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Negative affect, affect-related impulsivity, and receptive syringe sharing among people who inject drugs

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Abstract

Receptive syringe sharing (RSS) among people who inject drugs (PWID) is a risk factor for hepatitis C virus and HIV infections. PWID with borderline personality disorder (BPD) have increased risk of RSS, but it remains unclear what drives this association. This study used ecological momentary assessment (EMA) to study characteristics associated with BPD, and RSS among PWID. We recruited PWID, age 18–35, through two Community Outreach Intervention Projects syringe service program sites in Chicago, Illinois, USA. After a baseline interview, participants used a mobile phone app to respond to momentary surveys on mood, substance use, and injection risk behavior for two weeks. For each momentary assessment, ratings on negative mood descriptors were combined to create measures of total negative affect (NA), and NA components of dejection, shame, anger, irritability, and worry. RSS was defined by participant responses indicating that they had used a syringe that someone else had used. We estimated mixed effects logistic models, regressing RSS on baseline affect-related impulsivity, lagged momentary NA, and the interaction term. Out of 163 participants who completed at least two EMA assessments, 152 (93%) reported at least one injection event and had valid pre-injection mood assessments required to be included in the analysis. We found that affect-related impulsivity, combined with worried mood in the hours preceding the injection episode, predicted increased risk of RSS. PWID having difficulties with emotion regulation may be at increased risk of RSS during periods of anxiety or tension.

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ecological momentary assessment; emotion dysregulation; hepatitis C; injection drug use; borderline personality disorder

The prevalence and incidence of hepatitis C virus (HCV) infections in the United States has been on the rise for several years, with 41,200 new HCV infections occurring in 2016 alone (Centers for Disease Control and Prevention, 2018). New HCV infections increased most rapidly among young people (20 to 29 years old) (Centers for Disease Control and Prevention, 2017), fueled by an increase in injection drug use (IDU) (Chatterjee et al., 2011; Zibbell et al., 2018; Zibbell et al., 2015). An estimated 40% of people in the U.S. with recent IDU are HCV infected (Grebely et al., 2018). Sharing syringes and other injection equipment among people who inject drugs (PWID) is a significant risk factor for transmission and acquisition of blood-borne diseases including HIV and HCV (Centers for Disease Control and Prevention, 2012; Hagan et al., 2001; Pouget, Hagan, & Des Jarlais, 2012; Thorpe et al., 2002). Recent research has underscored heightened behavioral risk among PWID with co-occurring mental health disorders, placing them at increased risk of HIV and HCV infection (Disney et al., 2006; Gilchrist, Blazquez, & Torrens, 2011; King, Kidorf, Stoller, & Brooner, 2000; Majer, Komer, & Jason, 2015; Roy, Levesque, Bruneau, Jutras-Aswad, & Bertrand, 2014).

Models commonly used to explain individual variation in risky behavior have included factors such as knowledge, beliefs, attitudes, and behavioral skills as predictors (Bandura, 1994; Fishbein & Middlestadt, 1989; Fisher, Fisher, & Harman, 2003). Environmental and contextual factors are also important (Boodram, Golub, & Ouellet, 2010; Boodram, Hotton, Shekhtman, Gutfraind, & Dahari, 2018; Boodram, Mackesy-Amiti, & Latkin, 2015; German, Davey, & Latkin, 2007; Hotton & Boodram, 2017; Roy et al., 2011), especially in relation to planning public health responses, including harm reduction, increased testing, linkage to care, and availability of curative direct-acting antiviral (DAA) HCV therapy (Boodram et al., 2020; National Academies of Sciences Engineering and Medicine, 2016; Platt et al., 2018). The role of affect and emotion regulation in determining injection risk behavior, on the other hand, has received little attention. These are particularly important given the high rates of affective disorders among people who use drugs (Compton, Thomas, Stinson, & Grant, 2007; Grella, Karno, Warda, Niv, & Moore, 2009; Myrick & Brady, 2003) and the potential to identify novel targets for risk-reduction interventions. While negative affect and poor emotion regulation are implicated in the development and maintenance of substance use disorders (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004; Cheetham, Allen, Yucel, & Lubman, 2010; Kassel et al., 2007; G. Koob & Kreek, 2007; G. F. Koob, 2009), as well as other types of risky behavior (Weiss, Sullivan, & Tull, 2015), few studies have examined the relationship between negative affect and injection risk behavior (Mackesy-Amiti, Donenberg, & Ouellet, 2014; Pilowsky, Wu, Burchett, Blazer, & Ling, 2011; Stein, Solomon, Herman, Anderson, & Miller, 2003).

