6   Addiction: A Latent Property of the Dynamics of Choice

Gene M. Heyman

Introduction

The Great Lisbon Earthquake of 1755 prompted some of the first attempts to explain a natural disaster scientifically. Eighteenth-century, Enlightenment intellectuals suggested natural causes, such as expanding underground gases and explosive mixtures of chemical deposits and water. However, the quake was also interpreted as yet more evidence for the widely held view that natural disasters were the work of wrathful gods, showing their might and punishing evildoers. Today this debate is largely settled. It is generally accepted that momentous changes in the physical environment can be understood by the same principles that apply to their more moderate counterparts. The theory of plate tectonics explains earthquakes as well as the slow drift of the continents across the globe; the principles of heat exchange help explain hurricanes as well as the moderating diurnal shifts from warm sunny days to cool breezy nights.

In this chapter I take the same natural science approach to addiction that has proven so useful in the physical sciences. The governing idea is that the principles that describe everyday choice also describe addiction. That is, we need not assume disease or even psychological deficits to explain self-destructive drug use. Rather, addiction is a latent property of the rules of choice. These rules usually produce reasonable outcomes, and under some circumstances, they even yield optimal outcomes. However, under certain conditions these same principles lead to excessive, self-destructive outcomes. When one of the options is heroin or cocaine and there is a breakdown of protective social forces, the rules that describe everyday choice predict periods of drug binging alternating with periods of abstinence. The principles also predict why drugs like heroin and cocaine are more likely than other substances to support self-destructive behavior and even details of drug use such as the excuses that often accompany relapse. However, before describing how the logic of choice leads to addiction, a few preliminary matters need to be attended to.

My account of choice and addiction depends on the following preliminaries: a list of criteria for distinguishing between voluntary and involuntary activities, a list of criteria

for distinguishing between addicted and nonaddicted drug users, and an understanding of what researchers have learned about the time course of addiction and the factors that predict whether addiction persists or comes to an end. The definitional issues will be discussed first.

Part I: How to Tell Whether an Activity Is Voluntary and Whether a Drug User Is Addicted

The Voluntary/Involuntary Continuum: A Sampler

The two columns of table 6.1 identify behaviors that differ in the degree to which they are voluntary. The right column identifies activities that are universally recognized as voluntary. The left column identifies activities that to varying degrees are recognized as involuntary. For instance, Patty Hearst claimed that she did not voluntarily rob a bank but was brainwashed by her kidnapers, the Symbionese Liberation Army, and coerced upon threat of death. The jury didn't believe her, but others did. (Willie Sutton said he robbed banks because ''that's where the money is.'') On the other hand, probably everyone agrees that reflexive, defensive eye blinks—also in the left column—are involuntary. Although the table entries are heterogeneous, they share a common property. To varying degrees they vary in frequency as a function of their consequences. The items in the right column rise and fall with mathematical precision as a function of reward and punishment (e.g., Herrnstein 1970). In contrast, the frequencies of the items in the left column vary little or not at all as a function of their consequences. For instance, imagine that you are offered $10 to not blink in response to a jet of air

Table 6.1

Involuntary activities	Voluntary activities
blink	wink
patellar reflex	kick
blush	put on rouge
food elicited key peck	instrumental key peck
cause an accidental death	murder someone
Patty Hearst's bank robbery	Willie Sutton's bank robbery
thrifty metabolism obesity	overeating obesity
insulin receptor number/affinity plasticity	exercise that leads to changes in insulin receptors
whooping crane mating dance	Times Square dancing chicken dance
vomit up food	search for food
frigid lake induced decrease in the temperature of the liver	jumping into a frigid lake
infant's reflexive smile	adult's social smile
compulsive hand washing	conventional hand washing

aimed at your eye. You can't do it. Double, triple, or quadruple the offer, and you still can't do it. Blinks are reflexive, elicited responses that depend on the stimulus conditions, not their costs and benefits. If there ever were creatures that ruminated over whether they should blink or not as a projectile hurtled toward their eyes, they have long been replaced by hardwired blinkers.

For some of the entries in the left (involuntary) column, it is possible to imagine a scenario in which they actually belong in the right, voluntary column. Taking Patty Hearst at her word ("I was coerced"), it is not out of the question to argue that had she really believed in the rule of law, she would have refused to comply with her kidnappers' commands. She could have stood on principle, even if it meant her own demise. The Southwest Pima—also in the left column—are "thrifty" metabolizers. They efficiently turn food into immediately usable calories, storing the leftover nutrients as fat. This is a useful adaptation for environments frequented by droughts and privation. However, it leads to obesity and diabetes under current conditions of ever present fast-food retail outlets. Nevertheless, the Pima could maintain a reasonable body weight if only they engaged in vigorous exercise several hours a day and went on starvation diets on a regular basis (thereby simulating their old way of life). After all, scores of prisoners have successfully completed hunger strikes to protest inhumane prison conditions.

The question of whether the symptoms of obsessive-compulsive disorder (OCD, also in the left column) are under voluntary control raises different issues. With the help of a therapist, the majority of OCD sufferers can put their compulsions to rest (e.g., Seligman, Walker, and Rosenhan 2001). There are successful pharmacological and behavioral treatments. The behavioral treatments seem to offer more lasting effects in that the methods can continue to work after treatment is over. However, the approach requires much from the patients. They have to confront the conditions that induce the obsessive, anxiety-provoking ideas and feelings. This suggests that those who do not take advantage of treatment are, perhaps, doing so in order to avoid anxiety. Or, put another way, it could be said that they are choosing to remain obsessive. Thus, a number of the entries in the left, involuntary column, are hard to classify.

The underpinnings of volition: Neural and practical The table and commentary suggest three different ways for an activity to be considered involuntary, where involuntary means not susceptible to the influence of behavioral consequences. The first is the degree to which the neural circuits permit reward and punishment to influence the behavior. For example, there are two types of facial expressions: social/elicited and social/instrumental (Rinn 1984). Blind babies smile reflexively in response to social interactions. Later in life, blind children learn to monitor their facial expressions according to social norms, even to the point of disguising their actual emotions (e.g., Cole, Jenkins, and Shott 1989). These different smiles have their proximal underpinnings in

different neural control networks. The emotion-induced expressions rely largely on subcortical pathways, whereas the neural pathway for volitional facial movements includes the motor strip of the cortex, an area of the brain that has many connections with structures that are involved in learning and memory (Rinn 1984). But the table also makes it clear that neural pathways fail to provide a full account of the voluntary/involuntary distinction. There is also a matter of feasibility. It seems legitimate to say that there is no real choice when all but one alternative entails great and immediate harm. For instance, assuming that Patty Hearst's real choices were participating in the robbery or death, it is reasonable to say that she was not a voluntary participant in the robbery. Similarly, it seems unreasonable to say the Pima are choosing to be fat when the only way to be slim is weekly fasts. The OCD case is borderline. I think it is reasonable to say that if recovery from OCD typically depends on treatment, then OCD symptoms should be considered involuntary. That is, if most OCD sufferers require professional clinical help to reduce their compulsions then the compulsions are, by the feasibility standard, involuntary.

Is Addiction Voluntary Drug Use?

Table 6.1 and commentary provide some rules for determining whether drug use in addicts is voluntary. First, are the behaviors that comprise drug seeking and drug consumption susceptible to reward and punishment? Second, are the measures needed to curb drug use in addicts within the boundaries of acceptable behavior? For instance, do everyday rewards and punishments bring drug use to a halt in addicts, or must the consequences entail cruel and inhumane measures? Obviously this issue entails historical and cultural matters so that the answer may vary according to time and place. Third, is treatment usually a necessary component of recovery?

   Simple observation tells us that the activities that comprise drug seeking and drug consumption are ''wired up'' so as to be highly susceptible to the influence of punishment and reward. Hustling for resources, tracking down a dealer, drinking, injecting, and smoking are learned, motivated activities that vary as a function of reward and punishment. There is nothing innate about going into a store to buy liquor or sticking a needle in one's arm. But now consider these activities as means to an intoxicated state. What does it take to deter a heavy drinker from going to the store to buy gin in order to get drunk, or a heavy drug user from sticking a needle in his arm to get high on heroin? Will familiar everyday rewards and punishments do the job, or does it take draconian methods to keep a heroin addict off of heroin? Third, do addicts need professional assistance in order to quit using drugs? If draconian methods and/or professional assistance are prerequisite for quitting then it is reasonable, according to table 6.1 and the supporting discussion, to call addiction involuntary drug use. To answer these questions, we need to look at studies of how addicts behave. But to do this, we need to know how to identify addicts.

The Criteria for Identifying Addicts: The American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders*

The American Psychiatric Association's nosological handbook (1994), titled the *Diagnostic and Statistical Manual of Mental Disorders*, has become the gold standard for identifying psychiatric disorders for clinicians, researchers, and the courts. The manual substitutes the term ''substance dependence'' for ''addiction.'' It begins its description of substance dependence in the following words:

The essential feature of Substance Dependence is a cluster of cognitive, behavioral, and physiological symptoms indicating that the individual continues use of the substance despite significant substance-related problems. There is a pattern of repeated self-administration that usually results in tolerance, withdrawal, and compulsive drug-taking behavior. (176)

Following this passage is a list of seven observable, measurable signs related to drug use, such as tolerance, withdrawal, using more drug than initially intended, or failing to stop using after vowing to do so. If three or more of these symptoms are present in the previous twelve months then the drug user is considered drug dependent. These classification rules have proven reliable and useful. Direct tests of interclinician reliability reveal high correlations (e.g., Spitzer, Forman, and Nee 1979; Spitzer, Williams, and Skodol 1980), and research based on these criteria has led to systematic findings. Those who meet the criteria for addiction reliably differ from those who do not meet the criteria (e.g., Anthony and Helzer 1991). Thus, it is reasonable to use the APA criteria for distinguishing addicts from nonaddicts. Indeed there is no better set of guidelines to go by.

