The Utility of Operant Conditioning to Address Poverty and Drug Addiction

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Abstract

Poverty is associated with poor health. This article reviews research on proximal and distal operant interventions to address drug addiction and poverty. Proximal interventions promote health behaviors directly. Abstinence reinforcement, a common proximal intervention for the treatment of drug addiction, can be effective. Manipulating familiar parameters of operant conditioning can improve the effectiveness of abstinence reinforcement. Increasing reinforcement magnitude can increase the proportion of individuals that respond to abstinence reinforcement, arranging long-term exposure to abstinence reinforcement can prevent relapse, and arranging abstinence reinforcement sequentially across drugs can promote abstinence from multiple drugs. Distal interventions reduce risk factors that underlie poor health and may have an indirect beneficial effect on health. In the case of poverty, distal interventions seek to move people out of poverty. The therapeutic workplace includes both proximal and distal interventions to treat drug addiction and poverty. In the therapeutic workplace, participants earn stipends or wages to work. The therapeutic workplace uses employment-based reinforcement in which participants are required to provide drug-free urine samples or take scheduled doses of addiction medications to work and/or maintain maximum pay. The therapeutic workplace has two phases, a training and an employment phase. Special contingencies appear required to promote skill development during the training phase, employment-based reinforcement can promote abstinence from heroin and cocaine and adherence to naltrexone, and the therapeutic workplace can increase employment. Behavior analysts are well-suited to address both poverty and drug addiction using operant interventions like the therapeutic workplace.

Keywords Poverty · Incentives · Operant conditioning · Employment · Therapeutic workplace · Drug addiction

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Over 40 million people in the United States, more than 12% of the population, live in poverty (Semega, Fontenot, & Kollar, 2017) and are at increased risk of poor health (Silverman, Holtyn, & Jarvis, 2016a). Relative to the general population, people who live in poverty have higher rates of a variety of health problems including obesity (Drewnowski & Specter, 2004), cigarette smoking (Hiscock, Bauld, Amos, Fidler, & Munafo, 2012), injection drug use (Armstrong, 2007), heart failure (Hawkins, Jhund, McMurray, & Capewell, 2012), stroke (Addo et al., 2012), cancer (Ward et al., 2004), HIV (Oldenburg, Perez-Brumer, & Reisner, 2014), and death (Chetty et al., 2016; Muennig, Fiscella, Tancredi, & Franks, 2010). We might address poverty-related health disparities in two ways (Silverman, Holtyn et al., 2016a): 1) proximal interventions that directly promote health behaviors in low-income populations, and 2) distal anti-poverty interventions that move people out of poverty. Proximal interventions promote health behaviors directly. Abstinence reinforcement, in which patients receive some kind of desirable consequence for providing objective evidence of drug abstinence (e.g., drug-free urine samples), is a common proximal intervention for the treatment of drug addiction. Distal interventions reduce risk factors that underlie poor health and may have an indirect beneficial effect on health. Poverty is a risk factor for poor health. In the case of poverty, distal interventions seek to move people out of poverty. We will review selective research that we have conducted on proximal and distal operant interventions to address heroin and cocaine use in adults who live in poverty. The research that we review illustrates principles that should apply to the treatment of other drug problems and to a variety of health conditions.

Heroin and Cocaine Use in Low-Income Populations

Heroin and cocaine use are concentrated among people who live in poverty. At the broadest level, data from the *2017 National Survey on Drug Use and Health* (Center for Behavioral Health Statistics & Quality, 2018) show that use of cocaine and opioids in the United States is highest among people who live in poverty and decreases as income level increases. Injection drug use (Armstrong, 2007) increases as the poverty level increases; opioid overdoses (Rosenthal, Bol, & Gabello, 2016) and heroin and cocaine use (Williams & Latkin, 2007) are concentrated in neighborhoods with the highest rates of poverty. Unemployment is concentrated among people who use illicit drugs (Henkel, 2011), but interventions to promote employment in illicit drug users have had limited success (Magura, Staines, Blankertz, & Madison, 2004; Svikiel et al., 2012).

Proximal Interventions to Promote Heroin and Cocaine Abstinence

Abstinence Reinforcement

The principles of operant conditioning have been applied to the treatment of drug addiction in a variety of ways, but they have been applied most effectively in

procedures that arrange for the relatively direct reinforcement of drug abstinence. Abstinence reinforcement interventions are rooted in basic principles of operant conditioning (Silverman, DeFulio, & Everly, 2011a). Under abstinence reinforcement procedures, patients receive some kind of desirable consequence for providing objective evidence of drug abstinence (Bigelow, Stitzer, Griffiths, & Liebson, 1981). One abstinence reinforcement intervention that has shown considerable effectiveness is the voucher-based abstinence reinforcement intervention (Higgins et al., 1991). Under that intervention, patients received monetary vouchers for providing cocaine-free urine samples. Several meta-analyses and reviews suggest that the monetary-based abstinence reinforcement interventions are among the most effective psychosocial treatments for drug addiction (Benishek et al., 2014; Davis et al., 2016; Dutra et al., 2008; Lussier, Heil, Mongeon, Badger, & Higgins, 2006; Pilling, Strang, Gerada, & NICE, 2007; Silverman, Kaminski, Higgins, and Brady, 2011b).

