

Implicit and explicit alcohol cognitions and observed alcohol consumption: three studies in (semi)naturalistic drinking settings

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ABSTRACT

Aims Dual-process models imply that alcohol use is related to implicit as well as explicit cognitive processes. Few studies have tested whether both types of processes are related to *ad libitum* drinking. In a series of three studies, we tested whether both implicit and explicit alcohol-related cognitions predicted the amount of alcohol consumed in an *ad libitum* (semi)naturalistic drinking situation. **Design** Two experimental studies used trained confederates (same-sex peers) who consumed either alcoholic or non-alcoholic beverages, while observing participants' drinking behaviour in a 30-minute session. The third study involved observations of participants' alcohol use during a 45-minute session in which participants spent time with five to seven friends. **Setting** A (semi)naturalistic drinking setting, a laboratory bar. **Participants** Participants were undergraduates recruited at Radboud University (study 1: $n = 115$; study 2: $n = 121$; study 3: $n = 200$). **Measurements** We used coding of drinking behaviour from observations, questionnaire data on positive alcohol expectancies and alcohol use patterns and implicit association tests to assess alcohol associations. **Findings** Implicit associations were not related to observed alcohol use, whereas explicit positive expectancies were related positively to observed alcohol use in study 1 and study 2. **Conclusions** Among undergraduate students in (semi)naturalistic drinking settings with peers, implicit alcohol-related cognitions do not predict the amount of alcohol consumed.

Keywords Alcohol, experimental studies, explicit cognition, implicit cognition.

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INTRODUCTION

Alcohol-related cognitions such as outcome expectancies, attitudes and motivational processes are involved in adolescent and adult alcohol use. To unravel these processes, scholars have differentiated traditionally between explicit and implicit alcohol-related cognitions [1,2]. Explicit cognitions refer to cognitions that can be accessed consciously, are intentional and under individuals' cognitive control. To measure explicit alcohol-related cognitions, people are asked about their attitudes towards alcohol, personal expectancies about the effects of alcohol consumption or motives to drink. It is thus a conscious introspection of underlying thoughts, feelings

and behaviours concerning alcohol use. Conversely, implicit cognitions refer to associations in memory influencing cognitive and affective processes and behaviour in a relatively automatic, unconscious, way [3,4]. Whereas explicit drinking cognitions are assessed by the use of questionnaires, implicit alcohol-related cognitions are inferred indirectly from tasks such as word associations, false memory tests and implicit association tests (IATs) [4–6]. When the assessed implicit associations are strong, the likelihood that a certain behavioural pattern will be activated and rendered salient in memory increases [7]. Generally, it is assumed that the stronger individuals implicitly relate alcohol with positive outcomes, the more likely it is that they will consume alcohol.

According to dual-process theories, alcohol (mis)use is determined by an interplay or imbalance between two systems: faster, automatic, implicit and impulsive cognitive processes, on one hand, and slower, more conscious, explicit and reflective processes on the other hand [8]. Studies have shown that both explicit and implicit cognitions are associated with alcohol consumption in adolescents [7,9], undergraduates [10,11] and adults [6,12]. Therefore, it has been suggested that they might reflect different cognitive processes [8,13,14], so both systems seem relevant when investigating alcohol use.

The overwhelming majority of studies investigating the relation between implicit and explicit alcohol-related cognitions and drinking behaviour rely upon self-report data [11,15,16]. One of the problems with this approach is potentially biased information. Self-reports tap conscious attitudes that are susceptible to social desirability biases, and consequently these reports might not have much relation to real-world behaviour. Although some studies have demonstrated a relationship between alcohol expectancies and actual drinking [17–21], it remains unknown whether both implicit and explicit outcome expectancies are related to observed drinking in a simulated naturalistic drinking setting controlling for the influence of peer drinking [22]. In other words, do explicit and implicit alcohol cognitions relate to alcohol consumption in real-life settings, in particular that of young people's social drinking with their peers in a public house? This is relevant, as adolescent and young adult alcohol consumption is concentrated primarily in peer contexts and, especially in these age phases, people are highly sensitive to peer influence [23–25]. In most survey research on drinking, participants complete questions about their alcohol use in classroom settings during the day, and data about drinking behaviours are, thus, gathered outside the context in which these behaviours occur. To generalize research outcomes to real drinking situations, it is important to measure drinking behaviour in its context.