Recent studies in Australia (Darke, Williamson, Ross, Teesson, & Lynskey, 2004) and the United States (Mackesy-Amiti et al., 2014) have found an association between borderline

personality disorder (BPD) and risky injection practices. BPD is common among illicit drug users including PWID (Chen et al., 2011; Mackesy-Amiti, Donenberg, & Ouellet, 2012; Mills, Teesson, Darke, Ross, & Lynskey, 2004; Rounsaville et al., 1998; Torrens, Gilchrist, & Domingo-Salvany, 2011; Trull, Sher, Minks-Brown, Durbin, & Burr, 2000; Verheul, 2001). Individuals with BPD experience rapid mood swings, heightened emotional reactivity, vulnerability to negative affect, and slow recovery from dysphoric states (Crowell, Beauchaine, & Linehan, 2009; Lieb, Zannarini, Schmahl, Linehan, & Bohus, 2004; Linehan, 1993). This leads to dysfunctional response patterns during emotionally challenging events.

Impulsivity is also a hallmark symptom of BPD. Recently, researchers have differentiated multiple types of impulsivity (Whiteside & Lynam, 2001). Sensation seeking (a tendency to seek excitement and adventure) is differentiated from negative urgency (a tendency to commit rash or regrettable actions as a result of intense negative affect) and (lack of) premeditation (the tendency to delay action in favor of careful thinking and planning). BPD is particularly associated with negative urgency, the tendency to act impulsively when experiencing negative affect (Cyders & Smith, 2007; Peters, Upton, & Baer, 2012; Tragesser & Robinson, 2009). Negative urgency has been found to predict risky sexual behavior (Deckman & DeWall, 2011) as well as self-harm behavior (Dir, Karyadi, & Cyders, 2013; Riley, Combs, Jordan, & Smith, 2015) and may be an important construct linking BPD with risky injection behavior. Innovative methods are needed to clarify the dynamic relationship between mood states and injection behavior.

Ecological momentary assessment (EMA) is an optimal method for studying dynamic processes, such as mood and behavior, and to minimize problems of retrospective recall bias (Ebner-Priemer & Trull, 2009a, 2009b; Shiffman, Stone, & Hufford, 2008). Biases in retrospective reporting of events and experiences have been demonstrated in a number of empirical studies and may be exacerbated by mental health problems. For example, individuals with BPD may underestimate positive emotions and overestimate negative emotions in retrospective accounts, while healthy control participants exhibit the opposite pattern (Ebner-Priemer et al., 2006). EMA allows the study of within-person variability that is not possible with cross-sectional observational studies that provide information about between-person differences only. Moreover, EMA allows the study of the interplay of mood and behavior over time in a real-life context.

In this study, we sought to develop an understanding of the mechanisms that link BPD or emotion dysregulation with risky injection behavior. We conducted EMA with PWID using a mobile phone app to assess mood and injection risk behavior over a period of two weeks (Mackesy-Amiti & Boodram, 2018). Participants completed a screening for BPD and measures of emotion dysregulation and impulsivity at baseline. In a separate paper (Mackesy-Amiti & Donenberg, 2020) we report our findings on emotion dysregulation and patterns of negative affect in this sample, confirming that symptoms of BPD and emotion dysregulation were associated with more intense and unstable NA. In this paper, we examine the associations between EMA-reported receptive syringe sharing, momentary negative affect preceding the injection event, and baseline measures of affect-related impulsivity. We hypothesized that respondents with a high score on measures of affect-related impulsivity

would be more likely to engage in risk behavior such as receptive syringe sharing when experiencing high levels of negative affect.

Methods

Participant recruitment

The research was conducted at two field sites operated by Community Outreach Intervention Projects (COIP) in Chicago, Illinois, U.S. from February 2016 to June 2017. These locations provide harm reduction services including a syringe services program (SSP), HIV and HCV testing, counseling and case management services, and prevention-focused street outreach. People between the ages of 18 and 35 who injected illicit drugs in the past 30 days were eligible for the study. Participants were excluded if they could not read and understand English. COIP's SSP clients were invited to participate and were encouraged to refer other PWID to the study. Current injection was verified by trained counselors who inspected for injection stigmata and, when stigmata were absent or questionable, evaluated knowledge of the injection process. Age was verified with a driver's license or a state identification card. Individuals who met the eligibility criteria were offered \$10 to complete a screening questionnaire assessing symptoms of borderline personality disorder (*MacLean Screening Instrument for BPD*) (Zanarini et al., 2003). This screening was initially planned to ensure that at least 50% of our sample met the screening criteria for BPD (score ≥ 7). We expected 30-40% of subjects would score above the cutoff. It soon became clear that there would be no need to selectively sample on BPD screening, however we retained the 2-step procedure.

