A Comparison of Voucher-Delivery Schedules for the Initiation of Cocaine Abstinence

Christopher J. Correia
Auburn University

Stacey C. Sigmon
University of Vermont

Kenneth Silverman, George Bigelow, and Maxine L. Stitzer
Johns Hopkins University School of Medicine

Studies on the use of shaping procedures to increase rates of cocaine abstinence have produced promising results. This study used a Brief Abstinence Test to examine the impact of reinforcement for initial reductions in cocaine use on a subsequent abstinence reinforcement test. Methadone maintenance patients showing evidence of cocaine use were exposed to two 1-week reinforcement conditions. During the shaping condition, participants could earn $50 vouchers on Wednesday and Friday for meeting quantitative urinalysis criteria and a $100 voucher on the following Monday for meeting the more stringent qualitative criteria. During the terminal condition, only the $100 earning opportunity for meeting the qualitative criteria was provided. Participants were more likely to meet the qualitative reinforcement criteria on Wednesday and Friday in the shaping condition than in the terminal condition. However, contrary to the initial hypothesis, the shaping reinforcement condition did not increase rates of abstinence on the final abstinence test.

Keywords: cocaine, contingency management, vouchers, reinforcement

Numerous studies have reported high rates of cocaine use (Grella, Anglin, & Wugalter, 1997; Kidor & Stitzer, 1993) and cocaine dependence (Brooner, King, Kidor, Schmidt, & Bigelow, 1997) among methadone maintenance patients. Cocaine use during methadone treatment is associated with poorer clinical outcomes (Dunteman, Condelli, & Fairbank, 1992; Kidor, Stitzer, & Brooner, 1994), and patients who use cocaine increase their risk for HIV infection (Grella, Anglin, & Wugalter, 1995; Meandzija, O’Conner, Fitzgerald, Rounsaville, & Kosten, 1994), unemployment (Zanis, Metzger, & McLellan, 1994), and criminal activity (Hunt, Spunt, Lipton, Goldsmith, & Strug, 1986; Rothbard et al., 1999).

Research has shown that providing monetary-based incentives for cocaine-free urine samples is an effective tool for promoting cocaine abstinence. One of the most successful applications of contingency management is the use of the escalating schedule with a reset contingency, as developed by Higgins and colleagues (Higgins et al., 1991, 1993, 1994). Under the escalating schedule, participants earn monetary-based vouchers in exchange for the submission of cocaine-negative urinalysis specimens. The vouchers can then be exchanged for goods and services available in the community. The magnitude of the vouchers earned by the participant starts with a low initial value and then increases with each successive negative urine. With a reset contingency, the magnitude of the reinforcer returns to the lowest value after the detection of drug use. Thus, the escalating schedule uses a combination of positive and negative reinforcement to promote continuous abstinence. The escalating schedule effectively reduces cocaine use in methadone maintenance patients (Silverman, Chutuape, Bigelow, & Spitzer, 1999; Silverman et al., 1996, 1998). However, as observed by Petry (2000), a significant number of patients often fail to achieve sustained cocaine abstinence, and some fail to earn even a single reinforcer. One possible explanation for the failure to contact a reinforcer may be the low value of the initial voucher commonly used with the escalating schedule, which may negatively impact motivation to initiate abstinence. Another potential explanation may be the requirement that patients achieve complete and sustained cocaine abstinence, as opposed to gradual reductions in cocaine use, before earning their first reinforcer. Thus, while the escalating schedule promotes long-term abstinence in a number of patients, more research is needed to determine whether different schedules may maximize the proportion of patients that respond to the intervention and initiate cocaine abstinence.

Christopher J. Correia, Department of Psychology, Auburn University; Stacey C. Sigmon, Department of Psychiatry, University of Vermont; Kenneth Silverman, George Bigelow, and Maxine L. Stitzer, Department of Psychiatry, Johns Hopkins University School of Medicine.

This study was supported by Research Grant R01 DA12439 and Postdoctoral Training Grant T-32 DA07209, both from the National Institute on Drug Abuse.

