Relationship Between Drug Dreams, Affect, and Craving During Treatment for Substance Dependence

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Objectives: To explore the relationship between occurrence of drug dreams (DDs) and daytime negative affect and drug craving during the course of a 5-week treatment program for substance dependence.

Methods: Using the dream journal methodology, 86 participants reported occurrence of dreams, dream content, and ratings of affect and drug craving. The relationships between the experience of DD, dream content ("active" vs "passive"), and affect and craving were analyzed using mixed model methods.

Results: The experience of DD was associated with higher levels of negative affect ($P < 0.001$) and craving ($P < 0.001$). The occurrence of DD did not decrease significantly over the 5 weeks of the study. Cocaine/crack users reported a higher occurrence of DD ($P < 0.05$) than the other drug groups (opiates and alcohol), and DD involving "active" drug use was associated with larger ($P < 0.05$) changes in negative affect.

Conclusions: These results are consistent with the hypothesis that DD can act as drug-conditioned stimuli to elevate negative affect and craving in abstaining individuals. Although correlational, such findings support the implementation of psychological and pharmacological interventions aimed at minimizing the impact of DD on individuals in recovery from drug addiction.

Key Words: affect, conditioned responses, conditioned stimuli, craving, drug dream, residential treatment, sleep

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Drug dreams (DDs) can be defined as dreams in which withdrawing or recovering drug users dream about situations where drugs, drug paraphernalia, drug use, or other drug users are present. The content of the dreams has been reported to change as recovery progresses (Reid and Simeon, 2001), but common themes include using drugs, seeking or resisting use, or seeing other people using. Drug dreams are generally frequent during withdrawal and protracted abstinence (Christo and Franey, 1996; Flowers and Zweben, 1998; Colace, 2014), are mostly reported within the first week of abstinence (Colace, 2004), and can persist for weeks (Hajek and Belcher, 1991), months (Christo and Franey, 1996), and even years (Johnson, 2001) after the cessation of drug use. Although prevalence rates vary from study to study, it has been estimated that more than 85% of individuals experience DDs within 2 months after cessation of drug use (see Colace, 2014 for review).

There seems to be an association between DD and the subsequent experience of drug cravings. This association is suggested by frequent anecdotal reports and from studies that have explored the psychological and neurobiological bases of these 2 phenomena. For example, Colace (2004) argued that DD and drug cravings represent 2 different expressions of the same "motivational drive frustration" that are experienced when someone stops using drugs. More importantly, Johnson (2001) noted that the neural pathways involved in dreaming and drug craving overlap, and a recent review by Perogamvros and Schwartz (2012) indicated that the mesolimbic dopaminergic system, including the amygdala, the striatum, and the anterior cingulate cortex, plays a role in both processes.

The main hypothesis underlying this study was that DD can act as drug-conditioned stimuli. Drug-conditioned stimuli, which can be discrete (ie, a syringe) and/or environmental (ie, a room), acquire the ability to activate drug-oriented behaviors because they are repeatedly perceived in conjunction with the unconditioned effects of drugs of abuse (Stewart et al., 1984). Hence, through Pavlovian conditioning, drug-conditioned stimuli become "wanted" (Robinson and Berridge, 1993) and preferred (Moeller et al., 2009), "grab" attention (Field and Cox, 2008), and produce various physiological and psychological responses (Carter and Tiffany, 1999; Volkow et al., 2006), including increased self-reports of drug craving. Therefore, if DD act as drug-conditioned stimuli, they should be followed by various conditioned responses including elevation in cravings. This prediction is consistent with the neurobiological concordance between conditioned craving responses and increased neural activity in the amygdala and the anterior cingulate cortex (Childress et al., 1999).

Within this framework, it is interesting to note that different types of drug-conditioned stimuli can cause different physiological and psychological conditioned reactions. For example, Robbins et al. (1997) found that drug-related actions (handling drug paraphernalia) triggered more pronounced physiological reactions (lowered skin temperature) than seeing

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these actions without active participation (watching a video with drug scenes). Therefore, if DD can act as drug-conditioned stimuli, it is possible that the content of the dream can also have an impact on craving intensity.

