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.

**2 Methods**

*2.1 Participants*

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

*2.2 Measures*

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

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

A revised version of the AUQ [26] was used to establish drinking behaviour. The AUQ provides a binge score, as well as total alcohol units consumed per week. The binge score is calculated from the number of times being drunk (previous six months), percentage of times getting drunk when drinking (average), and speed of drinking (average drinks per hour). The median 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*(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 ≥ .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, $P$(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 $P$(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 | | $F(1,120)$ | $p$ | $\eta^2_p$ |
|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | | | |
| FW Boxes opened | 15.05 | 6.08 | 14.47 | 6.21 | .27 | .603 | .00 |
| FW *P*(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*(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; $\eta^2_p$ = 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 | Number of Times Reported USB | |
| --- | --- | --- |
| N = 122 | r | p |
| 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 $\eta^2_p$). 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 | $R^2$ | $\Delta R^2$ | 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 [$P$(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 [$P$(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].

16

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**

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

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