Correspondence concerning this article should be addressed to Christopher J. Correia, Department of Psychology, Auburn University, 226 Thach Hall, Auburn, AL 36849. E-mail: correcj@auburn.edu

Copyright 2005 by the American Psychological Association
2005, Vol. 13, No. 3, 253–258 1064-1297/05/$12.00 DOI: 10.1037/1064-1297.13.3.253
Other contingency management programs have been designed specifically to increase rates of abstinence initiation. For example, shaping is an operant procedure designed to establish a target behavior through successive reinforcement of closer approximations (Skinner, 1953). When applied to cocaine use, shaping procedures reinforce reductions in the quantity of cocaine metabolites found in the urine. Shaping procedures have been used to reduce cocaine use among tuberculosis-exposed and pregnant methadone patients (Elk et al., 1993, 1995). A more recent study by Preston and colleagues (Preston, Umbricht, Wong, & Epstein, 2001) used a shaping procedure with a group of cocaine-abusing patients to maximize their exposure to reinforcement. The study took advantage of recently developed quantitative urinalysis testing, which can be used to differentiate between new cocaine use and carryover elevation of the cocaine metabolite benzoylecgonine from previous use (Preston, Silverman, Schuster, & Cone, 1997). As a result, quantitative urinalysis can detect periods of abstinence as short as 2 days as opposed to the 3 to 5 days of abstinence typically required to meet the more stringent qualitative urinalysis abstinence criteria. Quantitative urinalysis can also be used to track reductions in cocaine use, as opposed to only differentiating between use and abstinence. The shaping group in the Preston et al. study was given an opportunity to earn vouchers for achieving modest (25%) reductions in benzoylecgonine levels during a 3-week period prior to initiation of a more stringent contingency based on qualitative testing criteria. The shaping and control groups did not differ in rates of cocaine use detected by qualitative criteria during the first 3 weeks of the study. However, those in the shaping group did receive more exposure to reinforcers on the basis of the less stringent criteria for reinforcement provided by the quantitative urine testing methodology. Subsequently, participants in the shaping group used less cocaine than did those in the standard contingency management group during the last 5 weeks of the intervention. Thus, the results suggest that the opportunity to earn reinforcers for reductions in cocaine use, as detected by quantitative urine testing methods, may better prepare patients for eventual abstinence.

The present study used a relatively new procedure, the Brief Abstinence Test (BAT; Robles et al., 2000), to examine the impact of initial voucher earning opportunities on the outcome of a subsequent abstinence reinforcement test. In this study, cocaine-abusing methadone patients were exposed to two different reinforcement schedules. During the shaping condition, participants could earn $50 vouchers on Wednesday and Friday for meeting quantitative criteria and a $100 voucher on the following Monday for meeting the more stringent qualitative criteria. During the terminal condition, only the $100 earning opportunity for meeting the qualitative criteria was provided. Two hypotheses were tested. First, it was hypothesized that participants would use less cocaine in the shaping condition when they were offered multiple opportunities to earn vouchers for reductions in cocaine use. Second, consistent with previous research on shaping cocaine abstinence, it was hypothesized that the multiple incentives offered during the shaping condition would produce a higher rate of success on the final qualitative abstinence test.

Method

Participants

Study participants were 47 cocaine-using methadone patients enrolled at the Behavioral Pharmacology Research Unit’s methadone treatment program in Baltimore, MD. At the time of clinic entry, all patients were intravenous opioid users with at least 1 year of opioid dependence as assessed by the Structured Clinical Interview for DSM–IV Axis I Disorders (Spitzer, Gibbon, & Williams, 1986). Other treatment entry criteria included being between the ages of 18–55, absence of serious medical and psychiatric disorders, and submission of an opioid- and cocaine-positive urine specimen during the treatment intake and admission procedure. Twenty-seven study participants were new admissions who provided a urine sample that tested positive for cocaine during their clinic intake process. Twenty of the participants were already enrolled in the clinic \( M = 202 \text{ days; range = 34–383 days} \) at the start of their study participation and qualified for the study by providing urinalysis evidence of current cocaine use. Specifically, at least two of the four urines submitted prior to study enrollment tested cocaine positive; urines were routinely collected every Monday, Wednesday, and Friday. New admissions and previously enrolled patients did not differ significantly on demographics or baseline drug use. Therefore, all participants were considered a single group for outcome analyses. Demographic and baseline drug use information is shown in Table 1.