However, even if DD and drug craving share psychological and neurobiological processes, several issues remain unclear. First, although cravings are an inevitable component of withdrawal, as stated in the *Diagnostic and Statistical Manual of Mental Disorders* (Fifth Edition) *DSM-5* (American Psychiatric Association, 2013), DDs are not (for a comprehensive review of the DD and craving issue, see Colace, 2014). Second, disturbed dreaming in the form of "vivid unpleasant dreams" is reported in the *DSM-5* as common occurrences during withdrawal from psychomotor stimulants (cocaine, methamphetamines), but not withdrawal from opiates and alcohol. Therefore, it may be that the experience of DD is related to the primary drug of abuse before withdrawal. Third, exposure to drug-conditioned stimuli is also associated with the experience of stress and negative affective states (Childress et al., 1988, 1994). Drug dreams are typically quite vivid, and bouts of disturbed dreaming (vivid dreams and nightmares) are well known to cause somatic and psychological distress (Zadra and Donderi, 2000; Levin and Fireman, 2002; Blagrove et al., 2004). Furthermore, sleep disturbances have been found to be both precursors and consequences of negative affective states (Zadra and Donderi, 2000), with intensity of nightmares being predictive of level of emotional distress during wakefulness (Levin and Nielsen, 2007). Therefore, DD may elevate craving as a consequence of disturbing sleep and/or by inducing negative affective states upon awakening.

The main objective of this study was to investigate DD occurrence and dream content in subjects attending 5-week residential treatment programs. The overarching hypothesis was that DDs act as drug-conditioned stimuli and, therefore, can negatively impact daytime affect and cravings. On the basis of findings presented above, it was also predicted that occurrence of DD would change during treatment, that it would be related to the type of drug primarily abused, and that DD content ("active" vs "passive" see below) would be associated with intensity of daytime negative affect and craving.

METHODS

Subjects

Participants were recruited between January 2012 and March 2013 from 2 residential treatment centers in Ontario offering 5-week long abstinence-based programs consisting primarily of group and individual therapy. Males and females, 18 and more, were included in the study. Forty-five participants were recruited from a woman-only facility (Womankind, St Joseph's Healthcare Hamilton), and 41 were recruited from a mixed-gender treatment center (Homewood Health Centre, Guelph). Demographic data, main drug of abuse, frequency of use in the month preceding admission, and mental health diagnosis are presented in Table 1. Potential participants were informed that the experience of DD was not a requirement for inclusion in the study. Those suffering from active psychosis or untreated schizophrenia symptoms were excluded. The research protocol was approved by the University of Guelph Research Ethic Board and Homewood Health Centre and St Joseph's Healthcare Hamilton Research Ethic Boards.

TABLE 1. Demographic Profile, Drug Use History and Mental Health Diagnosis of Participants Recruited From 2 Residential Treatment Centers in Ontario Between January 2012 and March 2013. Homewood Health Centre (Guelph) and St Joseph's Healthcare (Hamilton) Are Residential Facilities Offering 5-Week Long Abstinence-Based Programs Consisting Primarily of Group and Individual Therapy

	Males % (n = 25)	Females % (n = 61)	Total % (n = 86)
Age, y*			
<25	8 (2)	7 (4)	7 (6)
25–35	20 (5)	34 (21)	30 (26)
>35	68 (17)	51 (31)	56 (48)
Main drug used†			
Alcohol	60 (15)	36 (21)	43 (36)
Cocaine/crack	8 (2)	33 (19)	25 (21)
Opiates	20 (5)	15 (9)	16 (14)
Cannabis	4 (1)	9 (5)	7 (6)
Methamphetamines	0 (0)	2 (1)	1 (1)
Benzodiazepines	4 (1)	3 (2)	4 (3)
Other	4 (1)	2 (1)	2 (2)
Nicotine patch			
Yes	4 (1)	30 (18)	22 (19)
No	96 (24)	70 (43)	78 (67)
Mental health diagnosis‡			
Depression	41 (10)	64 (39)	58 (49)
Posttraumatic stress disorder	4 (1)	15 (9)	12 (10)
Bipolar	0 (0)	18 (11)	13 (11)
Schizophrenia	0 (0)	2 (1)	1 (1)
Anxiety	29 (7)	53 (32)	46 (39)
Other	8 (2)	5 (3)	6 (5)

*One male and 5 females did not report their age on the questionnaire, which accounts for the sums not adding up to the total n for the age category.

