Quitting Drugs: Quantitative and Qualitative Features

Gene M. Heyman

Department of Psychology, Boston College, Chestnut Hill, Massachusetts 02467; email: heymang@bc.edu, gheyman@fas.harvard.edu

Annu. Rev. Clin. Psychol. 2013. 9:29–59

First published online as a Review in Advance on January 16, 2013

The *Annual Review of Clinical Psychology* is online at http://clinpsy.annualreviews.org

This article's doi: 10.1146/annurev-clinpsy-032511-143041

Keywords

addiction, remission, maturing out, correlates of remission, probability of remission, exponential model of remission

Abstract

According to the idea that addiction is a chronic relapsing disease, remission is at most a temporary state. Either addicts never stop using drugs, or if they do stop, remission is short lived. However, research on remission reveals a more complex picture. In national epidemiological surveys that recruited representative drug users, remission rates varied widely and were markedly different for legal and illegal drugs and for different racial/ethnic groups. For instance, the half-life for cocaine dependence was four years, but for alcohol dependence it was 16 years, and although most dependent cocaine users remitted before age 30, about 5% remained heavy cocaine users well into their forties. Although varied, the remission results were orderly. An exponential growth curve closely approximated the cumulative frequency of remitting for different drugs and different ethnic/racial groups. Thus, each year a constant proportion of those still addicted remitted, independent of the number of years since the onset of dependence.

Contents

INTRODUCTION

In 1962, an article titled "Maturing Out of Narcotic Addiction" appeared in the quarterly report of a minor agency of the United Nations (Winick 1962). The author, Charles Winick, had analyzed

the Federal Bureau of Narcotics' yearly tally of American narcotic addicts for the years 1955 to 1959. He discovered a pattern. As the addicts got older, they disappeared from the census. In fact, by age 37, 73% of those who were once listed as heroin addicts were gone. Winick assumed—erroneously—that the roster included virtually every heroin addict in the United States and that those who were no longer listed had stopped using heroin, hence the title of his article. His explanation of why the men had remitted reflected the still strong influence of Freud on academic psychology. He speculated that young men began using heroin to escape their sexual and aggressive yearnings, but then, over time, these feelings subsided, thereby reducing the motivation to take the drug. By this account, addiction is secondary to underlying conflicts, which resolve on their own, and accordingly treatment need not play a role in recovery. Although Winick's assumptions about the Federal Bureau of Narcotics' records were wrong, it is possible that the descriptive aspects of his conclusions are correct. Addiction could be a disorder that comes to an end in early adulthood, often without professional help. In 1962 this was not a testable hypothesis because information on the time course of addiction was not available. However, today such information is available. The results are reliable and orderly; this review tells their story.

Although Winick's etiological theory was consonant with the times, his conclusions were not. According to professionals and the public, addicts would never stop using drugs unless they were forced to do so. Judges sent heroin addicts to "federal narcotic farms," which were hybrid prison/hospitals that operated on the premise that detoxification would cure addiction or at least keep addicts from spreading their disease to others. Private treatment centers had much the same viewpoint. According to the director of Synanon, a well-known residential therapeutic community devoted to heroin addicts, "a person with this fatal disease (heroin addiction) will have to live here all his life" (cited in Brecher 1972). Thus, the idea that one could mature out of addiction was not simply a minority position but also a radical departure from a growing consensus. Winick cited no earlier "maturing-out" publications, nor do today's digital reference sources list any.

In 1962 there were relatively few empirical studies of illicit drug use; today there are thousands. Nevertheless, the issues raised by Winick's paper are not fully resolved. On the one hand, the idea that addiction is a chronic, relapsing disease has become increasingly influential. On the other hand, an increasing number of empirical studies support key elements of the maturing-out thesis. Consider, for example, the following expert views on the nature of addiction and also the citation record for Winick's paper.

BACKGROUND AND DEFINITIONS

Received Opinion Regarding Addiction, Relapse, and Treatment

Charles O'Brien, director of the University of Pennsylvania Center for Studies of Addiction, and A. Thomas McLellan, the recent Deputy Director of the Office of National Drug Control Policy, write that "[a]ddictive disorders should be considered in the category with other disorders that require long-term or lifelong treatment" (O'Brien & McLellan 1996, p. 239). A few years later (McLellan et al. 2000), they add: "... [the] effects of drug dependence treatment are optimized when patients remain in continuing care and monitoring without limits or restrictions on the number of days or visits covered" (p. 1694). These comments echo those of the recent directors of the National Institute on Drug Abuse and National Institute on Alcohol Abuse and Alcoholism, who describe addiction as a chronic, relapsing disease, not unlike Alzheimer's, diabetes, or even cancer (Leshner 1999, 2001; Volkow & Fowler 2000; Volkow & Li 2004). Textbook authors concur (e.g., Mack et al. 2003, Ott et al. 1999): "For addiction patients, recovery is a never-ending process; the term *cure* is avoided" (Mack et al. 2003, p. 341). And in the *New York Times*, Douglas

Quenqua (2011) writes, "Armed with that understanding [addiction as a physical ailment], the management of folks with addiction becomes very much like the management of other chronic diseases, such as asthma, hypertension, or diabetes . . ." Thus, it is fair to say that current received opinion is that addicts remain addicts, but with the support of clinicians they can keep off drugs, just as, for example, the daily use of an inhaler can keep the symptoms of asthma at bay.

Empirical Support for Maturing Out

Nevertheless, Winick's 1962 paper has become more influential. Although it remains unlisted in both PsycINFO and PubMed, the two major reference sources used by addiction researchers, it continues to receive a steady flow of citations. There are now more than 200 publications on drug use in addicts that include either the phrase "maturing out" or a synonym, such as "spontaneous remission," "unassisted recovery," "recovery without treatment," "natural recovery," and "self-change." In these studies, addicts who are not in treatment quit or become controlled drug users (e.g., Biernacki 1986, Toneatto et al. 1999, Waldorf 1983, Waldorf et al. 1991). And in some recent papers, the authors assume that addiction is a time-limited—not a chronic—disorder, just as in other research and position papers the very opposite is assumed (see, for example, Mocenni's mathematical model of the time course of addiction: **http://www.dii.unisi.it/~mocenni/pres-addiction-nr.pdf**).

Maturing Out and Relapse Are Not Incompatible Results

In the half-century that has passed since "Maturing Out of Narcotic Addiction" was published, hundreds of papers on remission and relapse have been published. They support the following simple generalizations. Many addicts keep using drugs well into old age or until they die (e.g., Brecher 1972, Gossop et al. 2003, Hser 2007, Hser et al. 1993, Vaillant 1973). These addicts typically entered the research literature as subjects in treatment follow-up studies. Conversely, at least some addicts quit after a few years and do so without the benefit of treatment (e.g., Biernacki 1986, Toneatto et al. 1999, Waldorf 1983). These addicts typically entered the research literature as subjects in studies of nontreatment populations. That is, it is easy to find treatment follow-up studies whose results support the widely held claim that addiction is a chronic, relapsing disease and that addicts need lifelong assistance, and it is also easy to find community studies whose results support the notion that addiction is a time-limited disorder that somehow resolves on its own. These results need not be in conflict. In principle, they are simply the opposite ends of a distribution of time-spent-addicted durations: Some drug users quit early; some quit late. Indeed, this is the principle that guides this review. However, the following problems have stood in the way of this approach.

Barriers to a Synthesis

First, researchers have disagreed as to who is an addict. For example, in response to the high remission rates among opiate-using Vietnam War enlistees, many critics claimed that the veterans "were never really addicted" (Robins 1993). One version of this view is that if an "addict" recovers, he wasn't really an addict. This way of thinking turns an empirical question into an unresolvable semantic issue. Thus, the first order of business for empirical progress is to establish an acceptable, workable set of criteria as to who counts as an addict. Second, the natural history of addiction varies as a function of treatment history. One way to deal with this issue is to recruit subjects independent of their treatment history so that the sample includes representative numbers of

clinic and nonclinic addicts. Related to these points, different researchers use different criteria for defining treatment (e.g., Anthony & Helzer 1991, Stinson et al. 2005). This is a particularly difficult issue because there are many forms of treatment, from acupuncture to religious counseling to hospitalization, and it is likely that each has its partisan debunkers. Third, addiction has proven to be a moving target. Outcomes vary as a function of the demographic characteristics of drug users, and the demographic characteristics of drug users have changed markedly since the first publications on remission in the 1960s. As a result, some accounts of addiction are correct in respect to earlier research, but are not correct in respect to more recent research. Fourth, researchers who do follow-up studies have no common set of criteria for measures of drug use or for the proper duration of the follow-up period. Sometimes the criteria include the clinical significance of drug use (e.g., Teesson et al. 2008), and sometimes researchers simply measure whether drugs were used with no consideration of whether such use was social or was linked to clinical problems. In some studies, remission is measured over days (e.g., Goldstein & Herrera 1995), whereas in others it is measured over years (e.g., Rathod et al. 2005). Given such disparate approaches, different studies will produce different estimates of the frequency of remission for the same pattern of drug use.

The occasion for this review is that the disparate findings on remission are resolvable. The data support the idea that there is a single distribution of dependence durations. Those that are quite short fit the "mature-out" label, and those that are quite long fit the "chronic disease" label, yet a simple mathematical model reveals that they are members of a single, continuous distribution. This result rests on two developments. The first is methodological. The revised *Diagnostic and Statistical Manual of Mental Disorders* (DSM-III; Am. Psychiatr. Assoc. 1980) provides field-tested, reliable criteria for identifying and distinguishing social drug users, current addicts, and ex-addicts (see Spitzer et al. 1979, 1980). The second is empirical. On the basis of the revised DSM criteria, four nationwide surveys have gathered information on the time course and correlates of drug use in representative populations. These data establish a quantitative outline of the natural history of addiction, including its typical duration, the relationship between remission and onset, and the likelihood that addiction will persist for a relatively short or relatively long time. These findings form the core of this review, but we first consider the DSM definition of addiction.

How to Define Addiction

The DSM (Am. Psychiatr. Assoc. 1994) has become the standard text for identifying psychiatric disorders for clinicians, researchers, medical insurance plans, and the courts. The manual substitutes the term "substance dependence" for "addiction" and introduces the diagnosis in the following way:

> 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. (Am. Psychiatr. Assoc. 1994, p. 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 12 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 et al. 1979, 1980), and the criteria predict important outcomes such as future use of clinical services, future diagnoses, and drinking and/or drug problems in first-degree relatives (e.g., Helzer et al 1985,

1987). In scores if not hundreds of studies, the criteria differentiate addicts from drug users by level of drug use (e.g., Kidorf et al. 1998), neural activity (e.g., Volkow et al. 1997), educational attainment (e.g., Warner et al. 1995), and psychological traits that at face value appear relevant to addiction, such as impulsiveness (e.g., Kirby et al. 1999). That is, the survey procedures reliably sort the respondents into meaningful categories. In keeping with these results, the DSM criteria have become widely accepted by clinicians, researchers, and the justice system as the preferred tool for identifying addicts.

How to Define Remission

If the DSM criteria function as an effective tool for distinguishing addicts from social drug users, then they can also be used to distinguish current remitted (ex-) addicts from current addicts. The reasoning for this claim proceeds as follows. The epidemiological surveys publish lifetime prevalence and 12-month prevalence percentages for substance dependence. Lifetime prevalence means that the participant now or in the past met the criteria for substance dependence, and 12-month prevalence means that the participant met the criteria in the year prior to the interview. On the basis of these two numbers, we can calculate the percentage of those who were once dependent but have not been for the past year: %Remitted = (Lifetime% – 12-Month%)/Lifetime%. Notice that by this account, remission implies subthreshold symptoms for one or more years in someone who once met the criteria for dependence and that a remitted addict could relapse in the next year. Thus, whether remission is stable becomes an important issue. This and other methodological issues, such as the basic question of whether participants can provide accurate accounts of their present and past drug use, are taken up after the findings on remission are introduced.