Observational methods are an excellent tool to assess drinking habits [26]. In our opinion, the theoretical value of dual-process models will be particularly high if explicit and implicit cognitions are related to drinking in naturalistic drinking settings of young people—which are deeply social by nature—in which alcohol consumption is assessed reliably with unobtrusive measures. The vast majority of research on alcohol consumption does not concentrate on drinking behaviours in (semi)naturalistic settings, although some experimental studies with a balanced placebo design have looked at the function of expectancies in alcohol consumption while conducting their studies in a laboratory bar [27,28].

Although explicit alcohol expectancies consist of several dimensions, we assessed only positive expectan-

cies. Young adults are social drinkers who usually drink in the company of other peers which is, in all probability, guided by expectancies about the positive outcomes of drinking. We anticipated that individuals who attributed a positive valence to alcohol outcomes were more likely to consume alcohol in social settings in which they drink with peers than individuals who attributed a negative valence to outcomes of drinking [11,19]. Bot and colleagues [15] showed that especially positive explicit expectancies were related to observed alcohol consumption in an *ad-libitum* drinking context, even after controlling for the profound effects of peer drinking. However, the association between implicit alcohol cognitions and observed drinking in a social drinking setting still remains to be tested. Because studies in other domains have demonstrated that implicit measures predict spontaneous behaviours more accurately than explicit measures [29,30], we expected that positive implicit alcohol associations were related to observed drinking, after controlling for peer drinking and explicit positive expectancies.

METHODS STUDIES 1 AND 2

Participants

For study 1, a total of 115 students participated (54 women) with an average age of 21 years [range: 18–28; [standard deviation (SD) = 2.44], and consumed on average 11 (SD = 11.61) alcoholic beverages a week. For study 2, 121 students participated (64 women) with an average age of 20 years (range: 18–26; SD = 2.08), and consumed on average 13 (SD = 12.84) alcoholic beverages a week. Participants were recruited at the university campus. Abstainers and students younger than 18 years were excluded. The chronology of the studies presented is not similar to the order in which we actually conducted the studies: studies 1 and 3 were conducted in the same period of time, whereas study 2 was conducted subsequent to studies 1 and 3. Given that studies 1 and 2 were similar in terms of design, we chose to present these studies first, and then proceed with study 3.

Procedure

Both studies comprised similar between-subject designs and used the same procedures. All sessions were conducted between 4 p.m. and 9 p.m., and took place in a laboratory bar at the university, which is a room furnished as an ordinary Dutch public house [15]. Ten undergraduate students were employed as confederates. Confederates and participants were always of the same sex and confederates were instructed to drink a certain amount of alcohol or soda before the sessions began.

Participants first completed an informed consent statement and medical checklist. Next, they completed the IAT and subsequently completed a questionnaire containing questions on weekly alcohol use, frequency of binge drinking, explicit positive expectancies and several filler items to distract the attention away from alcohol. Participants met their co-participant (i.e. confederate) and entered the laboratory bar. They evaluated five general commercial advertisements for 10 minutes. This was a foil neutral task. Next, there was a 30-minute break. Participant and confederate were asked to sit at the bar where peanuts and alcoholic and non-alcoholic drinks were available (i.e. beer, red or white wine, rosé, soda and mineral water). Confederates were pre-instructed to either drink two sodas (i.e. 'Control' condition), one alcoholic drink and then one soda (i.e. 'light' condition), or three (women) or four (men) alcoholic drinks (i.e. 'heavy' condition). Subsequently, a Dutch alcohol prevention campaign was evaluated. After the data collection, participants were debriefed and received €12 for their participation. Participants who consumed alcohol were offered a taxi home. Protocols were approved by the Ethical Committee of the Faculty of Social Sciences, Radboud University [24].

