

*ATTENDANCE RATES IN A WORKPLACE PREDICT SUBSEQUENT
OUTCOME OF EMPLOYMENT-BASED REINFORCEMENT OF
COCAINE ABSTINENCE IN METHADONE PATIENTS*

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This study assessed whether attendance rates in a workplace predicted subsequent outcome of employment-based reinforcement of cocaine abstinence. Unemployed adults in Baltimore methadone programs who used cocaine ($N = 111$) could work in a workplace for 4 hr every weekday and earn \$10.00 per hour in vouchers for 26 weeks. During an induction period, participants provided urine samples but could work independent of their urinalysis results. After the induction period, participants had to provide urinalysis evidence of cocaine abstinence to work and maintain maximum pay. A multiple regression analysis showed that induction period attendance was independently associated with urinalysis evidence of cocaine abstinence under the employment-based abstinence reinforcement contingency. Induction period attendance may measure the reinforcing value of employment and could be used to guide the improvement of employment-based abstinence reinforcement.

DESCRIPTORS: abstinence reinforcement, cocaine addiction, contingency management, employment, methadone

Research in both the laboratory (Higgins et al., 2007; Nader & Woolverton, 1991) and the clinic (Dallery, Silverman, Chutuape, Bigelow, & Stitzer, 2001; Higgins et al., 2007; Silverman, Chutuape, Bigelow, & Stitzer, 1999; Stitzer & Bigelow, 1984) has shown that the effectiveness of abstinence reinforcement contingencies increases as the reinforcement mag-

nitude increases. Although low-magnitude abstinence reinforcement can have considerable clinical utility (Peirce et al., 2006), the substantial body of research on reinforcement magnitude suggests that for any population of drug abuse patients, the proportion of patients that respond to an abstinence reinforcement intervention by initiating abstinence should increase as the magnitude of reinforcement increases. Identifying practical ways to arrange high-magnitude abstinence reinforcement contingencies is an important challenge for clinicians and clinical researchers.

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To develop potentially practical ways of arranging high-magnitude abstinence reinforcement contingencies, some researchers have sought to identify high-magnitude reinforcers that are routinely dispensed in the community and that might be harnessed for therapeutic purposes (Donlin, Knealing, & Silverman, 2008). In this vein, a few researchers have explored the possibility of using contingent access to employment to reinforce drug abstinence (Cohen, Bigelow, Hargett, Allen, & Halsted, 1973; Crowley, 1986; Milby et al.,

1996; Miller, 1975; Silverman, Svikis, Robles, Stitzer, & Bigelow, 2001). Employment settings have several features that might make them ideal vehicles for arranging abstinence reinforcement contingencies (Silverman, 2004), but one of their most important features is that they can control high-magnitude reinforcers, most notably wages, that can be used to reinforce drug abstinence. Employment-based abstinence reinforcement can be arranged by hiring persistent drug users and requiring them to provide drug-free urine samples to gain and maintain access to the workplace.

A systematic program of research over the past several years has shown that employment can be a useful vehicle for arranging high-magnitude abstinence reinforcement (Silverman, 2004; Silverman *et al.*, 2001, 2002, 2007). That research, conducted primarily with methadone patients who continued to use cocaine and heroin despite exposure to routine counseling and daily methadone maintenance, has shown that employment-based reinforcement can be effective in promoting abstinence from cocaine and opiates in many patients (Silverman *et al.*, 2001, 2002, 2007). In these studies, participants were hired to work in a model therapeutic workplace where they could work 3 to 6 hr per day and earn between \$35.00 and \$60.00 per day for many months. To promote abstinence, participants in the therapeutic workplace were required to provide urinalysis evidence of drug abstinence to gain and maintain daily access to the workplace. Despite the high-magnitude reinforcement used in these studies, not all participants initiated abstinence when exposed to employment-based abstinence reinforcement (Silverman *et al.*, 2001, 2002, 2007); one study even failed to demonstrate the overall effectiveness of an employment-based abstinence reinforcement intervention (Knealing, Wong, Diemer, Hampton, & Silverman, 2006).

In an effort to increase the proportion of participants who respond to employment-based

reinforcement, Silverman *et al.* (2007) used a workplace induction procedure in which participants were hired and allowed to work in the workplace for about a month prior to initiation of an employment-based abstinence reinforcement contingency. This workplace induction period was designed to allow participants to sample the reinforcers available in the workplace (Kazdin, 1982) and to allow them to establish critical work-related behaviors (e.g., following a daily routine of waking up at a set time, traveling to the workplace, working on training programs, earning vouchers, and exchanging earned vouchers) prior to requiring that participants provide evidence of recent cocaine abstinence to work.

The induction period also affords the opportunity to assess individual differences in workplace attendance before arranging an employment-based abstinence reinforcement contingency. This measure of workplace attendance could be important because it may predict the extent to which contingent access to the workplace will serve as a reinforcer for individual participants. This expectation is based on research that has shown that the rate at which an organism contacts a stimulus when that stimulus is freely available is proportional to the magnitude of the reinforcement effect produced when that stimulus is presented contingent on some low-rate behavior (e.g., Premack, 1961, 1963).

This principle was illustrated in an early study that examined the reinforcement of lever pressing in rats with either contingent access to a drinking tube or a running wheel (Premack, 1963). In that study, rats were monitored in free-access assessment sessions in which they were given free access either to a running wheel (in morning sessions) or to a drinking tube that dispensed a sucrose solution (in afternoon sessions). The point of the free-access assessment sessions was to assess the percentage of the sessions that the rats spent engaging in the available behavior (running or drinking) when each activity was freely available. The probabil-

ities of running in the free-access running sessions and of drinking in free-access drinking sessions were varied by manipulating the force required to operate the wheel (low and high force) and the sucrose concentration in the drinking tube (low, medium, and high). After the assessment sessions, conditioning sessions were arranged in which three presses on a lever produced 15-s access to running (again in morning sessions) and separate conditioning sessions in which lever presses produced 15-s access to the drinking tube (again in afternoon sessions). The study showed that the amount of lever pressing in the conditioning sessions was directly related to the free-access probability of the contingent response as measured in the free-access assessment sessions.

The workplace induction period is analogous to the period in Premack's (1963) study in which he allowed free access to the drinking tube or the running wheel and allows us to measure the extent to which participants contact or attend the workplace when access to the workplace is freely available. The results obtained by Premack suggest that the effectiveness of an employment-based abstinence reinforcement contingency, when access to the workplace is made contingent on the provision of cocaine-negative urine samples, should be directly related to the rates that participants attended the workplace during the induction period.

