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Binge drinking and unplanned sexual behaviour: deconstructing the role of impulsivity

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1 **Title: Binge Drinking and Unplanned Sexual Behaviour: Deconstructing the Role of**
2 **Impulsivity**

3 ABSTRACT

4 The co-occurrence of binge drinking and unplanned sexual behaviour (USB) is a physiological
5 and social concern; however, potential underlying mechanisms in this relationship remain
6 largely unexplored. The current study compared low and high-binge drinkers on impulsivity
7 variants and USB. Participants were 122 university students (71 females). Questionnaires
8 measured binge drinking, USB, reward sensitivity, and trait impulsivity (Barratt Impulsiveness
9 Scales). Cognitive-behavioural aspects of impulsivity were assessed using a Stop Signal Task
10 (response inhibition) and an Information Sampling Task (IST: reflection-impulsivity). ANOVAs
11 revealed that high-binge drinkers scored more impulsively than low-bingers on self-report
12 impulsivity, and the decreasing win condition of the IST. A positive relationship was found
13 between USB and self-report, but not cognitive-behavioural, impulsivity. In regression
14 analysis, both binge drinking and trait impulsivity were found to have a unique effect on the
15 proclivity to engage in USB. Findings provide an insight into demarcating impulsivity's
16 relationship with both binge drinking and USB.

17 *Keywords:* Binge drinking, unplanned sexual behaviour, trait impulsivity, reflection-
18 impulsivity, response inhibition, reward sensitivity

19 **1. Introduction**

20 Repeated episodes of binge-style drinking (approximately four or more drinks for females and
21 five or more drinks for males within a two-hour period [1]) has been posited to be particularly
22 deleterious to neurocognitive functioning and puts the individual at an increased vulnerability

23 for long-term health problems and addiction [2]. Often associated with young adult students
24 [3, 4], this pattern of episodic alcohol consumption has also been implicated in an array of
25 adverse consequences including poor academic performance, criminal involvement, drink-
26 driving, perpetrating or being victims of physical or sexual assault, and unplanned and unsafe
27 sexual activity [5].

28 Unplanned sexual behaviour (USB) refers to the act of engaging in a brief sexual encounter
29 with someone outside of a committed relationship. Sometimes referred to as *casual sex* or a
30 *one-night stand*, this category of sexual activity typically occurs with someone only once and
31 is usually devoid of commitment or emotional involvement [6]. Concernedly, some studies
32 have found that when binge drinking precedes unplanned sex, both males and females are
33 more inclined to participate in unprotected sexual activity, thereby increasing their risk of
34 adverse outcomes such as unplanned pregnancy, sexually transmitted infections (STIs), and
35 the Human Immunodeficiency Virus (HIV) [7].

36 Previous research attempting to explore the underlying mechanisms in the relationship
37 between binge drinking and USB has focused on various theories including alcohol myopia [8]
38 and alcohol expectancies [9]. In addition, potential risk factors such as family background,
39 peer influence, and personality traits, including sensation seeking and impulsivity, have all
40 been considered [10]. Of interest here is the multi-dimensional construct of impulsivity, which
41 has previously been associated with both USB and binge drinking respectively [11, 12].

42 Regarding sexual behaviour, both unplanned and unprotected sexual activity have been
43 associated with various facets of trait impulsivity including negative and positive urgency, (a
44 lack of) premeditation, sensation seeking, and impulsive decision-making [11,15]; although it
45 should be noted that results have varied depending on the sample and criteria used for

46 unplanned or 'risky' sexual behavior. In addition, studies examining neurocognitive
47 performance on inhibitory control have evidenced a positive relationship between impulsive
48 behavior and sexual risk-taking [16, 17, 18].

49 In respect of binge drinking, varying dimensions of impulsivity have been implicated in both
50 the initiation and continuation of binge drinking. For example, an impulsive personality may
51 predispose an individual to drink to excess and from an early age and, in return, repeated
52 intoxication and withdrawal from ethanol can affect prefrontal neural systems responsible
53 for inhibitory control. This in turn can further exacerbate impulsive behaviour and a tendency
54 towards binge drinking creating a reciprocal effect [13, 14]. As such, the importance of testing
55 for both trait and behavioural measures of impulsivity is invaluable in exploring the
56 relationship with both binge drinking and USB.