Part II: On the Nature of Addiction

Is Addiction a Chronic, Relapsing Disease?

Scientific research papers, clinical texts, and National Institute on Drug Abuse (NIDA) public service announcements typically describe addiction as a ''chronic, relapsing disease.'' These claims are not without empirical support. In clinic outcome studies, individuals in treatment for addiction often resume drug use within a year or so of the end of treatment or simply never stop using drugs despite treatment (e.g., Hunt, Barnett, and Branch 1971; Robins 1993; Wasserman et al. 1998). However, most individuals who meet the APA criteria for addiction do not enter treatment (Anthony and Helzer 1991). For instance, the most recent large-scale survey of psychiatric health in the United States estimated that only 16% of those who met the lifetime criteria for addiction had been in treatment for one or more days (Stinson, Grant, and Dawson 2005; Stinson et al. 2006). This raises the possibility that the clinic studies are based on an unrepresentative sample of drug users, and as most of what is known about drug use is based on clinic samples, the broader suggestion is that current views of addiction

are based on atypical addicts. In particular, perhaps clinic addicts are less likely to quit using drugs than nonclinic addicts. If so then the current perception that addiction is a chronic disorder is based on an unrepresentative population. This hypothesis can be checked by evaluating the course of addiction in drug users who were identified at random, independent of whether they entered treatment. Four national psychiatric surveys recruited subjects in just this way.

Toward an Unbiased Estimate of Whether Addiction Is a Chronic, Relapsing Disorder
The studies were sponsored and supported by the various federal health institutes devoted to the study and treatment of drug problems (e.g., Kessler et al. 2005a,b; Robins and Regier 1991; Stinson, Grant, and Dawson 2005; Stinson et al. 2006; Warner et al. 1995). The researchers' overarching scientific goal was to obtain valid information about the prevalence of psychiatric disorders and their correlates. Subjects were recruited according to criteria that would produce a sample that approximated the demographic characteristics of the nation. In the first of these surveys groups that were considered more vulnerable to psychiatric problems were oversampled, such as prison populations (e.g., Anthony and Helzer 1991). The interviews followed semistructured, research-based guidelines that were designed to produce DSM diagnoses (e.g., Robins and Regier 1991). Sample sizes varied from about 8,000 (Kessler et al. 2005a,b) to more than 40,000 individuals (Stinson, Grant, and Dawson 2005; Stinson et al. 2006). In a foreword to the summary report of the initial (and precedent-setting) ECA survey, Daniel X. Freedman, longtime editor of the *Archives of American Psychiatry* and a leading spokesman for science-based clinical practice, wrote:

Here then is the soundest fundamental information about the range, extent and variety of psychiatric disorders ever assembled. In psychiatry, no single volume of the twentieth century has such importance and utility not just for the present but for the decades ahead. (Robins and Regier 1991, xxiv)

Freedman's words are important. If the data are, as he says, the "soundest fundamental information" available on the "extent of psychiatric disorders" then they promise to answer the question of whether addiction is a chronic relapsing disorder.

I calculated "remission" rates on the basis of estimated lifetime dependence rates and current dependence rates. For instance, the percentage of addicts in remission at the time of the interview is, by definition, the quotient: (*lifetime addicted—currently addicted)/lifetime addicted*. For the ECA study, which was conducted in the early 1980s, the criterion for current dependence was minimal, just one or more symptoms. For the other three surveys, the criterion for current dependence was the same as for lifetime dependence: three or more symptoms. Figure 6.1 shows the results.

The percentages vary from about 59% to 80%, which is to say the majority of those who ever met the criteria for dependence did not do so at the time of the surveys. The
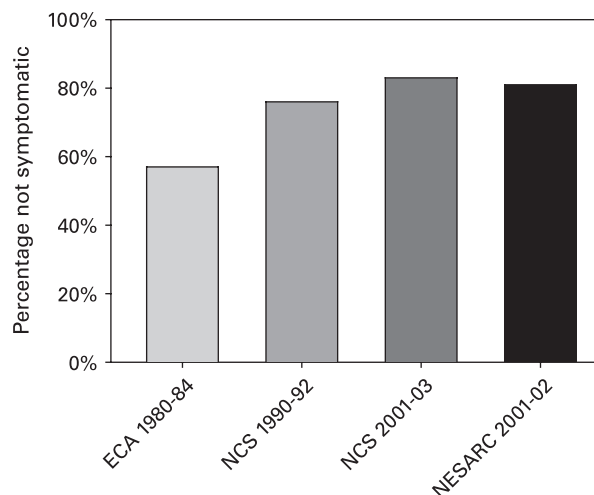
Figure 6.1
Percentage of individuals who met lifetime but not current criteria for drug abuse and dependence in national epidemiological studies.

details are worth some attention, as they are relevant to the question of whether the remission results are reliable.

The ECA had the highest rate of those still addicted (41%). Their criterion was one symptom whereas the other studies used the more standard rule of three or more symptoms. Thus, the results are sensible. When researchers used a more liberal standard for dependence, rates of dependence were higher. Moreover, it is possible to check if the markedly lower ECA remission rate is more a matter of method than fact. The NCS investigators recalculated current dependence rates using the ECA one-symptom rule. If the data are orderly, remission rates should decrease and approximate those of the ECA study. This is exactly what happened. Put another way, if the ECA researchers had used the more standard three-symptom rule, their remission rates would have been more like the other three studies.

However, the main point is that most of those who met lifetime criteria for addiction did not do so at the time of the interview. As the average age in these surveys was about 42 years old, most should still be addicted if addiction were in fact a chronic disease. This is puzzling. How can the most extensive systematic studies fail to support an idea that is so widely accepted? Perhaps the surveys are misleading. On the other hand, the surveys, despite their potential value to the understanding of addiction, go unmentioned in those reports that describe addiction as a chronic relapsing disease. The first step then at sorting this out is to see if in fact the results shown in figure 6.1 could be misleading. I first tested the idea that somehow (see below) the remission rates reflect a
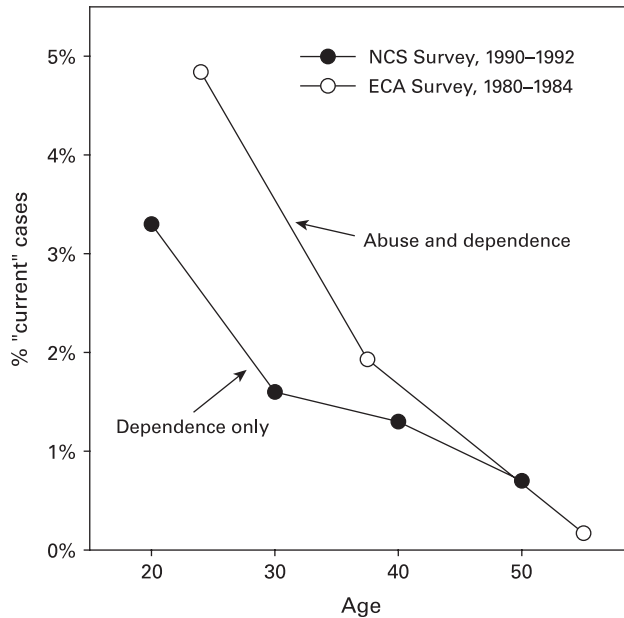
Figure 6.2
Current cases as a function of age.

temporary rather than permanent halt in drug use, and second I evaluated whether drug-specific remission rates would show the expected pattern for all but marijuana. Figures 6.2 and 6.3 test these hypotheses.

Was remission temporary?   Figure 6.2 shows current cases of dependence as a function of age (Anthony and Helzer 1991; Warner et al. 1995). This tests the possibility that the high remission rates really reflect a pattern in which relatively short periods of heavy drug use are followed by relatively long periods of abstinence. Given sufficiently biased "time-on/time-off" ratios, a one-shot interview could, in principle, produce misleading high remission rates. However, if one-year remission typically stretched into a lifetime of remission then the prevalence of current cases of addiction among lifetime addicts should plummet as a function of age. The graph shows two different cohorts. This provides a check for historical trends. For both cohorts, the overall percentage of current cases plummets. By age 30 more than half of those who were addicted at age 20 no longer are using illicit drugs in a clinically significant manner.

