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Psychosocial Treatments for Cocaine Dependence: The Role of Depressive Symptoms

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Abstract

Background—The association between cocaine use and depression has been frequently observed. However, less is known about the significance of depression in the treatment of cocaine use disorders. This study examined possible interrelations between drug use and depression severity among cocaine-dependent patients in psychosocial treatments for cocaine dependence.

Methods—Monthly assessed drug use and depression severity scores of N = 487 patients during 6-month psychosocial treatments for cocaine dependence were analyzed using hybrid latent growth models.

Results—Results indicated a moderate but statistically significant ($z = 3.13$, $p < .01$) influence of depression severity on increased drug use in the upcoming month, whereas drug use did not affect future depression severity.

Conclusions—Findings suggest that depression symptoms are an important predictor of drug use outcomes during psychosocial treatments for cocaine dependence and, hence, underline the importance of adequately addressing depression symptoms to improve treatment outcomes.

Keywords

Cocaine Dependence; Depression; Psychosocial Treatment; Interrelations; Hybrid Latent Growth Models

1. Introduction

Cocaine use is often associated with depression (Falck et al., 2004). Among treatment-seeking cocaine users, depression is one of the most common non-substance use disorders (Kleinman et al., 1990; Rounsaville et al., 1991) and even more of them are likely to suffer

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from subclinical levels of depressive symptomatology that do not justify diagnosis of depression but that might be clinically important nevertheless. Furthermore, there seems to be a specific trend for treatment-seeking cocaine abusers to have higher rates of depression than untreated community control subjects with cocaine abuse (Carroll and Rounsaville, 1992; Ford et al., 2009). Therefore, clinicians frequently encounter patients presenting with both cocaine abuse or dependence and depressive psychopathology.

Effective psychosocial treatments for cocaine dependence are available (Carroll, 2005; Dutra et al., 2008; Woody, 2003). For example, in the largest study done to date, in the National Institute on Drug Abuse (NIDA) Collaborative Cocaine Treatment Study (CCTS), all four treatments under examination–individual drug counseling, group drug counseling, and two types of professional psychotherapy–produced statistically and clinically significant improvements in terms of reducing cocaine use as well as overall drug use, with a pattern of greater clinical benefit for the group randomized to receive both group and individual drug counseling (Crits-Christoph et al., 1999). However, with a few exceptions (e.g., Brown et al., 1998), previous research has also shown the clinical significance of concurrent depression for the treatment of cocaine abuse or dependence (e.g., Hasin et al., 2002; Ziedonis and Kosten, 1991). Some of these studies found concurrent depression to be associated with positive (e.g., McKay et al., 2002), others with negative (e.g., Carroll et al., 1993) treatment outcomes. Whatever may apply, these findings suggest that the frequently high acute levels of depression in cocaine users when entering treatment warrant clinical attention and point to the need to better understand the role of depression symptoms in the treatment of cocaine dependence.

To explain the common association between substance use disorders and depression, different hypotheses have been formulated (Kosten et al., 1998; Mueser et al., 1998; Rounsaville, 2004). These models include: (a) depression as a cause of cocaine use (e.g., a high sensitivity of depressed patients to even small amounts of drugs may lead to protracted drug use and drug use disorders, or use of cocaine may represent as a self-medication coping response to manage depression symptoms) (Khantzian, 1985; Markou et al., 1998; Uslander et al., 1999); (b) cocaine use as a cause of depression (e.g., use of cocaine may lead to stressful life events that in turn promote depression, or pharmacological effects of cocaine may depress mood after prolonged or excessive use) (Kendler et al., 2003; Kosten et al., 1998; Weiss et al., 1992); (c) common risk factors (e.g., neuroticism, genetics, or antisocial personality traits) that represent shared vulnerabilities for both substance use and depression (Khan et al., 2005); and (d) bidirectional models hypothesizing that ongoing interactional effects account for the common association between substance use and depression (Mueser et al., 1998). There is at least partial support for all of these explanatory models, but none of them has unequivocal support for explaining all cases pointing to the need to further explore the relationship between the causes and course of cocaine use and depression during treatment (Mueser et al., 1998; Rounsaville, 2004). Following the recommendation of Mueser et al. (1998) that multiple assessments of substance use and affect over time (e.g., monthly) would provide much richer data for evaluating models of comorbidity, we used new statistical methods, so-called hybrid latent growth (HLG) models (Bollen and Curran, 2004), to carefully examine the relationships and the reciprocal influences of monthly assessed drug use and depression severity during 6-month psychosocial treatments for cocaine dependence.

