Impulsivity and risk-taking in co-occurring psychotic disorders and substance abuse

Stephanie Marcello Duva a,⁎, Steven Michael Silverstein a, Ralph Spiga b

a University of Medicine and Dentistry of New Jersey, USA
b Pragmatix, Moorestown, NJ & Institute of Behavioral Resources, Baltimore, MD, USA

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A B S T R A C T

Impulsivity is a risk-factor associated with substance use disorders. On paper-and-pencil measures, people with comorbid psychotic disorders and substance abuse have been shown to be more impulsive than their non-using counterparts. However, there has been little research on the behavioral components that, collectively, define the construct of impulsivity, which have been identified as: temporal discounting, risk taking, underestimating time, and failure to inhibit extraneous responding. This study compared people with psychotic disorders who did and did not use cocaine on behavioral measures of these components. One group (COC-now) had a positive urine drug screen (UDS) for cocaine (N=20). A second group (COC-past) had a negative UDS, but a positive cocaine history (N=20). Finally, the third group (control) had no history of cocaine use (N=20). Those with a current or past history of cocaine use engaged in more risk-taking behaviors and seemed to be less affected by anticipated loss and more attuned to monetary gains. However, contrary to our hypothesis, patients in the COC-now group selected larger, delayed rewards over the smaller, immediate rewards. Performance on the immediate/delay task also suggested greater attentiveness to the magnitude of the monetary reward for patients with a positive UDS.

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1. Introduction

People with a diagnosis of schizophrenia spectrum disorders have higher rates of substance use than the general population or groups characterized by other psychiatric disorders, ranging from 33% to 50% (Blanchard et al., 2000). Of particular concern is abuse and dependence of psychostimulants. Several studies have found that the frequency of cocaine use among people with schizophrenia was 27% higher than use of other substances (Sevy et al., 1990; Shaner et al., 1995; Genata et al., 2001). Cocaine use among people with psychotic disorders leads to poorer treatment outcomes, more severe psychiatric symptoms (including positive symptoms), increased rates of treatment noncompliance, violence, HIV infection, homelessness and higher medical costs (Genata et al., 2001). Given the association of schizophrenia spectrum disorders with substance dependence in general, and psychostimulant use in particular, it is important to better understand the psychological mechanisms that predispose to drug use. One candidate mechanism is impulsivity.

Few studies have examined impulsivity in clinical populations (Kjome et al., 2010) and the neural correlates of impulsivity in people with schizophrenia are not well understood (Kaladjian et al., 2010). Even though impulsivity has been found to characterize people with substance use disorders alone (Hollander and Rosen, 2000; Whiteside and Lynam, 2001), this construct is not well understood and often is used to refer to various and separable response tendencies (Dervaux et al., 2001). Therefore, this study adopted a multivariate approach to examine impulsivity in people with both psychotic disorders and substance dependence. Specifically, we assessed the following components: a) temporal discounting (whether a person chooses smaller, immediate rewards over larger, delayed rewards); b) risk taking (probability people who engage in risk-taking behaviors are concerned with the risk of injury versus the potential for rewards); c) underestimating time and; d) failure to inhibit extraneous responding (responding prematurely or having the inability to withhold a response). These measures were chosen based on published reports that substance abusers in the general population tend to: 1) discount the value of delayed rewards (Moeller et al., 2001; Petry, 2001; Holt et al., 2003) and tend to choose the smaller, more immediate alternatives compared to the larger, delayed reward-tendencies also found in animal studies of substance dependence (Madden et al., 1997; Vuchinich and Simpson, 1998; Kirby, et al., 1999; Crean et al., 2000; Odum et al., 2000; Moeller, et al., 2001; Petry, 2001; Holt, et al., 2003; Murray et al., 2003); 2) engage in more risk-taking behaviors (Zuckerman et al., 1990; DiClimente, 1993; Lejuez et al., 2002); 3) underestimate the span of time (White et al., 1999; Zimbardo et al., 1997); 4) fail to inhibit extraneous responding (Fillmore and Rush, 2002). In summary, we examined whether people with psychotic disorders who currently use cocaine relative to patients who only have a history of cocaine or no use at all are more...
impulsive, operationally defined as discounting delayed rewards, choosing riskier alternatives, underestimating the span of time and/or failing to inhibit extraneous responding.