57 To date, however, research integrating the three elements has been limited. Both Gullette
58 and Lyons [19] and Donohew et al. [20] discovered a positive relationship for impulsivity
59 variants, such as sensation seeking and impulsive decision-making, in co-occurring alcohol
60 and risky sexual behaviour. In a similar vein, a mediating role for both sensation seeking [21]
61 and excitement seeking [22] has been demonstrated in the relationship between alcohol use
62 and high-risk sexual behavior. Regarding behavioural impulsivity, a study by MacKillop et al.
63 [22] found a relationship between impulsive responding on a delay discounting task and
64 increased risky sexual behaviour during alcohol intoxication.

65 Nevertheless, a limitation of this research has been the utilization of single measures of
66 impulsivity and not accounting for the binge-style consumption of alcohol. A previous study
67 by Townshend, Kambouropoulos, Griffin, Hunt, and Milani [23] incorporated a cognitive-
68 behavioural measure of impulsivity to assess levels of reflection-impulsivity (i.e., the ability to

69 gather and evaluate information during decision making), as well as a single question to
70 measure self-reported impulsivity, and examined the relationship between binge drinking
71 and USB. Results revealed that the high-binge drinkers engaged in more unplanned sexual
72 encounters, rated themselves as more impulsive, and demonstrated aspects of reflection-
73 impulsivity compared to the low-binge drinkers, although no comprehensive trait measure of
74 impulsivity was included in their study.

75 Taking into consideration the ubiquity of both binge drinking and unplanned sexual activity in
76 university students during emerging adulthood [24], a clearer understanding of potential
77 mediating factors, such as impulsivity, would be advantageous in efforts intended to reduce
78 unwanted pregnancy, STIs, and coerced sexual activity, as well as alcohol-related problems
79 and dependence. Thus, the overriding aim of the current study was to explore the relationship
80 between binge drinking, USB, and impulsivity using an extensive battery of behavioural and
81 self-report measures to examine the various dimensions of impulsivity. Accordingly, a sample
82 of low and high-binge drinkers, derived from the Alcohol Use Questionnaire [25], were
83 compared on different dimensions of impulsivity, as well as the tendency to engage in USB.

84 Specifically, based on previous findings in the literature, it is predicted that the high-binge
85 drinking group will score higher on self-report measures of impulsivity, display poorer
86 response inhibition, and show signs of less reflection and more impulsiveness compared to
87 the low-binge drinking group. In addition, it is predicted that the high-binge drinking group
88 will report more episodes of USB, compared to the low-binge drinking group. Furthermore, it
89 is predicted that more impulsive individuals will report more episodes of USB, compared to
90 less impulsive individuals. Finally, based on previous research [23], an interaction will be
91 explored between binge drinking and impulsivity, and the tendency to engage in USB.

92 **2 Methods**

93 *2.1 Participants*

94 Participants (N = 125) were recruited through in-class announcements and university website.
95 Criteria included being aged between 18 and 30 and describing oneself as a “social drinker”
96 (occasional through to heavy consumption) but excluded those with a history of drug or
97 alcohol dependence. Participants, all full-time Psychology students, provided relevant
98 demographics details, including age of first drink and age of first intoxication. Participants
99 consuming more than eight units of alcohol in the preceding 24 hours were excluded from
100 the study. This last criterion excluded three participants leaving a total of 122 participants
101 ($M_{\text{age}} = 21.30$, $SD_{\text{age}} = 3.54$; 58% female).

102 *2.2 Measures*

103 All questionnaires used in the study are robust measures that have been employed in
104 numerous studies and are recognized as having high levels of reliability and validity. The one
105 exception is the Unplanned Sexual Behaviour Questionnaire (USBQ) that was utilized in the
106 previous study [see 23].

107 *2.2.1 Alcohol Use Questionnaire (AUQ [25]):*

108 A revised version of the AUQ [26] was used to establish drinking behaviour. The AUQ provides
109 a binge score, as well as total alcohol units consumed per week. The binge score is calculated
110 from the number of times being drunk (previous six months), percentage of times getting
111 drunk when drinking (average), and speed of drinking (average drinks per hour). The median
112 was then calculated from the binge score (22.5) and used to form two groups above and

113 below the median: high-binge drinkers (≥ 23 ; $n = 61$) and low-binge drinkers (≤ 22 ; $n = 61$)
114 respectively.