1.1 Hybrid Latent Growth Models

Traditionally there have been two broad classes of models for the analysis of longitudinal panel data: autoregressive (AR) models assume time-lagged effects of a variable on itself and examine these effects by the regression of a variable on its earlier value. Whereas these AR models allow the prior value to determine the current value of the same variable, they do

not account for person-specific change trajectories (i.e., individual differences in change). In contrast, latent growth curve (LGC) models account for person-specific change trajectories by allowing each case in the sample to have a different time trend as marked by a different intercept or slope. However, such LGC models do not simultaneously allow the prior value to determine the current value of the same variable or cross-lagged effects between multiple outcome variables.

In the past, the AR and the LGC models have often been perceived as competing and mutually exclusive methodologies for the analysis of change. However, recently introduced HLG models take advantages of both traditions through the incorporation of AR and LGC parameters into a more flexible structural equation modeling (SEM) framework (Bollen and Curran, 2004). Moreover, if there are multiple parallel processes, these HLG models may also include cross-lagged effects between different repeatedly assessed outcome variables. Conceptually these more encompassing HLG models estimate the AR, cross-lagged and LGC models simultaneously with one set of fit indices to evaluate the adequacy of the entire model. Furthermore, like LGC models, these HLG models can also include time-invariant variables (e.g., treatment type) as covariates to estimate their effects on developmental trajectories (e.g., change in drug use or depression severity).

In this study, we therefore used HLG models in a reanalysis of the NIDA CCTS data set to carefully examine the relationships and the reciprocal influences of cocaine use and depressive symptoms during psychosocial treatments for cocaine dependence.

2. Methods

2.1 Design and Procedures

The design and procedures of the NIDA CCTS are detailed elsewhere (Crits-Christoph et al., 1997; Crits-Christoph et al., 1999). Briefly, the NIDA CCTS was a multi-site randomized clinical trial that compared the efficacy of four psychosocial treatments for cocaine dependence: In two of these treatments, professional psychotherapy, either cognitive therapy (CT) or supportive-expressive psychodynamic therapy (SE), was added to group drug counseling (GDC). A third treatment combined individual drug counseling (IDC) with GDC, and the fourth consisted of GDC alone. All treatments were planned to include 6 months of active phase treatment and a 3-month booster phase. Cognitive therapy followed a detailed manual for CT of substance abuse or dependence (Beck et al., 1993). This treatment is based on the assumption that substance use disorders are related to individual's maladaptive beliefs and related thought processes. Among the treatment techniques used are Socratic questioning, advantages-disadvantages analysis, monitoring of drug-related beliefs and activities, behavioral experiments, and role playing. Brief SE psychodynamic therapy followed the general SE treatment manual by Luborsky (1984) with modifications for cocaine dependence (Mark and Luborsky, 1992). In this treatment, the problems associated with the use of cocaine and with its cessation are viewed in the context of understanding the person's interpersonal and intrapsychic functioning and they are addressed by supportive and interpretive techniques. Individual drug counseling followed a manual with specific stages, tasks, and goals based on the 12-step philosophy (Mercer and Woody, 1992). It focuses primarily on helping the patient achieve and maintain abstinence by encouraging behavioral changes, such as avoiding drug triggers, structuring one's life, and engaging in healthy behaviors (e.g., exercise). Group drug counseling followed a manual designed to educate patients about the stages of recovery from addiction, to strongly encourage participation in 12-step programs, and to provide a supportive group atmosphere for initiating abstinence and an alternative lifestyle (Mercer et al., 1994). Individual treatment sessions were held twice per week during the first 12 weeks, weekly during weeks 13 to 24, and monthly during the booster phase. Group drug counseling sessions were held weekly

during the active phase treatment and patients in the GDC alone condition met with the group counselor individually once per month during the booster phase.

2.2 Patients

A total of N = 487 outpatients, all of them having a principal diagnosis of cocaine dependence according to the 4th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American Psychiatric Association, 1994) and all of them using cocaine during the past 30 days, were randomly assigned to one of the four treatment conditions. Characteristics of these patients are found in Table 1. As shown there, more than half (55%) of the cocaine-dependent patients in the sample reported at least mild-moderate depression at treatment entry. 147 patients were diagnosed with mood disorders, most of them (n = 139) with a cocaine-induced mood disorder. Exclusion criteria are reported in detail elsewhere (Crits-Christoph et al., 1999). Relevant to the current analyses is that history of Bipolar I disorder, imminent suicide risk, and need to be maintained on a psychotropic medication were exclusion criteria (thus, no patients were receiving antidepressant medication).

