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Is Alcohol-Related Aggression Related to Automatic Alcohol–Power or Alcohol–Aggression Associations?

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Objective: One of the risks of alcohol use is violent behavior. The aim of the current study was to explore the role of automatic cognitive associations between alcohol and power and between alcohol and aggression in alcohol-related aggression and to test the moderating role of executive control. ***Method:*** Implicit association tests (IATs) were used to measure alcohol–power and alcohol–aggression associations in a sample of adolescents. The classical Stroop task was used to assess executive control. The tendency toward alcohol-related aggression was measured via self-report. ***Results:*** Alcohol–power associations predicted self-reported alcohol-related aggression, but there was no significant moderation by executive control. Alcohol–aggression associations did not predict self-reported alcohol-related aggression. Mathematical modeling was used to further explore differences between alcohol–power and alcohol–aggression associations. This analysis tentatively indicated that participants may have had a stronger tendency to overcome the bias in the alcohol–aggression IAT. ***Conclusions:*** Alcohol–power associations, but not alcohol–aggression associations, predicted alcohol-related aggression. Participants appear to exert more control when dealing with aggression- than with power-related alcohol associations, which may therefore better predict alcohol-related aggression. Implicit measures in combination with modeling techniques may be important in further disentangling the automatic processes involved in alcohol-related aggressive behavior, but the relationship between alcohol and power appears to be an essential factor.

Keywords: alcohol, alcohol-related aggression, IAT, power, aggression

Alcohol use is associated with aggression (Bushman & Cooper, 1990). Dual process models may help explain this relationship in terms of the interplay between automatic and controlled processes (Strack & Deutsch, 2004; Wiers et al., 2010). The current study had three aims. First, to test whether automatic associations between alcohol–power and/or alcohol–aggression would predict alcohol-related aggression. Second, to examine the modulatory role of regulatory control. Finally, to use the quadruple process model (hereafter referred to as the *quad model*; Conrey, Sherman, Gawronski, Hugenberg, & Groom, 2005) to explore effects involving parameters of alcohol–power and alcohol–aggression associations.

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The Alcohol–Aggression Relationship

There is a clear association between aggression and alcohol (Bushman & Cooper, 1990), but whether a specific individual shows alcohol-related aggression depends on a complex interaction between disinhibitory pharmacological effects and situational and individual factors that determine whether provocation results in aggression (for review, see Parrott & Eckhardt, 2018). Such relationships can be explained by alcohol myopia theory (Steele & Josephs, 1990): Acute alcohol consumption narrows attention to focus on salient stimuli and reduces the capacity to process their meaning. Alcohol-induced attention to provocative cues leads to negative affect, excessive hostile rumination, and reduced self-awareness, increasing the possibility of aggressive behavior (Giancola, Josephs, Parrott, & Duke, 2010). Of particular interest to the current study, alcohol increases feelings of power (McClelland, 1974; Newlin, 2002), and it may lead to overestimations of the interpersonal "resource holding value" (Parker, 1974), which could also play a role in connecting alcohol myopia to aggressive behavior.

A Dual Process Perspective

The application of dual-process or dual-system models (Strack & Deutsch, 2004) may help to integrate factors involved in alcohol-related aggression. Dual process models posit that information processing in the brain can occur in automatic or controlled ways (Strack & Deutsch, 2004; Wiers & Stacy, 2006). Automatic processes are fast but stimulus-driven, inflexible, and involuntary, and would thus become dominant under the effects of alcohol myopia. One way to study the role of automatic associative processes in alcohol-related aggression is the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). The IAT provides a measure of the strength of memory association between target concepts and emotional attributes. It has been shown that alcohol-related cues are able to activate aggressive thoughts even in the absence of actual alcohol consumption (Bartholow & Heinz, 2006). However, the impact of automatic memory associations on aggressive behavior depends on individual differences in the level of regulatory control (Hofmann, Friese, & Wiers, 2008). In line with this are the findings of a previous study (Wiers, Beckers, Houben, & Hofmann, 2009) in heavy drinking male university students, which examined the role of alcohol–power associations in predicting aggressive behavior after drinking in individuals with high and low executive control. Results revealed that alcohol–power associations were predictive of aggressive behavior after drinking specifically in participants with relatively weak executive control.

