ORIGINAL INVESTIGATION

Drinking frequency matters: links between consumption pattern and implicit/explicit attitudes towards alcohol

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Abstract

Rationale Attitudes towards alcohol constitute a central factor to predict future consumption. Previous studies showed that young adults with risky alcohol consumption present positive implicit and explicit attitudes towards alcohol.

Objectives It appears crucial to disentangle the relationship between specific consumption patterns (e.g., binge drinking or moderate daily drinking) and these alcohol-related attitudes.

Methods We compared implicit/explicit positive attitudes towards alcohol among 101 university students distributed in 4 groups [control low-drinking participants (CP), daily drinkers (DD), low binge drinkers (LBD), high binge drinkers (HBD)] differing regarding alcohol consumption profile, to explore the impact of consumption characteristics on alcohol-related attitudes. Participants performed a visual version of the Implicit Association Test (evaluating implicit attitudes towards alcohol), followed by self-reported measures of explicit alcohol-related attitudes and expectancies.

Results HBD and DD (but not LBD) presented stronger implicit positive attitudes towards alcohol than CP. All drinkers explicitly considered alcohol consumption as pleasant, but only DD qualified it as something good.

Conclusion Beyond and above the quantity consumed and the presence of binge drinking habits, consumption frequency appears as a central factor associated with high implicit/explicit positive attitudes towards alcohol in young drinkers. This underlines the need to consider this factor not only in future studies exploring implicit/explicit attitudes but also in the development of prevention and intervention campaigns in youth.

Keywords Alcohol-related attitudes · Implicit Association Test · Alcohol expectancies · Binge drinking

Introduction

According to dual-process models (e.g., Wiers et al. 2007), both explicit (e.g., alcohol-related expectancies) and implicit (e.g., alcohol-related automatic associations) attitudes towards alcohol influence the development and persistence of problematic drinking in young adults (Goldman et al. 1999; Wiers et al. 2002). Implicit and explicit attitudes are

progressively acquired and can be either positive or negative. Explicit attitudes are determined by deliberate propositional processes (rule-based inferences, conscious processing) whereas implicit attitudes are rather related to associative reasoning (guided by perceptual similarity and spatiotemporal contingency, unconscious processing; Hughes et al. 2011; Rydell and McConnell 2006). However, implicit associations may also rely on propositional processes (Hughes et al. 2011): for example, a proposition (e.g., "alcohol reduces negative emotions") can first be stored in memory based on explicit environmental information or experiences, and then be activated implicitly and automatically. This suggests that implicit alcohol-related associations do not only depend on the repeated exposure to a stimulus (i.e., spatiotemporal contingency). Indeed, experimental studies (e.g., Lindgren et al. 2009) supported that these associations can also be influenced by environmental context as well as previous experiences, modulating the mere influence of stimuli exposure. Several implicit tasks allow the capture of these implicit attitudes, and centrally

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(1) the Implicit Association Task (IAT; Greenwald et al. 1998), which is one of the most used tools in the literature (Lindgren et al. 2013), measuring the strength of implicit associations; (2) the Relational Responding Task (RRT; De Houwer et al. 2015), recently introduced, which constitutes a measure of implicit beliefs and of the way they are associated.

Alcohol consumption in young adults is often characterized by intense drunkenness episodes alternating with abstinence periods (i.e., binge drinking, observed in 40% of youth; ESPAD 2015; Kanny et al. 2013). This drinking pattern frequently occurs in festive and social contexts and is related to positive emotions (Kuntsche et al. 2005; Lannoy et al. 2019). However, binge drinking has also been recognized as particularly harmful, leading to brain impairments (Stephens and Duka 2008), which are stronger than those reported among individuals who drink the same weekly amount but in a less concentrated way (i.e., daily drinkers, presenting moderate daily consumption rather than the intense episodic one observed in binge drinking; Maurage et al. 2012). To date, the role of implicit/explicit attitudes towards alcohol has mostly been observed through the IAT in association with overall alcohol consumption. Nevertheless, only few studies have targeted the specificity of binge drinking patterns (i.e., high alcohol consumption on a single occasion) and, to our knowledge, none has investigated the extent of implicit/explicit attitudes in moderate daily drinking, a pattern of consumption that can also be observed more and more frequently among young people.

