

**Self-Report and Behavioural Measures of Impulsivity as Predictors of ‘Real World’ Impulsive Behaviour and Psychopathology in Male Prisoners**

Vyv Huddy<sup>2,3\*</sup>, Nathan Kitchenham<sup>1,2\*</sup>, Anna Roberts<sup>1,2</sup>, Manuela Jarrett<sup>1,2</sup>, Patricia Phillip<sup>1,2</sup>, Andrew Forrester<sup>1,2</sup>, Catherine Campbell<sup>1,2</sup>, Majella Byrne<sup>1,2</sup> and Lucia Valmaggia<sup>1,2</sup>

1. Institute of Psychiatry, Psychology & Neuroscience, King’s College London
2. South London & Maudsley NHS Foundation Trust
3. University College London

\*Joint first authors

**Address for correspondence:**

\* Corresponding concerning this article should be sent to Dr Vyv Huddy, University College London, Research Department of Clinical, Educational and Health Psychology (Rm. 444), 1-19 Torrington Place, London, WC1E 7HB Tel: 020 7679 1675 Email: v.huddy@ucl.ac.uk

**Running Head:** Impulsivity and substance misuse in prisoners

## **Abstract**

Impulsivity is an important factor in adverse outcomes such as substance use, problem gambling and psychopathology. Extensive research has shown these negative outcomes are associated with both self-report and behavioural measures of impulsivity but these two measurement domains are not themselves associated. There has been limited research in prison samples. This is surprising given the high variability in impulsive behaviours that should make them ideal for investigating the convergence of impulsivity measures. Using a cross sectional design we investigated the associations of impulsivity – measured by self-report and two behavioural indices - with substance misuse and psychopathology in a sample of 72 male prisoners. We found higher self-reported impulsivity was associated with crack/cocaine use, problem gambling and a positive screen for personality disorder. Behavioural measures of impulsivity showed fewer associations with problematic behaviours; they were also not independent predictors of impulsive behaviour in multivariate analyses. These data suggest that self-reported impulsivity is a more consistent predictor of problematic behaviours than behavioural measures in a sample of people with significant levels of substance use and psychopathology. This difference could reflect relevance of self-reported measures to emotionally charged decision-making in daily life compared to more neutral behavioural measures.

**Key words:** addiction; impulsivity; substance use; prison; offender; problem gambling

## Introduction

Higher levels of impulsivity have been linked to a range of behaviours that impact on daily functioning (Sharma, Markon & Clark, 2014). For example, there is evidence for higher levels of impulsivity in those with greater substances use problems (Verdejo-Garcia et al., 2006), psychopathology (Chamorro et al. 2012) or offending behaviour (Leverso, Bielby and Hoelter, 2015). Such findings have informed theories of addiction (West and Brown, 2013) and criminality (Lynam and Miller, 2004). However, recent commentary suggests further understanding of the construct of impulsivity is required before additional theoretical progress can be made in making sense of its role in adverse behavioural outcomes (Sharma et al. 2014). One obstacle concerns the measurement of impulsivity, which falls into two broad categories. One domain is self-report measures that are assumed to capture what participants do across time and situations. In contrast, behavioural measures are intended to capture the manifestations of underlying traits assessing what people do in specific situations. A recent comprehensive review of the literature found robust support for associations between problematic daily life behaviours and impulsivity across both the two main domains of measurement (Sharma et al. 2014). However, the associations between self-reported and laboratory behavioural measures of impulsivity were consistently low. They authors concluded that each domain is tapping unique variance in daily life behaviour, if true this would question of the validity of impulsivity as a single construct, and support the notion of ‘varieties of impulsivity’ (Evenden, 1999).

The majority of research on the two domains of impulsivity has been conducted within specific clinical groups or general population samples. These studies have shown weak associations between the two domains of impulsivity

measures though associations are somewhat stronger between measures of impulsivity and impulsive behaviour (Sharma et al. 2014). A possible means to increase sensitivity is to identify samples where there is likely to be high variability on measures of impulsivity, psychopathology and types of problematic behaviours. Prison populations are ideal in this regard as high levels of both substance use (Fazel et al. 2006; Cooper et al. 2016) and mental health difficulties (Fazel & Danesh, 2002) produce greater variability on these dimensions compared to the general population.