Procedures

Clients were recruited after they completed their visit at a COIP SSP. After the interviewer administered the written informed consent procedure, participants completed the screening questionnaire, followed by a baseline audio computer-assisted self-interview (ACASI) and were compensated \$25. Participants were then trained on the use of the mobile phone app to access the survey and answer the questions. An Android mobile phone (4.4 KitKat OS, retail value \$50) was provided, or participants could choose to use their own device. Phones were encrypted, password protected, and the EMA app and study-related messages were protected with an app lock. A mobile contact number was provided for participants to ask questions or report technical problems. Study personnel responded promptly to assistance requests during usual operating hours and as soon as possible outside of usual hours to troubleshoot and resolve issues. Participants received mobile surveys for 15 days (including partial first day); they were paid for each survey completed and could earn up to \$9 per day. At the end of the observation period, participants were notified to return to the field site for a brief follow-up survey, and to collect their compensation. The study coordinator attempted to locate participants who failed to appear for the final interview to document the reason for non-return. Study procedures were approved by the University of Illinois at Chicago Institutional Review Board.

We used the ilumivu mEMA platform (version 5.8; ilumivu Inc., 2016), that includes a web site for creating and managing surveys and data, and a mobile phone app to deliver the assessments. The mEMA app allows responses to be entered on the cell phone even when

there is no active internet connection, although an internet connection is needed to upload data. Assessments were scheduled to occur 4, 5, or 6 times per day at random time-points within a 12-hour window. As reported in a previous paper (Mackesy-Amiti & Boodram, 2018), we varied the number of daily assessments across participants to examine the impact on participation and completion. Start and end time were decided by the participant at the beginning of the study to accommodate individual schedules (nearly all within 08:00 to 23:00). Each day for 2 weeks, participants received a notification when an assessment was requested, followed by reminders after 5 minutes and 10 minutes if the survey was not accessed. After 20 minutes the survey became unavailable until the next scheduled assessment.

All participants could potentially earn up to \$9.00 per day regardless of the assigned number of assessments. Participants earned a bonus of \$10 for completing at least 80% of the assessments, and an additional \$10 if they completed 90% of the assessments. Participants who used their own mobile phone received \$25 to offset data usage. Participants who used a project phone received a minimum payout of \$25 for returning the phone. Participants received daily text message updates on their progress showing the number of assessments completed, and the number needed to reach the bonus level. If a participant missed all assessments on any day, they received a reminder to contact study personnel for assistance. If a participant did not complete any assessments for two consecutive days, the site study coordinator attempted to contact them to offer assistance. If a participant did not complete any assessments for a third day, they were notified to return to the study site. Detailed information on participation rates is reported in our previous paper (Mackesy-Amiti & Boodram, 2018).

Measures

Baseline Assessment.—The following measures were included in the baseline ACASI (average time to complete 45 minutes).

Borderline Personality Disorder. The McLean Screening Instrument for Borderline Personality Disorder (Zanarini et al., 2003) consists of ten yes-no items. The score is computed as the total number of items positively endorsed. Using a cutoff score of 7 or more items endorsed, the screening instrument achieved good sensitivity (.81) and specificity (.85) for the diagnosis of DSM-IV BPD, and criterion and construct validity have been supported (Gardner & Qualter, 2009; Patel, Sharp, & Fonagy, 2011). Minor changes were made to adapt the instrument for computer-assisted selfadministration. Internal consistency in the current sample was acceptable ($\alpha = 0.77$).

Sociodemographic and Geographic Characteristics. The questionnaire assessed demographic characteristics including sex, sexual orientation, race or ethnicity, and highest level of education attained. Residential zip code, sources of income, places lived or slept, homelessness, and drug treatment were assessed with reference to the past six months. Current participation in drug treatment was also assessed. Homelessness was measured with two different questions: 1) “In the past 6 months, have you thought of yourself as homeless?” and 2) “In the past 6 months, have you slept in a shelter, car, abandoned

building, public park, squatting place, or other non-dwelling for more than 7 nights in a row?” Based on these two questions, we created a composite variable with three levels: 1) not homeless, 2) thought of as homeless, 3) slept in non-dwelling.

Risk Behavior and HIV/HCV Status.: The NIDA Risk Behavior Assessment (National Institute on Drug Abuse, 1993), a widely used instrument with established reliability and validity (Needle et al., 1995; Weatherby et al., 1994), was administered to assess substance use and sexual risk behavior, and HIV testing history and outcomes. Items were added to measure HCV testing history and outcomes. Injection behaviors were assessed with reference to the past 6 months. Receptive syringe sharing (“Thinking about all the times you injected in the past 6 months, how often did you inject with needles that had been used before you by somebody else, even if the needle was cleaned first?”) was measured on a 7-point Likert type scale from “never” to “always”. We recoded responses into 3 categories: never, rarely, and sometimes (less than half the time to always).