The current study aimed to further study alcohol–power associations and executive control in an adolescent population. This is an important group because of their sensitivity to addiction and their relatively immature levels of executive control (Crone & Ridderinkhof, 2011; Gladwin, Figner, Crone, & Wiers, 2011; Huizinga, Dolan, & van der Molen, 2006). Further, we tested whether alcohol–aggression associations would better predict self-reported alcohol-related aggressive behaviors than alcohol–power associations. One could expect aggression to be a more directly relevant emotional association: If individuals automatically associate aggression with alcohol, they could be expected to become more aggressive after drinking. The drinking context would present cues activating memories and schemata related to aggression, skewing perception of others' behavior and biasing one's own responses toward aggression. However, one could also argue that alcohol–power associations are more relevant in the prediction of aggression after alcohol, for three reasons. First, on the basis of the theories described above (e.g., Newlin, 2002), alcohol–power associations may be an important link between drinking and aggression. Further, the desire to be seen as powerful moderated the relationship between alcohol expectancies and alcohol aggression (Quigley, Corbett, & Tedeschi, 2002). Finally, alcohol–aggression associations may also conceivably be more difficult to detect than alcohol–power associations, in case participants are differently motivated or able to overcome biases caused by aggression-related associations. There is a literature on faking the IAT, showing that participants can to some extent manipulate the outcome of their IAT scores, especially when they are motivated to do so (e.g., when trying to hide a socially unaccepted association, De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009). Perhaps in certain samples, aggression is considered socially unacceptable and participants attempt to obscure such tendencies (Banse, Schmidt, & Imhoff, 2016).

As traditional IAT scores reflect a mixture of automatic and controlled processes (Sherman et al., 2008), the third aim of the study was to disentangle these processes using the quad model (Beer et al., 2008; Conrey et al., 2005). Most relevant in the current context is that the quad model can separate: (1) the likelihood that an automatic association between stimulus categories (e.g., alcoholic drinks) and evaluative attributes (e.g., powerful or aggression) is activated and (2) the probability that participants successfully overcome a response bias due to an activated alcohol–power or alcohol–aggression association in favor of the correct response required in the task. We hypothesized that participants would be more motivated to overcome aggression-related than power-related biases, and thus that the alcohol–aggression-IAT would be associated with a higher overcoming-bias likelihood than the alcohol–power-IAT.

In sum, the aims of the current study were to study (1) alcohol–power and alcohol–aggression associations in relation to alcohol-related aggression in adolescents; (2) whether this hinges on available levels of regulatory control; and (3) differences in underlying processes, in particular overcoming biases, using the quad model. Therefore, a convenience sample of adolescents completed an alcohol–power and an alcohol–aggression IAT and also a classical Stroop test as an index for regulatory control. The Dutch version of the Alcohol-Related Aggression Questionnaire (ARAQ; McMurran et al., 2006) was used as an index for aggressive behavior after alcohol use. It was hypothesized that both alcohol–power and alcohol–aggression associations would predict aggressive behavior after alcohol use, that stronger effects would be observed in individuals with low levels of regulatory control, and that participants would be more likely to overcome biases due to alcohol–aggression associations.

Method

Participants

Adolescents ($N = 60$) were drawn from a public secondary school (two education levels: HAVO [higher general secondary education] and VWO [preuniversity education]) in the Netherlands (24 female, 33 male, 3 missing data; ages 15 to 20 years, $M = 16.4$, $SD = 1.05$). Nine participants reported never having used any alcoholic beverages and were excluded from further analyses. Some participants did not complete all questionnaires and tasks to use as many data as possible, for each analysis all available participants were used. The study was approved by the University of Amsterdam's Ethical Committee, and passive informed parental consent was obtained for all participating adolescents.

Materials

IATs. Two IATs were used to assess implicit associations between alcohol and power (alcohol–power-IAT [alc-pow-IAT]; Wiers et al., 2009) and between alcohol and aggression (alcohol–aggression-IAT [alc-agg-IAT]). The sequence of these IATs was randomized. Participants had to classify stimuli, as quickly and accurately as possible, from four categories using two response keys; one categorization concerned *alcohol* versus *soda* and the second concerned either *powerful* versus *weak* (alc-pow-IAT) or *aggression* versus *calm* (alc-agg-IAT). Each category contained four different stimuli (see Table 1), presented in random order. The IATs consisted of five blocks. During the first block, participants practiced categorizing stimuli into the alcohol or soda category (eight trials); in the second block, they practiced categorizing them into the powerful/aggression or weak/calm category (24 trials). In the third block (combination block), participants classified stimuli into both categories (48 trials). Participants pressed one key when