Are the high remission rates due to marijuana smokers?   Figure 6.3 tests whether remission rates vary markedly as a function of the type of drug that is abused. Perhaps
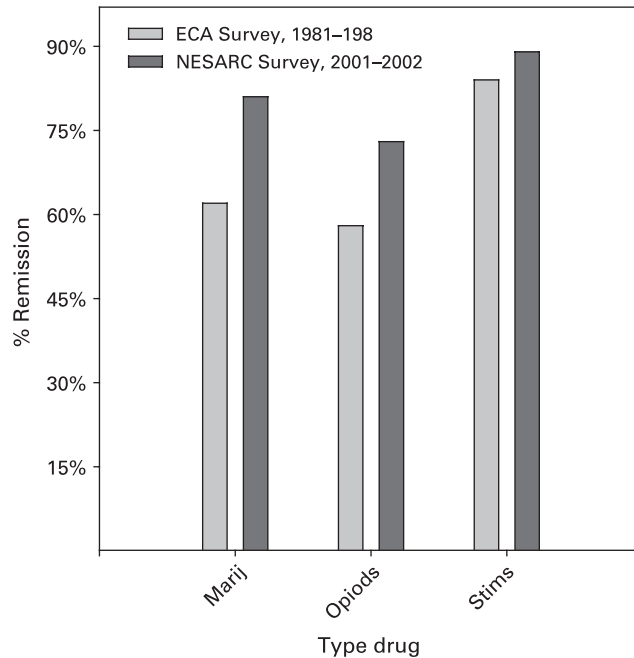
Figure 6.3
Type of drug.

those who met the criteria for marijuana dependence remit, whereas heavy stimulant and opiate users do not, thereby preserving the conventional view of addiction for the "harder" drugs. The figure shows the results for the two surveys that provided data for specific drug groups. These are also the two largest studies (Anthony and Helzer 1991; Stinson, Grant, and Dawson 2005; Stinson et al. 2006). Remission is about the same for marijuana, opiates, and stimulants. However, these and similar surveys show that remission rates are lower and less age-dependent for the two legal addictive drugs, alcohol and cigarettes (e.g., Helzer, Burnam, and McEvoy 1991). This suggests that access to drugs and the correlates of illegality play an important role in the persistence of drug use, even in those who are addicted.

Summary of remission (resolution) results These results do not say that all heavy illicit drug users automatically stop using drugs as they approach the end of their twenties. Clearly a significant number of individuals remain heavy illicit drug users into their forties and beyond. Those who do not quit include the clinic populations that have figured so heavily in the addiction literature, and they may also include the homeless and recidivist criminal offenders. But the vast majority of individuals who

meet the criteria for addiction are neither in jail nor homeless. Thus, the data say that most individuals who meet the criteria for addiction stop using at about age 30 or younger. Importantly, this same result was found in every major scientific population survey conducted over the last thirty years. These studies are models of current best practices. They randomly selected subjects; they used the APA criteria for classifying psychiatric disorders; and they employed interview techniques that have a strong track record for reliability and validity (e.g., Robins and Regier 1991; Spitzer, Forman, and Nee 1979; Spitzer, Williams, and Skodol 1980).

he Typical Correlates of Quitting Illicit Drugs: Draconian Punishments or the Mounting Pressures of Adult Life?

According to the four most recent national surveys of mental health in the United States, most addicts stop using illicit drugs at clinically significant levels by the time they reach their early thirties. As most of those who quit illicit drug use did not seek treatment, a reasonable inference is that the correlates of quitting were related to the various obligations and liabilities of age and maturity. Children, spouses, the need for employment and the various other liabilities and responsibilities that accompany getting older interfere with getting high on a regular basis, particularly if the drug is illegal. This inference suggests the more general point that addiction rates will vary markedly as a function of situational factors. Several lines of evidence support this inference. Biographies, ethnographic studies of drug-using populations, and large-scale surveys all point to everyday events as the correlates of quitting drugs among addicts. Some of the highlights of this large literature include the following.

William Burroughs (1959) vividly likened his state of mind as an addict to that of a rabid dog's state of mind. Just as a rabid dog cannot be tamed into not biting, the drug addict cannot be restrained from taking more drugs:

A dope fiend is a man in total need of dope. Beyond a certain frequency need knows absolutely no limit or control. In the words of total need: "*Wouldn't you?*" Yes you would. You would lie, cheat, inform on your friends, steal, do *anything* to satisfy total need. Because you would be in a state of total sickness, total possession, and not in a position to act in any other way. Dope fiends are sick people who cannot act other than they do. A rabid dog cannot choose but bite. (xxxix)

However, when Burroughs's stipend from home came to an end, he could no longer afford dope. Rather than take a job or turn to crime, he quit opiates. Toneatto and his colleagues (1999) studied the correlates of quitting cocaine in untreated former cocaine addicts. The control group was untreated current cocaine addicts. The two groups did not differ in terms of demographics, pharmacological history, or psychiatric characteristics. Rather, recovery was correlated with cognitive processes. Those who quit were more likely to report that they had spent some time "weighing the pros and cons" of continued cocaine use and had decided in favor of the cons. There were no particular

triggering events for quitting. Rather, it was a matter of everyday life events. Those who quit decided that everyday life would be better without cocaine. (But note this presumes that there are alternatives to cocaine.) Biernacki (1986) reports somewhat similar findings for a population of former heroin users, and Waldorf, Reinarman, and Murphy (1991) obtained comparable results for a population of former San Francisco Bay Area cocaine users.

For most individuals conventional responsibilities and heavy drug use are at odds. Over time the pressures of earning an income and maintaining ties with family and friends overwhelm the benefits that the drugs provide. Of course, this isn't true for everyone. For one thing not everyone has familial or occupational obligations, and as emphasized in the section on choice, drug use itself may have irreparably severed the addict's ties with family and occupation. However, these cases appear to be in the minority so that the survey results support the inference that the weight of the everyday ends up overwhelming drug use for most addicts.

Additional Psychiatric Disorders Distinguish Addicts Who Quit from Those Who Do Not

The issue of what distinguishes addicts who quit from those who do not is little studied, although it has to be one of the most (if not the most) relevant topics for the understanding of addiction and for research-based treatment design. Interestingly, the few available studies that used DSM criteria for identifying addicts (e.g., Carroll and Rounsaville 1992; Rounsaville and Kleber 1985) did not find differences in pharmacological history. Rather the research supports the conclusion that addicts who quit are much less likely to suffer from additional psychiatric disorders than those who do not quit (e.g., Heyman 2001; Regier et al. 1990). This fits in with the data presented so far. If quitting is a matter of choice then quitting depends on the availability of better choices. Psychiatric disorders undermine the ability to find better alternatives to drugs. Thus, it makes sense for the presence of additional psychiatric disorders to show up as the strongest predictor of the persistence of drug use in addicts.

The correlation between clinic addicts and psychiatric disorders is relevant to two points made at the beginning of this chapter regarding widely shared understandings of addiction and research studies that recruit their subjects from clinics. The two observations go hand in hand. Clinic addicts are much less likely to stop using drugs than nonclinic addicts. The comorbidity data help explain why this is the case. When addiction is coupled with additional disorders, it is much harder to quit drugs. The more general message is that whether addiction persists depends on individual differences. For most addicts drug use comes to a halt; for those with additional medical problems it is much less likely to come to a halt. This is sensible, but it is a sensibility that is missing from most of the writing on addiction.

Effective Clinic Treatments Mimic the Natural Recovery Results

The point of this review is not to say that drug addicts do not need help or that drug treatment is of little use. Rather the review shows that the correlates of quitting are often everyday circumstances. This suggests an approach to treatment. Assuming that the right interpretation of the literature is that drug use in addicts persists as a function of its costs and benefits, then treatments that alter the consequences of drug use should prove effective. The inference has no shortage of empirical support.

There are several effective pharmacotherapies for addiction (e.g., Dole and Nyswander 1967; Fiore et al. 1994; Pettinati et al. 2006). These all work by the same principle. They alter receptor dynamics so as to reduce the reward value of the drug, thereby shifting preference to nondrug activities. For example, methadone binds to opiate receptors. This mollifies withdrawal symptoms and attenuates the intensity of heroin's positive hedonic effects, particularly the rush. As a result heroin is less rewarding.

There are several proven behavioral therapies for addiction. These include Alcoholics Anonymous and its various relatives, voucher programs, and treatments that combine random drug testing with financial penalties. Alcoholics Anonymous and voucher programs are best known. They differ in numerous respects but both establish viable alternatives to drug use. In AA it is an alcohol-free social life. The voucher programs establish individually tailored activities, such as hobbies (e.g., Alcoholics Anonymous 1976; Higgins et al. 2000). The penalty programs are less well known but highly effective for addicts who have much to lose if they test positive for drug use. Figure 6.4 summarizes the results of treatment programs for physicians and airplane pilots. The
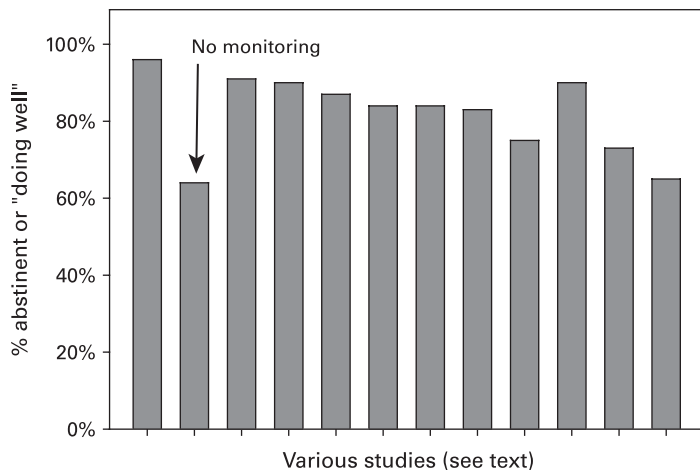

Figure 6.4
Abstinence when evidence of drug use can result in job loss.

common component in these treatment plans was testing for drug use (which in all but one case was random) and the contingency that a positive test could result in the suspension of professional activities. The studies were cited in a book on drug abuse in ''professionals'' (Coombs 1997). The graph shows that success rates averaged about 90% for those programs that included random testing. These results are not in accord with the claim that ''addiction is a chronic relapsing disease,'' but they do fit with the view that addicts voluntarily persist in self-destructive drug use.