Effectiveness of voucher-based abstinence reinforcement The effectiveness of voucher-based abstinence reinforcement is illustrated by a study with methadone patients who injected drugs and continued to use cocaine during methadone treatment (Silverman, Higgins, Brooner, Montoya, Cone, Schuster, and Preston, 1996b). After a 5-week baseline period, participants in that study were randomly assigned to an abstinence reinforcement group or to a yoked control group. Participants in the abstinence reinforcement group could earn up to \$1,155 in vouchers for providing cocaine-free urine samples every Monday, Wednesday, and Friday for 12 weeks. The value of the vouchers increased as the number of consecutive cocaine-free urine samples increased. If a participant ever provided a cocaine-positive urine sample or failed to provide a scheduled sample, the participant did not receive a voucher and the value of the next voucher earned was reset to the initial low value. Control participants received vouchers on a noncontingent basis, yoked in pattern and amount to vouchers received by participants in the abstinence reinforcement group. The voucher-based abstinence reinforcement intervention significantly increased the longest duration of cocaine abstinence that participants achieved during the 12-week period in which the voucher intervention was in effect. Half of the participants in the abstinence reinforcement group achieved between 7 and 12 weeks of sustained cocaine abstinence, but only one participant in the control group achieved more than 2 weeks of sustained abstinence. This study showed clearly that the voucher-based abstinence reinforcement intervention was effective in promoting cocaine abstinence in about half of the participants.

Other studies have shown that voucher-based abstinence reinforcement interventions can promote abstinence from opiates (Robles, Stitzer, Strain, Bigelow, & Silverman, 2002; Silverman, Wong, Higgins, Brooner, Montoya, Contoreggi, et al., 1996c) and cocaine (Robles et al., 2000; Silverman et al., 1998; Silverman, Robles, Mudric, Bigelow, & Stitzer, 2004) among injection drug users enrolled in methadone treatment, as well as in other populations (Benishek et al., 2014; Castells et al., 2009; Davis et al., 2016; Silverman et al., 2011b).

Some studies show that reinforcing abstinence from cocaine increases abstinence from both cocaine and opiates (Silverman et al., 1998; Silverman et al., 2004) and that reinforcing abstinence from opiates increases abstinence from both opiates and cocaine (Robles et al., 2002). Although we do not always see the indirect beneficial effect on

drugs that are not directly targeted by the reinforcement contingency, we have not seen an increase or substitution of drug use not targeted by the abstinence reinforcement contingency.

Parameters of abstinence-reinforcement interventions Not all participants respond to abstinence-reinforcement interventions (Silverman et al., 2011b). The study by Silverman, Higgins et al., 1996b) described above provides a good illustration of this point. About half of the participants in that study appeared unresponsive to the intervention, and their results looked similar to the results of the control participants. The effectiveness of reinforcement in initiating drug abstinence depends largely on familiar parameters of reinforcement that are critical to the effectiveness of any reinforcement contingency like magnitude and delay of reinforcement (Davis et al., 2016; Lussier et al., 2006). We know most about reinforcement magnitude and it is clear that the effectiveness of abstinence reinforcement interventions increases as the magnitude increases (Dallery, Silverman, Chutuape, Bigelow, & Stitzer, 2001; Higgins et al., 2007; Silverman, Chutuape, Bigelow, & Stitzer, 1999; Stitzer & Bigelow, 1984).

The effects of increasing the magnitude of abstinence reinforcement are illustrated in a study that focused on a group of treatment-refractory injection drug users who continued to use cocaine during methadone treatment (Silverman et al., 1999). After a 5-week baseline period, participants in that study were exposed to a 12-week voucher intervention in which they could earn up to \$1,155 in vouchers over the 12-week period for providing cocaine-free urine samples similar to the study described above. This study only included individuals who failed to initiate sustained cocaine abstinence when exposed to the voucher intervention. During the baseline period, those participants provided very low rates of cocaine-negative urine samples and they continued to provide very low rates of cocaine-negative urine samples throughout the 12-week voucher period.

Using a within-subject crossover design, participants were then exposed to a zero-, low-, and high-magnitude voucher intervention in counterbalanced order. During the zero-magnitude condition participants received vouchers that had no monetary value; during the low-magnitude condition, they could earn up to \$380 in vouchers for providing cocaine-free urine samples; and during the high-magnitude condition they could earn up to \$3,400 in vouchers for providing cocaine-free urine samples. Each condition was in effect for 9 weeks and followed by a 4-week washout period. The high-magnitude condition was effective in increasing cocaine abstinence: significantly more urine samples provided by participants were cocaine negative in the high-magnitude condition (46%) than in the zero- (8%) and low- (14%) magnitude conditions.

Preventing relapse after abstinence reinforcement ends As with other substance abuse treatments (McLellan, Lewis, O'Brien, & Kleber, 2000), we have known for years that many patients relapse to drug use after the abstinence-reinforcement contingencies are discontinued (Heil et al., 2008; Miller, Hersen, Eisler, & Watts, 1974; Shoptaw et al., 2002; Silverman, Wong et al., 1996c; Silverman, Higgins et al., 1996b; Silverman et al., 1998; Silverman et al., 1999; Stitzer & Bigelow, 1982). The propensity to relapse after an abstinence-reinforcement intervention is illustrated in the study described above (Silverman et al., 1999). That study used a within-subject, crossover design, which was only possible because participants relapsed to cocaine use during the 4-week washout periods that followed each 9-week abstinence reinforcement condition.

Although it would be ideal if we could apply a treatment for drug addiction that has irreversible effects, that may not be possible. The treatment for drug addiction appears similar to many medical conditions that return after treatment is discontinued (McLellan et al., 2000). Methadone treatment is an excellent example. Methadone is a highly effective treatment for opioid addiction, but relapse to opioid use is common when the methadone dose is gradually reduced (Sees et al., 2000).