115 *2.2.2 Unplanned Sexual Behaviour Questionnaire (USBQ [23]):*

116 The 16-item USBQ asks questions relating to unplanned sexual behaviour, decision making,
117 impulsivity, and regret. The two questions of relevance to this paper included: Q1,
118 “Approximately how many times have you ever engaged in unplanned sexual activity with
119 non-partners or strangers?”. Possible answers are on a scale from “never”, “once”, “2-5
120 occasions”, “6-10 occasions”, to “11 or more occasions”. Secondly, Q13 asks: “Generally,
121 would you describe yourself as an impulsive person?”. Answers are on a 5-point Likert scale
122 (1 = “not at all impulsive” to 5 = “very impulsive”).

123 *2.2.3 Barratt Impulsiveness Scale, Version 11 (BIS-11 [27]):*

124 The 30-item BIS-11 assesses the personality (trait) dimensions of impulsivity. For example, “I
125 do things without thinking”. Answers are on a 4-point Likert scale ranging from “rarely/never”
126 to “almost always/always”. Several items are reverse scored and the greater the summed
127 score, the higher the self-reported level of impulsivity. In addition to the total score, the BIS-
128 11 provides three subscales including attentional, motor, and non-planning facets of
129 impulsivity. Cronbach’s alphas for the current sample were .69 (attentional), .60 (motor), .69
130 (non-planning) and .82 (total score).

131 *2.2.4 Sensitivity to Reward Questionnaire (SPSRQ-SR [28]):*

132 This measure of reward sensitivity requires participants to tick “yes” or “no” to 17 items. For
133 example, “Do you often do things to be praised?”. A “yes” response is assigned a value of one
134 and a “no” response a zero, and then summed to form a SR scale score. The greater the

135 summed score, the higher the self-reported level of reward sensitivity. The Cronbach's
136 reliability coefficient was .74 for the current sample.

137 *2.2.5 Reflection Impulsivity: Information Sampling Task (IST; CANTAB Cambridge Cognition*
138 *Ltd.):*

139 The IST assesses reflection-impulsivity on two sets of ten trials. Twenty-five grey boxes are
140 presented on a 5x5 matrix with two differently coloured squares displayed beneath. When
141 respondents touch any of the grey squares they turn to one of the two colours displayed
142 below and remain that colour for the duration of each individual trial, so there is no working
143 memory requirement to the task. Participants are asked to decide which colour is in the
144 majority, basing their decision on the boxes revealed.

145 The first set of ten trials is the Fixed Win (FW) condition with a win of 100 points for a correct
146 choice, and a deduction of 100 points for an incorrect choice. Participants are informed that
147 they can open as many boxes as they wish. The second trial is the Decreasing Win (DW)
148 condition in which participants start with 250 points; however, this time the score decreases
149 by ten points with every box opened, consequently the earlier a decision is made the more
150 points are awarded, providing the selection is correct. As before, one hundred points is
151 deducted for a wrong decision. Performance on the two tasks is measured by the number of
152 boxes opened per trial, proportion of correct choices [$P(\text{correct})$; the mean probability of
153 being correct at the point of decision], number of errors committed when selecting the
154 colour, and time taken to make a decision (opening latency).

155 *2.2.6 Response inhibition: Stop Signal Task (SST; CANTAB Cambridge Cognition Ltd.):*

156 The SST provides a measure of an individual's ability to inhibit a prepotent response.
157 Participants are instructed to select the right or left-hand button on a press pad in accordance
158 with the right or left-pointing directional arrow presented on the screen in front of them.
159 Following this trial phase, the participant is then instructed to withhold their response if they
160 hear an auditory signal. The 'stop signal' (beep) is randomized and occurs on 25% of trials with
161 a variable 'stop signal delay' (SSD) between the onset of the arrow stimulus and the auditory
162 tone. The variation of the SSD is dependent on the participant's performance, but adjusted
163 so that 'stopping' occurs approximately 50% of the time for all participants. Performance on
164 this task is measured by the number of directional errors (DE), median response time on GO
165 trials (GoRT), and the stop-signal reaction time (SSRT), which is an estimate of the time
166 between the go and stop stimuli that the participants has successfully inhibited their response
167 50% of the time (a higher SSRT score indicates poor inhibitory control).