How to Recruit Subjects

Following the testing and publication of the revised DSM criteria, there have been four major, national surveys of the prevalence of psychiatric disorders and their correlates. These are the Epidemiological Catchment Area (ECA) survey, conducted in the early 1980s and summarized in a volume edited by Robins & Regier (1991); the National Comorbidity Study (NCS), conducted in the early 1990s and summarized in a series of articles by Kessler and his colleagues (e.g., Kessler et al. 1994, Warner et al. 1995); the National Comorbidity Study Replication (NCS-R), conducted over the years 2001 to 2003 (Kessler et al. 2005a,b); and the National Epidemiological Study of Alcohol and Related Conditions (NESARC), conducted over the years 2001 to 2002 (e.g., Grant & Dawson 2006, Hasin et al. 2005, Stinson et al. 2005). Each used the same strategy to recruit subjects. First, they located a large sample of individuals that approximated the demographic characteristics of the American public, using such criteria as gender, age, and ethnicity. These samples varied from about 8,000 individuals (e.g., NCS; Warner et al. 1995) to more than 40,000 (e.g., NESARC; Stinson et al. 2005). Next, all of the individuals in this initial sample were interviewed. The interviewer followed a script designed to detect whether the interviewee currently or in the past met the criteria for a DSM diagnostic category, to obtain treatment history, and to collect demographic information. For example, the line of questioning regarding drug use went like this: "Have you ever used heroin on your own more than five times in your life?" If the answer was "Yes," then the next question in the script was: "Have you ever tried to cut down on heroin but found you couldn't do it?" And so on.

This approach has the advantage of avoiding biases that come with studying just those individuals who show up in treatment. For example, addicts in treatment tend to have higher rates of additional psychiatric disorders than addicts not in treatment (e.g., Regier et al. 1990). However,

it is also true that interviews do not necessarily yield valid responses, that retrospective accounts of personal histories are subject to biases and error regardless of the intentions of the interviewee, and individuals with problems may be underrepresented in the original sample because they are harder to find or do not wish to cooperate with "intruding" researchers. These issues are revisited after some of the key findings are presented.

THE NATIONAL EPIDEMIOLOGICAL SURVEYS OF MENTAL HEALTH

In the first month of her husband's presidency (January 1977), Rosalynn Carter invited a number of the country's leading psychiatric researchers to the White House to discuss the state of mental health care in the United States. She was concerned that individuals with mental health problems were not getting the medical care that they needed and deserved. However, to determine whether this was really true, it was necessary to establish the prevalence of mental illnesses in the general public. Although previous surveys of mental disorders had not produced reliable results (e.g., Regier et al. 1984), the committee believed that the APA's newly revised diagnostic criteria (DSM-III; Spitzer et al. 1979) would prove reliable and robust enough to accurately assess the country's mental health needs. In 1977, Rosalynn Carter's President's Committee on Mental Health recommended that a nationwide survey collect data on the frequencies of psychiatric disorders, including addiction, in representative community samples.

The survey, now known as the Epidemiological Catchment Area Survey, was headed by Lee Robins, a sociologist who specialized in psychiatric epidemiology, and Darrel Regier, a psychiatrist and longtime director of research at the National Institutes of Mental Health. They organized a five-site, collaborative, national evaluation of psychiatric disorders, with emphasis on prevalence, demographic correlates, and the frequency of treatment. From 1980 to 1984, several hundred researchers interviewed nearly 20,000 people. The respondents were primarily household residents of large metropolitan areas (New Haven, Baltimore, Durham, St. Louis, and Los Angeles). However, high-risk institutionalized populations, such as men and women in prison, were interviewed as well. The ECA's objective was to obtain a representative national sample, not just those who were most easily reached at home and not just those in treatment. In the preface to the study summary, Daniel X. Freedman, longtime editor of the *Archives of American Psychiatry*, wrote: "Here then is the soundest fundamental information about the range and 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" (Freedman 1991, p. xxiv).

REMISSION FROM DRUG DEPENDENCE

The ECA Findings

Figure 1 shows remission frequencies for drug dependence and drug abuse as a function of age and gender in the ECA survey. In this study, unlike subsequent ones, abuse and dependence were combined into a single category. The drug data are from the chapter titled "Syndromes of Drug Abuse and Dependence" (Anthony & Helzer 1991) in the summary volume *Psychiatric Disorders in America* (Robins & Regier 1991). Anthony and Helzer did not list remission rates but did include the lifetime and 12-month prevalence rates. Thus, it was possible to calculate the percentage of those who once met the criteria for dependence or abuse but no longer did so as described above.

Overall, 57% of those who ever met the criteria for abuse and/or dependence had remitted, with females quitting drugs at higher rates than males. In the youngest cohort, age 18–29, about 50% of those who ever met the criteria for addiction were in remission for one year or more. In

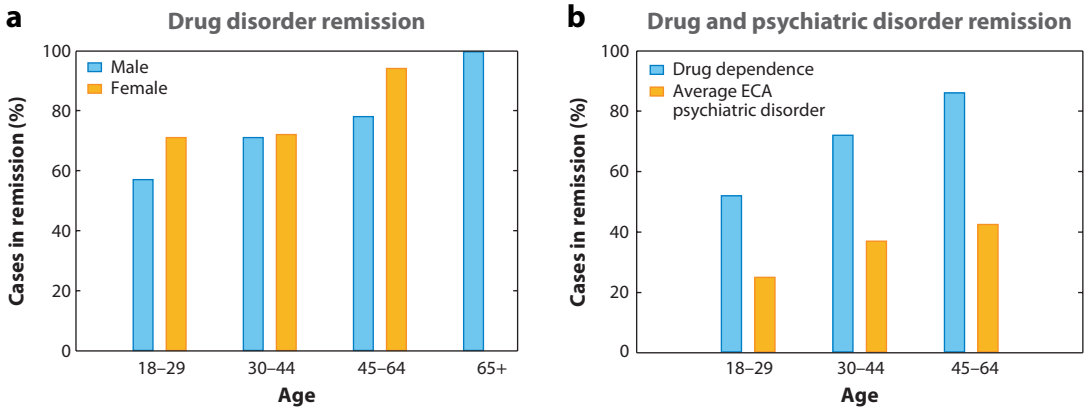

Figure 1

(*a*) The percentage of lifetime cases of abuse and/or dependence that did not report any symptoms in the past year as a function of age and gender in the Epidemiological Catchment Area (ECA) survey. (*b*) Comparison of remission rates for abuse/dependence with other psychiatric disorders as a function of age. "Average ECA psychiatric disorder" included all diagnoses that provided lifetime and current prevalence rates other than addiction and alcoholism.

the oldest cohort, age 64 years or older, more than 80% of those who ever met the criteria for addiction were in remission. The increasing trend could mean that remission was relatively stable (as this is the only way remission could increase as a function of age). Or, as the ECA survey was not a longitudinal study, this trend could also reflect cohort differences.

The ECA remission drug rates are in line with Winick's analysis of heroin addiction (1962) but are markedly higher than the rates predicted by research studies that were conducted at about the same time as Winick's or later (e.g., Brecher 1972, Maddux & Desmond 1980, Hser et al. 1993). To check whether the elevated ECA remission rates might somehow reflect the ECA methodology (rather than actual drug use), I calculated the remission rates for the nondrug psychiatric disorders. **Figure 1*b*** shows the results, again organized as a function of age. For nondrug psychiatric disorders, the proportion of remitted cases never exceeds 50%. Thus, high remission rates were not a necessary result of the ECA methodology.

Are the ECA Remission Rates Reliable?

The ECA survey generated much interest, scores of publications, and three new national surveys of psychiatric disorders and their correlates. In 1990, Ronald Kessler headed the NCS; in 2000, he and his colleagues initiated a follow-up study (NCS-R). The first NCS study recruited approximately 8,100 subjects, and the second recruited approximately 9,200 subjects. Both had aims similar to those of the ECA survey but recruited subjects from nonmetropolitan as well as metropolitan areas. Also in 2001, the National Institute on Alcohol Abuse and Alcoholism sponsored a survey that is now known as the NESARC. It enlisted approximately 43,000 subjects. **Figure 2** summarizes the remission rates for drug dependence for these three more recent national surveys along with the overall remission rate for the ECA survey.

The NCS remission rate was calculated on the basis of a summary article that listed both lifetime and 12-month prevalence rates (Warner et al. 1995), and the NCS-R and NESARC remission rates were calculated on the basis of articles that reported either lifetime prevalence (Conway et al. 2006, Kessler et al. 2005a) or 12-month prevalence (Kessler et al. 2005b, Stinson et al. 2005). That

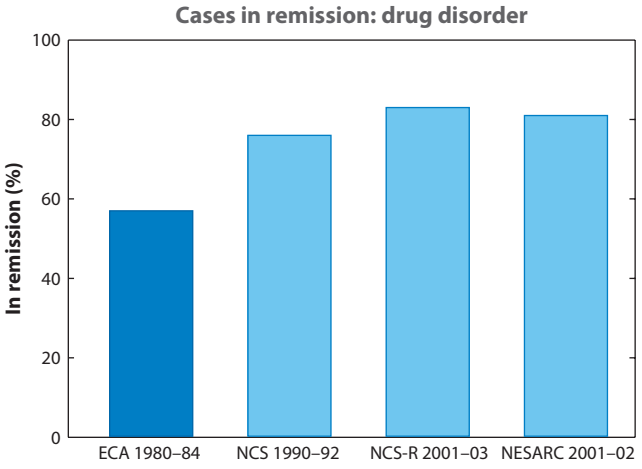

Figure 2

Remission from drug dependence in the three post-ECA (Epidemiological Catchment Area) national epidemiological surveys. The post-ECA results are for drug dependence (drug abuse cases are not included). NCS, National Comorbidity Survey; NCS-R, National Comorbidity Survey Replication; NESARC, National Epidemiology Survey on Alcohol and Related Disorders.

is, as was the case in the ECA account of addiction, the authors of the initial summaries of the NCS and NESARC epidemiological studies did not present remission as an explicit category.

Figure 2 shows that most of those who were ever drug dependent were in remission. The overall frequencies were 76%, 83%, and 81% for the NCS, NCS-R, and NESARC studies, respectively. **Figure 2** also shows that remission rates in the more recent surveys were substantially higher than in the ECA survey. Because the diagnostic criteria were not precisely the same across surveys, this creates an opportunity to test whether the diagnostic criteria were faithfully applied. For example, if the surveys used different rules for defining remission, then they should produce different results, all else being equal.

In the ECA survey, abuse and dependence cases were a single category, and the criterion for remission was zero (no) symptoms. In the NCS and NESARC studies, dependence and abuse were distinct categories, and the criterion for remission from dependence was two symptoms or less. For example, an individual whose symptom count dropped from three to two would count as an active case in the ECA survey but not in the NESARC or the two NCS surveys. Thus, if the researchers faithfully applied the criteria, remission rates should be higher in the later studies. This is exactly what happened. It is also possible that disaggregating abuse and dependence made a difference. For instance, on the basis of his longitudinal studies of alcoholism, George Vaillant (2003) concluded that those who abused alcohol were less likely to stop drinking than were those who were dependent on alcohol. Consequently, the ECA survey should have lower remission rates because it lumped together abuse and dependence. Thus, the pattern of results in **Figure 2** is exactly as expected if each of the surveys faithfully identified and classified its subjects with regard to present and past symptoms of drug dependence.