The average number of individual treatment sessions attended differed significantly between treatment conditions, $F(2,361) = 5.7$, $p < .01$. Patients in IDC+GDC attended significantly fewer sessions (M = 11.9, SD = 10.5) than patients in CT+GDC (M = 15.5, SD = 10.6) and SE+GDC (M = 15.7, SD = 11.3). The mean number of group treatment sessions attended was 8.6 (7.2) in IDC+GDC, 9.5 (7.2) in CT+GDC, 8.8 (6.8) in SE+GDC, and 8.6 (7.2) in GDC alone, $F(3,483) = 0.6$, n.s. Further details on therapies and therapists can be found in previous publications on the study (Crits-Christoph et al., 1997; Crits-Christoph et al., 1999).

2.3 Instruments and Data Collection

Patients were assessed on a battery of instruments at baseline and monthly during the 6-month active phase treatment. The following instruments were examined in this report.

2.3.1 Addiction Severity Index (ASI; McLellan et al., 1992)—As in the original trial (Crits-Christoph et al., 1999), the Drug Use Composite score of the interview-based ASI was the primary outcome measure of this study. Higher ASI–Drug Use Composite scores indicate more severe drug use. The Drug Use Composite score is composed of the number of days using each of 9 specific substances during the last month (heroin, opiates, barbiturates, sedatives, cocaine, amphetamines, cannabis, hallucinogens, and inhalants, but not alcohol), and of two additional items concerning how much drug use interferes and how much the patient thinks he or she needs treatment. In our study the Drug Use Composite score was essentially determined almost completely by cocaine use: When setting all substances except cocaine use (and the two items about interfering and need for treatment) to zero and then calculating a new composite score that is based only on cocaine use (and its effects as measured by those two additional items), then the correlation between this new cocaine use composite and the original drug use composite was greater than 0.95 at each of the monthly assessments (month 1-4: rs = .97, month 5-6: rs = .96). Thus, the ASI–Drug Use Composite was primarily picking up cocaine use in our study.

2.3.2 Beck Depression Inventory (BDI; Beck et al., 1961)—Depression severity was measured by the patient-rated BDI. The BDI contains 21 items, each presenting several statements concerning a depressive symptom (e.g., sadness, crying, indecisiveness), scored from 0 to 3 to reflect the intensity of that symptom. The internal consistency of the BDI was shown to be .86 for psychiatric patients (Beck et al., 1988).

2.4 Data Analysis

As the shape of change in an outcome variable is evaluated with the LGC part of the HLG model, in modeling step 1, unconditional LGC models (without covariates) were estimated to determine the shape of the developmental trajectory of drug use (as measured by the ASI–Drug Use Composite score) and depression severity (as measured by the BDI total score) during the 6-month active phase treatment separately. Subsequently, in modeling step 2, we examined whether AR effects significantly contribute to the explanation of the development of drug use and depression severity by estimating (unconditional) univariate HLG models with AR effects for ASI–Drug Use Composite and BDI total scores separately. Finally, to see whether there are interrelations between the development of drug use and depression severity, in modeling step 3, we calculated a multidimensional HLG model with cross-lagged effects between ASI–Drug Use Composite and BDI total scores. This final HLG model, which comes close to the autoregressive latent trajectory model suggested by Bollen and Curran (2004), also included the type of treatment (which was dummy-coded for these analyses) as a predictor of the latent growth parameters to control for effects of treatment modality.

These models were estimated using the Mplus software package (Version 3.11; Muthén and Muthén, 2004) and full information maximum likelihood estimation to deal with missing values in outcome variables. Currently available statistical packages can accommodate missing data on the outcome variables, assuming that data are missing at random (MAR; Rubin, 1976; Schafer and Graham, 2002). Within the context of the present study, MAR refers to the situation where missingness is not related to the unobserved measurements, but can be related to observed measurements or other covariates. In more practical terms, a MAR condition renders missingness as ignorable because controlling for all earlier measures or other background covariates related to the participant's missing data produces unbiased and efficient parameter estimates. Under MAR assumptions, when the missing data are not missing at random, most analytical approaches are suspect. Jamshidian and Mata (2006) review methods for the analysis of incomplete data for SEM and LGC models. We performed the postmodeling sensitivity analysis suggested by Allison (2003) and Schafer and Graham (2002). The postmodeling sensitivity approach examines the stability of the results of the LGC analysis over various subsamples.

The overall fit indices to evaluate the models (i.e., to see whether a hypothesized model fits the observed data satisfactorily) included χ^2, the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root-Mean-Square Error of Approximation (RMSEA), the Standardized Root-Mean-Square Residual (SRMR), and the Akaike Information Criterion (AIC). As in large samples χ^2 significance tests might have sufficient power to detect even substantively trivial departures of the model from the data, most researchers regard a model acceptable if the CFI and TLI (which are both based on the χ^2 statistic and on a comparison of the null (i.e., uncorrelated) model and the hypothesized model) are greater than 0.9 (the CFI and TLI both range between 0 and 1). A RMSEA (which is a measure of the discrepancy between the model and the data per degree of freedom with values closer to zero indicating better fit) of less than 0.05 is regarded as indicating a "good" fit and a RMSEA of less than 0.08 indicates "acceptable" fit. A SRMR (which represents the absolute difference between the observed and the model-implied correlations with values closer to zero indicating better fit) of less than 0.1 indicates "acceptable" fit (McDonald and Ho, 2002; Stull, 2008). For the AIC no absolute cutoffs are proposed, the model with the smallest (i.e., most negative) AIC is deemed best (Bollen and Curran, 2004).

