Patterns of Crime and Drug Use Trajectories in Relation to Treatment Initiation and 5-Year Outcomes: An Application of Growth Mixture Modeling Across Three Datasets

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Abstract

Drug abusers vary considerably in their drug use and criminal behavior over time, and these trajectories are likely to influence drug treatment participation and treatment outcomes. Drawing on longitudinal natural history data from three samples of adult male drug users, we identify four groups with distinctive drug use and crime trajectories over the 5 years prior to their first treatment episode. The groups' characteristics of initial treatment are compared. The trajectory groups are then included in Poisson growth curve models to predict drug use, incarceration, and employment over the 5 years following first treatment. Findings indicate that posttreatment drug use decreased and posttreatment employment increased. There was little change in posttreatment incarceration. Posttreatment trajectories for drug use, incarceration, and employment were significantly different across the four trajectory groups.

Keywords

drug use trajectories; crime trajectories; treatment; growth curve models; longitudinal analysis

Introduction

A large percentage of offenders within the criminal justice system have drug problems, and most of them cycle in and out of incarceration, supervision, and drug treatment multiple times over their criminal and drug use careers. For several decades, drug treatment has been provided to offenders under a variety of community options, such as intensive supervision programs (Petersilia and Turner 1993), Treatment Alternatives to Street Crime programs (Anglin, Longshore, and Turner 1999; Collins and Allison 1983), parolee case management programs (Longshore, Turner, and Fain 2005; Martin and Scarpitti 1993), and system-level innovations such as Breaking the Cycle (Harrell et al. 2003)—all of which are designed to reduce drug problems and criminal behavior among offenders on probation or parole. In addition, treatment programs have become a common feature of jails and, particularly, prisons as a way to address offenders' drug problems and to reduce recidivism (Hall et al. 2004; Knight, Simpson, and Hiller 1999; Martin et al. 1999; Wexler, DeLeon et al. 1999). Recently, through voter initiatives such as Proposition 200 in Arizona (*Arizona Drug Medicalization, Prevention, and Control Act of 1996*) and Proposition 36 in California (*Substance Abuse and Crime Prevention Act of 2000*; Longshore et al. 2004), the emphasis on community supervision and treatment over incarceration has been codified in law, applicable not just to offenders residing in particular jurisdictions or sent to particular institutions but to all persons convicted of eligible drug-related offenses in the state.

Studies indicate that retention in drug treatment is similar for criminal justice system (CJS)–referred clients and for other clients (e.g., Hubbard et al. 1989) and that drug treatment does have positive effects on drug use, crime, and other behavioral outcomes with CJS clients (e.g., Pearson and Lipton 1999), although the studies supporting these findings vary in their methodological rigor. However, most studies of the effectiveness of correctional treatment programs have focused on outcomes (usually drug use and crime) after a single episode of treatment and with a relatively short follow-up period (usually 1year and seldom more than 3years). Thus, little information is available on patterns of treatment outcomes across multiple treatment episodes or over a long-term perspective (e.g., 5 years). The impact of treatment on outcomes other than drug use and crime for this population has also received limited attention.

Illicit drug users frequently have a history of criminal involvement, and criminal offenders frequently have histories of illicit drug use (White and Gorman 2000). Although the relationship between drug use and crime is complicated, with no clear consensus among researchers, there does appear to be a reciprocal, or "multiplier," effect, such that greater involvement in one behavior leads to, or is associated with, greater involvement in the other (Murray 1992; Speckart and Anglin 1985). At some point, most drug users and criminals who use drugs become involved in the criminal justice system or in drug abuse treatment, or both. The prior drug use and criminal experience of these offenders, as well as other characteristics, are likely to influence their response to treatment, whether that treatment occurs in a community program or in a criminal justice program. Thus, we might expect that criminally involved drug users, compared with those who have no or limited criminal involvement, would be more likely to enter treatment earlier (due to contact with the criminal justice system), but would exhibit a shorter time to relapse following treatment and less change in their use over the years following treatment. Criminally involved drug users would also be more likely to continue their criminal behavior, to return to criminal justice supervision, and to have poorer outcomes in other behavioral domains.

Over the past 2 decades or so, criminologists have devoted considerable attention to examining criminal careers and the long-term patterns of offending, particularly factors that are related to criminal careers, including desistence (see Laub and Sampson 2003; Moffitt et al. 2001; Piquero, Farrington, and Blumstein 2007; Thornberry 2005). For adult offenders, this work has largely been driven by the work of Sampson and Laub (Laub and Sampson 2003; Sampson and Laub 1993, 2005). They argue that, regardless of any childhood propensity to crime, the persistence and desistence of crime in adulthood is mainly explained by the strength of social bonds that develop (or fail to develop) over the life course; in particular, they point to the social bonds (at least for men) stemming from marriage, employment, and military service. These life events and the social bonds associated with them shape and reshape crime trajectories over adulthood. What this age-graded theory of informal social control has not considered explicitly is whether positive social interventions, such as substance abuse treatment, can also alter crime trajectories. In addition, the life course perspective within criminology has limited its attention (understandably) to criminal careers (usually measured as arrest or incarceration), and has given little attention to other behaviors measured over time such as drug use or employment.

Taking advantage of three long-term follow-up studies, we examine (1) whether drug use and crime trajectories prior to a first treatment episode are related to the timing and other characteristics of the initial treatment, and (2) whether these pretreatment trajectories are related to posttreatment outcomes (drug use, incarceration, employment). As described below, we identified and compared four groups that have distinctive drug use and crime trajectories prior to the first treatment: High Incarceration/High Drug Use, High Incarceration/Low Drug Use, Low Incarceration/High Drug Use, and Low Incarceration/

Low Drug Use. These four groups were determined by applying growth mixture models to the number of days of drug use and to the number of months of incarceration over the 5 years prior to the first treatment (Muthén 2004; Muthén and Muthén 2000; Muthén and Shedden 1999; Nagin 1999).