Summary of Part II: On the Nature of Addition

The sources in this review have included biographies, ethnographic studies, and large-scale surveys. Each approach tells, in its own way, the same story. Drug use in addicts typically resolves before the user is much past thirty years old, and most often does so without the help of professional intervention. This suggests that the correlates of quitting are largely everyday events—the sort of occurrences that influence most decisions. Studies of recovery from addiction support this inference. As the costs of drug use increase and the benefits decrease, the addict is increasingly likely to quit. However, this finding leads to an apparently nonsensical conclusion. If drug use in addicts remains voluntary then they must have been engaged in voluntary self-destructive behavior. From the point of view that voluntary actions are guided by their consequences, this doesn't make sense. That is, given the definition that voluntary acts are those acts that are subject to their consequences then voluntary acts should extinguish once their costs outweigh their benefits. If addiction is a disorder then its costs must outweigh its benefits. Hence, addiction should never emerge or if it does emerge it should extinguish quickly. It does, as we just saw, extinguish, but not that quickly. Drug use that meets the criteria for addiction is robust and often persists for several years or more. This is puzzling. How can behavior that is maintained by its costs and benefits persist when the costs outweigh the benefits? As the empirical findings seem quite solid, the conceptual problem must hold the key to this riddle. Perhaps a more nuanced account of voluntary action is in order. The next section of this chapter focuses on the nature of voluntary action. The analysis leads to the result that addiction and other forms of excessive consumption are inherent in the principles that guide choice.

Part III: Choice and Addiction

Three Basic Features of Voluntary Behavior

This section presents an analysis of choice and addiction. It is based on three elementary features of voluntary behavior and proceeds in three steps. First the features are combined and displayed in graphs that plot the relationship between preference and the values of the competing options. Second, I trace out the logical implications of

the graphs for choice in general and addiction in particular. Third, I consider a few empirical tests of the analysis as it applies to addiction. These tests focus on behavioral phenomena that are unique to addiction. The results help explain why addicts continue to use drugs when they could improve their lot by cutting back or stopping altogether. More generally, the analysis helps solve a particular version of the general problem of voluntary self-destructive behavior. The model shows that excessive consumption levels are inherent to choice, and that depending on the properties of the commodities at hand, the degree of excess can be great. The three observations are as follows:

Many of the variables that influence choice change in value as a function of having been chosen, or consumed, or simply of time itself   Voluntary activities are goal oriented. The goals have value in the sense that they attract preferences. The values change as a function of the preferences. For instance, behaviors motivated by biological goals, such as satisfying hunger, reduce hunger, those motivated by cognitive concerns, say curiosity, reduce curiosity (at least locally), and similar dynamics apply to other wants, desires, and interests. The relationships need not follow a simple function, and the functions linking consumption and value need not slope downward. Potato chips augment the desire for more potato chips, at least at first, and activities that involve skills and/or knowledge, such as piano playing or birdwatching, often provide greater and greater enjoyment as skill and/or knowledge increase. However, whatever the shape of the function linking choice and goal values, it is usually if not always the case that the values that guide our choices change as a function of the choices we make.

For a series of choices there is more than one way of framing the possible options Given a series of choices between two or more items, it is possible to frame the choice locally or globally. The local frame of reference pits one item against the other. The global frame of reference combines the items so that the choice is between aggregates composed of different proportions of each item. For example, given apples and oranges, we can choose either one or the other, or we can organize the apples and oranges into bundles, and ask "should I commit to a basket of four oranges and six apples or a basket composed of two oranges and eight apples?" In economics textbooks, consumers are described as taking the market basket approach (e.g., Baumol and Blinder 1994; Samuelson 1967), whereas in experiments and in many everyday situations, individuals more often frame their options as items rather than market baskets even though they are in situations that involve a series of choices (e.g., Herrnstein et al. 1993; Heyman and Dunn 2002; Heyman and Tanz 1995; Vaughan 1981; Vaughan and Herrnstein 1987). Although the issue of framing options as items or aggregates has not been much discussed, it can make a great difference in terms of overall preference

and overall benefits. For example, it is possible to arrange choice experiments in which the item-by-item frame of reference yields exclusive preference for one item, whereas the aggregate frame of reference yields exclusive preference for the other item (e.g., Herrnstein et al. 1993; Heyman and Dunn 2002). Material presented in this chapter and elsewhere (Heyman 2003) shows that differences in the nature of the available commodities determine the degree to which frame of reference matters. For instance, when the available options include addictive drugs, frame of reference matters a great deal.

Individuals choose the best option As ''best'' is not independently defined, this may seem a tautological statement. However, it is a useful and commonplace observation. It helps establish a quantitative account of choice and furthers, I believe, our understanding of human behavior.

These three observations were combined to provide an account of everyday choice and of addiction. In keeping with the idea that addiction is a function of general principles of choice and does not require special rules, the everyday situation will be described first. The goal is to introduce the principles and then show that under certain circumstances these principles lead to addiction. The everyday example, eating out at restaurants, is based on an example initially introduced by Herrnstein (1990). More generally, the analysis presented here borrows and builds on Herrnstein and Prelec's (1992) account of addiction and distributed choice.

The Three Observations Predict That Choice Is Governed by Competing Equilibrium States

Figures 6.5 and 6.6 embody the three characteristics of voluntary behavior that were just reviewed. The first shows the relationship between choice and the value of eating out. Assume two restaurants and that the value of each cuisine changes as a function of how frequently it is sampled. For simplicity, the relationship between choice and value is linear. And as a way of depicting satiation and other consumption-dependent declines in value, the lines slope downward. Of course, there is any number of possible shapes to the value functions, but these complexities do not alter the conclusions discussed in this chapter.

On the x-axis of each graph is the number of times each restaurant was selected in the most recent ten meals. (The x-axis is a moving window that is updated with every choice.) The y-axis for the left panel shows the value of each meal when the options are framed as a series of independent choices. The right panel shows the same restaurants for the same consumer (that is, his or her tastes are the same), but now the restaurants are aggregated into competing combinations or market baskets, composed of ten restaurants each (a meal plan). For example, the leftmost point is a 10-Italian/ 0-Chinese meal plan, whereas the midpoint on the x-axis marks off a 5-Italian/

5-Chinese meal plan. Consequently, the y-axis for this graph shows the value of each of eleven possible combinations of Chinese and Italian meals. As noted below these values are obtained by weighting the value of a meal by the number or times it is consumed. The equations are given next. The symbol x stands for the number of times that the diner went to the Chinese restaurant in the last 10 meals, Vc is the value of a Chinese meal given that it had been selected x times in the last 10 meals, Vi is the value of an Italian meal given that it has been selected $10 - x$ times in the last 10 meals, and $Vmealplan$ is the value of meal plan composed of x Chinese meals and $10 - x$ Italian meals:

$$Vc = (10 - 0.9x) \tag{1a}$$

$$Vi = 4.5 - 0.15(10 - x) = 3 + 0.15x \tag{1b}$$

$$Vmealplan = xVc + (10 - x)Vi \tag{2}$$

Summary   In each graph the choice rule is the same: choose the option that has the higher value. However, in the left panel options are framed as individual meals, whereas in the right panel, options are framed as aggregates composed of different proportions of Chinese and Italian meals.

There are two possible equilibria—the world of choice is ambiguous   Figure 6.5 shows that each approach leads to an equilibrium. In the one-meal-at-a-time frame of reference, the diner switches restaurants when the one most recently visited has a
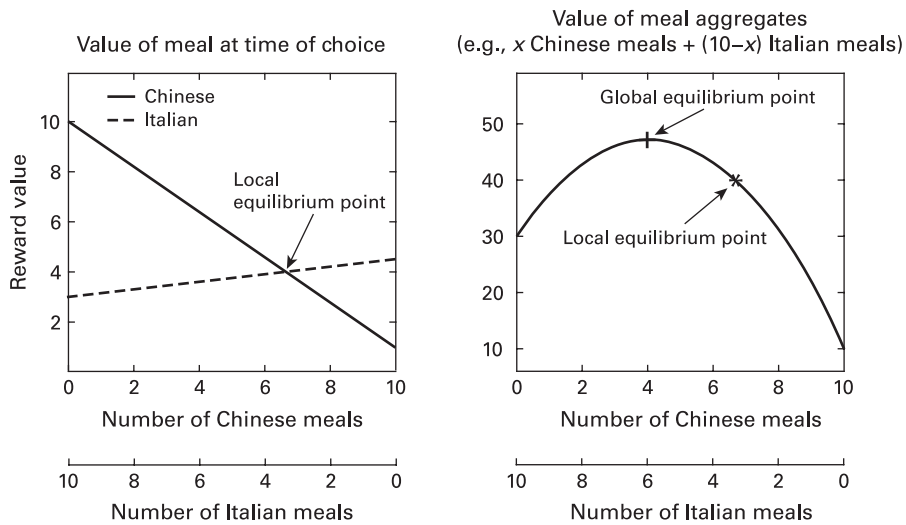

Figure 6.5

lower expected value. This drives overall preference to the point that each restaurant provides an equally good meal. This is where the lines cross. The crossing point is also the distribution of choices predicted by the matching law (Herrnstein 1970), a highly general choice rule (discussed later in this chapter). The dynamic process that yields matching (and the crossing point equilibrium) is referred to as "melioration," a term that captures the idea that individuals choose whatever is best at the moment (e.g., Vaughan 1981, Vaughan and Herrnstein 1987). The meal plan approach also leads to an equilibrium. Its equilibrium is the combination of meals that produces the highest overall value. However, the equilibria for the two approaches are not the same. The meal-at-a-time approach yields an overall preference for Chinese food; the meal-plan approach yields an overall preference for Italian food. Importantly, the differences are not economically neutral. The meal-plan approach earns about 20% more eating pleasure. The increment in value is not due to any change in the restaurants or the consumers' tastes. For example, the equations for the value of a meal are the same in the left and right panel (e.g., $Vc = 10 - 0.9x$ in both panels). Rather, the difference is entirely due to how the consumer frames his or her options. Thus, a shift in the frame of reference can, by itself, lead to changes in overall preference and overall benefits.

