Cognitive Biases for Social Alcohol-Related Pictures and Alcohol Use in Specific Social Settings: An Event-Level Study

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Background: Alcohol use occurs mainly among friends, in social contexts, and for social reasons. Moreover, cognitive biases, such as attentional and approach biases, have repeatedly been associated with alcohol use. This study aimed to test whether nondependent drinkers display cognitive biases for social alcohol-related (SA) pictures and whether these biases are associated with alcohol use in social drinking contexts.

Methods: The visual dot probe task and stimulus–response compatibility tasks were used to measure attentional and approach biases for alcohol-related pictures at baseline. Event-level alcohol use was measured using Ecological Momentary Assessments via personal smartphones. One hundred and ninety-two young adults (51.6% men; M_{age} = 20.73) completed the study, resulting in 11,257 assessments conducted on Thursday, Friday, and Saturday evenings for 5 consecutive weeks.

Results: While no overall attentional bias for alcohol-related pictures was found, young adults showed an approach bias for both social and nonsocial alcohol-related pictures. Multilevel models revealed no direct association between cognitive biases for alcohol-related pictures and alcohol use. However, higher levels of attentional bias for SA pictures were associated with more drinking when individuals were surrounded by a greater number of friends of opposite gender. Higher levels of an approach bias for SA pictures were associated with more drinking in women surrounded by a greater number of friends of the same gender.

Conclusions: In a nondependent sample, cognitive biases for SA pictures could not be associated with drinking directly. However, a cognitive bias for SA pictures moderated the association between alcohol use and number of friends present. As most observed effects were gender and situation specific, replication of these effects is warranted.

Key Words: Alcohol Use, Cognitive Bias, Young Adults, Event-Level.

ALCOHOL USE INCREASES dramatically during adolescence and young adulthood (Johnston et al., 2012; Poelen et al., 2005). Thirty to forty-five percent of young adults report binge drinking, making alcohol use one of the most prevalent health-threatening risk behaviors (Miller et al., 2007). Social aspects of drinking (e.g., social drinking context or peer influences) are associated with alcohol use (Dallas et al., 2014; Engels et al., 1999; Thombs et al., 1997). In addition, implicit cognitive biases, such as attentional and approach bias for alcohol-related stimuli, have been repeatedly found in heavy drinkers and alcohol-dependent individuals (Field et al., 2008; Townshend and Duka, 2001; Wiers et al., 2007). The aim of this study was to integrate these research domains by testing cognitive biases for alcohol-related pictures that include social content and by testing potential associations of these cognitive biases with alcohol use in social drinking contexts.

Alcohol use may be regarded as a form of social behavior, as it mainly occurs in social contexts (e.g., parties, bars) and with social company (Engels et al., 1999). Environmental factors in this social drinking context, such as being with drinking friends or intoxicated people, are predictive of heavy drinking (Clapp and Shillington, 2001). Studies have also indicated that more alcohol is consumed in larger groups (Cullum et al., 2012). Using experimental designs in a so-called bar-laboratory, young adults were found to imitate social drinking partners (Larsen et al., 2010a,b) and movie actors (Koordeman et al., 2011).

In addition to social factors, implicit processes such as cognitive biases for substance-related stimuli play an important role in substance use (Franken, 2003; Reich et al., 2010; Rook et al., 2008). According to the incentive sensitization theory (Robinson and Berridge, 1993), a cognitive bias is the result of Pavlovian conditioning. After repeated substance use, substance-related stimuli acquire incentive salience; they become more attractive, attention grabbing (i.e., attentional

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bias), and able to elicit behavioral approach tendencies (i.e., approach bias) (Robinson and Berridge, 2008; Wiers et al., 2007). A large body of literature has indicated that a cognitive bias, such as an attentional or approach bias, is a prominent factor in heavy alcohol use, and it could be the target of interventions in the addicted population (Cox et al., 2003; Dickter et al., 2014; Field and Powell, 2007; Schoenmakers et al., 2008; Wiers et al., 2007).

Yet, it has also been found that cognitive biases are less prominent in nondependent social drinkers (Field et al., 2008; Townshend and Duka, 2001), probably because the incentive sensitization process has not yet occurred. However, since nondependent drinkers mainly drink in social settings, conditioned alcohol-related stimuli could be paired with social contexts. Therefore, nondependent drinkers may not react to alcohol-related stimuli per se, but only when the alcohol is depicted in a context that is familiar. In addition, cognitive biases to these specific social alcohol-related (SA) stimuli may become particularly relevant when individuals are in a social drinking context, where these biases can directly trigger drinking behavior. Revealing such implicit cognitive process may help us to get more insight in nondependent social drinking. To our knowledge, no study has investigated cognitive biases for SA pictures in a sample of nondependent social drinkers. Two previous studies investigated attentional biases for alcohol-related pictures depicting humans, but only in alcohol-dependent students and escape drinkers, who drink to avoid negative mood. These studies found an overall attentional bias for SA pictures (Dickter et al., 2014) and an initial orientation toward SA pictures followed by a maintained orientation toward pictures depicting alcohol-only in escape drinkers (Forestell et al., 2012). Given these findings, it seems promising to examine whether biases for SA pictures could be revealed in a more general nondependent social drinking population.