2. Methods

2.1. Participants

Sixty patients (33 men and 27 women) with either a diagnosis of either schizophrenia, schizoaffective or psychosis disorders between the ages of 18–60 (M = 38.1, SD = 9.88) participated. Table 1 summarizes the demographic and diagnostic information of participants. See Table 2 for psychosocial variables for the subjects. There were no significant differences between the three groups on these variables. Urine drug screens (UDS), collected upon admission to the hospital, screened for alcohol, opiates, heroin, cocaine, barbiturates, amphetamines, cannabis, sedatives, hallucinogens and methadone. Based on their UDS and self-reported history of substance abuse, obtained through the Addiction Severity Index (McLellan et al., 1992), they were assigned to one of three groups. Group 1 (COC-now) had a positive UDS for cocaine and a self-reported history of cocaine abuse; Group 2 (COC-past) had a negative UDS for cocaine and other substances, but had a self-reported history of cocaine abuse; Group 3 (control) had a negative UDS and no history of substance abuse. Participants in all groups met diagnostic criteria for schizophrenia, schizoaffective disorder or psychotic disorder. All participants were taking antipsychotic medications. In the COC-now group patients were taking the following medications: Clozaril = 1; other atypical antipsychotics = 17; typical antipsychotics = 2. In the COC-past group: Clozaril = 1; other atypical antipsychotics = 15; typical antipsychotics = 4. In the control group: Clozaril = 5; other atypical antipsychotics = 11; typical antipsychotics = 4. All participants were clinically stabilized and none had active withdrawal symptoms. The exclusion criteria were: involuntary hospitalization, UDS for cocaine (COC-past and control); significant medical disorders sufficiently severe to require medical care while a patient on the unit; an IQ score less than 70 (measured by the Kaufman Brief Intelligence Test (Kaufman and Kaufman, 1990) or current suicidal ideation indicated during the administration of Structured Clinical Interview for DSM-IV Axis I Disorders (SCID) (First et al., 1997).

2.2. Procedures

Patients were referred by the acute psychiatry unit. Two screening instruments were used to determine eligibility to participate: the SCID and the Kaufman Brief Intelligence Test. On the morning of the first day of testing, participants completed three paper and pencil measures: the Addiction Severity Index, the Barratt Impulsiveness Scale-11 (BIS-11) (Patton et al., 1995) and the Cocaine Selective Severity Assessment (CSA) (Kampman, et al., 2001). The BIS-11 measured three components of impulsivity: ability to plan for the future (future planning), tendency to act without thinking (motor impulsivity) and tendency to make quick cognitive decisions.

Table 1

Demographic, intake urinalysis and drug use characteristics of the participants.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive use and history</td>
</tr>
<tr>
<td>n</td>
<td>20</td>
</tr>
<tr>
<td>Age</td>
<td>Mean: 39.75 (10.65)</td>
</tr>
<tr>
<td>Gender</td>
<td>Male: 10 (50%)</td>
</tr>
<tr>
<td></td>
<td>Female: 10 (50%)</td>
</tr>
<tr>
<td>Race/ethnic</td>
<td>Black: 14 (70%)</td>
</tr>
<tr>
<td></td>
<td>Caucasian: 4 (20%)</td>
</tr>
<tr>
<td></td>
<td>Hispanic: 2 (10%)</td>
</tr>
<tr>
<td></td>
<td>Asian: 0</td>
</tr>
<tr>
<td>Intake urinalysis</td>
<td>Cocaine: 20 (100%)</td>
</tr>
<tr>
<td></td>
<td>Cannabis: 3 (15%)</td>
</tr>
<tr>
<td></td>
<td>Heroin: 5 (25%)</td>
</tr>
<tr>
<td></td>
<td>Tranquilizer: 2 (10%)</td>
</tr>
<tr>
<td></td>
<td>Barbiturates: 5 (25%)</td>
</tr>
<tr>
<td></td>
<td>Methadone: 1 (5%)</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Schizophrenia: 14 (20%)</td>
</tr>
<tr>
<td></td>
<td>Schizoaffective: 2 (10%)</td>
</tr>
<tr>
<td></td>
<td>Psychosis NOS: 3 (15%)</td>
</tr>
<tr>
<td></td>
<td>Substance Abuse: 20 (100%)</td>
</tr>
<tr>
<td></td>
<td>Substance Dep.: 20 (100%)</td>
</tr>
</tbody>
</table>

