than when this response

assignment is incompatible, or does not match respondents' implicit associations. Hence, the difference in reaction time between the two combination tasks should reflect the strength of the associations of the target categories with the attribute categories (Greenwald et al. 1998).

Here, we used a standard IAT that measured whether alcohol is associated more strongly with negative affect or with positive affect (e.g., Houben and Wiers 2008b, 2009; Houben et al. 2010; Wiers et al. 2002). The IAT presented two target categories: an alcohol target category (wine, beer, pint, vodka, breezer, and whisky; label "alcohol") and a soft drink target category (coca-cola, fanta, orange soda, cassis, juice, and water; label "soft drinks"). The (Dutch) target categories were matched on number of syllables. Further, in the IAT, a positive attribute category (love, sunshine, warmth, peace, hug, and rainbow; label "pleasant") was paired with a negative attribute category (sorrow, war, depression, pain, fight, and disease; label "unpleasant"). The (Dutch) positive and negative attribute categories were matched on number of syllables. The IAT followed the standard IAT procedure (Greenwald et al. 1998; see Table 1). The assignment of the alcohol category and the soft drink category to the left and right response keys was counterbalanced across participants. Furthermore, the response assignment of the attribute categories was also counterbalanced, so that half the participants in each task performed the compatible combination task (i.e., alcohol+pleasant vs. soft drinks+unpleasant) before the incompatible combination task (i.e., alcohol+unpleasant vs. soft drinks+pleasant). The other half of the participants performed the incompatible combination task before the compatible combination task. Stimuli were presented in the middle of the computer screen. The labels of the categories assigned to the left and right response key were presented in the corresponding upper corners of the computer screen. Stimuli remained on screen until a correct response was given. The intertrial interval was 250 ms. Feedback ("wrong") was presented in red when participants misclassified a stimulus.

Explicit alcohol-related expectancies and attitudes Explicit alcohol-related expectancies were measured with 15 questions. Each question asked participants to indicate on a seven-point Likert scale how much they agreed (1=completely disagree, 7=completely agree) with the statement "After drinking alcohol, I feel …" which was completed with the following words: active, funny, energetic, cheerful, excited, pleasant, talkative, and happy for the positive expectancy items and miserable, awful, listless, nauseous, unpleasant, sad, and uncomfortable for the negative expectancy items. Explicit attitudes toward alcohol were assessed with four semantic differentials. Participants indicated on a seven-point Likert scale how much they considered drinking

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[1] As positive USs, we used six positive IAPS stimuli (IAPS numbers 1440, 1603, 1710, 2070, 2311, and 5760) or six smiling NimStim faces (01f_ha_o.bmp, 09f_ha_o.bmp, 10f_ha_o.bmp, 23m_ha_o.bmp, 35m_ha_o.bmp, and 36m_ha_o.bmp). Negative USs consisted of six negative IAPS stimuli (IAPS numbers 1300, 2811, 2900, 9301, 9373, and 9570) or six frowning NimStim faces (01f_an_c.bmp, 09f_an_c.bmp, 10f_an_c.bmp, 23m_an_c.bmp, 35m_an_c.bmp, and 36m_an_c.bmp). Finally, neutral USs were 12 neutral IAPS pictures (IAPS numbers 2383, 2840, 7037, 7038, 7041, 7050, 7052, 7100, 7150, 7235, 7500, and 7547) or 12 neutral NimStim faces (01f_ne_c.bmp, 02f_ne_c.bmp, 06f_ne_c.bmp, 07f_ne_c.bmp, 09f_ne_c.bmp, 10f_ne_c.bmp, 23m_ne_c.bmp, 24m_ne_c.bmp, 25m_ne_c.bmp, 34m_ne_c.bmp, 35m_ne_c.bmp, and 36m_ne_c.bmp).

Table 1 Overview of the IAT procedure

IAT				
Block	Trials	Function	Left key	Right key
1	24	Target practice	Alcohol	Soft drinks
2	24	Attribute practice	Pleasant	Unpleasant
3	24	Combination practice	Alcohol + pleasant	Soft drinks + unpleasant
4	48	Combination test	Alcohol + pleasant	Soft drinks + unpleasant
5	48	Reversed target practice	Soft drinks	Alcohol
6	24	Reversed combination practice	Soft drinks + pleasant	Alcohol + unpleasant
7	48	Reversed combination test	Soft drinks + pleasant	Alcohol + unpleasant

The assignment of the target and attribute categories to the left and right response key was counterbalanced across participants

alcohol to be unpleasant–pleasant, boring–fun, bad–good, and foolish–wise.