Table 1
Words Used in the IATs Per Stimulus Category

Alcohol	Soft drink	Powerful	Weak	Aggression	Calm
Beer (*Bier*)	Coke (*Cola*)	Powerful (*Krachtig*)	Weak (*Zwak*)	Hit (*Slaan*)	Discuss (*Praten*)
Wine (*Wijn*)	Fanta	Dominant	Defenseless (*Weerloos*)	Insult (*Schelden*)	Tolerate (*Tolereren*)
Bacardi (*Bacardi*)	Sprite	Strong (*Sterk*)	Helpless (*Hulpeloos*)	Fight (*Vechten*)	Talk it out (*Uitpraten*)
Rum (*Rum*)	Milk (*Melk*)	Won (*Gewonnen*)	Lost (*Verloren*)	Attack (*Aanvallen*)	Observe (*Toekijken*)

Note. English translations with the original Dutch stimuli in parentheses. IAT = Implicit Association Test.

stimuli referred to either alcohol or powerful/aggression and another key when they referred to soda or weak/calm. The fourth block (32 trials) was the same as the second block, but from this block forward the powerful/aggression or weak/calm categories changed sides, resulting in opposite response assignments. This reverse assignment consisted of more trials, which makes the IAT effect less sensitive to order effects (Nosek, Greenwald, & Banaji, 2005). In the fifth block (reversed combination block), participants again classified stimuli into all categories simultaneously (48 trials).

Stimuli were presented in the middle of the computer screen. The label 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 response was given. When a correct response was given, the next trial was presented after 400 ms (intertrial interval). When an incorrect response was given, a red square with the text “wrong” was presented for 500 ms and the same trial was presented again, until a correct response was given. The *E* and *I* keys were used as response buttons and key assignment was counterbalanced.

D600 scores were calculated from IAT scores following the standard procedure (Greenwald, Nosek, & Banaji, 2003); additionally, the first trial of each block was removed on the basis of earlier practice analyses conducted at our lab and confirmed by the observation of clearly deviant reaction times (RTs) on the first trials of blocks. Scores were calculated so that higher scores for the alc-pow-IAT reflect stronger associations between “alcohol” and “powerful” (and “soda” and “weak”) as compared with “alcohol” and “weak” (and “soda” and “powerful”) and higher scores for the alc-agg-IAT reflect stronger associations between “alcohol” and “aggression” (and “soda” and “calm”) as compared with “alcohol” and “calm” (and “soda” and “aggression”).

A measure of the internal consistency of the D600 scores in the current sample is given by the correlation between the D600 scores calculated for even and odd trials. For the alc-pow-IAT, the even–odd correlation was 0.38 (p = .003; the correlation corrected for halving the number of trials was 0.55 using the Spearman-Brown prophecy formula). For the alc-agg-IAT, the even–odd correlation was 0.63 ($p < .001$; the corrected correlation was 0.77). In both cases, the different subsets of trials thus generate highly correlated D600 scores. The corrected values are thus comparable to previously reported internal consistencies for the IAT (Banse, Seise, & Zerbes, 2001; Greenwald, Poehlman, Uhlmann, & Banaji, 2009).

Executive functioning: Classical Stroop task. The classical Stroop task (Stroop, 1935) was used to as a general index of executive control. In this task, attention must be endogenously directed to the correct stimulus features rather than be exogenously driven by external stimuli; or, put differently, task-irrelevant information must be inhibited by gating mechanisms that underlie the ability to selectively attend to task-relevant stimulus features (MacLeod, 1991). The current task started with 60 practice trials in which participants indicated as fast as possible the color of squares that were presented in the middle of the screen (red = 1, yellow = 3, green = 5, blue = 7). In the test phase, three types of trials were presented: (1) incongruent color words (red, yellow, green, and blue presented twice in the three other colors, resulting in 24 trials); (2) meaningless signs (* and # presented twice in each color, resulting in 16 trials); and (3) congruent color words (words presented four times in the ink of the same color, resulting in 16 trials). These 56 trials were presented in a random order. Each trial started with a fixation cross presented in the center of the screen for 1,000 ms. Then a stimulus was displayed until the participant reacted. After each trial, feedback was presented (*correct*, *incorrect*, or *too late*). When an incorrect response was given, the same trial was presented again, until a correct response was given.

To calculate a Stroop interference effect on RT, trials with errors and latencies outside the range of 150 and 1,500 ms were discarded. Mean response latencies were calculated for incongruent color word trials and for congruent color word trials of the test phase, and the incongruent–congruent difference was used as an index for executive control capacity. Lower scores thus indicate lower interference costs and higher executive control. An interference effect on errors was calculated as the error rate for incongruent trials minus the error rate for congruent trials so that lower values indicate lower interference costs. Facilitation and interference on the Stroop task are commonly described in terms of both RT and error rate; we therefore studied both performance measures, as neither RT nor accuracy is a theoretically a priori more valid measure, and they may measure different aspects of executive functioning.