Measures

Observed alcohol consumption. Observed alcohol consumption was assessed by counting the number of alcoholic drinks consumed in the observational session. One bottle of beer (5% alcohol) contained 170 ml and 8.5 ml pure alcohol. One glass of wine (12.5% alcohol) contained 110 ml and 13.8 ml pure alcohol. Because participants had to consume more beer than wine to reach the same amount of pure alcohol, we divided the total amount of beer consumed per participant by 1.62 in order to homogenize the drinks in terms of pure alcohol content [15,24]. Due to skewness, we used a log-transformation.

Binge drinking. Binge drinking was assessed with one question asking participants how many times they had drunk more than six alcoholic drinks per occasion over the past 12 months on a seven-point scale [31].

Weekly alcohol consumption was measured by asking on which of the previous 7 days the respondent consumed alcohol and, if so, how many drinks. The summed total of consumptions over these 7 days was used [32]. Due to skewness, we used a log-transformation.

Explicit positive expectancies. Explicit positive expectancies was measured with a six-item scale indicating expected outcomes of drinking that had a positive valence and medium arousal [11,15]. The scale was

introduced by the following text: 'Can you indicate to what amount the following effects occur to you when you drink alcohol or would be drinking alcohol?'. The reply categories began with the statement: 'Drinking makes me . . .' (e.g. fun, happy, nice) on a 1–7 scale (alpha study 1 = 0.92; study 2 = 0.88).

Implicit associations

In both studies, implicit attitudes towards alcohol were measured with IATs [33]. The IAT is a computerized sorting task that infers implicit attitudes from the simultaneous classification of two target categories and two affective attribute categories in two different sorting conditions. In both studies, the target words were 'alcohol' versus 'soda'. In study 1, target words were combined with a unipolar sorting of the attributes 'cheerful' versus 'neutral' [34]. Hence, in one combined sorting condition 'alcohol' and 'cheerful' shared a response-key, as did 'soda' and 'neutral'; in the other combined sorting condition 'alcohol' and 'neutral' shared a response-key, and 'soda' and 'cheerful'. The order of the combined blocks was counterbalanced, so that half the participants received the alcohol-cheerful (soda-neutral) sorting combinations first, while the other half received the alcohol-neutral (soda-cheerful) combination first. For each category five words were used.

In study 2, target words were combined with 'positive' and 'negative' attributes. In one sorting condition, alcohol-related targets shared a response with positive attributes, while soda-related targets were paired with negative attributes. In the other sorting condition the combination of target categories and attribute categories was reversed, so that alcohol was paired with negative words and soda with positive words [11]. For each category eight words were used. Both IATs consisted of seven blocks. The order of the combined blocks was counterbalanced. IAT scores were calculated with the D600 algorithm [35], so that more positive scores indicated relatively strong associations between alcohol and cheerful (i.e. study 1) and alcohol and positive (i.e. study 2). The IATs were conducted in cubicles prior to entering the laboratory bar.

METHOD STUDY 3

Participants

The sample comprised 200 participants (102 females) in aged between 18 and 27 years (mean = 21.5 years, SD = 1.98). A total of 31 groups participated, including 22 mixed-gender groups, five male groups and four female groups. Data were collected from all members of the groups. About half the groups consisted of six people (51%); eight groups consisted of seven people (28%); four

Table 1 Sample means and standard deviations (SD) for each study.