We compare and contrast the four groups in terms of the characteristics of initial treatment, controlling for background characteristics. We then examine whether these pretreatment drug use and crime trajectories predict outcomes over the 5-year posttreatment period. Specifically, our two main research questions are: (1) What is the influence of the four pretreatment trajectory groups on initiation to first treatment? (2) What are the relative patterns of drug use, incarceration, and employment following the first treatment episode for the four trajectory groups?

METHOD

Sample

The analyses presented here rely on data from a combined sample of subjects who participated in one of three studies that collected longitudinal information using a retrospective interview protocol (described below). The three samples were combined in order to have a large sample for analysis and to obtain a dataset of subjects with heterogeneous incarceration and drug use histories. Each study was conducted in southern California in the early to mid 1990s. The first study (Amity) was a 5-year follow-up evaluation of a prison-based therapeutic community at the R. J. Donovan Correctional Facility, a medium-security prison for men near San Diego (Prendergast et al. 2004; Wexler, De Leonet al. 1999; Wexler, Melnick et al. 1999). Subjects in the Amity study were randomized to the prison treatment program (n = 425) or to no treatment (n = 290). Interview data were collected at baseline (entrance to the program) and at 1 year and 5 years following release to parole. For the 5-year follow-up interview (on which the present analysis is based), 80% of the original sample were interviewed. A total of 448 subjects (all men) are included in the analyses.

The second study (Treatment Utilization Evaluation, TUE) consisted of 1,800 drug users who were recruited in Los Angeles County from sexually transmitted diseases clinics, emergency rooms, and jails (Hser et al. 2003). Although recruited from nontreatment sources, many subjects reported past and current participation in drug treatment. Successively smaller random subsets of the original sample completed annual follow-up interviews. For the second follow-up, interviews were completed with 566 subjects. Male subjects from this second follow-up who reported having participated in treatment (n = 129) are included in the analyses.

The third study (Treatment Process, TXPROC) examined treatment utilization and drug use, crime, and other outcomes of 511 drug abusers recruited from a stratified random sample of treatment programs in Los Angeles County (Marshall and Hser 2002). As with TUE, only men are used in the present analysis, for a total of 215 subjects. In sum, the analysis sample (N = 792) consisted of 56.6 % of subjects from the Amity Study, 16.3% from the TUE study, and 27.1% from the TXPROC study.

Assessment Instrument

The Natural History Interview (NHI), from which the variables for this analysis were derived, was used at the follow-up interviews to collect retrospective longitudinal data on drug use and related behaviors. Adapted from instruments originally developed by Nurco and colleagues (1975) the NHI has been used in numerous studies with drug-abusing populations over the past 30 years. The instrument consists of a set of "static" forms and a

set of "dynamic" forms that capture standard background data and longitudinal, sequential data on drug use, employment, criminal involvement, treatment, and other behaviors over the life course of the subjects (see McGlothlin, Anglin, and Wilson, 1977, for a detailed description). The static forms, administered once during the interview, collect demographic and background information. The dynamic forms collect retrospective and current data on the drug-use history of the subjects as well as data on events that might have shaped or have been shaped by drug use (e.g., crime, incarceration, employment, social support network, medical and psychiatric status and service utilization, and drug treatment). The dynamic part of the NHI involves repeated administration of each type of form for as many life segments (defined by major changes in life events) as necessary. The interviewer works closely with the respondent to structure the periods of interest, using corroborative information and memory aids (e.g., major life events, historical events). In this way, periods of drug use, criminal behavior, legal supervision, and treatment are anchored to major life events, such as the birth of a child, death of a family member, or loss of a job. The NHI has been shown to have generally high reliability, with correlation coefficients of inter-variable relationships, based on 46 variables measured at two interviews conducted 10 years apart, ranging as high as 0.86 and 0.90 (Chou, Hser, and Anglin 1996; Hser, Anglin, and Chou 1992).

Variables

Based on NHI data, the outcome and background variables used in these analyses are described below. Three outcomes are examined: *Drug use:* the average number of days per month that the participant used his primary drug (heroin, cocaine, or methamphetamine) in each year; *Incarceration:* the average number of months spent in jail or prison in each year; *Employment*: the average number of months of any employment in each year. These outcomes are assessed relative to the *First treatment episode,* which is defined as the treatment episode in which the subject stated that he had first participated. Treatment does not include education or self-help programs.

The main predictor variables in the analyses reported below are pretreatment incarceration/ drug use trajectories constructed from the NHI data. Constructing these trajectories involved identifying incarceration and drug use latent classes with distinctive trajectories over the 5 years prior to the first treatment. These trajectories were determined by applying a growth mixture model with a zero-inflated Poisson distribution to the number of months incarcerated and the number of days of drug use for each subject over the 5 years prior to the first treatment (Muthén 2004; Muthén and Muthén 2000; Muthén and Shedden 1999; Nagin 1999). Goodness fit was evaluated using the Bayesian Information Criterion (BIC) and the sample-size-adjusted BIC. The lowest value of BIC and sample-size-adjusted BIC indicated the optimal model. For incarceration, three trajectory groups were identified: an Increasing group (15.8%), a Low group (37.8%), and a High group (46.5%). For drug use, four groups were identified: a High group (44.2%), a Low group (21.7%), an Increasing group (20.7%), and a Decreasing group (13.8% of the sample).