Previous research indicated that alcohol-related expectations and motives (explicit attitudes, usually measured via self-report questionnaires) are positively correlated with current alcohol consumption (Goldman et al. 1999; Larsen et al. 2012; Wiers et al. 1997) and predict future alcohol use and binge drinking (Goldman and Darkes 2004; Lannoy et al. 2019; Stacy et al. 1993). Implicit alcohol-related associations also appear as robust predictors of changes in drinking behavior (for reviews, see Reich et al. 2010; Stacy and Wiers 2010). Positive implicit associations are the most prevalent in young drinkers who do not meet Alcohol Use Disorder criteria (e.g., Ostafin and Palfai 2006). They are also more strongly related to current alcohol use (Jajodia and Earleywine 2003; Thush and Wiers 2007) and are, therefore, better predictors of alcohol consumption over time compared to negative associations (Houben and Wiers 2007, 2008). Longitudinal studies (e.g., Colder et al. 2014; Houben and Wiers 2008; Peeters et al. 2016) have shown the predictive value of implicit associations for overall alcohol consumption in youth, but a recent one went further by using eight testing sessions (i.e., every 3 months) to establish a bidirectional link between increases in implicit alcohol-related associations and risky drinking behaviors among young students (Lindgren et al. 2018). In line with the predictions made by implicit cognition theories (Greenwald and Banaji 1995; Nosek et al. 2011), these results

suggest the existence of a vicious circle in which alcohol-related associations strengthen following early alcohol consumption, and then reinforce later consumptions.

Beyond the exploration of causal links, another key question still not thoroughly addressed is the variation of implicit positive associations according to alcohol consumption characteristics (e.g., specific drinking pattern, frequency, quantity). Indeed, earlier studies usually defined alcohol consumption and hazardous (or binge) drinking through simple quantity measures (e.g., number of drinks per week) and standard questionnaires [e.g., Alcohol Use Disorders Identification Test (AUDIT; Babor et al. 2001) and/or Rutgers Alcohol Problem Index (RAPI; White and Labouvie 1989)]. The links with consumption patterns and frequency (e.g., binge drinking episodes, daily consumption) have not been considered, thus preventing the identification of the key factors related to implicit/explicit alcohol-related associations.

In the present study, we explored the specific associations between alcohol attitudes and alcohol consumption characteristics in college students. We selected and compared four groups, namely control low-drinking participants (CP), daily drinkers (DD), low binge drinkers (LBD), and high binge drinkers (HBD). In particular, the comparison between LBD and DD (i.e., same global intake but different consumption modes) may clarify the specific links between implicit/explicit attitudes and *binge drinking consumption*, whereas the comparison between LBD and HBD (i.e., same consumption pattern but different alcohol intakes) can determine their relation with the *quantity of alcohol consumed* in the context of binge drinking habits. Moreover, the four groups differed regarding *alcohol consumption frequency*. We combined explicit (i.e., self-reported attitudes and expectancies) and implicit (i.e., IAT) measures of alcohol-related attitudes. Different implicit association measures have been validated in the literature. Here, we chose the unipolar positive version to specifically explore the presence of positive associations with alcohol. Especially, we used an adapted visual version of the IAT (Dormal et al. 2018). This IAT uses pictorial representations rather than words to illustrate both targets (i.e., pictures of alcohol or soft drinks) and attributes (i.e., positive or neutral pictures) categories, to offer a more ecological and cross-cultural evaluation of associations.

The direct comparison of these four groups will determine the links between consumption characteristics and the presence of explicit and implicit alcohol-related attitudes. If the mere exposure to alcohol consumption (moderate or excessive) is enough for positive implicit and/or explicit attitudes to develop, then such attitudes should be observed in all four drinking groups. Conversely, if the presence of positive attitudes is related to binge drinking habits, HBD and LBD should have stronger positive attitudes than the CP and DD. Finally, if drinking frequency is a crucial criterion, IAT scores and/or alcohol-related expectancies should be higher among

drinkers with high consumption frequency (HBD and/or DD). As previous studies have shown independent relationships between explicit and implicit positive attitudes (e.g., Reich et al. 2010), the links with alcohol consumption patterns were measured for both attitude types.