Existing research has established consistent associations between self reported impulsivity and substance use in prison samples (Cuomo et al., 2008, Devieux et al., 2002, Ireland and Mooney et al., 2008, Bernstein et al., 2015), with only isolated exceptions (Fishbein and Reuland, 1994). In contrast, there have been very few studies using laboratory measures in samples of prisoners. An exception is discounting, which is the tendency to perceive and attribute reduced value to delayed rewards, even if these are preferable to more immediate gratification (Bickel and Marsch, 2001). There is evidence of higher rates of discounting in prisoners compared to the general population (Arantes, Berg, Lawlor & Grace, 2013; Wilson and Daly, 2006) and evidence that discounting is associated with criminal thinking styles (Varghese, Charlton, Wood & Trower, 2014). However, only one of these studies examined the association between discounting and substance use in prisoners (Arantes et al. 2014) and this found this was not significant. In the same study there was no evidence of convergence between the domains of impulsivity. Instead they were, surprisingly, negative correlated (Arantes et al. 2013). The latter single finding is an indication of the very limited research on the degree of convergence between the two domains of impulsivity measurement in prison samples.

As already noted, mental health problems are elevated amongst prisoner populations but potentially the most important problem for current purposes is the heightened rates of personality disorder (Fazel & Danesh, 2002). There is substantial evidence of comorbidity between substance use and personality disorders (Nace et al, 1991; Bowden-Jones et al, 2004; Compton et al, 2007). It may be that this reflects bidirectional or mutual causation, whereby substance use is a response to extreme emotional states in those with personality disorder, which subsequently exacerbates affective disturbance. Similar bi-directionality also has been found in relation to criminality and substance use (Xue et al. 2009). Another perspective is that impulsivity could be a common factor underlying comorbid personality disorder and substance use (Trull et al, 2000). Indeed, the presence of a comorbid personality disorder in those that abuse substances is associated with markedly high impulsive behavior on various tasks (Petry, 2002; Dom et al, 2006; Rubio et al, 2007). Another revealing study by Dom et al (2006) found that while abnormalities in response inhibition distinguished problem drinkers with personality disorder from those without it, this discrepancy was not found on a delay-discounting task. This highlights the importance of studying impulsivity with multiple measures as this holds potential for disentangling the overlap between substances use and personality disorder in offending populations. Alternatively it may be that impulsivity is an underlying shared mechanism across these distinct adverse outcomes.

The current study aimed to determine both the relationship between the measurement domains of impulsivity and their individual associations with daily-life impulsive behaviour in a prison sample. For the behavioural domain of measurement we included the discounting task previously employed in studies of prisoners. This behavioural measure was complemented with matching familiar figures test (MFFT)

(Cairns & Cammock, 1978). The two tasks are thought tap different properties of impulsivity with discounting defined as ‘choice impulsivity’ and the MFFT measuring ‘reflection impulsivity’ (Sharma et al. 2014). Reflection impulsivity is the tendency for individuals to engage in behaviour without appropriate reflection or deliberation. Greater reflection impulsivity is associated with problematic use of various substances (Morgan 1998; Clark, Robbins, Ersche & Shakian, 2006). To our knowledge, no studies have been conducted on the association between reflection impulsivity and substance use in samples of prisoners. There has also been no research on the association between distinct behavioural measures of impulsivity in this population.

Our first aim was to establish the relationships between self-report and behavioural measures of impulsivity in a prison sample. Our second aim was to determine the associations of the three impulsivity measures with the extent of substance misuse, problem gambling and psychopathology. Evidence of psychopathology was determined using a screening tool for personality disorder (Moran et al. 2003).

## **Method**

### **Participants**

Seventy-two participants were recruited from a Category C adult male prison for prisoners aged 21 and older in London, United Kingdom (UK). Category C prisons are the third highest level of security in the UK justice system. They provide

closed conditions so that prisoners' movement is restricted so that they must spend much of their time confined in cells. Recruitment took place through a prison mental health service. The service screened prisoners less than 35 years old upon reception into prison for early detection of at risk mental states for psychosis (Jarrett et al., 2012). For the purpose of this study all prisoners screened were asked to participate independent of the outcome of their screening. Exclusion criteria included prisoners not screened by the mental health service (i.e. above 35 years or those refusing screening); those who could not speak English; and those identified as experiencing a current psychotic and/or severe depressive episode and/or those reporting a history of head injury, given potential interference of such difficulties during neuropsychological assessment (Heerey et al., 2007, Lempert and Pizzagalli, 2010, Slaughter et al., 2003). These participants' eligibility against these criteria was determined by interview.

