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## Associations between behavioral disinhibition and cocaine use history in individuals with cocaine dependence

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### Abstract

**Background**—Behavioral disinhibition has been suggested as both a cause and consequence of substance use disorders. Many studies examining associations between behavioral disinhibition and substance use history have focused on individuals with alcohol dependence or non-dependent college students. In the present study, the relationship between behavioral disinhibition and cocaine use history in individuals with cocaine dependence is examined.

**Methods**—Forty-six non-treatment-seeking cocaine-dependent men and women completed impulsivity (Barratt Impulsiveness Scale; BIS) and novelty seeking (Temperament and Character Inventory; TCI) questionnaires at the baseline visit of an ongoing study. Unadjusted, and adjusted for gender and age, Pearson correlations were calculated between BIS, TCI, and cocaine use variables from the Structured Clinical Interview for DSM-IV and Timeline Follow-back (age of onset, quantity/frequency of past 30 day cocaine use).

**Results**—As expected, elevated motor impulsivity and novelty seeking were each associated with younger age of dependence onset. Also, individuals with lower levels of persistence on the TCI reported more days of cocaine use over the previous month. Unexpectedly, increased novelty seeking and attentional impulsivity were associated with *fewer* days of cocaine use and *less* money spent on cocaine, respectively. Controlling for gender did not substantially change the pattern of observed associations.

**Conclusions**—The present study provides preliminary evidence for associations between behavioral disinhibition and cocaine use history in cocaine-dependent individuals. Given our relatively small sample size and the correlational nature of our findings, further research is needed to replicate and extend our results.

### Keywords

cocaine dependence; impulsivity; novelty seeking; cocaine use; age of onset

## 1. Introduction

The 2008 National Survey on Drug Use and Health (NSDUH) reported that approximately 1.4 million Americans had dependence on, or abuse of, cocaine (SAMHSA, 2009). Cocaine use disorders are associated with a number of serious negative outcomes, including impairment (Lozano, Domingo-Salvany, Martinez-Alonso, Brugal, Alonso, de la Fuente, & ITINERE Investigators, 2008), mortality (SAMHSA, 2010), and crime (ONDPCP, 2009).

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Given the high prevalence and exceedingly negative consequences of cocaine use disorders, elucidating the factors involved in the development and maintenance of cocaine use is an important goal of health research.

Behavioral disinhibition, a broad individual difference factor that subsumes more narrow constructs such as impulsivity and reinforcement sensitivity (Dawe, Gullo, & Loxton, 2004; Magid, MacLean, & Colder, 2007), has been suggested as both a potential cause and consequence of substance use disorders (Winstanley, Olausson, Taylor, & Jentsch, 2010). Of the various facets of behavioral disinhibition, “narrow” impulsivity (or “rash impulsiveness”; Dawe et al., 2004) and novelty seeking have arguably received the most scrutiny in the literature. Impulsivity can be generally defined as the tendency to respond without forethought (Robinson, Eagle, Economidou, Theobald, Mar, Murphy, Robbins, & Dalley, 2009); in humans, it is typically assessed using psychometric measures such as the Barratt Impulsivity Scale (BIS-11; Patton, Stanford, & Barratt, 1995), along with behavioral tasks that measure impulsive action or choice (Winstanley et al., 2010). Conversely, novelty seeking is the tendency to initiate exploratory behaviors in response to novelty and cues of reward; it is typically assessed using Cloninger’s Temperament and Character Inventory (TCI; Cloninger, Svrakic, & Przybeck, 1993). Research has demonstrated that impulsivity and novelty seeking are non-redundant facets of behavioral disinhibition (Perkins, Lerman, Coddington, Jetton, Karelitz, Scott, & Wilson, 2008), with differential associations to substance use acquisition and dependence (Belin, Mar, Dalley, Robbins, & Everitt, 2008).

Individuals with substance use disorders are consistently elevated on psychometric and behavioral measures of impulsivity (Kjome, Lane, Schmitz, Green, Ma, Prasla, Swann, & Moeller, 2010) and novelty seeking (Lukasiewicz, Neveu, Blecha, Falissard, Reynaud, & Gasquet, 2008), relative to healthy control subjects. Among alcohol-dependent individuals, novelty seeking and impulsivity, along with “persistence” (another TCI scale measuring the maintenance of behavior despite adverse consequences; Arnau, Mondon, & Santacreu, 2008), have repeatedly been associated with relapse (e.g., Muller, Weijers, Boning, & Wiesbeck, 2008). In non-substance-dependent individuals (typically college-students), impulsivity and novelty seeking have been linked to alcohol consumption (Skeel, Pilarski, Pytlak, & Neudecker, 2008) and the development of substance use disorders (Sher, Bartholow, & Wood, 2000). Finally, impulsivity (Dom, D’haene, Hulstijn, & Sabbe, 2006; Dougherty, Mathias, Tester, & Marsh, 2004) and novelty seeking (Lim, Oh, Shin, Kang, Kim, Park, Kim, & Lee, 2008; Schuckit and Smith, 2011) have each been associated with early onset of substance use initiation and/or dependence.