Figures 1 and **2** summarize the results of four major federally funded studies. Each recruited thousands of subjects. They selected subjects so as to provide an account of psychiatric disorders as they occur in the general population, which may not be the same as they occur in those who are in treatment. The results do not support the often heard claim that addiction is a chronic, relapsing disease. Indeed, addiction proved to be the psychiatric disorder with the highest, not

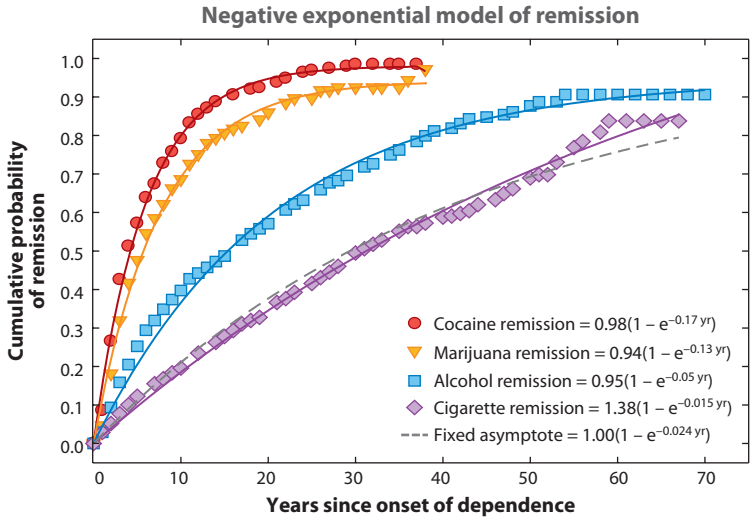

Figure 3

The cumulative probability of remission as a function of time since the onset of dependence, based on the report of Lopez-Quintero et al. (2011). For each drug, the proportion of addicts who quit each year was approximately constant. This means that the likelihood of remitting was independent of years of dependence.

the lowest, remission rate. The results also differ from the findings often reported by treatment follow-up studies. According to the many summaries of this literature (e.g., Brecher 1972, Mack et al. 2003, McLellan et al. 2005, Ott et al. 1999), most addicts relapse, which is to say that treatment interrupts but does not end addiction (see, e.g., Darke et al. 2007, Goldstein & Herrera 1995, Gossop et al. 2003, Hser 2007, Hser et al. 1993, Wasserman et al. 1998). Possibly the remission rates in **Figures 1** and **2** are also short lived. Age data would help determine if this is the case. It would also be of interest to determine whether all drug addictions show such elevated remission rates. The series of graphs in the following sections take up these issues. They show remission rates as a function of time for specific drugs and for specific populations.

Remission as a Function of Onset of Dependence, Drug Type, and Ethnicity

The NESARC researchers used a semi-structured interview schedule that included questions about the timing of psychiatric symptoms. For example, when a study participant reported that he had used a particular drug, he was then asked questions regarding problems that correspond to the DSM abuse and dependence symptoms; then, as determined by his answers, there were follow-up questions regarding when a particular problem first showed up and when it stopped showing up. The temporal inquiries yielded thousands of reports on the presence and timing of the DSM symptoms for drug dependence. The series of graphs below summarize some of the major findings. Two similar graphs appeared in an article published in the journal *Addiction* (Lopez-Quintero et al. 2011) The authors generously made the data available for the analyses presented in this review.

Figure 3 describes the relationship between time since the onset of dependence and remission for cocaine, marijuana, alcohol, and cigarettes (the legal drugs are included for comparison). On the *x*-axis is the amount of time in years since the onset of dependence. On the *y*-axis is the cumulative

probability of remission. This is the proportion of participants who had met the lifetime criteria for dependence but were currently remitted. Importantly, these are the participants who are currently and continuously remitted. If a participant had remitted in the past but now met the criteria for dependence, he or she was not counted as ever having remitted. However, a caution is in order: An individual who had remitted from a particular drug, say cocaine, could be dependent on one or more other drugs and could, of course, relapse later. For each drug, the proportion of dependent users who were in remission for at least a year increased smoothly as the time since the onset of dependence increased. However, the rates of remission differed. The likelihoods of quitting cocaine and marijuana were much higher than the likelihoods of quitting the two legal drugs. With the onset of dependence as the start date, half of those ever addicted to cocaine had quit using this drug at clinically significant levels by year 4, and the half-life for marijuana dependence was six years. In contrast, alcohol and cigarette dependence had much longer half-lives. For alcohol, the 50% remission mark was not reached until year 16, and for cigarettes, it took on average 30 years for dependent smokers to quit. Higher remission proportions yield larger absolute differences among the different drugs. For example, two-thirds of those ever dependent on cocaine no longer met the symptoms for dependence by year 7, but it took 27 years to reach the two-thirds threshold for alcoholics and 49 years to reach the two-thirds mark for cigarette smokers.

A simple mathematical model of remission generated the smooth lines. They are based on the assumption that each year the number of individuals who remitted was a constant proportion of those currently dependent, regardless of how long they had been dependent. Notice that this implies that the probability of remitting was constant, independent of time (and thus also independent of drug use). This is the simplest possible relationship between years of dependence and remission and when written out mathematically is the exponential equation for cumulative percentage growth: Cumulative Remission% at year $Y = A\,(1 - e^{-rY})$, where A is the asymptotic percentage of those who will eventually remit, and r is the proportion of those who will remit each year. For example, the equation that was fitted to the cocaine data (see **Figure 3**) says that 99% of those who were dependent on cocaine will eventually remit for at least a year, and the exponent, 0.16, says that every year an additional 16% of those who had not yet remitted will do so.

Despite the model's simplicity, it predicts the temporal pattern of the observed cumulative remission percentages. The asymptote parameter, A, closely approximated Lopez-Quintero et al.'s (2011) estimates of the percentage of eventual remitters, which they call the "lifetime remission" rate. However, the researchers determined total remitters empirically; they did not fit the exponential growth curve to their data. Similarly, the rate parameter, r, which determines the rate of rise, yields curves that do not deviate systematically from the observed quit percentages. For instance, the error term for the cocaine equation was less than 1%, and the pattern of deviations does not suggest any systematic departures from the model's assumption. There was an exception, however. Although the constant rate assumption led to a good fit for cigarette dependence (the error term was less than 1%), the predicted percentage of eventual remitters was not sensible. The maximum possible value is 1.0, but the best fitting exponential curve had an asymptote of 1.38. However, setting the asymptote to 1.0, which is a possible outcome, resulted in an equation that provided a very good fit of the quit percentages for smoking, $R^2 = 0.98$, even though only one parameter was free to vary. This model is shown by the dotted line. But notice that now the observed quit rates for smoking systematically fall above the dotted line at about the 55-year mark. This says that the likelihood of quitting cigarettes increased as smokers approached the end of their life (perhaps they were hospitalized and could not smoke)—which is why the initial estimate, when the asymptote was free to vary, did not work. Thus, the model is sensitive in that when its assumptions did not hold, as in the case of elderly cigarette smokers, there are systematic departures from its predictions.

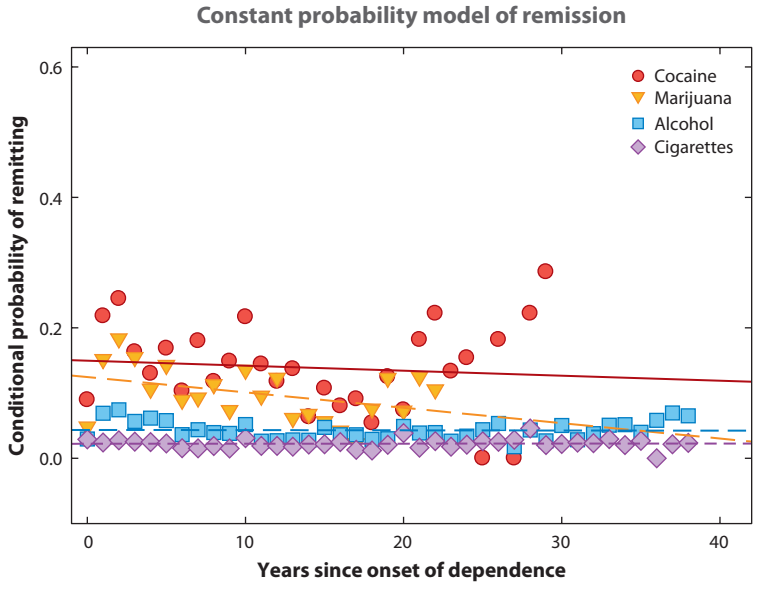

Figure 4

The conditional probability of remitting as a function of time since the onset of dependence. According to the exponential model, lines fit to the conditional probabilities of remitting should have a slope of 0.0. This was approximately correct.

The Probability of Remitting

The data presented in **Figure 3** show the cumulative probability of remitting since the onset of dependence. **Figure 4** shows the year-by-year probabilities (unaccumulated). The data were provided by Lopez-Quintero and her colleagues (C. Blanco, personal communication) and do not appear in their article.

Again, the *x*-axis shows years since the onset of dependence. On the *y*-axis is the probability of remitting for those individuals who had not yet remitted. According to the idea that the likelihood of remitting is constant, the lines fit to the year-by-year probabilities should have the following properties. The zero (left) intercept should approximate the quit rate constant, *r*, in the equations listed in **Figure 3**, and the slope should be approximately 0.0. As predicted, the intercepts closely approximated the rate constants listed in **Figure 3**. For example, the zero intercept for the line describing the cocaine remission probabilities is about 0.17, which closely approximates the remission constant in **Figure 3** (0.16), and for cigarettes it is about 0.11, which is the constant in **Figure 3**. The slopes were approximately 0.0, as predicted. The average absolute deviation from 0.0 was 0.0008, and even the steepest slope (marijuana) was not far from 0.0 (−0.002).

Although the parameters of the fitted lines in **Figure 4** closely approximated the expected values, the variability in the data requires some comment. The probabilities for smoking and drinking hug the theoretical line, but for marijuana and cocaine the probabilities tend to fan out as years since onset of dependence increase. This is most likely a function of the decrease in sample sizes. As remission proceeds (moving to the right along the *x*-axis), there are fewer and fewer potential remitters. Thus, the sample sizes for calculating the probabilities are decreasing, and the probabilities will necessarily become more variable as the *x*-axis increases. For nicotine and alcohol this effect is less apparent because there were so many heavy smokers and drinkers. For instance,

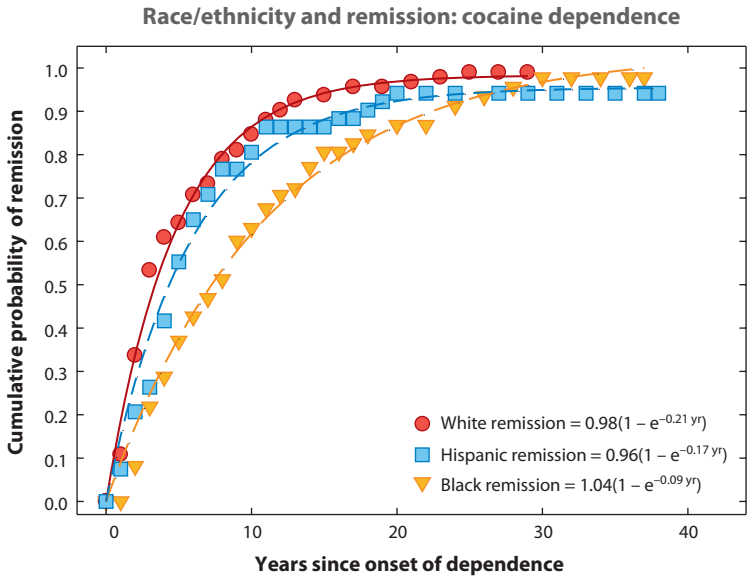

Figure 5

The cumulative proportion of remitted cases as a function of onset of cocaine dependence and race/ethnicity (Lopez-Quintero et al. 2011).

smokers outnumbered heavy cocaine users by seventeen to one, and alcoholics outnumbered heavy marijuana users by nine to one (Lopez-Quintero et al. 2011).

Racial/Ethnic Differences in Remission Rates

Figures 3 and **4** show that the probability of remitting varied as a function of type of drug. Lopez-Quintero et al. (2011) report that the remission rate also varied as a function of racial/ethnic group. The differences for marijuana and alcohol were small, but for cigarettes and cocaine they were relatively large. **Figure 5** shows the results for cocaine and race/ethnicity. The exponents on the best fitting equations imply that African Americans were about half as likely to remit as whites. This difference has profound consequences for how long heavy cocaine use persists. For example, after year 3 about 50% of whites had remitted, whereas the 50% criterion was not met until year 8 for African Americans. Considering that the median age of onset for drug dependence is about 20 (Kessler et al. 2005a) and that the mid-twenties is a period in which many people begin to start their careers and families, these differences are likely to have lifelong consequences.