## **Procedure**

Participants were seen for assessment in accordance with local prison policies governing the times during which prisoners are allowed out of their cells, usually for approximately two to three hours during the morning and for a similar period in the afternoon. The study was approved by both the local Research Ethics Committee and National Offender Management Service (NOMS). After informed consent was obtained they completed the measures in the order presented below.

## **Measures**

**Barratt impulsiveness scale (BIS).** The BIS (Version 11; (Patton et al., 1995)) is a 30-item measure widely used to assess impulsive personality traits, comprising a total score and subscale scores for trait domains of (i) attentional, (ii)

motor and (iii) non-planning impulsiveness. The current analysis used the total BIS score as a measure of trait impulsivity, with scores treated as continuous.

**Monetary choice questionnaire (MCQ).** The MCQ (Kirby and Marakovic, 1996, Kirby et al., 1999) was used to measure delayed reward discounting. The MCQ is a 27-item assessing how quickly individuals tend to discount delayed rewards in favour of immediate rewards; the discounting rate,  $k$ . Trials differ both in terms of temporal delay to receipt of larger reward and in size of delayed reward. Guidance from Kirby (Kirby, 2000) was used to infer  $k$  for each reward magnitude; the geometric mean of these was taken as an overall measure of discounting, as used previously (Kirby et al., 1999). Higher  $k$  is considered indicative of elevated discounting. Discount rates were treated as continuous for analysis.

**Matching familiar figures test (MFFT).** The MFFT is a 20-item behavioural measure of reflection impulsivity (Cairns & Cammock, 1978). The MFFT-20 has been used in the studies of reflection impulsivity in adult substance users (e.g. Morgan et al, 1998). The format for administration of the MFFT-20 involves the presentation of a familiar figure, such as a leaf or a house, alongside six similar figures where only one of these six matches the familiar figure exactly. Participants are asked to choose which of the six options matches the presented figure exactly. Individual performance is determined by calculating a participant's mean latency to first response and their total number of errors, each of which is computed into a standardised Z-score. An index of impulsivity is then created (i-score), by subtracting Z-latency from Z-error (Salkind & Wright, 1977; Messer & Brodzinsky, 1981).

**Substance misuse.** A semi-structured interview was employed that had been previously developed for use in this setting (Cooper et al 2016). This utilised



questions from Cannabis Experience Questionnaire (Barkus et al., 2006) that were extended to obtain detailed information on lifetime use of alcohol, tobacco, cannabis, cocaine (including crack cocaine), amphetamines and opiates (including substitute medication). The psychometric properties of this instrument have been established (Barkus, Stirling et al. 2006). Prison is an environment where current access to substances is restricted so lifetime substance use prior to incarceration was used as the main indicator of the severity of this aspect of impulsive behaviour. When the lifetime use of a substance was reported a further question on the intensity participants' peak lifetime episode of substance use was rated on five-point scale from "only once or twice a year" to "everyday". Prisoners were assured that their responses were confidential and would not be disclosed to other services.

**Problem Gambling.** The Problem Gambling Severity Index (PGSI) is a 9-item self-report questionnaire designed as a screening measure of problem gambling severity within the general population (Ferris & Wynne, 2001). Each item on the PGSI asks informants a question relating to some aspect of any gambling behaviour over the previous 12 months. A score of 8 or more is defined as a cut-off for severe problem gambling.

**Personality Disorder Screening.** The Standardised Assessment of Personality Abbreviated Scale (SAPAS) is a brief 8-item structured interview developed for use as a clinical screen for personality disorder (Moran et al, 2003). Existing studies support its validity as a brief screening tool and these include when used with offender populations (Pluck et al, 2012).

**Statistical Analyses.** Correlation analyses were initially used to establish the pattern of bivariate associations between 1) each of the measures of impulsivity and

2) all three measures of impulsivity with each substance use domain. Pearson correlations were used for normally distributed interval level data, Spearman Rank correlations for ordinal data and Point Biserial correlations for dichotomous variables. The latter analyses were required for the lifetime substance misuse measure, problem gambling and personality disorder screen. Multiple logistic regressions were next used to assess whether independent variables emerged as independent predictors of frequent use of a particular substance or personality disorder screening status. The MCQ-K variable was positively skewed so a root transform was performed for its use as a predictor in the multiple regression analyses.