This study had two objectives. The primary objective was to determine if workplace attendance during a workplace induction period predicted abstinence outcomes in a subsequent condition under an employment-based abstinence reinforcement contingency. The second purpose was to provide a systematic replication of the effectiveness of employment-based reinforcement of drug abstinence in methadone patients (Silverman et al., 2007).

METHOD

This study was conducted as a part of a larger randomized controlled study designed to eval-

uate the effectiveness of employment-based abstinence reinforcement as a maintenance intervention to sustain abstinence over an extended period of time. All participants in the larger trial were invited initially to attend the workplace for 6 months. Individuals who became abstinent from cocaine and opiates and acquired a minimal set of job and professional skills during that initial 6-month period were invited to attend the workplace for an additional year and participate in a randomized controlled study. This report describes data collected during the initial 6-month period of the larger study. The results of the randomized controlled trial will be published in a later article.

Settings and Materials

The current study was conducted in the therapeutic workplace at the Center for Learning and Health, a treatment-research unit at the Johns Hopkins Bayview Medical Center. Details of the therapeutic workplace setting, materials, and procedures are similar to procedures used by Silverman et al. (2007). The most important procedures for this study, as well as procedures that differ from those employed in the prior study, are described below.

On workdays, participants reported to the urinalysis laboratory in the therapeutic workplace, where they signed into the workplace and provided observed urine samples when required. The laboratory was near a central area, where up to three workroom assistants monitored the activities of the participants in workrooms. Participants passed through this centralized area to enter one of three workrooms, where all training was conducted.

Recruitment and Participant Selection

The Western Institutional Review Board approved this study. Participants were enrolled from October, 2003, to March, 2006. The study was advertised at 16 methadone clinics in Baltimore. Research staff visited these clinics, and flyers and letters were distributed within

these clinics to invite unemployed adults in methadone treatment to apply to enroll in a study that provided monetary vouchers for participating in job skills training.

When they contacted the Center for Learning and Health, individuals were asked to complete a brief screening interview containing eight questions to determine study eligibility. Questions asked age, marital status, zip code of residence, employment status, drug use, treatment enrollment, income, welfare status, and major medical conditions. Some of the questions were unrelated to study eligibility but were included to obscure inclusion criteria. Individuals indicating that they were 18 years of age or older, were unemployed, used cocaine or crack within the last 30 days, were receiving welfare benefits, and were enrolled in methadone maintenance in Baltimore were invited to the center to participate in a full screening interview.

Full Screening Interview

The full screening interview included a breath sample to measure alcohol use (not reported here); a urine sample to test for drug use; and assessments to characterize drug history, psychological status, and academic skills. Observed urine samples were tested for cocaine, opiates, benzodiazepines, methadone, and amphetamines. Research staff also filled out an assessment on the physical limitations of the individual to exclude those who could not operate a computer keyboard. Additional assessments were completed to ascertain cocaine and heroin dependence (Cottler, 1991), psychosocial functioning (McLellan *et al.*, 1985), HIV risk behaviors (Navaline *et al.*, 1994), and reading skill levels (Wilkinson, 1993). Participants were paid \$30.00 in vouchers for completing the full interview.

Study eligibility required that participants were at least 18 years old, were currently unemployed, were enrolled in a Baltimore City methadone maintenance program, provided a cocaine-positive urine sample at intake, met

criteria for cocaine dependence (American Psychiatric Association, 1994), were currently receiving welfare benefits in Baltimore, and achieved 80% correct on the reading assessment. Participants were excluded if they were considered to be at risk of suicide (reported on the Addiction Severity Index), reported auditory or visual hallucinations (reported on the Addiction Severity Index), had a physical limitation that prevented typing, were incarcerated in a halfway house or under constant monitoring, or if they earned more than \$200.00 in the last month in under-the-table (unreported) income.

Experimental Design

Eligible participants were invited to attend the workplace for 6 months. Urine samples were collected every Monday, Wednesday, and Friday and were tested for cocaine and opiates. The study employed a multiple baseline across drugs design to evaluate the effectiveness of employment-based abstinence reinforcement in promoting abstinence from cocaine and then opiates. After a workplace induction period in which participants could attend the workplace independent of their urinalysis results, employment-based reinforcement of cocaine abstinence was arranged. After a participant achieved 3 weeks of sustained cocaine abstinence, employment-based reinforcement of cocaine and opiate abstinence was arranged.

Workplace induction period. During the workplace induction period, participants could attend the workplace independent of their urinalysis results and could earn vouchers for their attendance in the workroom and for their performance on training programs. The voucher system was adapted from a voucher system originally developed for the treatment of primary cocaine dependence patients (Higgins *et al.*, 1991). Vouchers have monetary values and can be exchanged for goods and services that are purchased for participants by staff. Vouchers are used instead of cash to reduce the

chance that participants will use their earnings to purchase drugs.

Participants could earn a base pay of \$8.00 per hour for the time they spent in their assigned workrooms and approximately \$2.00 per hour in productivity pay for working on their training programs. Participants earned 5 min of paid break for every 55 min worked. Base pay and productivity pay accumulated in the participant's account as an electronic voucher until he or she chose to exchange the pay for gift cards or other approved goods and services. The workplace induction period continued for at least 4 weeks and until the participant attended the workplace for at least 5 min on 15 workdays. The requirement that participants attend the workplace on at least 15 days was arranged to ensure that all participants had a minimal amount of exposure to the workplace before being exposed to the employment-based abstinence reinforcement contingency.

Cocaine abstinence contingency. At the end of the induction period, participants were exposed to an employment-based abstinence reinforcement contingency in which they were required to provide evidence of recent cocaine abstinence to work and to maintain maximum pay. Under this contingency, mandatory urine samples were collected every Monday, Wednesday, and Friday, and participants were allowed access to the workplace only if the urine samples indicated recent cocaine abstinence. Recent cocaine abstinence was assumed if a participant's urinary benzoylecgonine concentration (a metabolite of cocaine) was ≤ 300 ng/ml or if the urinary benzoylecgonine concentration decreased by at least 20% per day since the last sample was submitted.

Under the cocaine abstinence contingency, a participant who submitted a cocaine-positive urine sample was denied access to work on that day. Following a positive urine sample, a participant could regain access to the workplace only if he or she showed evidence of cocaine

abstinence. In addition, base pay was reduced to \$1.00 per hour for the 1st day worked following a positive urine sample. Hourly base pay then increased by \$1.00 per hour for each day that the participant provided a cocaine-negative urine sample and worked at least 5 min, until the value reached the original \$8.00 per hour.