Emotion Dysregulation.: The Difficulties in Emotion Regulation Scales (DERS) (Gratz & Roemer, 2004) is a self-report instrument with six sub-scales, including non-acceptance of emotional responses, difficulties engaging in goal directed behavior, affect-related impulsivity, lack of emotional awareness, limited access to emotion regulation strategies, and lack of emotional clarity. The impulsivity subscale includes items such as “When I’m upset, I have difficulty controlling my behaviors,” and “When I’m upset, I feel out of control.” Scores are coded such that high scores indicate greater emotion dysregulation. The DERS has demonstrated adequate construct and predictive validity (Gratz & Roemer, 2004), and has been validated in samples of cocaine (Fox, Axelrod, Paliwal, Sleeper, & Sinha, 2007) and alcohol (Fox, Hong, & Sinha, 2008) dependent respondents. Total and subscale scores are computed as the sum of item ratings. In the current sample, internal consistency was excellent for the total scale ($\alpha = 0.95$) and good for all subscales ($\alpha = 0.82 - 0.87$). The mean DERS impulsivity score was 16.64 (SD 5.54; IQR 12, 20).

Impulsivity.: The SUPPS-P Impulsive Behavior Scale (Cyders, Littlefield, Coffey, & Karyadi, 2014) is a short version of the Urgency, Premeditation, Perseverance, Sensation Seeking, Positive Urgency Impulsive Behavior Scale (UPPS-P) (Cyders et al., 2007; Whiteside & Lynam, 2001; Whiteside, Lynam, Miller, & Reynolds, 2005), consisting of 20 four-point Likert scale items measuring five dimensions of impulsivity. The abbreviated scale demonstrated criterion validity similar to the full scale (Cyders et al., 2014). Subscale scores were computed as the mean of item ratings. The negative urgency (NU) scale includes items such as “When I feel bad, I will often do things I later regret in order to make myself feel better now,” and “When I am upset I often act without thinking.” In the current sample, internal consistency was acceptable for NU ($\alpha = 0.70$). The mean NU score was 3.21 (SD 0.58; IQR 2.75, 3.75).

EMA Measures.—The EMA assessments included questions on current mood, context (where and who with), current intoxication or withdrawal, injection since last report, and if applicable, recency of injection, and syringe and equipment sharing at last injection.

Momentary affect.: Participants were presented with a list of 20 mood descriptors and instructed to select up to four that described their current mood. Options also included *not sure* and *none of these*. For each selected item, participants then rated their mood intensity on a 10-point slider scale. The item set was developed largely based on the Positive and Negative Affect Schedule - Expanded Form (PANAS-X) (Watson & Clark, 1999; Watson, Clark, & Tellegen, 1988) through three rounds of pretesting with PWID recruited at COIP field stations. The items retained included two “serenity” items (calm, relaxed), six positive affect (PA) items (happy, energetic, excited, confident, determined, inspired) and ten PANAS negative affect (NA) items (angry, angry at self, ashamed, disgusted, distressed, downhearted, irritable, sad, scared, upset). We also included two new NA items relevant to this population (frustrated and worried), resulting in a 12-item NA scale. In pretesting, internal reliability was high for both the 6-item PA scale ($\alpha=0.81$) and the 12-item NA scale ($\alpha=0.91$), and the pick-4 format did not affect NA or PA intensity.

Unselected items were scored zero, and the mood ratings were averaged for all 12 negative mood descriptors to create a measure of general NA at each assessment. Similarly, the six positive mood ratings were averaged to create a measure of general PA. When a participant selected *none* or *not sure* and no mood items were rated, affect intensity was scored as zero.

To identify within-subject (state) components of NA, we conducted a multilevel exploratory factor analysis of the twelve NA ratings in Mplus (version 8; Muthén & Muthén, 2017), with the between-subject level unrestricted. Factors were subjected to GEOMIN rotation, and model fit was assessed by comparative fit index (CFI), root mean squared error of approximation (RMSEA), and standardized root mean square residuals (SRMR). We created measures of NA components by computing the mean of the two highest loading items for each factor (see Appendix A). Five within-subject level factors were extracted (CFI=0.99, RMSEA<0.001, SRMR=0.008). The NA components are 1) *shame*: ashamed and angry at self, 2) *dejection*: downhearted and distressed, 3) *irritability*: frustrated and irritable, 4) *anger*: angry and upset, and 5) *worry*: worried and scared.

Current state of intoxication or withdrawal.: Participants were asked, “Are you currently under the influence of alcohol or any drug (buzzed, high)?” and if they answered affirmatively they were asked to report the substance(s) involved (alcohol, marijuana, cocaine, heroin, opiate med, other). They were also asked, “Are you currently feeling any hangover or withdrawal effect?” and if so, to report which substance(s) were involved.

