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

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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. Whilst 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.

Key words: heroin dependence, personality, reward, impulsivity

1 Introduction

The ætiology 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 (Shin, Hong, & Jeon, 2011; Carlson, Johnson, & Jacobs, 2010), club-drug use (Loxton, Wan, 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 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, Gullo, & Loxton, 2004; Horn, Dolan, Elliott, Deakin, & Woodruff, 2003) and the mesolimbic dopaminergic system is thought to mediate reward sensitivity (Pickering,

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 that 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, Delafuente, & 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 (DIS) and boredom susceptibility (BS). As in previous studies, to avoid the risk of criterion contamination, items related to drinking or drug use were excluded from the analysis (e.g., Andrew & Cronin, 1997, Loxton, Wan, et al., 2008). For this study, the Sinhalese translations of all scales were used (Dissabandara, Loxton, Dias, Daglish, & Stadlin, 2011).

2.3 Data analysis

Percentages and means were calculated for the demographic variables and compared between heroin-dependent subjects and non-drug users using either chi-square for frequency level data or independent sample t-tests for continuous level data. The association between personality traits and heroin-dependent group status (heroin-users vs non-users) was tested using binomial logistic regression. Given the significant differences in age, level of education, marital status, occupation, alcohol use and tobacco smoking were found between heroin-dependent and control subjects, they were included as covariates. The association between personality traits and risky behaviours among heroin users only were tested using binomial logistic regression for dichotomous outcome variables (users and non-users of poly-drugs, injecting-drugs and risky sexual behaviour) and multiple regression for continuous outcome variables (age of first drug use, daily dose of heroin and AUDIT score). Age and level of education were included as covariates in all analyses within the heroin-dependent group. To account for multiple comparisons, a conservative Bonferroni correction was made, setting the alpha level at 0.007 (0.05/7) to be considered statistically significant. All analyses were done using SPSS 17 software (SPSS Inc.).

3 Results

3.1 Demographics

Demographic characteristics of heroin-dependent and non-drug users are summarised in Table 1. The age and level of education differed significantly between heroin users and non-users, with heroin users being younger and less educated than non-drug users. The heroin users also use alcohol and tobacco much more regularly than the non-drug users.

3.2 Questionnaire Reliability

Cronbach's α values for BIS, BAS-Drv, BAS-FS and BAS-RR were 0.73, 0.71, 0.74, 0.67 for non-drug users and 0.77, 0.64, 0.70, 0.74 for heroin users. Cronbach's α values for the SP and SR subscales of SPSRQ were 0.75, 0.57 for non-users and 0.66, 0.68 for heroin users. Cronbach's α values for Total SSS, TAS, ES, BS and DIS subscales of the SSS were 0.84, 0.80, 0.57, 0.55, 0.44 in non-users and 0.73, 0.71, 0.54, 0.59, 0.57 in heroin users. Due to the low α values for the DIS, ES and BS subscales in both groups, only the total SSS score was used in subsequent analyses. The variable reliability of the subscales is similar to previous research in drug-users using translated versions of these scales (e.g., Loxton, Wan, et al., 2008).

3.3 Drug-use patterns

Data on a subset of the study population has been previously reported (Dissabandara, Dias, Dodd, & Stadlin, 2009). The current population was comprised of male Sinhalese dependent heroin users. Dependent heroin users consumed an average daily dose of 428 mg (range 50-4000mg) of heroin. All the dependent heroin users were current regular tobacco smokers. Approximately 65% of them reported using alcohol on a regular basis (Table 1). 70% of the drug users had AUDIT scores less than 8 (indicative of low-risk drinking), 16% scored 8-15 (harmful use), 7% scored 16-19 (hazardous use) and 7% scored > 20 (probable dependence). Lifetime prevalence of poly-drug use was 82% and last 30 day prevalence was 77%. The second most commonly used drug was cannabis: lifetime and last 30 days prevalence were 88% and 55% respectively. Stimulant use was minimal, with lifetime prevalence 12% and last 30 days prevalence less than 3%. Heroin smoking ("chasing the dragon") was the main method of use. The lifetime prevalence of injecting drug use was 16%; no subject reported injecting during the

last 30 days. The ages of initiation of tobacco smoking, and use of alcohol, illicit drugs, poly-drugs and injecting drugs were 16.4 ± 3.7, 18.1 ± 3.9, 18.5 ± 4.1, 20.6 ± 5.1 and 22.5 ± 6.2 years respectively. The average duration of heroin use was 13.4 ± 6.8 years. There was no correlation between the length of heroin use and personality scores. Approximately 30% of dependent heroin users refused seeking treatment for their substance use disorder.