168 *2.3 Procedure*

169 The study was approved by the university's ethics sub-committee. Assurances were given
170 regarding anonymity, confidentiality and participants' right to withdraw. Participants
171 provided informed consent and were awarded research participation pool points for their
172 time. Participants were instructed to work through a battery of questionnaires interspersed
173 with two computer tasks. These were presented in the order of: demographics, BIS-11, SST,
174 SPSRQ-SR, USBQ, IST, and AUQ, with the order of the IST and SST being reversed between
175 participants. All procedures took place in a dedicated research laboratory onsite and lasted
176 approximately 50 minutes.

177 **3 Results**

178 *3.1 Demographics*

179 Table 1 shows the demographic data for the low and high-binge drinking groups, and
 180 separately for males and females. The high-binge drinkers drank more units of alcohol per
 181 week, $t(87.06) = -4.14, p < .001$, and first became drunk at a younger age, $t(116) = 2.16, p =$
 182 $.033$. There was also a difference between the ages of the groups with the high-binge drinkers
 183 being slightly younger compared to the low-binge drinkers, $t(85.57) = 3.66, p < .001$. Gender
 184 was added to check for a potential confound effect; however, there were no significant
 185 differences between males and females on the binge drinking score, $t(120) = 1.56, p = .122$,
 186 and just a trend-level difference on alcohol units per week, $t(120) = 1.87, p = .065$,
 187 demonstrating a slightly higher alcohol intake reported for males compared to females.

188 **Table 1**

189 Demographic and alcohol use data for low-binge and high-binge drinkers and for males and
 190 females within each group.

Group characteristics	Low-binge drinkers			High-binge drinkers		
	Total	Males	Females	Total	Males	Females
Number	61	21	40	61	30	31
Age***	22.41	22.05	22.60	20.18	20.57	19.81
Alcohol units ¹ per	10.03	12.20	8.89	18.73	20.05	17.45
Binge drinking	12.85	13.41	12.56	47.21	48.33	46.13
Age of first drink	14.48	14.57	14.43	14.08	14.20	13.97
Age of first time	16.39	16.84	16.16	15.52	15.80	15.26

191 *Note.* ¹ One unit is 8g of alcohol. Data are presented as mean (SD). * $p < 0.05$, *** $p < 0.001$
 192 differences between groups (low/high-binge drinkers).

193 *3.2 Self-report impulsivity measures*

194 A one-way MANOVA examined group differences on all self-report measures of impulsivity,
195 except for the BIS-11 total score, and demonstrated an overall main effect of binge drinking
196 group [Wilks' Lambda=.81, $F(5,116) = 5.30$, $p < .001$, $\eta^2_p = .19$]. Univariate analyses revealed
197 differences between low and high-binge drinkers, using a Bonferroni adjusted alpha of .001,
198 on sensitivity to reward, $F(1,120) = 13.15$, $p < .001$, $\eta^2_p = .10$, motor impulsivity, $F(1,120) =$
199 13.01 , $p < .001$, $\eta^2_p = .10$, and non-planning impulsivity, $F(1,120) = 15.07$, $p < .001$, $\eta^2_p = .11$. A
200 trend-level difference was revealed for the "how impulsive are you" question from the USBQ,
201 $F(1,120) = 6.18$, $p = .014$, $\eta^2_p = .05$. There was no effect of binge drinking on attentional
202 impulsivity, $F(1,120) = 3.79$, $p = .054$, $\eta^2_p = .03$. A separate univariate analysis was conducted
203 between the BIS-11 total score and binge group due to the high correlation between the BIS-
204 11 total score and the other BIS-11 subscales ($r \geq .75$). Results revealed a significant difference
205 between binge drinking groups, $F(1,120) = 16.29$, $p < .001$, $\eta^2_p = .12$. In all self-report
206 impulsivity measures the high-binge drinking group scored higher than the low-binge drinking
207 group.