Two computerized tasks were administered in the afternoon of the first day and included the Behavioral Measure of Risk Taking (BART) and the Single Key Impulsivity Paradigm (SKIP). On the second day of testing, participants completed three computer programs: the Two Choice Impulsivity Paradigm (TCP), the Time Paradigm (TIME) and the GoStop Impulsivity Paradigm (GoStop). Each of these laboratory measures of impulsivity is described below.

2.3. Measures

2.3.1. Behavioral measure of risk taking: the Balloon Analogue Risk Task (BART) (Lejue et al., 2002)

On each trial, a small balloon and a balloon pump are displayed on the computer screen along with a counter showing the total amount of money earned. The participant can inflate the balloon and earn $0.05 cents by pressing the mouse button. Five cents is added to the total amount earned if the inflation does not cause the balloon to explode.

If the participant inflates the balloon to the point of explosion by clicking the balloon pump too frequently, the participant loses all the money earned. At anytime, the participant can choose to collect all the money earned, and therefore reduce the risk of losing the accumulated earnings, by clicking the collect money button. After the participant’s balloon either explodes or the money is transferred to the accumulated total, a new balloon appears. There are a total of 30 trials.

2.3.2. Laboratory behavioral measures of impulsivity (Dougherty et al., 2002)

This battery includes four computerized behavioral tasks: GoStop impulsivity paradigm, single key impulsivity paradigm, time paradigm and two choice impulsivity paradigm.

a. GoStop Impulsivity Task — the GoStop task measures response inhibition. Participants are instructed to pay attention and remember numbers that appear on the computer monitor. On each trial, they are presented with a five digit black number against a white background. The set of numbers flashes once for two seconds on the screen. After the presentation of the first numbers another set of numbers appears. If the second set matches the first set (go signal), the participant has to click the left mouse button while the matching number is still visible (400 ms) to be rewarded. If the numbers do not match, the participant has to refrain from responding. However, on occasion, the second matching number turns red (stop signal). If this occurs, the participant has to withhold responding. Stop-signal color change happens after different intervals within 400 ms of a go signal. These stop signals adjust according to task performance: interval lengths decrease following failure to inhibit and increase following successful inhibition. Stop-signal intervals continue to adjust until the participant is able to inhibit at least 50% of trials. Once they meet the 50% criterion, the stop response time is calculated by subtracting the stop-signal delay from the go reaction time. Longer stop reaction time values reflect behavioral disinhibition (Reynolds et al., 2007).

b. Single Key Impulsivity Task — the SKIP task measures response inhibition. On this task, participants can press the button rapidly or slowly, but there are no temporal cues signaling when to press the button. The longer the delay between each response, the greater number of points earned. Response inhibition is the average inter-response time (IRT). IRT is the length of time between two consecutive responses.
c. Time Estimation Task — the TIME task assesses participant’s ability to estimate the passage of time. Participants are instructed to press a response button when they think 60 s elapsed. There are a total of five trials.

d. Two Choice Impulsivity Task — the TCIP task assesses temporal discounting (whether a person chooses smaller, immediate rewards over larger, delayed rewards). Each trial starts with the appearance of two shapes (circle and a square) on the monitor screen. The participant selects either the circle or the square. The unevaluated geometric figure is removed from the monitor. The selected figure fades from the screen over a 5 or 15 s period, depending on whether a circle or square was selected. After the 5 or 15 s elapses, the selected figure starts flashing. If a participant chooses the circle, the circle fades over 5 s and 5 points are added to their earnings. If a participant chooses a square, it fades over 15 s and 15 points are earned.

Participants were paid $0.10 for each point they earned on the GoStop, SKIP, TIME and TCIP tasks and were paid the total amount earned after all 30 trials on the BART. They were compensated after completing the last assessment. The compensation procedures and protocol were explained to participants during the consenting process. Prior to starting the computer tasks, all participants were read a scripted tutorial on procedures and protocol were explained to participants during the consenting process.