Alcohol-related aggression. Proneness to alcohol-related aggression was assessed with the Dutch version of the ARAQ (McMurran et al., 2006). The questionnaire consists of 28 statements regarding aggressive behavior after drinking alcohol. Those statements concern for example drinking and aggression outcome expectancies, the context in which they experience alcohol-related aggression, and what type of beverage they associate with aggression. Participants were asked to indicate whether each statement was *always true for me* (3 points), *mostly true for me* (2 points), *mostly false for me* (1 point), or *always false for me* (0 points). The total score ranges from 0 to 84, and higher scores indicate higher levels of alcohol-related aggression. The total ARAQ score has excellent internal consistency (Cronbach’s α = .96) and good test–retest reliability (Pearson’s r = .70; McMurran et al., 2006). The ARAQ thus has good psychometric properties as an overall measure of alcohol-related aggression, but we also analyzed its four-factor solution subscales: Alcohol-related Aggression (AA; aggression attributed directly to effects of alcohol); Trait Aggression (TA; underlying trait aggression only indirectly associated with alcohol); Drinking Contexts (DC; drinking in contexts where aggressive behavior is likely); and Sensitivity to Pain and Anxiety (SPA). Cronbach's alpha was .94 in the current sample for the total ARAQ score, .93 for AA, .65 TA, .86 for DC, and .56 for SPA.

Aggressive disposition. To assess an individual's disposition to aggressive behavior, we used the Buss–Perry Aggression Questionnaire (BPAQ; Buss & Perry, 1992). The questionnaire comprises 29 items belonging to four categories: physical aggression (PA), verbal aggression (VA), anger, and hostility. On a five-point Likert scale, participants indicated how characteristic of them each described behavior is (1 = *totally uncharacteristic*, 5 = *totally characteristic*). The BPAQ has good internal consistency (Cronbach's alpha ranging from .72 to .85 for subscales). Nine-week test–retest reliabilities varied between .72 to .80 (Buss & Perry, 1992). In the current sample, the alpha coefficient was .85 for physical aggression, .56 for verbal aggression, .84 for anger, and .82 for hostility. The validity of the BPAQ has been supported by correlations with for example assertiveness and peer ratings of aggressiveness (Buss & Perry, 1992).

Alcohol consumption and related problems. The Alcohol Use Disorder Identification Test (AUDIT; Saunders, Aasland, Babor, De La Fuente, & Grant, 1993) was used to assess alcohol consumption and alcohol-related problems. The AUDIT consists of 10 questions regarding quantity and frequency of drinking, drinking intensity, symptoms of dependence and tolerance, and alcohol-related negative consequences over the last 12 months. Total scores range between 0 and 40. Higher overall scores indicate more problematic drinking behavior, and a score of 8 and higher is generally used to identify hazardous drinking. Across several studies, alpha coefficients were approximately .80 (Allen, Litten, Fertig, & Babor, 1997), indicating good internal consistency. In the current study, Cronbach's alpha was .88. Furthermore, the AUDIT was able to identify persons with harmful/hazardous alcohol consumption in 92% of the cases (Saunders et al., 1993).

Procedure

The experiment took place in the school's computer room in groups of 15 to 20 people. Adolescents were informed about the procedure, and they provided written informed consent. The computer program (E-prime Version 2.0) started with the alcohol–power-IAT and alcohol–aggression-IAT (the order randomized across participants). Then the Stroop task was presented, which was followed by the questionnaires. During the experiment participants were allowed to ask questions regarding task instructions or words they did not understand. After the experiment participants received €5 for participation and were debriefed.

Results

Descriptive Data

For the questionnaires, the mean scores and standard deviations were as follows: Overall ARAQ 10.83 (SD = 11.13), alcohol-related aggression 8.00 (SD = 8.28), trait aggression 0.83 (SD = 1.36), drinking contexts 1.00 (SD = 1.49), sensitivity to pain and anxiety 1.00 (SD = 1.29), physical aggression 24.40 (SD = 7.33), verbal aggression 16.42 (SD = 3.32), anger 18.69 (SD = 5.75), hostility 21.77 (SD = 5.64), and AUDIT 7.80 (SD = 6.04). The mean Stroop interference effect was 51.50 ms (SD = 80.83), $t(57) = 5.85$, $p < .001$, for RT and −0.11 (SD = 0.17, $t(57) = 5.71$, $p < .001$, for accuracy. Both the alc-pow-IAT ($M = 0.59$, $SD = 0.43$, $t(45) = 9.31$, $p < .001$) and the alc-agg-IAT ($M = 0.62$, $SD = 0.45$, $t(42) = 8.96$, $p < .001$) had significantly nonzero D600 scores. Correlations between the variables are shown in Table 2. AUDIT, ARAQ, and BPAQ scales had strong positive correlations. Alcohol–power associations, but not alcohol–

