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Risk-taking but not response inhibition or delay discounting predict alcohol consumption in social drinkers

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ABSTRACT

Impulsivity and risk-taking are multi-dimensional constructs that have been implicated in heavy drinking and alcohol problems. Our aim was to identify the specific component of impulsivity or risk-taking that explained the greatest variance in heavy and problem drinking among a sample of young adults recruited from a university population. Participants ($N=75$) completed a test battery comprising two commonly used response inhibition tasks (a Go/No-Go task and a Stop signal task), a delay discounting procedure, and the Balloon Analogue Risk Task (BART) as a measure of risk-taking. Participants also completed the Barratt Impulsivity Scales (BIS) as a measure of trait impulsivity. In a hierarchical multiple regression model, risk-taking was identified as the only behavioural measure that predicted alcohol use and problems. In a secondary analysis, we demonstrated that risk-taking predicted unique variance in alcohol use and problems over and above that explained by trait impulsivity. Results suggest that among young adults, a behavioural measure of risk-taking predicts variance in alcohol consumption and alcohol problems, even when individual differences in trait impulsivity are statistically controlled. However, behavioural measures of response inhibition and delay discounting do not predict unique variance in alcohol use in young adult social drinkers.

1. Introduction

Current theories of addiction posit that increased impulsivity plays a key role in loss of control over alcohol and other drug use (Goldstein and Volkow, 2002; Jentsch and Taylor, 1999; Robinson and Berridge, 2001; Wiers et al., 2007). "Impulsivity" encompasses behaviours that are rash, poorly planned, or focus on short-term outcomes despite potentially negative consequences in the long-term (Ainslie, 1975; Dawe and Loxton, 2004). While risk-taking and impulsivity are considered to be overlapping constructs, they are not synonymous (Meda et al., 2009). Impulsivity itself is a multiple component construct (Lane et al., 2003; Meda et al., 2009; Reynolds et al., 2008) that is related to alcohol use and abuse (McAdams and Donnellan, 2009; Nigg et al., 2006; Stoltenberg et al., 2008; Von Diemen et al., 2008). However, to date few studies have investigated whether one specific component of impulsivity or risk-taking is a better predictor of alcohol use and alcohol problems than any other.

Several authors have suggested that two independent processes may contribute to impulsive behaviour (de Wit and Richards, 2004; Olmstead, 2006; Reynolds et al., 2006). The first process is impulsive decision-making, or 'cognitive impulsiveness' (Olmstead, 2006), where the choices or decisions of more impulsive individuals are influenced by the immediately available outcomes despite their long-term consequences. The second process is deficient inhibitory control, or 'motor impulsiveness' (Olmstead, 2006), which results in individuals having difficulty suppressing reward-driven behaviour or prepotent responses.

Impulsive decision-making has been identified largely on the basis of experiments using the delay discounting procedure. With this paradigm, preference for smaller, immediately available rewards over larger rewards that are only available after a delay indicates greater delay discounting which has been interpreted as increased impulsivity (Bickel et al., 2008; Madden et al., 1997). Alcoholics show increased delay discounting relative to healthy controls (Mitchell et al., 2005; Petry, 2001) while greater discounting has also been related to heavy or hazardous drinking in non-dependent samples (Field et al., 2007; Vuchinich and Simpson, 1998). However, the results are not consistent across studies and this association with alcohol problems or consumption has not been uniformly found (e.g. Kirby and Petry, 2004; MacKillop et al., 2007) making the utility of the delay discounting task as a predictor of alcohol use uncertain.

Tasks measuring inhibitory control operate on the basis of developing a prepotent response to one stimulus while requiring inhibition of responding when a different stimulus is presented. The most widely used examples of such tasks are Go/No-Go tasks and the Stop signal or Go Stop task (Logan, 1994; Logan and Cowan,

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1984). Within individuals, performance on the Go/No-Go and Stop tasks are highly correlated (Reynolds et al., 2006). Go/No-Go tasks vary in complexity and can be as simple as requiring responses to the appearance of one stimulus on-screen and no responses (inhibitions) to the rarer appearance of another (e.g. Archibald and Kerns, 1999), to more complex tasks where responses to multiple stimuli must be inhibited and this discrimination must be learned (e.g. Patterson et al., 1987). Using the Go/No-Go procedure, Colder and O'Connor (2002) found inhibition errors to be associated with heavy drinking, although Kamarajan et al. (2005) found no evidence for increased inhibition errors in alcoholics compared to controls. These tasks have also identified an inhibitory control impairment in abusers of other substances such as cocaine (Lane et al., 2007; Verdejo-García et al., 2007).

In the Stop signal task, individuals must make rapid discriminative manual responses to visually presented stimuli (Go signals). On a minority of trials an auditory or visual 'Stop' signal is presented after some delay and this signals that the participant must inhibit their response to the Go stimulus. The Stop task has revealed slower stop signal reaction times (indicative of impaired inhibition) in alcoholics compared to controls (Goudriaan et al., 2006). In social drinkers the relationship between heavy drinking and impaired inhibition may be moderated by gender, with pronounced deficits in female, but not male, heavy drinkers (Nederkoorn et al., 2009). The Stop task has also revealed deficient inhibitory control in illicit substance misusers relative to controls (Fillmore and Rush, 2002; Li et al., 2006; Monterosso et al., 2005) and in problem gamblers (Goudriaan et al., 2006). The distinction between cognitive and motor impulsivity has been confirmed using factor or principal components analyses with the tasks measuring each process loading onto different factors (e.g. Lane et al., 2003; Reynolds et al., 2006; Solanto et al., 2001). However, the inconsistent results across behavioural studies cited above mean that it is not currently possible to identify which task best predicts alcohol use and problems among non-dependent drinkers. Resolution of this issue would provide an insight into which facet of impulsivity is implicated in the development of heavy drinking and problems, or which specific aspect of increased impulsivity may arise as a consequence of chronic heavy drinking.