Alcohol use Alcohol use was measured with a self-report questionnaire based on the timeline follow-back method (TLFB; Sobell and Sobell 1990). Participants were asked to indicate how many alcoholic beverages they consumed during each day of the past week.

Procedure

Participants were tested via the Internet (www.impliciet.eu). All participants gave their informed consent prior to their inclusion in the study. First, participants received the IAT, which was followed by the expectancy questionnaire, the attitude questionnaire, the TLFB, and the AUDIT, in this order (for a discussion of issues regarding web-based assessment and a validation of the present measures for assessment via Internet, see Houben and Wiers 2008b). Next, participants were randomly assigned to one of the four EC conditions and performed the EC task; faces control condition: $n=35$ (26 females), faces experimental condition: $n=24$ (21 females), IAPS control condition: $n=28$ (21 females), IAPS experimental condition: $n=29$ (20 females). Afterwards, participants again received the IAT, the expectancy questionnaire, and the attitude questionnaire. Two weeks later, participants reported their alcohol intake in the week after the first session on the TLFB. Finally, participants were probed for contingency awareness and received a 15€ gift certificate as remuneration.

Design and statistical analyses

The dependent variables were implicit attitudes measured with the IAT, explicit expectancies and attitudes, and alcohol consumption. IAT effects at pre- and posttest were calculated with the D600 algorithm (Greenwald et al. 2003), so that higher scores indicate faster performance when alcohol was paired with pleasant (vs. soft drinks and unpleasant)

(vs. soft drinks and pleasant). Thus, higher scores indicate stronger positive implicit attitudes toward alcohol[2]. Mean scores were calculated for positive expectancy items, negative expectancy items, and attitude items at pre- and posttest. Weekly alcohol consumption was estimated from the TLFB by adding the number of alcoholic drinks consumed during the week before the manipulation (pretest: average alcohol consumption=10.48 alcohol drinks, SD=14.59, range=0–105 drinks) and during the week following the manipulation (posttest: average alcohol consumption=9.11 alcohol drinks, SD=12.98, range= 0–70 drinks). Possible differences between conditions at pretest were examined with a 2 (condition: experimental or control)×2 (US: faces or general) ANOVA on pretest scores. To examine effects of the EC on the dependent variables, difference scores were calculated for the implicit attitudes, positive and negative expectancies, explicit attitudes, and alcohol use, by subtracting scores at pretest from scores at posttest. These differences scores were subjected to a 2 (condition; experimental or control)×2 (US: faces or general) ANOVA. Partial eta squared (η_p^2) is reported as a measure of effect size.

Results

Implicit attitudes

Inspection of the IAT data showed that 12 participants had missing data on the IAT due to technical problems. Moreover, five participants had response latencies shorter than 300 ms on more than 10% of IAT trials or more than 40% errors in any of the combined sorting blocks. These 17

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[2] When IAT data were analyzed using the conventional log-transformed IAT measure (Greenwald et al. 1998), results showed two additional influential outliers on IAT scores. When these outliers were removed from the sample, analyses using the conventional IAT measure showed a similar pattern of results as analyses using the D600 IAT measure. Since the new algorithm is now the most accepted IAT measure, we only report findings with the D600 algorithm.

participants were therefore removed from the analyses of the IAT data (see Greenwald et al. 2003). Thus, analyses on the IAT data were performed with 99 participants (faces control condition: $n=29$, faces experimental condition: $n=24$, IAPS control condition: $n=25$, IAPS experimental condition: $n=21$). At pretest, the US effect was significant, $F(1,95)= 8.68$, $p<0.01$, $\eta_p^2=.08$, indicating stronger negative implicit attitudes toward alcohol in the conditions with faces as USs than in the conditions with general USs (see Table 2). The condition effect and the interaction effect were not significant ($F<1$).

Next, it was examined how implicit attitudes toward alcohol changed from pre- to posttest. Results showed a significant main effect of US on IAT difference scores, $F(1,95)=5.35$, $p=.02$, $\eta_p^2=.05$, while the effect of condition did not reach significance ($F<1$). In addition, the interaction between US and condition was significant, $F(1,95)= 4.41$, $p=.04$, $\eta_p^2=.04$. Follow-up analyses showed no effect of condition when the EC task used faces as USs ($F<1$). However, when the EC task used general USs, the effect of condition was significant $F(1,44)=3.98$, $p=.05$, $\eta_p^2=.08$, indicating a larger change in implicit attitudes in the experimental condition compared to the control condition. As can be seen in Fig. 1, when the EC task used general USs, implicit attitudes were significantly more negative at posttest than at pretest in the experimental condition, $t(20)= 2.30$, $p=.03$, while implicit attitudes toward alcohol did not change significantly from pre- to posttest in the control condition ($t<1$). When the EC task used faces as USs, implicit attitudes also did not significantly change from pre- to posttest in the control condition ($t<1.1$), while there was

a trend indicating that implicit attitudes toward alcohol became slightly more positive following the EC manipulation, $t(23)=1.90$, $p=.07$.

