

The Drug Dilemma: Manipulating the Demand

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Drug abuse in the United States has posed a dilemma during most of this century. Intemperate use of reinforcing drugs is hazardous to health and safety, but strict prohibition fosters an illicit market with criminal effects that may be equally harmful. The crux of the problem is the willingness of millions of people to risk toxicity and arrest to gain psychopharmacological rewards. Cocaine is the present source of most concern. Recommendations for reducing demand and abuse are given, including the implementation of preventive techniques, the investigation of various treatments, the use of modern chemical and electronic technology, and the development of new pharmacological alternatives.

DRUG ABUSE IS WIDELY VIEWED AS ONE OF THE CHIEF problems in the United States today. Approximately 28 million Americans used illicit drugs during the past year; marijuana was used by 10% and cocaine by about 4% (1). There is wide agreement that cocaine, especially inhaled, free-base "crack," is the most dangerous addicting substance and a significant cause of crime and injury. There is considerable controversy, however, about how to deal with the social and medical consequences of drug abuse. In this article, "drug" will refer to a self-administered, psychoactive chemical, and "abuse" to illicit or harmful use (2).

Formulating effective drug policy to reduce drug use without endangering personal liberty is a major challenge for government today. This article is partly a response to Nadelmann's review of drug legalization (3), plus a presentation of some specific proposals to deal with the American cocaine problem. I am emphasizing cocaine because it is so dangerous (4), but similar arguments apply to other abused drugs. My conclusions are that more effective constraints and rewards are necessary to reduce destructive drug-taking behavior, but care must be taken to respect the freedoms guaranteed by the Bill of Rights.

Two popular opposing views are (i) that we repeal our present prohibitory laws against controlled substances and legalize drugs (3, 5) or (ii) that we strengthen current laws (6). A Gallup poll reports that between 60 and 80% of the public supports continued prohibition (7); elected officials are usually sensitive to such strong public sentiments. Efforts to control illegal drug use in the United States during the past 75 years have emphasized interdiction of supply, which has repeatedly received more than 70% of the total congressional appropriations for drug control. However, despite large increases in expenditures for drug control, the prevalence of cocaine

abuse has increased each year from the mid-1970s to the mid-1980s (8).

In 1988, when Congress almost unanimously passed the Anti-Drug Abuse Act prohibiting production, marketing, and possession of harmful psychoactive drugs, there was talk of a 50-50 allocation to curtail both supply and demand, but the 70-30 split has held through 1990 (9). Highly publicized seizures of successively larger quantities of illegal drugs indicate both the immediate success and the long-term failure of interdiction. Thus, a sizable market persists. Cocaine use is decreasing among middle-class Americans but not in the inner city, nor among high school dropouts, the homeless, or arrestees. Prohibition and antidrug publicity seem to miss the most vulnerable populations. Musto has pointed out that there are fads in illicit drug use and that, hopefully, cocaine popularity may be fading now as it did at the turn of the century (10). Alarming, the market for heroin appears to be rising. Federal agents seized 514 pounds of heroin in 1982 and 1705 pounds in 1989. Marijuana seizures, on the other hand, dropped over the same period from over 2 million pounds to less than 800,000 pounds (11).

Effective governmental plans are needed to stem the worsening interactive cycles of poverty, psychiatric illness, crime, and drug abuse (12). The prevalence of drug abuse shows that the current approach of drug control, with its emphasis on interdiction of supply and little focus on causes of demand, is clearly inadequate. Increasingly draconian penalties (for example, making drug use or trafficking punishable by torture or death) would probably reduce use, without addressing the causes, but would be incompatible with our constitutional freedoms.

Etiology of Drug Abuse

Numerous variables underlie chemical dependence, including the chemical properties of the substances, the physiological and psychological condition of the user, and social and environmental factors. A large proportion of the population uses legal psychoactive drugs. There are 106 million adults who take at least one alcoholic drink per month and 57 million people who smoke cigarettes daily (1). It is estimated that caffeinated beverages are used by up to 90% of adults; with moderate use, these beverages are not considered dangerous.

When highly addictive drugs are proscribed from use and no alternative is available, a potential illicit market is created. The drugs considered most dangerous are listed in Schedules I and II of the Controlled Substance Act, which is periodically revised. They include cocaine, heroin, marijuana, phencyclidine (PCP), mescaline, and *N,N*-diethyl-*D*-lysergamide (LSD), among others. Schedule I drugs are considered to have high abuse potential and no medical utility.