Different approaches have been used to prevent relapse after an abstinence reinforcement intervention is discontinued, including combining abstinence reinforcement with different counseling approaches like cognitive behavior relapse prevention therapy, but none of the approaches have been effective (Silverman, Kaminski et al., 2011b). We expect that the best way to prevent partial or full relapse to drug use is to use abstinence reinforcement as a maintenance intervention (Silverman et al., 2002).

We conducted a study to see if we could maintain cocaine abstinence in methadone patients by maintaining the abstinence reinforcement intervention over an extended period of time. The key feature of this study is that we maintained the voucher-based abstinence reinforcement intervention for a full year. Injection drug users enrolled in methadone treatment who continued to use cocaine during the first 10 weeks of methadone treatment were randomly assigned to a Usual Care Control group, a Take-Home Only group, or a Take-Home & Voucher group. Urine samples were collected and tested for opiates and cocaine every Monday, Wednesday, and Friday. Both Take-Home groups earned take-home methadone doses (i.e., if a participant received a take-home methadone dose, that participant did not have to attend the methadone clinic to receive the next daily methadone dose) for providing urine samples negative for both opiates and cocaine. The Take-Home & Voucher group also earned monetary vouchers for providing cocaine-free urine samples over the entire year. In total, they could earn up to about \$5,800 in vouchers over the year. Cocaine abstinence in this group was significantly higher than the other two groups, and that effect was maintained throughout the year-long study. The potential to use abstinence reinforcement as a maintenance intervention was also demonstrated by Kirby et al. (2013), who randomly assigned cocaine-dependent adults in methadone treatment to a standard or extended duration of voucher-based abstinence reinforcement.

Distal Interventions to Reduce Poverty

Research examining the utility of operant conditioning in moving people out of poverty has been limited. Two types of research have been conducted in this area: Large-scale anti-poverty interventions that use incentives to increase education and employment in low-income adults (Holtyn, Jarvis, & Silverman, 2017); and the systematic application of incentives to promote skill development in unemployed adults with long histories of drug addiction (Silverman, Holtyn, and Subramaniam, 2018).

The Use of Incentives in Large-Scale Anti-Poverty Interventions

Large-scale anti-poverty programs were introduced in the United States in the 1960s, but had only minimal effects on poverty (Bitler & Karoly, 2015). In the 1990s, various

governments in the United States evaluated the role of financial incentives in large-scale anti-poverty programs to promote education and employment in welfare populations (Berlin, 2007; Holtyn et al., 2017). Although some incentive programs increased participation in educational programs or increased employment, they did not consistently promote employment or increase earnings.

Opportunity NYC provides a good example of a large-scale anti-poverty program that employed incentives (Riccio et al., 2013). Under that program, 4,800 families living in high-poverty areas in New York City were randomly assigned to a Family Rewards group or to a Control group. Families in the Family Rewards group could earn financial incentives over 3 years for meeting educational objectives for the children, attending health-care visits, and meeting employment-related goals for the parents. Parents could earn \$300 every 2 months if they worked at least 30 hours per week for 6 out of 8 weeks. Parents could also earn up to \$600 every 2 months if they completed an approved education or job-skills training course and maintained at least 10 hours per week of employment. The Family Rewards program had no effect on parental employment or employment earnings.

In general, the incentive programs used delayed, infrequent, and small reinforcement; they required a substantial amount of responding for reinforcement; they did not ensure that participants possessed the prerequisite skills needed to earn reinforcement; and the incentive systems were not adequately explained to participants (Holtyn et al., 2017). “The incentive-based, antipoverty programs had small or no effects on the target behaviors; they were implemented on large scales from the outset, without systematic development and evaluation of their components; and they did not apply principles of operant conditioning that have been shown to determine the effectiveness of incentive or reinforcement interventions” (Holtyn et al., 2017, p. 9). Although these incentive programs had many inadequacies, they did demonstrate the willingness and capacity of governments to incorporate incentives into their welfare programs (Holtyn et al., 2017).

Systematic Investigations of Incentives for Skill Development in Low-Income Adults

We have been developing and evaluating an employment-based intervention called “the therapeutic workplace,” which has provided an opportunity to conduct systematic studies on the use of incentives to develop skills that people need for employment (Silverman et al., 2018). In the therapeutic workplace, unemployed adults with histories of drug addiction are hired and paid to work. To promote abstinence, employment-based reinforcement is arranged in which participants are required to provide drug-free urine samples or take addiction-treatment medications to work and/or earn maximum pay. Because we have been treating adults who often have few job skills, the therapeutic workplace is divided into two phases through which participants progress sequentially. In Phase 1, each participant’s job is to engage in job skills training to prepare for employment. In Phase 2, participants perform real jobs. Research on Phase 1 of the therapeutic workplace has allowed us to conduct systematic research on the use of incentives to promote the development of skills in unemployed adults, most of whom live in poverty. That research has been reviewed previously (Silverman et al., 2018), but will be discussed briefly here.