3.4 Risky sexual behaviour

In the drug-user group 76.8% identified themselves as heterosexual, 4.1% as homosexual and 19.1% as bisexual. Prevalence of lifetime high-risk sexual behaviour were: 77.5% having sex with multiple partners, 69.3% having sex with commercial sex workers, only 24.6% used condoms on a regular basis, 6.8% reported having sex with someone known to have a sexually transmitted infection and 7.5% reported having sex for money.

3.5 Impulsivity vs drug use and drug use related parameters

Table 2 shows the statistically significant associations between personality variables (BAS subscales, SR, SP and SSS) and dichotomous drug use variables: dependent heroin use group status (heroin users vs non-drug users) for the total sample, and drug use behaviours within the heroin-dependent group: poly-drug use (vs single drug use), injecting drug use (vs non-injecting), risky sexual behaviour (vs non-risky sexual behaviour) and treatment seeking (vs non-treatment seeking). Measures of both reward sensitivity (BAS-FS and SR) and rash impulsivity (Total SSS) were significantly higher in the dependent heroin use group. Rash impulsivity but not reward sensitivity, was associated with greater likelihood of injecting drugs, engaging in risky sexual behaviour, and the likelihood of not seeking treatment. Punishment sensitivity (SP)

was negatively associated with injecting drug use. None of the personality traits tested was associated with poly-drug use.

Table 3 shows the statistically significant coefficients from multiple regression analyses between personality and drug/alcohol use behaviours (age of first drug use, daily dose of heroin and AUDIT score) in the dependent heroin users. BAS-FS was associated with hazardous drinking (AUDIT score), while BAS-Drv was associated with younger age of onset of drug use. Rash impulsivity (SSS) was associated with greater daily quantity of heroin consumed.

4 Discussion

This paper describes, for the first time, the association of two different dimensions of impulsivity with heroin dependence and related behaviours. Both reward sensitivity and rash impulsivity were significantly positively associated with dependent heroin use. While age of initiation was associated with high reward sensitivity (rather than rash impulsivity), hazardous drinking, increased drug consumption, injecting drug use and risky sexual behaviour were associated with high rash impulsivity.

4.1 Impulsivity in dependent heroin users vs non-drug users

Similar to club-drug users (Loxton, Wan, et al., 2008), both reward sensitivity (SR) and rash impulsivity (BAS-FS and SSS) were higher in dependent heroin users than in non-users. The largest effect was observed for BAS-FS, with approximately 48% (1:1.48) increase in the odds of being a heroin user for a one-unit increase in fun-seeking score.

Dawe & Loxton (2004) explicitly proposed that reward sensitivity likely plays a greater role in early (likely social) drug experimentation and an attraction to drug-related cues whereas

rash impulsivity plays a greater role in the progression to chronic drug dependence and additional high-risk behaviour. This proposal was supported in the current study in which we found reward sensitivity and rash impulsivity to be differentially related to heroin use and dependence with age-of-onset associated with reward sensitivity and high risk drug-related behaviours such as injecting drug use, dose and sexual behaviour associated with rash impulsivity.

4.2. Reward sensitivity and age of onset

In keeping with previous reports (Lyvers et al., 2011; Pardo et al., 2007) reward sensitivity (BAS-Drv), but not rash impulsivity, was significantly associated with a younger age of first drug use. This supports the role of the tendency to approach appetitive substances to be linked to experimentation and the early initiation of drug use. As age of onset is one of the strongest predictors of chronic drug use, reward sensitivity may provide a key index of longer-term drug risk (Grant, Stinson & Harfort, 2001). In part, early onset of drug use likely leads to additional problems due to long-term damage to the brain caused by CNS drug toxicity, particularly when exposed during the critical peri-pubertal period of brain development (Andersen, 2003). Recognizing reward-driven individuals at an early age could potentially help prevent vulnerable individuals from developing more subsequent SUDs. However, not all those who experiment with drugs subsequently develop chronic drug dependency. Other factors, including the toxic effects of drug on the developing brain, other impulsivity facets (such as rash impulsivity) and environmental factors (including education) also play roles in the progression from drug experimentation to drug abuse and dependence.

