

ment for alcoholism, drug addiction, and smoking more often than not relapse (Thombs 1994). However, if the population of addicts is expanded to include those who do not seek treatment a different picture emerges. Most addicts recover. More generally, when the study of addiction includes epidemiological, ethnographic, and experimental research, as well as clinic studies, the image of the addict as a victim of drug cravings becomes difficult to support. In its stead emerges a more complicated picture in which cravings are but one of several competing influences on drug consumption, and addicts actively choose whether or not to continue using drugs. For instance, the state of being addicted, although debilitating, does not preclude the salutary influences of nondrug activities and goals, such as employment, new relationships, and the desire to be a positive influence on others. A woman who was a regular cocaine user for 16 years describes quitting in terms of economics and parenting (Waldorf et al. 1991, p. 202): 'Oh, for a time my nose opened up when I went out partying and drinking, but I learned how to handle it...Once I stopped selling, I didn't have the money to buy it anymore. I would have literally had to say, "Sorry girls [her daughters], you don't eat this week" to buy some.' This article will flesh out these introductory remarks, focusing on three issues: the criteria for distinguishing drug use from drug abuse, the correlates of addiction, including pharmacological, social, and individual factors, and the correlates of recovery.

1. Terminology: Substance Dependence, Abuse, and Use

On the basis of a series of collaborative research projects (e.g., Spitzer et al. 1979), clinicians have crafted a set of diagnostic criteria that reliably distinguish three levels of drug use: 'substance dependence,' 'abuse,' and social or recreational use. An important consequence of this advance in terminology is that the results from different studies can be meaningfully compared, thereby setting the stage for a cumulative science of drug use and addiction.

According to the diagnostic manual of the American Psychiatric Association (1994), the 'essential feature' of *drug dependence* 'is a cluster of cognitive, behavioral, and physiological symptoms indicating that the individual continues use of the substance despite significant substance-related problems.' The physiological symptoms include tolerance and withdrawal. The cognitive-behavioral symptoms include taking the substance in larger amounts than was intended, a persistent desire to curtail drug use, increases in time spent in drug-related activity, and drug-related failures in fulfilling obligations at work and at home. In other words, the technical term 'substance dependence' replaces the more commonly used term 'addiction.'

Drug Use and Abuse: Cultural Concerns

In popular and scientific publications, addiction is often referred to as a chronic, relapsing disorder. In support of this claim, individuals who obtain treat-

Substance abuse is similar to dependence in that the central feature is continued use despite adverse consequences. However, other aspects of dependence, such as tolerance, withdrawal, and a persistent desire to control drug use, are absent.

Social or recreational drug use is a level of consumption that produces little or no harm. This is often a matter of learning from negative experiences. For example, the APA manual (1994) points out that when social drinkers experience alcohol-related problems, they learn to moderate their future drinking.

The World Health Organization has published a similar set of diagnostic criteria (1992). For instance, in both accounts the key concept is the relationship between drug use and drug-related aversive consequences.

1.1 Earlier Definitions of Substance Dependence

Earlier definitions of substance dependence put more emphasis on tolerance and withdrawal than do the current APA and WHO criteria. This reflects trends in drug use. Until the late 1970s, heroin dependence was the prototypical addiction, and it is characterized by a well defined set of withdrawal symptoms, including spasms ('kicking the habit'), chills, goose bumps ('going cold-turkey'), muscle aches, diarrhea, and agitation. However, in the late 1970s and early 1980s, cocaine use greatly increased. Cocaine leads to many of the same cognitive-behavioral signs of addiction as heroin, but without any obvious withdrawal syndrome. For example, withdrawal from cocaine may elicit dysphoric feelings but it does not produce somatic, flu-like symptoms, as does withdrawal from heroin. Accordingly, the diagnostic significance of withdrawal symptoms has decreased.

1.2 'Addiction' and 'Substance Dependence'

In everyday speech, heavy drug use is usually referred to as 'addiction' not 'substance dependence.' The different terms identify the same patterns of behavior, however 'addiction' has an additional meaning. It implies that drug consumption is involuntary or against one's will. For example, the Oxford English Dictionary defines *drug addiction* as 'a compulsion and need to continue taking a drug as a result of taking it in the past,' and it defines *compulsion* as '[acting according to an] irresistible impulse...' However, the idea that drug dependence entails irresistible urges is not a matter of fact, but a hypothesis that experts do not agree on. For example, experimental, clinical, and autobiographical reports show that addicts learn to resist drug cravings (e.g., Cohen et al. 1971, Waldorf 1983), especially when offered incentives for abstinence. Thus, the prudent course is to use the term 'substance dependence.' Its meaning is restricted to a

pattern of behavior that different observers reliably identify, and it does not imply a mechanism as to why drug use persists. (Although 'addiction' is an ambiguous word, it often fits better into sentences. Accordingly, when the word 'addiction' or 'addict' is used in this article, the referent is a pattern of behavior or a drug user who exhibits that pattern of behavior.)

