

# From Theory to Treatment: Understanding Addiction from an Operant Behavioral Perspective

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**Abstract:** Contingency management (CM) and the community reinforcement approach (CRA) are among the most effective psychosocial treatments for substance use disorders (SUD). This article briefly discusses these interventions and their outcomes, giving special emphasis to the underlying models of human behavior. We describe a theoretical perspective based on operant conditioning, and we review the literature on SUD treatment. The proven efficacy of CM and the CRA strongly supports the dissemination of an operant behavior-based understanding of addiction, as well as the interventions derived from it. Future studies should examine ways in which to make such dissemination more effective.

**Key words:** operant conditioning, substance use disorders, substance abuse treatment, alternative reinforcement, contingency management

## 1. Introduction

Substance use disorder (SUD) is among the three most prevalent psychiatric disorders in the United States (Kessler et al., 2005) and Europe (Wittchen & Jacobi, 2005). Drug abuse and addiction are associated with increased morbidity, as well as with social and occupational dysfunction (American Psychiatric Association, 1994). Despite substantial investment made in developing psychosocial interventions for SUD, few treatments have proven effective (Miller, 2009). Among those treatments for which there is evidence of improved outcomes, behavioral treatments based on alternative reinforcement, such as contingency management (CM) and the community reinforcement approach (CRA), are the most effective (Emmelkamp & Vedel, 2006; Higgins, Silverman, & Heil, 2008; Miller, 2009). The efficacy of these interventions is supported by methodologically rigorous experimental studies carried out in different populations and involving various substance types (Carroll & Onken, 2005). Nevertheless, despite the evidence that behavioral interventions based on alternative reinforcement are effective in treating SUD, the staff of most treatment facilities are unaware of their existence or lack the knowledge to apply them (Silverman, Roll, & Higgins, 2008).

This article represents an effort to increase awareness of these interventions among members of the scientific community and at facilities where SUD is treated.

Here, we present an overview of a theory of addiction based on operant conditioning, giving special

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emphasis to the principles of concurrent reinforcement that have led to the development of alternative interventions for SUD. Outcomes achieved in controlled studies of such reinforcement-based interventions are also considered.

## **2. The Operant Conditioning Perspective on Addiction**

The majority of authors who have examined drug addiction from an evidence-based perspective have portrayed it as a psychiatric disorder in which individuals engage in compulsive, uncontrolled substance use despite the destructive social, economic and health effects that such use has on them, their families and their communities (American Psychiatric Association, 1994). From a behavioral perspective, however, this view is inappropriate (Bigelow, Brooner & Silverman, 1998). Addictive behaviors are inappropriate and aversive, potentially resulting in severe losses to the individual and society. However, such behaviors are not pathological, as most medical guidelines suggest. All addictive behaviors follow the general principles of normal operant behaviors and, consequently, are controlled by the functional relationships among contingencies present in the environment (Bigelow et al., 1998; Silva, Guerra, Gonçalves, & Mijares, 2001). Drug abuse is a behavior that can be considered compulsive, if by that we mean that it is characterized by a high frequency of response (Silva et al., 2001), but not uncontrolled. To the contrary, it is strongly controlled by the immediate reinforcer (the effect of the drug), as well as by other, less immediate, and less-easily observed, conditioned reinforcers (Bigelow et al., 1998). A substantial body of research provides the empirical bases for an operant conditioning perspective on addiction, in which drug use can be considered a normal, learned behavior set along a continuum ranging from limited drug use, with few or no related problems, to excessive drug consumption, accompanied by numerous unwanted and destructive effects (Higgins, Heil & Lussier, 2004).

According to the operant conditioning perspective, drug use, abuse and addiction are learned responses that are sensitive to their own consequences and can therefore be understood as operant behaviors (Cahoon & Crosby, 1972). As an operant behavior, the acquisition and maintenance of drug use is controlled by contingencies of reinforcement (Crowley, 1972). In general, these contingencies include the following: unconditioned immediate positive reinforcement provided by the pharmacological effect of a substance; conditioned positive reinforcement associated with the social environment of drug use; negative reinforcement related to drug withdrawal; and negative reinforcement related to aversive aspects of the environment. In general, one or more of these contingencies are present in drug acquisition and maintenance, and it is likely that all of them are active after addiction has been established.

To fully appreciate the operant behavior theory of addiction, it is helpful to review the experimental evidence that has shaped this perspective on addiction.

