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Rash impulsiveness and reward sensitivity in relation to risky drinking by university students: Potential roles of frontal systems ☆

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ABSTRACT

Background: Two forms of impulsivity, rash impulsiveness and reward sensitivity, have been proposed to reflect aspects of frontal lobe functioning and promote substance use. The present study examined these two forms of impulsivity as well as frontal lobe symptoms in relation to risky drinking by university students.
Methods: University undergraduates aged 18–26 years completed the Alcohol Use Disorders Identification Test (AUDIT), Barratt Impulsiveness Scale (BIS-11), Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ), Frontal Systems Behavior Scale (FrSBe), and a demographics questionnaire assessing age, gender, and age of onset of weekly drinking (AOD).
Results: AUDIT-defined harmful drinkers reported earlier AOD and scored higher on BIS-11, the Sensitivity to Reward (SR) scale of the SPSRQ, and the Disinhibition and Executive Dysfunction scales of the FrSBe compared to lower risk groups. Differences remained significant after controlling for duration of alcohol exposure. Path analyses indicated that the influence of SR on AUDIT was mediated by FrSBe Disinhibition, whereas the influence of BIS-11 on AUDIT was mediated by both Disinhibition and Executive Dysfunction scales of the FrSBe.
Conclusions: Findings tentatively suggest that the influence of rash impulsiveness on drinking may reflect dysfunction in dorsolateral prefrontal and orbitofrontal systems, whereas the influence of reward sensitivity on drinking may primarily reflect orbitofrontal dysfunction. Irrespective of the underlying functional brain systems involved, results appear to be more consistent with a pre-drinking trait interpretation than effects of alcohol exposure.

1. Introduction

Research on the etiology of risky or problematic alcohol use has pointed to a complex interaction of genetic, developmental and environmental factors. Findings have implicated neurobiological and personality variables that preceded alcohol exposure as well as neurobehavioral deficits attributed to the duration and severity of alcohol exposure (Kreek, Nielsen, Butelman, & LaForge, 2005; Lyvers, 2000; Simons, Gaher, Correia, Hansen, & Christopher, 2005; Varma, Basu, Malhotra, Sharma, & Mattoo, 1994; Verdejo-García, Rivas-Péreza, López-Torrecillasa, & Pérez-García, 2006; Volkow & Li, 2004). Deficits of frontal lobe functioning and associated cognitive and behavioral manifestations have been attributed by some researchers to the cumulative effects of chronic alcohol misuse (Lyvers, 2000; Oscar-Berman & Marinkovic, 2007; Verdejo-García, Bechara, Recknor, & Pérez-García, 2006) and/or an early onset age for excessive alcohol use at a vulnerable time of cortical development (Crews, He, & Hodge, 2007; Pitkänen, Lyyra, & Pulkkinen, 2005). However, an alternative case can be made that to some extent such deficits may have predated the exposure to alcohol and may have predisposed to problematic drinking (Dawe, Gullo, & Loxton, 2004; Lyvers, Czerczyk, Follent, & Lodge, 2009; Lyvers, Duff, & Hasking, 2011). Such factors may include an inherited imbalance in the neural interactions between the prefrontal cortex and subcortical regions involved in reward and risk processing (Dawe et al., 2004; Spinella, 2003; Van Leijenhorst et al., 2010), as well as inherent personality traits such as appetitive impulsivity and aversive neuroticism (Hair & Hampson, 2006; Kambouropoulos & Staiger, 2007; Schmidt, Buckner, & Keough, 2007; Zuckerman & Kuhlman, 2000).