Treatment

Recall that in 1962 Winick did not list treatment as a factor in "maturing out of addiction," whereas today it is widely believed that remission depends on treatment (e.g., McLellan et al. 2000, O'Brien & McLellan 1996). On the basis of the national surveys it is possible to shed some light on the issue. In the ECA survey, 30% of those who met the criteria for dependence or abuse said "yes" to the question, "Did you mention your drug use to a health specialist?" (Anthony & Helzer 1991). This sets an upper limit on the percentage in treatment, so it is likely that less than 30% ever were in treatment.

In the NESARC survey, treatment was broadly albeit concretely defined. It included 12-step programs, social service agencies, inpatient wards, detoxification, methadone, residence in a halfway house, emergency room care from professionals (physician, psychiatrist, psychologist, and others), religious counseling, and so on. Nevertheless, no more that 16% of those who currently met the criteria for addiction were in treatment. This does not mean that just 16% of those who ever met the criteria for dependence were ever in treatment, but it does suggest that many of those who did remit were never in treatment. In support of this point is the large literature on unassisted recovery, referred to at the beginning of this review.

To my knowledge, the relationship between treatment and remission for addiction in population samples has yet to be published. However, Robins's (1993) study of Vietnam enlistees provides some relevant information on this matter. Entry into the army was determined largely by lot. There were of course biases in the system, for example, educational deferments, but given the way the draft worked it is plausible that the enlistees approximated a random sample of healthy American men aged 18 to 25. Of those who met the criteria for opiate dependence at departure from Vietnam, 6% reported that they had been in treatment. Their one-year relapse rate was nearly 70%. For the 94% that did not seek treatment, the relapse rate was less than 12%

Thus, it is fair to say that treatment is not a necessary condition for remission from drug dependence. In the ECA and Vietnam studies, the majority of the individuals who remitted were not in treatment, and it is highly likely that this was also the case for those who remitted in the NESARC study.

Age 30

According to Winick's (1962) analysis, most heroin addicts should no longer be dependent by their mid-thirties. As the average age for the onset of dependence is about 20, we can check if the results of Lopez-Quintero et al. (2011) agree with Winick's predictions. For instance, at year 10 in **Figures 3** and **5**, the participants are on average 30 years old. For nicotine, alcohol, marijuana, and cocaine dependence, the cumulative remission percentages at year 10 were 20%, 40%, 69%, and 79%, respectively, and at year 15, which corresponds to an average age of about 35, they were 28%, 49%, 81%, and 89%, respectively. Thus, Winick's analysis of heroin addicts overestimates remission percentages for the legal drugs but underestimates them for the illegal drugs.

Making Sense of High Relapse Rates and High Remission Rates

As noted in the Introduction section, some addiction studies report very high relapse rates, whereas others report very high remission rates. One possibility is that there are two kinds of addicts. Some addicts are truly compulsive drug users and invariably relapse. Other addicts are not really compulsive, and they can quit drugs. A similar idea is that researchers mistakenly lump together heavy but voluntary drug users with compulsive drug users. By this line of reasoning, only those addicts who do not quit are true addicts. A third possibility is that individuals who meet the DSM criteria for substance dependence share the same disorder but differ in terms of how long the disorder lasts. The relationship between the fitted lines and the data points supports the single-distribution interpretation. The equations represent a unitary process: Each year a fixed percentage of addicts quit using drugs at clinically significant levels. If this assumption were wrong then the data points would systematically deviate from the theoretical curves; they do not. However, before saying more about the implications of the last several graphs, the validity of the survey results needs to be assessed.

METHODOLOGICAL ISSUES

The survey findings are orderly. When different research programs used the same criteria for measuring remission, the rates hovered at about 80%, with an average absolute deviation of just 2.7%. The ECA remission rate was lower, but this was due to differences in the remission criteria. The relationship between probability of remission and onset of dependence was the same for four different drugs and for three different racial/ethnic populations. However, the rate constants differed as a function of drug and ethnicity, sometimes sizably. This is significant when dependence is counted in years. Nevertheless, epidemiological research methods are suspect. The interviewees may make errors, exaggerate or downplay drug use, or simply deceive the interviewer. The researchers may systematically fail to recruit certain drug users, and those drug users who are harder to contact may also be the ones who are less likely to stop using drugs. And, as is often pointed out, remission may be temporary. This could falsely increase remission rates. In light of these issues, a number of researchers and clinicians have questioned the reliability of the survey findings (e.g., Moos & Finney 2011). Their main point is that the high remission rates may be seriously misleading because single interviews cannot provide reliable estimates of the time course of addiction, and the addicts who stop using drugs are the ones most likely to participate in survey research. In support of these points, a number of epidemiological surveys are notorious for their unreliable estimates of the frequencies of psychiatric disorders (see discussion by Regier et al. 1984). However, these are empirical matters, and to my knowledge, no one has evaluated whether the errors in the ECA, NCS, and NESARC surveys are on the same scale as those that beset past epidemiological studies.

Are the Remission Rates Stable?

Clearly, some of those who are in remission for a year or more will relapse; conversely, some of those who are currently addicted will later remit. However, if remission is relatively stable, then the cumulative remission probabilities must increase, as in **Figures 3** and **5**. Similarly, if remission is stable, then treatment follow-up studies that track a cohort over a period of time should find an ever-increasing proportion of their subjects in remission. **Figure 6** summarizes a test of this idea.

I conducted a literature search based on the key terms "longitudinal," "remission," "follow-up," and "addiction or drug dependence." It produced a number of alcohol studies and a few drug studies. **Figure 6** shows the treatment results for the experiments that included three or more posttreatment evaluations and retained at least 70% of the participants for the course of the study.

Remission Stability in Treatment Follow-Up Studies

On the *x*-axis are successive follow-up evaluations. It is an ordinal scale because the actual time intervals varied widely, with some studies lasting 3 years (e.g., Teesson et al. 2008) and others lasting as long as 18 years (Vaillant 1973). The *y*-axis shows remission. However, the values were adjusted to take into consideration subjects who had died, were in prison, or for some other reason stopped participating in the study. Those who were missing but still alive may have relapsed, or they may have started a new, sober life and no longer want to have anything to do with drug use—including its researchers. In a recent review of the follow-up literature, Calabria and colleagues (2010) dealt with this issue by calculating two remission rates, one based on the actual number of remaining subjects and one based on the original study population. For example, if there were originally 200 subjects and at the last follow-up 140 were located, with 70 meeting the criteria for abstinence, the remission rate was 50% according to the actual number of remaining subjects, but

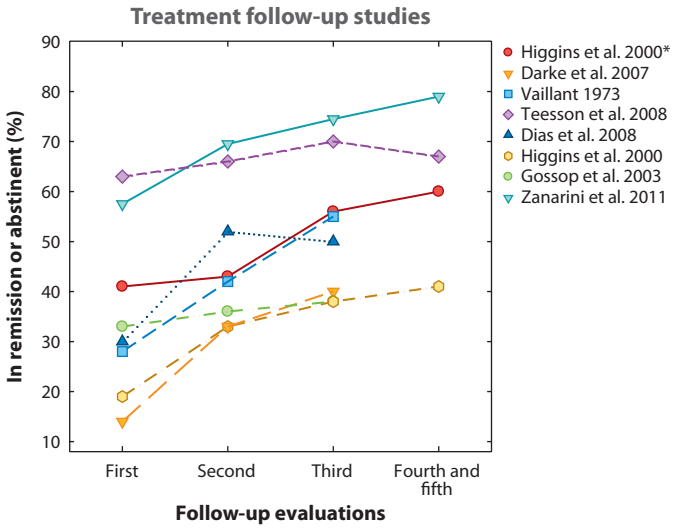

Figure 6

Remission at three different posttreatment times in addicts who are in treatment. Note: Asterisk indicates the Higgins et al. (2000) condition in which the treatment subjects received vouchers for clean urine samples.

35% according to the original number of subjects. The current sample size method necessarily gives the highest possible remission rate and is precisely correct if the missing subjects do not differ from the present subjects. The original sample size method necessarily gives the lowest possible remission rate and is precisely correct if all the missing subjects are still using (or would be still using if alive). Because it is unlikely that every missing addict resumed heavy drug use or that the missing subjects are exact replicates of the reevaluated subjects, the true remission rate must fall in between these two extremes. I dealt with this dilemma by taking the midpoint between the two ways of estimating remission rates.

Figure 6 shows that the absolute remission rates varied widely. This reflects the heterogeneous nature of the experiments. Drugs varied, the demographic characteristics of the addicts varied, and the criteria for remission varied. For example, in Vaillant's (1966, 1973) studies all the subjects were male, more than 90% had a prison record, and the remission criterion "was not abusing opiates in the previous year," whereas in Zanarini et al.'s (2011) study, 77% of the subjects were female, about one-third came from the top two tiers of the Hollingshead social economic scale (Zanarini et al. 2003), and remission was defined as two years of not meeting the criteria for drug dependence. However, despite the methodological differences, remission rates showed a similar pattern: They increased over time. Although the problem of missing subjects complicates the calculations, the increasing trends imply or strongly suggest that remission had to be stable. For instance, for those studies in which the remission rate exceeded 50%, the likelihood of remaining remitted had to be greater than 50% in order for the graph to show an increasing trend. For those follow-up projects in which remission rates increased but were below the 50% mark, this also may have been the case.

Note that the data points in **Figure 6** refer exclusively to drug users who were in treatment. This is because I could locate only one community study that had more than two evaluations. The Vietnam enlistees who were the participants in Robins's famous study of opiate use (1993) were evaluated four times (Ledgerwood et al. 2008, Price et al. 2009, Robins 1993). For those who met the criteria for dependence in Vietnam, the remission rates at 1 year, 3 years, and 24 years

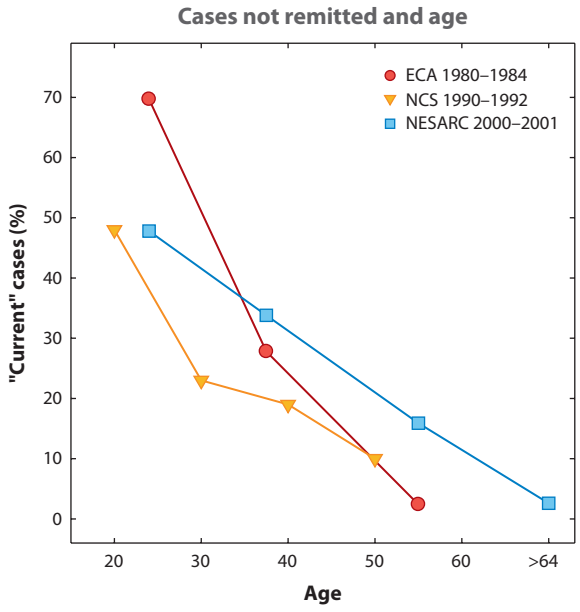

Figure 7

Active cases as a function of age (cohort) in the national epidemiological surveys. If age were the only determinant of relapse, the lines would be perfectly parallel.

were 95%, 88%, and 96%, respectively, and at each evaluation the verbal reports were confirmed by urine and/or hair samples for opiate metabolites. Thus, the follow-up research indicates that overall those who remit are more likely to stay remitted than to relapse.

The Relationship Between Age and Remission in Cross-Sectional Studies

The "current" status of the participants in the epidemiological surveys reflects a single moment in time. If someone qualifies as "currently dependent," they may not be dependent in the future, and, conversely, they may not have met the criteria for dependence in the past. Nevertheless, because we have data from four studies, conducted over a 30-year period, it is possible to fit them together so as to infer a longitudinal picture. In particular, if the relationship between age and dependence is about the same within each cohort, then it will be the same between cohorts. Thus, graphs of the age-dependence relationships for each study should look about the same. **Figure 7** tests this prediction.