People who use cocaine say they like the effects. The subjective rewarding effects from cocaine and other drugs (for example,

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heroin, marijuana, and nicotine) are immediate (7 to 30 seconds), especially when the drugs are inhaled or injected (13). There is a long delay between this rewarding reinforcement and the punishing consequences (for example, it takes days to months for seizures, heart attacks, or imprisonment to occur), and this delay favors continued use and contributes to two characteristics commonly found among drug users: an inability to assimilate information about the harmfulness of drugs and an optimistic bias or short-time horizon in assessing risk from their habit (14, 15).

Euphoriant and stimulant effects of cocaine seem linked to dopaminergic activation in the limbic and striatal brain systems; this also increases motor activity. Uncontrolled stereotyped behavior commonly occurs and may partially explain the compulsive self-administration of cocaine by animals and man (16). Cocaine promotes dopaminergic stimulation in regions such as the nucleus accumbens and frontal cortex, which mediate reinforcement, by binding the dopamine transporter and inhibiting reuptake. Opioids produce reinforcement in related areas (17).

Cocaine does not turn itself off. For most natural rewards (for example, food, water, sex, temperature) there is an upper boundary of self-administration. Ordinarily, satiety mechanisms exert a protective inhibitory influence, a homeostatic negative feedback (18); thus, central excitatory and inhibitory influences modulate the level of reinforcement. Somehow, intravenous or inhaled cocaine seems to elude this inhibitory defense mechanism; excitatory and inhibitory neurotransmitters in the brain were not designed to be directly stimulated. With low response cost, animals will self-administer intravenous psychomotor stimulants incessantly until they kill themselves; however, they will stop injecting if given appropriate psychological deterrence, for example, when they exceed the operant breaking point (the point at which they have to work too hard or bear too much pain to obtain the reward) (19). Thus, when cost exceeds benefit and perceived risk is too high, use will stop (20).

Drug use is a form of risk-taking that peaks during the teen years; adolescence is also the peak age for certain types of criminal behavior (14, 21). There are many theories, but not many facts, to explain this age-related phenomenon. Adolescence is also the time when the level of androgenic hormones rises. A variety of antisocial behaviors, including illicit drug-taking, have been correlated with high testosterone levels (22), which may account in part for the higher crime rate and illicit drug use in men versus women.

The use of so-called "gateway drugs," nicotine and alcohol, usually starts in adolescence. Social pressure (23) seems to be the major factor initiating stages of drug use: first wine or beer, then cigarettes and hard liquor, then marijuana, then, in the later teens or twenties, cocaine, heroin, or other illicit drugs (24). When drug experimentation begins in childhood or adolescence, the user is often handicapped by a drug-filled environment, poor family structure, emotional immaturity, ignorance or denial of the dangers of drug abuse, absence of a desirable role model, and the lack of treatment opportunities.

Vulnerability to drug-taking is a function of both heredity and environment. Studies indicate that alcoholics and illicit drug users are characterized by low self-esteem, poor family relationships, low socioeconomic and educational status, poor academic performance, the presence of psychiatric disturbances, and a high index of novelty- or sensation-seeking behavior; dependence is furthered by high peer pressure and the ready availability of drugs (25). Genetic factors definitely play a role in some addictions, such as alcoholism (26). By analogy, we may speculate that some individuals have an innate need for stimulants, perhaps because of deficiencies in dopamine D2 utilization in the limbic system (27). Sensation- or novelty-seeking is compatible with such a mechanism (28). If a hereditary propensity for drugs such as cocaine or heroin could be demonstrated, then

early preventive measures could be taken in individuals at risk.