Employment interventions for low-income adults and other unemployed populations follow two broad approaches: quick-entry or education-focused. Quick-entry

approaches seek to promote employment immediately. Education-focused interventions seek to develop skills that participants need to obtain gainful employment, in particular to obtain jobs that pay higher wages. We do not know whether education-focused or quick-entry approaches would better alleviate poverty in unemployed adults with histories of drug addiction, but many unemployed drug users lack the educational credentials and skills needed to obtain higher paying jobs. One analysis examined the reading, math, and spelling skills of 559 participants in six therapeutic workplace studies (Holtn, DeFulio, & Silverman, 2015). Only a little more than half of these participants completed high school or had a GED. On average, participants read at between 6th and 7th grade levels, and some participants had very limited reading skills. Their math and spelling skills were similar. To the extent that basic academic skills are important for obtaining and maintaining employment, these data show that many unemployed drug users lack these skills. Other research suggests that therapeutic workplace participants also lack computer knowledge and skills (Sigurdsson, Ring, O'Reilly, & Silverman, 2012).

Attendance in training depends on stipends Our data in the therapeutic workplace shows that many unemployed adults with long histories of drug addiction will attend paid training at high rates. In one analysis (Silverman et al., 2018), 169 therapeutic workplace participants from six different studies who could work and earn maximum pay independent of urinalysis or medication adherence attended the therapeutic workplace at relatively high rates. Across all studies, half of the participants attended about 70% or more of the days. Although that analysis showed that therapeutic workplace participants will attend training reliably, two studies suggest that they will do so only when they are paid for attendance (Koffarnus, Wong, Fingerhood, Sviki, Bigelow, and Silverman, 2013b; Silverman, Chutuape et al., 1996a). In one study (Koffarnus et al., 2011; Koffarnus, Koffarnus, Wong et al., 2013b), homeless adults with histories of alcohol addiction were randomly assigned to one of three groups. Two of the groups are most relevant to the current analysis. One group could work in the therapeutic-workplace training program and earn stipends for attendance and performance on the training programs independent of alcohol use. A second group could work in the therapeutic-workplace training program, but participants in that group did not earn stipends. Participants who earned stipends attended significantly more and progressed significantly farther in the training program than participants who could not earn training stipends.

Training performance depends on stipends Another study showed that participants would attend therapeutic-workplace training reliably when they can earn stipends for attendance, but most participants work on training programs substantially more when they can earn productivity pay for their performance on training programs than when they do not earn productivity pay (Koffarnus, DeFulio, Sigurdsson, and Silverman, 2013a). In that study, participants worked on two keyboarding programs: one focused on teaching participants to type alphanumeric keys using the standard QWERTY keyboard and the other program taught participants to type numeric keys on the number pad. Participants earned a base pay hourly wage while working on both programs. Some participants earned productivity pay for typing performance on the program that taught the standard QWERTY keyboard, but they only earned base pay when working

on the program that taught participants to type numeric keys using the number pad. Other participants earned productivity pay for performance on the number pad program and base pay only while working on the standard QWERTY keyboard program. Total hourly pay was almost identical across programs. Participants worked significantly more and completed more training steps when they could earn stipends for training performance than when they only earned base pay. Another study replicated those results (Subramaniam, Everly, & Silverman, 2017).

Stipend-supported computer-based training These studies show that many of the unemployed adults with long histories of drug addiction that we have served in the therapeutic workplace lack basic academic skills and credentials (e.g., high school diploma or GED). Many participants will attend the therapeutic workplace and progress on training programs, but primarily when they can earn training stipends. Many participants will work and progress on training programs most when some of the training stipends are provided for work on the training programs. These studies suggest that many unemployed adults with histories of drug addiction will work consistently on training programs when at least some incentives are offered for training-program performance. The data on the skill level of participants (Holtyn et al., 2015; Sigurdsson et al., 2012) suggests that these participants may require training on a wide range of skills. Computer-based training may be the most effective and efficient way to provide extensive training to this population. To provide computer-based training with performance incentives, we developed a computer-based training authoring and course presentation system that we have called ATTAIN. The software could be used to teach a wide range of skills. We have used ATTAIN to teach HIV treatment and prevention skills (Getty et al., 2018; Subramaniam et al., 2019), but we hope to use this or similar software to teach a wide range of skills that participants need to become employed using principles we have learned in our prior studies.

The Therapeutic Workplace: An Operant Intervention to Promote Drug Abstinence and Reduce Poverty

The therapeutic workplace was designed to treat poor, unemployed adults with long histories of drug addiction (Silverman, 2004). In addition to potentially serving as an anti-poverty intervention, the therapeutic workplace arranges employment-based reinforcement to promote drug abstinence and adherence to addiction medications. Most of the research we have conducted on the therapeutic workplace has focused on using employment-based reinforcement to promote and maintain abstinence and medication adherence (Silverman et al., 2012).

Drug Abstinence

The therapeutic workplace arranges employment-based reinforcement by requiring that participants provide drug-free urine samples to work and/or maintain maximum pay. Employment-based reinforcement in the therapeutic workplace has been effective in promoting (Silverman, Svikis, Robles, Stitzer, & Bigelow, 2001) and maintaining

(Aklin et al., 2014; Silverman et al., 2002) abstinence from opiates and cocaine among pregnant and postpartum women; promoting abstinence from cocaine in injection drug users enrolled in methadone treatment (Silverman et al., 2007); promoting (Donlin, Knealing, Needham, Wong, & Silverman, 2008) and maintaining (DeFulio, Donlin, Wong, & Silverman, 2009) cocaine abstinence among welfare recipients enrolled in methadone treatment; promoting opiate and cocaine abstinence among out-of-treatment injection drug users (Holtyn, Koffarnus, DeFulio, Sigurdsson, Strain, Schwartz, and Silverman, 2014b; Holtyn, Koffarnus, DeFulio, Sigurdsson, Strain, Schwartz, et al., 2014a); and promoting abstinence from alcohol among homeless, alcohol-dependent adults (Koffarnus et al., 2011). In addition to showing that the therapeutic workplace and employment-based reinforcement can promote drug abstinence, some of these studies have shown that employment alone is not sufficient to promote abstinence: the employment-based abstinence reinforcement contingency is needed (e.g., DeFulio et al., 2009; Silverman et al., 2007).