In addition, within a social drinking context, gender differences in alcohol use have been repeatedly found. Men drink more, cause more drinking-related problems to themselves and their social surroundings, and are less likely to abstain compared with women (Holmila and Raitasalo, 2005; Nolen-Hoeksema, 2004). Furthermore, men and women drink for different reasons (Kuntsche et al., 2006). Men are more likely to engage in heavy drinking within social settings (Gonzalez et al., 2009; Lied and Marlatt, 1979) and to imitate drinking behavior compared with women (Koordeman et al., 2011). These gender differences suggest that alcohol use by men and women in social settings may be caused by different underlying mechanisms.

The first aim of this study was to investigate attentional and approach biases for alcohol-related pictures including social content in a large group of young adults. Given that young adults drink mainly in social settings, we hypothesized that (i) young adults show a cognitive bias for alcohol-related pictures and that the bias is more pronounced for pictures showing alcohol in a social context as compared to a nonsocial context. Second, we aimed to relate these cognitive biases for alcohol-related pictures to real-life alcohol use in social drinking settings. One previous study examined the relation between cognitive biases and alcohol use by looking at automatic associations to alcohol words, measured with an implicit association task, and alcohol use as measured in a bar-laboratory (Larsen et al., 2012). This study did not reveal significant relationships between automatic associations and alcohol use in the bar-laboratory. Using stimuli that are more familiar to these social drinkers, that is, SA pictures instead of plain alcohol words, automatic associations in the form of an attention or approach biases may be revealed, and these may then be associated with alcohol use in a real-life setting. In addition to the use of different stimuli and different tasks, drinking in a social setting was not measured in the bar-laboratory as was done in the study of Larsen and colleagues (2012), but in the current study alcohol use was recorded in the individuals' real-life, with the use of Ecological Momentary Assessments (EMA). This method allows the researchers to obtain reliable data on the drinking behavior outside the laboratory (Kuntsche and Labhart, 2013a,b). Information on drinking behavior and social company was assessed during weekend nights (Gmel and Daeppen, 2007). It was hypothesized that (ii) a cognitive bias for SA pictures will be directly associated with alcohol use when participants are in a social situation with friends. Last, it was hypothesized (iii) that the strength of SA biases will influence the association between alcohol use and the number of friends present in a given situation.

MATERIALS AND METHODS

Procedure

Participants were recruited through (online) advertisements. A baseline assessment was scheduled in the bar-laboratory of the Radboud University. Participants were asked to be fully sober to exclude acute alcohol effects during testing (Fernie et al., 2012; Schoenmakers et al., 2008). A breath analyzer (Alcoscan AL9010; Healthy retail BV, Ermelo, the Netherlands) was used to verify alcohol abstinence. Participants completed the questionnaires first, followed by the attentional- and approach-bias tasks. Task order was counterbalanced over participants. Finally, participants were informed about the EMA data collection. The EMA data collection started on the first Thursday after the baseline assessment. Participants received 6 emails (9 PM, 10 PM, 11 PM, midnight, 1 AM, and the next morning at 11 AM) on their smartphones containing a hyperlink to a small online questionnaire every Thursday, Friday, and Saturday for 5 consecutive weeks (Kuntsche and Labhart, 2013a,b). Each questionnaire consisted of 4 small questions assessing the participants' alcohol use during the preceding 60 minutes. During these assessments, participants were asked to indicate how much they were drinking for several types of drinks, where they were drinking, with whom they were drinking, and how they were feeling. The morning assessment included the same questions pertaining to time from 1 AM until the next morning and was supplemented with a question assessing bedtime to calculate response rates. Of the 15,150 questionnaires sent, 750 questionnaires (5%) from the excluded participants were removed. Incomplete questionnaires (N = 1,932, 13.4%) and questionnaires completed more than 6 hours after the distribution of the questionnaire were excluded from analyses to minimize recall bias

(N = 1,211, 8.4%), resulting in 11,257 momentary assessments (74.3% of the total questionnaires sent).

Participants who completed the baseline assessment and at least 75% of the EMA questionnaires received €50. All participants provided informed consent. The ethics committee of the Faculty of Social Sciences at Radboud University (ECG2013-1308-117) approved the study.

Participants

Inclusion criteria were (i) being aged between 18 and 25 years, (ii) using alcohol at least weekly, and (iii) being in the possession of a smartphone with 3G Internet access. Five participants were excluded because they completed less than one-fourth of all questionnaires (2.5%) and 5 additional participants were excluded due to participation in another study using the same pictures (2.5%). This resulted in a final sample of 192 participants (93 women, 99 men), all students, with a mean age of 20.73 years (SD = 1.72). The excluded participants did not significantly differ from the included participants on cognitive biases and problematic or weekly drink scores (results not shown but available from the first author).

Measures at Baseline (Individual Level)

Alcohol Use: Participants were asked on which of the previous 7 days they had consumed alcohol and, if so, how many drinks. The sum score was used as a measure of weekly drinking. Furthermore, problematic alcohol use was measured with the Alcohol Use Disorders Identification Test (AUDIT) (Saunders et al., 1993).