Explicit attitudes and expectancies

Four out of 116 participants had missing data on the attitude questionnaire and were discarded from analyses on attitude scores (faces control condition: $n=33$, faces experimental condition: $n=24$, IAPS control condition: $n=27$, IAPS experimental condition: $n=28$). Two out of 116 participants missed data on the expectancy questionnaire and were excluded from analyses on expectancy scores (faces control condition: $n=34$, faces experimental condition: $n=24$, IAPS control condition: $n=27$, IAPS experimental condition: $n=29$). At pretest, there were no significant effects of condition or US on explicit expectancies (largest $F=1.19$), while there was a trend indicating stronger negative explicit attitudes toward alcohol in the conditions with faces as USs than in the conditions with general USs, $F(1,111)=3.43$, $p=.07$, $\eta_p^2=.03$ (see Table 2), in absence of a significant condition effect and interaction effect ($F<1$).

We then examined how explicit expectancies and attitudes changed from pre- to posttest. Results showed no significant effects of condition or US on difference scores for positive expectancies or explicit attitudes ($F<1.6$). As can be seen in Table 2, positive expectancies and explicit attitudes did not differ significantly between conditions nor did they change from pre- to posttest. With respect to negative expectancies, in contrast, results showed a significant effect of condition, $F(1,110)=4.33$, $p=.04$, $\eta_p^2=.04$, while effects

Table 2 Means and standard deviations for demographic variables and for the dependent variables at pre- and posttest, separately for each condition

| | | Faces | | | | IAPS | | | |
| | | Control | | Experimental | | Control | | Experimental | |
		M	SD	M	SD	M	SD	M	SD
Age ($n=116$)		21.59	2.19	21.96	7.29	20.33	2.72	21.38	5.58
AUDIT ($n=116$)		8.06	4.71	7.74	4.59	9.93	5.24	7.35	4.47
IAT effect ($n=99$)	Pretest	−0.72	0.38	−0.76	0.34	−0.55	0.40	−0.47	0.42
	Posttest	−0.66	0.40	−0.63	0.32	−0.50	0.31	−0.62	0.35
Positive expectancies ($n=114$)	Pretest	4.87	1.24	5.03	1.03	5.21	0.80	4.93	1.12
	Posttest	4.92	1.27	5.05	1.00	5.25	0.94	4.88	1.23
Negative expectancies ($n=114$)	Pretest	2.61	1.02	2.61	1.01	2.79	1.01	2.45	.92
	Posttest	2.41	0.95	2.62	1.12	2.58	1.02	2.40	1.06
Attitude ($n=112$)	Pretest	4.31	1.03	4.10	1.00	4.56	0.99	4.55	.91
	Posttest	4.21	1.04	3.99	1.15	4.33	0.85	4.31	0.96
Alcohol use ($n=116$)	Pretest	10.49	12.64	5.00	5.99	9.36	9.36	16.10	22.52
	Posttest	8.51	12.27	5.29	6.38	11.50	17.08	10.69	13.15
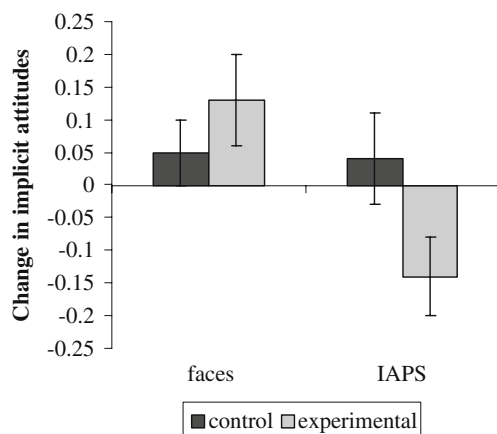
Fig. 1 Mean difference scores for the D600 IAT score with standard errors, separately for the experimental and control conditions

Fig. 2 Mean difference scores for alcohol use with standard errors, separately for the experimental and control conditions

involving US did not reach significance ($F<1$). As can be seen in Table 2, this difference between conditions was due to decreased negative expectancies in both the faces control condition and the general US control condition, $t(33)=2.63$, $p=.01$, and $t(26)=2.16$, $p=.04$, respectively, while negative expectancies in the experimental conditions did not change from pre- to posttest ($t<1$).