Figure 7 shows current cases of dependence as a function of age for the ECA, NCS, and NESARC surveys (age data for the NCS-R do not appear to be available in print). Current cases decreased, and, as predicted, the lines connecting the percentages are roughly parallel, which means that the age/dependence correlations were about the same across cohorts. Importantly, the lines connecting the observations are steeply declining. The simplest interpretation of the steep downturn is that remission was relatively stable.

Do the Epidemiological Surveys Miss a Significant Number of Addicts?

The surveys must miss some addicts. Addicts who don't quit using drugs are more likely to die, and according to some observers, addicts who remain heavy drug users are more likely to live in neighborhoods that are not adequately sampled by outside researchers. The directors of the ECA

survey oversampled at-risk populations, such as men in jail, to compensate for these potential biases, but later surveys appear not to have taken this tack. However, even if they had, there is probably no practical way to guarantee that addicts who are currently heavy drug users have the same likelihood of participating in research studies as addicts who are in remission. Thus, the question should be "to what extent will selection biases distort the survey results?" A 2010 letter to the editor of the *American Journal of Psychiatry* (Compton et al. 2010) introduces some of the issues.

Wilson Compton and his colleagues point out that the post-ECA community surveys did not sample individuals incarcerated in jails and prisons, a population that has high drug use rates. The authors calculate that this omission implies that the prevalence of drug dependence is about 25% higher than reported by epidemiological studies such as NESARC and NCS. Assuming that Compton and his colleagues are correct, what are the implications for the reported remission rates? For example, what is the true remission rate if 25% of all addicts were overlooked? How much lower would it be than the one that was reported? We can answer these questions with the help of the equation that was used to calculate the remission rates.

Calculating the Impact of Missing Addicts

Recall that the overall percentage of remitted cases is simply (Lifetime% – Current%)/Lifetime%. If we now add in the missing addicts, calling them "*X*", we can calculate the relationship between remission and missing addicts: $Remitted\% = ((LT + X) - (C + X))/(LT + X)$. The results are informative. If there were 25% more addicts than reported by NCS-R and NESARC and not one stopped using drugs, then the overall remission rate in these two surveys would decrease from approximately 80% to about 64%. However, if one out of two missing addicts quit by about age 37, which is about the average age for addicts in these surveys, then the overall current remission rate would pop back up to about 74%. Thus, if the surveys really did overlook 25% of all addicts, it would not change the conclusion that most addicts quit using drugs by about age 30.

Taking the logic of the above calculation one step further, we can also calculate the number of missing addicts for the claim that addiction is really a chronic, relapsing disease. Set the "real" remission rate at, say, 20%, rather than what was found: 80%. Then, solve for *X* in the "remitted percent" equation. The answer says that there have to be three missing addicts for every one that the surveys counted, and not one can have quit using drugs. Given that the percentage of lifetime cases of substance dependence is approximately 2.8% (Conway et al. 2006, Kessler et al. 2005a), this would imply that approximately one in ten adult Americans had become addicted to an illicit drug and that most were currently addicted. Assuming an adult population of 238 million (U.S. Census 2011; **www.census.gov**), this would increase the number of current addicts by almost 20 million. Put more generally, the idea that the high remission rates are a methodological artifact (due to missing addicts) requires the assumption that there are millions of addicts who never quit drugs and that despite the terrible problems that attend drug use, they have also escaped notice.

On the Validity of Self-Report in Epidemiological Surveys

Because self-report is fundamental to the understanding of addiction, researchers have used a variety of methods to check the validity of what their informants tell them. The most direct approach is to compare what informants say about drug use with metabolic tests of drug use. The correlations vary greatly. Some researchers routinely report low agreement between the metabolic tests and self reports, with the difference in the direction of underreporting (e.g., Fendrich et al. 2004), whereas others find "remarkable . . . consistency" (e.g., Darke 1998). However, a consensus appears to have emerged, yielding three generalizations. (*a*) When respondents have no apparent

fear of negative consequences, their self-reports match the metabolic results, whereas when censure or worse is possible, their reports are palpably false (e.g., Darke 1998, Land & Kushner 1990, Nair et al. 1994, Weatherby et al. 1994). (*b*) Underreporting is more likely in minorities and subjects that meet fewer dependence criteria (e.g., Colón et al. 2002, Ledgerwood et al. 2008). (*c*) False positives are not uncommon (i.e., subjects report drug use when the biological assays reveal no drug metabolites).

False positives are of particular interest, as they suggest that discrepancies between words and drug tests reflect recall errors. The drug-positive Vietnam veterans provide an interesting example of this phenomenon. In the 1996 follow-up evaluation of this population (referred to in the discussion of whether remission is a stable state), 6% of the Vietnam enlistees who had served as subjects in Robins's (1993) research reported that they had used opiates in the past 90 days (Ledgerwood et al. 2008). However, hair tests for metabolites revealed that 4.5% had used opiates. That is, the self-report prevalence was higher than metabolic prevalence. Other researchers report similar errors (e.g., Colón et al. 2002).

These results suggest that whether individuals candidly respond to questions about drug use depends on the nature of the study. For studies that used the techniques that are characteristic of the large national surveys, verbal reports typically matched the metabolic test results; however, there are exceptions (e.g., Fendrich et al. 2004). Some of the variation possibly is due to factors that are hard to measure, such as rapport between investigator and informant. In any case, as noted next, there are other ways of measuring the validity of the survey results.

Diagnostic Validity

A prerequisite for valid survey data is valid diagnostic nomenclature. Different diagnoses should predict different patterns of behavior. This was a central concern of the researchers who put together the ECA survey. No one had previously attempted to accurately diagnose 20,000 people who were not seeking psychiatric care. To see if their approach was going to work, the ECA researchers tested 325 respondents twice, at an interval of a year (Helzer et al. 1987). The interviews were carried out by psychiatrists and the lay interviewers who had been trained to conduct the ECA interviews. The dependent measures of most interest were diagnosis, use of clinical services, and drinking and/or drug problems in first-degree relatives. The Wave 1 diagnosis predicted mental health service visits, Wave 2 diagnosis, psychiatric history in first-degree relatives, and drinking problems in first-degree relatives. Moreover, the lay diagnoses and psychiatrist diagnoses were equally good at predicting Wave 2 outcomes.

Finally, as noted in the beginning of this review, perhaps the most telling evidence for the validity of the DSM criteria is that they have served as the foundation for an ever-increasing and systematic body of information on drug use and addiction. This would not be possible if the criteria failed to meaningfully distinguish between destructive drug use and nondestructive drug use.

Summary of Methodological Issues

The methodological problems that attend epidemiological studies of psychiatric disorders are well known and in the past have led to misleading results (e.g., Regier et al. 1984). Moreover, to some extent the problems are unavoidable. However, the proper question is not whether self-reported levels of drug use are sometimes wrong, but rather the degree to which the errors have influenced a particular set of findings. With data and logic, we can estimate the magnitude of the errors. For the major epidemiological surveys summarized in this review, this sort of logical/empirical analysis suggests that remission is relatively stable and that it is unlikely that there are enough missing

addicts to alter the finding that most addicts had stopped using drugs at clinically significant levels by about age 30. Similarly, the analysis revealed no good reason to doubt that the rate of remission remains approximately constant as a function of time since onset of dependence.

DIFFERENCES IN REMISSION RATES

Figures 1 to **5** reveal that addiction comes to an end in an orderly and reliable manner. The figures also reveal that individuals differ markedly in how long they remain problem drug users. Among those dependent on cocaine, half had remitted by four years, but 10% were dependent for at least 16 years, and 5% were dependent for at least 23 years. Similarly, although half of those dependent on marijuana remitted by year 7, 10% remained dependent for at least 23 years, and 5% remained dependent for at least 36 years. The graphs themselves shed some light on these differences; for instance, remission rates were much lower for legal drugs than for illegal drugs. However, the graphs, although orderly, are also puzzling. There is no theory of addiction that predicts that the probability of quitting drugs is independent of how long heavy drug use has been in place. Consequently, at this point little of substance can be said about the shape of the remission functions. However, much is known about the factors that are correlated with quitting drugs. The next section addresses this issue. The account is selective: I focus on the variables that were correlated with the differences in **Figures 3** to **5** (type of drug and race/ethnicity) and then review a series of historical events that led to major changes in addiction rates. A common factor in these events is a sudden change in the setting, analogous to an experimental manipulation. For instance, in 1914, opiates, which had been legal, were prohibited. According to the view that opiate addicts are compulsive drug users, the change in legal status should have had little influence on addiction rates. However, according to **Figure 3**, legislation may have a major influence on addiction. Although this review focuses primarily on illegal drugs, the historical examples of legislative influences on substance use include alcohol (Prohibition) and cigarettes (the anti-smoking campaign).

Racial/Ethnic Differences in Remission

Figure 5 shows that the half-life for cocaine dependence was more than twice as long for black Americans than for white Americans. However, race in the United States is correlated with a number of factors that influence drug use, such as education level and demographic characteristics (e.g., Heyman 2009, Warner et al. 1995). Arndt and colleagues (2010) tested whether these correlates explained the racial differences. They ran a series of multivariate analyses, with remission as the dependent measure and race plus its demographic correlates as the independent variables. Race/ethnicity continued to predict remission when treatment history, age of onset, current age, and gender were included in the analysis. However, when the multivariate model included marital status and completion of high school, the ethnic/racial differences disappeared; they were no longer significant correlates of remission. If race were a proxy for marital status and education in the NESARC project, then marital status and education should predict remission in other, similar surveys. This turns out to be the case. In the NCS survey, subjects with lower education levels were more likely to remain dependent on illicit drugs, although those with higher education levels were more likely to experiment with illicit drugs (Warner et al. 1995). In the ECA study, marital status was a potent predictor of dependence and abuse. Among active cases, 24% were married, but 61% were single (table 13.14 in Robins & Regier 1991). In contrast, for most other psychiatric disorders, individuals who are married make up the bulk of active cases (for a graph of these data, see Heyman 2009). Thus, the correlations between remission and race in **Figure 5** reflect more fundamental associations between education and drug use and marital status and drug use.

Drug Differences in Remission

Figure 3 shows that remission rates for legal drugs were much lower than for illegal drugs; in the illegal category, remission rates for marijuana were lower than for cocaine; and in the legal category, remission rates for cigarettes were much lower than for alcohol. The differences could reflect availability, pharmacology, or both. There is no gold standard for evaluating a drug's pharmacological addiction potential; however, reward value, as measured in animal self-administration tests, and subjective judgments in laboratory settings are probably the most popular approaches. In subjective tests of a drug's capacity to produce stimulating pleasurable effects, alcohol trumps tobacco and cocaine trumps marijuana (e.g., Warburton 1988). But this result yields predictions that are just the opposite of what was found. In subjective tests of a drug's capacity to produce relaxing pleasurable effects, alcohol again trumps tobacco, but marijuana is considerably more relaxing than cocaine. Thus, human psychopharmacology tests provide little insight into the remission rates. Animal self-administration studies also make the wrong predictions or are of little help. For instance, rats much more readily dose themselves with cocaine than with nicotine (see, e.g., Lenoir et al. 2007, Peartree et al. 2012).

In contrast to the pharmacological findings, availability provides a simple account of drug differences in remission. Marijuana is much more widely used than cocaine (e.g., Heyman 2009), and cigarettes remain easier to obtain than alcohol. For example, you can smoke while driving, and although smoking has become stigmatized, a morning drink is more frowned upon than a morning smoke. Thus, the simplest explanation of the differences in **Figure 3** is that remission rates for legal drugs are lower because legal drugs are more available than illegal drugs. This interpretation suggests that legislation can influence remission from addiction. From the perspective of other psychiatric disorders, this is a surprising result. We do not expect legal rulings to influence the course of schizophrenia or obsessive-compulsive disorder. However, if **Figure 3** reflects drug availability, then anti-drug legislation and anti-drug social movements should increase remission rates. Events in the history of opiate, alcohol, and cigarette use provide interesting tests of this prediction.