Cocaine is often taken to avoid or relieve stress or depression; one estimate is that about 50% of people taking cocaine show evidence of affective disorders (29), for which appropriate treatment encourages abstinence from cocaine. This use of cocaine as self-medication for such "chronic" disorders, coupled with the properties of the drug itself, almost guarantees that the user will develop a dependence. Also, many cocaine users appear to have antisocial personalities and are resistant to therapy; segregation, prison, exile, and death are ways that society has dealt with such individuals. In the United States, psychoactive substance use disorders are considered psychiatric illnesses amenable to treatment, for example, by group or individual psychotherapy, therapeutic communities, self-help groups such as Narcotics or Cocaine Anonymous, chemical substitution programs such as methadone maintenance for heroin addicts, or other pharmacotherapy. Nevertheless, most users of illicit drugs never receive treatment; instead, they may go to jail. For some, whose only previous crime was illegal drug use, prison is an introduction to crime as a way of life. Incarceration or the threat of prison should deter drug use to some extent, but without controls it is difficult to say how much. Prisons are overflowing with drug offenders. Still, most people continue to support prohibition of dangerous drugs with the focus on strengthening and enforcing existing laws. There seems to be less public interest in raising taxes to finance social programs than in using the money to build more prisons. Some scholars and others, however, object to using criminal sanctions against addicts and suggest legalization.

Arguments for Cocaine Legalization

The principal argument for drug legalization is economic. Making cocaine freely available and cheap would remove the profit and drastically reduce, if not eliminate, the illicit market (3). Drug-related crime spurred by the enormous amounts of money to be made in drug trafficking is a major problem created by prohibition (30). "Crack," or inhalable cocaine base, is distributed on the street mostly by inner-city minority youths motivated by entrepreneurial profit. In 1988, only 1.0% of whites but 2.4% of blacks and 2.2% of Hispanics used this form of cocaine (1), a finding that is consistent with the concentration of crack in inner-city ghettos. Legalization could remove the financial incentive for illegal drug marketing from these neighborhoods.

Legalization would also relieve the overburdened criminal justice system. Currently, justice is delayed or never delivered; plea bargaining has become a necessity. The mandatory felony sentence for any amount of cocaine possession in California, for example, is crippling that state's judicial system. The high incidence of drug-related crime shows that the threat of prison today has a very limited deterrent effect; the purpose of incarceration seems mainly to incapacitate drug users and traffickers and exact revenge. Legalization would reduce the need for prisons and allow law enforcement to focus on other crimes.

Proponents of legalization argue that, although legalization would increase drug availability, prohibition is either ineffective or unnecessary to accomplish its aims of protection. For example, high school seniors report that, although cocaine is illegal, availability has risen; nevertheless, cocaine use has fallen dramatically in this group, showing that students are capable of learning to resist temptation even in the face of an increased supply of drugs. The threat of arrest and prison may, of course, be a factor in this reduction of demand; it is hard to know whether education alone would have the same effect (31).

Proponents of legalization also contend that it would be better to

have an increased number of legal cocaine addicts treated medically than to have addicts sent to prison while the United States is subjected to a relatively ineffectual, violent, and costly "war on drugs." They also feel that quality-controlled drugs would be less toxic.

The Dutch system of dealing with illicit drugs approaches legalization on a limited scale (32). Although possession of cocaine, heroin, and cannabinoids is still illegal in the Netherlands, penalties and enforcement are lighter than in the United States or elsewhere. The drug abuse problem is viewed as a medical and not a criminal justice question. This applies to "hard drugs" as well as cannabinoids. The Dutch government carries out a sterile needle exchange program for addicts and subsidizes "junkie unions" that promote the welfare of addicts by distributing information to other addicts about safe drug use and safe sex. The Dutch treatment and counseling system reaches from 60 to 80% of addicts and emphasizes AIDS prevention. The lifetime prevalence of cannabis use in the Netherlands for 10- to 18-year-olds is 4.2%, compared with the U.S. High School Survey figure of approximately 30% (31). Advocates of legalization point to the Dutch "experiment" as an example to emulate (3). But a high standard of living and an ethnically homogeneous population may have much to do with the success of the Dutch policy.

Under what conditions could a society tolerate legalization of a strongly abusable drug such as inhalable or injectable cocaine? A sufficient majority of the population (say 99%) would need to be immunized against the use of the drug, for example, by fear of toxicity or by moral objection, so that they could successfully resist the temptation to experiment. This would require a heavily indoctrinated and compliant populace in which voluntary deviant behavior is conspicuously stigmatized (for example, many vegetarians have never tasted meat and most orthodox Jews and Moslems have never tasted pork). If the social pressure against cocaine use could be made as strong as social taboos and customs, legal prohibition for this drug might be relaxed. In a community where conformity is high and where most of the mentally ill and the poor are cared for by the society, such as among the Mormon or the Amish communities, legalization of cocaine could possibly succeed. Group disapproval or religious conviction may deter drug-taking more effectively than threat of prison; it may account for the lower use of legal alcohol and cigarettes in such communities.