Initiating drug abstinence A study of unemployed, out-of-treatment, opioid-dependent injection drug users provides a good example of the potential of employment-based reinforcement in the therapeutic workplace to promote abstinence among people living in poverty (Holtyn et al., 2014a, b). Participants in that study were invited to attend the therapeutic workplace and referred to methadone treatment. After 4 weeks in the therapeutic workplace, participants were invited to attend the workplace for 26 weeks where they could work and earn stipends for 4 hours every weekday. After 4 weeks, participants were randomly assigned to a Usual Care Control group, a Methadone Reinforcement group, or a Methadone and Abstinence Reinforcement group. Methadone Reinforcement and Methadone and Abstinence Reinforcement participants were required to enroll and remain in methadone treatment to continue attending the therapeutic workplace and to maintain maximum pay. Methadone and Abstinence Reinforcement participants were also required to provide urine samples negative for opiates and cocaine to maintain maximum pay. Methadone and Abstinence Reinforcement participants were exposed to the abstinence requirements sequentially. At first, participants were only required to enroll and continue in methadone treatment to work and maintain maximum pay. After a participant was enrolled in methadone treatment for 3 weeks, that participant was required to provide opiate-negative urine samples to maintain maximum pay. After that participant provided opiate-negative urine samples for 3 consecutive weeks, that participant was required to provide urine samples negative for opiates and cocaine to maintain maximum pay.

Almost all participants in that study (98%) lived in poverty. Figure 1 shows the percentage of urine samples negative for opiates (solid points) and cocaine (open points) for participants in the Methadone and Abstinence Reinforcement group for the nine urine samples before and after the onset of the opiate (top) and cocaine (bottom) employment-based abstinence-reinforcement contingencies. This figure shows clearly that participants maintained stable rates of opiate-negative urine samples prior to the onset of the opiate abstinence reinforcement contingency, but the rates of opiate-negative urine samples increased abruptly after the onset of that contingency. Likewise, participants maintained stable rates of cocaine-negative urine samples prior to the onset of the cocaine abstinence reinforcement contingency, but the rates of cocaine-negative urine samples increased abruptly after the onset of that contingency.

Fig. 1 The percentage of urine samples negative for opiates (filled circles) and cocaine (unfilled circles) relative to the onset of the opiate (top graph) and cocaine (bottom graph) contingency. Urinalysis results for the nine samples prior to and the nine samples following the onset of the contingency (represented at the 0 point on the x-axis) are shown. All missing values were coded as positive. From “Employment-Based Abstinence Reinforcement Promotes Opiate and Cocaine Abstinence in Out-of-Treatment Injection Drug Users” by A. F. Holtyn et al., 2014b, *Journal of Applied Behavior Analysis*, 47, 689. Copyright by Society for the Experimental Analysis of Behavior. Reprinted with permission

Maintaining drug abstinence Another study illustrates both the potential and limitations of employment-based reinforcement in the therapeutic workplace to address the long-term problem of drug addiction (DeFulio et al., 2009; DeFulio & Silverman, 2011; Donlin et al., 2008). In that study, unemployed adults who used cocaine, were receiving welfare benefits, and were enrolled in methadone treatment were invited to attend Phase 1 of the therapeutic workplace for 6 months. After an induction period, participants were required to provide urine samples negative for drugs (cocaine and opiates) to gain access to the workplace and maintain maximum pay. Participants who achieved

drug abstinence, attended the workplace, and acquired a minimal level of skills were invited to work in our simulated data-entry business (Phase 2) for 1 year and were randomly assigned to an abstinence-contingent employment group or an employment-only group. All participants could work 6 hours every weekday, earned money based on the hours attended and on data-entry performance, and were paid with standard paychecks every 2 weeks. Urine samples were collected from both groups every Monday, Wednesday, and Friday. Employment-only participants could work independent of urinalysis results; abstinence-contingent-employment participants had to provide drug-negative urine samples to work and to maintain maximum pay. The frequency of required drug-testing gradually decreased across the year for participants in the abstinence-contingent employment group as long as they continued to provide drug-negative urine samples and for employment only participants independent of attendance and urinalysis results.

Figure 2 shows cocaine urinalysis results for participants in the two groups before, during, and after participation in the therapeutic workplace (DeFulio & Silverman, 2011). Cocaine abstinence was very low at intake to the study. At the end of Phase 1, 6 months after enrollment, most participants in both groups were abstinent from cocaine. Participants in the two groups worked in the therapeutic workplace at comparable rates during the year in Phase 2, but the abstinence-contingent employment group provided significantly more cocaine-negative urine samples than participants in the employment-only group during the year of employment in the therapeutic workplace business (DeFulio et al., 2009; DeFulio & Silverman, 2011). At the 24- and 30-month assessments conducted after the end of employment in the therapeutic workplace, the two groups provided similar rates of cocaine-negative urine samples (DeFulio & Silverman, 2011). The study showed that employment-based abstinence reinforcement was effective at initiating (Donlin et al., 2008) and maintaining (DeFulio et al., 2009) cocaine abstinence among study participants for as long as a year; however, the effects of