Table 2
Correlations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. ARAQ	—													
2. AA	.98**	—												
3. TA	.83**	.75**	—											
4. DC	.73**	.62**	.55**	—										
5. SPA	.64**	.50**	.62**	.57**	—									
6. Pow	.381**	.34*	.468**	.23	.37*	—								
7. Agg	−.007	−.060	.060	.14	.099	.19	—							
8. Stroop RT	.17	.17	.063	.23	.025	.26	−.016	—						
9. Stroop error	−.14	−.17	−.025	−.11	.052	.23	−.12	−.10	—					
10. PA	.43**	.44**	.31*	.32*	.21	.24	.004	.16	.007	—				
11. VA	.17	.22	−.060	.12	−.070	.14	.091	.30*	−.10	.30*	—			
12. Anger	.371**	.382**	.189	.204	.316*	.117	.072	.054	−.058	.606**	.378**	—		
13. Hostility	.273	.263	.070	.286*	.266	.135	.266	.037	−.068	.310*	.196	.514**	—	
14. AUDIT	.388**	.369**	.234	.405**	.265	.117	.049	.114	.041	.270	−.034	.080	.222	—

Note. ARAQ = Alcohol-Related Aggression Questionnaire; AA = Alcohol-related Aggression subscale; TA = Trait Anxiety subscale; DC = Drinking Contexts subscale; SPA = Sensitivity to Pain and Anxiety subscale; Pow = D600 score for the alcohol–power-Implicit Association Test (IAT); Agg = D600 score for the alcohol–aggression-IAT; Stroop RT = Stroop effect on reaction time; Stroop error = Stroop effect on error rate; PA = Physical Aggression subscale of the Buss–Perry Aggression Questionnaire; VA = Verbal Aggression subscale of the Buss–Perry Aggression Questionnaire; AUDIT = Alcohol Use Disorder Identification Test.
* $p < .05$. ** $p < .01$.

aggression associations, were positively correlated with ARAQ scores.

Is alcohol-related aggression related to alcohol–power and alcohol–aggression associations? Linear regression in SPSS was used to address the question of whether self-reported alcohol-related aggression was related to implicit measures of alcohol-related associations. The dependent variables were the ARAQ score and the ARAQ subscale scores. The independent variables were the BPAQ subscale scores, gender, alcohol–power associations, and alcohol–aggression associations. Table 3 shows the parameter estimates for the regression model, $F(7, 33) = 3.056$, $p = .014$. Alcohol–power associations were a significant predictor, but alcohol–aggression associations were not. In follow-up analyses, we performed the same regression analysis for each of the ARAQ subscales, with each analysis using a given subscale as the dependent variable. The same result as for the ARAQ total score, that is, a significant coefficient for alcohol–power associations only, was found for alcohol-related aggression, trait aggression, and sensitivity to pain and anxiety, but not for drinking contexts, for which neither IAT measure was a significant predictor (see Table 3).

Do individual differences in executive control modulate the relationship between alcohol-related aggression and alcohol–aggression associations? To address the question of the role of executive control, we used hierarchical regression analysis to test whether the addition of a set of control-related predictors to the above regression model provided a significant increase in explained variance. Again, the dependent variables were the ARAQ score and subscale scores. In the first step of the model, the independent variables were again the BPAQ subscale scores, gender, alcohol–power associations, and alcohol–aggression associations. In the second step of the model, the following variables were added: the RT measure of Stroop interference, the accuracy measure of Stroop interference, and the interaction terms for the IAT scores with Stroop scores (calculated after centering the separate scores). The second step did not show a significant improvement in explained variance, R^2change $= 0.10$, $F(6, 27) = 0.92$, $p = .50$. These analyses were repeated using each ARAQ subscale as the dependent variable. The second model step remained nonsignificant for all subscales.

To further explore the results, as the relatively high number of variables could well influence individual predictors, we tested the explained variance, additionally to BPAQ subscale scores and gender, of each of the control-related predictors separately. No significant effects were found. We also performed the analysis for each gender separately, as effects on power could be specific to males. However, although this could be due to the resultant small remaining sample size, no significant effects were found.