3. Results

The sequentially developed models and their fit indices are summarized in Table 2. In step one, we determined the shape of the developmental trajectories of drug use (as measured by the ASI–Drug Use Composite score) and depression severity (as measured by the BDI total score) during the 6-month active phase treatment separately. For change in the ASI–Drug Use Composite score, which primarily picked up cocaine use in our sample, we implemented a phase-wise LGC model with phase 1 covering months 0-1 and phase 2 covering months 2-6 (model 1.1 in Table 2) as almost all of the average patient improvement was evident by the first month (Table 3 and Figure 1). Fit indices indicated moderate but acceptable fit of this phase-wise LGC model (Table 2): The CFI and TLI were both greater than 0.9 and the RMSEA and the SRMR were lower than 0.08. Therefore, this phase-wise LGC model of ASI–Drug Use Composite scores was retained for further analyses.

For the development of BDI total scores during treatment, a quadratic LGC model (model 1.2.1) fitted data well and outperformed a linear LGC model (model 1.2.2) on all fit indices (Table 2). Moreover, restricting the quadratic growth parameter of this LGC model to be zero (which resulted in a linear LGC model) resulted in a significant increase of the χ^2 value ($p < .001$). Thus, a quadratic LGC model of BDI total scores was retained for further analyses.

In modeling step two, we extended these univariate LGC models by incorporating AR effects between subsequent monthly ASI and BDI assessments, respectively, resulting in univariate HLG models. For both outcome dimensions we estimated HLG models with AR effects freely estimated and HLG models with AR effects estimated but restricted to be equal over time. These models with AR effects were compared to the respective HLG model with AR effects fixed to be zero to see whether neglecting AR effects results in substantial impairment of model fits, i.e., to see whether the assumption of AR effects is empirically supported by our data. As shown in Table 2, for ASI–Drug Use Composite scores a HLG model with AR effects freely estimated (model 2.1.1) turned out to fit data best. For BDI total scores a HLG model with AR effects restricted to be equal over time (model 2.2.2) best balanced fit and parsimony of the model.

Retaining these AR specifications, in step 3, we modeled a multidimensional HLG model which also included cross-lagged effects between ASI–Drug Use Composite scores and BDI total scores as well as type of treatment as a predictor of latent change trajectories. The multidimensional HLG model with correlations of the contemporaneous residual variances of ASI–Drug Use Composite and BDI total scores estimated but restricted to be equal over time (model 3.1.2) best fitted to the observed data and, hence, was retained to evaluate HLG models with different specifications of cross-lagged effects. There were three sets of restrictions in cross-lagged effects that did not result in a significant increment of the χ^2 value (i.e., that did not result in significant impairment of model fit) compared to the model with all cross-lagged effects freely estimated (model 3.1.1): In a first of these HLG models cross-lagged effects of BDI total scores on ASI–Drug Use Composite scores were freely estimated and cross-lagged effects of ASI–Drug Use Composite scores on BDI total scores were restricted to be zero (model 3.2.3). In a second model cross-lagged effects of BDI on ASI scores as well as cross-lagged effects of ASI on BDI scores were both estimated but restricted to be equal over time (model 3.2.5). Finally, in the third model cross-lagged effects of BDI on ASI scores were again estimated but restricted to be equal across time and cross-lagged effects of ASI on BDI scores were restricted to be zero (model 3.2.6). The additional restrictions incorporated in this latest model (i.e., the restriction of cross-lagged effects of BDI on ASI scores fixed to be equal over time and the restriction of cross-lagged

effects of ASI on BDI scores fixed to be zero) did not result in a significant increment of the χ^2 value compared to the first model (with time-variant cross-lagged effects of BDI on ASI scores), $\chi^2(5, N = 487) = 5.8$, n.s., and compared to the second model (with time-invariant cross-lagged effects of ASI on BDI scores estimated), $\chi^2(4, N = 487) = 5.1$, n.s. This indicated that the HLG model with time-invariant cross-lagged effects of BDI on ASI scores and no cross-lagged effects of ASI on BDI scores best balanced parsimony of the model and fit to the observed data.