2. Correlates of Drug Abuse

The transition from drug use to abuse depends on the interplay of three factors: characteristics of the drug, the setting, and the individual.

2.1 Pharmacological Impact

The importance of the drug is illustrated by two comparisons. First, although there are scores of highly reinforcing substances and activities, only a few support addiction, and these few are all drugs (with the possible exception of gambling). Second, changes in drug structure or route of administration can markedly influence the likelihood of addiction. For example, opiates were used for thousands of years with little or no mention of the dangers of addiction. However, in China during the eighteenth century, opium dependence became a national problem and the subject of governmental legislation. The key precipitating event was a change in the manner of consumption. The Chinese began smoking opium instead of taking it orally. Smoking increases the rate at which the psychoactive components of opium (e.g., morphine) enter the circulatory system, and this, in turn, greatly increases brain levels of these substances. There are similar stories for alcohol (the development of distillation), tobacco (the development of cigarettes), and stimulants (the development of the syringe and smokable forms). In each case, increasing the rate and magnitude of the pharmacological effect increased addiction rates.

However, pharmacology was not the only factor in the rise of opiate addiction in China. During the eighteenth century, smoking and opium use were familiar practices in many parts of the world, but only in China did the two combine to produce a significant social problem. Historical studies (e.g., Spence 1975) suggest that members of the bureaucratic classes were especially vulnerable to opiate addiction, and this may have been due to their wealth and available free time.

2.2 A Pharmacological Common Denominator for Dependence?

Much of the research on the pharmacological basis of addiction has been guided by the hypothesis that dopamine, a neurotransmitter that plays a key role in

reward and motor activity, is an essential component of the biology of addiction (e.g., Wise and Bozarth 1987). In support of this hypothesis, laboratory studies with animals show that self-administration of addictive drugs increases the availability of dopamine in areas of the brain that play an important role in motivated behavior, and, conversely, drugs that block dopamine receptors decrease or eliminate drug self-administration in animals. However, other laboratory findings indicate that it is too simplistic to equate addiction with dopamine. For instance, many non-addictive consummatory activities are associated with increases in brain dopamine levels, and in a series of recent experiments, mice self-administered cocaine even though they were missing the protein that mediates cocaine's ability to increase dopamine levels (Caine 1998). Thus, increases in brain dopamine levels are not a sufficient condition for drug dependence or a necessary consequence of drug self-administration.

Although there may not be a common receptor-level event for different addictions, there are common drug-related behavioral effects (Heyman 2001). These include rapid onset of action, few if any inhibiting mechanisms for self-administration (e.g., drugs do not satiate), intoxication (except for cigarettes), and the capacity to undermine the ability to engage in competing, nondrug related activities. For example, intoxication and withdrawal symptoms interfere with most work responsibilities and social conventions.

2.3 Setting

Interviews and questionnaires provide much of the information on the influence of setting on drug use. As these research methods depend on self-report, the results may not be valid. However, the literature presents a coherent account of drug use, with different studies producing quantitatively similar outcomes (e.g., compare Anthony and Helzer 1991 with Warner et al. 1995).

One of the strongest cases for the influence of setting on drug consumption is the story of opiate dependence among American soldiers in Vietnam (Robins et al. 1975). In contrast to conditions at home, the men entered a situation in which opiates, including heroin, were widely available, cheap, and largely free of sanctions.

Among the young enlistees, opiate use increased from less than 5 percent to 43 percent. Among those who used just once, about 60 percent became addicted. Among those who used more than four times, about 90 percent became addicted. However, upon return to the United States, dependence rates declined to near their pre-Vietnam levels (from about 20 percent to 1 percent). Even most of those who were regularly injecting heroin while in Vietnam were not dependent on heroin during the three-year period that they participated in the study.

The researchers were able to provide some information about the specific factors that influenced opiate dependence and recovery. Their results suggest that the increase in dependence was largely due to the increased availability of opiates, and that, conversely, the decline in dependence was largely due to the reassertion of negative drug-related consequences. For example, the veterans reported that they knew where to buy heroin—and 50 percent did at least once—but that they quit because of the 'sordid' atmosphere that surrounded its purchase and use, the higher prices, the criticism from relatives and friends, and the possibility of being arrested.