Quad model: Does the difference between results for alcohol–power and alcohol–aggression associations involve differences in the ability to overcome biases? The regression analyses showed that alcohol–power associations predicted alcohol-related aggression, but alcohol–aggression associations did not. This appears paradoxical—is the alcohol–aggression association not more directly related to alcohol-related aggression? One explanation of the current findings is that participants are more likely to exert control over effects of alcohol–aggression associations, than over effects of alcohol–power associations, for instance because of social desirability. To address this possibility, quad modeling was used to disentangle automatic and control contributions to IAT scores. The quad model is a multinomial model that predicts accuracy on the IAT on the basis of the probabilities of four underlying processes: (1) The likelihood that an automatic association between stimulus categories (e.g., alcoholic drinks vs. soft drinks) and evaluative attributes (e.g., powerful vs. weak) is activated (Association Activation or AC); (2) the likelihood that the correct response to the presented stimulus can be determined (Discriminability or D), that is, the baseline probability of determining the correct response required in the task; (3) the likelihood that an activated association is successfully overcome in favor of the required, correct response (overcoming bias or OB); and (4) the likelihood that a general response bias drives responses when other guides to response are absent (guessing or G). Estimates for these parameters can be found via a set of equations that relate IAT scores to the accuracy on different types of trials in the IAT (for further details, see Conrey et al., 2005).

Table 3
Prediction of Alcohol-Related Aggression Questionnaire (ARAQ) by Implicit Measures of Alcohol-Related Associations

Predictor	Total	AA	TA	DC	SPA
Intercept	−21.38 (9.65)*	−17.39 (7.26)*	−1.17 (1.12)	−2.85 (1.43)	.034 (1.28)
Gender	−2.12 (3.34)	−.830 (2.60)	−.25 (.40)	−.77 (.51)	−.27 (.46)
Physical aggression[a]	.13 (.27)	.081 (.20)	.015 (.031)	.042 (.040)	−.007 (.036)
Verbal aggression[a]	.79 (.53)	.74 (.40)	.024 (.061)	.10 (.078)	−.079 (.070)
Anger[a]	.25 (.39)	.22 (.29)	.021 (.045)	−.049 (.058)	.052 (.051)
Hostility[a]	.35 (.39)	.23 (.29)	−.004 (.045)	.090 (.058)	.038 (.051)
Alc-Pow-IAT	10.98 (3.72)**	7.22 (2.80)*	1.81 (.43)**	.77 (.55)	1.18 (.49)*
Alc-Agg-IAT	−3.74 (3.46)	−3.69 (2.60)	−.16 (.40)	.081 (.51)	.025 (.47)

Note. Values are the coefficients with standard errors in parentheses. AA = Alcohol-related Aggression subscale of the ARAQ; TA = Trait Aggression subscale of the ARAQ; DC = Drinking Contexts subscale of the ARAQ; SPA = Sensitivity to Pain and Anxiety subscale of the ARAQ; Intercept = constant term; Alc-Pow-IAT = D600 score for the Alcohol–Power-Implicit Association Test; Alc-Agg-IAT = D600 score for the Alcohol–Aggression-IAT.
[a] Physical Aggression, Verbal Aggression, Anger, and Hostility are subscales of the Buss–Perry Aggression Questionnaire.
* $p < .05$. ** $p < .01$.

The quad model was fitted to the power and aggression IAT scores, as in Conrey et al. (2005), using Multitree (Moshagen, 2010). For each IAT version, a single AC and a single OB parameter were defined; the D and G parameters were defined for target categories and emotional attributes separately. Constraints of the model were tested using the difference in Akaike information criterion (AIC) between the free and constrained models. We tested the effects of constraining either the AC or the OB parameter to be equal for both IAT versions.

The results of the quad model are shown in Table 4. The goodness-of-fit for the unconstrained model was $G^2(12) = 50.69$, $p < .001$; AIC = 7741.80; ΔAIC = 26.69; the data therefore significantly deviated from the model. Despite this lack of overall goodness-of-fit (of which the significance is difficult to interpret in general), constraining the AC and OB parameters to zero led to significant reductions in fit. The AIC increased, indicating decreased fit when constraining the AC parameter to zero for both alcohol–power associations (AIC-difference = 62.32) and alcohol–aggression associations (AIC-difference = 3945.23). Constraining the OB parameter to zero led to a worse fit for alcohol–aggression associations (AIC-difference = 0.04), but not for alcohol–power associations (AIC-difference = −2.00). The estimate of OB was lower for alcohol–power associations than for alcohol–aggression associations. However, constraining either the AC or the OB parameters to be equal for the two IAT versions led to a lower AIC, hence preferred model, suggesting that there was no real difference in these parameters between the IAT versions. These results thus, albeit weakly, suggest that participants (although imperfectly, as suggested by the nonzero D600 scores) exert more self-control over their responses in the IAT for alcohol–aggression associations than for alcohol–power associations.