Based on the cell frequencies for the cross-tabulated incarceration and drug use trajectories (see Table 1), we combined the three incarceration groups and the four drug use groups into four pretreatment incarceration/drug use trajectory groups for further analysis. Subjects in the High or Increasing Incarceration groups and the High or Increasing Drug Use groups were combined into a High Incarceration/High Drug Use group (n=314). Subjects in the High or Increasing Incarceration groups and in the Low or Decreasing Drug Use groups were combined into a High Incarceration/Low Drug Use group (n=179). Subjects in the Low Incarceration group and the High or Increasing Drug Use groups were combined into a Low Incarceration/High Drug Use group (n= 200). Subjects in the Low Incarceration group and the Low or Decreasing Drug Use groups were combined into a Low Incarceration/Low Drug Use group (n = 99).

Background variables (some of which are also control variables in the outcome analyses) include: *Project:* Amity, TUE, and TXPROC; *Race/Ethnicity:* White, Black, Hispanic, and Other; *Employed prior to first treatment:* whether the client was employed in the month before he entered his first treatment; *Primary drug:* the drug that the client reported as being the main problem; *Age at first use of a major drug:* the age at which the client reported first using heroin, cocaine, or methamphetamine; *Age at first arrest:* the age at which the client reported being arrested for the first time (including juvenile arrest); and *Age at first use of alcohol, cocaine, heroin, marijuana, or methamphetamine:* the earliest age at which the client reported using at least one of the listed drugs.

Characteristics of the first treatment episode (as defined above) focused on four variables: *Age of first treatment:* the self-reported age at which the client entered the first treatment episode; *First treatment referral:* whether referral to the first treatment episode was from jail or prison, from another criminal justice agency, or from some other source; *Modality of first treatment:* whether the first treatment episode occurred in jail or prison, in a community residential program, or in a community outpatient program; and *Duration of first treatment:* the number of months during which the client was in the first treatment episode.

Finally, the growth curve models included two time-varying covariates: *months incarcerated* and *months in treatment* for each of the 5 years following the first treatment episode. In the growth curve model with incarceration as the outcome, incarceration was not included as a time-varying covariate. Additionally, since preliminary analysis showed that the effect of drug treatment was consistent across the 5 years, time-varying treatment effects over years were constrained to one parameter, and only an average treatment effect is estimated.

Analytic Approach

ANOVA for continuous variables and chi-square tests for categorical variables were used to compare subjects' pretreatment demographics, drug use, and treatment history among the four trajectory groups. For continuous variables, we first used one-way ANOVAs to test for differences among the four groups. We then conducted two-way ANOVAs using the SAS GLM procedure to examine whether there were group differences due to drug use trajectories (high vs. low), incarceration trajectories (high vs. low), or the interaction of the two types of trajectories. Because the pretreatment trajectory groups were highly associated with the project from which subjects were recruited (see Table 2), *project* was included as a covariate in the rest of statistical tests to control for potential confounding due to project-related differences. The other control variables (age of first treatment, length of first treatment, race/ethnicity, location of first treatment, modality of first treatment, employment prior to first treatment, and incarceration and treatment following the first treatment) were selected because of their likely influence on the three dependent variables, separate from the influence of first treatment. Parallel analyses using chi-square and the SAS CATMOD procedure were conducted to examine group differences on categorical variables.

For each of the outcomes of interest (drug use, incarceration, and employment), the Incarceration/Drug trajectories for the 5 years before admission to first treatment and for the 5years after discharge from that treatment are plotted in Figures 1–3. The zero time point designates the month of discharge from the first treatment. The plots represent the observed pattern over time for each outcome by the four pretreatment trajectory groups.

Growth curve models were then developed and applied to test posttreatment trajectories of drug use, incarceration, and employment. Growth trajectories are generally characterized by intercept and slope parameters, and potential covariates can be included to test their influence on these growth parameters. Given that the outcome variables in this analysis are counts of the number of days in each month using drugs and the number of months of

incarceration or employment, we applied Poisson distribution growth curve models to examine outcomes in these three domains (Lambert 1992; Nagin and Land 1993). Specifically, the trajectory of each outcome variable over the 5 years following first treatment is treated as a dependent variable in growth curve modeling. The intercept for each growth model is the mean of the outcome variable in the month following discharge. The major independent covariate for the model is the four pretreatment trajectory groups. To test the main effects and interaction, the model includes incarceration (low vs. high), drug use (low vs. high), and the interaction of the incarceration and drug use grouping. To control for possible confounding, the models also include the following covariates: project, age at first treatment, length of first treatment, race/ethnicity, modality of first treatment, and employment prior to first treatment. In addition, as explained above, the models include months incarcerated and months in treatment as time-varying covariates for each of the 5 posttreatment years. The growth curve modeling was conducted using Mplus 6.0 (Muthén and Muthén2004). Effects of covariates in models are tested at a significance level of p . 05.

RESULTS

We first report the differences in the characteristics of the four pretreatment drug use and incarceration trajectory groups. We then examine whether and how these four groups differ with respect to the first drug treatment episode in which they participated. Finally, separately for each of the three outcomes, we report modeling results testing whether the four drug use and crime trajectory groups are significantly related to posttreatment outcomes.