In this final HLG model there was a significant correlation of the ASI and BDI intercept ($p < .05$) indicating a positive association between baseline drug use and depression severity. There were no significant effects of treatment types on ASI and BDI growth trajectories. However, in addition to significant AR effects in the ASI ($p < .001$) as well as in the BDI scores ($p < .05$), as mentioned above, there were significant cross-lagged effects of BDI scores on ASI scores ($p < .01$). The path coefficients of 0.001 indicate that with each additional point in the BDI total score in a particular month, the ASI–Drug Use Composite score in the upcoming month is increased by 0.001. Figure 1 contrasts the mean ASI and BDI scores estimated by this model to the observed scores in these outcome variables. Postmodeling sensitivity approach showed the stability of the results of the HLG analysis over various subsamples of the available data; there were significant time-invariant cross-lagged effects of BDI on ASI scores in subsamples with 0, 1, 2, 3, 4, and 5 missing data points.

4. Discussion

This study was designed to elucidate the role of depression symptoms in psychosocial treatments for cocaine dependence by reanalyzing the NIDA CCTS data using HLG models. A better understanding of the interrelations between cocaine use and depression severity during treatment may provide a powerful key to improve psychosocial interventions for cocaine use disorders.

In line with previous findings (Rounsaville, 2004; Weiss et al., 1989), treatment-seeking cocaine-dependent outpatients in the NIDA CCTS reported substantial depressive symptomatology when entering treatment and depression severity was positively associated to drug use severity at study entry. The subsequent, rapid reduction of drug use during psychosocial treatments for cocaine dependence was accompanied by a similarly rapid reduction of depression symptoms (Brown et al., 1998; Husband et al., 1996). At a first glance, this rapid decrease of depression severity during treatment might be seen as indication that depression symptoms were primarily substance-induced (Lesswing and Dougherty, 1993). However, our findings from multidimensional HLG model analysis suggest that, at least during psychosocial treatments, drug use severity does not affect future depression severity but that severity of ongoing depressive symptoms positively predicts drug use severity for the upcoming month. Given the rapid reduction of drug use in our sample, the lack of effects of drug use on depression severity also appears to contradict clinical observations that depressive symptoms may follow cessation of drug use (Dackis and Gold, 1987; Gawin, 1986; Gawin et al., 1989). However, elevated depression symptoms are typically most apparent in the first 3 to 5 days after cessation of cocaine use (Weddington et al., 1990) and, thus, it is possible that the monthly assessments in the NIDA CCTS may have failed to capture a transient increase in symptoms. In any event, it appears that reduction of drug use is not necessarily followed by longstanding depressive mood in patients receiving psychosocial interventions. The lack of direct effects of drug use on depression severity in our study also suggests that the strong decline in depression symptoms early in the course of treatment is probably directly attributable to other effects rather than mediated through a reduction of drug use. Because treatment seeking may be

increased during peaks in substance use and depressive symptoms, the relatively high motivation of treatment-seeking cocaine dependents, coupled with an increase in morale fostered by the counselor or therapist, might be important factors for the rapid reduction of depression symptoms. However, other natural recovery processes independent of treatment as well as regression to the mean are likely also contributing factors to the rapid remission of depression symptoms (Conner et al., 2008).

The impact of depressive symptoms on next month drug use appears to be clinically meaningful. The statistical model indicated that a change from a BDI score of 5, a score that is in the middle of the normal, non-clinical range, to a BDI score of 25, a score that is in the middle of the moderate-severe depression range (Beck et al., 1988), in the next month would be associated with an ASI–Drug Use Composite score increase of 0.020. To put this ASI–Drug Use change in context, it is worth noting that post-baseline estimated average ASI–Drug Use Composite scores for the treatment effects in the NIDA CCTS were IDC+GDC: 0.096, CT+GDC: 0.117, SE+GDC: 0.114, and GDC alone: 0.116 (Crits-Christoph et al., 1999). Thus, the impact of depressive symptoms changing from a non-clinical level to a moderate depression level is roughly equivalent to the post-baseline differences between treatment modalities in the NIDA CCTS.

The effects of depression symptoms on future drug use during treatment are in line with several reports that have demonstrated depression to affect aspects of cocaine use which are likely to lead to greater severity of drug use (Rounsaville, 2004). For example, studies have shown that depressed cocaine users experience greater euphoria associated with cocaine administration (Newton et al., 2003; Uslander et al., 1999) and higher levels of physiologic cocaine effects (Sofuoglu et al., 2001) than non-depressed users. Also, depression may hinder cessation of cocaine use as depressed cocaine users seem to experience more severe craving (Elman et al., 2002) and more severe withdrawal symptoms (Helmus et al., 2001) than non-depressed individuals when discontinuing drug use. These findings may help to explain the effects of depression on drug use severity during psychosocial treatments found in our study. The latter are in accordance with some previous findings that also suggest effects of depression on drug use severity among treatment-seeking cocaine users (Carroll et al., 1993). Accordingly, our data do not support contrary previous findings suggesting a positive effect of depression on substance use severity (McKay et al., 2002). Thus, the hypothesis that the experience of painful depression symptoms provides a strong incentive to desist from drug use because these symptoms represent compelling negative consequences of continued cocaine use (Rounsaville, 2004) is not supported by our findings.