Arguments for Cocaine Prohibition

Prohibition of the production, sale, and possession of drugs such as cocaine is an attempt by the government to protect the public from the toxic effects of such drugs (33). Wilson points out that without criminalization of drugs such as cocaine and heroin there would be a vast increase in use (34), with correspondingly greater drug-induced morbidity and mortality. It is estimated that tens of thousands of crack babies are born each year, and the long-term prognosis for these infants and their effect on society is grim. If dangerous drugs were legal in this country, the United States would become a source of cheap drugs for foreign black marketeers. Furthermore, if legalization were found to be a mistake, it would be difficult to reverse the situation. Kaplan makes a similar argument (35).

Prohibition has three major aims: to cut the availability of drugs, thereby reducing temptation to potential users, especially children; to defend society from the irrational behavior of users; and to protect users from toxic and sometimes lethal effects of drugs. Has prohibition worked in the past? Prohibition against the sale of alcohol from 1920 to 1930 did decrease alcohol use, but only by about 60 to 70%. It is possible that enforcement technology was too

primitive to eliminate bootlegging. Furthermore, it was legal to use alcoholic beverages. Today, with legalization, alcohol toxicity constitutes one of our most serious drug problems.

Neither prohibition nor regulation by the Food and Drug Administration was ever applied to tobacco in the United States; however, since mid-century, the prevalence of cigarette-smoking in young men has dropped from around 70% to less than 30%. In California physicians the incidence of smoking has dropped to less than 10%. This decline has occurred without laws against manufacture or sale; the change in behavior took place through a vigorous campaign sparked by private advocacy groups and carried on by a federal information campaign (36). In recent years, laws that restrict tobacco use have been made stronger, but this is not true of laws that restrict growing tobacco or manufacturing cigarettes. Of course, the short-term effects of tobacco are not as dangerous as those of cocaine or alcohol, but long-term effects on morbidity and mortality are comparable, or worse.

Three factors limit the effectiveness of prohibition. First, there is our reluctance to institute draconian controls that reduce drug use in totalitarian countries. Prohibition applied indiscriminately can threaten freedoms guaranteed by the Fourth and Eighth amendments in the Bill of Rights. Second, effective prohibition requires the voluntary cooperation of citizens or the ability to force compliance. Either of these is difficult in the United States. Third, enforcement of prohibition is very expensive. When taxes are insufficient to adequately support the criminal justice system, the illicit drug market flourishes. It appears that as long as there is demand for drugs, potential customers stimulate the development of an illicit market.

Recommended Strategies for Reducing Demand

The investment of more than 70% of the federal drug control money into supply reduction seems misplaced. If demand for a substance can be inhibited, its supply will become superfluous. If demand is high, however, it will overcome formidable barriers to supply (as the "War on Drugs" demonstrates). The factors contributing to demand (such as intrinsic physiological reward mechanisms, poor social conditions, and psychopathology) are difficult to ameliorate; supply factors (such as coca leaf production, methamphetamine laboratories, and antisocial individuals with enough intelligence and business acumen to form a black market) are somewhat more easily identified and attacked. Although there is a reciprocal relationship with supply, and once a market is established it perpetuates itself, demand (the willingness or desire to use drugs) is the limiting factor in the propagation of drug use. Dopaminergic and opioid receptors (and probably others) in the brain's reward centers represent an ever-present source of demand for the appropriate exogenous ligands.

Curtailling the supply of demanded drugs has been compared to squeezing a balloon: constrict it in one place and it expands somewhere else. Eradication of coca, opium, or marijuana plantations does reduce use, but it may encourage production elsewhere if demand is not reduced. An example is the expansion of the California marijuana crop after the availability of Mexican marijuana was reduced.

Strategies to reduce demand for abusable drugs are now officially formulated, evaluated, and coordinated by Dr. Herbert Kleber, Deputy Director for Demand in the Office of National Drug Control Policy. Policies of prevention and treatment are currently being implemented.