	Total		Men		Women		<i>t</i>
	Means	SD	Means	SD	Means	SD	
Study 1							
Q. binge drinking	4.43	1.83	5.08	1.63	3.70	1.79	4.33**
Q. Exp. Pos. Exp.	4.57	1.10	4.71	1.03	4.41	1.16	1.48
O. drinks consumed	0.48	0.70	0.69	0.78	0.25	0.51	3.74**
Implicit associations	-0.02	0.34	0.07	0.31	-0.11	0.34	2.94*
Study 2							
Q. binge drinking	4.51	1.76	5.12	1.70	3.95	1.63	3.85**
Q. Exp. Pos. Exp.	4.69	0.97	4.65	0.87	4.71	1.05	-0.37
O. drinks consumed	0.58	0.87	0.71	0.83	0.47	0.90	1.50
Implicit associations	-0.60	0.66	-0.70	0.52	-0.53	0.77	-1.38
Study 3							
Q. binge drinking	5.07	1.43	5.63	1.19	4.53	1.44	5.92**
Q. Exp. Pos. Exp.	4.74	0.79	4.80	0.70	4.67	0.87	1.16
O. drinks consumed	2.98	1.96	4.17	1.71	1.83	1.44	10.47**
Implicit associations	0.04	0.38	0.05	0.38	0.02	0.37	0.54

P* < 0.01; *P* < 0.001. Q: questionnaire data; O: observed data; Exp. Pos. Exp.: explicit positive expectancies.

groups consisted of eight people (16%); and two groups consisted of five people (5%). Participants were recruited at the university campus. Abstainers and students younger than 18 years were excluded.

Procedure

Participants were invited to come with five to seven friends to our laboratory bar [15] on weekdays between 4.30 p.m. and 9 p.m. We used group discussions as a cover for the real aim of the study: measuring their alcohol consumption. The break between the two tasks was 45 minutes; in all other aspects, the procedure resembled that of studies 1 and 2. Each group received a €30 reward after participation. Participants who consumed alcohol were offered a taxi home. The protocol was approved by the Ethical Committee of the Faculty of Social Sciences, Radboud University [36].

Measures

Observed alcohol consumption

The number of alcoholic drinks consumed in the laboratory bar was counted by the bartender and recorded on camera. In the case of unfinished drinks, the bartender subtracted the remaining volume from the total number of drinks that a participant consumed. In order to deal with the skewed data, we log-transformed the drinking measure.

The same measures for binge drinking, weekly drinking and explicit positive expectancies (alpha = 0.86 in study 3) used in studies 1 and 2 were also used in study 3. The same version of the IAT was used as in study 1.

Table 2 Frequency distribution of group variables.

	Total <i>n</i>	Men <i>n</i>	Women <i>n</i>
Study 1			
Control condition	42	22	20
Light condition	40	20	20
Heavy condition	33	19	14
Weekly drinking	56	29	27
Study 2			
Control condition	39	18	21
Light condition	41	19	22
Heavy condition	41	20	20
Weekly drinking	57	28	29
Study 3			
Weekly drinking	100	49	51

Weekly drinking groups were constructed based on the median for men and women separately.

RESULTS

Tables 1 and 2 provide descriptive information on the variables in our models for the three studies separately. In study 1, men reported higher levels of binge drinking and consumed more alcohol in the session than women. Women had more negative associations with alcohol than men. In studies 2 and 3, men reported higher levels of binge drinking. In study 3, men drank more alcohol in the session than women. The correlations between implicit and explicit alcohol-related cognitions were positive in studies 1 and 2, while in study 3 the correlation was non-significant (study 1: *r* = 0.24, *P* = 0.01; study 2: *r* = 0.25, *P* = 0.006; study 3: *r* = 0.06, *P* = 0.41). The

correlations between implicit associations and weekly drinking were $r = 0.33$ ($P < 0.001$) in study 1, $r = 0.14$ ($P = 0.12$) in study 2 and $r = 0.14$ ($P = 0.05$) in study 3. The correlations between implicit associations and binge drinking were $r = 0.30$ ($P = 0.001$) in study 1, $r = 0.24$ ($P = 0.01$) in study 2 and $r = 0.09$ ($P = 0.22$) in study 3. Finally, the correlations between self-reported drinking and observed drinking for all three studies were significantly positive (range 0.24–0.47).