We briefly note that a follow-up analysis was performed aimed at determining whether convergent results could be found using an alternative model. We used the ABC-model (Stahl & Degner, 2007), which was developed and validated for a different variant of the IAT but could conceptually be extended to the current data. Briefly, this simpler model explains accuracy data on mixed blocks as being due to automatic processing (A), controlled processing (C), or guessing (B), where A leads to errors during incongruent blocks but correct responses during congruent blocks. The model fit was better using the ABC-model: $G^2(2) = 1.69$, $p = .43$. For the alcohol–aggression IAT, A = 0.03, B = 0.55, and C = 0.91. For the alcohol–power IAT, A = 0.02, B = 0.53, and C = 0.88. AIC-based model comparisons, as used for the quad model, showed a significantly higher C parameter for the alcohol–aggression IAT than for the alcohol–power IAT, in line with the quad model findings.

Table 4
Quadruple Process Model Parameters

	Alcohol–power-IAT			Alcohol–aggression-IAT		
Parameter	Estimate	*SE*	95% CI	Estimate	*SE*	95% CI
AC	.06	.05	[−.05–.16]	.19	.09	[.02–.36]
D_A	.9	.01	[.88–.91]	.85	.01	[.83–.87]
D_T	.91	.01	[.89–.93]	.92	.01	[.90–.94]
G_A	.44	.04	[.37–.50]	.57	.03	[.51–.62]
G_T	.56	.05	[.46–.66]	.57	.06	[.46–.68]
OB	0	1.03	[−2.02–2.02]	.78	.16	[.46–1.09]

Note. Estimation results for the quadruple process model parameters, AC, D, OB, and G. The subscripts refer to the attribute (A) and target (T) stimulus category pairs. IAT = Implicit Association Test.

Discussion

The current study was focused on cognitive processes underlying alcohol-related aggression, and used an indirect measure—the IAT—to study automatically triggered associations. There were three research aims: (1) to determine whether alcohol–power and/or alcohol–aggression associations predict alcohol-related aggression and (2) whether this hinges on available levels of regulatory control and (3) to explore differences between IATs in terms of overcoming bias using a quad modeling approach.

In the current sample of adolescents, evidence for alcohol–power and alcohol–aggression associations were found, as indicated by significantly nonzero IAT scores. Alcohol–power associations predicted alcohol-related aggression, both in terms of an overall score and on subscales for alcohol-related aggression, trait aggression and sensitivity to pain and anxiety. The primary aim was not to disentangle specific aspects of alcohol-related aggression, but we briefly note that it may be the case that alcohol–power associations are related to alcohol-related aggression personality factors in general rather than to specific aspects as distinguished by the ARAQ; further, note that despite the absence of "alcohol" from the label, the "trait aggression" factor is best conceived of as alcohol-related exacerbation of trait aggression, not trait aggression independent of alcohol. If alcohol leads to an increase in one's own perceived power, this could lead to a reduction in fear or increase in self-perceived status, which in turn could increase the risk of becoming aggressive in the face of a perceived challenge or opportunity.

Alcohol–aggression associations, in contrast, did not predict self-reported aggression after drinking. In a sense this is unexpected, as the association between alcohol and aggression would appear to have a relatively direct link with self-reported aggressive behavior after alcohol use. However, individuals did appear to have alcohol–aggression associations, as reflected by the basic IAT congruence effects. This suggests that participants were not perfectly obscuring or inhibiting their association of alcohol with aggression, which, although still debated, is a potential concern (Röhner, Schröder-Abé, & Schütz, 2011). However, the precise nature of these associations cannot be inferred with certainty from such nonzero bias scores. Possibly, alcohol–aggression associations reflect experience with other people's behavior, rather than the participant's own aggression being associated with alcohol (Han, Czellar, Olson, & Fazio, 2010; Olson & Fazio, 2004). The IAT stimuli used in the current study (e.g., "hitting") are ambiguous in this sense: This stimulus could evoke the meaning of the participant hitting someone, or the participant being hit, or other people hitting each other. Alternatively, it may truly be the case that alcohol–aggression-associations do not play a significant role in alcohol-related aggression. Aggressive behavior may have different prerequisites than simply the activation of an aggression-related concept, such as an enhanced sense of personal power.