2.4. Statistical analysis

The three groups were compared on each measure using analysis of variance (ANOVA). Post hoc (HSD) analyses were used when there was a significant main effect of group.

3. Results

See Table 3 for between-group comparisons on each measure.

3.1. Paper-and-pencil measures

3.1.1. BIS-11

Future planning: there was a significant main effect of group, $F(2, 57) = 3.42, p = 0.05$. The mean subscale sum of the COC-now group was significantly ($p < 0.01$) higher than that of the control group. There was no significant difference between the COC-now and the COC-past group, or between the COC-past and the control group. Motor impulsivity: there was a significant main effect of group, $F(2, 57) = 6.80, p = 0.001$. The mean subscale sum of the COC-now group was significantly ($p < 0.001$) higher than that of the controls. There was no significant difference between the COC-now and COC-past groups, or between the COC-past and the control group.

Cognitive impulsivity: there was a significant main effect of group, $F = (2, 57) = 4.80, p = 0.01$. The mean subscale score of the COC-now group was significantly ($p < 0.01$) higher than that of the controls. There was no significant difference between the COC-now and COC-past groups, or between the COC-past and the control group.

Total BIS-11 score: the groups differed significantly on BIS-11 scores, $F = (2, 57) = 6.92, p = 0.001$. The mean COC-now score was significantly ($p < 0.01$) higher than that of the control group. There was no significant difference between the COC-now and COC-past groups, or between the COC-past and the control group.

In summary, patients with a cocaine positive UDS at intake were less likely than patients with either a past history of substance use or no substance use history to report planning future action and thinking before acting. Furthermore, this group was more likely to make quick cognitive decisions.

3.2. Behavioral measures of risk-taking and impulsivity

3.2.1. Balloon Analogue Risk Task (BART)

On the BART, the dependent variable was risk-taking, operationalized as the adjusted number of pumps across balloons. The adjusted average, defined as the average number of pumps on balloons that did not explode, is preferable to the unadjusted average because the latter is confounded by trial termination on exploded trials, limiting between-participant variability in the unadjusted averages (Lejuez et al., 2002). A comparison of the group means of these scores revealed a significant difference, $F = (2, 57) = 6.84, p = 0.001$. The means for COC-now and COC-past groups were not significantly different. However, each of these groups differed significantly ($p < 0.001$) from the control group. The proportion of explosions was equivalent for all groups.

3.2.2. Two-Choice Impulsivity Task (TCIP)

On the TCIP, the dependent variable was temporal discounting, which was operationalized as the total number of immediate choices divided by the total number of delayed choices. There was a significant main effect of group: $F = (2, 57) = 4.60, p = 0.01$. The mean number of immediate choices for COC-now was significantly smaller than the mean for COC-past and control groups. The mean number of immediate choices for the COC-past group was significantly ($p < 0.01$) higher than the control group ($p < 0.14$). Thus, patients who used cocaine at intake, and had a history of cocaine use, chose delayed rewards more frequently.

3.2.3. GoStop Impulsivity Task

There was a trend towards a main effect of group for inhibition between the COC-now and control group ($d = 1.47$), with the COC-now group demonstrating the greatest impairment, $F = (2, 57) = 2.98, p = 0.059$. There was no significant difference between the COC-now and COC-past groups, or between the COC-past and the control group.

3.2.4. TIME Impulsivity Task

On the TIME, the dependent variable was the average number of seconds that elapsed between the participants pushed the button, over five trials. The time estimation variable was operationalized as the total number of seconds divided by each of the five trials. The groups did not differ significantly in mean time estimated, $F(2, 57) = 42, p = 0.17$.

3.2.5. SKIP impulsivity task

The dependent measure of response inhibition was the average IRT. The main effect of group was not significant, $F(2, 57) = 1.51, p = 0.23$.

Table 3

Comparisons between each measure.