Materials and methods

Participants

A preliminary online screening questionnaire was sent by email or via social networks to students from the University to assess socio-demographic (age, gender) and alcohol consumption (consumption speed in alcohol units/hour, mean number of units/week, mean number of units/drinking occasion, mean number of drinking occasions/week, frequency of drunkenness episodes, percentage of drunkenness episodes compared to the total number of drinking episodes in the last 6 months) variables. The harmfulness of alcohol consumption was assessed by the French version of the AUDIT (Gache et al. 2005). We computed the binge drinking score (Townshend and Duka 2005), which is obtained by investigating how many times the participants have been drunk in the previous 6 months, the percentage of drunkenness, and the average drinks consumed per hour, with the following formula: $(4 \times \text{consumption speed}) + \text{number of drunkenness episodes} + (0.2 \times \text{drunkenness percentage})$. The definition of an alcohol unit (i.e., 10 gr of pure ethanol in Belgium) and the number of units contained in the most frequent categories of alcoholic drinks were explained to participants before filling in the questionnaire. We received a total of around 600 answers from students who wanted to take part in experimental studies.

A first selection was made based on the following inclusion criteria, measured through self-reported items: fluent French speaker, aged between 18 and 30 years old, no personal or family history of moderate/severe Alcohol Use Disorder, no psychological or neurological disorder, no current psychotropic medication, normal or corrected-to-normal vision, absence of past or current drug consumption (except alcohol and

nicotine). Then, a series of alcohol consumption characteristics have been precisely defined (Table 1) in order to distinguish between control low-drinking participants (CP), daily drinkers (DD), low binge drinkers (LBD), and high binge drinkers (HBD). The participants fulfilling these specific criteria were then contacted, and a total of 101 participants accepted to take part in the experimental phase of the study: 24 CP, 23 DD, 24 LBD, and 30 HBD. Details of the alcohol consumption characteristics of each group are presented in Table 2 and the between-group comparisons performed are available in the Supplementary Materials.

To control for psychopathological comorbidities, participants filled in questionnaires assessing depressive (Beck Depression Inventory, BDI-II; Beck et al. 1996) and anxiety (State-Trait Anxiety Inventory, STAI; Spielberger et al. 1983) symptoms. All participants had to refrain from consuming alcohol during the day preceding the experimental session. They provided informed consent, were debriefed at the end of the experiment, and were compensated for their participation (€15). This study was approved by the Ethical Committee of the Faculty and conducted according to the principles of the Declaration of Helsinki.

Measures and procedure

The session was administrated individually in a quiet room, participants being placed at 60cm from the screen (Dell E176FP, resolution: 1280×1024 pixels). It included a positive alcohol-related IAT (Dormal et al. 2018) and an online questionnaire measuring self-reported alcohol consumption and explicit alcohol-related cognitions (LLC, Qualtrics Software). The implicit measure (IAT) was presented using E-Prime 2 Professional® (Psychology Software Tools, Pittsburgh, PA, USA) and was administered before the explicit one to avoid carry-over effects (Bosson et al. 2000).

Implicit measure

In this positive alcohol-related IAT version (see Dormal et al. 2018 for a full description of the task), participants had to categorize pictures from four categories—two target

Table 1 Alcohol-related selection criteria for control participants (CP), daily drinkers (DD), low binge drinkers (LBD), and high binge drinkers (HBD) groups

Alcohol-related criteria	Groups			
	CP	DD	LBD	HBD
Number of units per week	< 10	< 22	< 22	/
Number of occasions per week	< 3	> 4	2-3	3-4
Number of units per occasion	< 3	< 4	> 3	> 5
Number of binge drinking episodes (i.e., > 6 units) per week	0	0	1-2	≥ 3
Binge drinking score	< 12	< 16	> 16	> 24

Table 2 Demographic, psychopathological, alcohol consumption, and implicit/explicit alcohol-related associations measures [mean (SD)] for control participants (CP), daily drinkers (DD), low binge drinkers (LBD), and high binge drinkers (HBD) groups