Injection drug use and syringe and equipment sharing.: Participants were asked, “Did you inject any drug since your last report?” If they answered affirmatively, they were asked “When did you last inject?” with response options ranging from 1 (*less than 1 hour ago*) to 7 (*more than 12 hours ago*). If injection was reported, participants were asked the following questions. (i) When you injected the last time did you: a) use a brand new syringe, b) re-use a syringe only you used before, or c) use a syringe that someone else had used? (ii) When you injected the last time did you: a) use new clean cooker, cotton & water, b) re-use any supplies that only you used before, or c) use any supplies that someone else had used? (iii) After you injected the last time did you give your syringe to someone else to use? Receptive

syringe sharing (RSS) was indicated by responses that the participant had used a syringe that someone else had used.

Analysis

Regression analyses were conducted in Stata (version 15; StataCorp, 2017). We tested between-subject effects of trait NA, DERS impulsivity, and negative urgency (NU) on momentary NA using GEE regression. For the main analysis, we conducted mixed effects logistic regression analyses predicting RSS during reported injection events, with random intercepts for subject. Mixed models were estimated using 15 points of integration for increased accuracy. Day and time of day effects were included in all models, as well as homelessness, as these variables were associated with the EMA response rate. We tested between-subject variables including sex, race or ethnicity, BPD screen, DERS total score, DERS impulsivity, and NU. To test our hypothesis that PWID experiencing high affect-related impulsivity would be more likely to engage in risk behavior during periods of elevated negative affect, we regressed RSS on lagged momentary NA (i.e. NA at the preceding EMA prompt), and interactions with DERS impulsivity and NU. Momentary affect ratings were subject-centered, and subject mean NA, computed over all reports during the 2-week observation period, was also included in the model to separate within and between-person effects (Curran & Bauer, 2011). Lagged effects were computed based on completed EMA reports, ignoring missed EMA prompts. Sensitivity analyses were conducted to test the effect of varying length of time lag between affect rating and injection reports, by adjusting for length of time lag or excluding observations with time lags greater than 4 hours. In addition, we conducted separate exploratory analyses of each NA component, following the same analytical procedure. We also tested models including withdrawal symptoms as a within-subject factor, to rule out the possibility that withdrawal could explain the effects of NA. A final model of NA component effects included all significant interaction terms.

Results

All eligible subjects agreed to participate and were enrolled in the study. Out of 185 participants with baseline data, our sample was restricted to the 165 (89%) who completed at least two mobile assessments during the two-week observation period, with an additional two subjects excluded due to missing data on the baseline instrument (total n=163). A previous paper reported on correlates of EMA response rate and study completion (Mackesy-Amiti & Boodram, 2018). On average, participants responded to 43% of survey prompts, providing a total of 5,525 EMA responses, 99% (n=5,475) with non-missing data on injection. Homelessness was associated with study dropout and lower response rate, as well as syringe sharing. Characteristics of the available sample are shown in Table 1. Seventy percent of subjects scored at or above the cutoff (7) on the BPD screener. Within this sample, 45% of EMA reports (2,473 / 5,475) included an injection event; 59 of these events (2.4%), reported by 21 individuals (13%), included RSS.

Between subject factors

The probability of RSS did not vary by subject sex, race or ethnicity, or age. Participants who reported being homeless at baseline (slept in a non-dwelling) were more likely to report RSS compared to others (OR = 5.79, 95% CI 1.21-27.61). Overall, momentary RSS was not associated with BPD screening status, DERS total score, DERS impulsivity, or negative urgency impulsivity.

Momentary negative affect

Overall momentary NA was significantly associated with trait negative affect ($b=0.09$, 95% CI 0.02-0.17) and DERS impulsivity ($b=0.14$, 95% CI 0.06-0.21), but not with NU. Analyses of NA effects used lagged values; this necessarily restricted the analysis to observations with non-missing lagged affect ratings within the same day. Out of 2,471 observations that included an injection event and non-missing data on RSS, 63% had a valid lagged affect rating recorded ($N=152$ subjects, 1,559 observations). Out of 912 injection events without a same-day lagged affect rating, about half (49%) were due to being the first scheduled observation of the day. Eleven individuals who were low frequency responders did not contribute any observations to the analysis. The mean time lag was 3 hours (SD 1.58), ranging from 0.19 to 10.96 (IQR [1.9, 3.6]), with 95% under 6 hours. RSS was reported on 40 (2.6%) of these observations, by 15 individuals. Overall, momentary RSS was not associated with lagged total NA, dejection, shame, irritability, anger, or worry. Interactions between total NA and NA components and affect-related impulsivity are summarized in Table 2 (NU) and Table 3 (DERS impulsivity). DERS impulsivity interacted with total NA to predict greater likelihood of RSS. In addition, high affect-related impulsivity on both measures was associated with increased likelihood of RSS when respondents reported feeling worried or scared in the preceding time period. An interaction between NU and anger was observed in the opposite direction than predicted, such that NU was associated with increased likelihood of RSS when anger was relatively low (but not when anger was high), and anger was negatively associated with RSS when NU was high. Adjusting for the effects of withdrawal in the preceding time period had no substantial impact on the estimates. Analyses with time lags restricted to four hours or less, or including length of time lag as a covariate, also produced similar results. In the final model, shown in Table 4, we included the three interaction terms and computed the predicted probabilities of RSS. We plotted the estimated effects on contour heatmaps, using Shepard interpolation (Press, Teukolsky, Vetterling, & Flannery, 2007) (Figure 1). Note that the distribution of NU is negatively skewed with a mean of 3.2, and 50% of scores between 2.75 and 3.75. Darker color indicates a higher predicted probability of RSS. Panel (a) shows the effect of NU combined with worry, panel (b) shows the effect of DERS impulsivity with worry, and panel (c) shows the effect of NU with anger. The hotspots in the upper right corner of panel (a) and panel (b) show the effect of worry and high NU or DERS impulsivity.