Attentional Bias: A visual probe task (VPT) was used to measure attentional bias (MacLeod et al., 1986; Schoenmakers et al., 2008). The task consisted of 4 picture categories, SA pictures, social soda-related (SS) pictures, nonsocial alcohol-related (NA) pictures, and nonsocial soda-related (NS) pictures. In the nonsocial pictures, alcoholic or soda drinks were depicted without any context. In the social pictures, a social drinking setting was displayed in which human interaction was shown in addition to the alcohol and soda drinks (Fig. 1). Pictures were presented in pairs, containing 1 alcohol-related and 1 soda picture. The total stimuli set consisted of 12 social and 12 nonsocial picture pairs. The tasks started with 8 practice trials. Each trial started with a fixation-cross displayed for 1,000 ms, followed by a 2,000-ms presentation of a picture pair. After the disappearance of the pictures, an arrow, pointing up or down, replaced either the alcohol or the nonalcohol picture. Participants were instructed to indicate the direction of the arrow by pressing the "up" or "down" key as quickly and accurately as possible. The arrow remained on the screen for a maximum of 2,000 ms or until the participant responded. Arrow orientation, that is, up or down, varied randomly over trials (Schoenmakers et al., 2008). To ensure that, pictures and arrow location, that is, left/right, were fully counterbalanced within participants. Specifically, in every block (i.e., a social and a nonsocial block), every picture was presented 4 times in total, resulting in 48 trials per block. Moreover, block order (i.e., social/nonsocial or nonsocial/social) was counterbalanced over participants. To calculate bias scores, mean reaction times to respond to an arrow at the same location as the alcohol-related pictures were subtracted from the mean reaction times to respond to an arrow at the location of the soda pictures for social and nonsocial pictures separately. In line with previous studies (Ataya et al., 2012), internal consistency of social and nonsocial picture pairs was poor (Cronbach's α = 0.109 and α = 0.266, respectively).

Approach Bias: The stimulus–response compatibility (SRC) task was used to measure alcohol approach bias (Field et al., 2011). The task consisted of the same 4 picture categories as the VPT (i.e., SA, SS, NA, NS; each represented by 8 pictures). The task started with 10 practice trials. Each trial started with a fixation-cross displayed for 1,000 ms, followed by a 2,000-ms presentation of the picture presented with a manikin randomly positioned above or below the picture. Responses were given by pressing the "up" and "down" keyboard buttons, moving the manikin in that direction. After incorrect responses, a red cross was presented on the screen for 2,000 ms. The social and the nonsocial pictures were presented in separate blocks, which consisted of 2 sub-blocks that varied in instructions. During "approach alcohol," participants were instructed to approach the pictures that depicted alcohol and to avoid the soda pictures. During "avoid alcohol," the instructions were reversed. All pictures were presented twice within a block, resulting in 32 trials per block (128 trials total). Context and instructions were counterbalanced over participants. For every picture category (i.e., SA, SS, NA, NS), a separate approach-bias score was calculated by subtracting the mean reaction time in the avoid block from that in the approach block. Cronbach's alpha coefficients were calculated for the difference scores (i.e., avoid minus approach) for all picture categories, showing poor internal consistency (SA α = 0.523, SS α = 0.572, NA α = 0.501, NS α = 0.414).

Ecological Momentary Assessments (Situational Level)

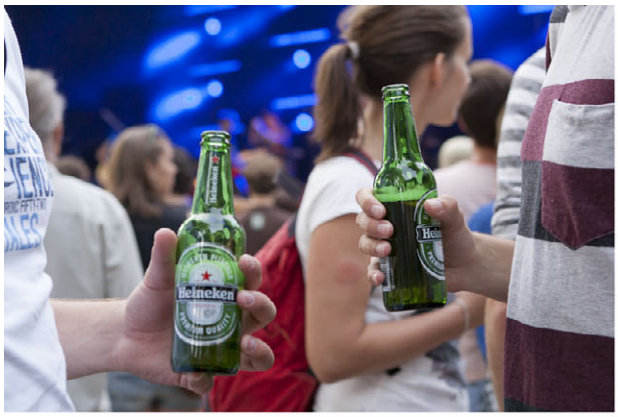
Alcohol Use: Alcohol use quantity was assessed with the question: "How many of the following drinks have you consumed between …"? with "beer," "wine," "strong liquor," "soda" as subquestions. Response categories were "0," "1," "2," "3," "4," or "5 or more." The "5 or more" category was chosen to adjust the questionnaires to the relatively small screens of smartphones. This category was recoded to a score of 5.5 for the analyses. Responses to "beer," "wine," and "strong liquor" were summed to represent alcohol use during a given time period.

Drinking Company: Drinking company was assessed with the following question: "In which company have you been?," with response categories "male friends," "female friends," "family," "unknown," or "other." The participants could respond by indicating a "0," "1," "2," "3," "4," or "5 or more" for every type of company. The number of female and the number of male friends were used as variables in our models as a proxy for social drinking context.

Statistical Analyses

The data from error trials (VPT 3.8%; SRC 4.4%) and outliers (defined as trials with reaction times 3 SDs below or above the mean; VPT 1.1%; SRC 2.2%) (Forestell et al., 2012) were excluded. First, to examine attentional and approach biases, 2 separate 2 × 2 repeated-measures analyses of variance (ANOVAs) in SPSS 19 (IBM, New York, NY) were used with two 2-level factors, that is, drink (alcohol, nonalcohol) and context (social, nonsocial). Pearson correlations were used to examine the relationship between cognitive bias scores and weekly drinking and AUDIT scores.