Prevention of drug use in the young is unquestionably the most important approach to the reduction of demand; it is also the most

complex, because it requires fundamental social changes. In high-risk communities, prevention implies modifying or working within unstable or defective family structures. An intimidating degree of social therapy is needed (37). It would be highly desirable if federally sponsored social programs, including family-planning and job programs, could be set up so that their impact on drug use could be statistically evaluated.

School programs are somewhat more manageable; they focus on creation of antidrug attitudes, especially to legal drugs—alcohol, cigarettes, and even caffeine. Avoidance of contact with illicit drugs, especially marijuana, is clearly important. Considering the high availability of drugs in U.S. society, resistance training is clearly necessary in schools. Most schools now have drug education programs, but controlled tests of the efficacy of these programs should be expanded. Different behavioral techniques will certainly be necessary in inner-city schools, where there are more dysfunctional families, than in suburban schools (38).

Treatment campuses are planned in which various treatment techniques can be evaluated in large numbers of voluntary and involuntary patients. Studies have already indicated that a spectrum of treatment modalities, including therapeutic communities, drug-free outpatient programs, and methadone for opioid users, are effective (39). For example, contingency contracting seems to work well with people (such as addicted physicians) who have a great deal to lose by continued drug use.

Pharmacological treatment has also shown promise. Replacement therapy has been tried with agents similar to but safer than abused drugs. Methadone maintenance treatment for opioid abuse is widely considered successful, although it is condemned by advocates for a drug-free society as neutralizing but not eliminating the addiction. It does have the virtue of bringing addicts into a medical therapeutic milieu. During withdrawal, benzodiazepines substitute for alcohol and nicotine polacrilex gum substitutes for nicotine in tobacco. There is, however, no safer stimulant substitute that successfully replaces cocaine or amphetamines. Trials with methylphenidate have been disappointing, except in patients with attention deficit disorder (40). On the other hand, cocaine cravings after withdrawal are reported to be reduced by a variety of agents, especially antidepressants. One investigator found that desipramine reduced cocaine craving for several weeks in cocaine-withdrawn patients who were not depressed, yielding a "window of opportunity" for behavioral therapy; depot flupenthixol decanoate, which has mixed antipsychotic and antidepressant properties, also reduced cocaine craving (41). Pharmacologic agents that are still under investigation include other tricyclic antidepressants, fluoxetine, buspirone, bromocriptine, clonidine, carbamazepine, and several others.

The craving that drug users experience as a result of abstinence may initially be a psychological response to physiological withdrawal symptoms; later, when physiology returns to normal, this craving is elicited by memory of drug reward. Extinction, deconditioning, or forgetting may be involved in behavioral reduction of craving, and methods for producing selective forgetting for drug-induced pleasure are under study but this is labor-intensive research (42).

Attitudes against drug use can be molded by mass media presentations designed by experts in social psychology, publicity, and advertising; controlled trials should be designed to evaluate their impact. At present, there is heavy dependence on voluntarism from private industry; and, although the results may be good, without government funding there is no requirement for outcome studies. The antitobacco campaign, sponsored and financed by the government, is an example of a mix of both controlled and uncontrolled programs. Since cigarette smoking has clearly decreased coincidentally with the campaign (43), perhaps such a mixture is not a problem; however, some controlled studies of outcome are essential.

Alternative Strategies

The foregoing approaches to prevention and treatment with the aim of reducing demand are well established and not particularly controversial. The following, however, are four suggestions which may not be on the national agenda. The first is an experimentally controlled community study designed to compare interdiction versus prevention and treatment, so that our resources may be most effectively utilized. The others are more speculative and based on recent medical technological advances.

1) A demonstration pilot project could objectively compare the relative effects of funding predominantly for reducing supply (interdiction) versus reducing demand (prevention and treatment). The design of the project would be analogous to the design of experiments on life-style changes in smoking and diet induced in communities (44). One, but not the other, of two communities with similar drug abuse problems and allocations could receive a supplementary grant for prevention and treatment activities; say, three times as large as its interdiction funding. Compulsory treatment of traffickers and addicts would be an area of overlap, but there could be enough separation of clear cases of supply and demand to make a test possible. The outcome in terms of drug use, crime, fear, morbidity, and mortality could begin to provide some data-based guidelines for policy and for fund allocation on a large scale.