2.4 Individual Differences

Individual differences play an important role in the etiology of substance dependence. For instance, in studies that compare same sex siblings or neighbors, the adolescent with a history of delinquency is significantly more likely to experiment with addictive drugs, especially heroin, and given experimentation, delinquency predicts dependence. However, it is not yet clear which individual traits are most important in relation to drug use and dependence. The following examples were selected as they are intuitively plausible and well established.

2.4.1 Psychiatric comorbidity. In the early 1980s the US National Institutes of Health sponsored a nationwide survey of psychiatric disorders and their correlates in a representative national sample (the Epidemiological Catchment Area study, Robins and Regier 1991). There were approximately 20,000 subjects, and they were evaluated according to the APA criteria for mental disorders. For those with a history of substance dependence or abuse, the expected likelihood of a nondrug related psychiatric disorder was 22 percent (Regier et al., 1990). The observed frequency was more than twice as great, 53 percent. Moreover, the likelihood of additional psychiatric disorders varied with type of drug abuse. For example, it was 65 percent and 76 percent for opiate and cocaine dependence, respectively. These results are consistent with (but do not prove) the ideas that substance dependence is sometimes a form of self-medication (for the underlying psychiatric disorder), and that addicts with psychiatric disorders are less likely to engage in activities that would displace drug use, such as holding a good job.

2.4.2 Individual differences in pharmacological response. There is also evidence of etiologically significant individual differences in the pharmacological response to addictive drugs. For instance, in a long-

itudinal study, the intoxicating effects of alcohol at age 20 predicted the development of alcoholism at age 30 (Schuckit 1994). Surprisingly, the men who reported the lowest intoxication scores were most likely to become alcoholic. The author reasoned that feeling less intoxicated invites heavier drinking.

2.4.3 Is there a genetic basis for some types substance dependence? The discussion of individual differences can be taken one step further. In general, individual differences reflect both genetic and experiential factors. Thus, there may be a genetic predisposition for substance dependence. This has been studied in regard to the etiology of alcoholism.

The basic finding is that male children of alcoholic fathers are about four times more likely to become alcoholics than male children of nonalcoholic fathers. Twin and adoption studies show that a significant component of this difference is heritable. For instance, in one frequently cited report (Pickens et al. 1991), the correlation for alcoholism was about 60 percent higher in identical twin boys than in fraternal twin boys (concordance rates of 0.59 and 0.36). The research also shows that the degree of heritability varies according to gender and pattern and level of drinking.

But heritability only specifies the extent to which genes influence the likelihood of the trait of interest. For both clinical and scientific purposes, it would be useful to know the processes that the genes influence. Broadly speaking, the possibilities are direct reactions to alcohol, such as tolerance, or behaviors that indirectly influence drinking, such as impulsivity and delinquency. These are not mutually exclusive outcomes, and the available data support both pathways (Cloninger 1987, Schuckit 1994). Also note that gene-influenced behavioral processes do not ineluctably lead to alcoholism. Rather, they establish a bias for alcoholism, just as Vietnam established a bias for opiate addiction.

2.5 On the Prerequisite Conditions for Substance Dependence

In representative populations, unassisted recovery from heroin addiction is common (e.g., Waldorf 1983). As heroin is the most addictive drug, this suggests that pharmacological processes establish a necessary but not a sufficient condition for addiction. The Vietnam experience demonstrates the importance and the limits of environmental influences. With easy access to heroin, there was about a 20-fold increase in addiction, yet 40 percent of those who experimented with this drug did not go on to become regular users. This suggests that there is no setting in which all drug users will become drug abusers. Similarly, the twin data show that individual characteristics matter, but not enough so that pharmacology or setting can be

ignored. Strictly speaking, then, a substance is not addicting. Rather some substances are more likely than others to become the focus of an addiction given the presence of other contributing factors. Similar statements can be made about dependence promoting settings and individual characteristics.

3. Recovery: Is Substance Dependence a Chronic Relapsing Disorder?

Clinic outcome studies show that individuals in treatment for substance abuse often relapse back to drug use. However, most of the men who were regular users of heroin in Vietnam stopped using upon return home. Which population is representative of most addicts? There are two large, epidemiological studies of psychiatric disorders that collected information on drug use (Anthony and Helzer 1991, Warner et al. 1995). Both found that most of those who at some point in their life met the criteria for substance dependence no longer did so. And according to the larger of the two studies (Robins and Regier 1991), substance abuse had the shortest duration and highest recovery rate of any other psychiatric disorder.