Many studies examining associations between behavioral disinhibition and substance use history (e.g., age of onset, recent consumption) have focused on individuals with alcohol dependence or non-dependent college students. Less research has been conducted on the relationship between behavioral disinhibition and cocaine use history in individuals with cocaine dependence (Lejuez, Bornovalova, Reynolds, & Daughters, 2007; Tziortzis, Mahoney, Kalechstein, Newton, & De La Garza, 2011). Better understanding of these relationships may help to identify therapeutic targets for cocaine-dependent individuals. The present study examined associations between psychometric measures of behavioral disinhibition (e.g., novelty seeking, impulsivity) and cocaine use history (age of onset, recent cocaine use) in a group of individuals with cocaine dependence. We hypothesized that measures of behavioral disinhibition would be associated with increased cocaine use and decreased age of onset of cocaine dependence.

## 2. Material and methods

### 2.1. Participants

Forty-six non-treatment-seeking cocaine-dependent men and women were recruited as volunteers for a larger, ongoing investigation of the effects of yohimbine on cocaine cue reactivity (ClinicalTrials.gov identifier: NCT00535002) through media advertisements in the local Charleston, SC area. All study procedures were performed in accordance with Good Clinical Practice Guidelines and the Declaration of Helsinki, with approval from the Medical University of South Carolina Institutional Review Board. Participants were nominally compensated for their time. Participants met DSM-IV criteria for Cocaine Dependence and indicated cocaine as their primary drug of choice. General exclusion criteria included: major medical (e.g., diabetes, HIV) and psychiatric conditions (e.g., affective disorders, posttraumatic stress disorder, panic disorder), psychotropic medications, BMI  $\geq 35$ , synthetic glucocorticoid or exogenous steroid therapy within 1 month of evaluation, pregnancy or nursing, and DSM-IV criteria for non-cocaine substance dependence (except caffeine, nicotine, marijuana, or alcohol) within the past 60 days.

### 2.2. Measures

Substance use disorder criteria (including age of onset) were assessed using the Structured Clinical Interview for DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 1994). Exclusionary Axis I disorders were assessed using the Mini International Neuropsychiatric Interview (MINI; Sheehan, Lecrubier, Sheehan, Amorim, Janavas, Weiller, Hergueta, Baker, & Dunbar, 1998). Cocaine use in the three preceding months was assessed using the Timeline Follow-back (Sobell and Sobell, 1992). Recent (i.e., past 30 day) cocaine use was represented with separate quantity (total dollar amount of cocaine used) and frequency variables (percent days used). Behavioral disinhibition was assessed using psychometric measures. The 125-item Temperament and Character Inventory (TCI; Cloninger et al., 1993) was used to assess novelty seeking and persistence, along with two other temperament dimensions, harm avoidance (tendency to inhibit behaviors, heavily influenced by negative affectivity) and reward dependence (tendency to maintain ongoing behaviors; Cloninger et al., 1993). The Barratt Impulsiveness Scale (BIS-11A; Barratt, 1994, prorated to BIS-11; Patton et al., 1995) was used to assess trait impulsivity; the BIS provides subscale scores for three non-redundant factors of impulsivity: motor impulsivity (acting without thinking), attentional impulsivity (ability to focus on the task at hand), and non-planning impulsivity (present orientation; Patton et al., 1995).

Coefficient alpha was calculated for all BIS and TCI scales and subscales. Because BIS and TCI items are ordinal and binary, respectively, we also included approximate internal consistency estimates adjusted for the presence of ordinal data (Zumbo, Gadermann, & Zeisser, 2007); the adjusted estimates are provided in brackets following the alpha estimates: TCI novelty seeking,  $\alpha = 0.45$  [0.60]; TCI persistence,  $\alpha = 0.17$  [0.30]; TCI harm avoidance,  $\alpha = 0.30$  [0.40]; TCI reward dependence,  $\alpha = 0.41$  [0.50]; BIS total score,  $\alpha = 0.81$  [0.85]; BIS motor,  $\alpha = 0.64$  [0.70]; BIS attentional,  $\alpha = 0.41$  [0.50]; BIS non-planning,  $\alpha = 0.72$  [0.80].

### 2.3. Procedures

All procedures included in the present report were conducted at a baseline screening visit, prior to the application of any experimental manipulations.