Opiate and cocaine abstinence contingency. After the successful completion of 3 consecutive weeks of cocaine abstinence during the abstinence contingency, participants were moved to a cocaine and opiate abstinence contingency. Under this condition, participants had to provide urinalysis evidence of recent abstinence from both cocaine and opiates on mandatory urine days to gain access to the workplace and to maintain maximum pay. Samples indicated cocaine and opiate abstinence if the urinary concentration of the drug's metabolite (benzoylecgonine and morphine, respectively) was ≤ 300 ng/ml or if the urinary metabolite concentration decreased by at least 20% per day since the last sample was submitted. If the sample failed to meet these criteria, workplace access was denied for that day, and base pay was decreased as previously described. Workplace access could be granted the following workday or any day thereafter by providing urinalysis evidence of recent cocaine and opiate abstinence.

General Workplace Procedure

The therapeutic workplace employed standard procedures that were applied with all participants. It was operated through a Web-based therapeutic workplace application program (Silverman et al., 2005, 2007). Participants could attend the workplace from 10:00 a.m. to 12:00 p.m. and 1:00 p.m. to 3:00 p.m. every weekday except holidays and weather emergencies.

On mandatory urine days, participants were required to submit samples in a bathroom in the presence of a same-sex research staff member using well-established procedures that

were designed to ensure valid specimen collection (Silverman *et al.*, 2007). The sample was tested for opiates and cocaine using the Abbott AxSYM system. Benzoylcegonine and morphine concentrations (the metabolites of cocaine and heroin, respectively) were quantified, using serial dilution procedures if necessary.

The therapeutic workplace software determined work eligibility and printed a urine feedback graph. The feedback graph provided a graphical and numerical display of benzoylcegonine and morphine concentrations, indicated whether or not the results indicated that the participant had used opiates or cocaine recently, and indicated whether or not the participant was granted access to the workplace. If all abstinence requirements were met or if no abstinence requirements were in effect, participants were given their identification (ID) cards, which they presented to a workroom staff member in the common area of the workplace. If abstinence requirements were not met, the participants were given their feedback graphs, were informed that they could not work on that day, were informed that their base pay would be reset to \$1.00 per hour, and were instructed on how and when their base pay could increase again to the maximum level of \$8.00 per hour. When participants had no abstinence requirements on a mandatory urine sample day (*i.e.*, during the induction period), the samples were tested later in the day, and feedback graphs were given to those individuals at their desks after testing.

General workroom procedure. Once participants received their ID cards, they presented their IDs to a workroom assistant who signed them into the workroom. Throughout the workday, participants' ID cards were swiped through a barcode reader each time they entered or left the workroom. This system allowed precise measurement of the duration of time that a participant spent in the workplace. All participants had their own cubicle workstations within one of the three workrooms. Through-

out the day, participants sat at their cubicles to work on computerized typing, keypad, and data-entry training programs.

Typing, keypad, and data-entry training programs. Training programs were designed in such a way that participants with no previous typing skills could become fluent typists (see Silverman *et al.*, 2007, for detailed description of the training programs). Briefly, the programs were divided into small steps through which participants could progress sequentially. Participants could earn vouchers for correct responses, lose vouchers for incorrect responses, and earn bonuses for passing steps. The programs were designed so that participants could earn approximately \$2.00 per hour in productivity pay for their work on the training programs.

Staff routinely monitored participant performance on training programs. If participants were having trouble passing particular steps, their training programs were modified to attempt to improve performance.

Voucher system. Each participant's computer displayed a home page that continuously tracked and updated earnings (an electronic voucher). The electronic voucher displayed base pay and productivity pay, hours worked, paid hours, accuracy, and earnings for the training programs. The electronic voucher could be used to purchase goods or services (gift cards, bills paid, etc.). Voucher purchases had to be for the participants or for the participants' immediate family. Vouchers could not be used to purchase cigarettes or alcohol, and gift certificates could not be obtained from stores that returned more than \$5.00 in cash back. Many gift cards were stocked continuously and could be obtained on the same day. Other purchases requested by the end of the day on Monday or Wednesday could be obtained by the next Wednesday or Friday, respectively.

On occasions when the therapeutic workplace was closed due to holidays or severe weather emergencies, participants received workplace closing pay. The closing pay was

the mean of the previous and following day's earnings, unless there was a reset on either day. If their base pay was reset either day, participants were ineligible to receive closing pay.

Trainee instruction. At the beginning of the study and at every transition to different conditions, participants were given instructions detailing the procedures of the therapeutic workplace. Original instructions explained work rules, testing procedures, and the voucher procedures. Transitional instructions provided information about the changes in contingencies (e.g., the introduction of the cocaine abstinence contingency). Instructions were read out loud by a workroom assistant, and throughout the instructions participants were required to answer multiple-choice questions. Participants could earn \$0.20 for every correct answer and \$0.10 for each corrected error. Quizzes were administered several days later to ensure retention and understanding of the instructions. Each participant kept a copy of the instructions at his or her workstation.

Standard Treatment Services

All participants were recruited from Baltimore methadone clinics, where they received routine drug abuse counseling concurrent with study participation. Participants reported mean methadone doses of 91 mg ($SD = 25$ mg), and all urine samples were positive for methadone at study enrollment. Participants had access to referrals to community services throughout the study and were offered referrals to employment services prior to being discharged from the study.

Data Analysis

Both visual inspection and statistical analyses were used to evaluate the effects of the contingencies. For each drug (cocaine and opiates), dichotomous outcome measures (e.g., cocaine-positive vs. cocaine-negative urine samples) were aggregated within participant for approximately 1 month prior to and 1 month following the introduction of each abstinence

contingency. This resulted in a precontingency (induction or baseline) percentage of negative samples and postcontingency (intervention) percentage of negative samples for each individual. Each of the baseline and intervention periods included 12 urine samples for cocaine and 10 urine samples for opiates. The opiate baseline and intervention periods included only 10 urine samples because some participants had only 10 urine sample days between the onset of the cocaine abstinence contingency and the onset of the opiate abstinence contingency. The percentage of samples testing negative in the induction and intervention periods were compared for both cocaine and opiates using a Wilcoxon signed ranks test and paired t tests. The Wilcoxon signed tanks tests were considered the primary analyses. For all analyses, urine samples were considered negative for cocaine and opiates if benzoylecgonine and morphine concentrations, respectively, were ≤ 300 ng/ml. To account for missing urine samples, two separate analyses were conducted that varied in how values for missing samples were derived. In one analysis, missing urine samples were treated as positive samples (missing positive). In the other analysis, values for missing samples were interpolated based on the values before and after the missing sample (missing interpolated). In the missing interpolated analysis, a missing sample or missing group of samples was considered positive if a urine sample before or after the missing sample or missing group of samples was positive.