<table>
<thead>
<tr>
<th>Scales</th>
<th>Group 1 Mean (SD)</th>
<th>Group 2 Mean (SD)</th>
<th>Group 3 Mean (SD)</th>
<th>F</th>
<th>p</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSSA</td>
<td>1.71 (0.40)</td>
<td>1.36 (0.30)</td>
<td>1.19 (0.28)</td>
<td>4.80</td>
<td>0.010**</td>
<td>20</td>
</tr>
<tr>
<td>BIS-11</td>
<td>18.00 (5.40)</td>
<td>16.40 (5.40)</td>
<td>13.63 (5.40)</td>
<td>3.42</td>
<td>0.040*</td>
<td>20</td>
</tr>
<tr>
<td>Future plan</td>
<td>18.35 (5.40)</td>
<td>14.35 (5.40)</td>
<td>12.30 (5.40)</td>
<td>6.80</td>
<td>0.001***</td>
<td>20</td>
</tr>
<tr>
<td>Motor</td>
<td>3.95 (3.92)</td>
<td>5.20 (4.77)</td>
<td>6.30 (4.40)</td>
<td>1.07</td>
<td>0.350</td>
<td>20</td>
</tr>
<tr>
<td>BIS-11</td>
<td>13.45 (4.92)</td>
<td>9.95 (4.77)</td>
<td>9.10 (4.40)</td>
<td>4.80</td>
<td>0.012**</td>
<td>20</td>
</tr>
<tr>
<td>Cognitive</td>
<td>47.40 (13.09)</td>
<td>38.85 (11.09)</td>
<td>33.30 (11.09)</td>
<td>6.92</td>
<td>0.001***</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>(12.03)</td>
<td>(9.65)</td>
<td>(14.13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BART</td>
<td>27.81 (21.25)</td>
<td>32.04 (26.44)</td>
<td>15.50 (37.81)</td>
<td>6.84</td>
<td>0.001***</td>
<td>20</td>
</tr>
<tr>
<td>TCIP</td>
<td>13.09 (10.19)</td>
<td>19.10 (11.00)</td>
<td>25.40 (14.40)</td>
<td>4.60</td>
<td>0.014**</td>
<td>20</td>
</tr>
<tr>
<td>Immm. Choice</td>
<td>21.25 (12.57)</td>
<td>26.44 (12.80)</td>
<td>37.81 (12.06)</td>
<td>2.98</td>
<td>0.059</td>
<td>20</td>
</tr>
<tr>
<td>GoStop</td>
<td>36.01 (231.67)</td>
<td>39.78 (158.62)</td>
<td>31.19 (95.53)</td>
<td>4.20</td>
<td>0.170</td>
<td>20</td>
</tr>
<tr>
<td>Inhibition</td>
<td>(5.09)</td>
<td>(5.85)</td>
<td>(6.85)</td>
<td>1.07</td>
<td>0.350</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>65.85 (231.67)</td>
<td>65.85 (158.62)</td>
<td>65.85 (95.53)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SKIP</td>
<td>14.00 (31.67)</td>
<td>29.61 (35.60)</td>
<td>28.73 (36.10)</td>
<td>1.51</td>
<td>0.230</td>
<td>20</td>
</tr>
</tbody>
</table>

*** Significant at the 0.001 level (2-tailed).
** Significant at the 0.01 level (2-tailed).
* Significant at the 0.05 level (2-tailed).
4. Discussion

A complex pattern of findings were observed; some were consistent with past research while others were not. While, in general, cocaine use was associated with impulsivity and risk-taking, this was also impacted by the magnitude of the possible reward. On the BART, patients with either a present or past cocaine use tended to inflate the balloons to higher monetary values, resulting in greater earnings. However, the proportion of trials with explosions was equivalent for all groups. Therefore, a reasonable conclusion is that people with schizophrenia spectrum disorders who use cocaine are less affected by threat of a loss. Conversely, they seemed to be more attuned to the monetary gains. This is consistent with findings that substance users engage in more risk-taking behaviors than non-substance users (Lejuez et al., 2003). In addition, these results are consistent with those of Dervaux et al. (2001) on the association between increased impulsivity and substance abuse in patients with schizophrenia.