208 *3.3 Reflection-impulsivity: Information Sampling Task (IST)*

209 The IST analysis was conducted in two parts: firstly, a trial by trial analysis involving a series
210 of one-way ANOVAs to examine potential binge group differences on number of boxes
211 opened, $P(\text{correct})$, total errors and latency, and secondly, a within-subjects analysis to
212 determine a potential effect of condition on performance *across* the FW and DW trials.

213 As Table 2 demonstrates, binge drinking groups were found to perform similarly on all IST
214 variables in the FW condition. In contrast, the DW condition revealed a significant difference
215 between low and high-binge drinking group for boxes opened and $P(\text{correct})$. Examination of

216 the means reveals that the high-binge drinkers opened fewer boxes than the low-binge
 217 drinkers, and that their probability of being correct was lower than for the low-binge drinkers.
 218 A series of mixed-model ANOVAs were then conducted to examine potential differences
 219 across the FW and DW conditions (data not shown). There was a significant difference
 220 between the FW and DW condition on *all* IST variables ($ps < .001$, $\eta^2_p > .42$), demonstrating
 221 that overall *all* participants altered their performance across the FW and DW conditions. This
 222 finding suggests a sensitivity to the altered reward characteristics between the two conditions
 223 and a desire to win more points. No differences were revealed between binge drinking groups
 224 on any of the IST variables ($ps > .05$, $\eta^2_p < .03$; combined FW and DW scores).

225 **Table 2**

226 Mean, standard deviation and group differences between low and high-binge drinkers on
 227 the Information Sampling Task (N=122).

Information Sampling Task variables	Low-binge drinkers		High-binge drinkers		$F(1,120)$	p	η^2_p
	M	SD	M	SD			
FW Boxes opened	15.05	6.08	14.47	6.21	.27	.603	.00
FW $P(\text{correct})$.81	.11	.81	.12	.00	.968	.00
FW Total Error	1.51	1.31	1.33	1.26	.60	.440	.01
FW Latency(ms)	961.10	800.92	850.27	450.07	.89	.348	.01
DW Boxes opened	8.69	3.40	7.02	2.91	8.56	.004	.07
DW $P(\text{correct})$.70	.07	.67	.07	6.43	.013	.05
DW Total Error	2.70	1.46	3.10	1.45	2.23	.138	.02
DW Latency(ms)	1272.28	653.54	1392.20	657.30	1.02	.314	.01

228 *Note.* FW = Fixed Win condition; DW = Decreasing Win condition; η^2_p = partial eta squared.

229 **3.4 Response inhibition: Stop Signal Task (SST)**

230 Independent t-tests were conducted to examine group differences on the SST variables
231 [direction errors (DE), median reaction time on Go trials (GoRT), and Stop-Signal Reaction
232 time (SSRT)]. Results revealed one group difference for DE ($p = .028$, Cohen's $d = .41$)
233 demonstrating that the high-binge group committed more directional errors than the low-
234 binge group (e.g., pressing the left button for a right arrow). There were no binge drinking
235 group differences for GoRT or SSRT ($ps > .05$).

236 *3.5 Unplanned sexual behaviour questionnaire (USBQ)*

237 A one-way ANOVA was conducted to examine group differences for times reported engaging
238 in unplanned sexual behaviour (USB). Results revealed a significant difference for binge
239 drinking group, $F(1,120) = 4.76$, $p = .031$, $\eta^2_p = .04$, with the high-binge drinkers ($M=2.70$,
240 $SD=1.36$) reporting more episodes of USB than the low-binge drinkers ($M=2.18$, $SD=1.30$). In
241 further analysis, a bivariate correlation between all self-report measures of impulsivity and
242 the number of times engaged in USB revealed a positive association with all variables, except
243 the BIS-11 attentional scale (see Table 3). No relationship was revealed between the number
244 of times engaged in USB and either of the IST or SST outcomes. These findings suggest that a
245 proclivity to engage in USB is related to higher scores for reward sensitivity, motor and non-
246 planning impulsivity, and the self-reported impulsivity question from the USBQ (Q13), but
247 that it is not associated with the dimensions of impulsivity elicited by behavioural and
248 cognitive measures.

249 **Table 3**

250 Pearsons' correlation matrix between number of times engaged in unplanned sexual
251 behaviour and all self-report measures of impulsivity.