Legislation, Opiate Addiction, and Remission

The Harrison Narcotics Tax Act offers an opportunity to test whether drug use in addicts is significantly influenced by the threat of arrest. In 1914, President Woodrow Wilson signed the Harrison Narcotics Tax Act into law. Although the law did not mention addiction, its effect was to make nonmedical opiate and cocaine use illegal. Hitherto, opiates and cocaine were legal and could be purchased at a local pharmacy or by way of the postal service from a mail-order company, such as Sears Roebuck. Historians concur that the number of addicts was between 200,000 and 300,000, and was probably closer to the larger number (e.g., Courtwright 1982, Musto 1973). Opiates were the drug of choice, and they had three different types of users: laudanum drinkers, opium smokers, and (after 1899) heroin sniffers. Each form of self-administration was linked to a distinct demographic profile. Laudanum drinking was referred to as an "aristocratic vice" (Day 1868), opium smoking attracted "evil" men and "ill-famed" women (Courtwright 1982), and heroin attracted young, largely unemployed, delinquent high school dropouts, referred to as "heroin boys" (Bailey 1916).

Following the Harrison Act, laudanum drinkers and opium smokers all but disappeared. Laudanum drinkers did not switch to heroin but rather sought treatment or somehow stopped using. Less is known about opium smokers, but as most were on the West Coast, few probably switched to heroin, which at the time was primarily an East Coast urban drug. Heroin use persisted, but because it was illegal, it became even more closely tied to criminal activity. Criminal

gangs took over heroin's distribution, adulterated heroin with inert substances, and raised prices. Users switched to injecting heroin in order to get the same kick that snorting had provided. Among the first to document the transformation of opiate use in America were Lawrence Kolb and A. G. Du Mez, physicians who worked for the Public Health Service and specialized in addiction. They characterized the demographic consequences of the Harrison Act in the following words:

> [A]ddiction is becoming more and more a vicious practice of unstable people, who, by their nature, have abnormal cravings which impel them to take much larger doses than those which were taken by the average person who so often innocently fell victim to narcotics some years ago. Normal people now do not become addicted or are, as a rule, quickly cured, leaving as addicts an abnormal type with a large appetite and little means of satisfying it. (Kolb & Du Mez 1924, p. 1191)

Put another way, the middle class laudanum drinkers disappeared, and the remaining addicts were hardened versions of Bailey's heroin boys.

The influence of the Harrison Act on opiate use in the United States reveals that social policy can influence the course of addiction but that it does so differentially. In this particular case, the differences have both pharmacological and demographic correlates. The new policy put pressure on drug use, and in predictable ways, some addicts stopped using drugs whereas others did not.

Legislation, Alcoholism, and Remission (Prohibition)

The Volstead Act prohibited the sale of "intoxicating liquors" in the United States between 1919 and 1933 (Prohibition). The law did not alter the demand for alcohol, and as a consequence, sales shifted from the legitimate market to the black market, which led to large increases in the price of alcohol. The initial reaction was a decrease in alcohol consumption. Economic-oriented researchers in both Canada and the United States wondered if alcoholics also began to drink less (e.g., Miron & Zwiebel 1991, Seeley 1960). They did not have any direct estimates of drinking in alcoholics, but instead used symptoms of alcoholism, such as cirrhosis of the liver, to determine whether Prohibition reduced drinking in alcoholics. This is a reasonable strategy. Most cases of cirrhosis of the liver are due to alcoholism, and when drinking stops, cirrhosis of the liver stops progressing.

In Canada, Prohibition led to a spike in the price of alcohol, although the beverage was still legal (Seeley 1960). This was followed by a deep dip in alcohol consumption and about a one-third drop in cirrhosis cases (for a graph of the results, see Heyman 1996). Miron & Zwiebel (1991) report a similar pattern for the United States, including significant decreases in alcoholic deaths and cirrhosis of the liver. Thus, the evidence suggests that an increase in price led to a decrease in drinking in alcoholics. Put more generally, drug availability has an inverse relationship with remission rates, which helps explain why alcohol and tobacco addiction last so much longer than cocaine and marijuana addiction.

The Antismoking Campaign, Education, and the Decline in Cigarette Dependence

For some years, smoking has been the target of an intense antismoking information campaign. Billboards, radio and television spots, and media accounts list the health risks of smoking. It is easy to imagine that the campaign will discourage someone to begin smoking, but it is not obvious that it could persuade an addicted smoker to give up cigarettes. Note that most smokers are regular smokers, and their behavior usually meets the criteria for addiction. Indeed, many addiction experts count cigarettes as an extremely addictive drug (e.g., Gahlinger 2001). Thus, the relationship

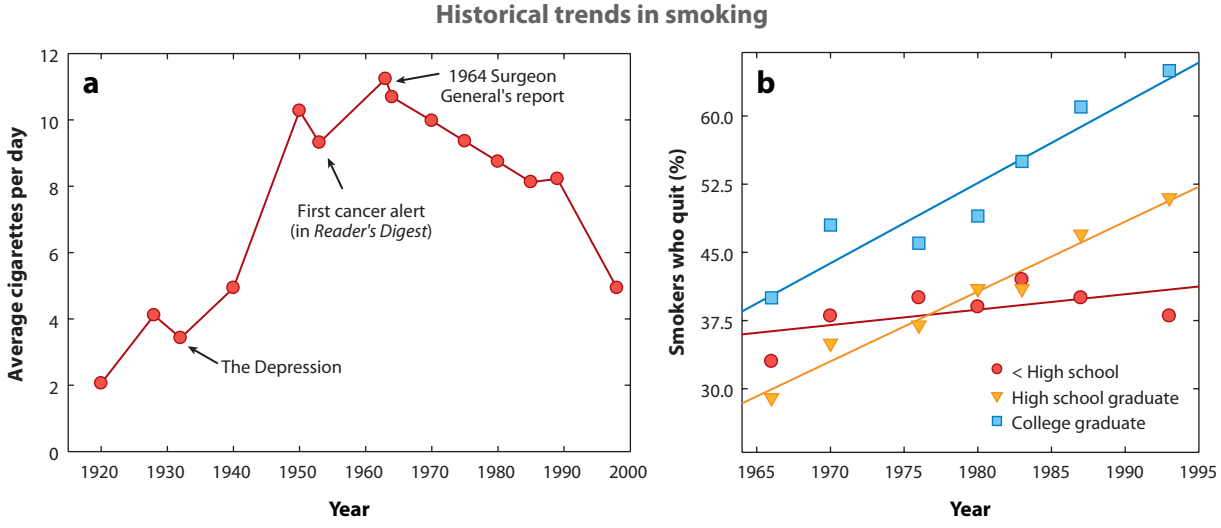

Figure 8

(*a*) Per capita cigarette sales as a function of time; the beginning of the Depression and the dates of two publications that focused on the health risks of smoking are highlighted. (*b*) Quit rates as a function of educational attainment.

between the antismoking campaign and smoking provides a test of whether information influences remission rate.

Figure 8 shows per capita cigarette consumption as a function of time for the years 1920 to 1995 (based largely on Fiore et al. 1993). The key dates are 1954 and 1964. In 1954, *Reader's Digest* published a widely read article that summarized the health risks of smoking (Miller & Monahan 1954). The graph shows that the article was followed by a marked decrease in smoking. In 1964, the U.S. Surgeon General published a massive summary of research results on the correlation between smoking and illness, focusing on lung cancer (U.S. Surg. Gen. Advisory Comm. Smok. Health 1964). Although highly technical, the report was headline news. The graph shows that its release was followed by a downturn in per capita smoking that is still in progress. Of course, the graph cannot tell us if there really is a causal link between the report and the decreases in smoking, but circumstantial evidence supports this interpretation. The downturn occurred immediately, preceding prohibitions on smoking, tax increases, warning labels, and the stigma that now surrounds smoking.

Figure 8*b* shows that smoking remission rates have varied according to education level. Those with more education have been more likely to quit. If we assume that those with more education are more susceptible to the influence of science-based information, then this graph supports the interpretation that information is one of the factors that has persuaded smokers to quit cigarettes. Put more generally, the graph suggests that information can influence the course of addiction.

Summary

Marital status, educational attainment, fear of arrest, drug price, and health concerns make a partial but representative list of the factors that influence remission from drug dependence. A common feature of the entries on this list is that each one is also a factor in decision making. Availability, price, and legal concerns are the sorts of things that influence our day-to-day decisions. Put more generally, the correlates of choice are also correlates of remission from drug dependence.

In contrast, the historical record does not provide a similar list of correlates for the frequencies of other psychiatric disorders. There is no equivalent of the Harrison Act or Prohibition for schizophrenia or obsessive-compulsive disorder. Similarly, we would not mount an advertising campaign against the symptoms of depression or anxiety, yet we have successfully done so in the case of nicotine dependence. Of course, psychiatric disorders have social correlates, but not to the degree that is found with remission from drug dependence.

A second feature of the list is that individual differences always played a role. Some drug users were influenced by legal sanctions; some were not. Similarly, at each education level some smokers were influenced by the Surgeon General's Report; others were not. This variation points to an important gap in this listing of the factors that influence remission. It is not exhaustive, and in particular, it is missing personal traits that influence remission, such as attitudes, ideas, and values (see, e.g., Miller 1998).

DISCUSSION

Winick Evaluated

Winick's paper included a number of important claims regarding the nature of remission. His estimate that most addicts quit in their mid-thirties turns out to be too old for cocaine and marijuana but too young for alcohol and cigarettes (see section Age 30, above). His maturing-out hypothesis entails two testable aspects. First, it predicts that addicts can remit without the benefit of treatment. Second, it predicts that the likelihood of remitting systematically varies as a function of age. We saw that many addicts do in fact remit without the benefit of professional help, so on that score Winick is correct. However, Winick's maturing-out theory was not supported by the results. Maturing out implies that the likelihood of quitting increases with age. This did not happen. Remission rates remained constant. Thus, the title of his article notwithstanding, Winick did not get the psychological dynamics of remitting right.

Others have also noticed that the probability of remission appears to be stationary. Vaillant explicitly discusses Winick's theory in his 20-year follow-up study of 100 Lexington U.S. Public Health Service Hospital narcotic addicts (Vaillant 1973). He concluded that "stable abstinence can be achieved at any point in an addict's career . . . whether an addict was addicted for one year or ten years did not appear to affect the odds that he would become abstinent over the next five years . . ." (p. 239). More recently, Verges et al. (2012) reported that the likelihood of remitting from alcohol dependence changed little as a function of time since onset.

Updating Winick

According to Winick, remission reflected psychological growth. According to the results presented in this review, remitting does not have a temporal trajectory. However, the results do agree with Winick in that they show that for illegal drugs, addiction is a disorder of youth. The typical illicit drug addict quits using drugs at clinically significant levels after about six to eight years from the onset of dependence and before he or she is 30 years old (assuming onset at about age 20). However, it is also the case that a significant minority of illicit drug addicts keep using for much longer. According to the material presented in this review, we can explain these differences in terms of the conditions surrounding drug use, such as price, health risks, and education level, as well as individual differences in susceptibility to these circumstances (e.g., personal values and attitudes). Related to this point, the finding that a single distribution function summarized the probabilities of quitting suggests that those who quit and those who did not quit share common characteristics that

function at different rates. There is not a subset of voluntary addicts who stay remitted and another subset of compulsive addicts who keep relapsing. Or put somewhat differently, if the correlates of quitting drugs are the correlates of decision making, then the correlates of not quitting are also the correlates of decision making.