Discussion

Previous research has found that PWID with BPD are more likely to engage in RSS (Darke et al., 2007; Darke, Ross, Williamson, & Teesson, 2005; Mackesy-Amiti et al., 2014), a practice that places them at risk for HIV and HCV infections. Our study used ecological

momentary assessment to study associations between negative affect, emotion dysregulation, affect-related impulsivity, and RSS among PWID. Specifically, we tested the hypothesis that those with high negative urgency or DERS impulsivity would be more likely to engage in RSS during periods of elevated negative affect. Our findings support that PWID who score high on DERS impulsivity are at relatively greater risk of RSS following elevated NA. In addition, both DERS impulsivity and NU were associated with greater risk of RSS following a report of being worried or scared, feelings that indicate a state of tension, anxiety, or fear. In a test of construct validity, the PANAS Fear dimension (scared, nervous, jittery, etc.) was strongly associated with the Profile of Mood States (POMS) Tension-Anxiety dimension (tense, nervous, anxious, etc.) Worry or anxiety (for example, associated with avoiding withdrawal or fear of getting caught engaging in illegal behaviors) may lead PWID who are lacking emotion regulation skills to take risks that they might otherwise avoid. The interaction between NU and anger was in the opposite direction than predicted, and was not replicated for DERS impulsivity. This suggests it may be spurious, perhaps due to the small number of people with low (<2) NU scores.

Measures of DERS impulsivity and NU assess related yet distinct facets of affect-related impulsivity. DERS impulsivity items assess loss of control when experiencing emotional distress, while NU items capture rash and regrettable behavior. Negative urgency impulsivity is described as a maladaptive strategy for coping with unpleasant affect, taking impulsive action to achieve immediate relief regardless of the consequences (Cyders & Smith, 2007, 2008). This disposition to engage in rash action contributes to risky behavior, including substance misuse and IDU (Mirhashem et al., 2017; Wardell, Strang, & Hendershot, 2016). Negative urgency is also associated with self-harm behavior (Dir et al., 2013; Glenn & Klonsky, 2010; Peterson, Davis-Becker, & Fischer, 2014) and suicidal ideation (Anestis & Joiner, 2011; Klonsky & May, 2010; Lynam, Miller, Miller, Bornovalova, & Lejuez, 2011), problems that are common among PWID and people with BPD. People with affect-related impulsivity may benefit from interventions that teach emotion regulation and distress tolerance skills. For PWID, such an intervention could be integrated with other harm reduction efforts to prevent risky behavior including syringe sharing and drug mixing, as well as augment treatment success.

Limitations

Participants in this study completed less than half of scheduled EMA assessments, potentially compromising the quality of the data collected. We reported on correlates of response rate in a previous paper (Mackesy-Amiti & Boodram, 2018). Homelessness was an important factor associated both with response and study completion rates and with RSS. Non-response and study dropout by homeless participants may have contributed to low rates of reported RSS. In addition, many of the participants were regular clients of the SSP, and may engage in less risky behavior than PWID in general. The low rate of RSS reported during the study may have limited our ability to detect effects. A longer duration of observation may be needed to observe somewhat rare occasions of syringe sharing that nevertheless pose a serious risk to health.

Our measure of momentary affect was comprised of a subset of items from one widely used measure of dimensions of affect. The pick-4 measure significantly reduces the burden on the participant, and still provides an adequate assessment of the respondent's mood on multiple dimensions (Mackesy-Amiti & Donenberg, 2020). We included *worried* as a novel mood term as it was more frequently endorsed in pretesting than terms such as *nervous* or *jittery*. Future research on risk behavior among PWID should pay greater attention to this dimension of affect.