The Psychology of Local and Global Bookkeeping
Before applying this analysis to drugs, it would be useful to add some "psychology" to the graph and also address a concern that is likely to have occurred to some readers. Following the dictum that there are "no free lunches," the market basket approach must have a catch. It does not seem plausible to increase earnings by 20% by simply reimagining the structure of the options.

There are costs. First, the market basket approach is considerably more complex than the meal-at-a time approach. For instance, in the restaurant problem the item-by-item equilibrium is a function of simply choosing the best of two options on each trial, whereas the global equilibrium entails eleven possible outcomes, each ten meals long. It would take a great deal of time to sample each ten meal combination and a good deal of record keeping to keep tabs on their respective values. There are, though, various strategies for simplifying the meal-plan comparisons. For example, a quantity used in economics, referred to as marginal utility, leads to the same preference equilibrium as does the best aggregate, but with much less computation. However, this measure remains considerably more complex than the meal-at-a-time approach, and, more important and more interesting, there is evidence that consumers do not track marginal utilities whereas there is evidence that under certain conditions, they do track market baskets or some feature of market baskets (other than marginal utility). For example, in several experiments with college students, Rachlin and his colleagues found that when they arranged the temporal pattern of choice trials to highlight the aggregate structure of a series of choices, the subjects began making choices as predicted by a market

basket frame of references (e.g., Kudadjie-Gyamfi and Rachlin 1996; Rachlin and Siegel 1994). Heyman and Tanz (1995) obtained similar results in a study with pigeons in which the aggregate structure of a series of choices was highlighted by the color of the stimulus lights.

Second, there is a temporal factor that favors the meal-at-a-time frame of reference. The advantages provided by the meal with the higher value arrive right away. In contrast, the advantages that accompany choosing the best series of meals build up slowly, and on occasion, this frame of reference requires taking the meal that is currently not favored. For example, if five of the last ten meals were Chinese, the graph says that on the next night out, the Chinese meal would provide more pleasure. However, the meal plan approach says that there should be six Italian meals for every four Chinese meals. Hence, to get the best eating experience, as measured over a series of meals, diners must occasionally eat at the restaurant that they currently like second best. It is not obvious how this is managed, but however it is, effort must be involved. For example, the opportunity for the better meal is either ignored or the forgone pleasure is reinterpreted as a sign that tomorrow holds the promise of an even better Chinese meal.

An Analysis of Choice Based on Fundamental Features of Voluntary Behavior Does Not Look Like Rational Choice

In economics and behavioral biology and some areas of psychology it is often assumed that individuals are global optimizers—which, in the terms of figure 6.5, is a way of saying that individuals take the meal-plan approach to choice. This is at least partially at odds with the vision of individual choice presented in these pages. The restaurant graph says that it is possible for choice to stabilize at a distribution that is suboptimal; that shifts in the frame of reference can lead to a shift in the distribution of choices (overall preference); and that the contingencies that guide voluntary action are inherently ambiguous. Given choice-dependent changes in value, it is always possible to draw up two ''best'' choice policies. These observations predict that consumers will often experience ambivalence and labile preferences, and end up at a suboptimal local equilibrium, although at each opportunity they made what seemed the best choice. These two visions of individual behavior reflect different origins. The idea that individuals are global optimizers has its roots in the idea that rationality serves as a reasonable foundational assumption for understanding human behavior (e.g., Ferguson and Gould 1975; Samuelson 1967). The analysis presented here combines rationality (''choose what is best'') with elementary features of voluntary action—namely that the values that guide choice are not stable and that in a series of choices, items can be framed as items or as aggregates.

Drug Use as Depicted by the ''Meal-at-a-Time'' and ''Meal-Plan'' Analysis

Figure 6.6 demonstrates that the three principles that generated the restaurant graph can generate a graph that approximates the American Psychiatric Association's (1994)
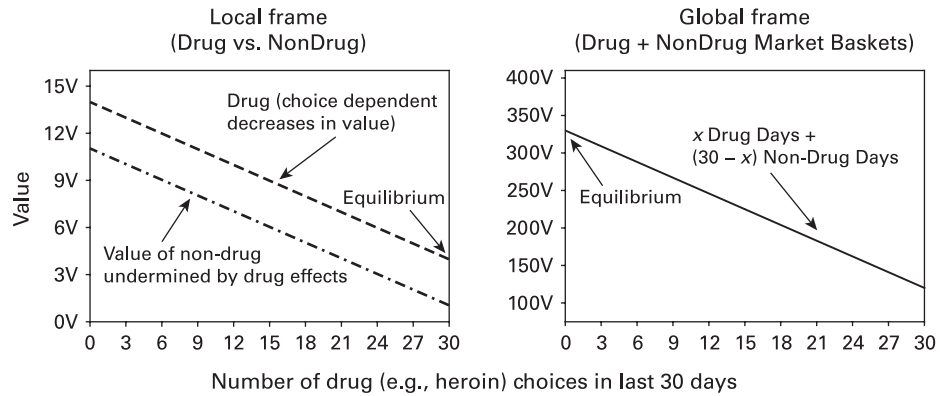
Figure 6.6
Number of drug (e.g., heroin) choices in the last thirty days.

account of addiction. The origins of the graph are experiments on choice. Herrnstein and his colleagues (1993) arranged a two-button choice procedure in which monetary rewards changed in value as a function of the subject's choices. Responses at one button reduced the monetary payoffs at both buttons, whereas responses at the other button increased the monetary payoffs at both buttons. Although they did not relate their study to addiction or other forms of excessive behavior, their contingency, displayed in figure 6.6, provides a close analogy to the verbal account of substance dependence found in the *Diagnostics and Statistical Manual of Mental Disorders*.

Graphing addiction   In figure 6.6, the x-axes measure the number of days an individual took drugs in the last thirty days. Note that as before, each x-axis is a moving window so that it reflects the most recent thirty choices, not necessarily the first thirty opportunities to use the drug. The y-axis in the left panel lists the current values of drug days and nondrug days. These values change as a function of the number of times the drug was used. In the right panel, the y-axis is the value of different combinations of drug days and nondrug days. For example at $x = 10$, the y-axis reveals the value of 10 drug days and 20 nondrug days, and at $x = 11$, the y-axis now shows the value of 11 drug days plus 19 nondrug days, etc. Thus, the idea of the left panel is that the individual chooses what to do one day at a time, whereas the perspective of the right panel is that the individual makes choices according to a 30-day lifestyle: "do I want to be high all the time, some of the time, or none of the time?" From here on out it will be simpler and more appropriate to refer to the "meal-at-a-time" frame of reference as "local bookkeeping" or "day-at-a-time" frame of reference, and the "meal-plan" frame of reference as "global bookkeeping" or "lifestyle" frame of reference. The equations that generated the lines for the two panels are in the endnote.[1]

The left panel shows what the APA account of addiction "looks" like   In the left panel, the top downward-sloping line represents the value of the drug and the bottom downward-sloping line represents the value of various competing nondrug activities. That the line representing the value of the drug is higher says that the drug is preferred (which is essential for a choice-based account of addiction), and that it slopes downward says that tolerance has decreased the value of the drug.

The line that depicts the value of nondrug activities also slopes downward. This is a literal translation of the cardinal feature of the APA account of addiction. Recall that according to the APA, the central feature of addiction is: *that drug use continues despite mounting negative consequences*. The graph assigns these negative consequences to the competing activities, because this is in fact what happens. The direct consequences of drug use, such as intoxication and withdrawal symptoms, interfere with the ability to function, particularly in conventional social situations. It is difficult to converse with customers or tend to family duties while drunk or hungover. The downward slope also captures the indirect, socially mediated liabilities of drug use. These include legal consequences, such as an arrest record, and the stigma that often accompanies heavy drug use. Individuals with a criminal record for drug offenses and a reputation for shooting up or drinking heavily tend to have fewer opportunities. For example, because of federal regulations, students with drug offenses on their records have a more difficult time obtaining loans for college study. Put more generally, addictive drug use undermines the value of legitimate activities that normally would compete with drug use. Thus, the value of the drug, although declining, remains higher than the value of the (shrinking) nondrug alternatives. In the end, the drug is chosen exclusively—a full-out binge.

Note that these dynamics differ from those in the restaurant problem. Eating Chinese food did not lead to binging on Chinese food because after a while Italian food was better. However, drugs do not let the competition get better. Rather, they make the competition worse. Thus, as shown in figure 6.6, drug use can lead to a situation in which the drug is the only commodity "left standing." The pattern looks exactly like an "out of control, drug binge." But reward value and choice, not compulsion, are the driving forces.

A lifestyle frame of reference predicts abstinence   The right panel shows the same two commodities from the perspective of organizing them into aggregates composed of series of 30 consecutive days. This represents decisions framed as competing lifestyles. In this framework, the best option is just the opposite of the best option in the local bookkeeping approach: never use drugs. The equilibrium is 0 days of drug plus 30 days of nondrug activities. Again, it should be emphasized that nothing has changed other than the frame of reference. The person in the right panel who never uses heroin likes heroin just as much as the person in the left panel who uses heroin every day.