2) Extension of modern chemical detection techniques has important possibilities for curbing drug abuse by identification of users, although this is a debatable area in terms of Fourth Amendment infringement (45). Kaplan (35) has indicated that the major factor in reducing drug use would be judicious application of urine testing. Despite higher cost, however, saliva testing is preferable to urine testing because saliva can be collected under direct observation without embarrassment or pain (46). Sensitive drug detectors have been developed that are invaluable in controlling drug abuse (45); the inevitable development of instruments that will detect a few airborne drug molecules like a trained dog should make drug concealment difficult. If deployed properly, these instruments could drastically reduce abuse. Chemical detection by modern analytical methods could probably be used to distinguish drug users from abstainers, but the admissibility of such evidence might be subject to debate.

Drug detection could also be used to generate antidrug social pressure. With voluntary participation in testing, drug use could be stigmatized and abstinence rewarded. In drug-infested communities, antidrug organizations could be established as a type of neighborhood watch. To join, one would have to agree to random saliva tests. Participants would receive an award for each negative test and ultimately a certificate, perhaps a button, medal, or shield, and a token redeemable for some monetary reward. Participants who tested positive would receive free counseling and immunity from prosecution. Since participation would be voluntary, these organizations would not constitute an invasion of privacy, and ostracism by the community would be the prime weapon used to encourage abstinence in potential drug users. Mistakes or false positives could be a problem, but appropriate redundancy or duplication of tests could prevent such errors.

Voluntary drug testing could be combined with a competing incentive in communities with high levels of drug abuse. For example, a monthly lottery with substantial prizes or free state lottery tickets could be available to residents who agreed to undergo random drug tests at any time. The rationale for this approach is that drug users tend to be sensation- or novelty-seekers (28), and gambling is a high-risk behavior likely to attract them. Furthermore, for casual users (not addicts) the reward could approximate the tangible value of drug dealing (for example, an automobile) and

substitute for that, as well as for drug reinforcement. A poll would tell if such a program was acceptable.

3) It would be useful to make aversive consequences (or at least token punishment) for using illicit drugs more immediate in volunteer patients or probationers. One way to approach this would be with constant ambulatory surveillance. The least expensive method would be to make convicted drug abusers wear pagers. Following random paging, drug abusers would be required to call a live or computerized monitor to give assurance that they were not using drugs. Occasional random urine checks would have to be done.

On a speculative level, a more elaborate device is a telemetering physiological transmitter. Drug abusers could be sentenced to wear an electronic detector that would measure tachycardia and lowered skin temperature, or both. This transmitter would be an adaptation of the telemetered bracelet now used in law enforcement. It would alert the officer or therapist whenever the ex-addict succumbed to a stimulant. The constant monitoring should discourage drug use more effectively than intermittent urine testing could. Electronic monitoring could also be used as an adjunct to contingency contracting (47) on a voluntary basis by clients who had not been arrested.

The system would have to discriminate drug use from false positives induced by stress, sex, or other activities; research is necessary to characterize specific physiological response patterns to cocaine or other drugs. Individual reactivity to drug use might be similar to voice prints, which can now be recognized by computers.

4) The search for a methadone analog for treatment of cocaine abuse has been frustrating. Some substitution drugs are helpful in stopping use of a problem drug, and, although drug-free advocates may disagree, there is abundant evidence that a psychoactive drug-free state is not optimal for some individuals. Indeed, pharmacotherapy of most chronic psychiatric disorders is based on this premise. There is, however, a troublesome line between normalization of dysphoric mood and mood elevation to a dangerous level. Perhaps in some addicts the degree of anxiety and sadness appropriate for normal functioning is not tolerable. Benzodiazepines, like alcohol, have euphoriant properties and, although they are widely prescribed, they are often abused. A new class of nonaddicting antianxiety drugs, exemplified by buspirone, causes a more gradual improvement in mood over weeks. Perhaps it is dangerous to take any drug that makes one feel significantly better than normal within minutes; a long delay of positive reinforcement, however, might reduce abuse potential.

Is a truly safe euphoriant or positively reinforcing drug substitute for cocaine or amphetamines or opioids even a possibility? This drug would have to relieve both withdrawal symptoms and delayed craving, "turn itself off" when dangerous levels or frequencies were reached, and produce satiety. As our knowledge of reinforcement mechanisms in the brain increases (27), we may learn how to make such a compound. There are already three agonist drugs that approach this goal: buprenorphine (48), nicotine (49), and caffeine (50).