†Three females reported more than 1 drug of choice and were therefore not entered into any of the categories.

‡Participants were asked to report all of their mental health diagnoses, which were included in the relevant categories. Therefore, sum of diagnoses is higher than the total number of male and female participants.

The number of required participants was calculated with G-Power 3.1 using conservative estimates (medium effect size, alpha at 0.05, and predicted correlation among measures of 0.3; power = 0.95). This method was used as a general guideline because, as far as the authors know, this type of study has never been performed. A sample size of 63 participants was suggested, and to account for an anticipated drop out rate of 20% the sample size was set to a minimum of 76 participants. The final sample size was subsequently increased to better balance male/female ratio, bringing the total number of participants to 86.

MEASURES

Questionnaires

Subjects provided informed consent following a description of study objectives and participation requirements, and they completed a questionnaire designed to gather demographic data, drug use, and treatment history information.

During this initial session, they were also provided with the first week of dream journals. They were instructed to complete these journals, daily upon awakening, to report dreams

and, if they were DDs, their content. The dream journal/diary method is considered a valid approach to explore the association between psychological health and dream content (Pesant and Zadra, 2006) and relationships between dream content and events experienced during the day (Schredl and Hofmann, 2003). Other methods, such as ecological momentary assessment, that would allow stricter control on when measurements are taken were not applicable to this study because it was impossible to estimate, on an individual basis, what was the most desirable time interval between awakening and explicit/accurate report of dreams and their content. This, of course, is an issue common to all studies of dreams.

The dream journal also included questions about drug cravings and affect. A single item visual-analog scale (0-10 cm) was used to self-report drug craving (Goddard et al., 2013) experienced on the previous day and in the morning upon waking. Affect was indexed by the short Positive and Negative Affect Scale with 10 items for each (scale: 1-5) (Watson et al., 1988), although only negative affect scores were analyzed in this manuscript.

The participants received a gift certificate for participation in the study regardless of the number of dream journals that were completed during the week.

Data analysis

Each participant reported whether they experienced a DD or a regular dream (RD) during the night. If neither was reported, the rater classified the night as a "no dream" (ND). Although it was not commonly observed, when a journal included both DD and RD in the same night, the rater classified the night as DD.

Linear mixed modeling (SPSS v21) was used to evaluate the relationship between dream type and self-reported scores of craving on the day preceding the dreams and in the morning following the dreams, and negative affect experienced in the morning following the dreams. This particular method of data analysis was used because it has the advantage of retaining participant's data despite missing entries throughout the data set (missing questionnaire entry or drop out from the study). Moreover, time (weeks of the study) is treated as continuous variable, and the method allows for post hoc mean comparisons using the Bonferroni adjustment.

To assess whether occurrence of DD changed over time, the percentage of total dreams that involved drugs was compared across the 5 weeks of treatment using a repeated measures analysis of variance. To assess the relationship between occurrence of DD and intensity negative affect and craving, Pearson correlations were performed for all weeks combined, and separately for each week of the study.

To explore whether the type of primary drug of abuse was related to occurrence of DD, a comparison of DD frequency (as a percentage of the total number of nights in the study) was performed for the 3 most commonly reported drug choices (see Table 1)—cocaine/crack, alcohol, and opiates (oxycodone, heroin, and morphine were merged). A Kruskal-Wallis test was also performed to confirm a significant group difference between the 3 drug categories.

Finally, the content of each DD was evaluated by 2 independent investigators for description of (1) the use of drugs—injecting, snorting, smoking, or drinking; (2) searching drugs; (3) resisting use; (4) temptation to use; and (5) looking at, or seeing, drugs. However, because the self-reports of categories 2 to 5 were low, such dreams were merged and categorized as "passive" DD and were compared with dreams in category 1—"active" DD. The interrater reliability Cronbach α was 0.90.