Impulsivity measure <i>N</i> = 122	Number of Times Reported USB	
	<i>r</i>	<i>p</i>
BIS Attentional	.17	.056
BIS Motor	.38***	<.001
BIS Non-planning	.30**	.001
BIS Total Score	.36***	<.001
SPSRQ-SR	.27**	.002
How impulsive are you? (USBQ)	.41***	<.001

252 *Note.* ** $p < 0.01$, *** $p < 0.001$. BIS = Barratt Impulsiveness Scale, version 11; SPSRQ-SR -
253 Sensitivity to Reward Questionnaire; USBQ – Unplanned Sexual Behaviour Questionnaire.

254 3.6 Regression analysis

255 A final analysis (Table 4) was conducted to examine the predictive relationship between binge
256 drinking, impulsivity and USB. The selection of predictors was determined by the power of
257 the aforementioned results (i.e., largest η^2_p). Preliminary analyses ensured no violations were
258 committed pertaining to assumptions of normality, linearity, and homoscedasticity. It was
259 anticipated that trait impulsivity may interact with binge drinking to influence engaging in
260 USB, therefore a product term was constructed from the binge score and the BIS-11 total
261 score prior to analysis. Both binge score and the BIS-11 total score were mean-centred prior
262 to analysis and the interaction term was constructed from the mean-centred variables to
263 minimise multicollinearity. Binge score and the BIS-11 total score were entered in Step 1 and
264 explained 18.3% of the variance in times engaged in USB. The product term of binge score
265 and BIS-11 total score was entered in Step 2 and explained an additional .35% of variance in
266 times engaged in USB. In the final model, both binge drinking and the BIS-11 total score were
267 significant predictors of times engaged in USB; however, the product term of trait impulsivity
268 and binge score was not significant (see Table 4).

269 **Table 4**

270 Hierarchical regression exploring interaction between impulsivity and binge drinking on
 271 times reported engaging in unplanned sexual behaviour.

Step and predictor variable	B	SE B	β	R^2	ΔR^2	t	p	sr^2
Step 1:				.18	.17***			
Binge score ^a	.02	.01	.26			2.83	.006	.05
BIS Total ^a	.03	.01	.26			2.86	.005	.06
Step 2:				.19	.00			
Binge score ^a	.02	.01	.28			2.81	.006	.05
BIS Total ^a	.03	.01	.25			2.79	.006	.05
BIS Total x Binge ^a	.00	.00	-.06			-.60	.553	.00

272 *Note.* *** p<.001. ^a = variables centred to avoid multicollinearity.

273 **4 Discussion**

274 The results are generally in line with prediction and revealed that a sample of heavier binge
 275 drinkers exhibited higher levels of trait impulsivity, reward sensitivity, and demonstrated
 276 impairments on a cognitive-behavioural task designed to measure reflection-impulsivity. In
 277 addition, the high-binge drinkers reported more episodes of unplanned sexual behaviour
 278 (USB), in comparison to low-binge drinkers. Furthermore, more impulsive individuals were
 279 found to report higher levels of USB, although interestingly, no interaction was demonstrated
 280 between impulsivity and binge drinking scores on episodes of USB in a regression analysis.
 281 Indeed, the results found here suggest that *both* binge drinking *and* an impulsive personality
 282 may be uniquely related to the tendency to engage in USB.

283 There is a plethora of research finding a positive relationship between alcohol use and USB
 284 and moreover, heightened impulsivity, or variants such as sensation seeking, have previously

285 been implicated in the relationship with risky sex [10]. However, there has been a paucity of
286 research incorporating binge drinking, USB and both trait and behavioural impulsivity in a
287 single study, and as such, these findings add to the existing literature; although further
288 replication of these findings is recommended. Nevertheless, the current study does
289 corroborate with the previous one by Townshend et al. [23], which found that high-binge
290 drinkers reported more episodes of USB and scored higher on a single self-report impulsivity
291 question, in comparison to the low-binge drinkers.