### **2.1 Experimental Findings**

It has been demonstrated that laboratory animals will voluntarily consume most<sup>1</sup> substances that are considered addictive in humans (Griffiths, Bigelow, & Henningfield, 1980), as well as learning and maintaining new behaviors in order to achieve continued administration of such substances. Although tolerance and withdrawal responses can affect the frequency and probability of drug use behaviors, voluntary drug use can occur even in their absence (Deneau, Yanagita & Seevers, 1969). In fact, without any prior exposure, animals will

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<sup>1</sup> Hallucinogens, which evoke a different pattern of response from humans than they do from laboratory animals, constitute the only known exception (Griffiths et al., 1980).

voluntarily consume large quantities of addictive substances, even reaching levels that risk overdose (Aigner & Balster 1978). Such findings suggest that, for these species, addictive substances act as unconditioned positive reinforcers (Higgins & Petry, 1999). As an unconditioned positive reinforcer, the drug effect will also lead to the reinforcement of any behavior that gives access to it (Catania, 1979). Hence, drug use-related behaviors are controlled according to their success in providing access to the reinforcer (drug effect) and are therefore considered operant behaviors.

After just a few instances of exposure to an addictive substance, some animals will begin to consume large quantities of that substance (Aigner & Balster, 1978). When a pattern of heavy consumption is established (high frequency of drug use responses) animals will choose to engage in high-frequency responses and abstain from primary reinforcers, such as consumption of food and water, in order to increase access to the addictive substance (Aigner & Balster, 1978; Petry & Heyman, 1995). Experimental studies demonstrate that drug effects are therefore not only powerful reinforcers but can also effectively compete with other major unconditioned and conditioned reinforcers.

Another important finding of laboratory research was the discovery that environmental factors unrelated to substance reinforcers can influence the likelihood and intensity of drug consumption (Higgins & Petry, 1999). Aversive stimuli, such as footshock, social aggression, social isolation or reduced availability of food, liquid or exercise opportunities, all appear to increase the incidence of drug use and heavy drug use among experimental animals (Goeder & Guerin, 1991; Wolffgramm & Heyne, 1995). However, when animals are exposed to alternative sources of non-drug-related reinforcers, the frequency of drug consumption will decrease significantly even among the heavy drug users. This is true regardless of whether or not the alternative reinforcers are contingent on the non-use of drugs (Higgins, 1997; 1996). Levels and frequency of drug use also decline substantially in animals exposed to direct or indirect losses of non-drug-related reinforcers contingent upon drug use. Increases in the intensity, number or difficulty of the responses needed in order to gain access to drugs will also diminish consumption (Bickel et al., 1991, 1995).

The results of laboratory and clinical studies involving human volunteers show that humans are quite similar to other species in terms of their reaction to the unconditioned positive reinforcing effect of drugs. Humans will learn and maintain new responses in order to achieve drug access, arrive at high levels of consumption, increase the frequency of drug use in the presence of aversive environmental stimuli and diminish that frequency if positive reinforcers are present in the environment (Higgins et al., 2008; Higgins & Silverman, 1999; Higgins, 1997, 1996; Vuchinich & Tucker, 1996, 1988). These findings suggest that drug use is controlled by the principles and processes of operant conditioning, in humans and non-human animals alike.

## **2.2 Understanding Drug Use as A Choice**

When we talk about drug abuse or addiction we are usually talking about individuals who give higher priority to drug use than to behaviors that society considers important, such as working, studying and spending time with family (Jaffe, 1990). Therefore, to understand drug use, we must understand the concept of choice and what causes a person to choose drug use over other activities. To discuss choice from a behavioral point of view, we have addressed the concept of concurrent reinforcers.

The growth of theoretical-methodological knowledge in behavioral science has led to a number of discoveries. For example, we now know that the effect that a reinforcer has upon a response is not controlled exclusively by a functional relationship between reinforcer and response but is also dependent on all other

possible reinforcers and responses present in the environmental context — that is to say, the effect of a reinforcer is always context-dependent (Herrnstein, 1961, 1970).

In the natural environment, the presence of more than one reinforcer, as well as the possibility that more than one class of response will produce reinforcers, is the rule rather than the exception. Therefore, understanding how individuals choose between concurrently available responses and reinforcers is critical for understanding behavior in natural settings (Myerson & Hale, 1984). Today, significant methodological and theoretical advances have provided tools for understanding, predicting and controlling behavioral choices in humans and in non-human animals. These include the generalized matching law (Baum, 1974) and delay discounting (Rachlin, Raineri, & Cross, 1991), as well as the behavioral economic principles that describe the substitutive and complementary functions of concurrent reinforcers (DeGrandpre, Bickel, Higgins, & Hughes, 1994).