Conclusions

Difficulties with emotion regulation are common among PWID. One manifestation of emotion dysregulation is negative urgency impulsivity - a tendency to commit rash or regrettable actions as a result of intense negative affect. Our findings suggest that PWID with high negative urgency may be more likely to engage in risky injection behavior at typical levels of negative affect, and more so during periods of anxiety or stress. Interventions that teach emotion regulation and distress tolerance skills may be beneficial for PWID and can be integrated into typical substance use and mental health programs.

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APPENDIX A

Table A1.

Multilevel exploratory factor analysis of momentary mood intensity ratings: Within-subject factors

GEOMIN ROTATED LOADINGS					
Item	1	2	3	4	5
Angry	0.11	-0.08 *	0.02	0.38 **	-0.02
Angry at self	0.61 **	0.00	0.04 *	0.00	0.02
Ashamed	0.43 **	0.00	-0.08	0.01	-0.01
Disgusted	0.11 *	0.06	0.01	0.21 **	-0.12 **
Distressed	0.03	0.20 **	0.10 **	0.01	0.00
Downhearted	0.00	0.63 **	0.00	-0.01	0.00
Frustrated	0.03	0.02	0.54 **	0.01	0.00
Irritable	-0.05	-0.02	0.32 **	0.09	0.04
Sad	0.01	0.11 *	-0.14 **	0.11	0.19 **
Scared	0.02	-0.01	-0.08	0.01	0.35 **
Upset	-0.04	0.02	0.03	0.32 **	0.33 **
Worried	0.04	-0.03	0.04	-0.09	0.44 **

* p < 0.01;

** p < 0.001

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Figure 1. Predicted Probability of Receptive Syringe Sharing (RSS)

Note: The predicted probability of receptive syringe sharing (RSS) based on the final model plotted by (a) negative urgency and preceding worry, (b) DERS impulsivity and preceding worry, and (c) negative urgency and preceding anger.

Table 1.

Characteristics of the sample (N = 163)

Variable	<i>n</i>	%
Sex		
Male	111	68.1
Female	52	31.9
Age, Mean (<i>SD</i>)	29.6 (3.9)	
Race/Ethnicity		
White, non-Hispanic	101	62.0
Black, non-Hispanic	12	7.4
Hispanic	37	22.7
Other, non-Hispanic ^a	11	6.7
Highest level of education		
Less than high school	33	20.2
High school graduate (12th grade) or GED	63	38.7
Some college or technical training	50	30.7
College graduate or higher	15	9.2
Residence (place slept most past 6 months)		
Chicago	97	59.5
Outside of Chicago	66	40.5
Homelessness past 6 months		
Not homeless	65	39.9
Thought of as homeless	34	20.9
Slept in non-dwelling > 7 nights	64	39.3
Frequency of injection past 6 months		
Less than daily	43	26.4
Daily, 1 to 4 times per day	71	43.6
Daily, 5 or more times per day	46	28.2
Receptive syringe sharing past 6 months		
Never	91	55.8
Rarely	35	21.5
Sometimes	36	22.1
BPD screening score		
Low (< 7)	49	30.1
High (≥ 7)	114	69.9
Negative urgency impulsivity: Mean (<i>SD</i>)	3.18 (0.58)	
DERS impulsivity: Mean (<i>SD</i>)	16.19 (5.54)	
PID negative affect: Mean (<i>SD</i>)	1.67 (0.73)	

^aIncludes Asian, Pacific Islander, Native American, Black or African-American, mixed race, and unidentified race.

DERS: Difficulties with Emotion Regulation Scale

PID: Personality Inventory for DSM-5

Note: some percentages add to less than 100% due to missing data.

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Table 2.

Multilevel mixed effects logistic regression on receptive syringe sharing during injection event: Effects of negative affect preceding the injection event and interactions with NU impulsivity, N=152 Ss, 1,559 obs