	CP (n=24)	DD (n=23)	LBD (n=24)	HBD (n=30)
Demographic measures				
Gender ratio (male/female)[ns]	14/10	14/9	14/10	15/15
Age[ns]	21.3 (2.4)	22.3 (2.9)	20.9 (1.9)	20.7 (1.7)
Psychopathological measures				
Beck Depression Inventory[ns]	4.7 (5.4)	7.7 (5.2)	4.5 (3.7)	6.4 (4.0)
State Anxiety Inventory[ns]	32.4 (8.6)	32.5 (8.8)	32.5 (7.4)	34.4 (9.0)
Trait Anxiety Inventory[ns]	38.2 (9.7)	37.3 (10.9)	38.8 (9.2)	40.3 (9.3)
Alcohol consumption measures				
Alcohol Use Disorders Identification Test**	7.00 (5.7)	11.86 (4.9)	17.00 (5.9)	20.33 (6.2)
Binge Drinking score**	5.91 (3.8)	9.18 (3.8)	26.57 (9.2)	41.89 (16.2)
Number of units per week**	2.85 (1.9)	11.39 (3.1)	13.39 (5.0)	32.46 (11.2)
Number of drinking occasions per week**	1.71 (0.9)	5.52 (0.7)	2.50 (0.9)	3.33 (0.7)
Number of units per occasion**	1.55 (1.1)	2.07 (0.5)	5.95 (3.0)	9.77 (2.4)
Implicit and explicit measures				
IAT D600 score*	0.039 (0.38)	0.359 (0.40)	0.294 (0.37)	0.337 (0.40)
Explicit Positive Expectancies score*	5.49 (0.8)	6.04 (0.6)	5.85 (0.8)	6.03 (0.7)
Explicit Attitudes score				
Unpleasant/pleasant**	4.33 (1.3)	6.30 (0.9)	5.75 (1.0)	6.03 (0.7)
Bad/good*	3.58 (0.9)	4.43 (1.2)	3.75 (1.0)	4.03 (0.9)

[ns] non-significant, ** $p<.001$, * $p<.05$

categories (i.e., alcohol or soft drinks pictures) and two attribute categories (i.e., positive or neutral pictures)—by pressing one of two response keys ("D" and "K"). The target and attribute pictures were selected from the Amsterdam Beverage Picture Set (Pronk et al. 2015) and the Nencki Affective Picture System (NAPS; Marchewka et al. 2014), respectively. The target pictures consisted of alcoholic drinks (i.e., beer, wine, spirit) and soft drinks (i.e., water, juice, soda), whereas the attribute set consisted of positive (e.g., woman smiling, dolphins, beach) and neutral (e.g., bicycle, pigeon, highway) pictures corresponding to three "pleasant" affective states related to alcohol drinking (happy, funny, lively) and to three "neutral" affective states (average, normal, usual). Targets and attributes stimuli were presented in the middle of a white background screen (picture size: 13.23×13.23cm for targets, 17.65×13.23cm for attributes). Each trial started with a black central fixation cross for a variable duration (500–1500ms), followed by the stimulus which remained on the screen until a response was given or for a maximum of 2000ms. A blank screen appeared between trials (2000ms minus the reaction time of the previous trial). During the task, the labels of the categories assigned to the left and right response keys were presented in the corresponding upper corners of the screen.

The task followed the typical IAT procedure and contained seven blocks: (1) a 32-trial target discrimination block (left=alcohol; right=soft); (2) a 32-trial attribute discrimination block (left=positive; right=neutral); (3) a 32-trial training congruent combination block (left=alcohol+positive; right=soft+neutral); (4) a 64-trial test block with the same combination as (3); (5) a 32-trial target discrimination block in which target categories were reversed (left=soft; right=alcohol); (6) a 32-trial training incongruent combination block (left=soft+positive; right=alcohol+neutral); and (7) a 64-trial test block with the same combination as (6). Stimuli for the target, attribute, and combination discrimination blocks were presented randomly. Each stimulus was presented twice in the test combination block. The IAT congruent and incongruent blocks were counterbalanced across participants.

The IAT data were transformed following the IAT scoring algorithm (Greenwald et al. 2003) to obtain a *D600 score*, based on the difference between congruent (alcohol/positive pictures and soft/neutral pictures) and incongruent (alcohol/neutral pictures and soft/positive pictures) response times. Moreover, error penalties (600ms) were added, and results were standardized at the individual level (Greenwald et al. 2003). Higher positive D600 scores reflect faster performance for alcohol/positive attributes and soft drinks/neutral attributes pairings, while negative D600 scores correspond to faster performance for alcohol/neutral attributes and soft drinks/positive pairs. Internal consistencies were calculated by correlating the D600 scores from the training part with scores from the test part (Greenwald et al. 2003).