Pretreatment Characteristics

The characteristics of the four Incarceration/Drug groups prior to the first treatment are shown in Table 2. The four groups differed significantly on most of the pretreatment characteristics, except for age at first alcohol use (with means for all groups at approximately 12 years old) and age at first methamphetamine use (around 20 years old). Adjusting for project, most group differences were due to criminal history as indicated by the incarceration trajectory. The two groups with high incarceration pretreatment trajectories were less likely to be employed, more likely to be primary heroin or methamphetamine users, and more likely to be at a younger age when they were first arrested, first used heroin, and first used marijuana.

First Treatment

Adjusting for project, the four groups did not differ in the average age of entering treatment for the first time, with mean ages being approximately 30 across groups (Table 3). However, groups with high pretreatment incarceration trajectories were more likely to have been referred to treatment through the criminal justice system and more likely to have received their first treatment in jail or prison; they also spent more time in treatment (approximately 12 months vs. 6 months). The drug use trajectories prior to the first treatment were not related to age at entering treatment, source of referral to treatment, modality of treatment, or length of stay in treatment.

Posttreatment Drug Use Outcome

Trajectories of drug use, shown in Figure 1, indicate that in both of the Low Drug Use groups, regardless of incarceration level, drug use after the first treatment was relatively low (e.g., less than 5 days of use per month) and continued to be quite stable over the 5-year posttreatment period. In contrast, in both of the High Drug Use groups, the levels of drug use decreased gradually over time after discharge from the first treatment, but remained at a higher level than those for the Low Drug Use groups.

The results of the growth curve model for the posttreatment outcome trajectory for drug use are shown in Table 4. Overall, after controlling for potential covariates, the total sample used drugs at a mean of 5.16 days ($=e^{1.64}$) in the month following discharge, and days of drug use per month decreased significantly over the 5 years after discharge from first treatment by an average rate of 0.82 ($=e^{-0.20}$) per year.[1] The main effects on drug use of the pretreatment drug use and incarceration trajectories, as well as their interaction, were all significant for both the posttreatment intercept and the slope. While high incarceration and low drug use during the pretreatment period were each associated with lower drug use right after treatment discharge, lower pretreatment drug use and incarceration further decreased the level of drug use after discharge. More specifically, the groups with a low pretreatment drug use trajectory showed low drug use regardless of their incarceration history, but the High Drug Use group showed lower drug use at discharge if they also had a high pretreatment incarceration trajectory. Over the years after treatment, while all groups decreased their drug use, such decreases were steeper among the High Incarceration and High Drug Use groups.

Subjects who entered their first treatment at an older age demonstrated a lower level of drug use just after discharge, but older addicts decreased their drug use at a slower rate over the years after treatment discharge. Longer first treatment stay, jail/prison treatment (relative to community outpatient treatment), and community residential treatment were each associated with reduced drug use right after discharge, but they were also less likely to be associated with a continuing decrease in drug use over the years after treatment. Particularly, the slope of drug use after jail/prison treatment was positive ($-.20+.31=.11$), indicating that drug use increased over time even though drug use at discharge was lower relative to those who participated in community treatment ($e^{-0.47}$ or 83% lesson days of using). Employment prior to the first treatment was also a significant predictor of the posttreatment drug use trajectory. Compared with unemployed subjects, employed subjects used drugs more frequently just after treatment discharge, but the rate of decreasing drug use over the years after treatment was significantly greater than that for unemployed subjects. Finally, incarceration and treatment were both negatively related to drug use during each year of the 5-year posttreatment period, reflecting the lower time at risk during which people are able to use drugs.

Posttreatment Incarceration Outcome

As shown in Figure 2, the two High Incarceration groups had similar patterns of high levels of incarceration after treatment compared with the two Low Incarceration groups. For both High Incarceration groups, months of incarceration dropped before treatment entry, increased slightly in the year after discharge from treatment (but not to the same level as in the pretreatment period), and then decreased over the subsequent years. On the other hand, for the two Low Incarceration groups, months of incarceration continued to increase after first treatment, and dropped slightly in the last 2 years of the posttreatment period, with a somewhat higher rate of incarceration for the Low Incarceration/High Drug Use group.

Controlling for potential confounding factors, neither the intercept nor slope of the posttreatment incarceration trajectory was significant for the overall sample (Table 4). The main effect of pretreatment incarceration and its interaction with drug use were significant for both the intercept and the slope. Relative to the High Incarceration groups, the Low Incarceration groups were less likely to be incarcerated just after treatment discharge;

[1] A Poisson distribution growth curve model was applied to examine the measures of the dependent variables (i.e., days per month using drugs, months incarcerated per year, months employed per year). In model fitting, A LOG transformation for each of these variables was used. As an example, for drug use, a coefficient of 1.64 indicates a mean of LOG of days of drug use. To transform back to the original scale, an EXP transformation is taken to get a mean of 5.16 days ($=e^{1.64}$).

however, the increase in their months of incarceration over the years after treatment was significantly higher. While the main effect of Drug Use group was not significant, the Low Incarceration/Low Drug Use Group was significantly less likely to be incarcerated just after discharge from treatment and had a lower incarceration rate over the years after treatment.

Older age at first treatment significantly reduced incarceration right after discharge from treatment and was also significantly associated with decreased incarceration over the years after treatment. Length of first treatment and employment prior to the first treatment each was significantly associated with reduced incarceration right after discharge from treatment; neither, however, had a significant effect on incarceration over the subsequent 5 years. Although those who received jail/prison treatment had a significantly lower level of incarceration right after treatment discharge than did those who had received community treatment, the increase in their incarceration ($\beta = 0.17$; $p < .01$) during the 5 years posttreatment was significantly higher than that for those whose first treatment was in the community.