Hierarchical regressions: studies 1 and 2

The association between implicit and explicit cognitions and observed drinking and self-reported binge drinking was tested with two hierarchical regression analyses. We controlled for gender, weekly drinking and the drinking behaviour of the confederate regarding observed drinking.

Study 1

Participants consumed more alcohol in the heavy drinking condition compared to the control condition (Table 3). Explicit positive expectancies were associated positively with both observed drinking and binge drinking. Participants with high levels of weekly drinking consumed more alcohol in the session. Implicit associations with alcohol were not related to the amount of observed drinking, but were marginally significant regarding the correlation with binge drinking. Positive associations were related to higher levels of binge drinking. The relation between implicit associations and observed drinking

was not moderated by gender, weekly drinking or the confederate's alcohol consumption.

Study 2

Men and women did not differ significantly in observed drinking, but men reported higher levels of binge drinking than women (Table 3). Participants consumed more alcohol in the heavy drinking condition compared to the control condition. Implicit associations were not related to drinking in the session, but were related to binge drinking. Explicit positive expectancies were related positively to both observed drinking and to binge drinking. Participants with high levels of weekly drinking consumed more alcohol during the session. There was an interaction between the drinking condition and explicit positive expectancies for observed drinking. We examined this interaction by using the median split to group the expectancy variable into low versus high positive expectancies. Simple effects demonstrated that in the heavy-drinking condition ($F_{(1,36)} = 6.30$, $P = 0.01$, $PES = 0.15$), participants with high positive expectancies consumed more than twice as much alcohol [mean = 1.62, standard error (SE) = 0.26] compared to participants with low positive expectancies (mean = 0.68, SE = 0.24).

Study 3

We conducted regressions in Mplus in controlling for the clustered sampling to ensure that the values were not inflated by group structure [37].

Table 3 Associations between implicit and explicit alcohol cognitions, condition and observed alcohol consumed and self-reported binge drinking: study 1 and study 2.

	Observed alcohol			Binge drinking		
	B	SE B	B	B	SE B	B
Study 1						
Sex	-0.08	0.03	-0.22*	-1.10	0.32	-0.30**
Control versus light	0.03	0.04	0.07	-	-	-
Control versus heavy	0.12	0.04	0.30**	-	-	-
Implicit associations	-0.06	0.05	-0.12	0.90	0.48	0.17 [†]
Exp. Pos. Exp.	0.03	0.01	0.17*	0.38	0.14	0.23**
Weekly drinking	0.09	0.04	0.24*			
Study 2						
Sex	-0.05	0.04	-0.12	-1.34	0.28	-0.38***
Control versus light	0.07	0.04	0.17	-	-	-
Control versus heavy	0.22	0.04	0.52***	-	-	-
Implicit associations	0.02	0.03	0.07	0.56	0.22	0.21*
Exp. Pos. Exp.	0.04	0.02	0.17*	0.62	0.15	0.34***
Weekly drinking	0.08	0.04	0.20*			

Observed study 1: $R^2 = 0.30$; study 2: $R^2 = 0.33$ step 1; $\Delta R^2 = 0.06$, $P = 0.007$. Binge study 1 $R^2 = 0.40$; study 2: $R^2 = 0.51$; $\Delta R^2 = 0.02$, $P = 0.051$. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; [†] $P = 0.064$. Exp. Pos. Exp. = explicit positive expectancies; SE: standard error.

Table 4 Associations between implicit and explicit alcohol cognitions and observed alcohol consumed and self-reported binge drinking: study 3.

	<i>Observed alcohol</i>			<i>Binge drinking</i>		
	<i>B</i>	<i>SE B</i>	<i>B</i>	<i>B</i>	<i>SE B</i>	<i>B</i>
Study 3						
Sex	-0.19	0.05	-0.35***	-1.05	0.16	-0.37***
Implicit associations	0.03	0.03	0.04	0.23	0.30	0.06
Exp. Pos. Exp.	0.01	0.03	0.03	0.40	0.12	0.22**
Weekly drinking	0.26	0.05	0.43***			

** $P < 0.01$; *** $P < 0.001$; † $P = 0.06$. Exp. Pos. Exp.: explicit positive expectancies; SE: standard error. In study 3, we accounted for the clustered sampling.