Buprenorphine is a mixed opioid agonist which in low doses stimulates opioid μ receptors but in high doses becomes a narcotic antagonist. It shows some promise in the treatment of both opioid and cocaine dependence (51). Nicotine has mild reinforcing effects at moderate doses (at levels of approximately 30 nanograms per milliliter of blood). It releases brain catecholamines, especially dopamine in the nucleus accumbens, but more moderately than cocaine does (52). At higher doses, it induces nausea and dizziness; therefore, cigarette smokers titrate their blood nicotine levels within narrow limits (53). Perhaps nicotine administered as a long-acting medication to cocaine users might reduce their craving. Caffeine has mild stimulant and euphoriant actions and it is relatively safe; it

successfully replaced cocaine in the most popular soft drink in the world. Caffeine essentially has a satiety mechanism that limits the ceiling of reward and keeps dosage low. There must be some limiting mechanism involving adenosine receptors in the reward centers of the brain that should be investigated. It would also be interesting to see whether a withdrawing cocaine abuser could obtain any benefit from caffeine, although a sensitive test of mood might be necessary to reveal a possibly subtle effect.

Pharmaceutical companies are loathe to develop rewarding drugs unless these drugs are to be used for life-threatening or painful conditions such as terminal cancer; companies will, however, search for the same type of substances under the names "mood elevator" and "performance enhancer." Nevertheless, a safe euphoriant or positive reinforcer that could be legally dispensed could conceivably displace the market for illicit drugs and possibly also for alcohol. Some such substance is envisioned by Huxley (54) and discussed in detail by Siegel (55).

Criminal Justice Accommodations

To relieve the burden on the criminal justice system, government must either (i) make the law enforceable (that is, provide adequate money for more prisons and courts—which seems unlikely with no new taxes) or (ii) lighten enforcement to correspond to fiscal reality. Greater discretion to judges in sentencing drug offenders could provide relief, and making the possession of small amounts of cocaine or heroin a misdemeanor under appropriate circumstances could result in a great savings in time, money, and jail space. By analogy, decriminalization of marijuana has already proven to be a tremendous cost saver in several states (56).

More intensive probation, as an intermediate punishment between parole and incarceration, is needed; it is cheaper than prison and could mandate provisions for rehabilitation. The key to intensive probation is continuous surveillance with frequent urine testing, which inhibits drug use, as shown in studies of Armed Services personnel (45).

Conclusions

If the present drug epidemic is to be contained, restrictions against cocaine should continue, with modifications to aid enforcement and to acknowledge financial constraints. Developments in chemical and electronic technology should help to reduce drug use, but appropriate privacy protections must be assured. A greater proportion of federal resources should be devoted to reduction of demand rather than interdiction of supply. Research to develop more effective methods of prevention and treatment is critical. Efforts should focus on stimulating social pressure and risk awareness, especially in the poor, uneducated, and psychiatrically ill. Reducing demand in these vulnerable groups should decrease the need for police and prisons and help to sustain the American ideals of democracy and freedom.

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Nuclear Decay Techniques in Ion Chemistry

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The spontaneous decay of chemically bound radioactive atoms affords a route to ions of well-defined structure and charge location, free of counterions. The nuclear nature of the ionization process makes it insensitive to environmental effects, so that exactly the same charged species can be generated, and its reactivity investigated, in

widely varying media, from low-pressure gases to liquids and solids. Techniques based on nuclear decay are used in studies of the production of otherwise inaccessible species, the structural characterization of free ions, and the comparative evaluation of their reactivity in different environments, in particular, gas phase and solution.

IN MOST TRACER APPLICATIONS OF RADIONUCLIDES, THE interest in the fate of a labeled molecule ceases immediately after the decay of the radioactive atom and the emission of a characteristic radiation that allows its detection and localization. In

this article, attention is focused instead precisely on what is left of the labeled molecule after the decay of a constituent radioactive atom. In most cases, irrespective of the nature of the precursor and of the specific decay mode, the newly formed species carry an electric charge and hence are commonly referred to as "daughter ions" or simply "decay ions." The interest in these unusual species, which frequently are unstable and extremely reactive, has steadily

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