### 2.4. Statistical Methods

In preliminary univariate analyses, all behavioral disinhibition, cocaine use, and sociodemographic variables were assessed to characterize the study sample and checked for

outliers and implausible values. Continuous variables were assessed for normality, and log-transformed variables used where required for parametric statistical tests. Next, unadjusted and age-and-gender-adjusted Pearson correlation coefficients were calculated to assess relationships between behavioral disinhibition and cocaine use variables. Statistical significance was evaluated at an uncorrected alpha level of 0.05 given the exploratory nature of the analyses; statistical trends (i.e.,  $p < 0.10$ ) were not interpreted. SAS 9.1 (Cary, NC) was used for all analyses.

### 3. Results

#### 3.1. Demographics

46 cocaine-dependent individuals were enrolled into the study, ranging in age from 21 to 61 years. Demographic and clinical characteristics are summarized in Table 1. Briefly, the study sample was characterized by high levels of unemployment (67%) and low levels of marriage or cohabitation (11%). Over 40% of participants had attended at least some college. Participants were predominantly male (65%). However, female participants used cocaine more frequently and tended to spend more money on cocaine in the 30 days preceding the study. A small number of participants ( $n = 7$ ) had co-occurring alcohol dependence at the time of the study.

#### 3.2. Correlations

Pearson correlations between behavioral disinhibition and cocaine use variables are presented in Table 2. Only age-and-gender-adjusted correlations are presented because women exhibited more extensive cocaine use in the 30 days preceding the assessment than did men. Motor impulsivity was significantly associated with lower age of onset ( $p < 0.05$ ). Furthermore, attentional impulsivity was *inversely* related to total dollar amount of cocaine used ( $p = 0.01$ ). In other words, individuals with higher attentional impulsivity scores tended to use less cocaine. Regarding the TCI, novelty seeking and persistence were significantly related to lower percent days used ( $p = 0.02$  and  $p < 0.05$ , respectively). In addition, novelty seeking was significantly associated with lower age of onset ( $p = 0.02$ ). To clarify whether associations between motor impulsivity, novelty seeking, and age of onset of cocaine dependence were confounded with total years of cocaine use, we examined correlations between years of cocaine use and all behavioral disinhibition subscales. Unlike age of onset, total years of use was not significantly associated with any of the BIS or TCI subscales.

### 4. Discussion

The present study investigated associations between behavioral disinhibition and cocaine use history in cocaine-dependent men and women. Consistent with past research (Najavits and Lester, 2008), cocaine-dependent women reported more frequent cocaine use in the 30 days preceding the study, relative to cocaine-dependent men. Also consistent with other studies in this area, various facets of behavioral disinhibition were associated with cocaine use history (Lejuez et al., 2007; Prisciandaro, McRae-Clark, Moran, Hartwell, & Brady, 2011; Tziortzis et al., 2011), controlling for gender and age. For example, elevated motor impulsivity and novelty seeking were both associated with younger age of cocaine dependence onset. Furthermore, individuals with lower levels of persistence on the TCI reported more days of cocaine use over the past month. However, there were also a number of associations that were unexpected given past research. Specifically, increased novelty seeking and attentional impulsivity were associated with *fewer* days of cocaine use and *less* money spent on cocaine, respectively. Importantly, past research on cocaine dependence and impulsivity has focused on differences in behavioral disinhibition between dependent and non-dependent individuals, or associations between broad measures of behavioral

disinhibition and cocaine use history (primarily age of onset), as opposed to associations between particular facets of behavioral disinhibition (e.g., motor impulsivity) and cocaine use history (age of onset and recent use). However, given the preliminary nature of these findings, they should be considered tentative until replicated. With this caveat in mind, we could speculate that individuals high on attentional impulsivity may have difficulty recruiting the cognitive resources necessary to obtain cocaine or the money necessary to purchase cocaine. Regarding novelty seeking, it is possible that the habitual nature of cocaine use in cocaine-dependent individuals promotes behaviors that have proven in the past to result in drug use rather than untested behaviors aimed at achieving novel experiences. One potential limitation of the present study is that, as is typically the case in the literature, internal reliability estimates for the TCI subscales, as well as the attentional impulsivity subscale of the BIS, were low. However, internal consistency is not a necessary nor sufficient measure of the acceptability of a psychometric scale for correlational analyses because internal consistency statistics are greatly influenced by the dimensionality of the scale (i.e., unidimensional vs. multidimensional), the scale of measurement of the items (i.e., continuous vs. ordinal vs. dichotomous), and the number of items included in the scale. Although low alpha levels can attenuate correlations between scales and relevant outcomes, research has demonstrated that such attenuations are typically not substantial (Schmitt, 1996).