The generalized matching law maintains that the distribution of responses exhibited by an individual is a function of all contingencies of reinforcement accessible in a given environment (Herrnstein, 1961, 1970). Reinforcement contingencies with relatively higher values will produce proportionally higher rates of response (Garcia-Mijares & Silva, 1999). However, the higher the number of concurrent contingencies of reinforcement present in the environment, the more the effect of a single reinforcer is reduced. The literature suggests that the generalized matching law accurately describes many characteristics of human choice in concurrent schedules of reinforcement in natural settings (McDowell, 1988). However, the law is not sensitive to the different ways in which concurrent reinforcers interact, and, as so, the interpretations it provides are incomplete. Use of the generalized matching law in combination with the behavioral economic principles of substitutes and complements can provide a more complete understanding of such phenomena (Bickel et al., 1995).

Behavioral economics states that concurrently available reinforcers will interact in one of three ways along a continuum (Hursh & Bauman, 1987). At one extreme, available reinforcers can interact as substitutes for one another. In other words, if the response cost (rate, difficulty, intensity and time) needed to obtain a particular reinforcer increases, the emission of this response decreases and the emission of the response that produces a substitute reinforcer increases proportionately. At the other end of the continuum, reinforcers interact as complements; when the response cost of a reinforcer increases and its emission decreases, emission of the response producing the other reinforcer also decreases. In the middle of this continuum, the reinforcers are independent, and a variation in the response cost of one reinforcer has no effect on the pattern of response that produces another reinforcer. Concurrent reinforcers can lie anywhere along this continuum, resulting in larger or smaller mutual effects (Bickel et al., 1995).

The amount of time that elapses between a response and its reinforcer also has a direct effect on the strength of reinforcement. For humans and non-human animals alike, a given reinforcer will have different reinforcing effects depending on the interval between the emission of an operant response and the presentation of the reinforcer. Shorter delays between reinforcer presentation and response translate to stronger the reinforcing effect (Catania, 1979).

Although every individual is sensitive to the delay between response and reinforcer, some individuals will discount the value of a delayed reward more than do others. Such individuals are often labeled impulsive, and their behaviors tend to be controlled by immediate consequences, even when the delayed reward consists of a greater amount of reinforcers (Critchfield & Kollins, 2001). Studies show that opiate-dependent individuals (Madden et al., 1997), heavy alcohol users (Vuchinich & Simpson, 1999), cigarette smokers (Odum, Madden, & Bickel, 2002) and pathological gamblers (Dixon, Marley, & Jacobs, 2003) discount delayed consequences more

severely than do individuals in matched controlled groups.

The findings mentioned above support the theoretical framework of the operant conditioning perspective on addiction, which maintains that the immediate reinforcing effects of substance use are important in controlling and maintaining drug consumption among individuals with SUD.

Understanding behavior in the context of concurrent reinforcers has had an immense impact on the operant-behavioral understanding of addiction as well as on the development of new treatment methods. Previously, punishment or extinction procedures were viewed as the only theoretically sound means of eliminating inappropriate drug-use behavior (Callner, 1975). Along with a better understanding of concurrent reinforcement, two other theory-based intervention for reducing or eliminating inappropriate behaviors emerged: increasing the rate of reinforcement from a concurrently available response; and simply increasing the rate of reinforcement for other available responses (Green & Freed, 1993).

In the case of human drug addiction, it has been demonstrated that the preference for drug-related behaviors in natural settings is influenced by a broader context involving the availability of, and constraints on obtaining, alternative sources of reinforcement (Vuchinich & Tucker, 1996). When access to alternative reinforcers is constrained, drug use increases (Vuchinich & Tucker, 1988). Conversely, it has been shown that the availability of alternative reinforcers can slow or prevent drug use and can suppress withdrawal symptoms (Carroll, 1996). It was in the context of these significant findings that operant behavioral treatments based on alternative reinforcers arose (Higgins & Silverman, 1999).

The observation that individuals with SUD are more sensitive to smaller, immediate reinforcers than to larger consequences that are delayed also an impact on the development of these interventions. Theoretically, interventions for SUD using contingencies that produce small, continuous and immediate reinforcers should be more effective than are interventions that produce large but more sporadic and delayed reinforcers. As will be seen later, this theoretical concept has received steady empirical support from studies of CM, a form of intervention that provides continuous and immediate reinforcing contingencies as a reward for objectively verified abstinence (Higgins et al., 2008).