The hypothesized interaction with executive control ability was not found. This difference with an earlier study (Wiers et al., 2009) may have been due to the mixture of males and females in the current study or to the age group. Neither alcohol–aggression associations nor their interaction with executive control, were significantly related to aggression after alcohol use.

The quad model analyses did not result in significant differences between the tasks, although the data were in the direction of a higher overcoming bias parameter on the alc-agg-IAT than on the alc-pow-IAT. This suggestion was strengthened by further exploratory analyses using the ABC model. This could reflect a prosocial perception that aggression-related impulsivity should not be displayed, which appears to be less the case for alcohol–power associations. Clearly, this requires further research.

Limitations

The only task used for measuring executive function was the Stroop task. This task has been used in number of previous moderation studies (e.g., Houben & Wiers, 2009; 2013; Peeters et al., 2012), but a more comprehensive view of executive function would have been achieved via a battery of tests, which could allow differentiation between different aspects of executive control (e.g., Hofmann, Friese, & Roefs, 2009; Miyake et al., 2000). Another potential issue is that in some analyses, IAT scores were tested against zero. We acknowledge that this is only a valid test of differences in associations under ideal circumstances: The degree to which IAT effects may be influenced by factors unrelated to associations is controversial, with evidence and arguments both for (Greenwald, Nosek, Banaji, & Klauer, 2005; Houben & Wiers, 2006) and against (Blanton & Jaccard, 2006; Blanton et al., 2009; Fiedler, Messner, & Bluemke, 2006; Rothermund & Wentura, 2004) a relatively straightforward interpretation of IAT results in terms of evaluative associations. In the case of the alc-agg-IAT, as noted earlier, it is not certain that congruence effects reflect processes related to participants' own aggression or to contextual associations they have about alcohol (Han et al., 2010; Olson & Fazio, 2004). The interpretation of the result in overcoming bias is in need of further exploration and replication. Although the effect could reflect attempts to provide more socially desirable responding, an alternative is that in the context of aggression-related stimuli the need for control is more strongly signaled in response–conflict situations because of the higher perceived costs of failures to exert sufficient control. A general problem with the OB parameter is that it is difficult to estimate: It involves a conjunction of events that only holds for a small subset of trials, which can only determine performance to a limited degree. A solution to this problem could be to increase the total number of mixed-block trials, which may provide a more stable estimate for the OB parameter. Although a concern could be a loss of effect size due to the increased number of trials, we found strong IAT effects in a previous study that used a long IAT protocol (Gladwin, den Uyl, & Wiers, 2012). In the same vein, the overall fit of the model was not good. Although this is a general difficulty of any *p* value-based evaluation of model fit, as increasing the amount of data will eventually "break" any model, this may indicate that the model is too complex for the normal version of the IAT to provide sufficient evidence for or against it. A further limitation is that the power and aggression stimulus sets for the alc-pow- and alc-agg-IATs differed in terms of valence: The power words were positive, whereas the aggression words were negative. This may have caused a valence effect that influenced the results, which could be controlled for in future studies. Finally, the study design may have affected the current results and resulted in differences from an earlier study (Wiers et al., 2009). In the current study, executive control was measured later in the procedure, which could have led to noisier results due to fatigue and hence a failure to replicate a moderating effect of executive control.

Research Implications

An important applied further question is whether findings hold in high-risk samples (e.g., prison inmates). Further modeling work, especially if the limitations noted above can be overcome, could be aimed at hypotheses beyond the specific questions of the current study. Of special interest is the further study of the OB parameter. Overcoming biases in the task context may require a similar kind of executive control as that required for self-control in situations that may lead to alcohol-related aggression, and research disentangling the components of the control process could be very informative.

Clinical and Policy Implications

Power associations might form a target for interventions. In anxiety and alcoholism, retraining interventions aimed at automatic processes have shown promising initial results, including effects possibly mediated by automatic associations (Gladwin, Rinck, Eberl, Becker, Lindenmeyer, & Wiers, 2015; Wiers, Gladwin, Hofmann, Salemink, & Ridderinkhof, 2013). It may be possible to de-couple alcohol cues from power-related memories and thereby reduce the chance of exacerbated consequences of drinking. It may also be helpful to focus on aspects of power in campaigns aimed at violence in nightlife.

In conclusion, alcohol–power associations play a role in alcohol-related aggression, in contrast to alcohol–aggression associations, possibly due to a crucial role of alcohol-related effects on self-perceived fitness or resource holding power. Modeling analyses may be helpful in determining in more detail the automatic and controlled processes related to alcohol-related aggressive behaviors and understanding results on implicit measures.

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