The model was saturated, so fit indices are not provided. When the clustered aspect of the data was corrected for (i.e. the grouping structure), the findings showed that men consumed more alcohol in the observed session and reported higher levels of binge drinking than women (Table 4). Also, higher levels of explicit positive expectancies were related to higher levels of self-reported binge drinking but not to observed drinking. Implicit associations were related neither to observed drinking nor to binge drinking. Participants with high levels of weekly drinking consumed more alcohol in the observed sessions. The relation between implicit associations and observed drinking was not moderated by gender or weekly drinking. The analyses for observed drinking were also conducted without controlling for weekly alcohol consumption. The results were similar to analyses in which we controlled for weekly alcohol consumption.

DISCUSSION

The three studies presented in this paper are, to our knowledge, the first to test the associations between implicit and explicit alcohol-related cognitions and observed drinking behaviour in *ad-libitum* social drinking settings. Clearly, the results revealed that implicit cognitions as measured by two versions of the IAT were not predictive of observed drinking levels of young adults, even though associations were found with self-reported binge-drinking. Explicit positive expectancies were related to observed drinking in two out of three studies. The essential advantage of the three studies is that the relation between explicit and implicit alcohol-related cognitions and observed alcohol consumption was tested systematically in *ad-libitum* (semi)naturalistic drinking settings. By using unobtrusive measures of drinking behaviour, such as 'real-life' observations, problems with potentially biased retrospective self-report were prevented.

Our findings failed to support the hypothesis that implicit alcohol cognitions are related to observed

drinking. In three separate studies, this association was not significant. Conversely, we gained more support for the role of explicit expectancies, as we found an association between positive expectancies and observed drinking in two studies. In studies 1 and 2, we found that individuals with higher scores on explicit positive expectancies consumed more alcohol in the observational session controlled for peer drinking in a dyadic drinking setting. Explicit expectancies are individual perceptions of outcomes of drinking—in this case, positive outcomes. Our findings thus emphasize the relevance of positive explicit expectancies in the attempt to explain alcohol consumption in social settings. In a social drinking context, the subjective expectation of drinking might be a more germane factor than the implicit associations.

The lingering question is why implicit associations as measured by two different IAT versions were not related to observed drinking. We have a few potential explanations for the lack of relation between implicit cognitions and observed drinking. First, previous studies have shown clearly that when people are in a social drinking setting, their drinking levels are affected strongly by that of the company they keep [23,24,38,39]. Mechanisms of norm-setting and social conformity, as well as behavioural imitation [40,41], might be so dominant that they over-ride many other potentially influential variables. In most correlational and experimental research on implicit associations and alcohol use, scholars do not take the social nature of drinking into account which, in fact, might explain the discrepancies in findings. Along these lines, an explanation for the lack of associations between implicit cognitions, on one hand, and observed alcohol intake, on the other hand, in study 3 lies probably in the relatively strong impact of the friend group members on participants' individual drinking levels. The characteristics of the friend group and the group dynamics during the break possibly affected the quantity of drinking of each group member, which might have over-ruled individual predictors of alcohol consumption, such as a person's implicit associations with alcohol. The high