Standard Treatment

Patients received weekly individual counseling and group therapy. Methadone doses were stabilized during the first 3 weeks of the study and were not disclosed to study patients or staff in contact with them. All new patients received an initial methadone dose of 30 mg and received 10-mg daily increases until they

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Study Participant Characteristics ((N = 47))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td>(M)</td>
</tr>
<tr>
<td>Age (mean years (\pm SD))</td>
<td>40.5</td>
</tr>
<tr>
<td>Education (mean years (\pm SD))</td>
<td>11.6</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Men (%)</td>
<td>36.2</td>
</tr>
<tr>
<td>Women (%)</td>
<td>63.8</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>Black (%)</td>
<td>70.2</td>
</tr>
<tr>
<td>White (%)</td>
<td>29.8</td>
</tr>
<tr>
<td>Employment status</td>
<td></td>
</tr>
<tr>
<td>Employed (%; FT \text{ or PT})</td>
<td>10.6</td>
</tr>
<tr>
<td>Unemployed (%)</td>
<td>89.4</td>
</tr>
<tr>
<td>Baseline cocaine use</td>
<td></td>
</tr>
<tr>
<td>Positive samples (%; M \pm SD)</td>
<td>69.1</td>
</tr>
<tr>
<td>Washout cocaine use</td>
<td></td>
</tr>
<tr>
<td>Positive samples (%; M \pm SD)</td>
<td>58.4</td>
</tr>
</tbody>
</table>

Note. FT = full time; PT = part time.

a Baseline urinalysis results are based on samples collected during 4 weeks prior to introduction of voucher conditions.

b Washout urinalysis results are based on samples collected during 2 weeks that separated the voucher conditions.
reached 100 mg. Patients were required to attend the clinic daily for the duration of the study in order to receive their methadone doses. Patients who completed the study were evaluated for admission into other ongoing studies or long-term methadone maintenance treatment. Those patients who were not retained in maintenance treatment were offered a 90-day methadone detoxification. Patients were terminated from treatment and the study if they missed 3 consecutive dosing days.

Urine Collection and Criteria

Urine samples were collected every Monday, Wednesday, and Friday under observation of same-sex technicians and were immediately temperature tested to confirm their validity. A urine specimen measuring above 37.2 °C or below 34.4 °C was deemed invalid, and a second replacement sample was requested. All urine specimens were analyzed using on-site quantitative urinalysis testing. Cocaine metabolite concentrations were measured by an enzyme multiplied immunoassay technique. Serial dilutions were performed on each sample, and the first sample falling within the detection range was used for analysis. The assays were performed with Dade-Behring reagents (Dade-Behring, Cupertino, CA) on a Syva 30R instrument according to the manufacturer’s recommended procedures.

The current study made use of both standard and quantitative urinalysis criteria. According to the standard criteria (i.e., qualitative), abstinence was inferred if the urine specimen contained \( \leq 300 \text{ ng/\mu l} \) of benzoylecgonine. Quantitative urinalysis was also used to detect reductions in cocaine use and/or brief cocaine abstinence that may not result in benzoylecgonine concentrations \( \leq 300 \text{ ng/\mu l} \). According to the quantitative criteria, a reduction in cocaine use was inferred if there was a 50% reduction in urinary benzoylecgonine concentrations over a 2- or 3-day period (Preston et al., 1997).

Experimental Design

The study used a within-subject design in which each participant was exposed to two experimental conditions, a terminal reinforcement condition and a shaping reinforcement condition, in counterbalanced order. Each condition lasted 1 week, and the two conditions were separated by a 2-week washout period. Information about cocaine use during the 2-week washout is presented in Table 1.

Experimental Procedures

Participants received instructions on the Monday of the study weeks in which incentives could be earned. They were told they would earn vouchers if their urine-test results indicated that they abstained from cocaine, and the rules of the relevant incentive condition were explained. During the terminal condition, participants could earn a $100 voucher if they met the qualitative urinalysis testing criteria (i.e., benzoylecgonine concentration \( \leq 300 \text{ ng/\mu l} \)) on the following Monday. During this condition, no further earnings were possible on Wednesday and Friday testing days. During the shaping condition, participants could earn a $50 voucher on Wednesday and Friday of the test week if they met the quantitative urinalysis criteria (i.e., 50% reduction in benzoylecgonine concentration over the preceding 2 days). As in the terminal condition, participants could also earn a $100 voucher on the following Monday if they met the quantitative urinalysis testing criteria for abstinence. Continuous cocaine-negative urinalysis results were not required to earn vouchers during the intermittent condition. Thus, for example, participants could earn the $100 voucher on the second Monday even if they failed to earn either of the two previously available $50 vouchers. Voucher incentives had monetary value that could be exchanged for goods and services in the local community. All incentive purchases were made by staff, and no money was given directly to participants.