Fig. 2 Percent of cocaine-negative samples collected at intake (Study Month 0), the end of the abstinence initiation and training phase (Study Month 6), during employment (Study Months 12 and 18), and at posttreatment follow-up (Study Months 24 and 30). Missing samples were counted as positive. The asterisk indicates that the groups are significantly different ($p < .05$) based on GEE analysis. From “Employment-Based Abstinence Reinforcement as a Maintenance Intervention for the Treatment of Cocaine Dependence: Post-Intervention Outcomes” by A. DeFulio and Silverman, 2011, *Addiction*. © 2011 The Authors, *Addiction* © 2011 Society for the Study of Addiction. Reprinted with permission

employment-based abstinence reinforcement were not maintained and participants relapsed to cocaine use in the year after the employment-based abstinence-reinforcement contingencies were discontinued (DeFulio & Silverman, 2011).

Medication Adherence

Naltrexone is an opioid antagonist that could be an effective medication treatment for opioid addiction, but few opioid-dependent adults will take it. A few studies have shown that employment-based reinforcement in the therapeutic workplace can promote adherence to naltrexone in opioid-dependent adults (DeFulio et al., 2012; Dunn et al., 2013; Everly et al., 2011). In those studies, opioid-dependent adults who completed an opioid-detoxification program and were inducted onto oral naltrexone were randomly assigned to a Contingency or Prescription group. Contingency participants were required to take scheduled doses of naltrexone to work and earn wages; Prescription participants were offered naltrexone, but not required to take scheduled doses of naltrexone to work. Those studies showed employment-based reinforcement was effective in promoting adherence to oral (Dunn et al., 2013) and extended-release injectable (DeFulio et al., 2012; Everly et al., 2011) naltrexone. Those studies also showed that many participants continued to use opiates even under naltrexone blockade, in particular when they were also using cocaine.

Medication Adherence and Drug Abstinence

We conducted another study to determine if we could eliminate opiate use by combining naltrexone and opiate-abstinence reinforcement (Jarvis et al., 2019) using an extended-release formulation of naltrexone that was approved by the FDA for the treatment of opioid dependence (extended-release naltrexone; XR-NTX). In this study, participants completed an opioid-detoxification program and then began taking oral naltrexone. After taking the maintenance dose of oral naltrexone for a week, participants were randomly assigned to four groups. All groups were invited to attend the workplace for 24 weeks. The groups differed as to whether participants received extended-release naltrexone, opiate-abstinence reinforcement, both, or neither. Participants who were offered extended-release naltrexone were required to take scheduled doses to work and maintain maximum pay.

Figure 3 shows the weekly opiate-urinalysis results for participants in this study. The four panels represent the four groups. Within each panel, each row represents data for a different participant. The 24 boxes within each row represent the 24 consecutive weekly urine samples. Each black box shows an opiate-negative urine sample for a given week. Each orange box shows an opiate-positive urine sample for a given week. The grey shaded areas show when participants were under blockade by extended-release naltrexone. The analyses showed that neither opiate-abstinence reinforcement alone nor extended-release naltrexone alone increased the percentage of opiate-negative urine samples compared to the Usual Care Control group. However, opiate-abstinence reinforcement and extended-release naltrexone combined increased opiate abstinence compared to each of the other three groups. Extended-release naltrexone plus opiate-abstinence reinforcement almost eliminated opiate use, at least while participants were

still attending the workplace. Participants in this group only provided two urine samples that were positive for opiates (far right panel in Figure 3).

Promoting Drug Abstinence and Employment

We have developed models to promote employment and maintain employment-based abstinence reinforcement over time (Silverman, Holtyn et al., 2016b). In all of these models, we expect that participants would be enrolled in Phase 1 first and then progress to Phase 2. We have examined the Social Business Model and we are in the process of examining the Wage Supplement Model. Under the Social Business Model, people in Phase 2 could be hired into a social business, which is a business that exists to address the needs of people who live in poverty. Under this model, Phase 1 graduates are hired in a social business and required to provide drug-free urine samples to maintain their access to the workplace and to maintain maximum pay. Under the Wage Supplement Model, graduates of Phase 1 of the therapeutic workplace are offered abstinence-contingent wage supplements if they obtain and maintain competitive employment in a community business.

The Social Business Model The therapeutic workplace could be created around different types of jobs and businesses. Our initial therapeutic workplace was designed to train and employ participants as data entry operators. To study Phase 2 of the intervention, we established a real data-entry social business called Hopkins Data Services. We evaluated the social business model in a long-term study of pregnant and postpartum women from the Center for Addiction and Pregnancy who were in methadone treatment but continuing to use

Fig. 3 Within each panel, rows of data represent an individual participant. Urinalysis results were determined a priori to be from the 24 once-weekly assessments completed during the intervention period. Urine samples were considered blocked by extended-release naltrexone (XR-NTX) if they were collected within 31 days of receiving XR-NTX. Empty squares represent missed assessments. Data are arranged within each panel from top to bottom (highest to lowest) first by collection rates and then by rates of opiate abstinence. Abbreviation: XR-NTX, extended-release injectable naltrexone. From “The Effects of Extended-Release Injectable Naltrexone and Incentives for Opiate Abstinence in Heroin-Dependent Adults in a Model Therapeutic Workplace: A Randomized Trial” by B. P. Jarvis et al., 2019, *Drug and Alcohol Dependence*. Copyright 2019 Elsevier, Inc. Reprinted with permission

opiates or cocaine during treatment (Aklin et al., 2014). Participants in this study were randomly assigned to a Usual Care Control and Therapeutic Workplace groups. Successful Therapeutic Workplace participants were hired as data entry operators in our data entry business about 3 years after random assignment when the data entry business opened.