## Results

**Sample characteristics.** Table 1 reports the age, substance use and summary statistics for the PGSI and SAPAS scales. The proportion of participants screening positive for problem gambling was (14%, N=10) and a positive screen for personality disorder was (51%, N=37). We chose to focus our analyses of substances use on lifetime usage of combined crack/cocaine and opiates. Participants' very frequently reported lifetime use of the remaining the substances (alcohol or cannabis in > 85% of participants) so no further analyses of associations with impulsivity were conducted using these variables.

== Table 1 about of here ==

**Associations between impulsivity measures (Table 2).** We found that higher scores on the BIS were weakly, but significantly, associated with greater reflection on the MFFT-I score and choice impulsivity indexed by the MCQ-K score. The two behavioural measures of impulsivity, however, not associated with one another.

== Table 2 about of here ==

**Associations of impulsivity measures with substance use, problem gambling and personality disorder screening status.** Higher BIS scores were associated with lifetime cocaine/crack use, problem gambling and a positive SAPAS screen. There were only isolated findings for the behavioural measures with a higher MFFT-I score associated with being a lifetime crack/cocaine use and higher MCQ-K associated with lifetime opiate use (see Table 2). We next examined associations of impulsivity measures with peak intensity of use in the subgroups of lifetime crack/cocaine or opiates user and found no significant correlations. A large majority of lifetime users of these substances reported intense past peak episodes of use (> 80% of participants reported taking the substance at least twice weekly) so there was limited variance on this measure.

== Table 3 about of here ==

**Impulsivity measures as independent predictors of crack/cocaine use, problem gambling and SAPAS screening status.** To determine if MFFT-I, MCQ-K and BIS had an independent relationship with substance use indicators we carried out a logistic regression analysis for cocaine/crack use as the dependent variable, with impulsivity variables (MFFT-I, MCQ-K and BIS) and SAPAS screening status as the predictor variables. We found the model was significant (Cox  $R^2 = .26$ ,  $\chi(1, N = 72) = 21.6$   $p < 0.001$ ) with BIS total explaining independent variance in lifetime crack/cocaine use but the other variables MFFT-I, SAPAS and MCQ-K did not reach significance as independent predictors (see Table 3). A logistic regression was used for prediction of those falling into the PGSI category of problem gambling but the overall model was not significant ( $\chi(1, N = 72) = 4.6$ ,  $p = .20$ ). The same was the case

for the logistic regression model where impulsivity variables were entered as predictors of opiate use ( $\chi(1, N = 72) = 4.3, p = .29$ ). Finally, we examined three impulsivity variables as predictors of screening status on the SAPAS. We found this model was significant (Cox  $R^2 = .15, \chi(1, N = 72) = 11.4, p = .01$ ). The BIS total score was again the only independent predictor in the model with the MCQ-K and MFFT-I not significant (see Table 3).

### **Discussion**

The first aim of the study was to establish the relationship between self-report and behavioural measures of impulsivity in a prison sample. We found limited overlap between the three impulsivity measures, which is consistent with the literature across both general population studies and those of substance using populations (Sharma et al. 2014). Specifically, we found that higher scores on behavioural measures of impulsivity were weakly associated with higher self-reported impulsivity. This is in the expected direction and contrasts with the previous study by Arantes et al. (2013). The weak correlations between self-report and behavioural measures are thought to reflect the lack shared method variance and demonstrate how both domains are necessary for sufficiently broad assessment of impulsivity (Sharma et al. 2014). In the current sample, where highly impulsive individuals are likely to have been over sampled, the pattern of associations between impulsivity measures was consistent with general population studies and no larger. Furthermore, we found the two behavioural measures of impulsivity were not associated with each other which supports the notion that the two measure tap onto distinct forms of impulsivity (Evenden, 1999).