4.3. Rash impulsivity in chronic drug use and risky behaviour

There is growing evidence of innate differences in the functioning of the prefrontal cortex to be a predisposing vulnerability to stimulant dependence (Ersche et al., 2012). There is also a wealth of evidence supporting damage to this same brain region from chronic drug use (e.g., Jentsch & Taylor, 1999). Thus, rash impulsivity can predispose to, as well as result from, chronic drug use, due to damage to the prefrontal cortex neural circuitry that controls impulsive behaviour. Heightened rash impulsivity likely functions as both a pre-existing vulnerability as well as a reflection of long-term exposure to drugs and increasing levels of addiction in dependent subjects. However, the cross-sectional nature of this study precludes teasing apart these causal pathways.

As found in earlier studies (Loxton, Wan, et al., 2008; Anker, Perry, Gliddon, & Carroll, 2009; Gullo et al., 2010) additional drug-related and other risky behaviours were specifically associated with the rash impulsive dimension of impulsivity. Risky sexual behaviour and illicit drug use commonly co-occur. Impulsivity is likely to be a common predisposing factor for both these behaviours. Previous studies have also reported positive association between rash impulsivity and sexual risk behaviours (Atkins, 2008; Chandra, Krishna, Benegal, & Ramakrishna, 2003). Harmful drinking is also linked with risky sexual behaviours (Rees, Saitz, Horton, & Samet, J., 2001; Stein, Anderson, Charuvastra, & Friedmann et al., 2001), but, we found no association between AUDIT score and level of risky sexual behaviour, suggesting that these behaviours are not driving each other but are separable and driven by impulsivity.

Higher daily consumption of heroin and injecting heroin were positively associated with rash impulsivity. Unlike most other countries, scarcity of injecting drug use is a key feature among heroin users in Sri Lanka (Dissabandara et al., 2009). Although rash impulsivity was associated with increased likelihood of injecting, high behavioural inhibition decreased this

likelihood. Subjects reported that fear of the risks, lack of practice and skill and unavailability of injectable preparations as the main reasons for not injecting. The significant negative association between SP score and injecting drug use (Table 2) may be indicative of a possible role of punishment sensitivity in inhibiting risky behaviours due to the suppression of risk-taking behaviour and suboptimal punishment sensitivity functioning could lead to disinhibition (Avila, 2001). Although not assessed specifically in this study, route of administration may also affect subjective drug effects (e.g., "drug rush" by intravenous administration vs a more calming sedating effect from smoking). Therefore, as suggested by our findings, high rash impulsivity heroin users may choose injecting and high punishment sensitive users choose smoking for these differential effects.

Although never specified in the Dawe and Loxton (2004) model, rash impulsivity was associated with a decrease in the likelihood of seeking treatment. The finding that increased rash impulsiveness is associated with poor treatment seeking may indicate that easier routes into treatment may be needed for highly rash impulsive individuals. Voluntarily seeking treatment is an important positive feature in the management of individuals with SUD. Acknowledgement of rash impulsive individuals with substance abuse problem could assist in identifying those most at risk of additional drug-related problems and the least likely to seek help.

Finally, hazardous drinking was associated with the BAS-FS scale. This association between BAS-FS and hazardous drinking has been found across a range of samples (e.g., Loxton & Dawe, 2001, Willem, Bijttebier, Claes & Uytterhaegen, 2012). Although this scale is considered a reward sensitivity scale, we note that this scale tends to correlate with measures of both reward sensitivity and rash impulsive scales (Caseras, Àvila & Torrubia, 2003; Dawe & Loxton, 2004). In this study, we used regression analyses that account for the shared variance of

BAS-FS and the other more reward senstivity-specific scales of BAS-DRV and BAS-RR. This suggests that the more rash impulsive aspect of the BAS-FS scale may be associated with additional drinking the this drug-dependent sample obtained from a typically abstinence-oriented Sri Lankan population.