intraclass correlation (0.70) implies that 70% of the variance in participants' alcohol consumption levels in the laboratory could be explained by group effects. Future research should attempt to unravel these group effects, which was impossible for us due to not enough power. Secondly, strong context effects have been demonstrated regarding the predictive value of implicit measures [42–45]. For example, when overweight participants were primed with health concepts their food-related associations were negative, but when they were primed with restaurant words, their food-related associations were positive [44]. In our study, the stimuli used in the IAT (e.g. alcoholic or soda) might have failed to activate the relevant alcohol associations related to the social drinking context. Also, the IAT and observed drinking was measured in different rooms. Thirdly, we used two different versions of the IAT (i.e. unipolar and bipolar). Effect sizes reported in two meta-analyses [6,12], representing the relationship between IAT and self-reported drinking, are generally higher than those found in the current three studies. In the regression model in study 3, we did not find significant associations between IAT and self-reported binge-drinking. However, when using the unipolar in study 1 (marginally significant: $P = 0.06$) and bipolar IAT in study 2, we found an association comparable to the effect sizes reported in the meta-analyses [6,12]. As many versions of the IAT exist [46], we cannot rule out that other assessments of implicit associations are indeed related to observed drinking. Future studies might profit from using a battery of IAT versions to test if and which aspects of implicit associations drive alcohol use. However, if different versions are used it cannot be ruled out that the different IAT variants assess different underlying constructs related to drinking. Also, other factors such as familiarity with the items used may influence response time [47]. Finally, studies indicate that implicit associations have the highest predictive value in situations where executive control abilities and motivation to control were poor [13,14]. Drinking in a laboratory bar is not habitual, as participants have never been there before. An advantage of applying *ad-libitum* drinking rather than self-reports is that self-report measures may be prone to intentional or unintentional reporting errors. For *ad-libitum* drinking to be a valid proxy of real-life drinking, it is crucial to create a naturalistic environment to avoid the drinking levels being influenced by the research context. In two earlier studies, we investigated the influence of another person's drinking on individual drinking levels in a real bar. In these studies, the findings in terms of drinking behaviour (unfortunately, we did not assess implicit cognitions) were similar to what we have found thus far in studies conducted in a laboratory bar (Larsen *et al.*, in press). This indicates that the behaviour observed in the laboratory bar seems to resemble real-life

drinking behaviour. However, even though the laboratory bar has good external validity in a narrow sense, which is also indicated by the positive correlations between observed and self-reported drinking (once you are in the bar, you behave accordingly), it is a momentary assessment and people may still realize that they are in a university setting. The notion of being in a university setting may induce more motivation to control one's drinking behaviour compared to the notion of being in a real leisure-time setting outside university. Therefore, it is possible that the awareness of being at a university bar might have increased (some) students' motivation to control their drinking which, in turn, made it difficult to detect associations between implicit cognitions and observed drinking. In future studies, this should be tested by conducting these types of studies in a real bar and not at university.

The generalizability of the present findings is restricted to college and university students and young adults. Future research should reveal whether findings are similar in other samples, such as younger adolescents and non-student populations. Moreover, as automatic processes are likely to be triggered more easily and linked strongly to craving and alcohol use in heavy users [48,49], research focusing only on heavy drinkers is warranted. It is possible that implicit associations are more important regarding the drinking of problem-drinking individuals, whereas explicit positive expectancies may predict non-problematic social drinking more clearly. Moreover, we assessed drinking levels during a shorter time-period for drinking occasions. Normally, young people go out for a longer time-period and often visit more than one drinking setting. This complexity of social environments, however, can hardly be examined systematically in a research project. Future studies might use a combination of methods, such as inviting people into the laboratory bar twice and letting them interact with both strangers and peers in an experimental design, and after these sessions following them in various drinking contexts for a couple of weeks by use of electronic diaries on the internet [50], wireless personal digital devices [51] or short message system (SMS) technology [52]. This would allow very specific examination of which, and how, implicit associations are related to (i) observed drinking under controlled circumstances and (ii) drinking in various real-life contexts while acknowledging the interdependence and complexity of drinking situations. In conclusion, the findings of three studies on observed drinking in a (semi)naturalistic setting suggest that in these samples explicit positive expectancies rather than implicit associations might be related to observed social drinking. Future studies should test these associations using different implicit measures, in real bars outside the university context and with problem drinkers.

Declarations of interest

The authors declare that they had no conflicts of interest with respect to their authorship or the publication of this paper.

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