Second, to examine the links between cognitive biases and event-level alcohol use in the company of female or male friend, multilevel regression models were estimated for the 2 cognitive biases separately using Mplus (Muthén and Muthén, 2007). Individual-level variables were gender, age, and cognitive bias scores (for each category: SA, SS, NA, NS). To improve interpretation of model output parameters in Mplus, cognitive bias scores were analyzed in seconds instead of milliseconds. Situation-level variables included "number of alcoholic drinks," "number of male friends," and "number of female friends." Day and time were entered as covariates at the situational level. Third, to investigate the moderating effect of cognitive biases on the strength of the association between the amount of alcohol use and number of female or male friends present, cross-level interactions were estimated for the 2 tasks separately. In line with previous EMA studies (Smit et al., 2015), and because of known differences in alcohol use between men and women (Holmila and Raitasalo, 2005; Nolen-Hoeksema, 2004), all multilevel regression models were estimated separately for males and females.



Social alcohol-related picture (SA)

Social soda-related picture (SS)

Nonsocial alcohol-related picture (NA)

Nonsocial soda-related picture (NS)

Fig. 1. Examples of picture categories.

RESULTS

Baseline Assessment

Descriptives and Correlations with Baseline Measures. Participants consumed on average 17.03 (SD = 13.13) drinks per week and had a mean AUDIT score of 12.79 (SD = 5.55). No significant correlations were found between either attentional-bias or approach-bias scores and weekly alcohol use and AUDIT scores (Table 1).

Attentional Bias. Mean reaction times and standard deviations per picture category are depicted in Fig. 2. To test the first hypothesis of an attentional bias to social and nonsocial alcohol pictures, a 2 × 2 repeated-measures ANOVA was performed and revealed a main effect of context, $F(1, 189) = 19.39$, $\eta_p^2 = 0.093$, $p < 0.001$, with slower reaction times for social pictures compared with nonsocial pictures. No main effect of drink, $F(1, 189) = 0.13$, $\eta_p^2 = 0.001$, $p = 0.737$, and no drink × context interaction effect was found, $F(1, 189) = 0.41$, $\eta_p^2 = 0.002$, $p = 0.523$.

Approach Bias. See Fig. 2 for mean reaction times. To test approach biases to social and nonsocial alcohol pictures, a 2 × 2 repeated-measures ANOVA was performed, which showed a main effect for drink, $F(1, 191) = 21.94$, $\eta_p^2 = 0.103$, $p<0.001$, but not for context, $F(1, 191) = 0.422$, $\eta_p^2 = 0.002$, $p = 0.517$. Overall, participants showed a larger approach bias to alcoholic pictures compared with soda pictures. The drink × context interaction effect approached significance, $F(1, 191) = 3.494$, $\eta_p^2 = 0.018$, $p = 0.063$. To further explore this trend interaction effect and investigate gender differences, post hoc tests were performed for men and women separately. Across men, significant effects of the type of drink in both the social, $F(1, 98) = 8.32$, $\eta_p^2 = 0.078$, $p = 0.005$, and nonsocial context, $F(1, 98) = 4.39$, $\eta_p^2 = 0.043$, $p = 0.039$, were found, showing a larger approach bias for alcoholic drinks compared with soda. No significant effect of context was found for alcohol pictures, $F(1, 98) = 0.35$, $\eta_p^2 = 0.004$, $p = 0.555$, showing that the alcohol approach bias for men was the same in social and nonsocial contexts. The social context also did not influence the approach bias for soda pictures, $F(1, 98) = 0.93$, $\eta_p^2 = 0.009$, $p = 0.337$. Among women, a significant effect of the type of drink in the social, $F(1, 92) = 12.30$, $\eta_p^2 = 0.118$, $p = 0.001$,

Table 1. Correlations of Weekly Alcohol and AUDIT Scores with the Cognitive Bias Scores for Men and Women Separately

	Weekly drinking				AUDIT			
	Men		Women		Men		Women	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Attentional bias								
SA	0.026	0.800	0.153	0.145	0.086	0.395	0.120	0.255
SS	0.022	0.830	0.139	0.187	0.078	0.443	0.093	0.381
NA	−0.106	0.297	0.087	0.411	0.020	0.846	0.142	0.179
NS	0.004	0.972	0.027	0.796	0.043	0.676	0.143	0.173
Approach bias								
SA	0.082	0.421	−0.066	0.531	0.079	0.436	0.174	0.095
SS	0.061	0.550	−0.058	0.548	−0.020	0.848	−0.063	0.548
NA	0.013	0.901	0.120	0.253	−0.042	0.680	0.181	0.083
NS	−0.127	0.210	−0.064	0.542	−0.121	0.231	−0.058	0.578
Weekly drinking					0.630	<0.001	0.391	<0.001

SA, social alcohol-related; SS, social soda-related; NA, nonsocial alcohol-related; NS, nonsocial soda-related; AUDIT, Alcohol Use Disorders Identification Test.