To determine if rates of attendance during the induction period predicted cocaine abstinence during the intervention period, correlations and multiple regression analyses were calculated. Data for the induction period were based on the first 4 weeks (20 days) of possible workplace attendance. Because baseline rates of cocaine and opiate abstinence have been associated with cocaine abstinence outcomes under voucher-based abstinence reinforcement (e.g., Silverman et al., 1998), we also assessed

whether the percentage of cocaine-negative urine samples and opiate-negative urine samples in the induction period predicted the percentage of cocaine negative samples in the intervention period. The percentage of cocaine-negative and opiate-negative samples were calculated by dividing submitted cocaine-negative and opiate-negative urine samples, respectively, by total scheduled urine samples during the induction period. Percentage of minutes worked was calculated as total minutes worked during the first 4 weeks of the induction period divided by 4,800 min, the maximum possible number of minutes in that period (240 min per day times 20 days). The percentage of cocaine-negative samples during the intervention period encompassed all possible workdays after the onset of the cocaine contingency and was calculated by dividing the total number of cocaine-negative urine samples by the number of total scheduled urine sample collections.

Both Spearman's (r) and Pearson's (P) correlation coefficients were calculated to assess the relation between each of the three induction-period measures (i.e., percentage of cocaine-negative urine samples, percentage of opiate-negative urine samples, and percentage of minutes worked) and the primary intervention-period outcome measure (i.e., the percentage of cocaine-negative samples in the intervention period). To determine if the percentage of minutes attended in the induction period was independently associated with the percentage of cocaine-negative urine samples in the intervention period, a multiple regression analysis was performed, with the percentage of minutes attended and the two induction-period drug use measures (i.e., percentage cocaine-negative and percentage opiate-negative urine samples) as predictor variables. The outcome measure for the multiple regression analysis was the percentage of cocaine-negative urine samples in the intervention period. In these analyses, values for missing urine samples were interpolated as described above, because replacing missing

urine samples with positive results would increase the correlation between the induction-period drug use measures and the measures of attendance.

Similar analyses were conducted to determine if daily earnings, like percentage of minutes attended, during the induction period predicted cocaine abstinence during the intervention period. For those analyses, induction pay per day was calculated by dividing the total earnings for the 4 weeks of the induction period by 20 days. Daily earnings in the induction period were highly correlated with the percentage of minutes attended in the induction period ($r = 0.924, p < .001; P = 0.917, p < .001$), and the results of the multiple regression analysis were similar to the analyses with the percentage of minutes attended. As a result, the data for daily earnings in the induction period as a predictor will not be presented here.

RESULTS

A total of 128 participants were enrolled in the workplace; however, 17 of those participants did not continue attending long enough to be exposed to the cocaine abstinence contingency. All participants who reached the cocaine abstinence requirement ($n = 111$) were included in the analysis to examine the effects of the cocaine abstinence reinforcement contingency on cocaine abstinence. Participants who reached the opiate and cocaine abstinence requirement ($n = 62$) were included in the analysis to examine the effects of the opiate and cocaine abstinence contingency. Table 1 describes the characteristics assessed at intake of the 111 individuals who were exposed at least to the cocaine abstinence contingency. At intake to the study, virtually all participants were living in poverty, most of their income came from welfare benefits, and much of their income was spent purchasing drugs.

Response to the Abstinence Contingencies

Participants showed very high rates of opiate abstinence during and after the induction

Table 1
Demographic Characteristics of Study Participants
Assessed at Intake ($N = 111$)

Age, M (SD), years ^a	43 (6.4)
Female ^a	77.5%
Black/white/other ^a	92.8%/6.3%/0.9%
Married ^a	9.4%
HIV positive ^b	13.5%
High school diploma or GED ^a	56.8%
Usually unemployed past 3 years ^a	73.9%
Past 30 days income, M (SD) ^a	
Employment	\$5.60 (\$25.80)
Unemployment	\$1.40 (\$14.20)
Welfare (DSS)	\$346.90 (\$189.90)
Pension, benefits, or social security	\$32.17 (\$128.24)
Mate, family, friends	\$45.54 (\$128.56)
Illegal	\$9.32 (\$60.70)
Living in poverty ^c	94.5%
Days used, past 30 days, M (SD) ^a	
Cocaine	18.1 (10.6)
Heroin	3.29 (5.77)
\$ spent on drugs, past 30 days, M (SD) ^a	\$294.95 (\$478.53)
Illegal activity for money, past 30 days ^a	1.2
Currently on parole or probation ^a	13.5%
Felony conviction in life ^a	64.9%
Cocaine dependence ^d	99.0%
Opiate dependence ^d	97.3%

^a From the Addiction Severity Index.

^b From the Risk Assessment Battery.

^c Based on U.S. Census Bureau Poverty Thresholds 2003. Weighted average thresholds for one person under 65 years = \$9,573 and 65 years and over = \$8,825. Annual income per participant was calculated by taking the sum of the employment, unemployment, welfare.

^d From the Composite International Diagnostic Interview.

period, which precluded the possibility of demonstrating effects of the abstinence reinforcement contingency on opiate abstinence. Specifically, 96% and 97% of the urine samples were negative for opiates (based on the missing interpolated analysis) during the induction and intervention periods, respectively. This compromised our ability to demonstrate the effects of the employment-based abstinence reinforcement contingencies using a multiple baseline design across drugs. To provide additional evidence of experimental control, we conducted further analyses of the effects on cocaine abstinence. Specifically, in addition to analyzing the effects of cocaine abstinence reinforcement on the total sample of participants exposed to

that contingency, we conducted secondary analyses on two sequential cohorts of participants within the total sample. The two cohorts were defined by the two major waves of recruitment that occurred in the study. The first cohort of participants was recruited from October 8, 2003, to August 11, 2004, and included 67 participants. After a 5-month break in recruitment, the second cohort was recruited from January 10, 2005, to March 8, 2006, and included 44 participants. Data on the effects of the cocaine abstinence reinforcement contingency were examined for the two cohorts to provide a replication of the effect across two different periods of calendar time.