SUMMARY POINTS

1. Chronicity. Although addiction is often described as a chronic relapsing disease, studies that recruited a wide range of drug users have found that it is not. The NESARC project (Lopez-Quintero et al. 2011) found that among those addicted to cocaine, 27% had remitted after two years, 51% had remitted after four years, and 76% had remitted after nine years. For marijuana, 55% had remitted by six years, and 75% had remitted by twelve years. Since the typical onset age for dependence is 20, most addicts were no longer using drugs at clinically significant levels by age 30.
2. Treatment. The idea that addiction is a disease characterized by compulsive (involuntary) drug use goes hand in hand with the belief that addicts require lifelong treatment and that treatment is necessary for recovery. However, the epidemiological results indicate that most addicts do not take advantage of treatment; nevertheless, most quit. The logical inference is that remission from drug dependence does not require treatment. The literature on unassisted recovery supports this conclusion (e.g., Klingemann et al. 2010, Mariezcurrena 1994, Sobell et al. 1999, Toneatto et al. 1999). Thus, the claim that remission from drug dependence requires lifelong professional support is not supported by the relevant data.
3. Legal versus illegal drugs. Although this review focuses on illegal drugs, it is noteworthy that remission rates were found to be substantially lower for legal drugs. When remission is expressed as years of dependence, the expected values are approximately 6, 8, 20, and 42 years for cocaine, marijuana, alcohol, and cigarettes, respectively (these calculations assume that the fitted rate constants, r, in the exponential equations are exactly on target, so that the average duration for dependence is $1/r$). These differences are large and suggest that drug availability plays an important role in the persistence of dependence.
4. Demographic correlates. Addiction is sometimes characterized as an equal opportunity disease (e.g., Chasnoff et al. 1990, Rosenberg et al. 1995). However, **Figure 5** shows that racial/ethnic differences in remission rates and the duration of addiction can be quite large. This result differs from the racial/ethnic correlates of experimentation with illegal drugs. For example, the initial NCS survey reported that whites had higher rates of "ever" using an illicit drug but lower rates of "12-month" (current) dependence (Warner et al. 1995).
5. Stationary remission probabilities. The probability of remission remained constant and independent of time since the onset of drug dependence. On the basis of both pharmacological and choice theories of addiction, this is a surprising result. Time since onset is necessarily correlated with drug exposure: The longer someone has been dependent, the more drugs he or she has consumed. Thus, any theory that claims a large role for pharmacology in remission (for example, the idea that addiction is the result of drug-induced neural adaptations) predicts that as drug use proceeds, the likelihood of remission must decrease. Yet remission probabilities were stationary and thereby independent of cumulative drug dose.

This same puzzle attends choice theories of addiction. For example, in Herrnstein & Prelec's (1992) analysis of addiction, drugs undermine the value of competing rewards so that the value of the drug increases over time. The data in **Figures 3**, **4**, and **5** are inconsistent with this account. The constant remission probabilities imply that after the onset of dependence, the relative value of drug use remained constant.

FUTURE ISSUES

1. Stationary remission probabilities. That the probability of remission did not systematically increase or decrease as a function of time has no ready explanation. As emphasized, this also means that given the onset of dependence (which does of course involve exposure to drugs), there was no systematic relationship between remitting and further exposure to drugs; similarly, there was no systematic relationship between remitting and further exposure to the problems that heavy drug use causes. Although this finding has no ready solution, a somewhat more elaborate description of the stationary remission rates may prove useful.

   The relationship between remitting and time is compatible with the idea that addiction involves a steady but fragile state that can abruptly shift to a new state. For example, ethnographic studies reveal that for many drug users, addiction is not simply drug use but also represents a way of life that involves a social network and social roles (e.g., Biernacki 1986, Waldorf 1983, Waldorf et al. 1991). What **Figures 3** to **5** add to this picture is that addiction is a static way of life that does not weaken or deepen but instead ends abruptly. In support of the abruptness of remission are the idioms associated with quitting drugs. Remission is linked to the phrases "kicking the habit" and "going cold turkey." Taken literally, these idioms refer to the symptoms of heroin withdrawal and have come to mean quitting any drug on your own, without professional help, and all at once. Also notice that we do not say someone emerged from depression or schizophrenia cold turkey. Thus, the language of addiction presaged the findings in this review, including their quantitative features. However, an explanation of why people quit drugs cold turkey but do not quit other psychiatric disorders cold turkey awaits explanation.

   Finally, it may also be useful to point out that **Figures 3** to **5** suggest that the probability of relapsing may also prove constant. This would be difficult to test and would be a most surprising result. For instance, if it were true then it would be possible to describe complex human behavior with simple Markov models that entailed multiple steady states and constant transition probabilities.

2. The influence of values and attitudes on remission. According to autobiographical accounts by ex-addicts, values and moral considerations, particularly in regard to family members, played a large role in why they eventually quit or cut back on drugs (e.g., Heyman 2009). Ex-addicts explain that they quit drugs in order to win back their parents or children's respect or that they were not raised to put their own desires ahead of those of their children (Jorquez 1983, Waldorf 1983). However, it is hard to interpret these findings because personal values are correlated with other factors, such as education and gender. What is needed is a research project that can dissociate values and the demographic factors that are correlated with both values and drug use.

3. Is treatment a significant predictor of remission in community samples? **Figure 6** shows that some treatment programs are associated with high remission rates (e.g., Zanarini et al. 2011), whereas others are not (e.g., Darke et al. 2007). However, it is not obvious that treatment is a better predictor of remission than is nontreatment when controls are in place for demographic factors. For example, the participants in Zanarini et al.'s (2011) successful treatment program were 77% female, with many having high-SES backgrounds. In contrast, in Darke et al.'s (2007) relatively less successful follow-up study, 65% of the participants were male, 54% had a criminal record, and only 18% were employed. Given that the NESARC researchers tracked the temporal pattern of remission and gathered information on the demographic characteristics and treatment history of their participants, it seems reasonable to suppose that their data set provides an opportunity to test whether treatment leads to higher remission rates when controlling for demographic factors that predict drug use.
4. The strongest correlate of remission was legal status. For instance, the half-life of alcohol dependence was about four times longer than the half-life of cocaine dependence (16 and 4 years, respectively). The simplest explanation of this difference is that alcohol is legal and therefore more available. However, during Prohibition, when alcohol was illegal, rates of drinking eventually crept back up to about 70% of their pre-Prohibition level (Miron & Zwiebel 1991). This means that the demand for alcohol remained relatively strong even though it had become illegal and suggests the possibility that if cocaine were a legal drug, alcohol dependence might still be more persistent than cocaine dependence. In any case, the role that legal status plays in drug dependence deserves more attention. The findings could prove useful as well as interesting.

DISCLOSURE STATEMENT

The author is not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

LITERATURE CITED

Am. Psychiatr. Assoc. 1980. *Diagnostic and Statistical Manual of Mental Disorders*. Washington, DC: Am. Psychiatr. Assoc. 3rd ed.

Am. Psychiatr. Assoc. 1994. *Diagnostic and Statistical Manual of Mental Disorders*. Washington, DC: Am. Psychiatr. Assoc. 4th ed.

Anthony JC, Helzer JE. 1991. Syndromes of drug abuse and dependence. In *Psychiatric Disorders in America: The Epidemiologic Catchment Area Study*, ed. LN Robins, DA Regier, pp. 116–54. New York: Free Press

Arndt S, Vélez MB, Segre L, Clayton R. 2010. Remission from substance dependence in U.S. Whites, African Americans, and Latinos. *J. Ethn. Subst. Abuse* 9:237–48

Bailey P. 1916. The heroin habit. *New Repub.* 6:314–16

Biernacki P. 1986. *Pathways from Heroin Addiction: Recovery Without Treatment*. Philadelphia, PA: Temple Univ. Press

Brecher EM. 1972. *Licit and Illicit Drugs; The Consumers Union Report on Narcotics, Stimulants, Depressants, Inhalants, Hallucinogens, and Marijuana—Including Caffeine, Nicotine, and Alcohol*. Boston, MA: Little, Brown. 1st ed.

Calabria B, Degenhardt L, Briegleb C, Vos T, Hall W, et al. 2010. Systematic review of prospective studies investigating "remission" from amphetamine, cannabis, cocaine or opioid dependence. *Addict. Behav.* 35:741–49

Chasnoff IJ, Landress HJ, Barrett ME. 1990. The prevalence of illicit-drug or alcohol use during pregnancy and discrepancies in mandatory reporting in Pinellas County, Florida. *N. Engl. J. Med.* 322:1202–6

Colón HM, Robles RR, Sahai H. 2002. The validity of drug use self-reports among hard core drug users in a household survey in Puerto Rico: comparison of survey responses of cocaine and heroin use with hair tests. *Drug Alcohol Depend.* 67:269–79

Compton WM, Dawson D, Duffy SQ, Grant BF. 2010. The effect of inmate populations on estimates of DSM-IV alcohol and drug use disorders in the United States. *Am. J. Psychiatry* 167:473–74

Conway KP, Compton W, Stinson FS, Grant BF. 2006. Lifetime comorbidity of DSM-IV mood and anxiety disorders and specific drug use disorders: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *J. Clin. Psychiatry* 67:247–57

Courtwright DT. 1982. *Dark Paradise: Opiate Addiction in America Before 1940*. Cambridge, MA: Harvard Univ. Press

Darke S. 1998. Self-report among injecting drug users: a review. *Drug Alcohol Depend.* 51:253–63

Darke S, Ross J, Mills KL, Williamson A, Havard A, Teesson M. 2007. Patterns of sustained heroin abstinence amongst long-term, dependent heroin users: 36 months findings from the Australian Treatment Outcome Study (ATOS). *Addict. Behav.* 32:1897–906

Day HB. 1868. *The Opium Habit, With Suggestions as to the Remedy*. New York: Harper

Dias AC, Ribeiro M, Dunn J, Sesso R, Laranjeira R. 2008. Follow-up study of crack cocaine users: situation of the patients after 2, 5, and 12 years. *Subst. Abuse* 29:71–79

Fendrich M, Johnson TP, Wislar JS, Hubbell A, Spiehler V. 2004. The utility of drug testing in epidemiological research: results from a general population survey. *Addiction* 99:197–208

Fiore MC, Newcomb P, McBride P. 1993. Natural history of tobacco use and addiction. In *Nicotine Addiction: Principles and Management*, ed. CT Orleans, J Slade, pp. 89–104. New York: Oxford Univ. Press

Freedman DX. 1991. Forward. In *Psychiatric Disorders in America: The Epidemiologic Catchment Area Study*, ed. Robins, DA Regier, pp. xiii–xxiv. New York: Free Press

Gahlinger PM. 2001. *Illegal Drugs: A Sagebrush Medical Guide*. Salt Lake City, UT: Sagebrush

Goldstein A, Herrera J. 1995. Heroin addicts and methadone treatment in Albuquerque: a 22-year follow-up. *Drug Alcohol Depend.* 40:139–50

Gossop M, Marsden J, Stewart D, Kidd T. 2003. The National Treatment Outcome Research Study (NTORS): 4–5 year follow-up results. *Addiction* 98:291–303

Grant BF, Dawson DA. 2006. Introduction to the National Epidemiologic Survey on Alcohol and Related Conditions. *Alcohol Res. Health* 29:74–78

Hasin DS, Hatzenbueler M, Smith S, Grant BF. 2005. Co-occurring DSM-IV drug abuse in DSM-IV drug dependence: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Drug Alcohol Depend.* 80:117–23

Helzer JE, Robins LN, McEvoy LT, Spitznagel EL, Stoltzman RK, et al. 1985. A comparison of clinical and Diagnostic Interview Schedule diagnoses: physician reexamination of lay-interviewed cases in the general population. *Arch. Gen. Psychiatry* 42:657–66

Helzer JE, Spitznagel EL, McEvoy L. 1987. The predictive validity of lay Diagnostic Interview Schedule diagnoses in the general population. A comparison with physician examiners. *Arch. Gen. Psychiatry* 44:1069–77

Herrnstein RJ, Prelec D. 1992. A theory of addiction. In *Choice Over Time*, ed. G Loewenstein, J Elster, pp. 331–60. New York: Sage Found.

Heyman GM. 1996. Elasticity of demand for alcohol in humans and rats. In *Advances in Behavioral Economics, Substance Use and Abuse*, ed. L Green, JH Kagel, vol. 3, pp. 107–32. Norwood, NJ: Ablex Publ.