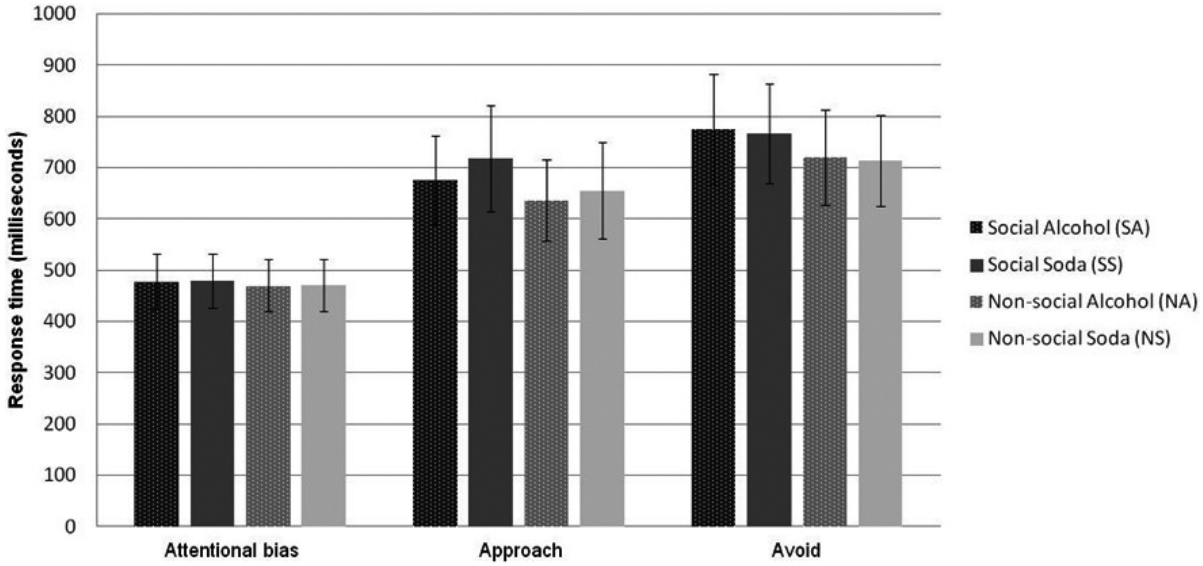


Fig. 2. Mean response times per picture category for both attentional bias (visual probe task) and approach bias (stimulus-response compatibility task). Error bars show standard deviations.

but not in the nonsocial context, $F(1, 92) = 2.51$, $\eta_p^2 = 0.027$, $p = 0.117$, was found, showing a larger approach bias for alcoholic drinks compared with soda only in the social context. A significant effect of context was only found for alcohol pictures, $F(1, 92) = 5.80$, $\eta_p^2 = 0.059$, $p = 0.018$, showing that women had a larger approach bias for alcohol pictures in social contexts compared with the nonsocial contexts, while the social context did not influence the approach bias for soda pictures, $F(1, 92) = 0.44$, $\eta_p^2 = 0.005$, $p = 0.508$.

Ecological Momentary Assessments

Descriptives. Descriptives for the number of drinking situations, alcohol use, and baseline measurement of attentional and approach biases are shown in Table 2 for men and women separately. Overall, men experienced more drinking situations and when they were drinking, they consumed a greater number of alcoholic drinks compared with women. Participants were more likely to drink around friends of the same gender compared with friends of the opposite gender. Last, women showed higher attentional bias and SA approach bias compared with men.

The results of the multilevel models testing the second hypothesis on the relation of attentional and approach biases with event-level alcohol use are shown in Table 3. Significant associations were found between alcohol use and the number of male and female friends for both men and women. An attentional bias for SS pictures at baseline was directly associated with less alcohol use in men, and an attentional bias for NS pictures was associated with less alcohol use in women. No direct associations between attentional bias for alcohol-related pictures and alcohol use were found.

Table 2. Descriptive Statistics

	Men	Women	*t*	*p*
Situational level (*n*)	5,892	5,365		
No. drinking situations (% of *n*)	2,788 (46.89%)	1,725 (31.93%)	−6.45	<0.001
No. drinks per situation	2.47 (0.88)	1.79 (0.68)	−5.93	<0.001
No. male friends present	2.92 (1.27)	1.54 (1.16)	−7.80	<0.001
No. female friends present	1.39 (1.08)	2.42 (1.13)	6.44	<0.001
Individual level (*n*)	99 (51%)	93 (49%)		
Mean age	20.74 (1.82)	20.73 (1.62)	0.03	0.980
AUDIT	14.63 (6.16)	10.83 (4.00)	5.03	<0.001
Weekly alcohol use	22.09 (14.49)	11.45 (8.86)	6.09	<0.001
SA attentional bias	463.78 (49.85)	494.55 (54.21)	−4.08	<0.001
SS attentional bias	465.19 (48.25)	496.55 (53.17)	−4.26	<0.001
NA attentional bias	457.50 (44.50)	484.87 (54.27)	−3.81	<0.001
NS attentional bias	456.57 (43.11)	486.24 (52.70)	−4.27	<0.001
SA approach bias	86.68 (83.10)	111.84 (85.53)	−2.07	0.040
SS approach bias	42.30 (96.79)	56.44 (100.72)	−0.99	0.322
NA approach bias	80.56 (80.05)	87.30 (79.16)	−0.59	0.558
NS approach bias	52.66 (83.27)	65.05 (91.50)	−0.98	0.327

SA, social alcohol-related; SS, social soda-related; NA, nonsocial alcohol-related; NS, nonsocial soda-related; AUDIT, Alcohol Use Disorders Identification Test.