Our second aim was to determine the association of these impulsivity measures with the extent of substance misuse, problem gambling and psychopathology in the prison sample. Increases in self-reported impulsivity were also related to an increased frequency of crack/cocaine use, problem gambling and a positive screen for personality disorder. These findings are again consistent with the large body of evidence supporting the association between self-reported impulsivity and substance use in both prisoners and general population samples that was reported in the introduction. However, while there was some evidence for associations between the behavioural measures of impulsivity and substance use these were less consistent than those with self reported impulsivity. Furthermore, behavioural measures of impulsivity not independent predictors of addictive behaviours or a personality disorder screen when regression models included both domains. Taken together these findings do not support the idea the behavioural measures capture any additional variance in impulsive behaviour in prisoners that is not already explained by a self-report measure.

The behavioural measures of impulsivity that were employed in the current study featured neutral materials that lacked direct relevance to value events or goals of the participants. Self-report measures, however, encourage the recall of daily life decisions where choices could have significant short-term benefits, potential risks and a more enriched emotional context. Cross, Copping, and Campbell (2011) suggest that there is a distinction between impulsivity that occurs in this type of ‘hot’ emotional context versus ‘cool’ situations. The behavioural measures use in the current study may reflect the ‘cool’ variety of impulsivity and therefore, be less likely to predict substance use behaviour as would presumably entail an emotionally charged decision making processes. Thus, our findings support the use of self-report

or interview based assessments that enable the elaboration of crucial details of decision-making in a personally relevant context.

There were a number of limitations to the design of the study. The cross-sectional design of the study prevents any causal interpretations of the any relationship between impulsivity and addiction in prisoners. Causal relationships are likely to be complex as there is evidence supporting the notion that impulsivity can both act as a determinant of substances use but also a consequence of their use (de Wit, 2008). Sampling for the current study within one prison setting also restricts how these findings can be generalised to other prisoner groups. For instance recruitment was undertaken from a specific cohort of prisoners, limiting the relevance of findings to those not represented in the sample (e.g. those detained in non-Category C prisons, female prisons or young offender institutions). It is important to note that this study, in common with others on discounting in offending populations, could have been subject to a desirability bias to present themselves in a positive light (Mills & Kroner, 2006). Paulhus (2002) suggests that those displaying a high in desirability bias should demonstrate dissociation between self-report and behavioural measures of a construct. The finding that these measures were associated in the current sample, albeit weakly, suggests reporting biases were not so prominent to undermine the validity of the self-report. Another consideration is for the use of a more conservative alpha as a control for multiple comparisons. A number of correlations in between behavioural measures of impulsivity were also small in magnitude. However, the effect sizes of these predictors in the regression models were negligible.

In conclusion, we found that self reported impulsivity was associated with impulsive behaviour and behavioural measures of impulsivity. The latter did not explain independent variance in substance use or psychopathology. This is consistent

with findings of previous research in general population and clinical samples. The findings of this study need to be interpreted with greater caution than those with general population samples because of the limitations highlighted above in relation to potential impression management. However, we did not find clear evidence against the validity of self-report impulsivity, as there were associations with laboratory measures, albeit weak. This allows the tentative conclusion that previous research in prison samples, which has been dominated by studies using self-report measures, would not have been substantially improved by including potentially time-consuming behavioural tasks.

## References

Arantes, J., Berg, M. E., Lawlor, D., & Grace, R. C. (2013) Offenders have higher delay-discounting rates than non-offenders after controlling for differences in drug and alcohol abuse. *Legal and Criminological Psychology*, 18, 240-253.

Barkus, E. J., Stirling, J., Hopkins, R. S. & Lewis, S. 2006. Cannabis induced psychosis-like experiences are associated with high schizotypy. *Psychopathology*, 39, 175-178.

Bernstein, M. H., Mcsheffrey, S. N., Van den berg, J. J., Vela, J. E., Stein, L. A., Roberts, M. B., Martin, R. A. & Clarke, J. G. (2015). The association between impulsivity and alcohol/drug use among prison inmates. *Addictive Behaviors*, 42, 140-3.

Bickel, W. K. & Marsch, L. A. (2001). Toward a behavioral economic understanding of drug dependence: delay discounting processes. *Addiction*, 96, 73-86.

Bretteville-jensen, A. L. 1999. Addiction and discounting. *Journal of Health Economics*, 18, 393-407.

Bowden-Jones, O., Iqbal, M., Tyrer, P. et al. (2004) Prevalence of personality disorder in alcohol and drug services and associated comorbidity. *Addiction*, 99, 1306–1314.