The common factor in the studies with higher recovery rates is that subjects were selected independently of their treatment history. In contrast, in studies that find high relapse rates, the subjects are drawn from clinic rosters. The clinic data include two biases. First, most addicts do not seek treatment (e.g., Anthony and Helzer 1991). Second, the frequency of psychiatric comorbidity is much greater for the clinic population. For example, in the ECA study, 64 percent of the addicts who were in treatment had an additional nondrug related psychiatric diagnosis, whereas the comorbidity rate for addicts not in treatment was 29 percent (Regier et al. 1990). Thus, higher relapse rates for clinic populations are correlated with higher comorbidity rates.

4. Factors that Influence Recovery

4.1 Values, Employment, and Cultural Milieu

Autobiographical accounts of recovery often include a pivotal event that triggers evaluative judgments about drug use, such as the desire to change in order to please parents and children. In support of these accounts, which may be biased, an ethnography of a population of recovered heroin addicts found that the most frequently cited reason for change was an event that led to feelings of regret about addiction or the junkie lifestyle (Waldorf 1983).

In a series of longitudinal studies on heroin addicts and alcoholics, the strongest correlate of recovery was the ability to hold a job (Vaillant 1992). The author hypothesized that a job weakens drug use by removing

the addict from drug taking cues and by reinforcing patterns of behavior that are incompatible with drug use, such as keeping to a daily schedule.

Since 1964 more than 50 million people have quit smoking in the United States (e.g., Schelling 1992). This decline is correlated with the 1964 publication of the Surgeon General's report on the health risks of cigarette smoking and the subsequent changes in the culture of cigarette smoking. For instance, movies no longer represent the cigarette as a sign of sophistication, and many if not most public places are now smoke free.

4.2 Pharmacological Treatments

Methadone and nicotine replacement therapies increase abstinence rates for addicts in treatment. This does not contradict the research on the situational correlates of recovery. Rather, by attenuating the distracting effects of withdrawal symptoms, the pharmacotherapies increase the likelihood that conventional alternatives to drug use will take hold.

4.3 Correlates of Recovery and the APA Criteria for Substance Dependence

An important theme in the study of recovery is that factors that are important in bringing drug use to a halt play much less of a role, if any, in disorders that are widely acknowledged as entailing compulsions, such as obsessive compulsive disorder or Tourette's syndrome. For example, incentives and social disapproval can persuade addicts to stop using drugs (Higgins et al. 1994, Robins et al. 1975) but, in general, do not markedly decrease symptoms such as repetitive hand washing or motor tics. This comparison suggests that the APA criteria for substance dependence although useful are overstated. Addicts may be less sensitive to the negative consequences of drug use than nonaddicts, but, as shown in laboratory and natural experiments (e.g., Vietnam), they are not immune to them. Put another way, the nature of recovery from addiction implies that it is not a compulsive disorder.

5. Brain, Substance Dependence, and Recovery

In recent brain imaging studies, drug users and control subjects differed in terms of dopamine receptor density and dopamine related neural functioning (e.g., Volkow and Fowler 2000). Interestingly, the differences were in areas of the brain that are believed to play a role in decision making. This work is new, and it is not known if the imaging results reflect drug use, the correlates of drug use (e.g., a pre-existing state), or both. Similarly, it is not known if the neural correlates of drug use influence decision-making capacities or preference for the drug (leaving rationality intact).

A further complexity is that the relationships between drug consumption, brain function, and behavior can also be initiated by changes at the 'surface.' Just as drugs may alter the brain in ways that promote future drug consumption, the environmental events and changes in behavior that lead to recovery must modify the brain in ways that decrease the likelihood of future drug consumption. For example, when cognitive-behavioral treatments for obsessive-compulsive disorder are effective they lead to changes in brain structures that are correlated with the patients' symptoms (Schwartz 1998). A number of research groups are beginning to study the complex interrelationships between drug use, decision-making, and brain functioning. Thus, the next generation of addiction studies promises a wealth of new information on the biology and psychology of decision-making as well as on the biology and psychology of substance use and abuse.

See also: Drug Addiction; Drug Addiction: Sociological Aspects; Drug Use and Abuse: Psychosocial Aspects; Drugs and Behavior, Psychiatry of; Smoking and Health; Smoking Prevention and Smoking Cessation

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