Posttreatment Employment Outcome

The unadjusted employment level (number of months employed during the year) during the 5-year pretreatment and posttreatment periods were plotted for the four pretreatment drug use and incarceration trajectory groups, as shown in Figure 3. Overall, there was a clear separation by incarceration grouping; those with high pretreatment incarceration trajectories showed low levels of employment during the pretreatment period, with their level of employment slightly increasing in the first 3 years after treatment discharge, and then showing a decline. For the two Low Incarceration groups, their employment rate was similar just after discharge from treatment, but the Low Drug Use group improved over time, while the High Drug Use group declined, only to converge with the Low Drug Use group at 5 years.

The growth curve modeling of posttreatment employment outcomes (Table 4) showed that, for the overall sample, months of employment significantly increased ($\beta = 0.10$, $p < .05$) over the years after treatment. The pretreatment incarceration and drug use groupings did not differ in the intercept of the posttreatment employment level. However, the main effect of drug use and the interaction of the drug use and incarceration grouping were significant predictors of the slope of the posttreatment employment pattern, with the Low Incarceration/ Low Drug Use group showing the highest increasing rate of employment, or an increase of 138% per year (= $e^{(0.10-0.01+0.10+0.33)} = 1.38$).

Few covariates were significantly related to the employment level right after discharge, except that subjects who were employed prior to treatment had a significantly higher level of employment just after discharge ($\beta = 1.48$, $p < 0.01$); however, their employment over the years after treatment decreased significantly ($\beta = -0.19$, $p < 0.01$) relative to those unemployed prior to their first treatment. The level of employment increased at a slower rate for jail/prison treatment compared with community treatment, and at a faster rate for residential treatment compared with outpatient treatment. Employment was unrelated to subsequent participation in treatment following discharge from the first treatment. As would be expected, periods of incarceration over the years following the first treatment episode were associated with reduced employment.

DISCUSSION

This paper sought to examine whether crime and drug use trajectories of substance users prior to their first treatment episode were related to characteristics of that initial treatment, and whether these pretreatment trajectories were related to posttreatment drug use,

incarceration, and employment outcomes. The data for the analysis was derived from three studies of drug users for whom we had data on long-term patterns of drug use, incarceration, and employment, as well as on standard demographic characteristics. Although previous analyses of treatment response among substance-using offenders have controlled for baseline measures, few have controlled for pretreatment crime and drug use over time. In the present analysis, we identified trajectories for these behaviors over the 5 years prior to the treatment episode of interest (i.e., the first reported treatment) in order to control for background differences in these behaviors in predicting outcomes following treatment. Using growth mixture modeling, we identified four groups with distinct crime and drug use trajectories based on the number of months incarcerated and the number of days using drugs during the 5 years prior to the first treatment. The four groups were High Incarceration/High Drug Use, High Incarceration/Low Drug Use, Low Incarceration/High Drug Use, and Low Incarceration/Low Drug Use.

With respect to the first treatment episode (see Table 3), after controlling for study project, the mean age at which participants in each of the four trajectories entered their first treatment episode was the same, about age 30, which is the typical age found in studies of treatment utilization (Anglin, Hser, and Grella 1997; Brecht et al.2004). Our expectation that subjects with more criminal involvement (as indicated by incarceration) would enter treatment later than those who were less criminally involved was not supported. Not surprisingly, the two High Incarceration pretreatment trajectory groups were much more likely to have been referred to treatment while they were in jail or prison, whereas the Low Incarceration pretreatment groups were more likely to have received their first treatment referral through a non-criminal justice source. Similarly, the first treatment for the High Incarceration groups occurred more often in jail or prison than in the community. Finally, the High Incarceration trajectory groups averaged nearly twice as many months in treatment as the Low Incarceration groups. These differences are largely explained by the fact that the High Incarceration groups consisted of a large proportion of clients from the Amity study, which involved a prison-based therapeutic community. In general, there were clear differences among the combined incarceration/drug use trajectory groups with respect to variables associated with the first treatment, but those differences were accounted for by incarceration history rather than by drug use history.

Our second question had to do with the long-term patterns of drug use, incarceration, and employment following first treatment, controlling for the pretreatment incarceration/drug use trajectory groups and other covariates. We applied growth curve models, with a Poisson distribution, to examine this question. Overall, as shown in Table 4, drug use decreased and employment increased over the5years following treatment; incarceration, however, did not significantly change over those same 5 years. Although pretreatment drug use and incarceration trajectories were significantly related to posttreatment outcomes, the patterns of relationships are varied among drug use, incarceration, and employment. Both pretreatment drug use and incarceration trajectories and their interaction were related to posttreatment drug use. However, pretreatment drug use alone was not related to posttreatment incarceration, nor was pretreatment incarceration alone related to posttreatment employment.

The pattern of findings for the four pretreatment trajectory groups is more easily seen in the (unadjusted) plots of the observed drug use, incarceration, and employments outcomes (see Figures 1–3). For drug use, although the High Drug Use groups maintained a higher level of use than the Low Drug Use groups, their use steadily declined over the years following treatment, while the Low Drug Use groups showed a virtually flat pattern of use. Clients who received their first treatment in jail or prison had a lower level of drug use after discharge than those treated in community programs, possibly because they were under

probation or parole supervision (during which their drug use was monitored) following their release. Over time, however, those initially treated in jail or prison were more likely than those treated in the community to increase their use over time. The supervision and monitoring associated with criminal justice treatment appears to have a short-term benefit (relative to community-based treatment), but fails to have long-term effects. Finally, relative to subjects who had been unemployed prior to their first treatment, those who had been employed reported a higher level of drug use just after discharge from treatment, but over time, the decline in drug use was greater for the employed than for the unemployed.