Cairns, E. & Cammock, T. (1978). Development of a more reliable version of the Matching Familiar Figures Test. *Developmental Psychology*, 14, 555-560.

Center on Addiction and Substance Use. 2010. Behind Bars II: Substance Abuse and America's prison Population. USA.



Chamorro, J., Bernardi, S., Potenza, M. N., Grant, J. E., Marsh, R., Wang, S., & Blanco, C. (2012). Impulsivity in the general population: A national study. *Journal of Psychiatric Research*, 46, 994–1001.

Clark, L., Robbins, T. W., Ersche, K. D. & Sahakian, B. J. (2006). Reflection impulsivity in current and former substance users. *Biological Psychiatry*, 60, 515-522.

Coffey, S. F., Gudleski, G. D., Saladin, M. E. & Brady, K. T. (2003). Impulsivity and rapid discounting of delayed hypothetical rewards in cocaine-dependent individuals. *Experimental and Clinical Psychopharmacology*, 11, 18-25.

Compton, W. M., Thomas, Y. F., Stinson, F. S. & Grant, B. F. (2007). Prevalence, Correlates, Disability, and Comorbidity of *DSM-IV* Drug Abuse and Dependence in the United States. Results From the National Epidemiologic Survey on Alcohol and Related Conditions. *Archives of General Psychiatry*, 64, 566-576.

Cooper, J., Jarrett, M., Forrester, A., di Forti, M., Murray, R.M., Huddy, Vyv., Roberts, A., Phillip, P., Campbell, C., Byrne, M., McGuire, P., Craig, T., & Valmaggia, L. (2016) *Early Intervention In Psychiatry (in press)*

Cross, C. P., Copping, L. T., & Campbell, A. (2011). Sex differences in impulsivity: A meta-analysis. *Psychological Bulletin*, 137, 97–130.

Cuomo, C., Sarchiapone, M., Giannantonio, M. D., Mancini, M. & Roy, A. (2008). Aggression, impulsivity, personality traits, and childhood trauma of prisoners with substance abuse and addiction. *American Journal of Drug and Alcohol Abuse*, 34, 339-345.

Devieux, J., Malow, R., Stein, J. A., Jennings, T. E., Lucenko, B. A., Averhart, C. & Kalichman, S. (2002). Impulsivity and HIV risk among adjudicated

alcohol- and other drug-abusing adolescent offenders. *AIDS Education and Prevention*, 14, 24-35.

de Wit, H. (2008) Impulsivity as a determinant and consequence of drug use: a review of underlying processes *Addiction Biology*, 14, 22–31

Evenden, J. L. 1999. Varieties of impulsivity. *Psychopharmacology*, 146, 348-361.

Dom, G., de Wilde, B., Hulstijn, W., van den Brink, W. & Sabbe, B. (2006). Behavioural aspects of impulsivity in alcoholics with and without a Cluster-B personality disorder. *Alcohol & Alcoholism*, 41, 412-420.

Evenden, J. L. (1999) Varieties of impulsivity. *Psychopharmacology*, 146, 348–361.

Fazel S, & Danesh J. (2002) Serious mental disorder in 23000 prisoners: a systematic review of 62 surveys. *Lancet*; 359, 545–50.

Fazel, S., Bains, P. & Doll, H. (2006). Substance abuse and dependence in prisoners: a systematic review. *Addiction*, 101, 181-191.

Ferris, J. & Wynne, H. (2001). The Canadian problem gambling index: Final report. Ottawa, ON: Canadian Centre on Substance Abuse.

Fishbein, D. H. & Reuland, M. (1994) Psychological correlates of frequency and type of drug-use among jail inmates. *Addictive Behaviours*, 19, 583-598.

Heerey, E. A., Robinson, B. M., McMahon, R. P. & Gold, J. M. (2007) Delay discounting in schizophrenia. *Cognitive Neuropsychiatry*, 12, 213-221.

Ireland, J. L. & Higgins, P. (2013) Behavioural Stimulation and Sensation-Seeking among prisoners: Applications to substance dependency. *International Journal of Law and Psychiatry*, 36, 229-234.

Jarrett, M., Craig, T., Parrott, J., Forrester, A., Winton-brown, T., Maguire, H., McGuire, P. & Valmaggia, L. (2012). Identifying men at ultra high risk of psychosis in a prison population. *Schizophrenia Research*, 136, 1-6.