Numbers in the table are means (standard deviations in parentheses). The described *t*-tests were performed on an aggregated and not situational level.

Table 3. Main Effects of Situational and Individual Factors on the Number of Drinks in a Given Situation, Separate for Gender

	Attention bias				Approach bias			
	Men	*p*	Women	*p*	Men	*p*	Women	*p*
Situational factors[a]								
Male friends	0.398 (0.025)	<0.001	0.165 (0.026)	<0.001	0.379 (0.025)	<0.001	0.174 (0.026)	<0.001
Female friends	0.110 (0.033)	0.001	0.161 (0.014)	<0.001	0.110 (0.033)	0.001	0.160 (0.014)	<0.001
Day	0.045 (0.039)	0.239	0.035 (0.030)	0.255	0.045 (0.039)	0.239	0.037 (0.032)	0.244
Time	0.115 (0.018)	<0.001	0.096 (0.014)	<0.001	0.115 (0.018)	<0.001	0.097 (0.014)	<0.001
Individual factors[b]								
SA	3.812 (2.711)	0.160	−0.150 (1.331)	0.910	−0.432 (0.761)	0.570	0.166 (0.515)	0.748
SS	−5.090 (2.170)	0.019	2.299 (1.649)	0.163	−0.172 (0.581)	0.767	−0.113 (0.294)	0.702
NA	1.232 (1.810)	0.496	0.667 (1.292)	0.606	0.494 (0.782)	0.528	−0.238 (0.466)	0.609
NS	0.802 (1.745)	0.646	−3.542 (1.228)	0.004	−0.549 (0.634)	0.387	−0.329 (0.534)	0.538
Age	0.048 (0.029)	0.101	−0.011 (0.015)	0.452	0.057 (0.026)	0.027	−0.023 (0.019)	0.238

SA, social alcohol-related; SS, social soda-related; NA, nonsocial alcohol-related; NS, nonsocial soda-related.

[a]Adjusted for day (Thursday, Friday, Saturday) and time (from 8 PM to 1 AM) effects.

[b]Adjusted for age effects.

Figures shown are unstandardized regression coefficients (standard errors in parentheses). Attentional and approach biases were tested in 2 separate models, but displayed in 1 table for illustration purposes.

To test the third hypothesis on whether the strength of SA biases influenced the association between alcohol use and the number of friends present in a given situation, cross-level interaction models were performed (see Table 4). In men, the main effect of SS attentional bias was confirmed in these analyses. In women, the stronger the NS attentional bias, the stronger the negative link between the number of female friends present and alcohol use in a given situation. Furthermore, the results showed that stronger attentional bias for SA pictures was associated with a stronger positive link between the number of friends of opposite gender and the amount of alcohol consumed. In other words, stronger NS attentional bias was linked to decreased alcohol consumption when more female friends were present in a given situation, whereas stronger attentional bias for SA pictures was linked to increased alcohol consumption when women were in the presence of greater number of male friends.

Further, the significant interaction term in the approach-bias analyses showed that stronger approach bias for SA pictures in females indicated stronger association between the number of female friends present and alcohol use in a given situation. Last, stronger approach bias for NS pictures in females indicated stronger negative link between the number of female friends present and alcohol use in a given situation.

DISCUSSION

The present study focused on cognitive biases for SA pictures and tested whether these biases measured at baseline were associated with event-level alcohol use in social settings.

Table 4. Cross-Level Interactions on the Moderating Role of Attentional and Approach Biases on the Relation Between the Number of Male/Female Friends and Alcohol Use