Limitations

The samples recruited into this study represent the patterns of substance use within Sri Lankan society. The non-drug using sample showed very low, by Western standards, rates of alcohol and tobacco use, while the heroin sample tended towards poly-substance use even though their primary substance was heroin. To a degree this may limit the generalisability of our findings to other societies. However, the clustering of a wide variety of substance use behaviours in this way gives insights into impulsivity traits that may drive substance use generically that cannot be so easily examined in other cultures where routine use of alcohol, tobacco and possibly cannabis are widely accepted. However, to address issues of possible confounding factors, variables such as poly-drug use, alcohol and tobacco were used as covariates during analyses.

There could still be other unmeasured covariates which could have influenced the outcome variables considered. The use of many self-report measures of socially stigmatised behaviours does raise the possibility of reporting bias. It is therefore possible that impulsivity is associated with a willingness to report illicit behaviour. However, such bias would be unlikely to show differential effects of different subtypes of impulsivity on reporting of different, but equally stigmatised, behaviours. The cross-sectional design of this study limited the evaluation of the progression of addiction and related behaviours in relation to personality traits.

5. Conclusion

This study provides support for the role of a two dimensional model of impulsivity in SUD. It also outlines some possible mechanisms of how each subtype of impulsivity may be causally associated with heroin dependence and other drug-use related phenotypes. As hypothesised, both reward sensitivity and rash impulsivity distinguished heroin users from non-users. Higher reward sensitivity was associated with younger age of initiation of heroin use, while rash impulsivity was the major predictor of problems associated with dependent heroin use. Prospective studies on at risk populations could provide further direction as to how these two facets of impulsivity function at different stages of addiction. Considering the evidence for a substantial genetic basis for both personality and addiction, it would be pertinent to investigate the role these facets play as potential mediators of the genetic influences on addiction.

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Statement 3 - Conflict of Interest
All the authors declare that they have no conflicts of interest.

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Tables

Table 1 – Demographic data and sample characteristics

		Non-drug users (n=232)	Dependent heroin users (n=293)
Age* (mean±SD)		35.8±11.9	34±7.9
Marital status (%)	Married	59.5	46.7
	Never married	40.5	49.3
	Divorced/separated	0	4
Education* (%)	Primary	18.1	29.3
	Secondary	81.9	70.7
Occupation (%)	Labourers/Street vendors	53.5	45.8
	Others	46.5	54.2
Tobacco Smoking (%)	Regular	22.5	100
	Rarely/Never	77.5	0
Alcohol use (%)	Regular	13	65
	Rarely/Never	87	35

* $p<0.05$

Table 2 – Personality traits significantly associated with heroin dependence and related dichotomous risk factors.

Outcome Phenotype	N	Predictor Personality Score	Odds Ratio	95% C.I. for OR Lower	Upper	Sig.
Dependent heroin use	293	BAS-FS	1.48	1.31	1.68	<0.001
(vs Non drug user)	232	SSS Total	1.16	1.11	1.22	<0.001
		SR	1.36	1.24	1.50	<0.001
Injecting Drug Use	49	BAS-RR	1.23	1.00	1.52	<0.05
(vs Non injecting drug user)	244	SSS Total	1.49	1.31	1.70	<0.001
		SP	0.84	0.75	0.95	<0.005
Risky sexual behaviour	227	SSS Total	1.12	1.05	1.20	.<0.001
(vs no risky sexual behaviour)	66	SR	1.13	1.01	1.25	<0.05
Non treatment seeking	89	SSS Total	1.08	1.02	1.14	<0.001
(vs Treatment seeking)	204					

Note. The group in parentheses is the reference group

BAS-FS = BAS Fun Seeking, BAS-RR = BAS Reward Responsiveness, SSS Total =Total sensation seeking, SP = Sensitivity to punishment, SR = Sensitivity to reward.

Table 3 – Personality traits significantly associated with heroin dependence and related continuous variables.

Outcome Phenotype	Predictor Personality Score	B	SE	Beta	Sig.
Daily Heroin dose	SSS Total	11.93	4.37	0.16	0.006
AUDIT score	BAS-FS	0.64	0.19	0.20	0.001
Age of first drug use	BAS-Drv	-0.31	0.10	-0.17	0.004

N=293

BAS-FS = BAS Fun Seeking, BAS-Drv = BAS Drive, SSS Total = Total Sensation Seeking Scale

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 behaviors.>RS and RI have distinct roles in heroin dependence.>