Kirby, K. & Marakovic, N. (1996) Delay-discounting probabilistic rewards: Rates decrease as amounts increase. *Psychonomic Bulletin & Review*, 3, 100-104.

Kirby, K. N. (2000). Instructions for inferring discount rates from choices between immediate and delayed rewards. Williams College.

Kirby, K. N. & Petry, N. M. (2004) Heroin and cocaine abusers have higher discount rates for delayed rewards than alcoholics or non-drug-using controls. *Addiction*, 99, 461-471.

Kirby, K. N., Petry, N. M. & Bickel, W. K. (1999) Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *Journal of Experimental Psychology*, 128, 78-87.

Lempert, K. M. & Pizzagalli, D. A. (2010) Delay discounting and future-directed thinking in anhedonic individuals. *Journal of Behavior Therapy and Experimental Psychiatry*, 41, 258-264.

Levero, J., Bielby, W. & Hoelter, L.F. (2015) Back on the streets: Maturation and risk factors for recidivism among serious juvenile offenders. *Journal of Adolescence*, 41, 67-75.

Lynam, D. R., & Miller, J. D. (2004). Personality pathways to impulsive behavior and relations to deviance: Results from three samples. *Journal of Quantitative Criminology*, 20, 319–341.

Mackillop, J., Amlung, M. T., Few, L. R., Ray, L. A., Sweet, L. H. & Munafò, M. R. (2011) Delayed reward discounting and addictive behavior: a meta-analysis. *Psychopharmacology*, 216, 305-321.

Messer, S. B. & Brodzinsky, D. M. (1981). Three-year stability of reflection-impulsivity in young adolescents. *Developmental Psychology*, 17, 848-850.

Mills, J. F. & Kroner, D. G. (2006) Impression Management and Self-Report Among Violent Offenders. *Journal of Interpersonal Violence*, 21, 178 – 192.

Mooney, J. L., Minor, K. I., Wells, J. B., Leukefeld, C., Oser, C. B. & Tindall, M. S. (2008). The Relationship of Stress, Impulsivity, and Beliefs to Drug Use Severity in a Sample of Women Prison Inmates. *International Journal of Offender Therapy and Comparative Criminology*, 52, 686-697.

Moran, P., Leese, M., Lee, T., Walters, P., Thornicroft, G., & Mann, A. (2003). Standardised Assessment of Personality Abbreviated Scale (SAPAS): preliminary validation of a brief screen for personality disorder. *British Journal of Psychiatry*, 183, 228-232

Morgan, M. J. (1998). Recreational use of "Ecstasy" (MDMA) is associated with elevated impulsivity. *Neuropsychopharmacology*, 19, 252-264.

Nace, E. P., Davis, C. W. & Gaspari, J. P. (1991). Axis II comorbidity in substance abusers. *American Journal of Psychiatry*, 148, 118-120.

Patton, J. H., Stanford, M. S. & Barratt, E. S. (1995). Factor structure of the Barratt impulsiveness scale. *Journal of Clinical Psychology*, 51, 768-774.

Paulhus, D. L. (2002). Socially desirable responding: The evolution of a construct. In H. Braun, D. N. Jackson, & D. E. Wiley (Eds.), *The role of constructs in psychological and educational measurement* (pp. 67-88). Hillsdale, NJ: Lawrence Erlbaum.

Petry, N. M. (2002). Discounting of delayed rewards in substance abusers: relationship to antisocial personality disorder. *Psychopharmacology*, 162, 425-432.

Pluck, G., Sirdifield, C., Brooker, C., & Moran, P. (2012). Screening for personality disorder in probationers: Validation of the Standardised Assessment of Personality Abbreviated Scale (SAPAS). *Personality and Mental Health*, 6, 61-68.

Rubio, G., Jimenez, M., Rodriguez-Jimenez, R., Martinez, I., Iribarren, M. M., Jimenez-Arriero, M. A., Ponce, G. & Avila, C. (2007). Varieties of impulsivity in males with alcohol dependence: the role of Cluster-B personality disorder. *Alcoholism: Clinical and Experimental Research*, 31, 1826-1832.

Salkind, N. J. & Wright, J. C. (1977). The development of reflection-impulsivity and cognitive efficiency. *Human Development*, 20, 377-387.