Figure 1 shows the percentage of the participants who provided cocaine-negative urine samples across the entire 6-month period for the two cohorts of participants and for the total sample. Because participants were not exposed to the cocaine contingency until they had been in the study for at least 1 month and had attended the workplace on at least 15 days, they were exposed to the contingency at different time points throughout the 6-month study. The solid line represents the percentage of participants cumulatively exposed to the cocaine abstinence contingency. For each cohort and for the total sample, the percentages of cocaine-negative urine samples were stable during the induction period and increased roughly in proportion to the cumulative percentage of participants exposed to the cocaine abstinence reinforcement contingency. Although the two cohorts of participants showed different levels of cocaine abstinence during the induction period (Cohort 1 had higher rates of cocaine-negative urine samples than Cohort 2), each cohort and the total sample showed similar and large increases in the percentage of cocaine abstinence with the onset of the cocaine abstinence contingency.

Figure 2 shows the percentage of participants abstinent from cocaine for the 12 samples (1 month) prior to and the 12 samples following

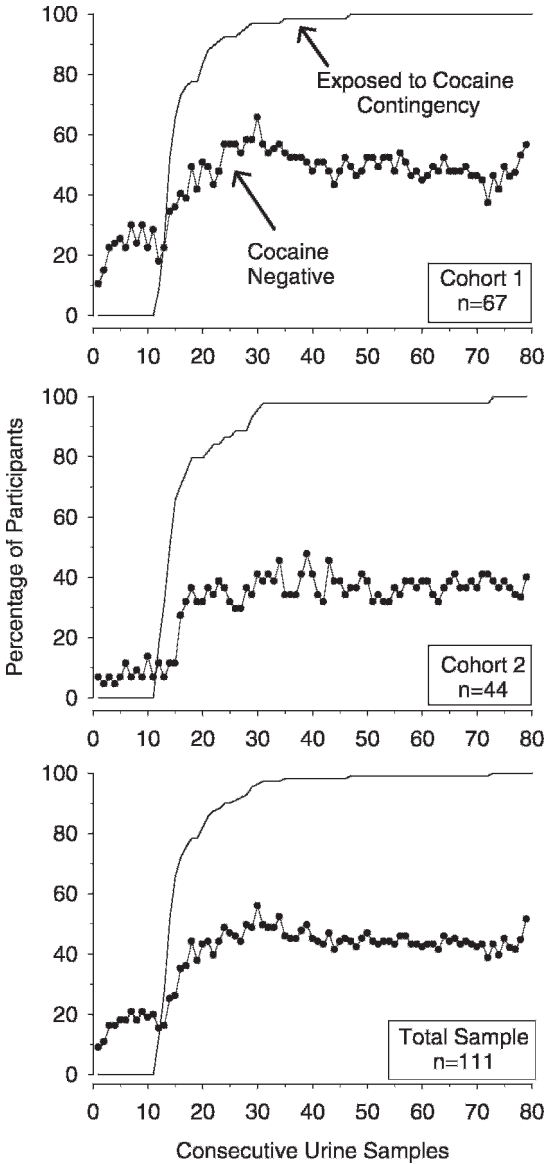


Figure 1. Percentage of cocaine urine samples submitted over the entire 6-month experiment. The filled circles represent the percentage of participants who submitted a cocaine-negative urine sample for each consecutive urine sample for Cohort 1 (top, $n = 67$), Cohort 2 (middle, $n = 44$), and the total sample (bottom, $n = 111$). The solid line in each panel represents the percentage of participants cumulatively exposed to the cocaine abstinence contingency. All missing values were coded as positive.

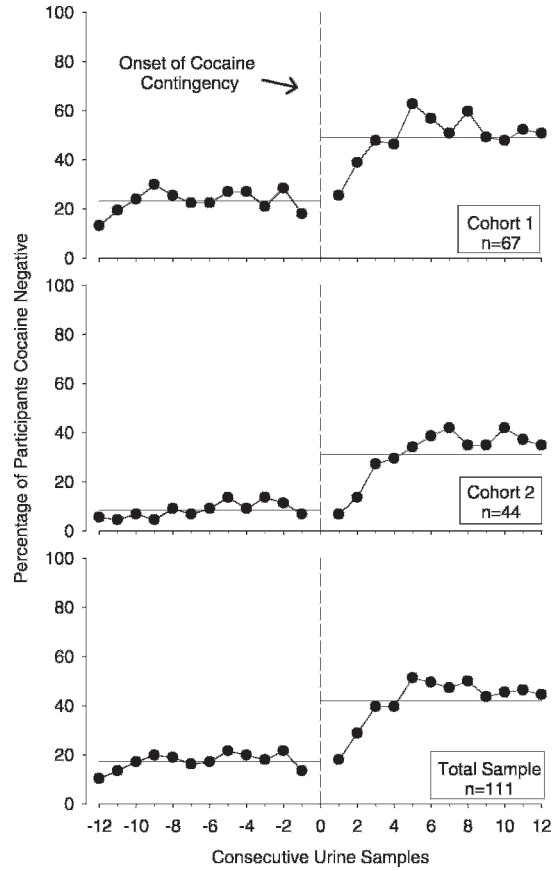


Figure 2. The percentage of participants who submitted cocaine-negative urine samples relative to the onset of the cocaine abstinence contingency. The filled circles represent the percentage of participants from Cohort 1 (top, $n = 67$), Cohort 2 (middle, $n = 44$), and the total sample (bottom, $n = 111$) who submitted a cocaine-negative urine for the 12 samples prior to and the 12 samples following the onset of the cocaine contingency (represented at the 0 point on the x axis). All missing values were coded as positive.

the onset of the cocaine abstinence contingency for the two cohorts and the total sample. For the month prior to the contingency, the percentage of participants that tested negative for cocaine was extremely stable for each cohort and for the total sample. For each cohort and for the total sample, the percentage of participants that provided cocaine-negative urine samples increased abruptly after the introduction of the cocaine abstinence contingency,

Table 2
 Percentage of Urine Samples Negative for Cocaine and Percentage of Samples Missing during the Induction and Intervention Periods

		Induction	Intervention	Wilcoxon signed ranks test	
				Z	p
Cocaine-negative urine samples					
Cohort 1					
	Missing positive	23% (32%)	49% (39%)	5.64	< .001*
	Missing interpolated	27% (37%)	52% (40%)	5.36	< .001*
Cohort 2					
	Missing positive	9% (20%)	31% (34%)	4.20	< .001*
	Missing interpolated	10% (24%)	34% (37%)	4.10	< .001*
Total sample					
	Missing positive	17% (28%)	42% (38%)	7.13	< .001*
	Missing interpolated	20% (34%)	45% (40%)	6.80	< .001*
Missing data					
Cohort 1		26% (21%)	25% (29%)	7.92	.43
Cohort 2		22% (18%)	38% (32%)	2.64	< .001*
Total sample		25% (20%)	30% (31%)	1.17	.24*

Note. Data are reported as means with standard deviations in parentheses.