RESULTS

Information pertaining to the main characteristics of subjects is reported in Table 1. Fifty-two (60.5%) reported polydrug use, whereas 34 (39.5%) reported using only 1 drug. Analysis of drug use before admission indicated that 65% of the participants had less than a week of abstinence before initiation of treatment. Over the entire study period, considering that the average stay in treatment was 2.2 weeks, a total of 1324 dream journals were collected (1 journal per night per participant). This average length of stay reflects a treatment drop out rate that is typical of many residential programs.

In these dream journals, 633 (74%) and 227 (26%) RD and DD were reported, respectively (mean RD per week per participant = 3.4; mean DD per week per participant = 1.3). Fourteen (21%) participants never reported a DD, and 8 (12%) reported no RD during their participation in the study. The proportion of participants who reported at least 1 DD during the study period was as follows: week 1 = 49%; week 2 = 57%; week 3 = 61%; week 4 = 51%; and week 5 = 22%. Compliance rate for dream journals completion, defined as the number of daily dream journals filled out in relation to the total number of days of participation in the study, was 88.6%. The drop out rate, defined as the number of participants who enrolled in the study but for whom ND journals were received, was 17.4%.

The linear mixed model analysis indicated that craving scores following DD were significantly higher than following ND and RD in weeks 2 to 4 (see Fig. 1). The overall (all weeks included) correlation between DD occurrence and intensity of craving was significant ($r = 0.37$; $P < 0.05$), but the effect was primarily due to a significant correlation in week 3 ($r = 0.62$; $P < 0.001$), possibly because of smaller sample size in weeks 4 and 5. The same analysis performed on craving experienced on the day preceding the dreams revealed no significant differences ($P = 0.08$).

The linear mixed model analysis indicated that negative affect scores following DD were significantly higher than following ND and RD in weeks 2 to 4 (see Fig. 2). The overall (all weeks included) correlation between DD occurrence and intensity of negative affect was significant ($r = 0.33$; $P = 0.02$), but the effect was primarily due to significant correlations in weeks 2 and 3 ($r = 0.47$; $P < 0.05$ and $r = 0.51$; $P < 0.05$, respectively), possibly because of smaller sample size in weeks 4 and 5.

The occurrence of DD, calculated as a mean frequency of DD in proportion to all dreams experienced by a participant during a given week (only participants who experienced at least 1 DD during each week of the study were included in this analysis of variance), did not decrease significantly from week 1 to week 5 (means = 43, 42, 42, 41, and 27, respectively [$F_{4,48} = 0.84$; $P = 0.51$]).

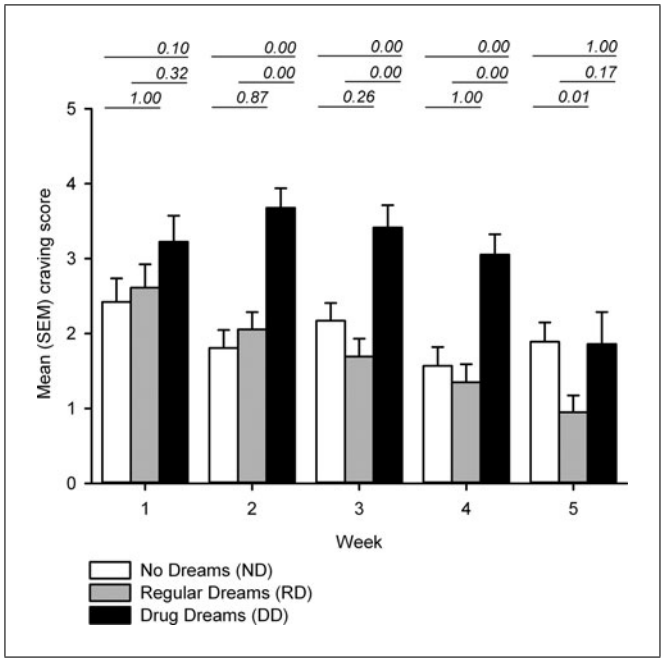

FIGURE 1. Mean (SEM) craving scores (maximum score = 10) self-reported by participants after the experience of drug dreams (DD), regular dreams (DR), or no dreams (ND) on each of the 5 weeks of treatment. The numbers above the bars represent the significance value of individual mean comparisons yield by a linear mixed model analysis followed by the Bonferroni correction.