Pretreatment incarceration and its interaction with drug use had significant effects on incarceration. Pretreatment drug use alone was not a significant predictor of posttreatment incarceration. As might be expected, subjects who had spent little or no time in prison or jail before treatment were much less likely to have been incarcerated after treatment discharge than those who had spent many months incarcerated. This might have been because the first treatment of those in the Low Incarceration groups was more likely to have been in the community, and at treatment discharge they were not under criminal justice supervision, as was the case with many of the prison treatment participants in the High Incarceration groups (see Table 3). The subsequent decline in the rate of incarceration in the High Incarceration groups compared with the Low Incarceration groups (evident in Figure 2) is more difficult to explain. The age effect found in most studies of criminal careers (Farrington, 1986; Laub and Sampson 2001) does not appear to apply here since subjects in each of the groups entered their first treatment when they were about 30 years old. There is some indication that a high level of pretreatment drug use increases the risk of later incarceration, at least among those with a low incarceration history.

During the years following the first treatment, there was an overall positive effect on employment, as measured by the average number of months employed per year. Perhaps not surprisingly, the Low Incarceration/Low Drug Use group exhibited the highest rate of increasing employment over the 5 years, compared with the other trajectory groups.

The findings from these analyses need to be considered in light of several limitations. First, subjects from the Amity study constituted the largest proportion of the total analysis sample, and they differed from the other two samples in that most had received prison treatment as their first treatment. Potential bias from this source was controlled for in statistical comparisons in Tables 2 and 3 and in the growth curve models in Table 4. A second limitation was the problem of assessing outcomes in the presence of incarceration, which decreases time at risk for behaviors that occur "on the street." That is, during times when study participants were incarcerated, they could not use drugs (or only to a very limited extent), nor could they be employed. Again, our identification of pretreatment incarceration trajectories and the inclusion of incarceration as a time-varying covariate in the growth curve models should at least partially control for time at risk. Third, for this analysis, we used incarceration as a measure of crime because the Natural History Instrument does not collect time-based information on arrests and because we had arrest records on only one of the study samples. In addition, in retrospective studies, self-reports of incarceration are likely to be more accurate than self-reports of criminal activity. Conceptually, however, it would be better to have a measure of crime that is closer to the actual activity and less influenced by the policies and procedures of the criminal justice system (Maltz 1984). But an advantage of incarceration is that, as noted, we could use it as a way to control for time at risk with respect to drug use and employment. Finally, in addition to pretreatment incarceration and drug use trajectories as predictors in the growth curve models, several other variables were included to control for confounding. Although each of these is related to the outcomes theoretically or empirically, other background variables might have been added to improve the models. Also, it is likely that over the 5 years posttreatment,

experiences and behaviors other than incarceration and treatment could have influenced drug use, incarceration, and employment outcomes, and these might have affected the findings had they been included as time-varying covariates.

With few exceptions (Piquero, Farrington, and Blumstein 2003), research on criminal careers has generally not included the effects of social interventions on careers, but has rather examined such life events as marriage, employment, and military service, which cannot be manipulated (at least not easily) for specific populations of interest, such as offenders or drug users. Our findings indicate that persistent offenders do respond to treatment, that their posttreatment trajectories of drug use and incarceration are relatively lower than their pretreatment trajectories, and that their posttreatment employment trajectories are higher than their pretreatment trajectories. These results indicate a modest effect of treatment on subsequent behavior and suggest the need for research on criminal careers to include the influence of social interventions when accounting for long-term patterns of deviant behavior such as drug use and crime.

Acknowledgments

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FIGURE 1.
Days of Drug Use over the 5 Years before and the Five Years after the First Treatment
Episode, by Incarceration and Drug Use Trajectory Groups

FIGURE 2.
Months of Incarceration over the 5 Years before and the 5 Years after the First Treatment Episode, by Incarceration and Drug Use Trajectory Groups