* Significant based on paired *t* test, *p* ≤ .05.

increased progressively over the first several postcontingency urine samples, and reached a steady level that was well above the level in the induction period. Table 2 shows that participants in Cohort 1, Cohort 2, and the total sample provided significantly more cocaine-negative urine samples during the 4 weeks after (intervention) than before (induction) the onset of the cocaine contingency, based on both Wilcoxon signed ranks tests and paired *t* tests and independent of how missing samples were handled. Table 2 also shows that there were more missing samples in the intervention period after the onset of the cocaine abstinence contingency.

Figure 3 shows the patterns of cocaine-positive, cocaine-negative, and missing urine samples across the entire study for each individual participant. There was considerable variability in the responses of individual participants to the cocaine abstinence contingency. Some participants submitted cocaine-negative samples on the 1st day of the cocaine contingency, and others submitted several positive samples before becoming abstinent. A few participants did not initiate long periods of sustained cocaine abstinence until several

months after the onset of the cocaine abstinence reinforcement contingency. The participants on the lower portion of the graph tended to submit several positive samples under the contingency. Subsequently, many of those participants stopped attending the workplace. Interestingly, a number of individuals never submitted a cocaine-negative sample and continued to submit positive samples intermittently for several months after the initiation of the cocaine abstinence reinforcement contingency. Participants who submitted a higher proportion of cocaine-negative urine samples during induction generally responded well to the contingency. Participants who submitted all positive samples during induction varied in their response to the contingency. Many (e.g., Participant 101) achieved long durations of abstinence during the intervention period, and others never submitted even one negative urine sample.

Variables Associated with Cocaine Treatment Success

Figure 4 shows the relation between the percentages of minutes that participants attended the workplace in the induction period and

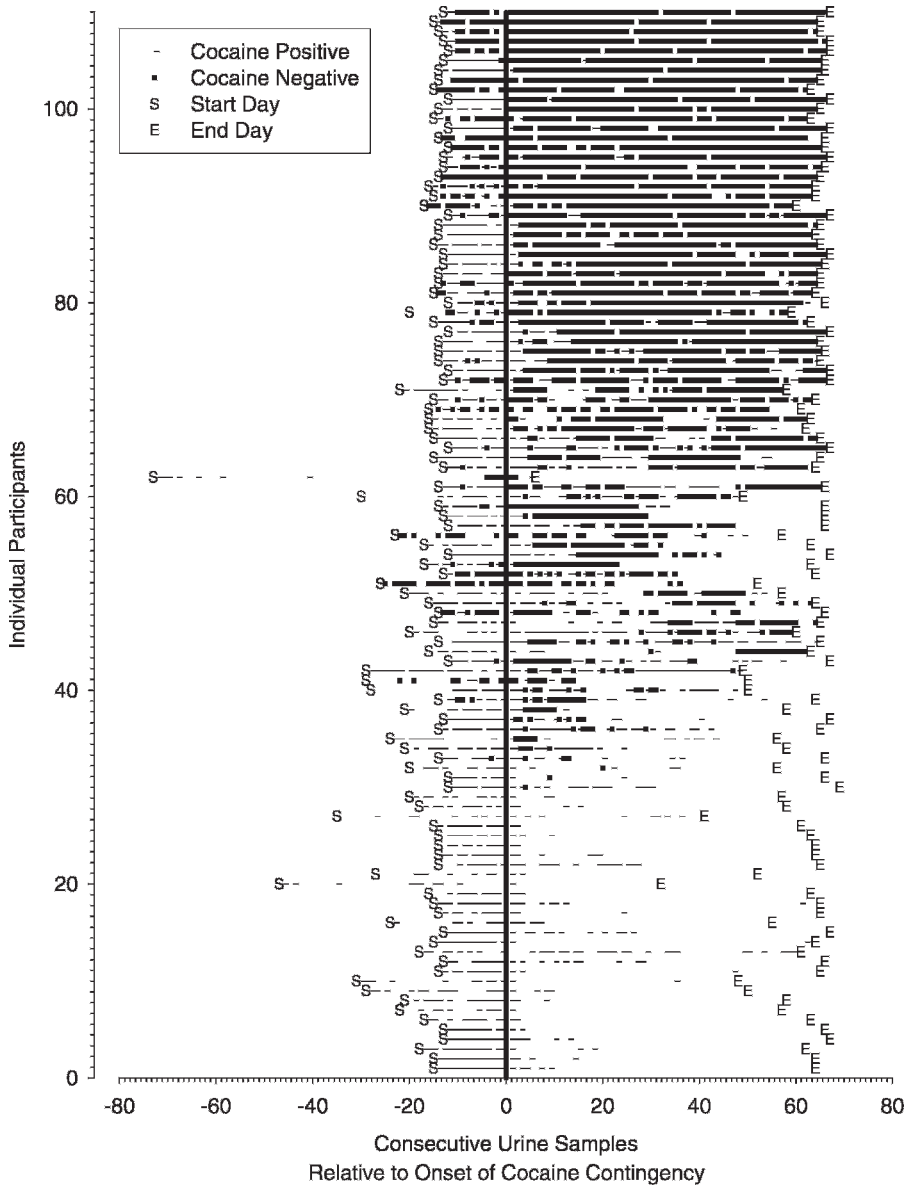


Figure 3. Cocaine urinalysis results of mandatory urine samples relative to the onset of the cocaine abstinence contingency for individual participants. For all participants, the results of 76 to 80 urine samples are shown. Each horizontal line (*y* axis) represents 1 participant across consecutive urine collections of the study. The 0 point on the *x* axis represents the point of onset of the cocaine abstinence contingency; negative values indicate samples that occurred before the onset of the contingency, and positive values indicate samples that were scheduled after the onset of the contingency. Participants were ranked according to the percentage of samples that were cocaine negative during the intervention period. Participants higher on the graph submitted a higher proportion of cocaine-negative urine samples during the intervention. The S on each horizontal line represents the point at which the individual participant began the study, and the E represents the last scheduled day of enrollment for the participant. A blank space on an individual participant line between S and E represents a missed urine sample. A solid box represents a cocaine-negative urine sample, and a thin horizontal line represents a cocaine-positive urine sample.

