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The dual-process model in young adults with a consistent binge drinking trajectory into adulthood

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ABSTRACT

Background: Binge Drinking (BD) generally declines once students have left university. However, many individuals continue to partake in BD into adulthood, constituting a scarcely investigated high-risk group towards whom interventions should be prioritized. Following the dual-process model, we examined the relationship between BD and both the reflective system (executive functions) and the affective system (alcohol bias) in young adults with a consistent BD trajectory. We considered impulsivity as a moderator in the relationship between BD and alcohol bias.

Methods: A cohort of 63 (31♀) young adults were followed for eleven years (18–29 years old). In the last assessment, participants, with high and low drinking trajectories underwent neuropsychological assessment of executive functions (working memory [SOPT], cognitive flexibility [TMT −Verbal Fluency], inhibition [Stroop]) and alcohol bias (Addiction Stroop). The Barratt Impulsivity Scale measured impulsivity. Generalized linear mixed models and regression-based moderation models were applied.

Results: BD was associated with weak inhibitory control, poor working memory and greater alcohol bias moderated by non-planning impulsivity. At moderate levels of non-planning impulsivity, BD was associated with greater alcohol bias. This association was not found at high levels of impulsivity. These deficits were related to loss of control over drinking and severity of alcohol use.

Conclusions: The imbalance between poor cognitive control and greater alcohol bias may contribute to the persistence of BD into adulthood. The findings highlight the complexities of the dual-process model, with intervention implications.

1. Introduction

Binge drinking (BD), which is a prevalent pattern among young adults, is usually defined as the consumption within a short period of the amount of alcohol leading to a blood alcohol concentration of at least 0.8 g/l (National Institute on Alcohol Abuse and Alcoholism [NIAAA], 2004). This pattern peaks during late adolescence, generally in the early 20s, coinciding with the college/university years (Merrill and Carey, 2016), i.e., a period when the brain is still undergoing significant neuromaturational development (Fuhrmann et al., 2015). Later on, in emerging adulthood, there is generally a decline in alcohol use linked to adult role transitions (Winograd et al., 2012). However, a non-negligible number of individuals appear to maintain the BD pattern into adulthood (Jefferis et al., 2005; Moure-Rodríguez et al., 2016). Although scarcely investigated, these individuals constitute a group with a high risk of developing further complications such as alcohol use disorders or other substance use and related psychiatric comorbidities (Chassin et al., 2002; Viner and Taylor, 2007).

The incidence of BD during adolescence and young adulthood has been related to long-lasting neurocognitive alterations (Silveri et al., 2016). Previous studies have demonstrated that individuals who partake in BD have poor executive functions, among other deficits. In particular, BDs display difficulties in demanding working memory (WM) tasks that require self-monitoring of information (Carbia et al., 2017; Scaife and Duka, 2009; Townshend and Duka, 2005). Young BDs also seem to have difficulties in suppressing prepotent responses (Czapla et al., 2015) and regulating interference control (Winward et al., 2014a,b). These deficits may also favor the loss of control over drinking (López-Caneda et al., 2014), especially when combined with other features such as elevated trait impulsivity (Fernie et al., 2010; Shin et al., 2012; Stautz and Cooper, 2013). In addition to weak restraint, the presence of so-called alcohol-related cognitive bias may

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contribute further to perpetuating this pattern not characteristic of adults (Field et al., 2010).

Alcohol cognitive bias refers to the effect whereby alcohol cues become emotionally and motivationally salient at the expense of other stimuli (Field et al., 2004). The visual probe task typically measures this bias (see Field et al., 2014) and the addiction Stroop task, which has shown to have the greatest reliability of the two (Ataya et al., 2012). In the addiction Stroop task, slower color-naming of alcohol-related words is assumed to indicate involuntary processing of the semantic content of the words, which becomes interfering (Field and Cox, 2008). Overall, studies have provided mixed evidence for alcohol cognitive bias in young BDs, probably because of differences between samples (alcohol use criterion, other substance use, etc.) and variations in tasks (Ataya et al., 2012). Nonetheless, studies using similar methods have shown that young BDs appear to display alcohol cognitive bias related slow processes of maintenance or disengagement of attention from alcohol-related stimuli (Field and Cox, 2008). It has recently been suggested that impulsivity may act as a moderator between alcohol consumption and alcohol cognitive bias, as it may modulate the salience of alcohol cues by affecting the cognitive abilities of individuals, at least when considering addictive behavior in general (Coskunpinar and Cyders, 2013; Leung et al., 2017). Consequently, impulsivity may be a previously overlooked factor that contributes to the heterogeneous findings on alcohol bias.

Together, studies as mentioned above highlight that BD is linked to both cognitive and affective alterations, traditionally framed within the "dual-process model" (Gladwin et al., 2011). This model, which has been widely validated for alcohol dependence, posits that decisions regarding substance use result from an imbalance between an underactive or weak reflective system (e.g., executive functions) and an overactive affective system (e.g., alcohol cognitive bias; emotional/motivational evaluation of the stimuli) (Lannoy et al., 2014). An in-depth exploration of these two systems may help to define the key neurocognitive features that characterize the at-risk group of young people resistant to abandoning BD on entering adulthood, and it may ultimately provide valuable insights that can be applied in the design of target-focused interventions.