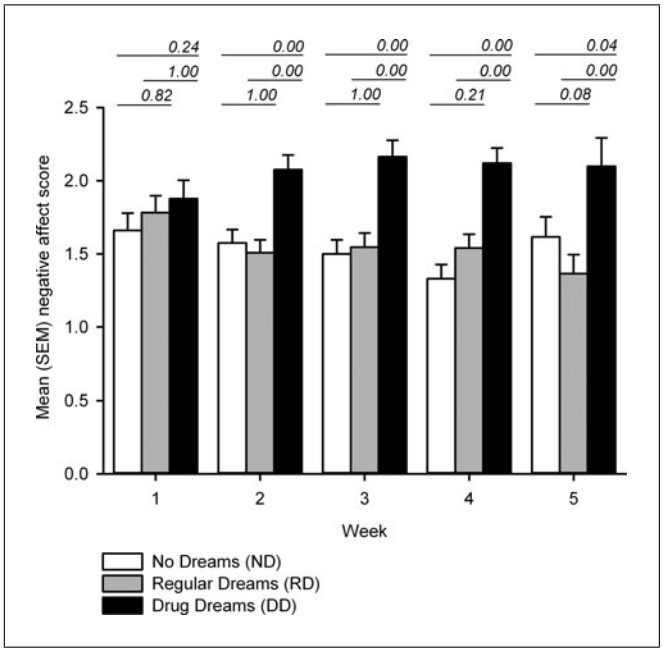

FIGURE 2. Mean (SEM) negative affect scores (maximum score = 5) self-reported by participants after the experience of drug dreams (DD), regular dreams (DR), or no dreams (ND) on each of the 5 weeks of treatment. The numbers above the bars represent the significance value of individual mean comparisons yield by a linear mixed model analysis followed by the Bonferroni correction.

The occurrence of DD was found to vary as a function of the primary drug of abuse ($P = 0.3$). Hence, when all DD nights were pooled among participants, a higher percentage of DD was reported by cocaine/crack users (26.1%), in comparison with alcohol and opiate users (12.6% and 13.1%, respectively).

Finally, "active" DDs were associated with significantly higher negative affect scores than "passive" DDs (see Fig. 3A; mixed linear model, $P < 0.05$). This relationship was also observed on the craving measure (see Fig. 3B), but it was not statistically significant.

A final exploratory analysis investigated possible differences between females and males. A χ^2 test did not reveal a significant difference in overall dreaming frequency (DDs and RDs calculated as a percentage of all nights in the study; females = 52.5%, males = 53.3%, $\chi^2 = 0.06$, $P = 0.80$), but females experienced more DDs (females = 18.3%, males = 13.5%, $\chi^2 = 4.56$, $P = 0.003$). This said, the relationships between DD and craving and negative affect were similar in both females and males.

DISCUSSION

This study explored the relationships between the experience and content of DDs and self-reported drug craving and negative affect in 86 volunteers enrolled in 2 residential addiction treatment programs. It was found that the experience of DD was associated with higher levels of both craving and negative affect. Craving levels reported the day before the dreaming occurrences did not differ significantly