(The equation for the value of heroin in both panels is $Vh = 14 - 0.33x$, where x is the number of days heroin was used in the last 30 days.) However, the person represented by the right panel considers heroin from the perspective of its influence on subsequent nondrug days as well as its influence on subsequent heroin days, which is to say, the decision is a lifestyle decision. (The corresponding equation is $xVh + (30 - x)Vnh$, where Vnh is the value of a nondrug day.)

Summary: Ambiguity, Relapse, and Abstinence

The choice rule for each graph is take what is best. However, the outcomes could not be more different: always use heroin/never use heroin. From the perspective of the right panel, the individual in the left panel could not be doing worse, and, from the perspective of the right panel, the reason is that he or she is doing so poorly is excessive drug use. From the perspective of the left panel, heroin is the best choice. Again, it should be emphasized that heroin has the same value on a day-to-day basis in both panels. Thus, frame of reference accounts for what seems like a compulsive, out-of-control pattern of drug use.

Two possible equilibrium states and the temporal pattern of heavy drug use One of the implications of this analysis is that the contingencies that guide voluntary action are inherently ambiguous. This is because under most conditions, the local and global equilibria diverge, although often not by much (the analysis supporting this point is not presented in this chapter).

As it is always possible for conditions to change so that the frame of reference changes, the fact that the local and global equilibria are usually different means that there is always the potential for preference to shift from one equilibrium to the other. Consequently, it is more accurate to say that the equilibria that attend choice are "semistable" or inherently labile. For instance, the ever-present local equilibrium ensures that there is an ever-present threat of relapse (for the abstinent drug user), and conversely, the ever-present global equilibrium ensures that the heavy drug user could quit all at once. Together these observations suggest that drug use will often vacillate between periods of heavy use and periods of abstinence. This is what is observed.

If the Local Frame of Reference Supports Self-Destructive Patterns of Behavior, Why Does It Persist?

Addiction is a disposition. It reflects the accumulating consequences of a series of choices. One drink does not imply alcoholism, just as one day without a drink does not imply temperance. According to the analysis presented here, those who use drugs self-destructively fail to frame their choices in a way that is commensurate with the dispositional character of addiction. They make their choices one at a time, as if they were always taking the drug just once. In contrast, those who do not fall victim to the

seductive powers of drugs treat drugs, and commodities like them, dispositionally. They choose a safe rate of consumption, which is to say, they choose a rate (and it may be zero) that does not undermine other important concerns. But given that the local frame of reference yields such poor results when one of the choices is an addictive drug, it is puzzling that this approach to decisions persists. Shouldn't all drug users learn that they have to take into consideration a drug's lifestyle value as well as its current value? These points suggest that the factors that prop up local bookkeeping must be powerful. Next I list three reasons why the local frame of reference persists despite its liabilities.

The perceptual structure of experience favors item-by-item choices   Perceptual experience seems largely to follow the outlines of items and individual activities, not aggregates made up of items and activities. Restaurants exist as independent units; the opportunities to use heroin arrive one at a time. Conversely, the aggregate "eight Chinese meals plus two Italian meals" is not a naturally occurring unit. Similarly, the bundle "three days of heroin plus twenty-seven nondrug days" is not a naturally occurring unit. To be sure, one can create multiday meal plans and multiday drug-use plans, but these are abstractions. They require thinking ahead, imagined consequences, and new categories that compound unlike activities and objects: "first I will mow the lawn, then reward myself with an hour on the courts." By definition, abstractions are less vivid, and less compelling than tangible goods and activities. Local bookkeeping is in accord with the natural fracture lines of nature. In contrast, global bookkeeping requires a reworking of the world as it is perceived and experienced. These comments point out that local bookkeeping options—items and activities—are more salient, and this in turn suggests that saliency directly or indirectly reinforces local bookkeeping.

Hyperbolic discounting and the difficulty of detecting delayed costs   As demonstrated in numerous studies, the motivational pull of behavioral consequences declines steeply as a function of delay (see Ainslie 1975, 1992; Green and Myerson 2004; Rachlin 2000). A characteristic of all addictive drugs is that their positive effects come quickly if not immediately, whereas their costs are greatly delayed. For example, cigarettes provide virtually instantaneous benefits (taste, nicotine, and the sensory pleasures of inhaling smoke), whereas their costs are probabilistic and take years if not decades to show up (cancer and other diseases). As a result, smoking can persist for some time before its true costs are realized.

The failure to take advantage of socially mediated guidelines that promote the global equilibrium   The global reward options are complex. Recall, for example, that in the restaurant problem there were eleven candidates for the best global meal plan. How-

ever, there is a way around these difficulties. Recall that in the restaurant and addiction graphs (figures 6.5 and 6.6), the local equilibrium was to the right of the global equilibrium. This suggests (and it can be proven) that any practice that reduces consumption of the most favored item or activity will push the local equilibrium toward the global equilibrium. Socially mediated rules on appetites are usually restrictive. They stress moderation, temperance, and in some cases outright abstinence. Social mores and even laws restrict when and where sex can occur, and to varying degrees social customs do the same for all other appetites. (This is not to deny Dionysian cultural traditions, but these do not seem as pervasive or powerful as those stressing temperance.) Thus, an individual can ensure that he or she will not end up at the local equilibrium by simply following, perhaps blindly, culturally mediated teachings on appetites. Indeed this analysis provides a convenient story for why humans are willing to support social institutions that limit their own freedoms, and why humans are so socially docile, either by learning or inheritance or both.

But what about individuals who reject mainstream societal prohibitions on appetites? According to this analysis of social mores, they will have a much more difficult time avoiding the local equilibrium. They will have to find the global equilibrium on their own, and the graphs reveal that this is not easy. Thus, local bookkeeping may also be sustained by antisocial attitudes. However, it should be added that these issues are very complex. For example, nonconventional value systems, such as those found in spiritual movements, often reject intoxicating drugs. This suggests that any value system, including nonconventional ones, that promotes behaviors that are more in line with global bookkeeping will end up rejecting addictive drugs. In any case, society offers values and practices that help people avoid the penalties inherent to local bookkeeping. These methods simply require adherence to the norms. This is a much simpler approach than sorting out the best policy regarding one's needs and appetites from scratch.

Summary

There are good reasons for the local frame of reference to persist if not dominate most decision making. The decision process is simpler, the true costs are often hard to detect at first, and the options are framed so as to fit well if not precisely with perceptual experience. However, logic and experience also reveal that pitfalls will eventually emerge. Fortunately, the level of overall benefits associated with the local and global equilibria are not that different for most commodities. However, for a few commodities, the local equilibrium is seriously deficient. We say that these commodities are dangerous, and accordingly, they are often the target of informal and legal prohibitions. One way around the danger's posed by seriously suboptimal local equilibria is to ''nibble at the edges'' until a safe level of consumption is arrived at. Or one can simply adhere to the prohibitions, relying on tradition for how to pursue one's own appetites.

Part IV: Evidence and Predictions That Support the Local/Global Analysis of Appetites and Addiction

Behavioral Studies

If the analysis presented in these pages is correct then voluntary actions should gravitate to the local or global equilibrium. The local equilibrium is equivalent to the matching law predictions (see, e.g., Herrnstein 1990). The matching law predictions have been summarized in various books and review articles (Davison and McCarthy 1988; Herrnstein 1970, 1990; Williams 1988). They hold for different species, different reinforcers, in laboratory settings, in nonlaboratory settings, and are now the subject of research in economics, psychopharmacology, and neuroscience. There is no shortage of support for the prediction that choice gravitates to the local equilibrium.

The global equilibrium describes the ideal distribution of choices. However, it was pointed out that the perceptual structure of experience is more in accord with locally framed options. This predicts that experimenters can push subjects from the local to the global equilibrium by arranging stimulus conditions that highlight the aggregate structure of a series of choices. There are several experiments in which subjects distributed their choices as predicted by the global equilibrium. As predicted by the discussion of the ''natural fracture lines of experience,'' the experimenters arranged stimuli that corresponded to the abstract, aggregate structure of a series of choices (e.g., Heyman and Tanz 1995; Rachlin and Siegel 1994).

One line of experiments and naturalistic studies reveals that choice distributions settle in at the local equilibrium (e.g., the matching law literature). Another line shows that under certain conditions, choice distributions settle in at the global equilibrium or at some point in between the local and global predictions. The two literatures fit together nicely. The natural or default choice allocation is the one predicted by the simple rule: ''choose the best item or activity.'' Economic analyses reveal the liabilities of local bookkeeping and the advantages of paying attention to choice-dependent changes in value. Thus, when the default approach to choice is supplemented by analysis and/or prudential (socially mediated) rules, the global equilibrium or an approximation of it emerges (see Prelec and Herrnstein 1991 for a fascinating discussion of this issue).

The Local/Global Analysis Predicts Spontaneous Recovery and the Rationalizations That Accompany Relapse

The local/global analysis predicts specific features of addiction as well as the overall pattern of drug binges and periods of abstinence. Next, I review two predictions. They are good test cases because they distinguish addiction from other disorders. One is spontaneous recovery. The other is the utterance that often accompanies relapse: ''this is the last time.''