Data Analysis

Analyses were performed to understand the impact of the contingent reinforcement interventions on rates and patterns of cocaine use and cocaine abstinence. The first hypothesis was that participants would use less cocaine during the test week in the shaping reinforcement condition than in the terminal condition. This hypothesis was tested across groups by comparing the percentage of cocaine-negative urines submitted on each test day by using an analysis of variance (ANOVA) with condition (terminal vs. shaping) and time (study day) as factors, with condition order (terminal first vs. shaping first) entered as covariate separate analyses conducted for qualitative and quantitative urinalysis data. The second hypothesis, that participants exposed to the shaping reinforcement condition would have better outcomes on a brief abstinence test on the final day of the study, was tested by comparing the percentage of participants in each condition who earned the terminal reinforcer (on the final Monday) by submitting a cocaine-negative urine sample under qualitative testing criteria (\( \leq 300 \text{ ng/\mu l} \) benzoylecgonine). Order effects and individual differences in responses to the final brief abstinence test were reviewed.

Results

Cocaine Use During the Test Week

Figure 1 (left panel) shows that a higher percentage of participants submitted urine specimens meeting the qualitative abstinence criteria on Wednesday and Friday in the shaping condition than in the terminal reinforcement condition. An ANOVA revealed significant condition, \( F(1, 46) = 8.15, p < .01 \), and time effects, \( F(3, 138) = 12.15, p < .001 \). The covariate assessing potential order effects was also significant, \( F(1, 45) = 6.23, p < .05 \). Across the two conditions, participants exposed to the shaping condition first submitted more urine samples meeting the qualitative criteria (73%) than those first exposed to the terminal condition (31%). None of the interaction terms was significant.

Quantitative testing provides a more detailed picture of initial cocaine abstinence than does qualitative testing because it can detect brief periods of abstinence that do not result in benzoylecgonine concentrations of \( \leq 300 \text{ ng/\mu l} \). Although Figure 1 (right panel) suggests that there was a trend toward higher rates of cocaine-negative urines, especially on Wednesday, in the shaping condition, the ANOVA on quantitative test results revealed no statistically significant effects for condition or time and no Condition \( \times \) Time interaction. As with the qualitative test, there was an order effect, \( F(1, 45) = 5.33, p < .05 \), with those exposed to the shaping condition first submitting more urine samples meeting the quantitative criteria (83%) over the 2 test weeks than those first exposed to the terminal condition (63%).
Abstinence on Final Test Day

As shown in Figure 1, the percentage of participants meeting the qualitative abstinence criteria on the final Monday (68%) was identical for the shaping condition and the terminal condition. Regarding order effects, participants were more likely to meet the qualitative criteria on the final days of each study of each condition if they were first exposed to the shaping condition (90% vs. 70% for those first exposed to the terminal condition). Examination of individual differences in the outcome of the final abstinence test revealed that 29 participants (62%) were able to earn the $100 reinforcer in both of the experimental conditions (i.e., they earned both $100 reinforcers). Twelve participants (26%) failed to earn the final reinforcement in either condition. Among the 6 participants (13%) who earned the final $100 reinforcer in one condition only, 3 earned reinforcement in the terminal condition and 3 earned reinforcement in the shaping condition.

Discussion

The current study used a brief abstinence model to evaluate experimentally the influence of two different reinforcement schedules on rates of cocaine abstinence among cocaine-dependent methadone maintenance patients. More specifically, the study was designed to determine the impact of initial voucher earning opportunities on the outcome of a subsequent BAT. The shaping reinforcement condition provided opportunities on Wednesday and Friday of Week 1 to earn $50 contingent on meeting a quantitative urinalysis criteria, and a single opportunity on the following Monday to earn $100 for meeting the more stringent qualitative abstinence criteria. A greater percentage of participants met the qualitative abstinence criteria on Wednesday and Friday in the shaping condition than in the terminal reinforcement condition, which offered only a single $100 voucher for meeting the qualitative abstinence criteria on the final Monday. This suggests that the shaping procedure succeeded in promoting earlier initiation of sustained abstinence. However, the shaping reinforcement condition did not increase rates of successfully meeting qualitative abstinence criteria on the final Monday. That is, participants were equally likely to meet the qualitative abstinence criteria on the final day of each condition, independent of the provision of intermediate reinforcers. This may be a testament to the potency of the large $100 reinforcer for motivating abstinence initiation in both groups.