Drinking behavior

At pretest, there was a trend indicating that participants who received faces as USs consumed less alcohol at pretest than participants who received general USs, $F(1,112)=3.48$, $p=.07$, $\eta_p^2=.03$. Further, while there was no significant condition effect ($F<1$), the interaction between condition and US was significant, $F(1,112)=5.23$, $p<0.05$, $\eta_p^2=.05$. Although the experimental and control condition that received general USs did not differ at pretest, $F(1,55)=2.15$, $p=.15$, the experimental condition that received faces as USs consumed less alcohol relative to the control condition, $F(1,57)=3.90$, $p=.05$, $\eta_p^2=.06$ (see Table 2).

Next, it was examined how drinking behavior changed from pre- to posttest. Results showed a significant interaction effect of US and condition on alcohol use difference scores, $F(1,112)=7.13$, $p=.01$, $\eta_p^2=.01$, in the absence of significant main effects of US ($F<1$) and condition ($F=2.1$). Follow-up analyses showed no effect of condition on alcohol use difference scores when the EC task used faces as USs ($F<1.2$). However, when the EC task used general USs, the effect of condition was significant $F(1,55)=6.35$, $p=.02$, $\eta_p^2=.10$, indicating a larger change in alcohol use in the experimental condition compared to the control condition. As shown in Fig. 2, alcohol use decreased significantly from pre- to posttest in the experimental condition that was subjected to the EC task with general USs, $t(28)=2.75$, $p=.01$, while alcohol
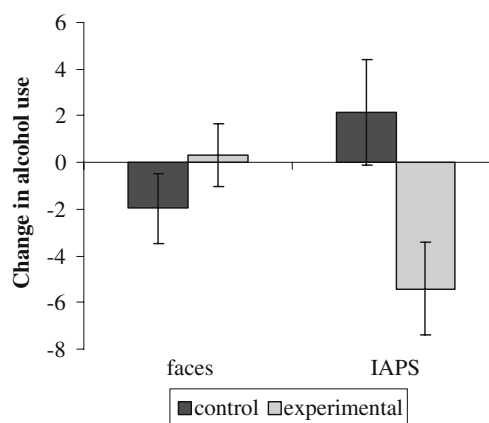
use did not change significantly from pre- to posttest in any of the other three conditions ($t<1.5$).

Contingency awareness

In total, 49 participants indicated that they noticed the CS–US pairings. A 2 (condition: experimental or control)×2 (US: faces or general)×2 (contingency aware: yes or no) ANOVA on difference scores for implicit attitudes, negative expectancies, and alcohol use indicated that the effects of EC on these dependent variables were unaffected by contingency awareness. With contingency awareness added to the model, none of the analyses showed significant main or interaction effects involving this factor ($F≤2$).

Discussion

The goal of this study was to examine whether EC can be used to effectively change implicit attitudes toward alcohol and to decrease alcohol use in a non-clinical sample of participants. Participants who performed an EC task that consistently paired alcohol-related stimuli with general negative pictures showed stronger negative implicit attitudes toward alcohol compared to control participants who were not exposed to the critical alcohol-negative pairings. In contrast, implicit attitudes toward alcohol were left unchanged following an EC task that repeatedly paired alcohol-related stimuli with pictures of frowning faces. On explicit measures, participants in both experimental conditions endorsed stronger negative expectancies than control subjects, while there were no differences on positive expectancies or attitudes. However, results indicated that this effect was not due to increased negative expectancies in the experimental conditions, but rather to decreased negative expectancies in the control conditions. Perhaps mere exposure

to alcohol-related cues during the experiment task caused decreased negative expectancies at posttest. The EC may then have counteracted this mere exposure effect in the experimental conditions. Finally, pairing alcohol-related stimuli with general negative affective pictures also induced a behavioral change: Participants in the experimental condition consumed less alcohol in the week following EC compared with control participants. Conversely, pairing alcohol-related stimuli with frowning faces did not induce a behavioral change in the experimental condition relative to the control condition.