Figure 4 shows the percentages of urine samples that were negative for opiates (top) and cocaine (middle) and the percentage of months that participants reported being employed full time (bottom) for participants in the therapeutic workplace and Usual Care Control groups during months 37–48 after random assignment when Therapeutic Workplace participants could be employed in the data entry business. Employees in the data entry business required and appeared responsive to special contingencies to promote punctuality and complete work shifts (Wong, Dillon, Sylvest, and Silverman, 2004a, 2004b). During the fourth year after random assignment when the data entry business was open, Therapeutic Workplace participants provided significantly more urine samples negative for opiates and cocaine, and they reported being employed full-time significantly more than Usual Care Control participants. The data on employment are particularly important because they show that the women in the Usual Care Control group rarely reported any employment at all. Although most of the employment of Therapeutic Workplace participants was in our data entry business, these data show that these women will work at fairly high rates if given the opportunity. The significant differences between the two groups on drug (opiates or cocaine) abstinence and employment were not maintained in the three years after the data entry business closed (Aklin et al., 2014).

The Wage Supplement Model We are currently conducting a study to evaluate the effectiveness of the Wage Supplement Model in promoting and maintaining opiate and cocaine abstinence and employment in unemployed opioid-dependent adults (R01DA037314). In this study, participants are enrolled in Phase 1 of the therapeutic workplace for 3 months. During this time, participants are required to provide urine samples negative for opiates and cocaine to maintain their maximum pay in the therapeutic workplace. Participants who are still attending the therapeutic workplace at the end of 3 months are invited to attend the workplace for an additional year. Half of the participants are assigned an employment specialist who helps the participants get a job using Individual Placement and Support supported employment or IPS (IPS Only). IPS is a supported employment intervention that has been shown effective in promoting employment in people with severe mental illness (Bond, Drake, & Becker, 2012). The other participants also receive IPS, but in addition, they receive abstinence-contingent wage supplements (IPS Plus Abstinence-Contingent Wage Supplements). Under this wage supplement program, participants can receive up to \$8 per hour for working up to 40 hours per week, but they have to continue to provide urine samples at random times that are negative for opiates and cocaine to continue earning \$8 per hour in wage supplements. Before they become employed, they can also receive abstinence-contingent stipends for working with their IPS employment specialist—but only for a maximum of 20 hours per week.

This study is still ongoing, so we only have preliminary results. However, two things are already clear. First, participants in the IPS Only group stop working with the employment specialist almost immediately, whereas participants in the IPS Plus Abstinence-Contingent Wage Supplements group work relatively consistently with the employment specialist (Silverman et al., 2018). Second, although IPS Plus Abstinence-Contingent Wage Supplements participants may achieve more abstinence

and employment than IPS Only participants (a firm answer to this question will have to wait for all the data to be collected and analyzed), it is clear that even IPS Plus Abstinence-Contingent Wage Supplements participants do not work consistently throughout the year and they do not obtain high-paying jobs. More systematic research will be needed to develop the IPS Plus Abstinence-Contingent Wage Supplements intervention so that it can move people out of poverty.

Remaining Challenges to Address Poverty and Drug Addiction

We have much to learn about promoting sustained health in people who live in poverty. Behavior analysts and others have conducted extensive research on the direct reinforcement of health behaviors in low-income populations. We illustrated the potential therapeutic benefits of direct reinforcement in improving the health of low-income populations by reviewing selected research on the treatment of heroin and cocaine addiction. It is clear that we can treat drug addiction in low-income populations by the direct reinforcement of drug abstinence and medication adherence. Direct reinforcement, whether voucher reinforcement or employment-based reinforcement, can promote abstinence from heroin and cocaine and medication adherence among adults who live in poverty. However, direct reinforcement also has limitations. In particular, not all individuals respond to direct reinforcement interventions, many individuals relapse to unhealthy behaviors (e.g., heroin and cocaine use) after the reinforcement contingencies are discontinued, and reinforcing one health behavior does not necessarily increase other health behaviors (e.g., reinforcing cocaine abstinence does not always lead to increases in opiate abstinence). Although we have not resolved these problems, we have made some progress in addressing these limitations: increasing the reinforcement magnitude can increase the proportion of patients that respond to the reinforcement intervention (e.g., Dallery et al., 2001; Silverman et al., 1999); arranging long-term exposure to reinforcement can prevent relapse, at least as long as the abstinence reinforcement contingency is in effect (e.g., DeFulio & Silverman, 2011; Silverman et al., 2004); and arranging reinforcement sequentially across target health behaviors can promote multiple health behaviors (e.g., Holtyn et al., 2014b).

We know much less about reducing poverty. Large-scale anti-poverty programs (Bitler & Karoly, 2015) and the large-scale application of incentives in government-sponsored welfare-to-work programs like Opportunity NYC (Holtyn et al., 2017) in the United States have had limited effects, possibly because these programs have been applied in large populations without systematic scientific development (Holtyn et al., 2017). Nevertheless, these programs illustrate the interest of governments in the United States in addressing poverty and their willingness and capacity to use incentives to address this problem; however, we are far from effectively resolving the problems of unemployment and poverty.