The definition of impulsiveness given above also includes behaviours that are 'risky'. While one could argue that cognitive and motor impulsivity could account for risky behaviour by, for example, a failure to inhibit risk-taking or a focus on the short-term thrill rather than long-term consequences of risky activities, some have suggested that risk-taking may be a further distinct aspect of impulsivity that is more closely associated with substance abuse and heavy drinking than the other two processes (Lejuez et al., 2007, 2003a,b; Meda et al., 2009). This is because risky behaviour is not unambiguously disadvantageous – risky behaviours yield positive consequences, including peer approval and the pleasurable effects of substance intoxication, and these may (subjectively) outweigh long-term consequences, particularly if the inherent risk is perceived to be low (Gamma et al., 2005; Lejuez et al., 2003a; Skeel et al., 2008). Thus risk-taking may contribute additional information to understanding the relationship between impulsivity and alcohol use and abuse. Risk-taking has most recently been assessed with the Balloon Analogue Risk Task (BART; Lejuez et al., 2002) in which participants must inflate simulated balloons for money or points, but bank these points before the balloons burst. Performance on the BART explains variance in real-world risk-taking (Aklin et al., 2005; Lejuez et al., 2002), has successfully differentiated between smokers and non-smokers (Lejuez et al., 2003a), and interacts with personality measures (Tridimensional Personality Questionnaire; Cloninger, 1987; Cloninger et al., 1991) to predict alcohol consumption (Skeel et al., 2008) although this result has yet to be replicated. However, performance on this task has also been found to load onto the same factor as delay discounting in a student sample (Reynolds et al., 2006) although this result has also yet to be replicated or related to alcohol use.

Impulsivity has also been considered as a personality trait which can be measured with self-report questionnaires, such as the Barratt Impulsivity Scales (BIS-11; Patton et al., 1995). Scores on the BIS-11 are consistently positively correlated with elevated alcohol consumption, or alcohol problems, in adolescents and in adults (e.g. Gunnarsson et al., 2008; McAdams and Donnellan, 2009; Von Diemen et al., 2008; Von Knorring et al., 1987). While there is evidence that subjective self-reports and behavioural measures are not related (Dom et al., 2007; Lane et al., 2003; Reynolds et al., 2006) a recent report (Meda et al., 2009) suggests that there is overlap between at least one behavioural measure of delay discounting (Experiential Discounting Task; Reynolds and Schiffbauer, 2004) and one self-report scale (the Behavioural Inhibition Scale; Carver and White, 1994). We included the BIS-11 in the present study in order to examine whether behavioural measures of impulsivity would explain variance in alcohol use and problems, over and above that explained by self-report questionnaire measures.

Given the inconsistent results across studies investigating the relationship between impulsivity/risk-taking and alcohol consumption summarized above, the current study was designed to examine which behavioural measure(s) would explain the most variance in alcohol use in young adults. To this end, we used two commonly administered response inhibition tasks (Go/No-Go and Stop signal), a delay discounting procedure, and the BART as a measure of risk-taking to test which was the best predictor of alcohol consumption. The inclusion of four behavioural tasks also afforded the opportunity to examine the independence of these different components of behavioural impulsivity as reported by Reynolds et al. (2006) who reported that behavioural inhibition measures were unrelated to measures of delay discounting and risk-taking, although the latter two measures loaded onto the same underlying factor. As in the Reynolds et al. study, we used a computerized delay discounting procedure which allowed us to investigate whether the relationship between alcohol consumption and cognitive impulsivity that was found using a paper and pencil version of the delay discounting procedure (Field et al., 2007) could be replicated using an easily administered computerized version (Kowal et al., 2007).

2. Methodology

2.1. Participants

Seventy-five participants were recruited from the staff and students at the University of Liverpool through email and poster advertisements and through word of mouth. The text of advertisements aimed to recruit a broad range of social drinkers, from those who consumed alcohol very infrequently (at least once per week) up to those who drank heavily on a regular basis; however people who did not drink alcohol were excluded. Participants were required to speak fluent English, to have normal or corrected to normal eyesight and have a minimum age of 18. Exclusion criteria included self-reported alcohol dependence, or having received advice from a medical practitioner to stop or cut down drinking. All participants provided informed consent. The Research Ethics Committee in the School of Psychology at the University of Liverpool approved the study. Participants received course credit or a £5 honorarium for their participation.

2.2. Laboratory behavioural tasks

2.2.1. Stop task – Fillmore and Vogel-Sprott (1999). A computerized Stop task was programmed using Inquisit software (version 2.0) (Millisecond, 2006). Each trial began with the presentation of a fixation symbol (#) for 500 ms, followed by the presentation of one of four letter stimuli (A, B, C, or D) in the centre of the computer screen. Participants were told to rapidly respond to each letter stimulus as quickly as possible by pressing one of two buttons on a parallel port response box. One button was assigned to the letters A and C, the other button was assigned to letters B and D. This discrimination means that participants must maintain attention on the task at hand (Avila and Parcet, 2001; Corbin and Cronce, 2007; Fillmore and Vogel-Sprott, 1999) and the task is more difficult than a simpler two-option discrimination (Logan et al., 1997; Rubia et al., 1998). On 25% of trials ('Stop' trials) a 900 Hz tone