We have followed a cohort of students during a period of eleven years (18–29 years old). During this period, we have collected information regarding trajectories of alcohol use and during the last follow-up we administered a neuropsychological battery of tests to participants. We hypothesized that trait impulsivity would be associated with BD trajectory. In accordance with previous findings, we hypothesized that BD trajectory will be associated with poor executive functions (inhibition; working memory; cognitive flexibility) and greater alcohol bias, conditioned by impulsivity. In particular, difficulties in executive functions will be related to increased binge behaviour, whereas alcohol bias will be linked to alcohol severity, as reported in chronic alcoholism studies (Lannoy et al., 2014).

2. Material and methods

2.1. Participants

We carried out a cohort study of university students, between November 2005 and September 2016 (baseline [18 years-old]; 2-year follow-up [20 years-old]; 4-year follow-up [22 years-old]; 6-year follow-up [24 years-old]; 9-year follow-up [27 years-old]; and 11-year follow-up [29 years old]). We used cluster sampling to select the participants (for more information about the Compostela Cohort, see Caamaño-Isorna et al., 2017; Gómez et al., 2017; Moure-Rodríguez et al., 2016). Thus, at least one of the first-year classes was randomly selected from each of the 33 university faculties/schools (a total of 53 classes). The number of classes selected in each faculty/school was proportional to the number of students. All students present in the classes on the day of the survey were invited to participate in the study (n = 1363). In the final follow-up, we invited participants with continuous high alcohol consumption trajectories and participants with continuous low alcohol consumption trajectories to participate in a neuropsychological study. The exclusion criteria were as follows: severe motor or sensory deficits, history of any neurological or psychiatric disorders, medication that affects cognitive functions and family history of alcoholism in first degree relatives (due to the potential heritability of trait impulsivity, see Verdejo-García et al., 2008). On the day of testing, the subjects self-reported to be abstinent from alcohol for at least 48 h and to have slept well the night before. A total of 70 participants underwent a clinical interview and a neuropsychological assessment. Seven of them were excluded according to the exclusion criteria. The final sample comprised 63 participants. The individuals received monetary compensation (30 euros) for participation and gave their written informed consent. This study was approved by the Bioethics Committee of the Universidade de Santiago de Compostela.

2.2. General procedure

Participants provided information about their alcohol and substance use by completing a questionnaire on alcohol and other drug use within the classroom (1st and 2nd evaluation). Students who provided a phone number were subsequently evaluated by phone (3rd, 4th, 5th evaluation). In the final follow-up, we invited participants with previous high alcohol consumption trajectory (AUDIT-C [first three questions] score ≥ 4 at least in three assessments) and participants with continuous low alcohol consumption trajectory (AUDIT-C score < 4 in all assessments) and who had taken part in at least three epidemiological follow-ups to participate in a neuropsychological assessment. The total number of potential participants was 600. We ordered the potential participants by optimal continuity of low/high trajectories and sex (males non-BD = 118; males BD = 80; females non-BD = 143; females BD = 133) and contacted them by phone to invite them to participate in the final follow-up. The attrition levels throughout the follow-ups and the invariability of consumption variables over time (e.g., age of onset, AUDIT scores, other drug use) are reported in Supplementary Table 1. The follow-up samples are representative of the initial sample. Participants underwent neuropsychological assessment and a clinical interview by a trained psychologist blinded to participant status. Impulsivity (motor, cognitive and non-planning) was measured with the Barratt Impulsivity Scale (BIS). Executive functions were measured with the SOPT (WM); Stroop task (inhibition) and Verbal fluency and TMT (flexibility), whereas alcohol bias was measured with the addiction Stroop task. The Vocabulary subtest of the WAIS-III (Wechsler, 1997) was used to estimate the intellectual level. Alcohol use was measured with the AUDIT (Babor et al., 2001). None of the participants scored more than 20 in the AUDIT, which is usually considered a cut-off for alcohol dependence. At the last follow-up, participants also completed another questionnaire about other substance use and a calendar of alcohol consumption during the month prior to the evaluation (Alcohol Timeline Followback (Sobell and Sobell, 1995)). Current psychopathological symptoms were measured by the Global Severity Index (GSI) of the SCL-90-R (Degoratis, 1983).

2.3. Material

Self-Ordered Pointing Test (SOPT), abstract design version (Petrides and Milner, 1982). This test consists of a booklet of abstract designs repeated on all pages but in different positions. Subjects are asked to point out a different stimulus on each page without repeating previous choices. The test is divided into four blocks (6, 8, 10, and 12 stimuli), and each block consists of three trials. The SOPT assesses planning and self-monitoring aspects of WM. The variables considered were total number of errors and perseverative errors (pointing to the same item chosen on the immediately preceding page).

Addiction Stroop task (Sanchez-Lopez et al., 2015). In the first part