Effect	OR	SE	95% Conf. Int.	p
Total NA ^a	0.94	0.25	0.56 1.57	0.813
NU (Std.)	1.94	0.75	0.91 4.16	0.088
Total NA x NU	0.95	0.38	0.43 2.10	0.901
Mean Total NA ^b	1.21	1.09	0.21 7.08	0.829
Dejection ^a	0.96	0.06	0.85 1.08	0.459
NU (Std.)	1.82	0.68	0.87 3.77	0.110
Dejection x NU	1.09	0.14	0.84 1.42	0.512
Mean dejection ^b	4.10	3.17	0.90 18.64	0.068
Shame ^a	1.01	0.02	0.96 1.05	0.782
NU (Std.)	2.04	0.86	0.89 4.67	0.091
Shame x NU	1.01	0.06	0.89 1.14	0.909
Mean shame ^b	0.85	0.69	0.17 4.20	0.838
Anger ^a	0.97	0.06	0.85 1.10	0.619
NU (Std.)	2.04	0.80	0.95 4.38	0.067
Anger x NU	0.77	0.08	0.62 0.95	0.016
Mean anger ^b	1.12	0.91	0.23 5.47	0.888
Irritability ^a	0.89	0.16	0.62 1.27	0.529
NU (Std.)	2.10	0.73	1.06 4.16	0.033
Irritability x NU	1.00	0.19	0.69 1.45	0.994
Mean irritability ^b	0.65	0.26	0.30 1.43	0.286
Worry ^a	0.57	0.21	0.28 1.16	0.120
NU (Std.)	2.33	0.98	1.02 5.32	0.044
Worry x NU	2.45	0.88	1.21 4.95	0.013
Mean worry ^b	1.48	0.78	0.52 4.18	0.464

^aWithin-person effect (person-centered momentary affect)

^bBetween-person effect (person-mean affect over all observations)

NA: Negative affect; NU: Negative urgency; Std: Standardized

Models are adjusted for day, time of day, and homelessness

Table 3.

Mixed effects logistic regression on receptive syringe sharing during injection event: Effects of negative affect preceding the injection event and interactions with DERS impulsivity, N=152 Ss, 1,559 obs

Effect	OR	SE	95% Conf. Int.	p
Total NA ^a	0.46	0.21	0.18 1.15	0.095
DERS Impulsivity (Std.)	1.43	0.77	0.50 4.08	0.499
Total NA x DERS Impulsivity	1.78	0.45	1.08 2.91	0.022
Mean Total NA ^b	1.15	0.90	0.25 5.35	0.856
Dejection ^a	0.96	0.13	0.73 1.25	0.752
DERS Impulsivity (Std.)	1.13	0.57	0.42 3.06	0.803
Dejection x DERS Impulsivity	1.01	0.10	0.84 1.23	0.893
Mean dejection ^b	4.20	2.96	1.05 16.73	0.042
Shame ^a	1.06	0.08	0.92 1.23	0.402
DERS Impulsivity (Std.)	1.41	0.69	0.54 3.68	0.483
Shame x DERS Impulsivity	0.96	0.04	0.89 1.05	0.374
Mean shame ^b	0.83	0.58	0.21 3.25	0.790
Anger ^a	0.86	0.06	0.74 0.99	0.042
DERS Impulsivity (Std.)	1.37	0.65	0.54 3.48	0.504
Anger x DERS Impulsivity	1.10	0.10	0.91 1.32	0.326
Mean anger ^b	1.01	0.66	0.28 3.61	0.984
Irritability ^a	0.89	0.18	0.60 1.34	0.585
DERS Impulsivity (Std.)	1.48	0.85	0.48 4.57	0.500
Irritability x DERS Impulsivity	0.99	0.19	0.68 1.45	0.952
Mean irritability ^b	0.67	0.30	0.27 1.61	0.367
Worry ^a	0.53	0.22	0.24 1.19	0.123
DERS Impulsivity (Std.)	1.35	0.73	0.47 3.92	0.579
Worry x DERS Impulsivity	2.46	0.77	1.33 4.54	0.004
Mean worry ^b	1.29	0.60	0.52 3.21	0.579

^aWithin-person effect (person-centered momentary affect)

^bBetween-person effect (person-mean affect over all observations)

NA: Negative affect; NU: Negative urgency; Std: Standardized

Models are adjusted for day, time of day, and homelessness

Table 4.

Mixed effects logistic regression on receptive syringe sharing during injection event: Effects of worry and anger preceding the injection event and interactions with NU and DERS impulsivity, N=152 Ss, 1,559 obs

Effect	OR	SE	95% Conf. Int.		p
Worry ^a	0.38	0.16	0.17	0.88	0.023
DERS Impulsivity (Std.)	1.07	0.70	0.30	3.85	0.916
Worry x DERS Impulsivity	2.24	0.68	1.24	4.05	0.008
NU (Std.)	2.11	1.18	0.71	6.34	0.181
Worry x NU	1.73	0.51	0.97	3.07	0.061
Anger ^a	0.96	0.06	0.85	1.09	0.556
Anger x NU	0.74	0.08	0.59	0.93	0.009
Mean worry ^b	1.29	0.91	0.32	5.16	0.720
Mean anger ^b	0.86	0.78	0.14	5.12	0.866

^a Within-person effect (person-centered momentary affect)

^b Between-person effect (person-mean affect over all observations)

NA: Negative affect; NU: Negative urgency; DERS: Difficulties with Emotion Regulation Scale; Std: Standardized

Model is adjusted for day, time of day, and homelessness