Heyman GM. 2009. *Addiction: A Disorder of Choice*. Cambridge, MA: Harvard Univ. Press

Higgins ST, Wong CJ, Badger GJ, Ogden DE, Dantona RL. 2000. Contingent reinforcement increases cocaine abstinence during outpatient treatment and 1 year of follow-up. *J. Consult. Clin. Psychol.* 68:64–72

Hser YI. 2007. Predicting long-term stable recovery from heroin addiction: findings from a 33-year follow-up study. *J. Addict. Dis.* 26:51–60

Hser YI, Anglin D, Powers K. 1993. A 24-year follow-up of California narcotics addicts. *Arch. Gen. Psychiatry* 50:577–84

Jorquez JS. 1983. The retirement phase of heroin using careers. *J. Drug Issues* 13:343–65

Kessler RC, Berglund P, Demler O, Jin R, Merikangas KR, Walters EE. 2005a. Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Arch. Gen. Psychiatry* 62:593–602

Kessler RC, Chiu WT, Demler O, Merikangas KR, Walters EE. 2005b. Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. *Arch. Gen. Psychiatry* 62:617–27

Kessler RC, McGonagle KA, Zhao S, Nelson CB, Hughes M, et al. 1994. Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States. Results from the National Comorbidity Survey. *Arch. Gen. Psychiatry* 51:8–19

Kidorf M, Brooner RK, King VL, Stoller KB, Wertz J. 1998. Predictive validity of cocaine, sedative, and alcohol dependence diagnoses. *J. Consult. Clin. Psychol.* 66:168–73

Kirby K, Petry N, Bickel W. 1999. Heroin addicts discount delayed rewards at higher rates than non-drug-using controls. *J. Exp. Psychol.: Gen.* 128:78–87

Klingemann HK, Sobell MB, Sobell LC. 2010. Continuities and changes in self-change research. *Addiction* 105:1510–18

Kolb L, Du Mez AG. 1924. The prevalence and trend of drug addiction in the United States and factors influencing it. *Public Health Rep.* 39:1180–88

Land DB, Kushner R. 1990. Drug abuse during pregnancy in an inner-city hospital: prevalence and patterns. *J. Am. Osteopath. Assoc.* 90:421–26

Ledgerwood DM, Goldberger BA, Risk NK, Lewis CE, Price RK. 2008. Comparison between self-report and hair analysis of illicit drug use in a community sample of middle-aged men. *Addict. Behav.* 33:1131–39

Lenoir M, Serre F, Cantin L, Ahmed SH. 2007. Intense sweetness surpasses cocaine reward. *PLoS ONE* 2:e698

Leshner AI. 1999. Science-based views of drug addiction and its treatment. *J. Am. Med. Assoc.* 282:1314–16

Leshner AI. 2001. Addiction is a brain disease. *Issues Sci. Technol.* 17:75–80

Lopez-Quintero C, Hasin DS, de los Cobos JP, Pines A, Wang S, et al. 2011. Probability and predictors of remission from life-time nicotine, alcohol, cannabis or cocaine dependence: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Addiction* 106:657–69

Mack AH, Franklin J, Frances R. 2003. Substance use disorders. In *The American Psychiatric Publishing Textbook of Clinical Psychiatry*, ed. RE Hales, SC Yudofsky, pp. 309–77. Washington, DC: Am. Psychiatr. Assoc. 4th ed.

Maddux JF, Desmond DP. 1980. New light on the maturing out hypothesis in opioid dependence. *Bull. Narc.* 32:15–25

Mariezcurrena R. 1994. Recovery from addictions without treatment: literature review. *Scand. J. Behav. Ther.* 23:131–54

McLellan AT, Lewis DC, O'Brien CP, Kleber HD. 2000. Drug dependence, a chronic medical illness: implications for treatment, insurance, and outcomes evaluation. *J. Am. Med. Assoc.* 284:1689–95

McLellan AT, McKay J, Forman R, Cacciola J, Kemp J. 2005. Reconsidering the evaluation of addiction treatment: from retrospective follow-up to concurrent recovery monitoring. *Addiction* 100:447–58

Miller LM, Monahan J. 1954. The facts behind the cigarette controversy. *Reader's Digest* 65:1–6

Miller WR. 1998. Researching the spiritual dimensions of alcohol and other drug problems. *Addiction* 93:979–90

Miron JA, Zwiebel J. 1991. Alcohol consumption during prohibition. *Am. Econ. Rev.* 81:242–47

Moos RH, Finney JW. 2011. Commentary on Lopez-Quintero et al. 2011. Remission and relapse? The yin-yang of addictive disorders. *Addiction* 106:670–71

Musto DF. 1973. *The American Disease: Origins of Narcotic Control*. New York: Oxford Univ. Press

Nair P, Rothblum S, Hebel R. 1994. Neonatal outcome in evidence of fetal exposure to opiates, cocaine, and cannabinoids. *Clin. Pediatr.* 33:280–85

O'Brien CP, McLellan AT. 1996. Myths about the treatment of addiction. *Lancet* 347:237–40

Ott PJ, Tarter RE, Ammerman RT. 1999. *Sourcebook on Substance Abuse: Etiology, Epidemiology, Assessment, and Treatment*. Needham Heights, MA: Allyn & Bacon

Peartree NA, Sanabria F, Thiel KJ, Weber SM, Cheung TH, Neisewander L. 2012. A new criterion for acquisition of nicotine self-administration in rats. *Drug Alcohol Depend.* 124:63–69

Price RK, Chen L, Risk NK, Haden AH, Widner GA, et al. 2009. Suicide in a natural history study: lessons and insights learned from a follow-up of Vietnam veterans at risk for suicide. In *Research with High-Risk Populations: Balancing Science, Ethics, and Law*, ed. D Buchanan, CB Fisher, L Gable, pp. 109–32. Washington, DC: Am. Psychol. Assoc.

Quenqua D. 2011. July 10. Rethinking addiction's roots, and its treatment. *N.Y. Times.* **http://www.nytimes.com/2011/07/11/health/11addictions.html**

Rathod NH, Addenbrooke WM, Rosenbach AF. 2005. Heroin dependence in an English town: 33-year follow-up. *Br. J. Psychiatry* 187:421–25

Regier DA, Farmer ME, Rae DS, Locke BZ, Keith SJ, et al. 1990. Comorbidity of mental disorders with alcohol and other drug abuse. Results from the Epidemiologic Catchment Area (ECA) study. *J. Am. Med. Assoc.* 264:2511–18

Regier DA, Myers JK, Kramer M, Robins LN, Blazer DG, et al. 1984. The NIMH Epidemiologic Catchment Area Program: historical context, major objectives, and study population characteristics. *Arch. Gen. Psychiatry* 41:934–41

Robins LN. 1993. The sixth Thomas James Okey Memorial Lecture. Vietnam veterans' rapid recovery from heroin addiction: a fluke or normal expectation? *Addiction* 88:1041–54

Robins LN, Regier DA. 1991. *Psychiatric Disorders in America: The Epidemiologic Catchment Area Study*. New York: Free Press

Rosenberg NM, Marino D, Meert KL, Kauffman RF. 1995. Comparison of cocaine and opiate exposures between young urban and suburban children. *Arch. Pediatr. Adolesc. Med.* 149:1362–64

Seeley JR. 1960. Death by liver cirrhosis and the price of beverage alcohol. *Can. Med. Assoc. J.* 83:1361–66

Sobell LC, Klingemann HK, Toneatto T, Sobell MB, Agrawal S, Leo GI. 2001. Alcohol and drug abusers' perceived reasons for self-change in Canada and Switzerland: computer-assisted content analysis. *Subst. Use Misuse* 36:1467–1500

Spitzer RL, Forman J, Nee J. 1979. DSM-III field trial: I. Initial interrater diagnostic reliability. *Am. J. Psychiatry* 136:815–17

Spitzer RL, Williams JB, Skodol AE. 1980. DSM-III: the major achievements and an overview. *Am. J. Psychiatry* 137:151–64

Stinson FS, Grant BF, Dawson D, Ruan WJ, Huang B, Saha T. 2005. Comorbidity between DSM-IV alcohol and specific drug use disorders in the United States: results from the National Epidemiological Survey on Alcohol and Related Conditions. *Drug Alcohol Depend.* 80:105–16

Teesson M, Mills K, Ross J, Darke S, Williamson A, Havard A. 2008. The impact of treatment on 3 years' outcome for heroin dependence: findings from the Australian Treatment Outcome Study (ATOS). *Addiction* 103:80–88

Toneatto T, Sobell LC, Sobell MB, Rubel E. 1999. Natural recovery from cocaine dependence. *Psychol. Addict. Behav.* 13:259–68

U.S. Surg. Gen. Advisory Comm. Smok. Health. 1964. Smoking and health: Report of the Advisory Committee to the Surgeon General of the Public Health Service; Surgeon General's Report on Smoking and Health. Washington DC: U.S. Dep. Health Educ. Welf., Public Health Serv.; Supt. Docs., U.S. Gov. Print. Office

Vaillant GE. 1966. A twelve-year follow-up of New York narcotic addicts: IV. Some characteristics and determinants of abstinence. *Am. J. Psychiatry* 123:573–58

Vaillant GE. 1973. A 20-year follow-up of New York narcotic addicts. *Arch. Gen. Psychiatry* 29:237–41

Vaillant GE. 2003. A 60-year follow-up of alcoholic men. *Addiction* 98:1043–51

Vergés A, Jackson KM, Bucholz KK, Grant JD, Trull TJ, et al. 2012. Deconstructing the age-prevalence curve of alcohol dependence: why "maturing out" is only a small piece of the puzzle. *J. Abnorm. Psychol.* 121:511–23

Volkow ND, Fowler JS. 2000. Addiction, a disease of compulsion and drive: involvement of the orbitofrontal cortex. *Cereb. Cortex* 10:318–25

Volkow ND, Li TK. 2004. Drug addiction: the neurobiology of behaviour gone awry. *Nat. Rev. Neurosci.* 5:963–70

Volkow ND, Wang GJ, Fowler JS. 1997. Decreased striatal dopaminergic responsiveness in detoxified cocaine-dependent subjects. *Nature* 386:830–33

Waldorf D. 1983. Natural recovery from opiate addiction: some social-psychological processes of untreated recovery. *J. Drug Issues* 13:237–79

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

Warburton DM. 1988. The puzzle of nicotine use. In *The Psychopharmacology of Addiction*, ed. Lader MH, pp. 27–49. New York: Oxford Univ. Press

Warner LA, Kessler RC, Hughes M, Anthony JC, Nelson CB. 1995. Prevalence and correlates of drug use and dependence in the United States. Results from the National Comorbidity Survey. *Arch. Gen. Psychiatry* 52:219–29

Wasserman DA, Weinstein MG, Havassy BE, Hall SM. 1998. Factors associated with lapses to heroin use during methadone maintenance. *Drug Alcohol Depend.* 52:183–92

Weatherby NL, Needle R, Cesari H, Booth R, McCoy CB, et al. 1994. Validity of self-reported drug use among injection drug users and crack cocaine users recruited through street outreach. *Eval. Program Plan.* 17:347–55

Winick C. 1962. Maturing out of narcotic addiction. *Bull. Narc.* 14:1–7

Zanarini MC, Frankenburg FR, Hennen J, Silk KR. 2003. The longitudinal course of borderline psychopathology: 6-year prospective follow-up of the phenomenology of borderline personality disorder. *Am. J. Psychiatry* 160:274–83

Zanarini MC, Frankenbur FR, Weingeroff JL, Reich DB, Fitzmaurice GM, Weiss RD. 2011. The course of substance use disorders in patients with borderline personality disorder and Axis II comparison subjects: a 10-year follow-up study. *Addiction* 106:342–48

Annual Review of
Clinical Psychology
Volume 9, 2013

Contents

Indexes

Errata

An online log of corrections to *Annual Review of Clinical Psychology* articles may be found at http://clinpsy.annualreviews.org