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Dependent heroin use and associated risky behaviour: The role of rash impulsiveness and reward sensitivity

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HIGHLIGHTS

- We studied the 2-factor model of impulsivity in relation to heroin dependence.
- Reward sensitivity (RS) is associated with initiation.
- Rash impulsiveness (RI) is associated with a number of risky behaviours.
- RS and RI have distinct roles in heroin dependence.

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ABSTRACT

Impulsive temperament has long been considered as a risk factor for substance use disorders (SUD). Considering the heterogeneity of impulsivity, a biologically-based 2-factor model incorporating reward sensitivity and rash impulsiveness facets, has been proposed. Here we report how these two facets of impulsiveness could be associated with different aspects of dependent heroin use and associated risky behaviour. Two hundred and ninety three dependent heroin users and 232 non-users were assessed on reward sensitivity, rash impulsivity, and the related trait of punishment sensitivity. After adjusting for multiple comparisons, heroin users were found to be more rash-impulsive and reward-sensitive than non-users ($p < 0.001$). Within users, rash impulsivity was associated with high risk behaviour including escalating heroin consumption, injecting heroin use, hazardous drinking, low treatment-seeking and risky sexual behaviour. Reward sensitivity was uniquely associated with early onset of drug use. While greater impulsivity is a common trait in drug users compared with non-users, the use of a 2-factor model of impulsivity provides additional information regarding specific aspects of drug initiation and maintenance that can be targeted in the prevention and treatment of heroin dependence.

1. Introduction

The aetiology of substance use disorders (SUD) is complex: individual, biological and environmental factors interact to produce diverse addiction-related phenotypes. Many personality traits have been implicated in the development and maintenance of substance misuse (Dawe et al., 2007). Traits associated with an impulsive temperament, in particular, have been consistently reported to be associated with substance use disorders in general (James & Taylor, 2007), alcohol abuse and dependence (Carlson, Johnson, & Jacobs, 2010; Shin, Hong, & Jeon, 2011), club-drug use (Loxton et al., 2008) and with initial drug experimentation, continuing drug use and relapses (e.g., Everitt et al., 2008). Indeed, trait impulsivity measured in young children is a key predictor of alcohol use and drug experimentation in adolescents (Fergusson, Boden, & Horwood, 2008; Tarter et al., 2003) and conveys

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a greater risk than socioeconomic status and intelligence (Caspi, 2000). Further, previous evidence suggests impulsivity as a mediator of the genetic basis for SUD (Ducci & Goldman, 2008).

Dawe and colleagues have described a two dimensional model of impulsivity, consisting of 1) reward sensitivity (also referred to as Reward Drive) and 2) rash impulsivity as pertinent in relation to substance use disorders (Dawe, Gullo, & Loxton, 2004; Dawe & Loxton, 2004). Using Gray's Reinforcement Sensitivity Theory (RST), reward sensitivity refers to individual differences in sensitivity to noticing, and increased motivation in obtaining, conditioned and unconditioned rewards (Gray, 1970; Gray & McNaughton, 2000). Rash impulsiveness (reflecting traditional models of impulsiveness) is the tendency to persevere in approach behaviours regardless of outcomes. The prefrontal cortex (PFC) is the proposed neural substrate for rash impulsivity (Dawe et al., 2004; Horn, Dolan, Elliott, Deakin, & Woodruff, 2003) and the mesolimbic dopaminergic system is thought to mediate reward sensitivity (Pickering & Gray, 1999). RST also includes traits associated with punishment sensitivity mediated by the Behavioural Inhibition System (BIS) and the Fight/Flight/Freeze System (FFFS), although purpose-built measures of FFFS have only recently been published and are untested in drug-using populations (see Smillie, Loxton, & Avery, 2011).

The impact of neuro-cognitive variables such as personality on addictive behaviour may change as the addiction develops (Kreek, Nielsen, Butelman, & LaForge, 2005). Dawe and Loxton (2004) proposed that reward sensitivity is more likely to be involved in the initiation and experimentation with drugs and sensitization of the neural circuitry to reward cues. In line with this, subsequent studies have found that reward sensitivity is associated with earlier onset of drinking (Lyvers, Duff, & Hasking, 2011; Pardo, Aguilar, Molnuevo, & Torrubia, 2007). Individuals with increased reward sensitivity readily respond to the rewarding effects of drugs and develop stronger conditioned learning response that gives more salience to drug-associated cues (Robinson & Berridge, 2003).