### **3. Interventions Based on Alternative Reinforcers**

#### **3.1 Community Reinforcement Approach**

The first type of intervention to be developed based on alternative reinforcers was the CRA, which was developed by Hunt & Azrin (1973) as a treatment for severe alcoholism and later extended to other forms of addiction (Abbott, Weller, Delaney, & Moore, 1998; Smith, Meyers, & William, 2001). The CRA theoretical framework considers the presence of drug-related reinforcers and the lack of non-drug alternative reinforcers to be the cause of addiction maintenance (Meyers & Smith, 1995). In keeping with this view, the CRA uses behavioral counseling to alter the balance of reinforcers at work in the lifestyle of a drug user. The counseling employed in the CRA attempts to create a social environment that is able to compete with drug-use reinforcers and seeks to reduce or eliminate conditioned reinforcers (typically social reinforcers) related to drug use (Schottenfeld, Pantaloni, Chawarski, & Pakes, 2000). The CRA attempts to create a more strongly reinforcing environment in an individual's work, recreational and family contexts, for instance through participation in job clubs or social clubs, as well as through coping skills, communication training and behavioral couples therapy (Smith et al., 2001).

Studies evaluating the efficacy of the CRA provide strong evidence that it is more effective than is usual care

in reducing drinking days and problems related to drinking for individuals diagnosed with alcoholism, in inpatient and outpatient settings (Roozen et al., 2004; Smith et al., 2001). A study conducted by Abbott et al. (1998) showed the CRA to be more effective than is usual care in inducing abstinence and reducing heroin use among patients in methadone maintenance program. We found no studies comparing the effectiveness of usual care with that of the CRA alone for cocaine or amphetamine addiction.

In addition to reducing alcohol and heroin use, CRA treatment provides additional positive outcomes for patients, such as better compliance with treatment, more frequent attendance at treatment sessions, fewer days spent unemployed and improvements in social skills (Higgins & Silverman, 1999; Smith et al., 2001).

### **3.2 Contingency Management**

In CM, as in the CRA, the maintenance of addictive behavior is viewed as a product of unconditioned and conditioned reinforcements related to drug use and the lack of non-drug-alternative reinforcers (Bigelow & Silverman, 1999). In this view, the unequal competition between drug and non-drug related reinforcers makes it difficult to change undesirable behaviors that lead to drug reinforcers. Proponents of CM believe that undesirable behaviors can most effectively be modified through punishment or through the introduction of other powerful reinforcers (that can compete with drug-related reinforcers) contingent upon incompatible behaviors, such as verified drug abstinence, medication adherence or treatment compliance (Higgins & Silverman, 1999). Although punishment can be effective, it has several disadvantages (Sidman, 1989) such as higher rates of treatment dropout, induction of aversive emotional states and impairment of interpersonal relations between staff and patients (Kirby, Amass, & McLellan, 1999). In addition, the use of positive reinforcers in CM-based treatments has been shown to produce outcomes that are more favorable than are those obtained through the use of punishment (Stitzer, Iguchi, Kidorf, & Bigelow, 1993).

For CM to be effective, the following components are considered necessary: the use of a strong, competing, alternative reinforcer; the development of an effective schedule of reinforcement; the selection of an appropriate target behavior; objective and systematic verification of target behavior achievement; and immediate reinforcement of target behaviors (Stitzer & Petry, 2006).

The most commonly employed target behavior is (verified) drug abstinence. However, CM treatments have also used reinforced medication compliance (usually for alcohol or heroin antagonists), treatment attendance and achievement of treatment goals (Higgins & Petry, 1999). To reinforce desired behaviors, CM treatments have used a variety of reinforcers, including takeaway methadone privileges, offers of shelter or housing, vouchers and access to work (Higgins et al., 2008).