Research on the therapeutic workplace provides a potential approach to develop an effective anti-poverty program for low-income adults (Silverman et al., 2018). We do not know whether quick-entry or education-focused interventions are better for this population, but our therapeutic workplace research shows that many of the low-income, unemployed adults who have long histories of drug addiction lack the skills that they might need to obtain and maintain good paying jobs (Holtyn et al., 2015; Sigurdsson

et al., 2012). Our research has shown that special contingencies may be required and effective to promote training and work behaviors. In particular, our participants will attend our training program, but primarily when offered financial incentives for attendance (Koffarnus et al., 2011; Koffarnus et al., 2013b; Silverman et al., 1996a); they will work on training programs, but primarily when offered some portion of their pay contingent on performance on training programs (Koffarnus et al., 2013a;

◀ **Fig. 4** Percentage of urine samples negative for opiates (top panel) and cocaine (middle panel) and percentage of months that participants reported being employed full-time (bottom panel) when the data entry business, Hopkins Data Services, was opened during the 4th year after intake. Based on 30-day assessments collected when Hopkins Data Services was opened and between months 37 and 48 after treatment entry. Dots represent data for individual participants and lines represent group means. Missing samples were considered positive for opiates (top) and cocaine (middle) and unemployed (bottom). Because the business opened on a fixed dates and participants were enrolled in the study at different dates, participants had different number of 30-day assessments during Year 4 that the business was open. Adapted from “A Therapeutic Workplace for the Long-Term Treatment of Drug Addiction and Unemployment: Eight-Year Outcomes of a Social Business Intervention” by W. M. Aklin et al., 2014, *Journal of Substance Abuse Treatment*, 47, 335. Copyright 2014 Elsevier Inc. Reprinted with permission

Subramaniam et al., 2017); they will work with an employment specialist to look for employment, but primarily when offered stipends for working with the employment specialist (Silverman et al., 2018); and as employees in a therapeutic workplace business, they will arrive to work on time and work complete work shifts, but primarily when special contingencies are arranged to promote punctuality and complete work shifts (Wong et al., 2004a, 2004b). This research has demonstrated both the limitations of the adults who have participated in the therapeutic workplace and potential reinforcement contingencies that could be effective in promoting skill development and employment in this population. These studies suggest that anti-poverty programs may require special and strategic use of reinforcement contingencies to promote skill development, job search behaviors, and employment in low-income, unemployed adults who have long histories of drug addiction. We do not know whether we will need the same kinds of reinforcement contingencies for other groups of people who live in poverty, but research on welfare-to-work programs suggests that these kinds of reinforcement contingencies might be useful (Holtyn et al., 2017).

We have had some limited success in promoting employment. We have promoted employment in our social business that hired therapeutic workplace participants, although some social business employees did not maintain employment after employment in the social business ended (Aklin et al., 2014). Social businesses devoted to employing people who live in poverty may be an effective means of promoting employment in unemployed adults, but they may have limited capacities. We are in the process of evaluating the utility of abstinence-contingent wage supplements in promoting employment. We will not have clear data on employment outcomes of this approach until all the data are collected and analyzed, but it is already clear that abstinence-contingent wage supplements do not promote consistent full-time employment and participants do not consistently obtain high paying jobs.

Moving people out of poverty is considerably more difficult than promoting employment. Moving people out of poverty requires promoting consistent employment in high paying jobs. We suspect that we may achieve that goal best through education-focused interventions that seek to establish needed academic and job skills that might qualify individuals for consistent employment in high paying jobs. If that is true, stipend-supported computer-based training as we have provided using ATTAIn (Getty et al., 2018; Subramaniam et al., 2019) may be a useful approach to establish needed skills.

We do not know whether moving people out of poverty will improve the broad range of health conditions that appear adversely affected by poverty. However, we can only resolve this issue if we develop effective anti-poverty programs so that we can

experimentally move people out of poverty. Developing effective anti-poverty programs might be a means to improve a broad range of poverty-related adverse health conditions. At the very least, developing effective anti-poverty programs could help reduce poverty, which is an important goal in itself.

The therapeutic workplace intervention could serve as a useful program for unemployed adults who have long histories of drug addiction (Silverman, 2004). The therapeutic workplace arranges high-magnitude and long-duration reinforcement for drug abstinence (Silverman et al., 2012) and provides potential ways to maintain exposure to long-term abstinence reinforcement, at least as long as the employment can be maintained (Silverman et al., 2016b). For those in need of academic and job skills training, the therapeutic workplace provides stipend-supported education and job-skills training prior to employment (Silverman et al., 2018). Conducting research on the therapeutic workplace and implementing therapeutic workplace procedures in the society is particularly challenging because neither the substance-abuse treatment nor employment programs include the needed infrastructure. Of course, neither contexts offers substantial financial incentives for drug abstinence, training performance, or work.

Reducing poverty and promoting sustained drug abstinence are substantial challenges that available interventions have not adequately addressed. The research reviewed in this article suggests that operant conditioning could be useful in addressing poverty and drug addiction. As experts in the principles of operant conditioning, behavior analysts are well-suited to address both poverty and drug addiction. However, most behavior analysts have not focused on this area. In fact, research in this area is only just beginning and has been extremely limited to date, particularly research on reducing poverty. Behavior analysts could make enormous contributions to efforts to address poverty and drug addiction, and improve health.

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Compliance with ethical standards

Conflict of Interest The authors declare that they have no conflicts of interest related to the material in this manuscript.

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