Sharma, L., Markon, K. E. & Clark, L. A. (2014) Toward a Theory of Distinct Types of “Impulsive” Behaviors: A Meta-Analysis of Self-Report and Behavioral Measures. *Psychological Bulletin*, 140, 374- 408.

Slaughter, B., Fann, J. R. & Ehde, D. 2003. Traumatic brain injury in a county jail population: prevalence, neuropsychological functioning and psychiatric disorders. *Brain Injury*, 17, 731-741.

Trull, T. J., Sher, K. J., Minks-Brown, C., Durbin, J. & Burr, R. (2000).  
Borderline personality disorder and substance use disorders: A review and integration.  
*Clinical Psychology Review*, 20, 235-253.

Varghese, F. P., Charlton, S. R., Wood, M., & Trower, E. (2014) Temporal  
Discounting and Criminal Thinking: Understanding Cognitive Processes to Align  
Services. *Psychological Services*, 11, 171 – 178.

Verdejo-Garcia, A., Bechara, A., Recknor, E. C. & Perez-Garcia, M. 2006.  
Executive dysfunction in substance dependent individuals during drug use and  
abstinence: An examination of the behavioral, cognitive and emotional correlates of  
addiction. *Journal of the International Neuropsychological Society*, 12, 405-415.

West, R. & Brown, J. 2013. Theory of Addiction. West Sussex, John Wiley &  
Sons, Ltd. .

Wilson, M. & Daly, M. (2006) Are Juvenile offenders extreme future  
discounters? *Psychological Science*, 17, 989 – 994.

Xue, Y., Zimmerman, M. A., & Cunningham, R. (2009). Relationship  
between alcohol use and violent behavior among urban African American youths from  
adolescence to emerging adulthood: A longitudinal study. *American Journal of Public  
Health*, 99, 2041–2048.

Table 1: Sample Characteristics: age, Lifetime substance use, Problem Gambling Severity Index (PGSI) and Standardised Assessment of Personality Abbreviated Scale (SAPAS)

Characteristic	
Age Mean (SD)	21.0 (2.1)
Lifetime substance use; % (n)	
Binge Drinking	94 (68)
Cannabis	85 (61)
Lifetime Cocaine / Crack	40 (29)
Opiates	17 (12)
Problem Gambling; Mean (SD)	
PGSI	2.1 (4.7)
Personality Disorder Screen; Mean (SD)	
SAPAS	2.7 (1.4)
Impulsivity; Mean (SD)	
Barrett Impulsivity Scale	64.7 (13.7)

Table 2: Correlation coefficients of associations between the Barrett Impulsivity Scale (BIS), Monetary Choice Questionnaire score K (MCQ-K), Matching Familiar Figures Test I score (MFFT-I), Lifetime Substance Use, Problem Gambling Severity Index (PGSI) and Standardised Assessment of Personality Abbreviated Scale (SAPAS)

	BIS	MCQ – K	MFFT – I
Impulsivity measures			
MCQ –K	.29*	-	-
MFFT	.26*	.02	-
Lifetime Substance use			
Cocaine / crack <sup>PB</sup>	.43**	.16	.27*
Opiates <sup>PB</sup>	.14	.24*	-.06
Problem Gambling			
PGSI <sup>PB</sup>	.24*	.07	.03
Personality Disorder Screen			
SAPAS <sup>PB</sup>	.36**	.2	.01

Note: \*p < .05, \*\*p < .01.

PB Point bi-serial correlation



Table 3: Individual predictors from logistic regression models of crack/cocaine use and SAPAS screening status

Predictors	Wald	Exp(B)	95% Confidence Interval		Significance
			Lower	Upper	
<b>Lifetime Crack/Cocaine</b>					
BIS Total	5.6	1.1	1.0	1.2	<b>p = .02</b>
MCQ-K	2.7	4.6	0.0	951	p = .58
MFFT-I	.2	1.4	1.0	1.9	p = .08
SAPAS	1.6	3.1	1.0	9.8	p = .05
<b>SAPAS Screen</b>					
BIS Total	7.4	1.1	1.0	1.1	<b>p = .007</b>
MCQ-K	.722	7.8	.1	876	p = .40
MFFT-I	.46	.9	.67	1.2	p = .50