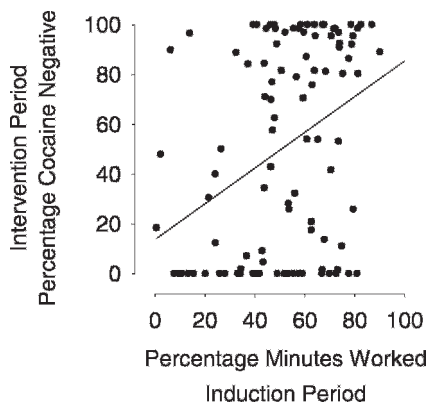


Figure 4. Percentage of minutes worked in the induction period (x axis) correlated with the percentage of cocaine-negative urine samples in the intervention period (y axis). Dots in all panels represent individual participants, and the solid sloping line represents the regression equation for the correlation. The induction period includes the first 20 days of the study, and the intervention period encompasses all days following the onset of the cocaine abstinence contingency. All missing values were interpolated.

the percentages of cocaine-negative urine samples in the intervention period. Pearson's correlation (r) and Spearman's correlation (P) coefficients were calculated for the variables. The percentage of minutes worked ($r = 0.350$, $p < .001$; $P = 0.357$, $p = .002$) and percentage of cocaine-negative urine samples ($r = 0.576$, $p < .001$; $P = 0.658$, $p < .001$) in the induction period were each significantly correlated with the percentage of cocaine-negative urine samples in the intervention period. The percentage of opiate-negative urine samples in the induction period was not significantly correlated with the percentage of cocaine-negative urine samples in the intervention period ($r = 0.131$, $p = .172$; $P = 0.109$, $p = .08$), possibly because of the high rates and relatively little variability in the percentage of opiate-negative urine samples across individuals.

The multiple regression analyses showed that the percentage of minutes that participants attended the workplace, $\beta = 0.556$, $t(107) = 3.67$, $p < .001$, and percentage of cocaine-negative urine samples, $\beta = 0.664$, $t(107) =$

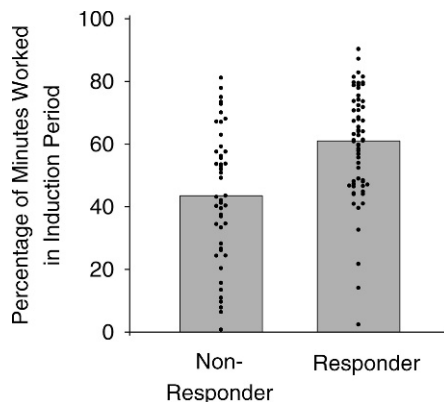


Figure 5. Percentage of minutes worked in the induction period for individual participants grouped according to the responder or nonresponder designation. Dots represent individual participant values, and bars represent group means. Participants were considered responders if they achieved 3 weeks of sustained cocaine abstinence during the intervention period. The induction-period data include data from the first 20 days of the induction period.

7.01 , $p < .001$, in the induction period were each independently associated with the percentage of cocaine-negative urine samples in the intervention period. Using percentage of minutes worked during the induction period, the regression equation was significant ($F_3 = 24.51$, $p < .001$), with an unadjusted $R^2 = 0.407$ and model adjusted $R^2 = 0.391$.

Finally, Figure 5 shows the percentage of minutes that participants attended the workplace in the induction period for participants who did not (nonresponders) and did (responders) achieve 3 weeks of sustained cocaine abstinence during the intervention period. Of the 111 individuals, 64 (57.7%) were coded as responders to the cocaine intervention. The mean ($\pm SD$) percentage of minutes worked during induction was significantly higher for responders ($60.6\% \pm 18.1\%$) than nonresponders ($43.5\% \pm 21.1\%$; Mann-Whitney U test statistic = 792.5, $p < .001$). The mean ($\pm SD$) induction percentage of cocaine-negative urine samples submitted for the responders ($29.9\% \pm 37.1\%$) was higher than the nonresponders ($7.39\% \pm 23.6\%$; Mann-

Whitney *U* test statistic = 845.0, $p < .001$). The mean induction percentage of opiate-negative urine samples submitted was not significantly different for responders and non-responders. These data show that participants who attended the workplace for less than about 40% of the maximum possible amount of time in the induction period were very unlikely to achieve sustained cocaine abstinence when exposed to the employment-based abstinence reinforcement intervention.

DISCUSSION

The present study had two main findings. First, this study provides novel evidence that the amount of time that participants attended the workplace during an induction period predicts cocaine abstinence outcomes under the employment-based abstinence reinforcement intervention. Second, this study provides a systematic replication of prior research that employment-based abstinence reinforcement can increase cocaine abstinence.

This study provides novel evidence, not shown in prior research, that the amount of workplace attendance during an induction period, in which participants were allowed to work independent of their urinalysis results, predicted cocaine abstinence outcomes under the employment-based abstinence reinforcement intervention. Although the descriptive nature of this result does not allow for definitive conclusions, these results have potential practical and theoretical implications that are worthy of further investigation.

Practically, these results suggest that employment-based abstinence reinforcement may be most effective if each participant's workplace attendance could be increased before imposing the abstinence reinforcement contingency. Increasing the reinforcement for attendance or changing the types of work to meet each participant's interests are two potential ways to increase attendance. Future studies could inves-

tigate methods to increase attendance. Once methods of increasing workplace attendance are established, then research could be conducted to determine if exposing participants to interventions that increase their attendance could increase their subsequent response to employment-based abstinence reinforcement.

Second, the data from this study, in combination with data from prior studies, suggest that there are some circumstances in which employment-based abstinence reinforcement should not be arranged. Like other abstinence reinforcement interventions, employment-based abstinence reinforcement has not been effective in all participants (e.g., Silverman *et al.*, 2007). Unfortunately, arranging employment-based abstinence reinforcement in nonresponsive individuals can have the undesirable effect of dramatically reducing (Silverman *et al.*, 2007) or even ending (Knealing *et al.*, 2006) their workplace participation. The data from the current study suggest that we may be able to identify some of those potentially nonresponsive individuals prior to arranging the employment-based reinforcement contingency by examining their rates of attendance during an induction period similar to the period used in this study. In the current study, for example, participants who attended less than 40% of the available minutes during the induction period were not likely to achieve sustained cocaine abstinence in the intervention period (Figure 5). Because imposing an employment-based abstinence reinforcement contingency with those individuals may also have the undesirable effect of reducing or ending their workplace participation (e.g., see Figure 3), it may be therapeutically counterproductive to initiate an employment-based abstinence reinforcement contingency for those individuals, at least as long as their induction period attendance remains low.