Both reward sensitivity and rash impulsivity are higher in hazardous drinkers and illicit drug users (Gullo, Ward, Dawe, Powell, & Jackson, 2010; Loxton, Nguyen, Casey, & Dawe, 2008). However, rash impulsivity, but not reward sensitivity, is associated with poly-drug abuse and higher levels of hazardous drinking (Loxton, Wan, et al., 2008; Lyvers et al., 2011). Findings on punishment sensitivity (i.e., BIS) in addiction have been mixed, with most studies finding either low punishment sensitivity associated with substance use and abuse (e.g., Loxton, Wan, et al., 2008; Pardo et al., 2007) or no relationship (Kambouropoulos & Staiger, 2007; Loxton & Dawe, 2007). Thus, it is unclear how punishment sensitivity features in substance misuse.

Better understanding of the mechanisms driving different phases of addiction (e.g., drug experimentation; age of onset; maintenance) can help the design of personalized intervention and treatment programs (Conrod, Castellanos-Ryan, & Mackie, 2011). However, few studies have tested the two-factor impulsivity model in addiction and even fewer have specifically examined this model with substance-dependent individuals (Gullo et al., 2010; Loxton, Wan, et al., 2008). Here we investigate how these two dimensions of impulsivity are associated with SUD in a sample of dependent heroin users and ethnically-matched non-users. We hypothesised that 1) both dimensions of impulsivity differentiate dependent heroin users from non-users; 2) reward sensitivity, but not rash impulsivity, is associated with earlier initiation of heroin use; 3) rash impulsivity is a better predictor of high-risk drug-related problems; and 4) punishment sensitivity is protective against high-risk drug-related behaviours. This is a novel study in that these traits were tested in a unique sample of heroin users in a culture in which any substance use is considered an aberrant behaviour. The ability to obtain a control sample with virtually no lifetime substance use is also another unique element in this study.

2. Methods

2.1. Study sample

The participants for this study were selected from a database of 320 male heroin users in a prison rehabilitation facility and 278 non-drug-using male subjects that were recruited for a genetic study of dependent heroin use in Sri Lanka. The heroin users had been imprisoned for a period ranging from 2 to 33 months at the time of the study. The selection criteria for the heroin users for this study include dependent heroin use according to DSM-IV criteria, Sinhalese ethnicity, absence of any other major psychiatric illnesses and that imprisonment was solely for drug use related charges. A control group of male subjects who never used illicit drugs and who did not have a past history of major psychiatric illness was selected, while primarily attempting to match for age and ethnicity. The final group consisted of 293 heroin users and 232 non-drug users. Written informed consent was obtained from all the subjects. The human research ethics committee of the Faculty of Medicine, University of Peradeniya approved the study.

2.2. Data collection

Data on substance use were collected using a battery of interviewer administered questionnaires relating to the period immediately prior to imprisonment for the heroin users and for the period leading up to the interview for the control subjects.

2.2.1. Demographics and sexual behaviour

Data were collected using a battery of interviewer administered questionnaires consisting of questions regarding selected demographics and sexual behaviour. The demographics included age, level of education, occupation and marital status. Questions on sexual behaviour included sexual orientation and risky sexual practices such as having sex with multiple partners including commercial sex workers, unprotected sex and sex for money.

2.2.2. Substance use

Age of initiation of substance use, the pattern of substance use, poly-drug use, injecting drug use and treatment-seeking were used as drug-related variables. For the present study, poly-drug use was defined as taking more than one drug excluding alcohol and tobacco during the same time period. The Alcohol Use Disorders Identification Test (AUDIT) was used to assess participant's alcohol consumption (Saunders, Aasland, Babor, De La Fuente, & Grant, 1993).

2.2.3. Personality

Three personality inventories were used.

2.2.3.1. Reward and punishment sensitivity. Reward and punishment sensitivity were assessed using the Behavioural Inhibition System/Behavioural Activation System (BIS/BAS) scales (Carver & White, 1994) and the Sensitivity to Punishment and Sensitivity to Reward Questionnaire, Short Version (SPSRQ-SV) (O'Connor, Colder, & Hawk, 2004). The BIS/BAS questionnaire consists of 20 items assessing a single BIS scale and three BAS subscales: BAS drive (BAS-Drv), BAS fun seeking (BAS-FS) and BAS reward responsiveness (BAS-RR). The SPSRQ-SV is a 35-item scale that yields sub-scales of Sensitivity to Punishment (SP) and Sensitivity to Reward (SR). Thus, the BAS subscales and SR scale were used to assess reward sensitivity, whereas the BIS and SP scales were used to assess punishment sensitivity.

2.2.3.2. Rash impulsivity. Rash impulsiveness was assessed using the 40-item Zuckerman Sensation Seeking Scale (SSS) (Zuckerman, 1994). This scale measures 4 dimensions of sensation seeking: thrill and adventure seeking (TAS), experience seeking (ES), disinhibition