Explicit measures

Both explicit positive expectancies and attitudes were evaluated through three different scores: an *Explicit positive expectancies score* was computed with a 6-item questionnaire (Wiers et al. 2002, 2005). Each item consisted of a statement on alcohol drinking (i.e., "drinking alcohol makes me feel…") completed with the following positive words presented randomly: talkative, excited, cheerful, happy, funny, and lively (the same positive words that were used as attribute pictures in the IAT). Participants indicated their level of agreement with each item on a 7-point Likert scale from 1 (completely disagree) to 7 (completely agree). A mean score was calculated, higher scores indicating more positive expectancies towards alcohol. Moreover, explicit attitudes towards alcohol were assessed using two semantic differentials (Dormal et al. 2018; Houben and Wiers 2008) with a 7-point Likert scale: (1) from "drinking alcohol is totally unpleasant" to "drinking alcohol is totally pleasant" (*Explicit unpleasant/pleasant attitudes score*); and (2) from "drinking alcohol is bad" to "drinking alcohol is good" (*Explicit bad/good attitudes*). Low scores indicate negative explicit attitudes towards alcohol, while high scores reflect positive explicit attitudes towards alcohol.

Statistical analyses

First, between-group comparisons [one-way analyses of variance (ANOVAs) and chi-square independent test] were performed on demographic and psychopathological variables to check the quality of group pairing. Second, to evaluate implicit alcohol-related associations, the D600 internal reliability was assessed and t-tests to zero on the D600 score were performed for each group. Moreover, one-way ANOVAs were performed with group (CP, DD, LBD, HBD) as between-subjects factor to compare implicit (*D600*) and explicit (*Explicit positive expectancies*, *Explicit unpleasant/pleasant attitudes, and Explicit bad/good attitudes*) alcohol-related measures. All post hoc comparisons were performed using two-tailed t-tests ($p<.05$) adjusted for multiple comparisons using Bonferroni correction (the reported p-values hereafter were already multiplied by the number of comparisons made; i.e., 3).

Results

Demographic and alcohol consumption characteristics (Table 2)

No significant group difference was observed for age [$F(3,100)=2.482$, $p=.065$], gender [$\chi^2(3,N=101)=0.760$, $p=.859$], depressive symptoms [$F(3,100)=2.509$, $p=.063$],

state [$F(3,100)=0.370$, $p=.775$], or trait anxiety [$F(3,100)=0.425$, $p=.736$].
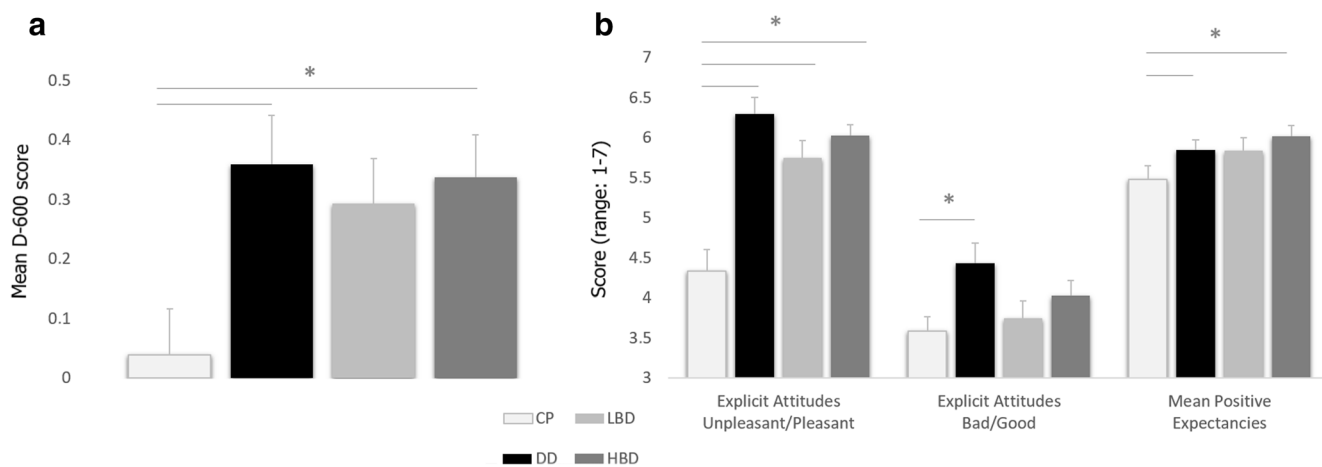
Implicit and explicit measures (Table 2)