Spontaneous remission   It was pointed out that shifts in the frame of reference could lead to abrupt changes in the pattern of drug use. For a currently abstinent but previously heavy drug user, a shift to the local frame of reference implies relapse. Conversely, for a currently heavy drug user, a shift to a global frame of reference implies abstinence, which is likely to be labeled ''spontaneous recovery,'' particularly if the antecedents of the shift in the frame of reference are obscure. Assuming that choice plays much more of a role in addiction than other psychiatric disorders, these observations imply that addiction will be the disorder most closely linked with spontaneous recovery. A number of findings support this prediction.

To test whether addiction was the psychiatric disorder most closely linked to spontaneous recovery, I did a search in the digital reference source, *psychINFO*. The search terms ''addiction or dependence or alcoholism'' and ''spontaneous recovery'' triggered 29 hits. In contrast, the same search with ''obsessive-compulsive disorder'' and ''Tourettes'' as substitutes for the addictions triggered just three hits. More interesting, addiction seems to be the only psychiatric disorder listed in the DSM that has been a source of new terms for spontaneous recovery. The phrases ''going cold turkey'' and ''kicking the habit'' refer to the process of going off heroin and have remained within the domain of addiction. No one talks about going ''cold turkey'' in relationship to OCD or schizophrenia, but they do talk about ''going cold turkey'' in regard to smoking. The implication is that people do quit heroin and smoking all at once, but not OCD.

The vocabulary of relapse   Just as there are specific terms for quitting drugs, there are also verbal formulas linked to relapse. Those who plan to quit drugs but don't, typically preface their next drink or shot of heroin with the words, ''this is the last time,'' or ''I will start my detox tomorrow.'' An interesting feature of this excuse is that it is so robust. Although hackneyed and usually misleading, it seems not to lose its power. This is curious. How can an utterance that is so transparently misleading continue to survive? The local/global analysis provides some hints. The key idea is in a kind of logical trick that resolves the conflicting demands of local and global bookkeeping.

Global bookkeeping provides the best strategy when outcomes depend on a series of choices. However, we also saw that this can mean taking the second-best choice on some trials. This creates a conflict between what is best now and what is best overall. The ideal solution would be to somehow enjoy both what is best now and what is best overall. On many trials this is the case (see, for example, figure 6.5). However, there are always some trials when the two approaches call for different choices, and for some commodities and some people these occasions may be rather frequent. For instance, according to Alcoholics Anonymous there is a population of drinkers who are either teetotalers are helpless drunks; they cannot drink socially. However, even for this population there is one occasion in which the conflict between local and global dissolves. The last choice in a series has no future consequences. Logically, it is a singlet. If it

really is the last opportunity to have a drink then the ''alcoholic'' can safely have a drink. Thus, it is possible to justify any local decision that is at odds with a global decision if it is framed as the ''last time.'' On any true last time this is legitimate. However, in advance it is hard to tell whether this time is really the last time. Accordingly, the preface to relapse and not quitting drugs are the words: ''this is the last time.''

Why Drugs?

Nothing has been said about why drugs are the most likely focus for excessive, self-destructive consumption patterns. This may seem a fault of the analysis. It does not specify any particular substance or activity. However, there is a connection. If we ask what sort of commodities fit the addiction graph, the answer is commodities that undermine the value of competing commodities. This point then leads to the observation that drugs are particularly good at spoiling competing reinforcers.

First, according to the analysis presented in the previous section of this chapter, excessiveness and addiction depend on the relationship between the local and global equilibria. The distance between the two equilibria along the x-axis defines the degree of excessiveness, and the distance along the y-axis defines the degree of inefficiency or self-destructiveness. Second, the restaurant and addiction graphs reveal that these differences reflect the properties of the available commodities and activities. For instance, recall that individuals who adopted a local bookkeeping approach to the restaurant problem ate too much Chinese food. However, their gluttony pales in comparison to the degree of excessiveness that emerged in the heroin addiction graph, figure 6.6. The implication is that something about heroin (as displayed in the graph) promoted excessiveness. Inspection reveals that this ''something'' is that heroin undermined the value of the competing nondrug rewards. Preference for heroin increased even though its value declined because it spoiled the value of the competing activities.

Thus, the question of ''why are drugs the most likely focus of addictive behavior?'' can be rephrased as ''why are drugs the commodities that are most likely to undermine the value of competing rewards?'' The answers are various versions of the fact that addictive drugs interact directly with neurons, the biological substrates of behavior. Cocaine and heroin bind directly to receptor sites. This means that their effects are virtually immediate (once they reach the receptor) and given that common dose levels are several orders of magnitude greater than the circulating levels of the neurotransmitters that normally bind to the receptor sites, the drug effects are immense, producing psychological states that are not obtainable by other means. The immediate consequences of these intense drug effects are intoxication and acute withdrawal states. Both interfere with competing activities, particularly conventional ones. The long-term consequences of the drug effects are chronic withdrawal conditions and toxic reactions, such as illness and psychological disturbance. These consequences also undermine

nondrug competing activities. Finally, because the drugs act directly on the neural underpinnings of behavior they do not (with the exception of alcohol[2]) trigger satiating mechanisms. This leaves judgment as the only counterweight to consumption. However, intoxicating drugs undermine judgment. Thus, drugs that act on the central nervous system are particularly good at setting in motion forces that push the local equilibrium to the right of and below the global equilibrium.

Summary

The goals of this chapter were threefold: (1) to introduce readers to important but not well-known findings regarding the time course of addiction and the correlates of quitting drugs, (2) to develop a model of choice, and (3) to apply the model to addiction. The key results were that the contingencies that guide choice are ambiguous; that when one of the options is an addictive drug, everyday choice processes can lead to drug binging and a pattern of consumption that closely matches the American Psychiatric Association's description of addiction; and that differences in how choices are framed (either as items or aggregates) can have a profound effect on the overall distribution of choices and the overall returns on those choices, all else the same. According to these observations, addiction is not the result of a disease process or even of faulty decision making. It is the result of a kind of perverse interaction between the rules of choice and rewarding commodities and activities that have the capacity to undermine competing activities.[3]

   Given that everyday decision processes are a sufficient condition for addiction and that most people have used alcohol and/or an addictive illegal drug, logic says that most people should become addicts. However, most people do not become addicts. The reason is not lack of access. Virtually everyone has had an alcoholic drink or an illegal addictive drug at least once, and a good portion of the population partakes of these substances on a regular basis. This implies that there are powerful antiaddiction processes at work. This chapter pointed out two. First, if individuals frame their choices in terms of lifestyle consequences, referred to here as global bookkeeping, then making the best choice implies a non-self-destructive consumption pattern—thereby ruling out addiction. Second, social proscriptions on appetites tend to push consumption toward the global equilibrium. Hence, it is possible to avoid the dangers of local bookkeeping by simply following social conventions regarding drug use. Values such as prudence and respect for the law support this approach. These observations suggest that social factors and values play an important role in drug use.

   The applied implications of the analysis presented in this chapter are that prevention programs should enhance nondrug interests and that treatment programs should focus on decreasing the relative reward value of the drug. There are many programs

that focus on the relative reward value of the drug. These include pharmacotherapies that reduce the reward value of the drug, and behavioral programs that increase the reward value of abstinence (e.g., Alcoholics Anonymous 1976; Higgins et al. 2000; Silverman et al. 2002). As with OCD, logic says that the behavioral programs are essential since they offer methods that can work after treatment is formally over. Possibly these programs would be more available in an environment in which addiction was not presented as a disease. In any case, to call a disorder a disease when it is possible to bring about a ''cure'' by rearranging factors that influence the reward value of the symptoms is likely to prove counterproductive in the long run. That we don't cure Tourettes syndrome by rewarding ''not-ticing,'' but do bring addiction to a halt by rewarding abstinence, will eventually become apparent to all. It also might be useful to point out that there is no perfect solution to drug problems. Economics and psychology tell us that if addictive drugs provide psychological benefits that are not readily available elsewhere, there will be a demand for them. Political realities tell us that in liberal democracies, this demand will find a way to express itself. Thus, what is possible are measures that decrease the likelihood that the demand for intoxication turns into addiction. According to this chapter, these measures should be based on global bookkeeping consumption rates but packaged so that they appear as local bookkeeping options.

Notes

1. The equation for the value of the drug is $(14 - 0.33x)$, where x is the number of drug days. The equation for the value of nondrug competing activities is $(11 - 0.33x)$. Note that choosing the drug, x, leads to a decrease in the value of all commodities, as implied by the APA account of addiction.

2. Alcohol differs from the other addictive drugs in that it does not directly bind to receptor sites.

3. Smoking may not seem to fit this account. Cigarettes differ from other addictive drugs in that they are not intoxicating, and in fact are highly compatible with virtually any other activity, from horseback riding to sitting at a desk. What this shows is that they have created a niche in which they are the only occupant. Hence, having no competition, they are always chosen. Thus, they do not need to undermine the competition; it didn't exist in the first place.

References

Ainslie, G. W. (1975). Specious reward: A behavioral theory of impulsiveness and impulse control. *Psychological Bulletin* 82 (4): 463–496.

Ainslie, G. W. (1992). *Picoeconomics: The Strategic Interaction of Successive Motivational States within the Person*. Cambridge: Cambridge University Press.

Alcoholics Anonymous (1976). *Alcoholics Anonymous: The Story of How Many Thousands of Men and Women Have Recovered from Alcoholism*. New York: A.A. World Services.

American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders: DSM-IV*, 4th ed. Washington, D.C.: American Psychiatric Association.