	Attentional bias				Approach bias			
	Men	*p*	Women	*p*	Men	*p*	Women	*p*
Main effects								
Situational factors[a]								
Male friends present	0.918 (0.265)	<0.001	0.211 (0.260)	0.418	0.418 (0.067)	<0.001	0.175 (0.045)	<0.001
Female friends present	0.069 (0.262)	0.792	0.320 (0.117)	0.006	0.097 (0.067)	0.149	0.113 (0.030)	<0.001
Day	0.041 (0.034)	0.228	0.045 (0.029)	0.112	0.039 (0.035)	0.254	0.045 (0.031)	0.145
Time	0.101 (0.017)	<0.001	0.085 (0.013)	<0.001	0.100 (0.017)	<0.001	0.089 (0.013)	<0.001
Individual factors[b]								
SA	2.824 (1.785)	0.114	−0.863 (1.115)	0.439	0.144 (0.495)	0.770	−0.591 (0.355)	0.096
SS	−4.572 (1.687)	0.007	1.956 (1.286)	0.128	0.068 (0.481)	0.888	−0.242 (0.268)	0.366
NA	2.707 (1.552)	0.081	−0.126 (1.315)	0.923	0.457 (0.591)	0.439	−0.111 (0.400)	0.781
NS	2.018 (1.558)	0.195	−1.024 (1.045)	0.327	−0.194 (0.581)	0.739	0.084 (0.481)	0.861
Age	0.035 (0.023)	0.116	0.012 (0.016)	0.460	0.042 (0.023)	0.067	0.001 (0.018)	0.973
Cross-level interactions								
Male friends present[a]								
SA	−1.842 (1.201)	0.125	1.971 (0.880)	0.025	−0.343 (0.411)	0.404	0.215 (0.370)	0.561
SS	1.036 (1.050)	0.324	−0.145 (0.957)	0.880	−0.270 (0.312)	0.387	−0.031 (0.269)	0.908
NA	−0.411 (1.135)	0.717	−1.410 (1.076)	0.190	0.121 (0.407)	0.767	−0.040 (0.323)	0.902
NS	0.084 (1.108)	0.940	−0.593 (0.948)	0.532	0.144 (0.291)	0.621	−0.578 (0.250)	0.021
Female friends present[a]								
SA	4.018 (1.212)	0.001	−0.409 (0.530)	0.440	0.175 (0.489)	0.720	0.508 (0.215)	0.018
SS	−2.707 (1.478)	0.067	0.148 (0.688)	0.830	0.078 (0.393)	0.842	0.118 (0.108)	0.273
NA	−0.122 (1.045)	0.907	1.070 (0.546)	0.050	0.037 (0.337)	0.913	−0.116 (0.189)	0.539
NS	−1.121 (1.215)	0.356	−1.116 (0.566)	0.048	−0.034 (0.330)	0.917	−0.019 (0.158)	0.903

SA, social alcohol-related; SS, social soda-related; NA, nonsocial alcohol-related; NS, nonsocial soda-related.
[a]Adjusted for day and time effects.
[b]Adjusted for age effects.
Figures shown are unstandardized regression coefficients (standard errors in parentheses). Attentional and approach biases were tested in 2 separate models, but displayed in 1 table for illustration purposes.

No attentional bias for social or nonsocial alcohol pictures was found. Yet, the findings showed an approach bias for social and nonsocial alcohol pictures. Despite the absence of a generic alcohol-related attentional bias in young adults, individual differences in attentional bias were related to situation-specific drinking behavior. Specifically, higher levels of attentional bias for SA pictures were related to more alcohol use in men and women in the presence of a greater number of friends of the opposite gender. Furthermore, a SA approach bias was associated with more alcohol use in women in the presence of a greater number of female friends.

No attentional bias for NA pictures was found in nondependent drinkers (M_{AUDIT} = 12). This finding is in line with contemporary literature showing attentional bias in alcohol-dependent participants but not in nondependent drinkers (Cox et al., 2003; Dickter et al., 2014; Field and Cox, 2008; Franken, 2003). Furthermore, no attentional bias for SA pictures was found. The incentive sensitization theory would predict an attentional bias for pictures, including social content, as social contexts are strongly associated with drinking among young adults. Moreover, previous studies have found an attentional bias for alcohol-related pictures with human content in nondependent escape drinkers (Dickter et al., 2014; Forestell et al., 2012). It is important for future research to identify people who show attention bias for specific alcohol cues, including social cues, as this information could facilitate the development of more tailored and even personalized treatment approaches. Additionally, attentional bias has been shown to be amplified in more challenging situations, such as during stress or after alcohol priming (Field and Powell, 2007; Schoenmakers et al., 2008). The current study procedures might not have triggered sufficient levels of attentional bias; therefore, it is relevant to validate the findings in paradigms with elevated stress and priming manipulations.

Regarding approach bias, the results contribute to the recent literature on automatic approach tendencies (Wiers et al., 2007) by confirming the existence of an approach bias for alcohol-related pictures in a sample of nondependent drinkers (Janssen et al., 2015). More importantly, for the first time, we demonstrated an approach bias for alcohol-related pictures with social content. These results suggest that incentive sensitization to SA pictures also occurs in social drinkers, increasing the tendency to approach social alcohol scenes and possibly trigger implicit behavior tendencies to use alcohol. Importantly, the interaction with the social context was only found to be a trend effect. Therefore, it cannot be concluded that the approach bias to SA pictures is larger compared with the approach bias to NA pictures.

The second goal was to investigate the associations between attentional and approach biases and actual alcohol use in social settings. In contrast to our hypothesis, the results showed no direct relation between an attentional bias for SA pictures and drinking in a social context. Thus,

individual differences in attentional bias for SA pictures do not seem to be predictive of alcohol use among nondependent social drinkers. The absence of a main effect could represent a true lack of an association or could be due to the low variance and low reliability of attentional bias scores. However, when including the number of friends in the drinking setting in the analyses, the results indicated that higher levels of attentional bias for SA pictures are related to increased alcohol use in men and women when they are with a greater number of friends of the opposite gender. In other words, when people pay more attention to SA pictures, their alcohol consumption will depend on the characteristics of the social drinking context. While no direct effects of SA attentional biases on alcohol use emerged, it seems that in certain social contexts, individual differences in attentional bias may trigger alcohol use. Given the novelty of the current study design, the interaction analyses were explorative. The current findings therefore can be used as a starting point for a new research field investigating the effects of cognitive biases in specific situations. One speculative explanation for the current findings is related to social processes that occur in mixed-gender groups. It has been found that women tend to use alcohol for specific purposes in the company of men, such as for gaining positive attention (LaBrie et al., 2007; Young et al., 2005), and men who drink for coping motives drink more in situations with female friends around, possibly due to an increase in stress levels (Smit et al., 2015). It could therefore be that young adults' drinking in mixed-gender groups demonstrates increased social competition and social stress. Attentional biases for alcohol cues are more pronounced during such challenging situations (Field and Powell, 2007; Schoenmakers et al., 2008), thereby explaining the observed influence of SA attentional bias on drinking in larger mixed-gender groups. Future research could examine different group-consistencies more closely to reveal possible unique mixed-groups drinking dynamics.