Regarding *implicit measures*, the D600 split-half reliability (Pearson's correlation) was $r=.570$ ($p<.001$), suggesting good IAT internal consistency. The *D600 score* significantly and positively differed from zero in each group [DD: $t(22)=4.282$, $p<.001$; LBD: $t(23)=3.910$, $p=.001$; HBD: $t(29)=4.636$, $p<.001$], except for the CP group [$t(23)=0.495$, $p=.625$; Fig. 1a]. The one-way ANOVA on the *D600 score* revealed a significant difference between groups [$F(3,100)=3.530$, $p=.018$]: DD [$t(45)=2.786$, $p=.024$] and HBD [$t(52)=2.773$, $p=.024$] presented larger D600 scores than CP (Fig. 1a).

Regarding *Explicit Attitudes scores*, significant differences were observed for the unpleasant/pleasant scale [$F(3,100)=17.820$, $p<.001$] and for the bad/good scale [$F(3,100)=3.019$, $p=.034$]: LBD [$t(46)=4.102$, $p<.001$], HBD [$t(52)=5.966$, $p<.001$], and DD [$t(45)=5.745$, $p<.001$] presented more pleasant scores than CP (Fig. 1b) whereas only DD had a higher bad/good score than CP [$t(45)=2.728$, $p=.027$; Fig. 1b]. Differences between groups were also reported for the *Explicit Positive Expectancies score* [$F(3,100)=2.995$, $p=.035$]: DD [$t(45)=2.698$, $p=.030$] and HBD [$t(52)=2.528$, $p=.045$] had significant larger *Explicit Positive Expectancies scores* than CP (Fig. 1b).

Discussion

By comparing implicit and explicit positive alcohol-related attitudes among four contrasted groups of young drinkers, the present study investigated if the alcohol consumption pattern is associated with the presence and extent of these attitudes. The comparison between LBD and HBD (i.e., same consumption pattern but different alcohol consumption quantity) explored the quantitative factor (i.e., amount of alcohol intakes) in the context of binge drinking habits, whereas the comparison between LBD and DD (i.e., same global intakes but different consumption patterns) explored the qualitative factor (i.e., the specific influence of binge drinking consumption mode). In addition, groups differed regarding alcohol consumption frequency, as HBD and DD drank alcohol more frequently than CP and LBD.

The first main result of this study is that, whereas positive explicit expectancies were observed in each group (underlining the globally positive perception of alcohol in youth), the presence of implicit positive alcohol-related attitudes, evaluated through a unipolar positive IAT version, was confirmed in all groups except CP. These results are in line with previous studies among young people and heavy drinkers (e.g., Houben and Wiers 2008; Jajodia and Earleywine 2003;

Fig. 1 **a** Mean implicit positive alcohol-related associations (i.e., D600 score) as a function of group [control low-drinking participants (CP), daily drinkers (DD), low binge drinkers (LBD), high binge drinkers (HBD)]; **b** Mean explicit alcohol-related associations (i.e., explicit unpleasant-pleasant/bad-good attitudes and positive expectancies) as a function of group. Error bars represent the standard error. *$p < .05$

Thush and Wiers 2007), confirming that implicit and explicit attitudes are weakly related (Reich et al. 2010) and that explicit attitudes may be influenced by social desirability (Reich et al. 2010; Rydell and McConnell 2006). Importantly, these findings also suggest that the implicit positive alcohol-related associations may occur in moderate/daily to heavy/episodic alcohol consumption but may be absent in low drinkers.

In this regard, direct group comparisons determined which consumption characteristics were preferentially linked with these attitudes. Regarding implicit attitudes, only HBD and DD showed higher D600 scores than CP. The absence of such significant difference in LBD suggests that the amount of alcohol intakes (identical between DD and LBD) and the presence of binge drinking habits (in LBD and HBD) are not the only factors related to implicit attitudes. Alcohol-related implicit attitudes rather appear differentially linked with quantity and frequency of alcohol intakes. This demonstrates that consumption frequency is also related to high implicit positive attitudes. This observation is coherent with a recent longitudinal study (Silins et al. 2018) showing that the frequency of alcohol use among adolescents predicted problematic substance use as much as (and even possibly more than) binge drinking episodes. Together, these results underline the importance to consider alcohol frequency in future studies. Indeed, earlier works proposed that binge drinking leads to particularly harmful cognitive consequences (Stephens and Duka 2008). This proposal has been supported at the brain level (Maurage et al. 2012) and tends to be confirmed at the behavioral level (e.g., Lannoy et al. 2018; Sanhueza et al. 2011; Scaife and Duka 2009). Nevertheless, beyond cognitive abilities, when focusing on factors directly related to (problematic) alcohol use, both drinking frequency and quantity appear central. Importantly, these findings should also be considered for the development of prevention and care programs: it is usually advised to drink less or to alternate