Concerning differential treatment effects of the four psychosocial interventions under consideration (IDC, CT, SE, and GDC), there were no significant differences between the treatments, neither with respect to the development of drug use nor in terms of the progression of depression severity during treatment. Thus, interestingly, professional psychotherapies (CT and SE) did not perform better than drug counseling approaches (IDC and GDC) in terms of reducing depression symptoms, as had been previously reported using a different analysis approach (Crits-Christoph et al., 2001). On the other hand, the superiority of IDC to the three other treatments under consideration in terms of reducing drug use, which has been reported by Crits-Christoph et al. (1999), was also not evident with the analysis techniques used here. This failure to replicate the superiority of IDC might arise from the fact that the HLG model used in our study did also consider AR effects in the analysis of change, as well as the fact that the previously reported superiority of IDC included analysis of data from intake to month 12 (Crits-Christoph et al., 1999), not just intake to month 6.

However, our study also has some limitations: First, if available, weekly collected urine specimens were used to examine the validity of self-reported drug use as measured by the ASI. Only 10% of the urine tests indicated some drug use during a month when the patient denied use. Despite this good agreement between urine test results and self-reports of cocaine use, whether patients were using cocaine at times when no urine assessments were available is unknown. Second, because the analyses were post-hoc exploratory analyses and due to the correlational nature of the findings precluding mechanistic conclusions, further research is necessary to replicate our findings with independent datasets. Third, change was assessed only during the treatment period and not longer-term, so the results do not tell us if depression severity influences treatment maintenance over longer time periods. Fourth, monthly psychometric assessments performed in the NIDA CCTS could have missed relatively short-term fluctuations in depressive symptoms (e.g., dysphoric mood that is inherent in cocaine withdrawal, according to the DSM-IV). Fifth, the randomized controlled nature of the NIDA CCTS, which brings some limitations concerning external validity, calls for further research to examine whether our findings do also apply to naturalistic settings and routine care. Sixth, it remains unclear whether our findings also generalize to cocaine-dependent patients with more severe psychiatric comorbidity (in particular with more severe depression) as current psychotropic medication was an exclusion criterion in the CCTS. Accordingly, our patients reported somewhat lower levels of baseline depression severity as measured by the BDI compared to other studies of treatment-seeking cocaine dependent outpatients (Husband et al., 1996; Weiss et al., 1989), perhaps as a result of the specific exclusion criteria used in the CCTS. Seventh, future studies should also examine additional predictors as well as change in other (e.g., biomedical) outcome measures. And finally, another direction for future research would be to evaluate possible subtypes of cocaine dependents based on the interplay between drug use and depression as the population of cocaine dependents is large and likely heterogeneous not only with respect to drug use outcomes (Stulz et al., 2010) but also in terms of the interplay between drug use and depression. Such identification of more homogeneous subgroups could facilitate the development or tailoring of interventions designed to meet the specific needs of each subgroup.

In summary, the moderate but statistically significant effects of depression symptoms on increased drug use found in our study suggest that depression symptoms are an important predictor of drug use outcomes during psychosocial treatments for cocaine dependence and, thus, should be taken seriously when occurring among cocaine-dependent patients. This may also have clinical implications for the sequence of treatments or treatment components being offered to cocaine-dependent patients with co-occurring depression symptoms (Carroll et al., 2004; Nunes et al., 2006). In particular, the present findings suggest that psychosocial treatments for cocaine dependence should take specific measures to target the frequently co-occurring depression symptoms among cocaine-dependent patients to improve drug use outcomes.