## 5. Conclusions

In conclusion, the present study provides evidence for associations between behavioral disinhibition and cocaine use history in cocaine-dependent individuals, extending similar research in alcohol-dependent populations. Although preliminary, this research suggests that individuals with cocaine-dependence and elevated behavioral disinhibition may particularly benefit from treatments that target impulsivity/aggression (e.g., dialectical behavior therapy, mood stabilizing medications). Because different facets of behavioral disinhibition, for example impulsivity and novelty seeking, each have distinct behavioral manifestations and unique neural fingerprints (Belin et al., 2008), better understanding the pattern of associations between facets of behavioral disinhibition and cocaine use may help to identify therapeutic targets for cocaine-dependent individuals. Given our relatively small sample size and participants' wide age range (21 to 61 years old), and the exploratory nature of our findings, however, further research is needed to replicate and extend our results before firm recommendations can be offered.

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**Table 1**

Demographic and clinical characteristics stratified by gender

	Female (n=16)	Male (n=30)	
	N (%)	N (%)	p-value
Race/ethnicity: N (%)			0.13
<i>Non-Hispanic Black</i>	9 (56.2%)	21 (70.0%)	
<i>Non-Hispanic White</i>	5 (31.2%)	9 (30.0%)	
<i>Hispanic</i>	2 (12.5%)	0 (0.0%)	
Age: N (%)			0.55
20-29	2 (12.5%)	3 (10.0%)	
30-39	3 (18.8%)	11 (36.7%)	
40-49	10 (62.5%)	13 (43.3%)	
50+	1 (6.2%)	3 (10.0%)	
Education			0.58
<i>Less than high school</i>	4 (25.0%)	6 (20.0%)	
<i>High school</i>	7 (43.8%)	10 (33.3%)	
<i>Some college</i>	2 (12.5%)	7 (23.3%)	
<i>Two year college degree</i>	3 (18.8%)	4 (13.3%)	
<i>Four year college degree</i>	0 (0.0%)	3 (10.0%)	
Employment			0.16
<i>Full time</i>	0 (0.0%)	7 (23.3%)	
<i>Part time</i>	3 (18.8%)	4 (13.3%)	
<i>Unemployed</i>	13 (81.2%)	18 (60.0%)	
<i>Student</i>	0 (0.0%)	1 (3.3%)	
Marital status			0.75
<i>Married/cohabiting</i>	1 (6.2%)	4 (13.3%)	
<i>Divorced/separated/widowed</i>	7 (43.5%)	13 (43.3%)	
<i>Never married</i>	8 (50.0%)	13 (43.3%)	
Cocaine Use History			
<i>Percent days used, last 30 (mean, SD)</i>	40.6% (19.9%)	24.2% (25.2%)	0.03
<i>\$ amount used, last 30 days (mean, SD)</i>	\$1,022 (\$1,308)	\$410 (\$436)	0.098
<i>Age of onset (mean, SD)</i>	31.3 (12.2)	25.8 (9.6)	0.15
Other drug dependence, current: N (%)	0 (0%)	0 (0%)	NA
Other drug dependence, past: N (%)	4 (26.7%)	15 (50.0%)	0.14
Alcohol dependence, current: N (%)	3 (20.0%)	4 (13.3%)	0.56
Alcohol dependence, past: N (%)	4 (26.7%)	11 (36.7%)	0.50



Table 2

Gender- and age-adjusted Pearson correlation coefficients between behavioral disinhibition and cocaine use measures.

	Cocaine use			Barratt Impulsivity Scale (BIS)			Temperament and Character Inventory (TCI)				
	Age of onset	Total \$ amount used <sup>1</sup>	Percent days used <sup>1</sup>	Motor	Attentional	Non-planning	Total	Novelty seeking	Persistence	Harm avoidance	Reward dependence
BIS											
<i>Motor impulsivity</i>	-0.347*	-0.102	-0.122	1.000	0.382*	0.498*	0.829*	0.262	0.131	0.166	-0.116
<i>Attentional impulsivity</i>	-0.095	-0.409*	-0.249		1.000	0.396*	0.654*	0.270	0.025	0.061	-0.195
<i>Non-planning impulsivity</i>	-0.057	-0.081	-0.106			1.000	0.839*	0.119	-0.290	0.184	-0.188
<i>Total BIS</i>	-0.229	-0.204	-0.185				1.000	0.278	-0.091	0.209	-0.228
TCI											
<i>Novelty seeking</i>	-0.392*	-0.229	-0.385*					1.000	0.085	0.219	-0.306*
<i>Persistence</i>	0.132	-0.228	-0.310*						1.000	-0.145	-0.077
<i>Harm avoidance</i>	-0.323	0.111	0.172							1.000	-0.046
<i>Reward dependence</i>	0.176	0.181	0.265								1.000

<sup>1</sup> Previous 30 days

\* p<0.05