Anthony, J. C., and Helzer, J. E. (1991). Syndromes of drug abuse and dependence. In L. N. Robins and D. A. Regier, eds., *Psychiatric Disorders in America: The Epidemiologic Catchment Area Study*, pp. 116–154. New York: Free Press.

Baumol, W. J., and Blinder, A. S. (1994). *Economics: Principles and Policy*, 6th ed. Fort Worth: Dryden Press.

Biernacki, P. (1986). *Pathways from Heroin Addiction: Recovery without Treatment*. Philadelphia: Temple University Press.

Burroughs, W. S. (1959). *Naked Lunch*. New York: Grove Weidenfeld.

Carroll, K. M., and Rounsaville, B. (1992). Contrast of treatment-seeking and untreated cocaine abusers. *Archives of General Psychiatry* 49: 464–471.

Cole, P. M., Jenkins, P. A., and Shott, C. (1989). Spontaneous expressive control in blind and sighted children. *Child Development* 60: 683–688.

Coombs, R. H. (1997). *Drug-impaired Professionals*. Cambridge, MA: Harvard University Press.

Davison, M., and McCarthy, D. (1988). *The Matching Law: A Research Review*. Hillsdale, NJ: Lawrence Erlbaum.

Dole, V. P., and Nyswander, M. E. (1967). Heroin addiction—a metabolic disease. *Archives of Internal Medicine* 120: 19–24.

Ferguson, C. E., and Gould, J. P. (1975). *Microeconomic Theory*. Homewood, IL: Richard D. Irwin.

Fiore, M. C., Smith, S. S., Jorenby, D. E., and Baker, T. B. (1994). The effectiveness of the nicotine patch for smoking cessation: A meta-analysis. *Journal of the American Medical Association* 271: 1940–1947.

Green, L., and Myerson, J. (2004). A discounting framework for choice with delayed and probabilistic rewards. *Psychological Bulletin* 130: 769–792.

Helzer, J. E., Burnam, A., and McEvoy, L. T. (1991). Alcohol abuse and dependency. In L. N. Robins and D. A. Regier, eds., *Psychiatric Disorders in America: The Epidemiologic Catchment Area Study*, pp. 81–115. New York: Free Press.

Herrnstein, R. J. (1970). On the law of effect. *Journal of the Experimental Analysis of Behavior* 13: 243–266.

Herrnstein, R. J. (1990). Rational choice theory: Necessary but not sufficient. *Journal of the American Psychologist* 45: 356–367.

Herrnstein, R. J., Loewenstein, G. F., Prelec, D., and Vaughan, W. (1993). Utility maximization and melioration: Internalities in individual choice. *Journal of Behavioral Decision Making* 6: 149–185.

Herrnstein, R. J., and Prelec, D. (1992). A theory of addiction. In G. Loewenstein and J. Elster, eds., *Choice Over Time*, pp. 331–360. New York: Russell Sage Foundation.

Heyman, G. M. (2001). Is addiction a chronic, relapsing disease? Relapse rates, estimates of duration, and a theory of addiction. In P. Heymann and W. Brownsberger, eds., *Drug Addiction and Drug Policy*, pp. 81–117. Cambridge, MA: Harvard University Press.

Heyman, G. M. (2003). Consumption dependent changes in reward value: A framework for understanding addiction. In R. E. Vuchinich and N. Heather, eds., *Choice, Behavioral Economics, and Addiction*, pp. 95–127. Amsterdam, Netherlands: Pergamon/Elsevier Science.

Heyman, G. M., and Dunn, B. (2002). Decision biases and persistent illicit drug use: An experimental study of distributed choice and addiction. *Drug and Alcohol Dependence* 67: 193–203.

Heyman, G. M., and Tanz, L. (1995). How to teach a pigeon to maximize overall reinforcement rate. *Journal of the Experimental Analysis of Behavior* 64: 277–297.

Higgins, S. T., Wong, C. J., Badger, G. J., Ogden, D. E., and Dantona, R. L. (2000). Contingent reinforcement increases cocaine abstinence during outpatient treatment and 1 year of follow-up. *Journal of Consulting and Clinical Psychology* 68 (1): 64–72.

Hunt, W. A., Barnett, L. W., and Branch, L. G. (1971). Relapse rates in addiction programs. *Journal of Clinical Psychology* 27 (4): 455–456.

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., and Walters, E. E. (2005a). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the national comorbidity survey replication. *Archives of General Psychiatry* 62: 593–602.

Kessler, R. C., Chiu, W. T., Demler, O., Merikangas, K. R., and Walters, E. E. (2005b). Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the national comorbidity survey replication. *Archives of General Psychiatry* 62: 617–627.

Kudadjie-Gyamfi, E., and Rachlin, H. (1996). Temporal patterning in choice among delayed outcomes. *Organizational Behavior and Human Decision Processes* 65: 61–67.

Pettinati, H., O'Brien, C. P., Rabinowitz, A. R., Wortman, S. P., Oslin, D. W., Kampman, K. M., and Dackis, C. A. (2006). The status of naltrexone in the treatment of alcohol dependence: Specific effects on heavy drinking, *Journal of Clinical Psychopharmacology* 26: 610–625.

Prelec, D., and Herrnstein, R. J. (1991). Preferences and principles, alternative guidelines for choice. In R. Zeckhauser, ed., *Strategic Reflections on Human Behavior*, pp. 319–240. Cambridge, MA: MIT Press.

Rachlin, H. C. (2000). *The Science of Self-control*. Cambridge, MA: Harvard University Press.

Rachlin, H., and Siegel, E. (1994). Temporal patterning in probabilistic choice. *Organizational Behavior and Human Decision Processes* 59: 161–176.

Regier, D. A., Farmer, M. E., Rae, D. S., Locke, B. Z., Keith, S. J., and Judd, L. L. (1990). Comorbidity of mental disorders with alcohol and other drug abuse. Results from the epidemiologic catchment area (ECA) study. *Journal of the American Medical Association* 264 (19): 2511–2518.

Rinn, W. E. (1984). The neuropsychology of facial expression: A review of the neurological and psychological mechanisms for producing facial expressions. *Psychological Bulletin* 95 (1): 52–77.

Robins, L. N. (1993). Vietnam veterans' rapid recovery from heroin addiction: A fluke or normal expectation? *Addiction* 88: 1041–1954.

Robins, L. N., and Regier, D. A. (1991). *Psychiatric Disorders in America: The Epidemiologic Catchment Area Study*. New York: Free Press.

Rounsaville, B. J., and Kleber, H. D. (1985). Untreated opiate addicts: How do they differ from those seeking treatment? *Archives of General Psychiatry* 42: 1072–1077.

Samuelson, P. A. (1967). *Economics*, 7th ed. New York: McGraw-Hill.

Seligman, M. E. P., Walker, E. F., and Rosenhan, D. L. (2001). *Abnormal Psychology*, 4th ed. New York: W.W. Norton.

Silverman, K., Svikis, D., Wong, C. J., Hampton, J., Stitzer, M. L., and Bigelow, G. E. (2002). A reinforcement-based therapeutic workplace for the treatment of drug abuse: Three-year abstinence outcomes. *Experimental and Clinical Psychopharmacology* 10: 228–240.

Spitzer, R. L., Forman, J. B., and Nee, J. (1979). DSM-III field trials: I. Initial interrater diagnostic reliability. *American Journal of Psychiatry* 136: 815–817.

Spitzer, R. L., Williams, J. B., and Skodol, A. E. (1980). DSM-III: The major achievements and an overview. *American Journal of Psychiatry* 137: 151–164.

Stinson, F. S., Grant, B. F., and Dawson, D. A. (2005). Comorbidity between DSM-IV alcohol and specific drug use disorders in the United States: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Drug and Alcohol Dependence* 80: 105–116.

Stinson, F. S., Grant, B. F., Dawson, D. A., Ruan, W. J., Huang, B., and Saha, T. (2006). Comorbidity between DSM-IV alcohol and specific drug use disorders in the United States: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Alcohol Research and Health* 29 (2): 94–106.

Toneatto, T., Sobell, L. C., Sobell, M. B., and Rubel, E. (1999). Natural recovery from cocaine dependence. *Psychology of Addictive Behaviors: Journal of the Society of Psychologists in Addictive Behaviors* 13: 259–268.

Vaughan, W. (1981). Melioration, matching, and maximization. *Journal of the Experimental Analysis of Behavior* 36 (2): 141–149.

Vaughan, W., Jr., and Herrnstein, R. J. (1987). Stability, melioration, and natural selection. In L. Green and J. H. Kagel, eds., *Advances in Behavioral Economics*, pp. 185–215. Norwood, NJ: Ablex Publishing.

Waldorf, D., Reinarman, C., and Murphy, S. (1991). *Cocaine Changes: The Experience of Using and Quitting*. Philadelphia: Temple University Press.

Warner, L. A., Kessler, R. C., Hughes, M., Anthony, J. C., and Nelson, C. B. (1995). Prevalence and correlates of drug use and dependence in the United States: Results from the National Comorbidity Survey. *Archives of General Psychiatry* 52: 219–229.

Wasserman, D. A., Weinstein, M. G., Havassy, B. E., and Hall, S. M. (1998). Factors associated with lapses to heroin use during methadone maintenance. *Drug and Alcohol Dependence* 52: 183–192.

Williams, B. A. (1988). Reinforcement, choice, and response strength. In S. S. Stevens and R. C. Atkinson, eds., *Stevens' Handbook of Experimental Psychology: Learning and Cognition*, 2nd ed., pp. 167–244. New York: Wiley.