Impulsivity is a trait known to be linked to frontal lobe functioning (Berlin, Rolls, & Kischka, 2004; Chen et al., 2007; Elliott & Deakin, 2005; Franken, van Strien, Nijs, & Muris, 2008; Schoenbaum & Shaham, 2008; Yacubian et al., 2007) as well as problematic drinking and other forms of substance misuse (Dawe & Loxton, 2004; Dawe et al., 2004; Hanson, Luciana, & Sullwold, 2008; O'Connor & Colder, 2005; Simons et al., 2005; Spinella, 2004). Dawe et al. (2004) distinguished between two forms of impulsivity that promote excessive substance use: reward sensitivity and rash impulsiveness. Reward sensitivity refers to the degree to which behavior tends to be

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motivated by the prospect of positive reinforcement, and according to Dawe et al. can be measured by the SR scale of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Ávila, Moltó, & Caseras, 2001). Rash impulsiveness refers to acting without due regard for negative consequences, and according to Dawe et al. can be measured by the Barratt Impulsiveness Scale (BIS-11; Patton, Stanford, & Barratt, 1995). Different brain systems were proposed to underlie these two forms of impulsivity, i.e., the mesolimbic dopamine system for reward sensitivity and the orbitofrontal cortex and anterior cingulate for rash impulsiveness. Dawe et al. suggested that reward sensitivity may play a major role in the onset of regular substance use, whereas rash impulsiveness may promote ongoing excessive or problematic substance use despite adverse outcomes. Dawe et al.'s distinction between two forms of impulsivity that promote risky or problematic alcohol or other substance use has recently been supported in multiple large samples (Gullo, Dawe, Kambouropoulis, Staiger, & Jackson, 2010; Gullo, Ward, Dawe, Powell, & Jackson, 2011).

Lyvers et al. (2011) recently assessed a community sample of social drinkers on the SR and BIS-11 measures of reward sensitivity and rash impulsiveness, respectively, as well as on the Frontal Systems Behavior Scale (FrSBe; Grace & Malloy, 2001). The FrSBe has three scales designed to assess behavior changes associated with damage to three prefrontal systems: the Apathy scale (anterior cingulate dysfunction), the Disinhibition scale (orbitofrontal dysfunction), and the Executive Dysfunction scale (dorsolateral prefrontal dysfunction). As predicted by Dawe et al. (2004), both SR and BIS-11 were positively associated with risky drinking as defined by the Alcohol Use Disorders Identification Test (AUDIT; Babor, de la Fuente, Saunders, & Grant, 1992). However, contrary to Dawe et al.'s model there was no association of risky drinking with the FrSBe Apathy scale implicating the anterior cingulate; rather, both the Disinhibition and Executive Dysfunction scales of the FrSBe were positively associated with risky drinking, potentially implicating orbitofrontal and dorsolateral prefrontal dysfunction respectively. Findings were consistent with the hypothesis that inherently poorer frontal lobe functioning, manifesting as high levels of sensitivity to reward and rash impulsiveness, may reflect risk factors for problematic alcohol consumption. The FrSBe Disinhibition scale was strongly related to both SR and AUDIT, consistent with evidence that patients with orbitofrontal damage exhibit abnormally elevated sensitivity to reward (Hornak et al., 2004) and are at increased risk of problematic substance use (Spinella, 2003). Further, consistent with the hypothesized role of reward sensitivity, Lyvers et al. (2011) found an inverse relationship between SR and the age at which an individual started drinking weekly (AOD), suggesting that over-responsiveness to reward contingencies influences the drinking-related choices made at younger ages (Crews et al., 2007; Loxton & Dawe, 2001; Monti et al., 2005; Pardo, Aguilar, Molinuevo, & Torrubia, 2007; Volkow & Li, 2004). By contrast the FrSBe Executive Dysfunction scale was strongly related to BIS-11 and AUDIT, consistent with a theoretical link between impaired executive control, rash impulsiveness and problematic drinking (Lyvers, 2000). Alcoholics have been reported to exhibit high levels of rash impulsiveness (Ketzenberger & Forrest, 2000) and tend to make excessive errors on the Wisconsin Card Sorting Test, a neuropsychological task sensitive to dorsolateral prefrontal cortical functioning (Dolan, Bechara, & Nathan, 2008; Smith, Perdices, O'Sullivan, Large, & Barrett, 1997).