Individual differences in alcohol-related approach bias were also not directly related to event-level alcohol use. Nevertheless, women with a stronger social alcohol approach bias consumed more alcohol in the company of a higher number of female friends. This effect may be specific to women as it was found that they have a social-specific alcohol approach bias, whereas men have an alcohol approach bias both to social and nonsocial contexts. Moreover, especially perceived same-sex drinking norms are related to drinking (Lewis and Neighbors, 2004), and individuals will drink more when group size increases and when context specific drinking norms are high (Cullum et al., 2012). Thus, when drinking norms do not support alcohol consumption and women are with a smaller number of friends, SA approach biases do not strongly influence drinking behavior. On the other hand, when drinking norms increase in the presence of a greater number of female friends, the increased tendency to approach social alcohol cues may result in increased drinking. In sum, the results indicated that a SA approach bias might influence drinking in women only in certain social situations. As the current study is the first to show a gender-situation specific relation between approach biases and actual drinking behavior, replication of these results is strongly warranted. If replicated, the insights gained may eventually be used to adapt alcohol approach bias training programs that have been previously found to successfully reduce drinking behavior in dependent drinkers (Wiers et al., 2011) but not in undergraduate social drinkers (Lindgren et al., 2015). For example, training may include SA pictures to target specific populations (e.g., young-adult women who tend to drink in social situations). Moreover, as cognitive biases were found to be particularly important predictors among individuals with relatively weak executive control (Stacey and Wiers, 2010; Wiers et al., 2015), future studies should examine the possible role of executive control on the association between cognitive biases and alcohol use in a social setting. From a theoretical perspective, it can be hypothesized that drug taking behavior is also affected by more controlled processes (Wiers et al., 2007); thus, examining the interplay between automatic and controlled processes within the drinking context seems highly relevant. Another recommendation for future research is to measure state-dependent cognitive biases in the moment, to get more detailed information about the influence of social circumstances on the strength of cognitive biases.

When interpreting the current results, some limitations should be considered. First, the reliabilities of the VPT and SRC tasks were poor. Recently, the limited internal reliability of implicit reaction time tests across the literature has been thoroughly discussed (Ataya et al., 2012). While the complexity of the pictures used in the tasks may have influenced the reliability, our scores appeared to be similar to other studies (Ataya et al., 2012; Emery and Simons, 2015). Poor internal reliability of the cognitive bias measures could have reduced the chances to find significant interaction effects, as these effects are likely to be small in size. As the internal reliability of cognitive bias measures is pivotal for the interpretation of the results, future studies should continue to report the reliability measures and focus on the development of more valid cognitive bias measures. A second consideration in interpreting the results is that brands were included in the pictures, given that without brands it would be difficult to categorize the alcohol and soda pictures (e.g., a glass of water could also be a glass of Vodka). Nevertheless, attentional and approach biases could be affected by brands in the pictures (Plassmann et al., 2012). We aimed to diminish the effect of personal preferences on bias scores by including various brands. Third, it should be noted that the study design does not permit an analysis of causal relationship between cognitive biases and drinking in a social context. Therefore, the question remains whether having a cognitive bias has an effect on the selection of drinking context or whether it affects individuals when they are already in a certain drinking context. Individuals with stronger alcohol-related cognitive biases might be more likely to attend drinking events where they are surrounded

by many friends while individuals without such alcohol-related cognitive biases might drink only in situations with a low number of friends present. These assumptions might have affected the current results. Despite these limitations, measuring behavior with the use of EMA is found to be a very robust and valuable new technique within this research field. Recent literature has proven that measuring in the moment can reveal important insights (Kuntsche and Labhart, 2013a). In addition, combining these momentary drinking behavior assessments with cognitive biases, measured in the laboratory, provides a unique research question. Last, with over 11,000 assessments and low dropout rates, the data have strong ecological validity. Together, the strengths of this study are its innovative design with the unique combination of measuring cognitive biases for SA pictures and the assessment of alcohol use in the event.

CONCLUSION

The current findings suggest that an alcohol-related approach bias rather than attentional bias can be found in young–adult nondependent drinkers. Additionally, cognitive biases for SA pictures were not found to be directly associated with greater alcohol use; however, cognitive biases were moderating the association between alcohol use and the number of friends, in specific social situations. Investigating the complex association between cognitive biases and event-level alcohol use is crucial in alcohol research, as a direct translation between implicit cognitive biases and drinking in daily life may not be straightforward. Instead, social implicit cognitive biases seem to only affect the alcohol use in gender-specific social drinking situations.

CONFLICTS OF INTEREST

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

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