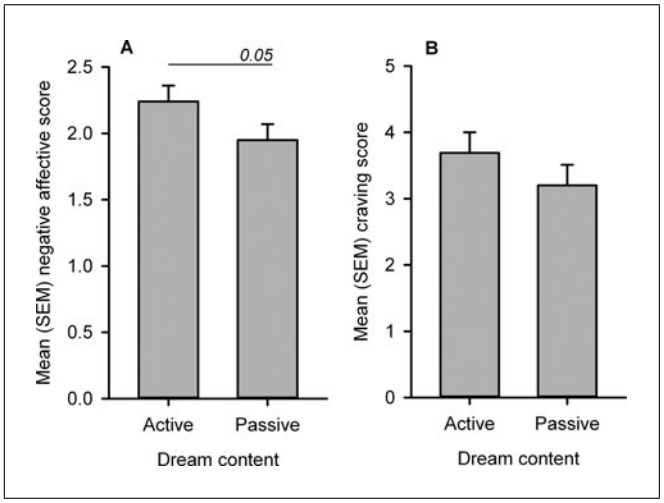

FIGURE 3. Panel A: mean (SEM) negative affect scores self-reported in dream journals that included "active" versus "passive" drug dreams. The number above the bars represents the significance value of a mean comparisons yield by a linear mixed model analysis. Panel B: mean (SEM) craving scores self-reported by participants in dream journals that included "active" versus "passive" drug dreams.

between dream types but did vary significantly when craving was measured the morning following the dreaming occurrences. Also, the relationship between DD content and daytime negative affect was significantly greater for dreams involving drug use (ie, "active") than for dreams involving searching drugs, resisting use, temptations to use, and looking at/seeing drugs (ie, "passive"). The same was observed for craving, but the result was not statistically significant. Finally, individuals in treatment for cocaine/crack addiction reported a higher occurrence of DD than those in treatment for alcohol or opiate addiction. Taken together, these correlational data are consistent with the hypothesis that DD can act as drug-conditioned stimuli to elevate craving and negative affect in abstaining individuals. Given the role of these subjective experiences in continued drug use (Sinha et al., 2000) and relapse (Sinha et al., 2006), it is concluded that interventions aimed at minimizing the emotional impact of DD may be clinically relevant.

In this study, occurrence of DD did not decrease significantly over the 5 weeks of treatment. However, it has been observed that frequency of DD significantly abates over longer periods of time (ie, months following treatment; Christo and Franey, 1996; Reid and Simeon, 2001; Yee et al., 2004). Hence, because almost half of the participants stopped using drugs only a few days before recruitment in this study, it seems that DD may be particularly common during early withdrawal from drugs. This may also explain why there were no significant relationships between DD and cravings or negative affect in week 1—acute withdrawal may have interfered with the ability of the subjects to identify and/or self-report dreams and affective states.

There are at least 3 possible interpretations for the main findings of this study. First, as stated above, the hypothesis formulated on the basis of neurobiological evidence suggests that DDs function as drug-conditioned stimuli and, therefore, can induce conditioned responses experienced either during sleep or during subsequent waking. However, a second interpretation suggests that DDs act as general stressful stimuli, rather than specific conditioned stimuli. Indeed, it is known that disturbed dreaming alters sleep (Simor et al., 2012), and that disturbed sleep can cause negative affective states (Zadra and Donderi, 2000; Levin et al., 2011). Here, it is important to note that 52% of participants in this study reported being awakened by their DD. Of course, these 2 interpretations are not mutually exclusive, and it is very likely that DD, craving, and negative affect interact in complex ways. For example, there is evidence that hypnotically induced negative mood states alter the intensity of craving precipitated by exposure to drug-conditioned stimuli (Childress et al., 1994).

The third possibility is that withdrawal symptoms, negative affect, and craving experienced during the day induced dreams about drugs. This would be consistent with the observations that negative affect experienced during the day can promote disturbed dreaming during the night (Pesant and Zadra, 2006), and that dream content is frequently based on the thoughts and activities of one's daily experience (Zadra and Donderi, 2000). Unfortunately, this interpretation, which essentially reverses the direction of effect hypothesized in this study, cannot be completely ruled. This said, it should be noted that there was no correlation between level of craving experienced the previous day and type of dream reported on the same night, whereas dependent users experience craving during withdrawal, not all concurrently experience DDs; in this study, cocaine users reported more DDs than alcohol users, and there are no a priori reasons to believe that these 2 subgroups would have different experiences during treatment; the participants were attending residential treatment centers, and consequently they were not using drugs, or manipulating drug paraphernalia, as part of their daily activities; and, finally, thoughts about drugs, while inevitable during treatment, are also prominent during active drug use, and yet DDs during active use periods are quite infrequent.