The majority of the community sample recruited by Lyvers et al. (2011) across a broad age range of 18–68 years consisted of Low risk drinkers by AUDIT criteria, which compromised the sensitivity of the study to factors associated with AUDIT-defined Harmful drinking (only 9% of their sample). The present study utilized the same measures in an Australian university student sample aged 18–26 years, a group known to be characterized by high levels of both Hazardous and Harmful drinking (Hasking, Lyvers, & Carlopio, 2011; Lyvers, Hasking, Hani, Rhodes, & Trew, 2010; Lyvers et al., 2009). Relationships of the Disinhibition and Executive Dysfunction indices of the FrSBe with the two dimensions of impulsivity (as proposed by Dawe et al., 2004) and drinking were explored with a view to identifying how these dimensions of impulsivity may be related to harmful drinking as an expression of dysfunction in frontal systems. Based on the recent findings of Lyvers et al. (2011) we expected to obtain evidence that AUDIT-defined Harmful drinking is related both to high reward sensitivity and rash impulsiveness in young adult social drinkers. We further hypothesized that the relationship between the SR index of reward sensitivity and drinking as assessed by AUDIT scores would be mediated via the FrSBe index of orbitofrontal dysfunction, the Disinhibition scale, whereas the relationship between the BIS-11 index of rash impulsiveness and AUDIT scores would be mediated via the FrSBe index of dorsolateral prefrontal dysfunction, the Executive Dysfunction scale.

2. Method

2.1. Participants

The 124 university student participants were 84 females and 40 males who all reported drinking alcohol at least occasionally. These psychology and marketing undergraduate students were all recruited at Bond University and participated for course credit. Ages ranged from 18 to 26 years ($M = 20.08$ years, $SD = 1.72$). The sample was characterized by very low rates of both illicit drug use and smoking.

2.2. Materials

The *Alcohol Use Disorders Identification Test* (AUDIT; Babor et al., 1992) contains 10 questions consisting of 3 quantity/frequency questions (e.g. "How often do you have a drink containing alcohol?"), 3 dependence-related items (e.g. "How often during the last year have you failed to do what was normally expected of you because of drinking?"), and 4 alcohol-related consequences or harm questions (e.g. "Have you or someone else been injured because of your drinking?"). Every AUDIT question is scored from 0 to 4, with an overall score ranging from 0 to 40. The suggested cut-offs are 1–7 for Low risk drinking, 8–15 for Hazardous drinking and 16+ for Harmful drinking (Babor et al.). Internal consistency is high ranging from $\alpha = .80$ (Kane, Loxton, Staiger, & Dawe, 2004) to $\alpha = .94$ (Pal, Jena, & Yadav, 2004). Temporal stability is also high ranging from $r = .87$ over one week (Rubin et al., 2006) to $r = .93$ and .95 over four weeks (Bergman & Källmén, 2002; Dybek et al., 2006). Convergent validity with the Michigan Alcoholism Screening Test has been established (Pal et al., 2004).

The *Frontal Systems Behavior Scale* (FrSBe; Grace & Malloy, 2001) is a 46-item scale assessing everyday behaviors associated with dysfunction in three major prefrontal cortical systems. The FrSBe has three corresponding subscales: Apathy (poor initiation, reduced drive and interest, e.g., "Sit around doing nothing"; anterior cingulate dysfunction), Disinhibition (restlessness, risk taking, socially inappropriate behavior, e.g., "Do or say embarrassing things"; orbitofrontal dysfunction), and Executive Dysfunction (problems with learning, sequencing, working memory, and mental flexibility, e.g., "Make the same mistakes over and over, do not learn from past experience"; dorsolateral prefrontal dysfunction). The standard version of the self rating form of the FrSBe measures behavioral change by obtaining pre- and post-lesion ratings. For the purposes of this study and in keeping with previous research (Lyvers, Onuoha, Thorberg, & Samios, 2012; Lyvers et al., 2009, 2011; Spinella, 2003; Verdejo-García, Rivas-Péreza, López-Torrecillasa, & Pérez-García, 2006) only current self-ratings were obtained. Items are rated on a 5 point Likert-type scale from 'almost never' to 'almost always'. The first 32 items represent deficits and are rated accordingly, with the final 14 positively stated items reverse scored. Scores are summated in each subscale to indicate the degree of impairment. Factor analyses of the FrSBe in clinical populations have