292 The discovery that the high-binge drinkers displayed higher levels of trait impulsivity and
293 reward sensitivity is congruent with previous research [29, 30]. Specifically, the high-binge
294 drinking group scored higher on non-planning and motor impulsiveness, suggesting a lack of
295 forethought and the tendency to act on the spur of the moment without regard for adverse
296 consequences. In addition, the high-binge drinkers reported higher levels on a reward
297 sensitivity measure suggestive of a heightened appetitive motivation towards binge drinking.
298 Indeed, these findings confirm previous factor analytic research proposing two distinct
299 components of impulsivity (i.e., *rash-spontaneous impulsivity* and *reward sensitivity*) that
300 appear to be positively associated with alcohol or substance use [31].

301 Further evidence for the multi-dimensional construct of impulsivity was demonstrated by the
302 finding that the high-binge drinkers opened fewer boxes and thus, significantly lowered their
303 probability of being correct [$P(\text{correct})$] in the Decreasing Win (DW) condition of the IST
304 (where points were deducted for each subsequent box opened). These findings partially
305 corroborate with previous studies; for example, the previous study by Townshend et al. [23]
306 demonstrated a similar difference between high and low binge drinkers, although this was
307 revealed in the Fixed Win (FW), not the DW condition. Research elsewhere has been mixed,

308 with some studies demonstrating a group difference between alcohol or cannabis users and
309 healthy controls on *both* conditions of the IST [32, 33], whereas others have failed to find a
310 difference on *either* condition [34, 29]. Nevertheless, the results found here are congruent
311 with a study by Bø, Aker, Billieux, and Landrø [35], who found that binge drinking was a
312 significant predictor of the probability of being correct [$P(\text{correct})$] in the DW condition, and
313 not the FW. This outcome suggests that the high-binge drinkers may have played the task
314 more strategically than the low-binge drinkers, with a group difference only transpiring with
315 the opportunity to accrue more points. As Bø et al. [35] assert, this may suggest that the binge
316 drinkers are more sensitive to the positive consequences of the DW condition, rather than
317 impaired decision making and evaluating information per se (the central tenets of reflection-
318 impulsivity).

319 An additional behavioural task, the SST, carried out to determine a difference between binge
320 drinking groups on response inhibition was not significant. This study failed to demonstrate a
321 group difference on either GoRT (the median response time on Go trials), or the key measure
322 of stop-signal reaction time (a higher SSRT is an index of impaired response inhibition).
323 However, the finding that high-binge drinkers committed more directional errors, in
324 comparison to low-binge drinkers, is in line with previous research demonstrating an impaired
325 performance on go accuracy errors from heavy drinkers [36]. Further research is warranted,
326 but these findings suggest that inaccuracy in performance on the SST may be indicative of a
327 difference in attention or cognitive impairment, which may be exacerbated in high-binge
328 drinkers. The lack of outcome on the SSRT variable may reflect the characteristics of this
329 sample (i.e., young adult social drinkers) as opposed to alcohol dependents, who have
330 previously been shown to demonstrate increased response inhibition [33].

331 A limitation of the current study is the cross-sectional design, thus prohibiting a causal
332 inference from the findings. Also, worthy to note is that the current sample was taken from a
333 single university in the UK and thus, findings may not generalise to other geographical or non-
334 student populations. Inarguably, taking into consideration the cohort of young adult students,
335 the co-occurrence of binge drinking and USB may be high anyway. However, an important
336 contribution to the existing literature in this area was the demonstration that elevated levels
337 of trait impulsivity were positively related to *both* binge drinking and times reported to
338 engage in USB. Furthermore, the finding that either high levels of trait impulsivity *or* binge
339 drinking may be predictive of USB is worthy of further attention.

340 Previous research has suggested that heightened impulsivity from a young age may engender
341 an individual to engage in early experimentation of risky behaviours, such as binge drinking
342 and unplanned and unprotected sexual activity [37]. In addition, prolonged binge drinking has
343 been evidenced to effect neural systems responsible for inhibitory control, thus exacerbating
344 impulsive behaviour and potentially creating a reciprocal cycle [13, 14]. As such, early
345 identification of individuals high in impulsivity may be advantageous in efforts and treatment
346 programs intended to reduce risky-type behaviours. In sum, the current study's findings
347 support the supposition that impulsivity is multi-dimensional and help to expand previous
348 research demonstrating that specific aspects of impulsivity may be influential in the
349 relationship with both binge drinking and USB.

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353 **Conflicts of interest**

354 The authors declare that they have no conflict of interest.

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