One unexpected finding was the significant order effect of experimental conditions on rates of cocaine use, despite our attempts to control for order effects by counterbalancing and installing a 2-week washout period between conditions. Participants who were first exposed to the shaping condition were more likely to meet abstinence criteria during the test week, and on the final day of the test week, compared with those participants who were first exposed to the terminal condition. While the results may suggest that initial exposure to the shaping condition prepared participants for later success during the terminal condition, it would be premature to draw that conclusion without conducting a study specifically designed to test a hypothesis about presentation of order effects.

Previous studies investigating the impact of prior exposure to reinforcement opportunities on subsequent abstinence rates have produced mixed results. For example, a study by Silverman and colleagues (1998) reported outcomes for methadone patients exposed to a standard escalating schedule, an escalating schedule with up to $600 in start-up bonuses for initial abstinence, or a noncontingent reinforcement control condition. Both the escalating schedule and the escalating schedule with start-up bonuses significantly increased rates of cocaine abstinence. However, contrary to the authors’ original hypothesis, the start-up bonuses did not produce higher rates of cocaine abstinence than did the standard escalating schedule. In contrast, the shaping study conducted by Preston and colleagues (2001) suggested that the opportunity to earn reinforcers for reductions in cocaine use, as detected by quantitative urine testing methods, may better prepare patients for eventual longer term abstinence.

The Preston et al. (2001) study differs from the current study in at least two important ways. First, while each of our two conditions lasted 1 week, the shaping procedure used in the Preston et al. study lasted 3 weeks, and the total study duration was 8 weeks. Thus, it may be that the schedules used in the current study did not provide sufficient opportunities for intermediate reinforcement prior to the final abstinence test to produce meaningful effects. Second, the
Preston study used an escalating reinforcement schedule that offered lower magnitude reinforcers ($2.50 for the initial voucher, average daily payment was $9.89). Escalating schedules have been found to produce higher rates of drug abstinence (Roll & Higgins, 2000) and lower rates of drug relapse (Roll, Higgins, & Badger, 1996) than fixed magnitude reinforcement schedules.

The overall pattern of results generated from the current study and previous studies on voucher-delivery schedules (e.g., Kirby, Marlowe, Festinger, Lamb, & Platt, 1998) suggests that more research about the effects of reinforcement schedules on the initiation of cocaine abstinence is warranted. Future research might focus on more specific factors that lead to differential schedule effects, including schedule length, reinforcer magnitude, and participant characteristics.

As in previous BAT studies (Correia et al., 2003; Katz et al., 2002; Robles et al., 2000; Sigmon, Correia, & Stitzer, 2004), the combination of a high-magnitude reinforcer and low-response requirement continues to produce significant reductions in cocaine use among methadone maintenance patients. This consistency of findings across studies using similar methods supports reliability of BAT and its utility for examining variables that may influence the initiation of cocaine abstinence. The results of the current study also suggest that an alternative version of BAT could use qualitative testing, which would make the procedure more practical for widespread use in research or clinical practice.

The current study has several limitations. First, a substantial number of participants (n = 13; 28%) qualified for the study but did not use any cocaine during either reinforcement condition. While this is a good outcome from a clinical perspective, their continuous abstinence limits our ability to detect differential effects of study conditions. However, the lack of schedule-induced differences on the final abstinence test is not likely to change with a larger sample. Second, there may be a ceiling on the number of participants that are able to initiate abstinence within the parameters of a BAT procedure. It may also be difficult for a shaping procedure to improve upon a terminal condition using a high-magnitude reinforcer, given the high rate of response to the single $100 earning opportunity. While this shows the potency of the high-magnitude reinforcer, schedules using lower magnitude incentives might actually provide a more sensitive test of intermediate reinforcement conditions. Third, as previously mentioned, the length of the interventions may not be ideal for investigating the initiation of cocaine abstinence, especially given the binge patterns typically seen with cocaine use. Fourth, participants in the current study, and in all previous BAT studies, were methadone maintenance patients. It remains uncertain if the results of these studies would generalize to other cocaine-abusing populations.

References