Hence, EC effectively reduced implicit attitudes toward alcohol. However, the present findings cannot clarify whether the EC in fact increased negative implicit associations with alcohol and/or reduced positive implicit alcohol associations. Given that previous research has shown that positive implicit associations are more strongly related to drinking behavior than negative implicit alcohol associations (e.g., Houben and Wiers 2008a; Jajodia and Earleywine 2003; McCarthy and Thompsen 2006), future research needs to further investigate this issue using IAT variants that can assess positive and negative implicit alcohol associations separately. Further, we only found an effect on implicit attitudes and behavior when the EC used general negative pictures as USs, but not when using frowning faces as USs. One explanation for this finding is that the facial expressions may have had lower affective value compared to the IAPS pictures. Alternatively, implicit attitudes toward alcohol could be more strongly based on experienced affective states rather than social feedback, which could also explain why we found stronger effects of EC with general affective pictures than with pictures of faces. It should be noted though that analyses on pretest scores demonstrated that the conditions that received the EC task with faces as USs displayed stronger negative implicit and explicit attitudes toward alcohol and consumed less alcohol than the conditions which received the EC task with IAPS pictures as the USs. Hence, it could also be argued that there was more room for improvement in the latter condition. This issue also needs to be addressed in future research.

Importantly, the current findings suggest that EC may be a useful tool to change implicit alcohol-related cognitions and drinking behavior. The implication of these findings is that EC may prove to be a useful tool supplement to existing interventions. Current intervention strategies are typically focused on changing explicit alcohol-related thoughts and feelings, but leave implicit attitudes with alcohol largely unaffected (e.g., Wiers et al. 2005), which may partly explain their short-lived effect on behavior (Wiers et al. 2005; Wood et al. 2007). According to dual-process models, implicit attitudes may continue to generate impulses to drink alcohol when they are left unchanged. Hence, EC could be a useful strategy to change implicit attitudes in addition to explicit attitudes. However, the

present sample did not solely consist of hazardous drinkers, and it is unclear how many of the present participants met the criteria for alcohol dependence. Consequently, it is unclear whether the present findings also generalize to clinical samples, and future research needs to examine the usefulness of EC to change implicit attitudes and drinking behavior in clinical samples before its effectiveness as an intervention tool can be established. In this respect, it is interesting to note that EC has been found to be highly resistant to extinction (De Houwer et al. 2001) and therefore holds the potential to induce long-lasting changes in implicit attitudes and behavior, which may further increase the value of EC as an intervention tool.

However, there are some limitations to the present findings that need to be noted. First, there were some baseline differences between the experimental and control conditions in drinking behavior that may have influenced the present findings. Although baseline differences in drinking were not significant for the EC conditions with general USs, some caution is nevertheless advised when interpreting the effect of the general EC on drinking behavior. Specifically, since the control condition consumed less alcohol compared to the experimental condition at baseline, it could be possible that there was simply more room for improvement in the latter condition. Further, it is also possible that we failed to find an effect of the EC with faces on drinking because the experimental condition already consumed significantly less alcohol than the control condition at baseline. Therefore, although the present findings suggest that EC can be an effective strategy to reduce alcohol use, these findings are in need of further replication before strong conclusions can be drawn regarding the value of EC as a means to reduce drinking. Second, we only assessed alcohol consumption during 1 week following the EC, which is a relatively short time frame. Given that drinking patterns may fluctuate from week to week, it is conceivable that this short-term follow-up may overestimate or underestimate the true effect of EC on drinking behavior. Also, the evaluative conditioning effects that were found in the present study were relatively small, and it is unclear at this time whether the EC procedure we used is extensive enough to produce long-term effects. This issue needs to be addressed in future research by examining the effect of EC on alcohol consumption over a longer period, using more extensive evaluative conditioning procedures. Third, the present sample consisted of mostly female students. Although gender was relatively evenly divided over the four conditions, making it highly unlikely that any of the observed effects were caused by gender differences, the present study cannot draw any firm conclusions regarding the effectivity of the EC task across gender. Future research needs to further examine whether EC is equally effective for both men and women. Finally,

the present study cannot draw any solid conclusions regarding the causal role of changed implicit attitudes on the reduction in alcohol consumption. Although it seems plausible that the changes in implicit attitudes were causally related to the changes in drinking behavior, the present sample size did not permit a powerful test of this premise. Therefore, future research should further investigate this issue.

In conclusion, this study demonstrates that an EC procedure that consistently pairs alcohol-related cues with negative affect can change existing implicit alcohol-related attitudes and decrease alcohol consumption. Although there are still some issues that need to addressed by future research such as the longevity of the EC effects and the underlying processes of the effects, these findings nevertheless suggest that EC may potentially be a useful intervention tool to change implicit cognitions and drinking behavior. If the present findings can also be replicated in clinical samples, EC procedures may carry an enormous potential and could be a beneficial addition to existing intervention techniques. We are therefore confident that the present research will stimulate future research into the effectiveness of EC in clinical samples.

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