FIGURE 3.
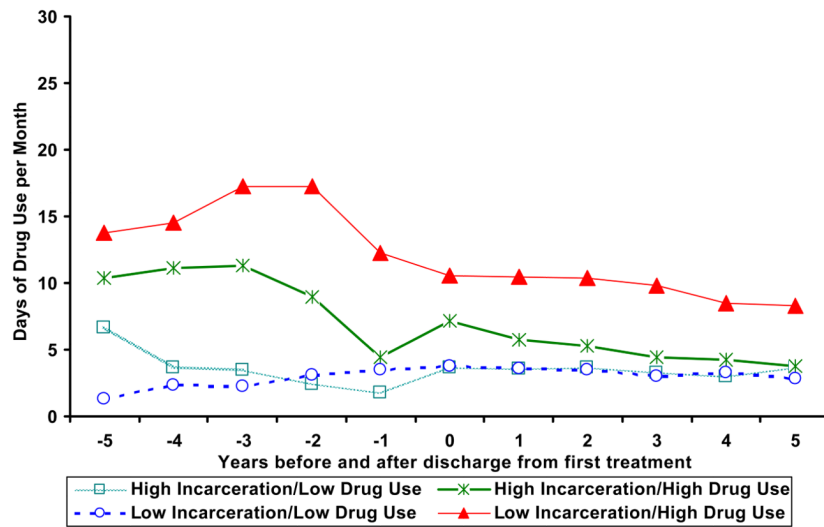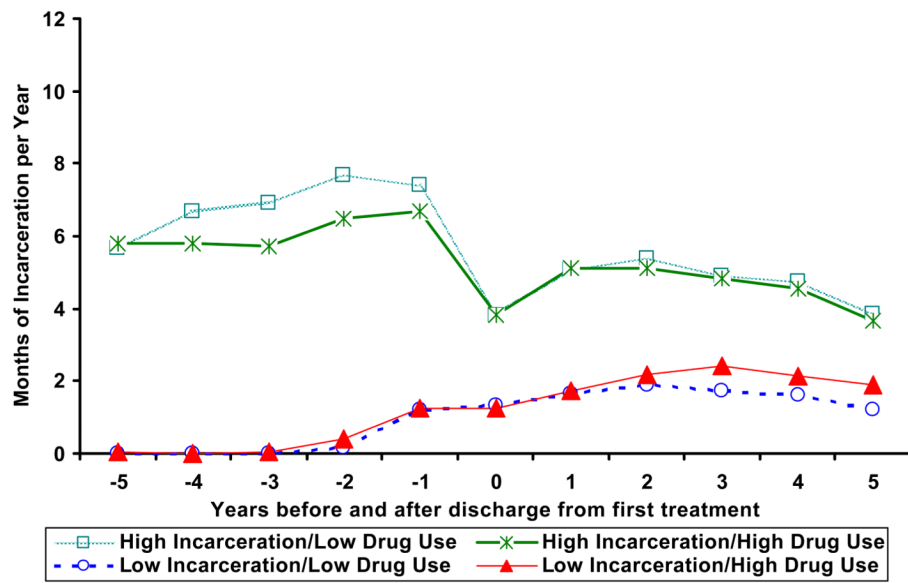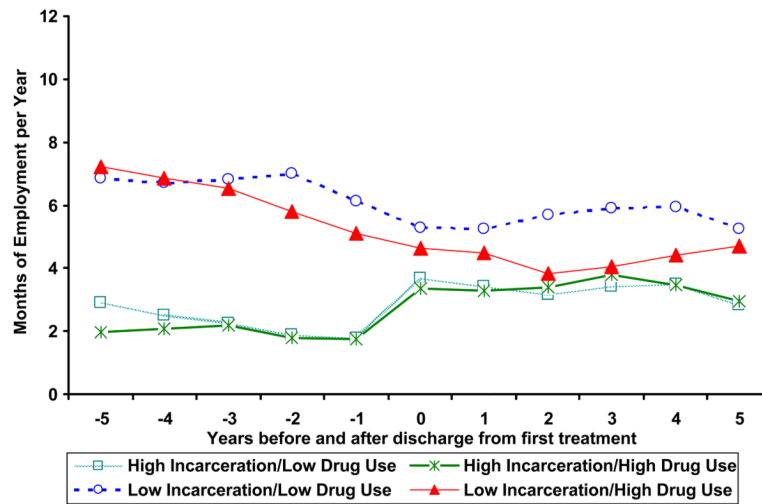Months of Employment over the 5 Years before and the 5 Years after the First Treatment
Episode, by Incarceration and Drug Use Trajectory Groups

TABLE 1

Pretreatment Incarceration and Drug Use Trajectory Groups

	Incarceration Groups			
Drug Use Groups	*Low*	*Increasing*	*High*	*Total*
	n	n	n	n
Low	84[a]	19[c]	69[c]	172
Decreasing	15[a]	32[c]	59[c]	106
Increasing	69[b]	19[d]	76[d]	164
High	131[b]	55[d]	164[d]	350
Total	299	125	368	792

[a] Subjects in the Low Incarceration group and the Low or Decreasing Drug Use groups were combined into a Low Incarceration/Low Drug Use group.

[b] Subjects in the Low Incarceration group and the High or Increasing Drug Use groups were combined into a Low Incarceration/High Drug Use group.

[c] Subjects in the High or Increasing Incarceration groups and in the Low or Decreasing Drug Use groups were combined into a High Incarceration/Low Drug Use group.

[d] Subjects in the High or Increasing Incarceration groups and the High or Increasing Drug Use groups were combined into a High Incarceration/High Drug Use group.

TABLE 2

Characteristics of Incarceration and Drug Use Groups Prior to the First Treatment Episode

	High incarceration/ Low drug use (n = 179)	High incarceration/ High drug use (n = 314)	Low incarceration/ Low drug use (n = 99)	Low incarceration/ High drug use (n = 200)
Project [**]C, D				
Amity	78.2%	79.6%	17.2%	20.5%
TUE	8.9%	10.8%	16.2%	31.5%
TXPROC	12.9%	9.6%	66.7%	48.0%
Ethnicity [*]				
White	29.1%	36.6%	31.3%	35.5%
Black	39.1%	32.2%	36.4%	34.5%
Hispanic	29.0%	29.6%	23.2%	23.5%
Asian/Other	2.8%	1.6%	9.1%	6.5%
Employed prior to first treatment [**]C, D	14.0%	8.6%	52.5%	40.0%
Primary drug [**]C, D				
Alcohol	19.1%	1.6%	31.6%	8.8%
Cocaine	23.6%	29.2%	25.5%	35.1%
Heroin	23.6%	31.5%	16.3%	28.4%
Marijuana	10.1%	1.0%	14.3%	3.1%
Methamphetamine	17.4%	31.8%	7.1%	20.1%
Other	6.2%	4.9%	5.1%	4.7%
Age at first arrest [**]C	16.1 (4.3)	15.8 (4.4)	18.4 (6.1)	17.6 (6.0)
Age at first use of major drug (heroin, cocaine, methamphetamine) [**]D	17.8 (4.2)	17.0 (3.9)	19.0 (6.3)	17.9 (5.1)
Age at first alcohol use	12.2 (4.0)	11.9 (3.9)	12.3 (3.6)	11.8 (4.0)
Age at first cocaine use [**]	19.5 (5.7)	18.9 (5.6)	20.6 (6.8)	21.0 (7.2)
Age at first heroin use C	19.4 (4.3)	18.8 (4.6)	20.8 (5.6)	19.9 (5.9)
Age at first marijuana use [**]C	13.0 (3.0)	13.0 (3.0)	14.9 (3.9)	14.0 (3.3)
Age at first methamphetamine use	19.7 (5.6)	20.6 (6.4)	19.3 (5.2)	19.6 (6.6)

[*]
$p < 0.05$,

[**]
$p < 0.01$ for significant chi-square test or one-way ANOVA testing difference among the four groups.