The most widely used CM interventions is the distribution of voucher-based incentives. Patients receive vouchers that can be exchanged for goods contingent upon verification of drug abstinence (Higgins Silverman, & Heil, 2008; Higgins & Silverman, 1999). Voucher values can increase as continuous abstinence is maintained, as in the case of vouchers that escalate in value with each negative urine sample. Results obtained with CM treatment suggest that this method, used either as a stand-alone outpatient treatment or as part of a multi-element treatment program, is effective in promoting sustained periods of abstinence from a variety of substances (Dutra et al., 2008; Higgins et al., 2008; Prendergast et al., 2006; Stitzer & Petry, 2006). A meta-analysis conducted by Prendergast et al. (2006) showed that, compared with control groups, CM was most effective in inducing sustained abstinence from cocaine only, opiates only and tobacco only, as well as from polydrug use. In a review by Stitzer & Petry (2006), CM was found to be highly effective in promoting sustained abstinence from stimulants,

alcohol and marijuana when applied in psychosocial counseling treatment programs. The authors also found CM to be effective in promoting abstinence from stimulant, opioid, tobacco and polydrug use among individuals in methadone treatment programs.

In another recent meta-analysis, Dutra et al. (2008) suggested that CM, alone or combined with cognitive behavioral therapy, is the most effective treatment for relapse prevention. Two books, *Motivating behavior change among illicit-drug abusers: Research on contingency management interventions* (Higgins & Silverman, 1999) and *Contingency Management in Substance Abuse Treatment* (Higgins et al., 2008) present numerous examples of studies in which CM has proven effective in promoting continued abstinence from alcohol, tobacco, marijuana, methamphetamines, cocaine and opioids, as well as polydrug use. Both books also show that CM is effective in various subpopulations, such as pregnant women, adolescents, homosexuals, bisexuals, war veterans, individuals with HIV, individuals with hepatitis B or C and individuals with severe mental disorders (Higgins et al., 2008; Higgins & Silverman, 1999).

Studies have shown that CM is also effective in enhancing target behaviors, such as medication adherence and treatment compliance, as well as promoting the achievement of treatment goals (Stitzer & Petry, 2006; Higgins et al., 2008). The use of CM can result in the establishment and maintenance of abstinence for a great number of patients; however, as with the majority of treatments for drug addiction, treatment outcomes (abstinence) tend to deteriorate after treatment has ended (Higgins et al., 2008; Prendergast et al., 2006). It is worth noting, however, that the decline in outcomes after treatment discharge never falls below the baseline value (Higgins et al., 2008).

### **3.3 The CRA-CM Combination**

There have been few clinical studies combining CRA and CM interventions for the treatment of substance addiction. However, the results obtained in a cocaine-treatment study that compared the effectiveness of CM alone with that of the CRA-CM combination suggest that combination treatment can increase the number of favorable outcomes (Higgins et al., 2003). In cocaine-dependent patients, combining the CRA with CM appears to produce abstinence more rapidly, leading to better compliance with treatment, greater retention in treatment programs, more days of paid employment, less alcohol intoxication, fewer depressive symptoms and less frequent hospitalization, than does using CM alone. Studies also show that positive outcomes for cocaine abstinence produced during CRA-plus-CM treatments are partially maintained after a 2-year follow up (Higgins et al., 2007).

Additional studies are needed in order to understand the outcomes that can be achieved through CM-plus-CRA interventions in different populations with SUD. However, current knowledge supports the dissemination of these techniques to professionals working in the field of drug abuse treatment.

## **4. Conclusion**

In drug addiction, the theoretical framework of operant behavior has been upheld by a substantial number of methodologically rigorous empirical research studies in humans and non-human animals, in laboratory and clinical settings. The framework maintains that drug use by humans and non-human animals is strongly influenced by the immediate reinforcing effects of a substance and by other, less immediate, social reinforcers (Bigelow et al., 1998). Drug use, abuse and addiction are controlled by their ability to produce certain consequences with a certain probability, and hence are operant behaviors (Cahoon & Crosby, 1972).

There is empirical evidence that treatments based on the CRA, which creates alternative non-drug-related

reinforcers and can extinguish social, conditioned, drug-related reinforcers, are effective in diminishing drug consumption (Smith et al., 2001; Roozen et al., 2004). However, interventions based on CM, in which non-drug alternative reinforcers are presented contingent on a targeted behavior (such as drug abstinence) either as a stand-alone treatment or combined with other psychosocial treatments, are today the most effective interventions for helping patients achieve continuous abstinence and for preventing relapse (Dutra et al., 2008; Higgins et al., 2008).

The few studies that have used CM and the CRA as a combined treatment have obtained promising results, and further studies on this topic should be encouraged.

Finally, the currently available information regarding the efficacy of interventions based on alternative reinforcers strongly supports the dissemination of the operant theory of addiction and the techniques derived from it to the scientific community and to practitioners. Studies of how to promote this dissemination more effectively are also needed.

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