On the temporal discounting variable, we hypothesized that patients with current use or a drug use history would choose smaller more immediate rewards over larger, delayed rewards (similar to the BART balloon task). This hypothesis was consistent with past research on substance use that found greater discounting rates in people with a substance use disorder (Kirby et al., 1999; Crean et al., 2000; Vuchinich and Simpson, 1998). Contrary to our hypothesis and past research, we found that patients who used cocaine were more likely to select the larger, delayed rewards over the smaller, immediate rewards. A possible explanation for this apparent difference with past findings is that, in this study, the delay may have not been long enough between the immediate and delayed rewards to make this distinction valid. On the other hand, this study examined impulsivity using behavioral measures which may produce different results than the self-report instruments used in past studies. In addition, performance on the immediate/delay task also suggests greater attentiveness to the magnitude of monetary reward, consistent with the data on the BART noted above.

The nature of inhibition in schizophrenia is controversial (Bellgrove et al., 2005), and deficits are not universally found (Rubia et al., 2001). On the inhibition tasks, there were no significant differences between the three groups. Enticott et al. (2008) found that people with schizophrenia had slower inhibitory processes, but there was no association with impulsivity, suggesting a looser coupling of these processes in schizophrenia, compared to others.

On the BIS-11, which is a self-report measure of impulsivity, there were significant differences between the COC-now and control groups. Participants who had a positive UDS for substances scored higher on the three components of the BIS-11 than the control group. These results are consistent with the literature on people with substance use disorder alone (Bankston et al., 2009; Kjome et al., 2010). Some studies that have used the BIS-11 with people with schizophrenia and substance use disorder have found significant differences on future planning, motor impulsivity and cognitive impulsivity (Dervaux et al., 2001) when compared to people with schizophrenia alone. Recently, Kaladjian et al. (2010) found that people with schizophrenia were more impulsive than healthy subjects, as indicated by higher BIS-11 scores. However, Gut-Fayand et al. (2001) found no differences on motor impulsivity in people with schizophrenia with and without substance use disorders. People with schizophrenia in the Gut-Fayand et al. (2001) study did have higher scores on the BIS-11 for total score, cognitive impulsivity and non-planning.

In summary, this study found that participants with either a current or past cocaine use history took more risks than schizophrenia spectrum patients with no drug use history. In addition, patients with a positive UDS for cocaine scored higher on impulsivity measures when compared to patients with a negative UDS. Also, schizophrenia spectrum patients with a positive UDS chose larger, delayed rewards over smaller more immediate rewards and were less affected by the threat of loss. In contrast, there were no group differences on the time estimation or response inhibition components of impulsivity.

Our findings of larger reward modulating the tendency to prefer immediate reward suggest that contingency management approaches to substance abuse treatment in schizophrenia would be effective. This hypothesis is consistent with preliminary data on this issue. For example, Kinnaman et al. (2007) and Roll et al. (2004) demonstrated the effectiveness of voucher-based reinforcement therapy, a type of contingency management intervention for people with schizophrenia and cocaine use where vouchers earned for negative UDS are redeemable for goods or services.

A limitation of this study is the relatively small sample size, and so this study needs to be considered as preliminary. Another possible limitation is that we did not control for antipsychotic medications, especially Clozaril use, which may reduce impulsivity (Dursun et al., 2000). However, only a small number of patients in each group were taking Clozapine, all subjects were taking antipsychotic medications, and significant group difference in impulsivity still emerged. Another limitation is that the mean IQ for participants in all three groups was probably an underestimate of premorbid IQ. Replication with a sample with higher IQ’s is necessary to evaluate the generalizability of findings to other people with schizophrenia spectrum disorders.

An unexplored issue is this paper is directionality of substance abuse and impulsivity. Researchers and clinicians typically assume that impulsivity is a causal factor leading to substance abuse. However, the opposite could also be true and longitudinal studies can help examine this. As an example of this in our data, on the BIS-11, the COC-past group were not significantly different than the control group, whereas the COC-now group rated themselves as more impulsive. This suggests the possibility that the presence of cocaine makes this group rate themselves as more impulsive. However, although there may be effects of cocaine on impulsivity, this begs the question of what causes cocaine use in the first place (i.e., the extent to which trait-impulsivity is associated with attraction to the immediate high of use without regard to consequences). Our data suggest this is the case. Finally, it is necessary to investigate impulsivity and risk-taking in people with schizophrenia who primarily use other drugs, such as, cannabis, alcohol, etc.

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