Theoretically, the data from this study, in combination with basic research on reinforcement (Premack, 1961, 1963), suggest that

induction-period measures of attendance provide a measure of the reinforcing value of the employment for individual participants. Prior research on reinforcement has shown that the amount that an organism engages in a behavior when given relatively unconstrained opportunity is related to the likelihood that access to that behavior will serve as a reinforcer when offered in the context of a reinforcement contingency (Premack, 1961, 1963). This principle has been applied to identify potential reinforcers for children with developmental delays or autism and in other applied contexts (e.g., Hagopian, Rush, Lewin, & Long, 2001), but it has not been used to identify reinforcers that could be used to reinforce drug abstinence in contingency management interventions. Prior studies have attempted to identify potential reinforcers that could be used in contingency management interventions for drug abuse treatment populations; however, those studies have relied exclusively on patient ratings of a range of potential reinforcers presented in reinforcer surveys (Amass, Bickel, Crean, Higgins, & Badger, 1996; Chutuape, Silverman, & Stitzer, 1998; Schmitz, Rhoades, & Grabowski, 1994). Furthermore, those studies did not evaluate whether the results of the reinforcer survey predicted actual reinforcement effects.

The demonstration of the effectiveness of the employment-based abstinence reinforcement intervention is particularly noteworthy because of the population that was the focus of this study. Participants were unemployed adults who were receiving welfare benefits and methadone treatment in community methadone treatment programs. Despite the fact that these individuals were engaged both in community drug abuse treatment and in the social service system, they continued to use cocaine persistently and remained unemployed. This population is in desperate need of effective interventions to address both their persistent cocaine use and their unemployment. Our results provided a systematic replication of results obtained in a

prior study (Silverman et al., 2007) that showed that employment-based abstinence reinforcement could increase cocaine abstinence in a similar population of unemployed injection drug users who also persisted in using cocaine during community methadone treatment. This replication is particularly important because participants in the current study shared characteristics with participants in a prior study by Knealing et al. (2006) that failed to show a clear and significant effect of employment-based abstinence reinforcement. Participants in all three of the recent studies (Knealing et al.; Silverman et al., 2007; and the present study) were enrolled in community methadone treatment programs and used cocaine persistently during methadone treatment. However, like participants in the study by Knealing et al. and unlike the study by Silverman et al., the participants in the current study had to be receiving welfare benefits to be eligible to participate. The failure of employment-based abstinence reinforcement in the study by Knealing et al. could have resulted from the fact that the welfare benefits received by participants in that study provided an alternative source of income, which may have diminished the effectiveness of abstinence reinforcement intervention (see discussion of open and closed economies in Hursh, 1980). The current study shows that employment-based abstinence reinforcement can be effective in adults who are receiving welfare benefits.

The study employed a multiple baseline design across drugs (cocaine and opiates), which was compromised because opiate abstinence was very high in this population and could not be increased further with the employment-based abstinence reinforcement intervention. Nevertheless, two aspects of the study design provided sound evidence that the employment-based abstinence reinforcement intervention did increase cocaine abstinence. First, cocaine abstinence was extremely stable prior to the introduction of the intervention and increased

abruptly (Figures 1, 2, and 3) and significantly (Table 2) after its introduction. Second, because participants were enrolled in the study gradually over a 3-year period (from October, 2003, to March, 2006), the introduction of the abstinence reinforcement contingency was staggered across calendar days, which reduced the chance that some kind of public or unknown event (e.g., a change in drug laws or a change in the availability of cocaine) caused the abrupt change in cocaine abstinence. To provide further evidence that the intervention produced the increase in cocaine abstinence, as opposed to some major uncontrolled and unknown event, we conducted a secondary analysis of two sequential cohorts of participants within the total sample who were enrolled in separate waves of recruitment. Indeed, both cohorts showed very similar results as the total sample. In both cohorts, rates of cocaine abstinence were extremely stable during the period before the introduction of the cocaine abstinence reinforcement contingency and then increased abruptly immediately after the introduction of the contingency (Figures 1 and 2). Even though this is an unorthodox experimental design, given the large numbers of participants in the separate cohorts and the total sample and the remarkably clear results within each cohort and the total sample, it seems clear that the employment-based abstinence reinforcement contingency produced the increase in cocaine abstinence. Alternative explanations would be very strained.

One limitation of this study is that there was no control group for comparison, and as described above, there was an unorthodox within-participant experimental design (i.e., staggered introduction of the abstinence contingency over calendar days across participants and across cohorts of participants). Without a control group or a more rigorous within-participant experimental design, we cannot be certain that the employment-based abstinence reinforcement intervention produced the

change in cocaine abstinence observed in the intervention period. Furthermore, without a control group that was not exposed to the intervention, we cannot know for certain the extent to which the measures of induction-period attendance predicted the outcome of a reinforcement contingency (i.e., employment-based reinforcement of cocaine abstinence) or whether those induction-period measures are simply marker variables that are associated with subsequent higher rates of cocaine abstinence, which would have been evident even if participants had not been exposed to the employment-based abstinence reinforcement contingency. This potential alternative explanation could be examined in a future experiment that conducts similar correlation and multiple regression analyses in participants who, after a similar workplace induction period, are randomly assigned to receive or not to receive exposure to an employment-based abstinence reinforcement contingency. If attendance during the workplace induction period predicts cocaine abstinence only in participants subsequently exposed to an employment-based abstinence reinforcement intervention, that would provide stronger support for the interpretations proposed in this paper.

Virtually all abstinence reinforcement interventions that have been evaluated in controlled studies have shown that not all individuals respond to the interventions. In most or all instances, fixed quantities of the scheduled reinforcers are used, and efforts have not been made to determine the extent to which the reinforcing value of those putative reinforcers varies across individuals. As suggested by the data in the current study, using employment as a reinforcer in an abstinence reinforcement intervention appears to offer a unique opportunity to assess the value of the reinforcer for each individual prior to implementation of the contingency. Such reinforcer assessments may allow employers in therapeutically oriented workplaces to manipulate parameters of the

employment conditions to increase the reinforcing value of employment for each individual and thereby increase the effectiveness of employment-based abstinence reinforcement contingencies for those individuals.

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