C
indicates a significant incarceration group effect ($p < 0.05$) after controlling for project.

D
indicates a significant drug group effect ($p < 0.05$) after controlling for project.

TABLE 3

Characteristics of the First Treatment Episode, by Incarceration and Drug Use Groups

	High incarceration/ Low drug use (n = 179)	High incarceration/ High drug use (n = 314)	Low incarceration/ Low drug use (n = 99)	Low incarceration/ High drug use (n = 200)
Age of first treatment	30.1 (7.8)	31.3 (7.4)	30.4 (9.8)	30.4 (9.2)
Source of first treatment referral ** C				
Jail/prison	61.5 %	63.1 %	13.1 %	11.5 %
Criminal justice	15.6 %	13.4 %	22.2 %	24.5 %
Others	22.9 %	23.6 %	64.7 %	64.0 %
Modality of first treatment ** C				
Jail/prison	61.5 %	63.1 %	13.1 %	11.5 %
Community residential	23.5 %	22.6 %	37.4 %	46.5 %
Community outpatient	15.1 %	14.3 %	49.5 %	42.0 %
Duration of first treatment (months) ** C	11.0 (13.5)	12.2 (11.6)	6.3 (7.8)	6.3 (8.4)

*
$p < 0.05$,

**
$p < 0.01$ for significant chi-square test or one-way ANOVA testing difference among the four groups.

C
indicates a significant incarceration group effect ($p < 0.05$) after controlling for project.

D
indicates a significant drug group effect ($p < 0.05$) after controlling for project.

TABLE 4

Growth Curve Model (Poisson) of Treatment Outcomes over 5 Years after Discharge from the First Treatment Episode, Controlling for Time-varying Covariates

	Drug Use	Incarceration	Employment
Means			
Intercept	1.64[**]	−0.15	−0.37[**]
Slope	−0.20[**]	0.02	0.10[*]
Covariates on Intercept			
AMITY (ref: TXPROC)	1.34[**]	3.36[*]	1.42[**]
TUE (ref: TXPROC)	0.31[**]	0.74[**]	0.08
Incarceration (ref: HIGH)	0.23[**]	−0.65[**]	−0.04
Drug (ref: HIGH)	−1.10[**]	0.03	−0.03
Drug [*]incarceration	−1.14[**]	−0.33[**]	0.04
Age at first treatment	−0.02[**]	−0.04[**]	0.001
Length of first treatment	−0.03[**]	−0.04[**]	0.001
Whites (ref: Hispanics)	−0.11	0.04	−0.04
Blacks (ref: Hispanics)	−0.38[**]	0.22[**]	0.03
Jail treatment (ref: community outpatient)	−0.47[**]	−0.45[**]	0.08
Residential modality (ref: community outpatient)	−0.36[**]	−0.06	0.02
Employed prior to first treatment	0.50[**]	−0.46[**]	1.48[**]
Covariates on Slope			
AMITY (ref: TXPROC)	−0.46[**]	0.06	−0.01
TUE (ref: TXPROC)	−0.04[*]	0.14[**]	−0.04
Incarceration (ref: HIGH)	0.19[**]	0.09[**]	−0.01
Drug (ref: HIGH)	0.16[**]	0.001	−0.10[**]
Drug [*]Incarceration	−0.23[**]	−0.15[**]	0.33[**]
Age at first treatment	0.002[*]	−0.01[**]	−0.003[**]
Length of first treatment	0.004[*]	0.001	0.001
Whites (ref: Hispanics)	−0.01	−0.04[*]	0.15[**]
Blacks (ref: Hispanics)	−0.19[**]	−0.03[*]	−0.07[**]
Jail treatment (ref: community outpatient)	0.31[**]	0.17[**]	−0.07[*]
Residential modality (ref: community outpatient)	0.07[**]	0.11[**]	0.06[**]
Employed prior to first treatment	−0.11[**]	0.02	−0.19[**]
Time-Varying Covariates			
Incarceration at Year 0	−0.21[**]	--	−0.37[**]
Incarceration at Year 1	−0.17[**]	--	−0.27[**]
Incarceration at Year 2	−0.15[**]	--	−0.23[**]

	Drug Use	Incarceration	Employment
Incarceration at Year 3	−0.16[**]	--	−0.20[**]
Incarceration at Year 4	−0.21[**]	--	−0.24[**]
Incarceration at Year 5	−0.27[**]	--	−0.30[**]
Treatment in Year 0 through Year 5	−0.09[**]	0.03[**]	0.002
Variance-Covariance			
Intercept	1.93[**]	2.81[**]	3.45[**]
Slope	0.20[**]	0.07[**]	0.18[**]
Intercept *Slope	−0.30[**]	−0.07[**]	−0.53[**]

[*]
$p < 0.05$,

[**]
$p < 0.01$