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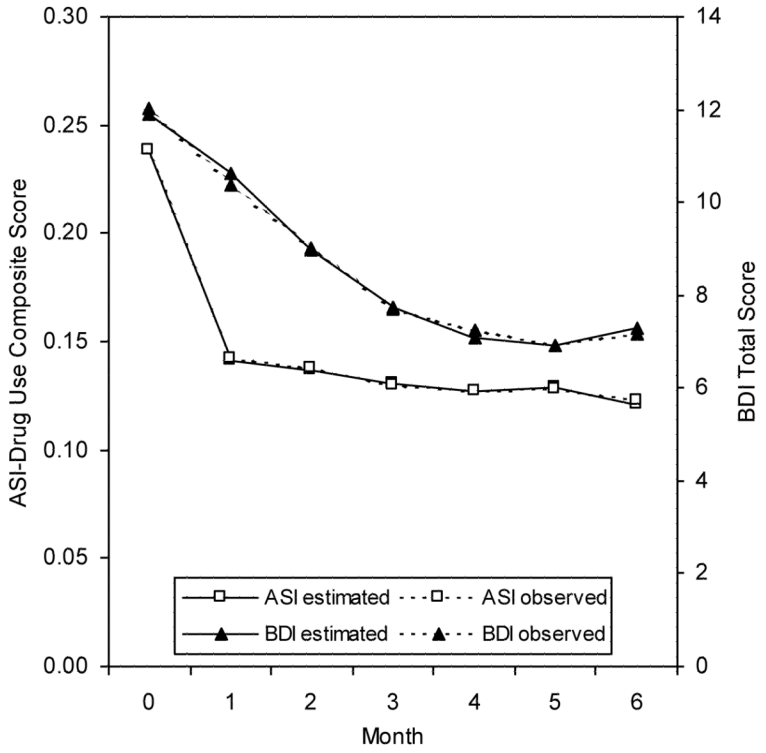

Figure 1.

Observed and Estimated Mean Courses of Drug Use (ASI–Drug Use Composite Scores) and Depression Severity (BDI Total Scores) During 6 Month Psychosocial Treatment for Cocaine Dependence. The y-Axis on the Left Refers to ASI–Drug Use Composite Scores, the y-Axis on the Right to BDI Total Scores.

Note. ASI = Addiction Severity Index; BDI = Beck Depression Inventory.

Table 1

Patient Characteristics (n = 487).[1]

Characteristic	
Men, No. (%)	374 (77)
Age, Years	33.9 (6.3)
White, No. (%)	282 (58)
Living Alone, No. (%)	339 (70)
Education, Years	13.0 (2.0)
Employed, No. (%)	293 (60)[2]
ASI–Drug Use Composite Score (Baseline)	0.24 (0.06)
Cocaine Use, Years (Baseline)	6.9 (4.8)
Crack and Drug Injectors, No. (%)	394 (81)[2]
Mood Disorder, No. (%)[3]	147 (30)
Major Depressive Disorder	2 (0.4)
Dysthymia	5 (1)
Cocaine-Induced Mood Disorder	139 (29)
Depressive Disorder Not Otherwise Specified	3 (0.6)
BDI Total Score (Baseline)	12.1 (8.9)
No Depression (BDI Total Score: 0-9), No. (%)	215 (45)[4]
Mild-Moderate Depression (BDI Total Score: 10-18), No. (%)	163 (34)[4]
Moderate-Severe Depression (BDI Total Score: 19-29), No. (%)	80 (16)[4]
Severe Depression (BDI Total Score: 30-63), No. (%)	25 (5)[4]

Note.

[1] Data are given as mean (SD) unless otherwise indicated.

[2] Data were not available for 1 patient.

[3] Two subjects were diagnosed with more than one mood disorder.

[4] Data were not available for 4 patients

Table 2

Step-Wise Development of the Hybrid Latent Growth Model: Preliminary Models and the Final Model, each with Fit Indices

Model	RMSEA (90% CI)	SRMR	AIC	CFI	TLI	χ^2	df	$\Delta\chi^2$	Δ df
Unconditional Unidimensional Latent Growth Models:									
1.1 ASI: Phase-wise[1,2]	0.068 (0.050 – 0.086)	0.063	−6473.002	0.941	0.939	64.648***	20		
1.2.1 BDI: Quadratic[1,3]	0.036 (0.009 – 0.059)	0.032	−5917.667	0.990	0.988	31.296*	19		
1.2.2 BDI: Linear[3]	0.070 (0.053 – 0.087)	0.053	−5879.464	0.954	0.958	77.499***	23	46.203***	4
Unconditional Unidimensional Hybrid Latent Growth Models with Autoregressive (AR) Effects:									
2.1.1 ASI: AR effects freely estimated[1,1]	0.026 (0.000 – 0.051)	0.035	−6509.216	0.993	0.991	22.434	17		
2.1.2 ASI: AR effects restricted to be equal[4]	0.041 (0.019 – 0.061)	0.046	−6501.829	0.977	0.978	39.822*	22	17.388**	5
2.1.3 ASI: AR effects restricted to be zero[4]	0.073 (0.056 – 0.090)	0.072	−6461.122	0.922	0.929	82.528***	23	60.094***	6
2.2.1 BDI: AR effects freely estimated[1,5]	0.040 (0.014 – 0.064)	0.031	−5914.367	0.989	0.986	28.596*	16		
2.2.2 BDI: AR effects restricted to be equal[5].	0.031 (0.000 – 0.053)	0.033	−5922.427	0.992	0.992	30.536	21	1.940	5
2.2.3 BDI: AR effects restricted to be zero[5]	0.036 (0.012 – 0.057)	0.035	−5918.876	0.988	0.989	36.088*	22	7.492	6
Conditional Multidimensional Hybrid Latent Growth Models with Autoregressive (AR) and Cross-Lagged Effects:									
3.1.1 Contemporaneous residual variances freely estimated (Unrestricted Model)[2,2,4,5]	0.029 (0.015 – 0.040)	0.033	−11127.265	0.984	0.975	123.004*	88		
3.1.2 Contemporaneous residual variances	0.026 (0.012 – 0.038)	0.034	−11136.724	0.985	0.979	125.545*	94	2.541	6