To our knowledge, this is the first demonstration that DDs involving use of drugs (ie, "active") are significantly associated with affect scores reported upon awakening. This is consistent with the observation of more pronounced cue-reactivity in subjects asked to actively manipulate drug paraphernalia (Childress et al., 1988; Robbins et al., 1997) and support the possibility that drug stimuli experienced during dreaming may be similar to drug stimuli perceived during waking. Furthermore, this study also revealed that main drug of abuse may be related to the experience of DD during early withdrawal, with cocaine/crack being associated with the highest occurrence, followed by opiates and alcohol. This evidence, although preliminary, is in line with the inclusion in the *DSM-5* of disturbed dreaming episodes as common symptoms of withdrawal for stimulant abusers. For the moment, neuropharmacological mechanisms underlying this observation remain unclear.

When interpreting the results of this study, it is necessary to consider additional limitations. First, all data were self-reported retrospectively, and although it is known that self-report measures of dreaming, drug use, craving, and negative affect are generally valid (Pesant and Zadra, 2006; Rosenberg, 2009; Sinha et al., 2009; Perez and Arroyo, 2010), there is no empirical method to verify the accuracy of self-reported dreams and dream content. This, however, does not undermine the relevance of dreaming and of dream content as relevant subjective experiences, nor should deter investigations of the phenomenon. Second, it is possible that the correlations among the variables of interest were an artifact of them being collected all at the same time. This, however, is unlikely because the results changed over the 5 weeks of the study. Third, because the dream journals were collected once a week, it is possible that participants did not comply with the protocol of daily recordings. This, however, is also unlikely because no penalties were incurred for skipping journals, and it seems unlikely that dream content was fabricated just before the collection of the journals. Fourth, the statistical power of this study was not conceived to allow inclusion of mental health disorders (depression, anxiety, posttraumatic stress disorder, and schizophrenia) and level of dependence, as covariates in the analyses. Clearly, all of these factors could mediate the relationship between dreaming, craving, and negative affect. Fifth, the clinical relevance of the findings could be questioned because the averaged self-reported scores on the craving scale and on the Positive and Negative Affect Scale were in the mid-low end of the range. This, however, could simply be the

outcome of having studied subjects within a residential clinical setting. Many participants also reported a mental health diagnosis concurrent to their substance dependence. There is a possibility that the conditions themselves, or the medications used to treat them, could have impacted dreaming patterns during the study. However, because the diagnoses were reported as preexisting, most of the participants were already stabilized on their medications, these confounding elements are unlikely to play a major role in the results. Finally, the analysis of DD occurrence in groups created on the basis of "main drug used" is limited by the fact that most participants were poly-drug users.

Notwithstanding these limitations, the current results suggest the interesting possibility that DD may be associated with emotional responses considered central to the process of recovery from drug addiction. Within this context, it should be considered that the experience of DD, unlike exposure to environmental drug-conditioned stimuli, cannot be readily controlled by an individual. Therefore, imagery rehearsal therapy, which is used to treat posttraumatic nightmares (Casement and Swanson, 2012) or chronic nightmares (Krakow and Zadra, 2006), might be beneficial for those who experience frequent and vivid DD. Also, drugs such as Prazosin, an alpha-1 adrenergic antagonist, might be considered as adjunct pharmacotherapy for individuals who are particularly troubled by DD. This drug is considered an effective treatment for posttraumatic stress disorder nightmares (Kung et al., 2012), and there is preliminary evidence that it can reduce craving precipitated by stress and exposure to drug cues (Fox et al., 2012). Incidentally, if DDs are partly reflective of craving and negative affect experienced during the day as a result of withdrawal, then clinical approaches to reduce their impact could be conceived as a broader withdrawal management strategy.

CONCLUSIONS

Using a methodology on the basis of retrospective self-reports, it was found that the occurrence of DDs was associated with higher levels of both negative affect and craving. These correlational data support the hypothesis that DDs can act as drug-conditioned stimuli and suggest that some individuals in acute withdrawal from drugs might profit from specialized psychological and pharmacological interventions.

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