drinking alcohol and water, and we propose here to consider not only reducing drinking intensity but also drinking frequency.

Regarding explicit attitudes towards alcohol, a similar pattern of results is observed for positive expectancies, with higher expectations for HBD and DD than CP. Interestingly, the three groups with moderate to heavy drinking (i.e., LBD, HBD, DD) all consider alcohol consumption to be a highly pleasant activity, this score correlating with both AUDIT and binge drinking scores, as well as drinking quantity/frequency. Finally, only DD presented significantly higher score than CP on the bad/good attitude scale, and therefore consider alcohol consumption to be something good. This suggests that this specific group do not associate alcohol consumption with dangerous or excessive elements at all, which is observed among other groups, independently of their alcohol drinking pattern. Although moderate DD (reporting a limited but daily consumption) exhibit general control over their drinking and may experience limited effects on health, studies showed that moderate alcohol consumption already leads to brain impairments (Anderson et al. 2012). Moreover, previous and current results underline the harmfulness of this consumption pattern by indicating its relationship with future problematic drinking. While acknowledging that the presence of high positive expectancies, at both explicit and implicit level, may predict risky drinking behaviors in the future, prevention campaigns and the implementation of interventions to reduce positive alcohol-related bias (e.g., Luehring-Jones et al. 2017) should also consider this group as a potential target.

Despite the widespread recognition of implicit/explicit positive attitudes towards alcohol in youth, this study is the first to disentangle the specific influence of alcohol consumption patterns. Accordingly, several points should be acknowledged to go further in this direction. First, the cross-sectional nature of this study does not allow to clarify the causal links between

specific alcohol consumption factors and implicit/explicit attitudes. This question should be addressed through longitudinal designs, possibly including non-drinking adolescents to determine the joint development and interactions between alcohol-related attitudes and the characteristics of their actual alcohol consumption (e.g., binge or daily drinking, frequency and/or quantity). To better qualify how the specific relations between implicit alcohol-related beliefs and alcohol consumption were established, additional studies should also consider the usefulness of the RRT (De Houwer et al. 2015). Second, we recruited a group of DD to evaluate the extent of alcohol use frequency (compared to LBD). However, future studies may want to go beyond the role of alcohol use quantity and frequency to explore the influence of other alcohol-related variables. Third, whereas we focused on positive attitudes, as they are more predictive of risky alcohol consumption, it would be interesting to explore whether similar influences of drinking characteristics would be observed for implicit/explicit negative attitudes, and replicated with other measures (e.g., word-related IAT). Fourth, although the sample size of the current study has allowed identifying significant group differences (strictly controlled for multiple comparisons), subsequent research should confirm these results with larger samples. Finally, to offer a reliable exploration of the consumption pattern, we ensured that participants remained abstinent in the day preceding the experiment. However, craving or acute alcohol consumption measures should also be considered in future studies to determine their possible influence on both explicit and implicit attitudes towards alcohol.

In conclusion, this study evaluated the relationship between alcohol consumption pattern (binge or daily drinking, quantity/frequency) and implicit/explicit attitudes towards alcohol, through the joint use of a positive unilateral IAT and self-reported explicit measures. As HBD and DD presented stronger implicit positive attitudes towards alcohol than CP, and as this result was not found among LBD, consumption frequency might be considered an important factor in association with implicit/explicit positive attitudes towards alcohol among students. Stronger positive explicit attitudes towards alcohol were also found among DD when compared to other drinking groups, showing that this alcohol consumption pattern, currently not considered by prevention campaigns, is related to strong implicit/explicit positive alcohol-related attitudes, which might influence the evolution towards alcohol-related disorders.

Declarations

Conflict of interest The authors declare no competing interests.

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