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Model	RMSEA (90% CI)	SRMR	AIC	CFI	TLI	χ^2	df	$\Delta\chi^2$	Δ df
restricted to be equal[2,5,5]									
3.1.3 Contemporaneous residual variances restricted to be zero[3,4,5]	0.051 (0.042 – 0.060)	0.042	−11049.396	0.944	0.922	214.873***	95	91.869***	7
3.2.1 BDI on ASI freely estimated & ASI on BDI freely estimated[1,2,4,5]	0.026 (0.012 – 0.038)	0.034	−11136.724	0.985	0.979	125.545*	94		
3.2.2 BDI on ASI freely estimated & ASI on BDI restricted to be equal[2,4,5]	0.028 (0.015 – 0.039)	0.037	−11135.226	0.982	0.976	137.043**	99	11.498*	5
3.2.3 BDI on ASI freely estimated & ASI on BDI restricted to be zero[2,4,5]	0.028 (0.015 – 0.039)	0.037	−11136.751	0.982	0.977	137.518**	100	11.973	6
3.2.4 BDI on ASI restricted to be equal & ASI on BDI freely estimated[2,4,5]	_ 6	_ 6	_ 6	_ 6	_ 6	_ 6	_ 6	_ 6	_ 6
3.2.5 BDI on ASI restricted to be equal & ASI on BDI restricted to be equal[2,4,1]	0.028 (0.015 – 0.038)	0.040	−11139.635	0.982	0.977	142.635**	104	17.090	10
3.2.6 BDI on ASI restricted to be equal & ASI on BDI restricted to be zero[2,4,5]	0.027 (0.015 – 0.038)	0.040	−11140.925	0.982	0.977	143.344**	105	17.799	11
3.2.7 BDI on ASI restricted to be zero & ASI on BDI freely estimated[2,4,5]	0.030 (0.018 – 0.040)	0.038	−11130.711	0.980	0.973	143.559**	100	18.014**	6
3.2.8 BDI on ASI restricted to be zero & ASI on BDI restricted to be equal[2,4,5]	0.030 (0.019 – 0.041)	0.041	−11131.704	0.978	0.972	152.565**	105	27.020**	11
3.2.9 BDI on ASI restricted to be zero & ASI on BDI restricted to be zero[2,4,5]	0.030 (0.019 – 0.040)	0.041	−11133.241	0.978	0.972	153.028**	106	27.483**	12

Note. ASI = Addiction Severity Index–Drug Use Composite score; BDI = Beck Depression Inventory; RMSEA = root-mean-square error of approximation; CI = confidence interval; SRMR = standardized root-mean-square residual; AIC = Akaike information criterion; CFI = comparative fit index; TLI = Tucker-Lewis index.

[1] Model was used as reference for the evaluation of more restricted models within the respective modeling step.

[2] The covariance of the intercept and of the slope of change during months 0 to 1 was fixed to be zero due to convergence problems.

[3] Data were not available for 2 patients.

[4] The residual variance of the slope of change during months 2 to 6 was fixed to be zero due to convergence problems.

[5] The residual variance of the quadratic growth parameter was fixed to be zero due to convergence problems.

[6] The model estimation did not converge indicating that the model does not fit the data.

* $p < .05$

** $p < .01$

*** $p < .001$.

Table 3

Means and Standard Deviations of the Addiction Severity Index (ASI)–Drug Use Composite Score and of the Beck Depression Inventory (BDI) Total Score at Baseline and After Treatment Months 1 to 6

	ASI–Drug Use Composite Score			BDI		
Assessment	***n***	***M***	***SD***	***n***	***M***	***SD***
Baseline	487	.24	.06	483	12.1	8.9
Month 1	380	.14	.08	332	10.0	8.9
Month 2	365	.14	.09	311	8.8	8.3
Month 3	349	.12	.08	298	7.3	8.4
Month 4	363	.13	.09	304	7.0	9.0
Month 5	363	.13	.09	299	6.9	8.8
Month 6	376	.12	.09	335	7.1	9.2